



## Closure Report

Parcel A, Former Gorham Manufacturing Facility  
333 Adelaide Avenue, Providence, Rhode Island  
Project # 3651170068

Prepared for:

**Textron, Inc.**

40 Westminster Street, Providence, Rhode Island

21-Aug-18

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### Prepared for:

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## 1.0 INTRODUCTION

On behalf of Textron, Inc. (Textron), Wood Environment & Infrastructure Solutions, Inc. (Wood), formerly Amec Foster Wheeler Environment & Infrastructure, Inc., has prepared this Remedial Action Closure Report for Parcel A of the Former Gorham Manufacturing Facility located at 333 Adelaide Avenue, Providence, Rhode Island (the Site) (**Figure 1**).

The Remedial Action Closure Report (RACR) summarizes the salient aspects of Parcel A's historic remediation and current regulatory status, and documents the Parcel's closure process as required by the Rhode Island Department of Environmental Management (RIDEM) Remediation Regulations. Information regarding the remediation and closure of Parcel A has been obtained from previously submitted documents that have been accepted and/or approved by RIDEM as cited within this report. It is not the intent of this closure report to recapture the full details of these previously submitted reports, but rather to reaffirm the main and relevant events in the remediation and closure process, and to certify that Parcel A has been properly remediated and closed in accordance with approved Remedial Action Work Plans (RAWPs) and/or Short-Term Response Actions under the RIDEM Remediation Regulations. Both a groundwater treatment system and an active sub-slab depressurization system are currently operating in and around the existing retail building on Parcel A. With the submittal of this RACR, Textron is requesting an **Interim Letter of Compliance** from RIDEM documenting the satisfactory completion of the remedy and interim closure of Parcel A.

### 1.1 Property and Site History

The Former Gorham Manufacturing Facility is located at 333 Adelaide Avenue, Providence, Rhode Island encompassing 37 acres (**Figures 1 and 2**). Parcel A, which is the subject of this RACR, is approximately 12.1 acres and one of the four parcels (A, B, C, and D [currently referred to as Parcel C-1]) that comprise the Former Gorham Manufacturing Facility property. More recent Parcel A conditions are shown in the aerial photograph in **Figure 2**. In this figure, Parcel A is located immediately north of Adelaide Avenue and directly west of the Amtrak railroad tracks.

The Gorham Silver manufacturing facility engaged in the manufacture of silverware (sterling and plated) and bronze castings from approximately 1890 to 1985. Operations included casting, rolling, polishing, lacquering, forging, plating, annealing, soldering, degreasing, machining, and melting. Vapor degreasers reportedly used trichloroethene (TCE), tetrachloroethene (PCE), and 1,1,1-trichloroethane (1,1,1-TCA). Historically, structures located upon and activities conducted within structures on Parcel A included vapor degreasers and spray booths.

In 1967, the Gorham Manufacturing business and property were purchased by Textron and operated as a division of Textron until 1985. In 1986 Textron sold the facility to the Winoker Group. The Winoker Group subsequently sold the facility to another group of investors, the Adelaide Development Corporation, which in turn sold the facility to the Seaman Equity Group. In 1990, Seaman defaulted on its taxes and the City of Providence foreclosed. The City of Providence currently owns the property at 333 Adelaide Avenue including the Site. The City, via the Providence Redevelopment Agency (PRA), divided the property into the four parcels (A, B, C, and D [now Parcel C-1]) for development purposes.

Through a 1994 agreement with the City of Providence, Textron, Inc. retained the responsibility to investigate and remediate Parcel A to support the commercial reuse of the property (industrial/commercial direct exposure criteria [I/C DEC]) for Site soils and GB Groundwater Criteria for Site groundwater. In 2001, the City of Providence entered into a 20-year lease agreement with Churchill & Banks (C&B), to develop Parcel A as a 70,000-square foot retail facility, and associated parking lot and public vehicle fueling station.

The former Gorham manufacturing facility was razed in 2001 and the retail complex was constructed in 2002, which included a large retail space, several smaller retail spaces, and a public gasoline fueling station. The Stop & Shop Supermarket Company (Stop & Shop), a tenant of the large retail space, opened for business in 2002. The Stop & Shop retail store ceased business and vacated the retail complex in October 2006. The former Stop & Shop gasoline station was closed in 2006 and the underground storage tank (UST) was removed in 2007. The three remaining retail stores eventually closed leaving the retail building vacant until Stop & Shop sublet the eastern half of the large retail space to a fitness center (currently called “Blast”) in 2013. The western half of the former Stop & Shop space is still unoccupied.

All three small retail store operations ceased by 2009. A church then moved into the western-most retail space in 2010. Intermittently, the eastern-most small retail space was leased out several times on a monthly basis for several campaign offices until June 2016, when another church moved into the eastern-most small retail space and a consignment shop occupied the center small retail space. In 2018, the consignment shop took over the eastern-most small retail space and used it for storage. The City remains the owner of Parcel A. The property is currently managed by Paolino Properties, who purchased the property management contract for Parcel A from the previous property management firm Kimco in 2013.

## 1.2 Physical Setting

Parcel A is developed as a 70,000-square foot retail facility including loading docks, parking areas for approximately 600 vehicles, and ancillary/access roads. A storm water detention basin that collects storm water from the retail building roof drains and parking area, and adjacent high school (Parcel B) is located on the northern edge of Parcel A. An access driveway to an active Amtrak High Speed railroad electrical substation is located on the northeastern corner of the parcel. A fueling station comprised of one, 20,000-gallon two-compartment (12,000-gallon regular/8,000-gallon premium) underground gasoline storage tank (UST) and dispensing pumps were temporarily closed in April 2007 by Stop & Shop (RIDEM, 2006b). The temporary closure included removal of tank contents, locking and securing the fill cap and fill lines, maintaining the interstitial tank monitoring system to monitor for a release, removing the fuel dispensers, and maintaining all tank records. The tank and supporting equipment were removed in August 2007 (Shaw, 2007a).

Parcel A is bordered to the east by the active Amtrak High Speed railroad tracks and associated right-of-way. To the west of Parcel A is the public high school (Dr. Jorge Alvarez High School) which was constructed on Parcel B in 2007. Further west and north of Parcel A are Parcels C and C-1 (formerly Parcel D) and Mashapaug Pond. Parcels C and C-1 were remediated and capped in 2012 and 2015 in accordance with the final Remedial Action Work Plans (RAWPs) (AMEC, 2012, 2015) and RIDEM’s August 10, 2012 Remedial Approval Letter and July 9, 2015 Order of Approval. Parcel C and C-1 remediation was completed and a Closure Report submitted to RIDEM in May 2017. Popeye’s restaurant is located south of Parcel A along Reservoir Avenue (Parcel D), along with a residential neighborhood on both Downing Street and Adelaide Avenue.

Parcel A is largely flat, measuring an elevation of approximately 65 feet above mean sea level (MSL). Previous investigations indicate that the subsurface conditions of Parcel A are characterized as sand, with areas of sand and gravel to the depth of the water table which was measured at approximately 25 feet below ground surface [bgs]. Beneath the water table, conditions were characterized as a mixture of sand, silty sand, and sandy silt to a depth of between 45 and over 60 feet bgs. Previous investigations also indicate that a dense till material consisting of silt, sand and little clay and fine gravel (also referred to as a confining silt layer) was present at approximately 45 to 60 feet bgs. The bedrock surface is estimated to be approximately 200 feet bgs (MACTEC, 2006a).

Groundwater beneath the entire Gorham property is classified by RIDEM as Class GB, which is not suitable for public or private drinking water use without treatment. According to previous investigations, groundwater beneath Parcel A is not used as a source of drinking water, and the nearest public water supply (Scituate Reservoir) is located approximately 9 miles to the west of the Gorham property (MACTEC, 2006a). Previous investigations found that public or private wells do not exist within a 4-mile radius of the Gorham property (ABB, 1995a).

Most of the groundwater below Parcel A flows either east, or north towards Mashapaug Pond. A groundwater divide runs approximately parallel with the Gorham eastern property boundary and along Adelaide Avenue to the south. East of the divide, groundwater flows east towards the railroad tracks and Narragansett Bay further to the east. Groundwater flow on the east and southeastern areas of the Gorham property is further divided in the southeastern portion of Parcel A. In this area, groundwater flows downward (sinks) towards a leaking 80-inch Narragansett Bay Commission (NBC) sewer main located adjacent to the railroad tracks east of the Site (HLA, 1999a).

### 1.3 Regulatory Background and Previous Investigations

Environmental investigations of the Former Gorham Manufacturing property including Parcel A have been performed since 1986. To reduce confusion, we have provided a list of company names that developed the historical reports or work plans for this Site and are cited within this closure report. This list of company names have all been incorporated under Wood Environment & Infrastructure Solutions, Inc. (Wood) or APTIM Environment & Infrastructure, Inc. (APTIM) as listed below. Please note that when citing a report/document, we use the appropriate company name as listed on the document/report at the time it was published/submitted.

#### Wood

- ) ABB Environmental Services, Inc. (ABB-ES)
- ) Harding Lawson Associates (HLA)
- ) Harding ESE
- ) MACTEC Engineering and Consulting, Inc. (MACTEC)
- ) AMEC Environment & Infrastructure, Inc. (AMEC)
- ) Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler)

#### APTIM Environment & Infrastructure, Inc.

- ) IT
- ) Shaw Environmental, Inc.
- ) CB&I

In addition, when this report discusses activities conducted by Wood or APTIM or their predecessors listed above (i.e., submittal of work plans, reports, response to comments, or conducting investigation activities), it is inferred that Wood or APTIM, respectively, submitted the document or conducted the activities on behalf of Textron. AECOM has also conducted work on Parcel A.

Beginning in the late 1980s, several USTs were removed and environmental investigations were initiated on Parcel A by Wood and APTIM, and their predecessors on behalf of Textron. The following is a bulleted summary of some of the key events and investigations that have occurred within Parcel A. Investigations that were conducted to date that include other areas of the Site (Parcels C and C-1) are not included

unless those investigations included work on Parcel A. Source areas identified during these investigations are described in Section 1.4, and the remedial programs/activities conducted in response to these identified source areas are described in Section 2.0.

**1995.** Remedial Investigation Report (ABB-ES, 1995a) and a Supplemental Remedial Investigation Report (ABB-ES, 1995b) were prepared to assess Property conditions, including Parcel A.

**1996.** A Remedial Action Work Plan (RAWP) was prepared in 1996 by ABB-ES and submitted to conduct additional groundwater and soil investigations to further characterize the extent of groundwater contamination on Parcel A. Results of these investigations were documented in ABB-ES' 1996 Limited Design Investigation Report (ABB-ES, 1996) and were used to formulate a risk assessment and establish Remedial Action objectives.

**1997.** Demolition of the former Gorham Manufacturing Facility structures began. Wood conducted a RIDEM-approved (RIDEM, 1997) Short-Term Response Action in accordance with the Notice of Intent to Perform a Short-Term Response Action (ABB-ES, 1997a) to excavate and remove soil impacted by polychlorinated biphenyls (PCBs) (Section 1.4.1) to eliminate exposure issues for site workers during the demolition of the remaining buildings on Parcel A. The Response Action was summarized in a Short-Term Response Action Report (ABB-ES, 2007b).

**1999.** A Site Investigation Summary Report and Risk Assessment (HLA, 1999b) was prepared and submitted to RIDEM that addressed the entire 333 Adelaide Avenue property, including Parcel A, with a follow-up Response to RIDEM Comments submittal in 2000. This report included a Method 1 risk assessment and identified remedial alternatives for the entire Gorham property, and was formally approved by RIDEM in a June 15, 2001 RIDEM Remedial Decision Letter.

**April 2001.** Wood submitted a RAWP (Harding ESE, 2001) for the Property outlining the selected remedial alternatives. This RAWP proposed to construct a pavement/retail building and landscaped area cap on Parcel A and stabilize light non-aqueous phase liquid (LNAPL) fuel oil found between the now existing western end of the current retail building and the high school. RIDEM provided comments on the 2001 RAWP (RIDEM, 2001a & 2001b) and Wood addressed RIDEM comments in two letter submittals (Harding ESE, 2001a and 2001b). The RAWP was formally approved by RIDEM in an October 11, 2001 Order of Approval (RIDEM, 2001c). Investigation/remediation activities detailed in this work plan were conducted by Wood in 2001 and 2002.

Following the completion of the LNAPL remediation in January 2002, Textron provided the approved 2001 RAWP to the City and its developer C&B. On behalf of the City, C&B implemented the approved soil cap remedy on Parcel A as part of Site development work including the construction of the retail building, and construction and paving of the parking lot and associated access roads. A description of the final cap is provided in Section 2.1.2.

**November 2001.** IT submitted revisions to the approved 2001 RAWP (IT, 2002a, 2002b and 2002c) for in-situ injection of permanganate to treat the volatile organic compounds (VOCs) in groundwater at the former Building W location. RIDEM then issued a revised Order of Approval in 2002 (RIDEM, 2002a). This approval replaced the October 11, 2001 Order of Approval RIDEM issued for the 2001 RAWP (RIDEM, 2001c). IT completed the initial injection for the Building W groundwater plume by April 2002 as described in Section 2.2, and based on the results of baseline, interim, and post-injection groundwater data concluded that an additional injection was required.

**May 2003.** Shaw submitted a revised RAWP (Shaw, 2004a) for an additional injection of permanganate (in-situ). RIDEM approved the revised RAWP on July 27, 2004 (RIDEM, 2004). IT completed the second round of permanganate injections by October 4, 2004.

**November 2005.** Shaw submitted a RAWP addendum (Shaw, 2005a) to propose modifying the groundwater remedial approach and to conduct a limited site investigation to evaluate the chemical rebound. RIDEM conditionally approved the RAWP addendum on January 6, 2006 (RIDEM, 2006a).

**2006.** Shaw collected representative soil and groundwater samples in December 2006 and then conducted a treatability study to evaluate enhanced bioremediation of PCE source area soils. These results were presented in the March 27, 2007 Status Report (Shaw, 2007b)

**April 2007.** Wood prepared and submitted a soil vapor investigation work plan (MACTEC, 2007a) to measure concentrations of VOCs in sub-slab soil gas beneath and along the perimeter of the retail building. The results of these soil vapor investigations and the proposed indoor air investigations were presented to RIDEM in the August 22, 2007 letter report (MACTEC, 2007b).

**November 2007.** The August 2007 letter report included a work plan for follow-up indoor air investigations of the retail complex spaces. Wood conducted the follow-up soil vapor groundwater investigations in November 2007 to characterize the potential presence of VOCs in the indoor air of the Stop & Shop and three other retail stores. The November 5, 2007 letter report (MACTEC, 2007c) presented the results of this indoor air investigation. A source investigation was then proposed to determine the vertical and horizontal extent of the VOCs within the soil gas.

**March - June 2008.** Wood submitted work plans for additional soil vapor and groundwater investigations to confirm that soil vapor conditions along Adelaide Avenue were not a concern to the adjacent residential properties and to further assess the nature and extent of groundwater beneath and in the immediate vicinity of the retail complex (MACTEC, 2008a and b). Wood completed these investigations in April 2008. Additional investigations were proposed in April 2008, including indoor air sampling of the residential properties on Adelaide Avenue (MACTEC, 2008c).

**July 2008.** Wood designed an active soil depressurization (ASD) system for the Parcel A retail complex and submitted a Short Term Response Action work plan (MACTEC, 2008d and 2008f) to install the system. RIDEM approved the system design (RIDEM, 2008a, 2008b) and required a long-term soil vapor and air monitoring compliance program. Wood installed the ASD system in 2008 and the long-term vapor and air monitoring compliance program began in February 2009 as documented in the Short-Term Response Action Closure Report (MACTEC, 2009c). As required, quarterly indoor air monitoring reports were prepared by Wood and submitted to RIDEM for posting on the Project website.

**October 2009.** Groundwater investigations were proposed in multiple work plans in 2008 and 2009 to further define the nature and extent of the groundwater contamination originating on Parcel A. The investigation results were submitted to RIDEM in May 2008 and April 2010 (MACTEC, 2008e and 2010a).

**April 2011.** AECOM submitted a work plan (AECOM, 2011) to investigate the use of a groundwater remediation system for chlorinated VOCs in Parcel A groundwater. RIDEM approved the work plan. AECOM then completed pump tests on the north side of the retail building to support the design of the short term measure groundwater treatment system. A Remediation General Permit was issued by RIDEM on July 22, 2011 for the discharge of treated water into the detention basin immediately north of the retail building.

**October 2012.** AECOM submitted a RAWP (AECOM, 2012a) to RIDEM documenting the design, and proposed installation and operation of the groundwater extraction and treatment system (GWETS) for Parcel A. RIDEM approved AECOM's design (RIDEM, 2012a Remedial Decision Letter), and based on the requirements described in the RIDEM Order of Approval (RIDEM, 2012b) the GWETS was constructed on Parcel A by May 2013 (AECOM, 2016). System monitoring reports were and continue to be prepared by AECOM and submitted to RIDEM on a regular schedule.

**June 2015.** The City of Providence signed the Environmental Land Usage Restriction (ELUR) and filed both the ELUR and Soil Management Plan (SMP), previously approved by RIDEM, in the Providence Land Evidence Records (**Appendix A**).

**March 2016.** AECOM submitted a Remedial System Installation Report to document the 2012 installation and 2013 startup of the groundwater recovery and treatment system on Parcel A (AECOM, 2016).

## 1.4 Source Areas and Response Actions

The source areas encountered during Parcel A investigations as discussed above and the response actions conducted for each of the areas and impacted media are summarized below.

### 1.4.1 Soil

During the 1994 RI, Wood encountered PCBs exceeding the RIDEM Method 1 soil criterion (10 mg/kg) in soil collected from the crawl space below former Building F and adjacent to a concrete support column of that building (**Appendix B-1**, Figure 1-2). To eliminate the potential for site worker exposures during planned building demolition activities, in June 1997, Wood implemented a RIDEM-approved Short Term Response Action (ABB-ES, 1997b) to remove visibly stained soils surrounding two Building F support columns and other visibly stained surface soil surrounding the concrete support column.

On May 1, 1997 the City of Providence issued a Building Demolition and Underground Storage Tank Removal contract and bid specification document. This document outlined the specifications to demolish the Gorham buildings (**Appendix B-1**, Figure 1-2) and to remove two No. 6 fuel oil USTs (two 30,000-gallon fuel oil tanks). Wood, on behalf of Textron, provided oversight of building demolition activities to document the subsurface soil and groundwater conditions. During the demolition process, four building materials were observed including an asphalt based material, oily sands, excavated demolition debris, and materials from a pit that all required characterization for reuse or disposal.

In November 1998, the City of Providence submitted a Permanent Closure Application for Underground Storage Tank Removal for two 19,000-gallon No. 6 fuel oil tanks located on Parcel A. RIDEM approved the closure (RIDEM, 1998) on November 24, 1998 and Wood observed the tank removal activities in November 1998 (HLA, 1999a).

Extensive Site investigation and remediation activities determined that soil within Parcel A contained concentrations of total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAHs) and metals (arsenic, copper, and lead) that exceeded either residential or I/C DEC and required remediation. Separate phase product (light non-aqueous phase liquid [LNAPL]) was detected in two former site groundwater monitoring wells (MW-H and MW-I) at a maximum measured thickness of 1 foot. This LNAPL was related to the fuel oil USTs removed by the City, as described above. In all, five areas (Areas 1 through 5) of upper concentration limit (UCL) exceedances (including NAPL) were identified for remediation. The approximate extent of remediation is depicted on Figure 2 of the *Monthly Progress Report for December 2001* (Harding ESE, 2002b) (**Appendix B-2**, Figures 1 and 3). As shown, Areas 1 and 2 had TPH/PAH UCL exceedances which were attributed to the two former 19,000-gallon No. 6 fuel oil USTs, a concrete vault formerly used for No. 6 fuel oil, and three former 8,000-gallon No. 4 fuel oil USTs. Areas 3 and 5 had copper UCL exceedances and Area 4 had lead UCL exceedances, which were attributed to the fill material present within those areas.

The 2001 RAWP addressed these five areas (Areas 1 through 5) (Harding ESE, 2001a) as follows:

- J Excavate, asphalt batch, and/or stabilize soil for onsite reuse for soil impacts exceeding the UCL for TPH of 30,000 parts per million (ppm) and metals (arsenic, copper, and lead) that exceed site-specific background concentrations) or impacted with NAPL;

- J Stabilize LNAPL fuel oil located between the now existing western end of the retail building and the high school;
- J Isolate soil impacts exceeding RIDEM DEC by capping Parcel A using an 18-inch cover consisting of either a 12-inch sand drainage layer and 6-inch soil cover with an underlying geofabric barrier (residential exposure) or pavement (parking areas), building structures, or landscaped areas (commercial exposure). Incorporate the capping of Parcel A with the redevelopment conducted by C&B; and
- J Implement an ELUR and SMP for Parcel A to prevent sensitive uses/activities of the parcel, limit potential exposures related to outdoor recreational and future maintenance activities conducted on Parcel A, and to preserve the Parcel A cap.

### 1.4.2 Groundwater

Extensive groundwater investigations were conducted throughout Parcel A which identified chlorinated VOCs in groundwater. Based on this data, identifiable chlorinated VOC groundwater plumes exist beneath Parcel A and extend towards the Mashapaug Inner Cove:

- J Parcel A - PCE plume originates from the former Building W area (coincides with the location of the former Stop & Shop gasoline station), and
- J Parcel A - 1, 1, 1-TCA and TCE plume originates immediately south of the retail building.

**Figure 3** shows the approximate historic extent of the Parcel A plumes. The April 2001 RAWP (Harding ESE, 2001a) outlined the selected groundwater remedial alternative for the Building W groundwater plume as:

- J Treat Parcel A groundwater via in-situ chemical oxidation (ISCO) by injecting potassium permanganate, and implementing a long-term groundwater monitoring program to confirm successful remediation; and
- J Implement an ELUR and SMP for Parcel A. The ELUR was signed by the City of Providence June 4, 2015 and both the ELUR and SMP were filed with the Providence Land Evidence Records (**Appendix A**).

Note the ISCO injection was later modified to be sodium permanganate as part of the construction.

As discussed above, the groundwater contamination originating immediately south of the retail building was not identified until 2008. Between 2008 and 2011 Wood and AECOM conducted additional groundwater investigations and pumping tests (AECOM, 2011). The groundwater treatment system design and permitted discharge of the treated water was then completed and constructed in April 2013. The groundwater treatment system includes:

- J Three groundwater extraction wells were installed in the former Building W area, south of the retail building and north of the retail building. The groundwater is treated by a shallow-tray air stripper, activated carbon and polished by a resin.
- J Treated groundwater is discharged into a nearby storm water catch basin which then flows into the retention basin located immediately north of the retail building. This discharge is conducted in accordance with the July 2011 Remediation General Permit (RIG85E003).

### 1.4.3 Soil Vapor

Wood conducted a soil vapor investigation in August 2007 in accordance with an approved Soil Vapor Investigation Work Plan (MACTEC, 2007a). Wood confirmed the presence of VOCs in the sub-slab soil vapor above then-current Connecticut Department of Environmental Protection Proposed Industrial / Commercial Soil Vapor Volatilization Criteria (CT DEP PI/CSVVC) (in the absence of analogous RI criteria). Wood then collected indoor air samples from within the retail complex spaces to determine if a soil vapor intrusion pathway existed to indoor air. These indoor air sampling results confirmed the need for vapor mitigation (MACTEC, 2007b).

In addition, Wood conducted sub-slab soil vapor sampling and indoor air sampling at four residential buildings along Adelaide Avenue following the RIDEM-approved work plan (MACTEC, 2008b) to evaluate the potential for vapor intrusion at those residences. The results did not show any exceedances of applicable standards, but Textron opted to install individual sub-slab mitigation systems within these four residences as a proactive measure.

- J An ASD was designed and approved by RIDEM as a Short Term Response Action for the retail space to include five vapor extraction well points within the former Stop & Shop for collection and treatment by granular activated carbon (GAC). One of these extraction wells was installed along the western wall of the former Stop & Shop to address the soil vapor beneath the eastern most small retail space. This extraction well was connected to a radon fan blower which discharged at the roof line. One extraction well point was also installed in each of the central and western small retail spaces and connected to radon fan blowers for discharge above the roof line. A long-term monitoring program was implemented beginning in 2009 to assess the system operation and indoor air quality. GAC changeouts have been conducted approximately every 3-4 years, based on monitoring of the GAC influent and effluent.
- J A single vapor extraction well point and radon blower were installed in the basements of four residences along Adelaide Avenue with discharge above the roof line. Wood confirms the continued operation of these systems as part of the ASD system inspection and sampling program described above.

## 2.0 REMEDIAL ACTIONS

The April 2001 RAWP (Harding ESE, 2001a) stipulated remediation of the petroleum and metals contaminated soils on Parcels A, B and C as described in subsequent sections below. Remediation of the Parcel A groundwater plumes is described in Section 2.2, and vapor mitigation is addressed in Section 2.3.

### 2.1 Soil Remediation

#### 2.1.1 2001-2002 UCL Soil Remediation

United Retek Corporation (URC) began excavation and treatment of soils exceeding RIDEM UCLs (including LNAPL) in the five areas in December 2001 and completed the soil remediation activities on February 6, 2002 (Harding ESE, 2002a, 2002c [December 2001 and March 2002 Monthly Progress Reports]) (**Appendix B-2, Figures 1 and 3**).

In December 2001 contaminated soil in Areas 3, 4, and 5 were excavated, treated and returned to the excavation as backfill material. These soils had metals UCL exceedances: copper in Areas 3 and 5, and lead in Area 4. The excavated soils were treated using cement to stabilize the copper and lead and then returned to their respective excavation locations. Confirmatory soil samples were collected to confirm no UCL exceedances remained in the excavations. Samples of treated soils were also submitted for laboratory analysis to confirm treatment effectiveness.

At Area 1, TPH/PAH UCL exceedances (including LNAPL) started at a depth of 10 feet bgs and extended to the water table. At Area 2, the TPH/PAH UCL extended to a depth of 15 feet bgs. Clean overburden soils in Areas 1 and 2 were removed and stockpiled on the site as future backfill material. The impacted overburden soils were then excavated to a depth close to the water table (approximately 20 feet below ground surface) and test pits were dug around the perimeter to confirm the LNAPL extent. These impacted soils were excavated, treated with asphalt batch mix and stockpiled to be used as backfill material during site development. Some impacted soil within Area 1 was removed from below the water table for treatment and reuse on the site. These soils with TPH/PAH UCL exceedances were asphalt batched and stockpiled on the site.

Some LNAPL was vacuumed up from the water table surface during the soil excavation and backfill operations. This LNAPL and water mix was disposed of at an off-site, permitted facility by Clean Harbors, Inc. Following the confirmatory soil sampling, the clean overburden soils were placed and compacted within the excavated areas to extend several feet above the water table. Then the treated soils were placed and compacted just below the ground surface to provide structural support to the proposed building foundations and parking surfaces.

Photographs of the soil excavation and remediation are included in **Appendix B-2**.

During excavations in Areas 1 and 2, a pipe chase connecting a large subsurface concrete box/vault was discovered, demolished, and the petroleum-impacted soils were excavated and treated for reuse. Confirmatory test pits showed no evidence of petroleum in the soils within the concrete box/vault area or the concrete box/vault floor located approximately 12 feet below grade.

Over the course of the remediation, approximately 82 tons of metals-contaminated soil was stabilized with cement and approximately 18,580 tons of TPH/PAH-contaminated soil was treated by asphalt batching. The clean overburden soil was placed in the excavation areas to an average depth of 13 feet bgs. The treated soil was then returned to the excavation areas and compacted leaving a level surface to cover with the building foundation and parking lots.

## 2.1.2 2002 Retail Building and Cap Construction

Textron provided the approved 2001 RAWP (Harding ESE, 2001a) to the City and its developer (C&B). On behalf of the City, C&B implemented the approved soil cap remedy on Parcel A as part of site development work in 2001 including the construction of the former Stop & Shop building, smaller retail stores, and construction and paving of the parking lot and associated access roads. The City and C&B did not provide as-built documents or descriptions of the soils used in constructing the cap.

In order to document the construction of the approved cap, Wood reviewed the logs for soil borings, monitoring wells, soil vapor extraction wells and groundwater extraction wells completed between 2002 and 2013. Logs documenting the construction of the approved cap include the soil borings installed beneath the retail building, groundwater extraction wells supporting the operating groundwater treatment system and the piping trench connecting the extraction wells to the treatment system (AMEC, 2014). Copies of the logs that describe the lithology of soils and photographs that show the condition of soils present beneath the former Stop & Shop building and surrounding parking areas are provided in **Appendix C**. Figure 1 in Appendix C provides a reference to the photograph locations. As shown, these logs and photographs confirm the minimum thickness of 12-inches of cover over the soil (soil and/or pavement) over Parcel A. Figure 1 in **Appendix C** also presents the location for each of the soil borings, groundwater extraction wells, and utility trenches that were completed on Parcel A subsequent to the installation of the cap and construction of the Stop & Shop building construction. Together these data sources document that the Parcel A cap was constructed in accordance with the 2001 RAWP.

Compliance inspections are to be conducted by the City of Providence to confirm that the Parcel A cap remains intact as described in Section 3.1.

## 2.2 Groundwater Remediation

### 2.2.1 2001-2005 Former Building W Permanganate / ISCO Treatment

The Parcel A Building W groundwater plume was treated using ISCO to lower the contaminant concentration. IT (APTIM) completed soil oxidant demand (SOD) studies in October 2001 to support the injection program, and completed monitoring well and injection well installation and sampling by February 2002. The first of two injections was conducted in March and April 2002. APTIM injected 10,000 gallons of a 20% sodium permanganate solution into the PCE source area (**Appendix B-3**). Following the completion of the first injection and monitoring results, RIDEM requested that Textron install three additional groundwater monitoring compliance well clusters (shallow and deep wells) at the same screened intervals as MW-101S and MW-101D. RIDEM requested two well clusters along the Parcel B boundary (Dr. Jorge Alvarez High School) on the western edge of the Stop & Shop boundary (MW-216 and MW-217), and one well cluster (MW-218) along Adelaide Avenue boundary of the property south of MW-101S and MW-101D. The locations of these additional well clusters are shown in **Appendix B-3**. These wells were developed and sampled, and are included in the quarterly compliance sampling events.

Based on the results of baseline, interim, and post-injection groundwater data as described in monthly status reports, APTIM concluded that the site-specific treatment goal of 7,700 ug/L PCE was achieved in several groundwater monitoring wells in the treatment area, but could not be achieved in all wells with only one injection (Shaw, 2004a). APTIM indicated that a reduced area around MW-101S, MW-101D, MW-202S, MW-202D, and MW-205 (**Appendix B-3**) in the southeast portion of the 2002 treatment area required an additional injection to reduce the concentrations of chlorinated VOCs. APTIM completed additional sampling events in January through April 2003 and again in March and April 2004. These data are summarized in the June 2004 Monthly Status Report (Shaw, 2004b) and show that the source area remained centered around monitoring wells MW-101S and MW-101D (**Appendix B-3**).

APTIM proposed a second injection of permanganate for a reduced area of the former Building W groundwater plume in the June 2004 revised RAWP (Shaw, 2004a). Shaw's design was based on additional laboratory SOD, total organic carbon (TOC), fractional organic carbon (FOC), and VOC analysis of soil collected from southeast of the initial treatment area. RIDEM approved the revised RAWP on July 27, 2004 (RIDEM, 2004). APTIM initiated the second round of ISCO in September 2004 and by October 4, 2004, injected approximately 24,400 pounds of sodium permanganate into the expanded treatment area covering approximately 13,000 square feet (**Appendix B-3**). After the 3<sup>rd</sup> quarterly round of groundwater sampling following this second injection, data showed that rebound in concentrations of chlorinated VOCs had occurred within the treatment area (Shaw, August 2005b). APTIM suggested that a modification of the remedial approach was necessary, and continued the quarterly and semi-annual groundwater monitoring.

APTIM submitted a Remedial Action Work Plan Addendum in November 2005 (Shaw, 2005a) to conduct additional soil and groundwater investigations of the source area. Based on these results and further quarterly monitoring results, APTIM proposed to conduct a treatability bench-scale test on the Parcel A groundwater to assess the potential for enhanced biodegradation of the remaining VOCs in the groundwater (Shaw, 2006b). APTIM continued to conduct the quarterly groundwater monitoring program under the existing Order of Approval pending their results of the bench-scale tests. APTIM's March 27, 2007 status report (Shaw, 2007b) confirmed that the potential use of enhanced bioremediation was not fully successful in the reduction of PCE in the source area. Shaw (now APTIM) has continued to conduct the groundwater compliance monitoring program specified in the RIDEM Order of Approval.

Because the second round of ISCO did not address the remaining chlorinated VOCs and the potential off-site migration of impacted groundwater, Textron contracted AECOM (ENSR, a subsidiary to AECOM) to further investigate the source area at the former Building W. These investigations were conducted between October and December 2007. Concurrent with this source area investigation, Wood was completing their assessment of the groundwater and soil vapor around and beneath the retail building and indoor air within the retail building discussed below. These investigations confirmed that 1,1,1-TCA and TCE had been released to the soil and groundwater immediately south of the retail building during the former mill operations.

These investigations concluded that the northern plume (also known as the Parcel A 1,1,1-TCA and TCE plume) originates in the vicinity of the retail building, flows beneath the retail building and discharges to Mashapaug Inner Cove. The 1,1,1-TCA impacted groundwater is mostly present in the shallow aquifer (30-40 feet bgs) and TCE impacts extend to approximately 60 feet bgs. The southern plume (also known as the Parcel A PCE plume) originates east of the former Stop & Shop gasoline filling station, and bifurcates along the groundwater divide with a portion flowing north to Mashapaug Inner Cove and a portion flowing northeast toward the 80-inch NBC sewer main that runs parallel to the eastern property boundary. PCE is the primary chlorinated VOC present within the southern plume, which extends to depths of over 60 feet to the top of till. AECOM also reported the presence of dense non-aqueous phase liquid (DNAPL) in soil borings installed in the source area of the southern plume.

Textron contracted with AECOM to design a groundwater remediation system to address both Parcel A chlorinated VOC groundwater plumes. The objective of the treatment system was to reduce the concentrations of chlorinated VOCs in groundwater and provide hydraulic containment of the contaminants from discharging into the Mashapaug Inner Cove. AECOM conducted a groundwater study and pilot test which included the installation of recovery well RW-1 located on the northern side of the retail building. AECOM completed the design and permitting of the groundwater treatment system, as described above.

RIDEM issued a Remedial Decision Letter on October 17, 2012 (RIDEM, 2012a) approving the groundwater investigations and directing Textron to prepare a RAWP. AECOM submitted a RAWP to RIDEM documenting the design and proposed installation and operation of the GWETS (AECOM, 2012a). RIDEM approved AECOM's GWETS design (RIDEM, 2012c Order of Approval).

## 2.2.2 2013 Groundwater Extraction and Treatment

Based on the requirements described in the RIDEM December 17, 2012 Order of Approval, AECOM constructed the GWETS on Parcel A in April 2013. AECOM installed two additional recovery wells (RW-2 and RW-3). RW-2 was installed in the vicinity of the northern plume to a depth of approximately 55 feet bgs and RW-3 was installed in the southern plume to a depth of approximately 66.5 feet bgs. All three extraction wells have screen lengths of 20 feet. A utility trench approximately 950 feet long by 4 feet deep was installed to connect the new and existing extraction wells to the GWETS. A National Environmental Systems, Inc. (NES) pre-manufactured 30-foot long cargo container groundwater treatment system was placed behind the retail building in the vicinity of RW-1 (**Appendix D-1**). This ready-to-operate system was pre-wired, piped, and pre-tested and included analog and digital instruments and control loops. The system's control logic includes a programmable logic control (PLC) and remote monitoring, control, data acquisition, and alarm notification via a standard telephone connection. Quarterly groundwater sampling, analysis, and reporting has been conducted consistent with the RIDEM December 2012 Order of Approval.

Extracted groundwater is pumped by Grundfos® electrical submersible pumps (contained within each recovery well) at a combined rate of approximately 16 gallons per minute (4 gallons per minute for wells RW-1 and RW-2 and 8 gallons per minute for well RW-3). The higher pumping rate of RW-3 was specified to obtain containment of the southern plume across both sides of the groundwater divide and to maximize mass recovery from the area of the highest concentrations of chlorinated VOCs (AECOM, 2016). AECOM's Figure 2 in **Appendix D-1** shows the treatment system design capture zone which is providing hydraulic containment of the plumes and eliminates their discharge into the Inner Cove.

Pumped groundwater is directed to the treatment system by way of 2-inch piping and treated by a shallow-tray air stripper. Treated water is then polished with GAC and ion exchange resin before being discharged into the catch basin located north of the retail building. From there, treated water flows into the storm water detention basin located directly north of the retail building (**Appendix D-1, Figure 1**) for infiltration into the ground. An air treatment vessel removes VOCs from the air flowing out of the air stripper before the air is discharged to the atmosphere. A mechanical flow meter measures the amount of treated groundwater that is discharged under the RIPDES Permit #RIG85E004 (RIDEM, 2012d) to the catch basin on the northern side of Parcel A. The Completion Report and as-built drawings for the groundwater treatment system are included in **Appendix D-2**.

AECOM started the GWETS on May 15, 2013, and collected treatment system water samples (e.g., influent, effluent, etc.) during May and June 2013 to confirm treatment system effectiveness. Copper and nickel exceeded the RIPDES discharge limits in these initial samples. AECOM shut the system down and replaced the liquid-phase GAC and zeolite metals treatment media with fresh materials. The change-out of materials did not resolve the metals exceedances and the system was again shutdown. AECOM evaluated alternative metals treatment and submitted a request to RIDEM in September 2013. AECOM proposed to perform a system amendment to replace zeolite media with a proprietary ion exchange media supplied by Siemens (now Evoqua). RIDEM approved the amendment and the GWETS was restarted on September 27, 2013. AECOM submitted a proposed modification to the metals treatment portion of the treatment stream to add cartridge filtration to improve metals treatment. RIDEM approved the amendment and AECOM modified the system on September 23, 2014. Except for periodic maintenance, the system has been running as designed since that time (AECOM, 2016). Additional

information on the design and installation of the GWETS, included system drawings and P&IDs, is provided in the March 2016 Groundwater Recovery and Treatment System Installation Report (AECOM, 2016). AECOM continues to conduct the groundwater sampling, analysis, and reporting consistent with the RIDEM Order of Approval as described in Section 3.2.

## 2.3 Soil Vapor Remediation

### 2.3.1 2008 Vapor Intrusion Mitigation – Retail Building Short Term Response Action

To mitigate soil vapor migration into the retail complex, Wood proposed and designed an ASD for the Parcel A retail complex (MACTEC, 2008b). RIDEM approved the system design (RIDEM, 2008a and 2008b) stipulating the implementation of a long-term soil vapor and air monitoring compliance program. The ASD system was installed in accordance with a RIDEM-approved Short Term Response Action work plan (MACTEC, 2009b).

Five soil gas extraction wells were installed in the large retail space (EW-1 through EW-5), and one well each was installed in the central (EW-6) and western (EW-7) small retail spaces. One soil gas extraction well (eastern EW-5) was installed in the large retail space; this system also treats vapor captured from the eastern small retail space. The soil gas extraction wells were installed to a depth of 10 feet below the concrete floor and screened from 5 to 10 feet below the top of the concrete. The solid extraction well risers extend to the bottom of the floor slab, which was saw-cut from the nearest steel column to the extraction well. The vertical pipes were fastened to the adjacent steel columns and continued above the suspended ceiling. The extraction well piping continues north, above the suspended ceiling, to the back walls of the large retail space, the central small retail space, and the western small retail space. The roof joists in the western small retail space are exposed since there is no suspended ceiling. The piping is supported by joist hangers at regular spacing above the suspended ceiling. Piping for EW-1 through EW-4 was routed to an ASD system enclosure through the north exterior wall of the large retail space. The piping from these four extraction wells is manifolded into one pipe inside the ASD enclosure. Piping for EW-5, EW-6, and EW-7 was routed to the north walls of the large retail space, the central small retail space, and the western small retail space respectively. After penetrating their respective north walls, EW-5, EW-6, and EW-7 were connected to radon type fans and vented to the atmosphere. All extraction wells are set in flush-mounted floor “vaults” or road boxes large enough to accommodate sample ports on the horizontal section of the piping.

Seven 12-inch vacuum monitoring wells (VMWs) were installed in the retail complex, four in the large space (VMW-1 through VMW-4) and one in each of the three smaller retail spaces (VMW-5 through VMW-7) to a depth of eight feet below the bottom of the concrete floor slab approximately 50 feet away from its respective extraction well. The VMW function is to measure the vacuum in the vadose zone exerted by the ASD. Teflon tubing extends from the vapor monitoring implant to the ground surface with a sample valve set in a 4-inch diameter flush mounted road box.

The ASD enclosure contains a regenerative blower, condensate drum, two 400-pound carbon drums in series, an emissions stack (vented to the atmosphere), and a control panel. Sampling ports and vacuum gauges are located before and after the carbon drums. The air pollution equipment, VSC-400 Vapor Phase Absorbers, was registered with the RIDEM’s Office of Air Resources on August 15, 2008. The ASD enclosure was supplied by ESD Waste 2 Water Inc. of Ocala, FL, and installed by Clean Harbors Environmental Services (CHES) on an 8-inch thick reinforced concrete pad on January 8, 2009. The concrete pad was constructed on 6 inches of certified “clean”, compacted crushed stone bedding (MACTEC, 2009b). An 8-foot high chain link fence, with a gate, was installed around the ASD enclosure to

prevent unauthorized entry or vandalism. These ASD system components are shown on the ASD record as-built drawings contained in the Short-Term Response Action Closure Report. Copies of the as-built drawings and select photographs from the ASD system installation and sampling events are included in **Appendix E**.

Wood collected baseline compliance air samples on January 16, 2009 as described in the Order of Approval and Order of Approval Addendum (RIDEM, 2008a & 2008b). On January 29, 2009, CHES performed system start-up and began system O&M. Implementation of the long-term vapor and air-monitoring compliance sampling program, as required by the RIDEM Order of Approval, began on February 3, 2009. Compliance sampling consists of 4 indoor air samples inside the large retail space (IA-1, IA-2, IA-3, and IA-4); one indoor air sample each in the eastern small retail space (IA-5), central small retail space (IA-6), and the western small retail space (IA-7); one soil gas sample from each of the extraction wells (EW-5, EW-6, and EW-7) in the larger retail space, central small retail space, and the western small retail space, respectively; and one sample from the combined air stream of the four extraction wells EW-1 through EW-4 (EW-Combined). One sample is also collected from the effluent of the carbon treatment unit (EW-Post Carbon) to monitor the effectiveness of the air pollution control equipment. In addition, vacuum pressure is measured at all vacuum monitoring wells during sampling events. A vacuum has been consistently detected at each vacuum monitoring well except for a few times in 2010 and 2012 at VMW-3 and VMW-7.

In April 2012, a wall was constructed east of soil vapor extraction wells EW-2 and E-4 dividing the large retail space into two commercial spaces (**Appendix E**). The location of the new wall coincided with the existing well piping for EW-2 and EW-4. Stop & Shop and their environmental consultant directed their general contractor to put an offset in the EW-2 and EW-4 piping in order to have it run parallel with the new wall framing and not impact the ASD system. In November and December 2012, a health fitness club was constructed on the eastern end of the former Stop & Shop space. This area of the retail space contains indoor air sample locations IA-2 and IA-4 and sub-slab vacuum monitoring well VMW-2. Indoor air locations IA-1 and IA-3, vapor extraction well EW-5 and sub-slab vacuum monitoring VMW-1, VMW-3, and VMW-4 were not impacted by the proposed construction.

On September 13, 2012, Textron collected indoor air samples prior to the start of construction and again at the completion of the construction of the fitness club. Sampling results confirmed that the design and construction of the new commercial space did not impact the effectiveness of the ASD system and the indoor air quality. Occupancy of the health fitness club began in January 2013. As of February 2018, the eastern end of the large retail space was occupied by Blast, a health fitness center. The eastern small retail space (indoor air sample location IA-5) is occupied by a church. The center small retail space (sample location IA-6) remains occupied by a consignment shop and the western small retail space (sample location IA-7) is intermittently occupied for church functions.

The long-term vapor and air monitoring compliance program began in February 2009 as documented in the Short Term Response Action Closure Report (MACTEC, 2009c) and continues to present day. Quarterly air monitoring was conducted from 2009 to March 2016. The small retail spaces have had two exceedances of the PCE TAC of 5 ug/m<sup>3</sup>, once in IA-5 (December 2011) and once in IA-7 (September 2013). Concentrations of PCE immediately dropped in the subsequent monitoring rounds. TCE was detected above its TAC of 1.0 ug/m<sup>3</sup> only during the initial sampling rounds in IA-5 (January 2009), IA-6 (January and February 2009, and IA-7 (January and February 2009). There have been no exceedances of the TCE TAC through the most recent round of sampling in February 2018.

Within the eastern section of the large retail space (sample locations IA-2 and IA-4), indoor air sample results have been in compliance with action levels for the last several years. After system startup in 2009, IA-2 and IA-4 had infrequent detections of PCE above its TAC (5 ug/m<sup>3</sup>); however, these results were not

considered compliance violations because these detections were consistent with outdoor/background concentrations reported on the same day. TCE has been detected infrequently in IA-2 and IA-4 samples. The last exceedance of the TCE TAC of 1 ug/m<sup>3</sup> occurred in December 2010 (IA-2) and December 2014 (IA-4). None of these intermittent exceedances of the TACs have been sustained and all have dropped to non-detect. Otherwise the indoor air in the eastern section of the large retail space meets the TACs for all-site related VOC compounds.

The western section of the large retail space has been unoccupied since the ASD system started operation in January 2009. After system startup these two indoor air monitoring locations (IA-1 and IA-3) exceeded the TAC for PCE in February 17, 2011 (associated with the outside air PCE concentrations) and December 18, 2015. Immediately following both exceedances the PCE concentrations dropped to non-detect. Site-related VOCs have not exceeded the TACs any other times between 2009 and February 2018 within the large retail space. The PCE and TCE concentrations in the combined extracted air (EW-1 through EW-4) have exhibited a general reduction since system startup.

Based on the amount and results of analytical indoor air data, in March 2016 Textron requested and RIDEM agreed to reduce the air monitoring requirements from quarterly to semi-annually. Should there be an exceedance of the TACs for the site-related VOCs during a semi-annual sampling event, Textron will conduct a follow-up indoor air sample within that affected space to confirm the return to stable site conditions. Consistent with this change in the monitoring program, Wood conducted the semi-annual compliance monitoring in August 2016 and semiannually thereafter to the most recent event in February 2018. Results were reported to RIDEM semi-annually (Amec Foster Wheeler, 2016b, 2017a, 2017b and 2018). The next semi-annual sampling round is scheduled for August 2018.

All original laboratory analytical data results are included with each quarterly and semi-annual report. Since installation, the ASD system has been regularly monitored by the current operation and maintenance (O&M) contractor, CHES. The system is also equipped with a remote communication system, which sends out a daily facsimile to CHES and will contact CHES in the event of a “no flow” condition or equipment failure. A description of the operation and maintenance of the system is described in Section 4.1. The status of the quarterly vapor compliance sampling is presented in Section 3.3.1.

### 2.3.2 Soil Vapor Mitigation – Residential Buildings

Based on the results of the residential soil vapor investigation and indoor air sampling, Textron elected to proactively install vapor mitigation systems comprised of radon type fans and piping in the basements of four residential structures on Adelaide Avenue in April 2011. These systems are designed to capture and exhaust the subslab soil vapor to the atmosphere. Indoor air sampling was conducted prior to and immediately following the installation of the radon systems (December 2010 and May 2011) confirming the successful performance of the systems. Wood confirms the continued operation of these vapor mitigation systems in conjunction with the retail building indoor air sampling events (quarterly from 2011 to March 2016 and semi-annually thereafter).

## 3.0 QUALITY CONTROL / MONITORING AND COMPLIANCE POINTS

### 3.1 Soil Cap

Consistent with the ELUR language, the Parcel A cap is inspected and maintained by the property management company on behalf of the City of Providence. Inspections include the following aspects:

- ) Verifying the integrity of the cap
- ) Checking for pavement upsets, cracks, depression, etc.
- ) Confirming that the ELUR and SMP are being followed

Damages to or deviations from the approved cap system are corrected by the property owner or owner's designee.

### 3.2 Groundwater Treatment System

#### 3.2.1 Operation and Maintenance

AECOM continues to operate and maintain the groundwater treatment system. Inspections and routine maintenance (as needed) are performed twice per month following a standard system checklist. The following parameters/conditions are checked during each on-site system/site inspection:

- ) Pressure, flow rate, and total volume readings from all recovery wells and the system discharge;
- ) Filter pressures and conditions;
- ) Depth to water elevations at each recovery well;
- ) Pressure at each treatment vessel; and
- ) Air stripper air flow and PID readings in the vapor stream.

System filters are changed on a monthly basis or more frequently as necessary based on the results of the inspection and a review of the operational data.

AECOM also collects water treatment samples from the influent and effluent of the system twice per month and submits the samples for VOCs (USEPA Method 8260), total suspended solids (TSS), and select total metals (copper, iron, lead, nickel, silver, zinc) analysis in accordance with RIPDES RGP requirements.

AECOM collected air samples from the influent, midpoint and effluent to the vapor GAC adsorbers during initial system operation in 2013 and submitted to Eurofins/Air Toxics for analyses of VOCs using EPA method TO-15. Results from the air samples indicate that concentrations are below the listed RIDEM Air Pollution Control Regulation No. 9, Appendix A, Minimum Quantities (pounds per year) and List of Federal Hazardous Air Pollutants (HAPs) of the air regulations applicable standards. AECOM included these laboratory analysis reports in the March 2016 Groundwater Recovery and Treatment System Installation Report (AECOM, 2016).

#### 3.2.2 Long-Term Groundwater Monitoring Program

Shaw (now APTIM) has continued to conduct the groundwater compliance monitoring program specified in the RIDEM Order of Approval associated with the ISCO injections at the former Building W source area. This includes monthly limited groundwater sampling and a full sampling event on a quarterly basis. Reporting of these results is done on a semi-annual basis. Three monitoring wells are used in the monthly

limited sampling program, MW-112, MW-116S and MW-116D. Nine compliance groundwater monitoring wells and 15 treatment area groundwater monitoring wells are sampled during each quarterly round.

### **Compliance Wells**

- J CW-01
- J CW-02
- J CW-06
- J GZA-3
- J MW-109D
- J MW-112
- J MW-209D
- J MW-218D
- J MW-218S

### **Area Groundwater Monitoring Wells**

- J MW-101D
- J MW-101S
- J MW-116D
- J MW-116S
- J GW-201D
- J MW-202D
- J MW-202S
- J MW-207D
- J MW-207S
- J MW-216D
- J MW-216S
- J MW-217D
- J MW-217S
- J MW-218D
- J MW-218S

Prior to each sampling round, APTIM measures the groundwater elevation and collects field water quality measurements including oxidation/reduction potential (ORP), dissolved oxygen (DO), pH, temperature, and specific conductance (SC) at each well sampled. During the groundwater gauging activities light non-aqueous phase liquid (LNAPL) thickness measurements are also collected and documented. Field parameter and gauging results are presented in summary tables that APTIM includes in the status reports

submitted to RIDEM. As presented in APTIM status reports (Shaw and CBI, 2013 through 2016), LNAPL has been detected in MW-221S consistently at a thickness of approximately 0.4 feet.

Proposed changes to the current groundwater monitoring program are detailed in the following Long-Term Groundwater Monitoring Plan section.

### 3.2.3 Long-Term Monitoring Plan for Parcel A Groundwater

This section presents results of the field and analytical work conducted between November 2017 and February 2018 to assess current groundwater conditions due to impacts by VOCs at the Site. This section also presents a Long-Term Groundwater Monitoring Plan considered necessary for the closure of Parcel A.

#### Investigation Activities

The following provides a discussion of investigation activities completed between November 2017 and January 2018 by Wood. Work was conducted in general accordance with the Well Inventory and Baseline Groundwater Sampling Plan prepared by Wood and submitted to RIDEM on December 12, 2017 (Amec Foster Wheeler, 2017c). All significant deviations from the plan during execution of the work are noted where applicable within the following sections.

#### Summary of Field Monitoring Well Inventory and Gauging

On November 2, 2017, Wood completed an inventory of monitoring wells at and around the Parcel A Plume, the interpreted historic location of which is shown on **Figure 3**. During the inventory, accessible wells were gauged to determine depth to groundwater table and depth to bottom of the well (to help confirm well identity and condition). The results of the baseline inventory and gauging are presented on **Table 1** which includes well ID, well diameter, depth to water table and bottom of well, and condition or status of well on November 2, 2017. The table also includes screened interval (from well construction records) and well installation date (if known). Wells assessed during the inventory are identified on **Figure 3**. The inventoried wells are further distinguished by the following:

- ) Wells accessible and gauged (Quantity: 42)
- ) Wells found but not accessible/gaugeable at time of inventory (Quantity: 5). Some of these wells were rendered accessible with additional effort during the subsequent well sampling event completed during the week of January 15, 2018.
- ) Wells searched for but not located (Quantity: 3).

#### Baseline Groundwater Sampling

Baseline groundwater sampling was conducted in accordance with the Well Inventory and Baseline Groundwater Sampling Plan January 15 through January 19, 2018. In accordance with the Plan the following general methods were employed:

- ) Sampling was conducted at existing groundwater monitoring wells located both at the fringes and inside the interpreted plume. Where available and appropriate, co-located shallow and deep wells (a.k.a. well couplets) were selected to provide information about vertical distribution of contaminants. The locations of the sampled wells are shown on **Figure 3**. **Table 1** identifies the sampled wells, including the "type" of well (deep or shallow) and rationale for well selection/sampling.
- ) Samples were collected using EPA low flow or equivalent low-aquifer-stress method.
- ) Sample containers were placed on ice in coolers until delivered to the lab under proper chains of custody.

) Sampling was conducted while the on-site groundwater treatment system was operational.

A total of 31 field samples were collected. In addition, three duplicate samples and two matrix spike/matrix spike duplicate samples (MS/MSD) were collected and analyzed.

Samples were hand-delivered to ESS Laboratories in Cranston, Rhode Island, and analyzed for VOCs by USEPA Method 8260. The laboratory reported seven analytes of principal concern at the Site: 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethane (1,1-DCA), 1,1-dichloroethene (1,1-DCE), cis-1,2-dichloroethene (cis-1,2-DCE), tetrachloroethene (PCE), trichloroethene (TCE), and vinyl chloride (VC).

Once received from the laboratory, the results were reviewed for usability, and a preliminary comparison to historic results was performed. Results for two wells, MW-218S and MW-218D, were significantly higher than recent previous results. Consequently, the wells were resampled on April 18, 2018 and analyzed for the same seven analytes. In addition, one duplicate sample was collected and analyzed. A discussion of the January 2018 and April 2018 results is presented in following sections of this Closure Report.

As part of the groundwater sampling events, wells were gauged to determine depth to groundwater table. The results are discussed in greater detail in following sections.

## Well Survey

On January 24, 2018, all sampled wells and other accessible wells were surveyed by a surveyor licensed to practice in Rhode Island. The survey utilized an existing benchmark on Parcel C used during previous engineering projects at the Site, to allow comparison/integration of the new spatial data with older data. Both elevations of wells, measured at a point on the well riser (from which depth to water is also determined), and horizontal coordinates of wells and certain other features (building corners, etc.) were determined.

## Investigation Results

### Groundwater Elevation and Flow Direction

Results from the two groundwater gauging events in November 2017 and January 2018 are provided on **Table 2**. Groundwater in the overburden is considered to comprise one aquifer. Previous investigations have characterized the saturated overburden as a mixture of sand, silty sand, and sandy silt to depths ranging from 45 ft. to 60 ft. below ground surface (bgs), underlain by a dense till material described as a confining silt layer. Bedrock is estimated to be at approximately 200 ft. bgs. Because 1) the well set consists of both shallow water table wells (“shallow wells”) and deeper fully-saturated wells (“deep wells”) and 2) the deep and shallow wells may represent zones of different permeability, contour maps of hydraulic head were developed for the two different well sets. The groundwater elevation contours were developed using Golden Software, Inc.’s Surfer groundwater contouring software. The deep and shallow groundwater contours for the November 2017 event are presented on **Figures 4** and **5**, and the shallow and deep contours for the January 2018 event are presented on **Figures 6** and **7**, respectively. Using the contour information, approximate groundwater flow directions were inferred and added to the figures by a Wood hydrogeologist.

The interpreted shallow groundwater flow directions are generally consistent between the November 2017 and January 2018 events. Consistent with previous reported conditions, an apparent, somewhat linear, groundwater divide or ridge, oriented SW – NE, is located near the middle of the Site. Groundwater flow is generally away from the ridge; northwest towards Mashapaug Pond and southeast or east away from the divide.

The interpreted deeper groundwater flow directions were significantly different between November 2017 and January 2018. In November 2017, flow conditions were generally similar to the November 2017 shallow flow conditions, with a groundwater divide through the middle of the site resulting in divergent groundwater flow to the north and east/southeast. In January, the highest groundwater elevations (40.94 ft.) were observed in wells at the margin of Mashapaug Pond. The elevated level of the pond compared to surrounding groundwater may be a result of accumulated stormwater runoff from a heavy precipitation event (3.34 inches) which occurred a few days prior to the gauging. Overall, groundwater flow was generally from the northwest (i.e., Mashapaug Pond) to the southeast across the site. However, the lowest groundwater elevation, 39.70 ft., was measured at MW-228, and appears to represent a local groundwater sink. This low elevation, which differed from the November 2017 conditions, may reflect influence of the nearby groundwater extraction well RW-2 (which was not operating during the November 2017 event).

The vertical hydraulic gradient results calculated using seasonal groundwater gauging data from November 2017 and January 2018 are provided in **Table 3** of this report. The table shows the difference in piezometric elevation measured between pairs of co-located shallow and deep overburden groundwater monitoring wells.

Based on this information, the vertical gradients at most locations are slight, and generally range between negligible to 0.068 ft./ft. The value of one gradient, 0.224 ft./ft. (MW-231S and D) during the November 2017 event, is considered suspect although the direction of the gradient (upward) is likely correct. Upward and downward gradients are present throughout the site. Most locations exhibited consistent upward or downward gradients during both gauging events. However, one well couplet, MW-223S and -223D, saw a change from downward to upward gradient between the two events. The results generally suggest the aquifer is essentially unconfined, although variations in stratigraphy (and associated permeability), groundwater recharge events (i.e., rainfall/runoff), and groundwater treatment system pumping conditions may have some effects on localized vertical gradients and resultant groundwater flow.

### Groundwater Analytical Results

Once available, the laboratory results were reviewed by a Wood chemist for data quality and usability. All results are considered acceptable for intended use. Any required data qualifiers are included and described in the results section of this report and on the results summary table. The laboratory analytical reports are included in **Appendix F** (January 2018 results) and **Appendix G** (April 2018 results) and summarized on **Table 4**. In addition to the 2018 results, **Table 4** also presents up to an additional four recent historic results for the baseline wells.

The results for the seven reported CVOCs, 1,1,1-TCA, 1,1-DCA, 1,1-DCE, - cis-1,2-DCE, PCE, TCE, and VC are also shown on **Figures 8** through **14**, respectively. On each figure, analytical results are differentiated according to concentration levels: non-detect, detected below the RIDEM GB Groundwater Objective ("GB Objective"), and detected above the GB Objective. Groundwater at the Site is classified as GB. In addition, there is an ELUR on the property which provides for both engineering controls and groundwater usage restrictions to limit exposure to groundwater. Therefore, the GB Groundwater Objective is considered both appropriate and conservative for comparison purposes.

As shown in the following table, of the 31 wells sampled in January 2018, seven wells were non-detect for all CVOCs. In 16 wells, one or more CVOCs were detected above the method reporting limit, but at concentrations below the CVOCs' respective GB Objectives.

CVOC Result	Total # of Wells	# of Shallow Wells	# of Deep Wells
All Analytes Non-Detect	7	4	3
Analyte(s) Detected, but below GB Objective	16	8	8
Analyte(s) Detected above GB Objective	8	3	5

Eight wells contained one or more CVOCs at concentrations above the respective GB Objective. The eight wells represented five locations (due to presence of exceedances in well couplets): CW-1, MW-218, MW-227, MW-226, and MW-228. Locations MW-226, MW-227, and MW-228 are located near the middle of the site, while locations MW-218 and CW-1 are near the south and southeast margins of the site, likely downgradient of historic contaminant source locations.

Analytes detected above their respective GB Objective include 1,1-DCE, PCE, and TCE. Results for the other four analytes, 1,1,1-TCA, 1,1-DCA, cis-1,2-DCE and VC were below the GB Objective.

Results from the January 2018 sampling were compared to up to four of the most recent available previous results (**Table 4**). With two exceptions discussed below, the results from January 2018 were generally consistent with or lower than earlier sampling results.

At location MW-218, concentrations of PCE and cis-1,2-DCE were an order of magnitude (or more) higher than recent previous results in samples from both the shallow (MW-218S) and deep (MW-218D) wells. The results from resampling of these wells in April 2018, while lower than the January 2018 results, remained above recent historic results. Consistent with recent historic results, only PCE exceeded its GB Objective, and none of the detected analytes exceeded their respective Rhode Island Upper Concentration Limits (UCLs). While a definitive cause of the increase in concentrations has not been determined, it likely represents an expression of the slug of groundwater with higher concentrations that was observed at MW-112 within the past few years, as it migrates towards and is captured by recovery well RW-3.

In summary, with the two exceptions noted above, CVOC presence and concentrations in groundwater remain generally consistent with recent historic results. An apparently limited region of groundwater with higher concentration CVOCs may be moving through the vicinity of MW-218S and MW-218D.

### Proposed Long-Term Groundwater Monitoring Plan

This proposed Long-Term Groundwater Monitoring (LTGM) Plan has been developed to evaluate the stability of the CVOC plume and compliance with the RIDEM GB Objectives at Parcel A of the Former Gorham facility. The wells were selected based on a review of available historic analytical results for wells associated with Parcel A as presented in **Appendix H**. The Plan preferentially uses existing groundwater monitoring well couplets (shallow and deep) that are located both at the fringes of and inside the plume. The locations of the wells proposed for long-term monitoring are shown on **Figure 15**. The wells will be sampled at a minimum annually, with certain wells sampled on a more frequent basis to monitor recent short-term anomalous results. **Table 5** lists the wells and well couplets that have been selected, along with location and rationale for sampling, the depth interval of the well screens, the type of well (deep or shallow), the date the wells were installed, and the proposed sampling frequency.

Wells will be sampled using low-flow sampling techniques. The samples will be analyzed for the three CVOCs that have been detected recently at the Site above the GB Objective: 1,1-DCE, PCE, and TCE.

The analytical results will be reviewed to evaluate: 1) the continuing effectiveness of the existing groundwater treatment system, 2) trends associated with analyte concentrations at monitored wells, 3) analyte levels compared to GB Objectives, and 4) stability of the CVOC plume. Results will be reviewed as they become available and presented in an annual report.

### 3.3 Soil Vapor Mitigation Systems

#### 3.3.1 Retail Building ASD System

In accordance with RIDEM's Short Term Response Action Order of Approval, dated July 24, 2008 and the Addendum to the Order of Approval dated August 7, 2008 Textron continues to conduct air and vapor extraction sampling and vacuum monitoring to confirm the ASD system is working as designed. The ASD system is maintained and the performance is monitored monthly by CHES as described in Sections 2.3.1 and 4.3.1.

Samples of indoor air from within each of the retail spaces (sample locations IA-1 through IA-7) and outdoors (AA-1) are collected and submitted for VOC analysis by USEPA Method TO-15. One air sample is collected (EW-Combined) from the manifold that collects air from four extraction wells within the large retail space, and one air sample is collected from each vapor extraction well located within the small retail spaces (EW-5, EW-6, and EW-7) and submitted for VOC analysis by USEPA Method TO-15. Soil vapor mitigation sampling locations are shown in **Appendix E**. The outdoor reference air sample (AA-1) is located upwind of the retail building. Results of the indoor air sampling are compared to Draft Connecticut Industrial/Commercial Indoor TACs, which were identified as action levels in the Orders of Approval.

Sub-slab vacuum monitoring (i.e., pressure differential measurements) is also conducted at the seven vacuum monitoring wells (VMW-1 through VMW-7) in conjunction with each air sampling event to measure the vacuum in the vadose zone exerted by the ASD and to confirm that the system is operating as designed.

The long term vapor and air monitoring compliance program began in February 2009 and continues to present day. Air monitoring was conducted quarterly from 2009 to March 2016, and semi-annually starting in August 2016.

**Small Retail Space Results** - As summarized in multiple quarterly and semi-annual reports, the small retail spaces have had isolated exceedances of PCE in IA-5 (December 2011) and IA-7 (September 2013). Concentrations of PCE immediately dropped in the subsequent monitoring rounds (0.12 and 0.22  $\mu\text{g}/\text{m}^3$ , respectively), and have remained below the criteria since then. Concentrations of TCE exceeded its criteria the first two sampling rounds in January and February 2009 in IA-5, IA-6, and IA-7, but have remained below the criteria since then. Site-related VOCs have not exceeded the TACs any other time between 2009 and the most recent sampling event (February 2018). The vacuum monitoring results measured during the sampling events also indicate that the ASD system is operating as designed.

**Large Retail Space Results** - Within the eastern section of the large retail space (IA-2 and IA-4), indoor air sample results for site-related compounds have been in compliance with action levels since 2010 (IA-2) and 2014 (IA-4). After system startup in 2009 IA-2 had one detection of PCE in 2011 at 5.2  $\mu\text{g}/\text{m}^3$  (vs. 5.0  $\mu\text{g}/\text{m}^3$  TAC), while IA-4 has had three intermittent detections of TCE ranging from 1.2 to 1.8  $\mu\text{g}/\text{m}^3$  (vs 1.0  $\mu\text{g}/\text{m}^3$  TAC) in 2010 and 2014. None of these intermittent exceedances has been sustained and all have dropped to non-detect. Otherwise the indoor air in the eastern section of the large retail space meets the TACs for all site related VOC compounds.

The western section of the large retail space has been generally unoccupied since the ASD system started operation in January 2009. After system startup these two indoor air monitoring locations (IA-1, IA-3) exceeded the TAC for PCE on February 17, 2011 (associated with the outside air PCE concentrations) and December 18, 2015. Immediately following both exceedances, the PCE concentrations dropped to non-detect. Since the 2015 exceedance, PCE levels have remained below 1 ug/m<sup>3</sup>. TCE had historical detections above its TAC, but results have not exceeded the TCE TAC since 2010. With the exceptions noted above, site-related VOCs have not exceeded the TACs any other time between 2009 and February 2018 within the large retail space.

Periodic detections of carbon tetrachloride and chloroform have been reported in samples from both the large and small retail spaces. As documented in communication to RIDEM in previous reports, carbon tetrachloride is ubiquitous to urban settings and is not one of the compounds for which the ASD system was installed. Thus, the concentration of carbon tetrachloride above the action level did not constitute a violation of the action levels contained in the Orders of Approval. Similarly, chloroform is not a constituent of concern for the site and is therefore not one of the compounds for which the vapor mitigation system was designed to address. Increased activity in the large retail space in 2014 may have introduced some volatile compounds into the indoor air through cleaning fluids or other products. The chloroform appears to be unrelated to the vapor intrusion pathway and the concentrations of chloroform above the action level do not constitute a violation of the action levels contained in the Orders of Approval.

Should there be an exceedance of the TACs for the site-related VOCs during a semi-annual sampling event, Textron will conduct a follow-up indoor air sample within that affected space to confirm the return to stable site conditions.

### 3.3.2 Residential Vapor Mitigation Systems

Textron conducted quarterly audible checks of the residential building sub-slab soil vapor radon fan units up through February 2016 and has continued to conduct these audible checks on the operating systems on a semi-annual basis in conjunction with the monitoring of the ASD system in the retail building. Wood personnel listen for indication of the radon fan operation to confirm the system is running. Over the course of the operating period (2008 to 2018) Wood noted during one of the inspections the radon fan unit in one of the residential structures was not operating at the time of Wood's audible check. An occupant of the residence had inadvertently turned off the system and corrected the error by turning the system back on. The systems will continue to be monitored as described in Section 4.1.2.

## 4.0 OPERATIONS AND MAINTENANCE

### 4.1 Soil Cap Inspection

Consistent with the ELUR language, the Parcel A cap will be inspected and maintained by the property owner or the owner's designee. Inspections will include the verification of the cap integrity, checking for pavement cracks, depressions, etc. and confirming the signed and filed ELUR/SMP are being followed. Damages to or deviations from the approved cap system will be corrected by the City.

### 4.2 Groundwater Treatment System

Textron will maintain responsibility for continued operation and maintenance of the groundwater treatment system currently operating at Parcel A. The system will continue to be inspected on a monthly basis, and effluent sampling will continue on a quarterly basis. Sampling of groundwater (from monitoring wells) to assess changes in CVOC presence and concentrations and effectiveness of the treatment system will be performed in accordance with the Long-Term Groundwater Monitoring Plan presented in Section 3.2.3.

Once the Long-Term Groundwater Monitoring Plan has been approved by RIDEM, Textron will abandon those wells *not* identified for continued monitoring.

### 4.3 Vapor Intrusion System

#### 4.3.1 Retail Building ASD System

As described previously, Textron conducts quarterly air and vapor extraction sampling, and vacuum monitoring to confirm the retail building ASD system is working as designed.

ASD system performance is monitored and maintained monthly by a Textron contractor. The most recent carbon vessel change-outs were completed May 8, 2015. Monitoring of the GAC influent and effluent will continue to be used to determine the need for changeout of the two GAC vessels. As described in previously submitted monitoring reports, occasionally the ASD system experienced an alarm condition (e.g., low flow condition, high level water condition, etc.). These alarms were reported via the remote monitoring system and a Textron contractor responded to correct the condition. Alarm notification and response will continue as part of system operations and maintenance.

Compliance sampling points will be monitored on a semi-annual basis to correspond with the heating season (February) and air conditioning season (August) of each year. The performance monitoring and system alarm response conducted by Textron contractors will be continued to maintain the ASD system and to verify that the system is operating as designed.

#### 4.3.2 Residential Vapor Mitigation Systems

As described previously, Textron will confirm the operation of the residential radon fan units through audible inspections of the four vapor mitigation systems. These will be conducted on a semi-annual basis in conjunction with ASD monitoring program.

## 5.0 REPORTING

### 5.1 Engineered Cap Inspection and Maintenance

Consistent with the ELUR language, a summary of the annual cap inspection and maintenance results will be submitted by the property owner to RIDEM.

### 5.2 Groundwater Remediation

Textron is available to review the proposed long-term groundwater monitoring program and monitoring well abandonment program (Section 4.2) with the RIDEM. Based on past performance and generally consistent monitoring results, the groundwater and treatment system operating results will be presented to RIDEM in annual letter reports, as proposed in Section 3.2.3 (Long-Term Groundwater Monitoring Plan), beginning after RIDEM approval of the Plan.

### 5.3 Vapor Intrusion

Textron will continue monitoring the ASD system performance and conduct the audible inspection of the four residential vapor mitigation systems on a semi-annual basis. Inspections and monitoring will occur semi-annually in February and August. Results will be summarized in a letter report to RIDEM approximately one month following the sampling and inspection events.

## 6.0 ENVIRONMENTAL LAND USAGE RESTRICTION

The ELUR and SMP for Parcel A, signed by the City of Providence June 4, 2015 and recorded in the Providence Land Evidence Records, is included in **Appendix A**. The ELUR and SMP describe the restrictions for use of Parcel A and the requirements for future activities on Parcel A that have the potential for soil disturbance, respectively.

Implementation of the groundwater and soil remedies as described in this report in conjunction with the implementation of the ELUR, has prepared the Site for closure under the Remediation Regulations and for future use.

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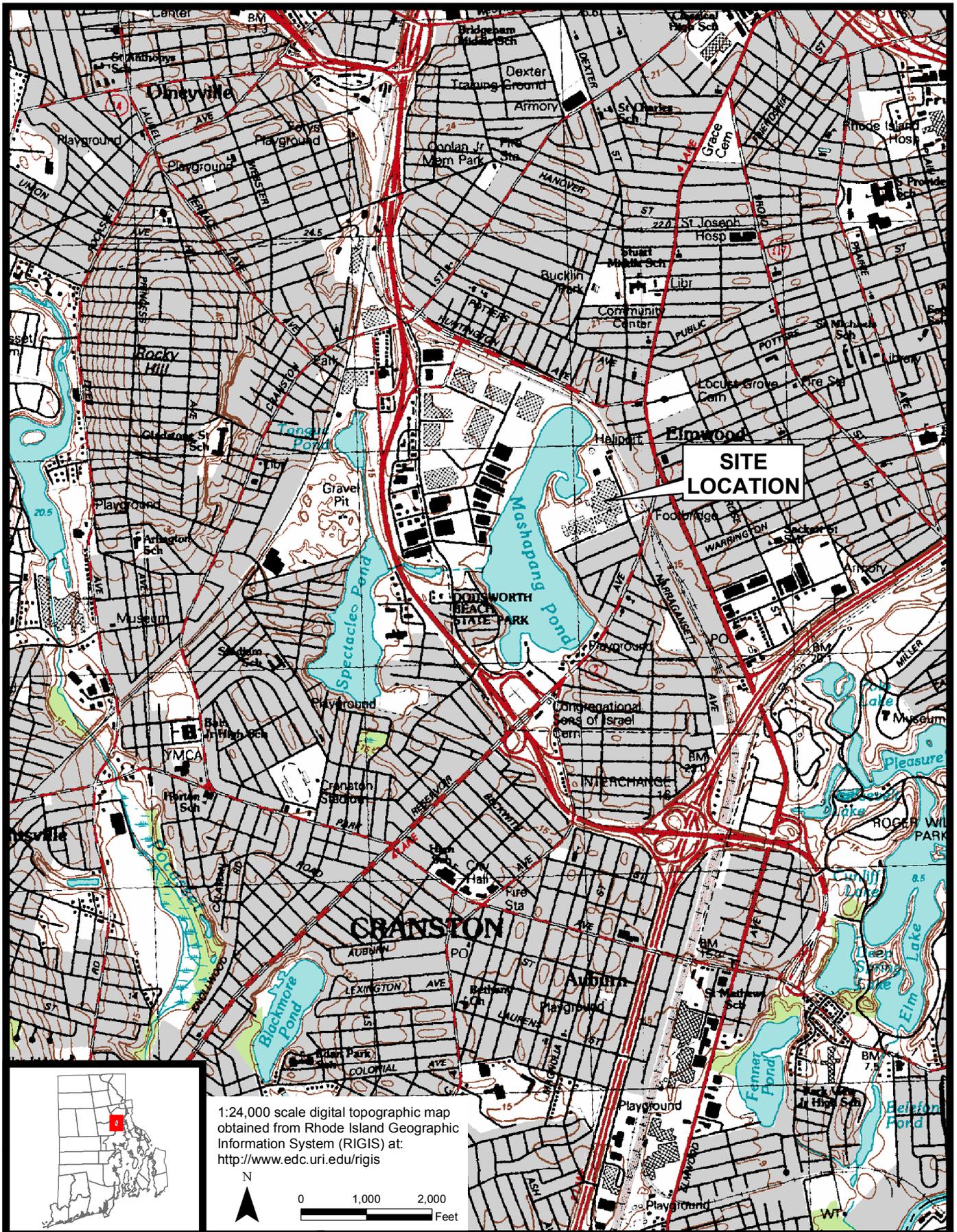
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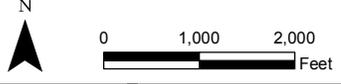
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in the state that filed a notice of intent and/or had an existing NPDES Exclusion Permit was issued a RIPDES RGP with a specific permit number and site-specific monitoring requirements. November 2, 2012.

## **FIGURES**



1:24,000 scale digital topographic map  
 obtained from Rhode Island Geographic  
 Information System (RIGIS) at:  
<http://www.edc.uri.edu/rigis>



Former Gorham Manufacturing Site  
 333 Adelaide Avenue  
 Providence, RI



Site Location Map  
 Project 3652-16-0007  
 Figure 1



**Legend**

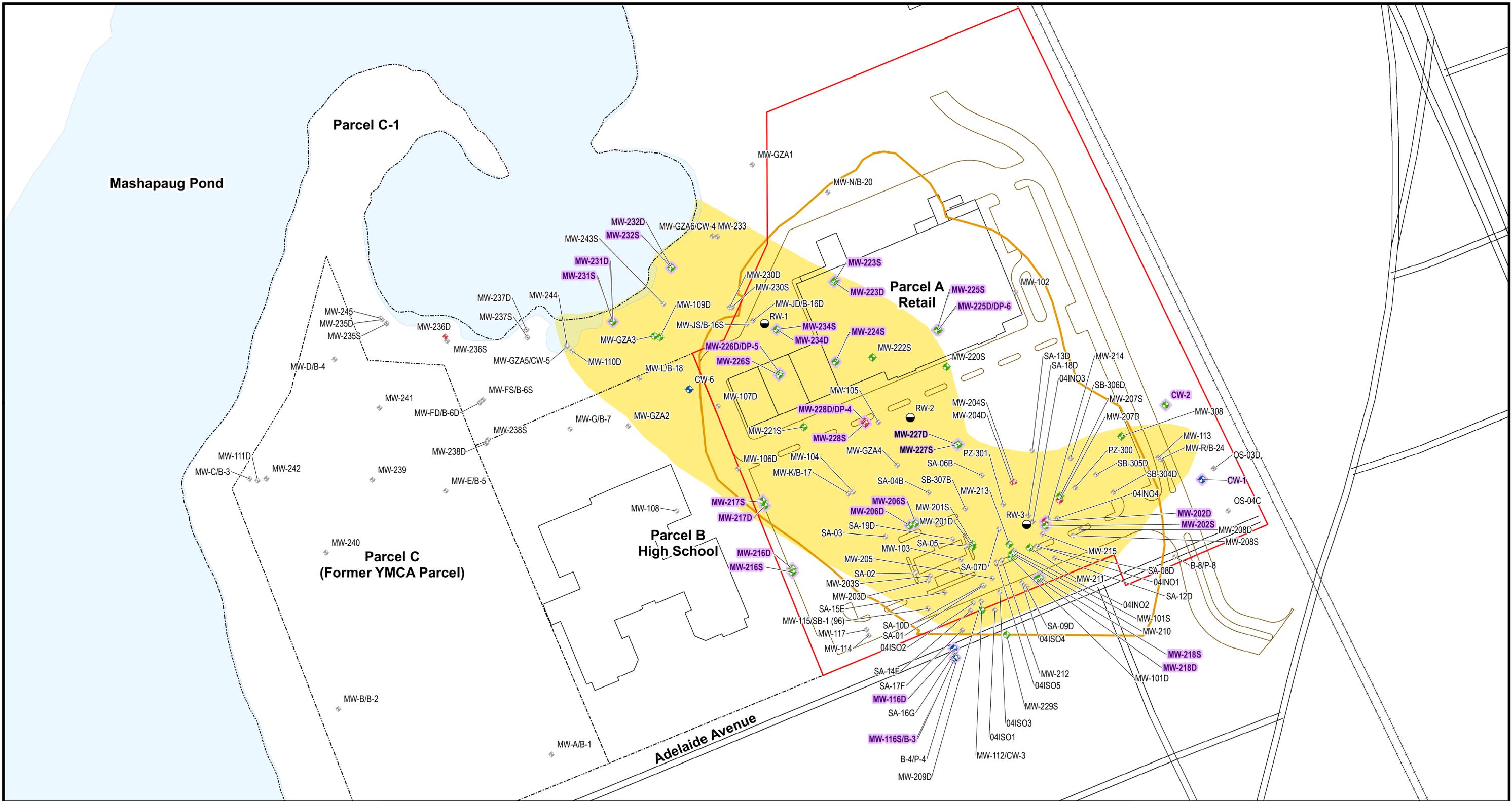
- Parcel A Boundary
- Approximate Parcel Boundary
- Former Slag Area

Note: 2011 Ortho photo obtained from Rhode Island Geographic Information System (RIGIS)

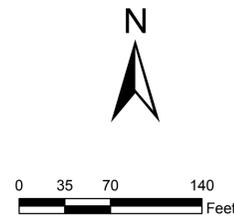
Former Gorham Manufacturing Site  
 425 Adelaide Avenue  
 Providence, RI



**Site Plan**  
 Project 3651170068 Figure 2



**wood.**  
 Wood Environment &  
 Infrastructure Solutions, Inc.  
 271 Mill Road  
 Chelmsford, MA 01824



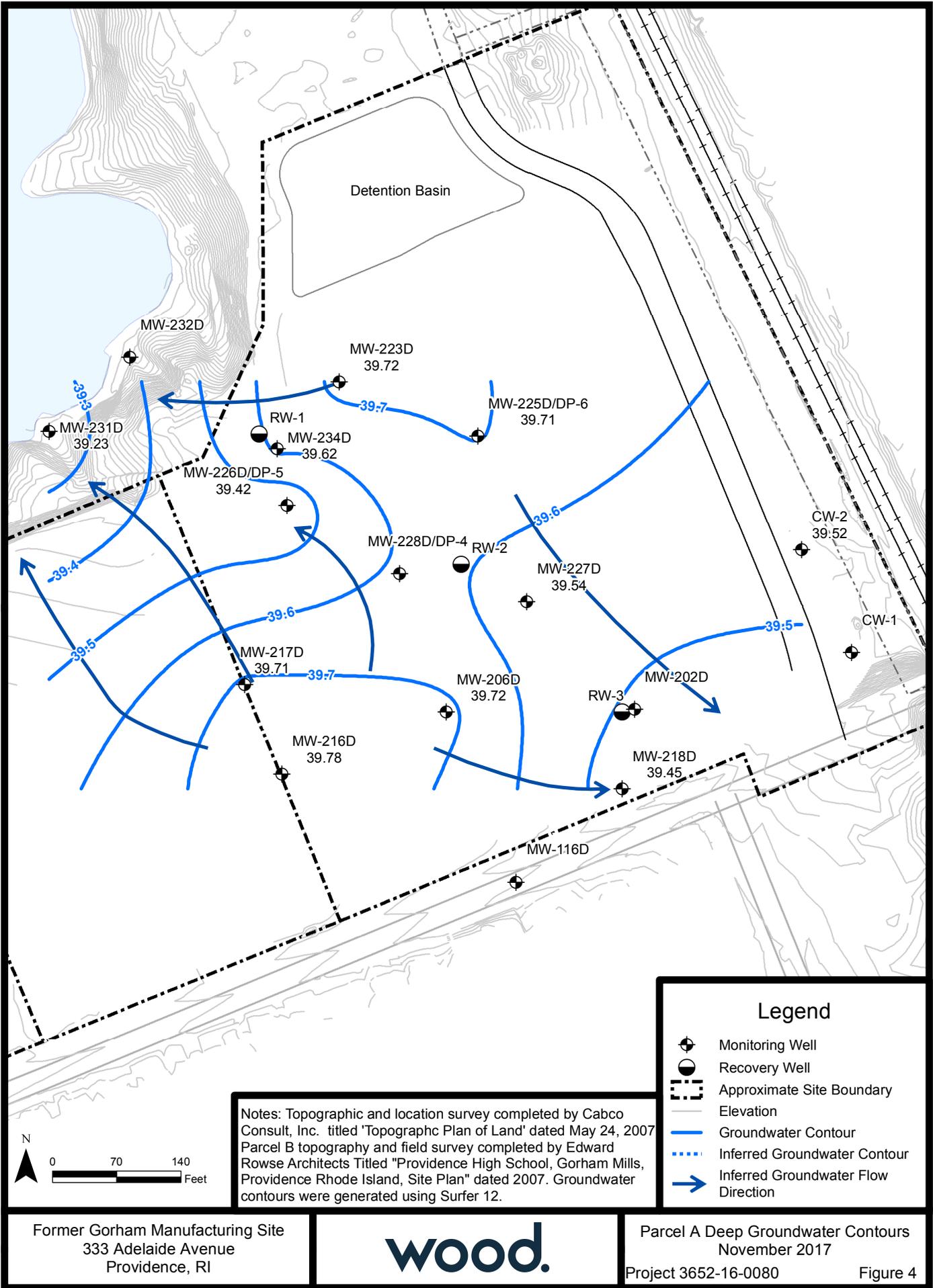
**Legend**

- ◆ Wells Found and Gauged 11/17
- ◆ Wells Found Unopenable 11/17
- ◆ Well Looked For, Not Found
- ◆ All Other Monitoring Wells
- ◆ Baseline Wells (Sampled)
- Recovery Well
- Parcel A Boundary
- Parcel Boundary
- Groundwater Treatment Collection Area
- Historic CVOC Plume
- Railroad
- Pavement

**Figure 3**  
**Baseline Wells**

**333 Adelaide Avenue**  
**Providence, Rhode Island**

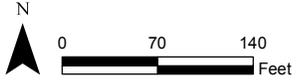
H:\Treston-Gorham\Providence\_RITask6\MXD\Fig2\_MW\_Locations\_SamplingPlan.mxd May 31, 2018 DWN: emily.gardner CHKD: HWC



Notes: Topographic and location survey completed by Cabco Consult, Inc. titled "Topographic Plan of Land" dated May 24, 2007. Parcel B topography and field survey completed by Edward Rowse Architects Titled "Providence High School, Gorham Mills, Providence Rhode Island, Site Plan" dated 2007. Groundwater contours were generated using Surfer 12.

### Legend

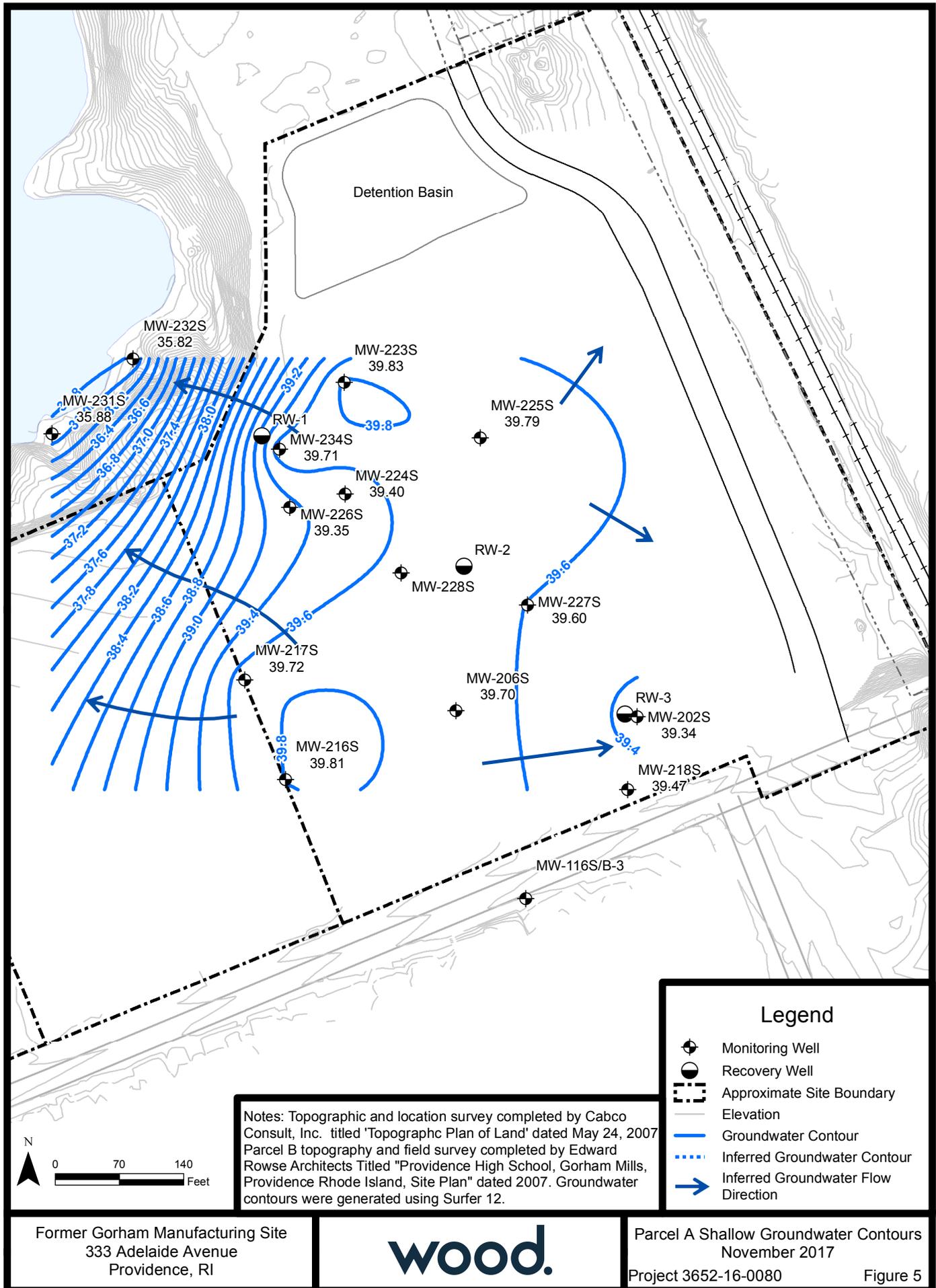
-  Monitoring Well
-  Recovery Well
-  Approximate Site Boundary
-  Elevation
-  Groundwater Contour
-  Inferred Groundwater Contour
-  Inferred Groundwater Flow Direction



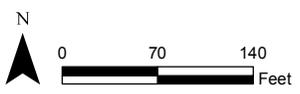
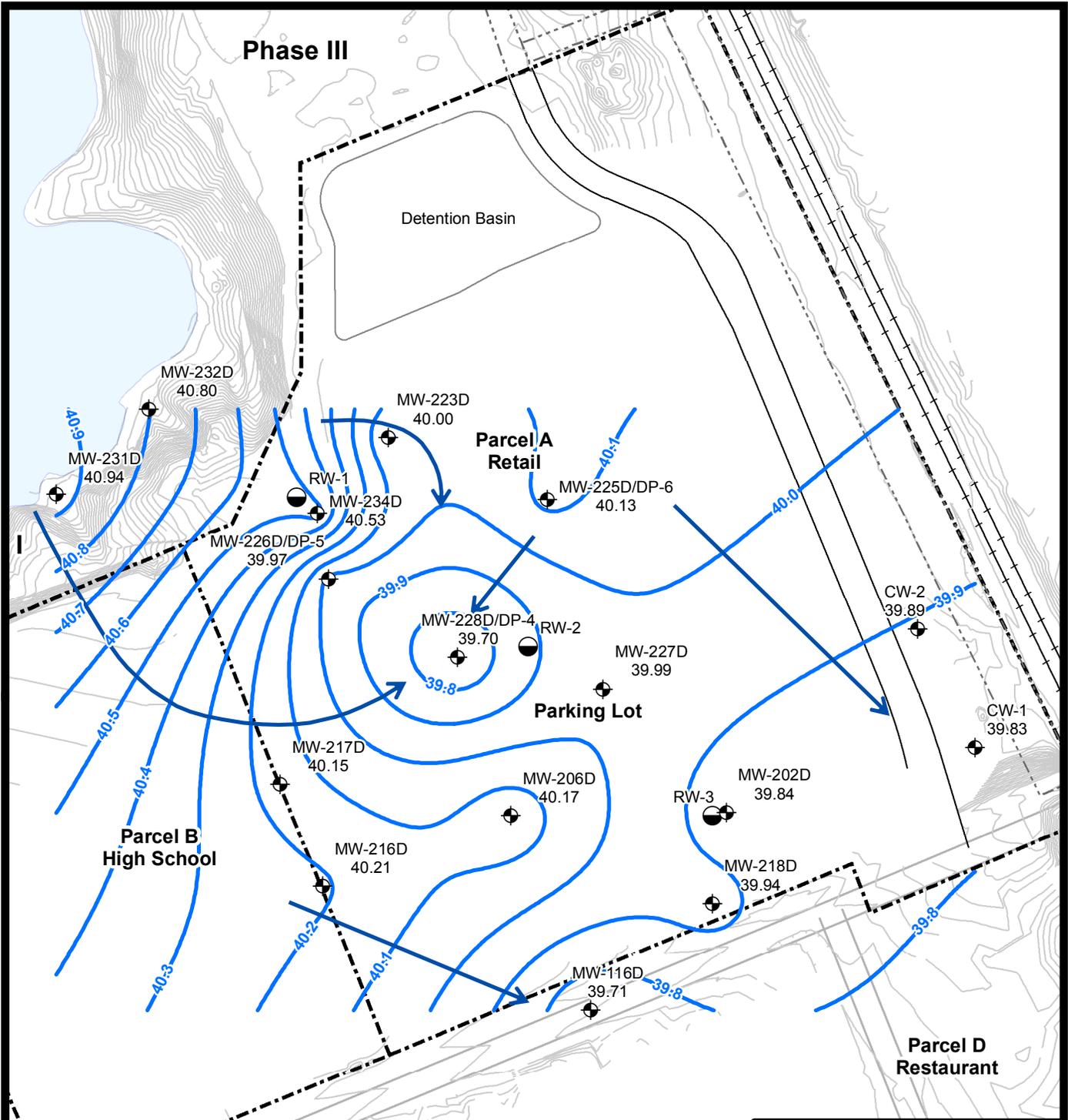
Former Gorham Manufacturing Site  
333 Adelaide Avenue  
Providence, RI



Parcel A Deep Groundwater Contours  
November 2017  
Project 3652-16-0080 Figure 4



# Phase III



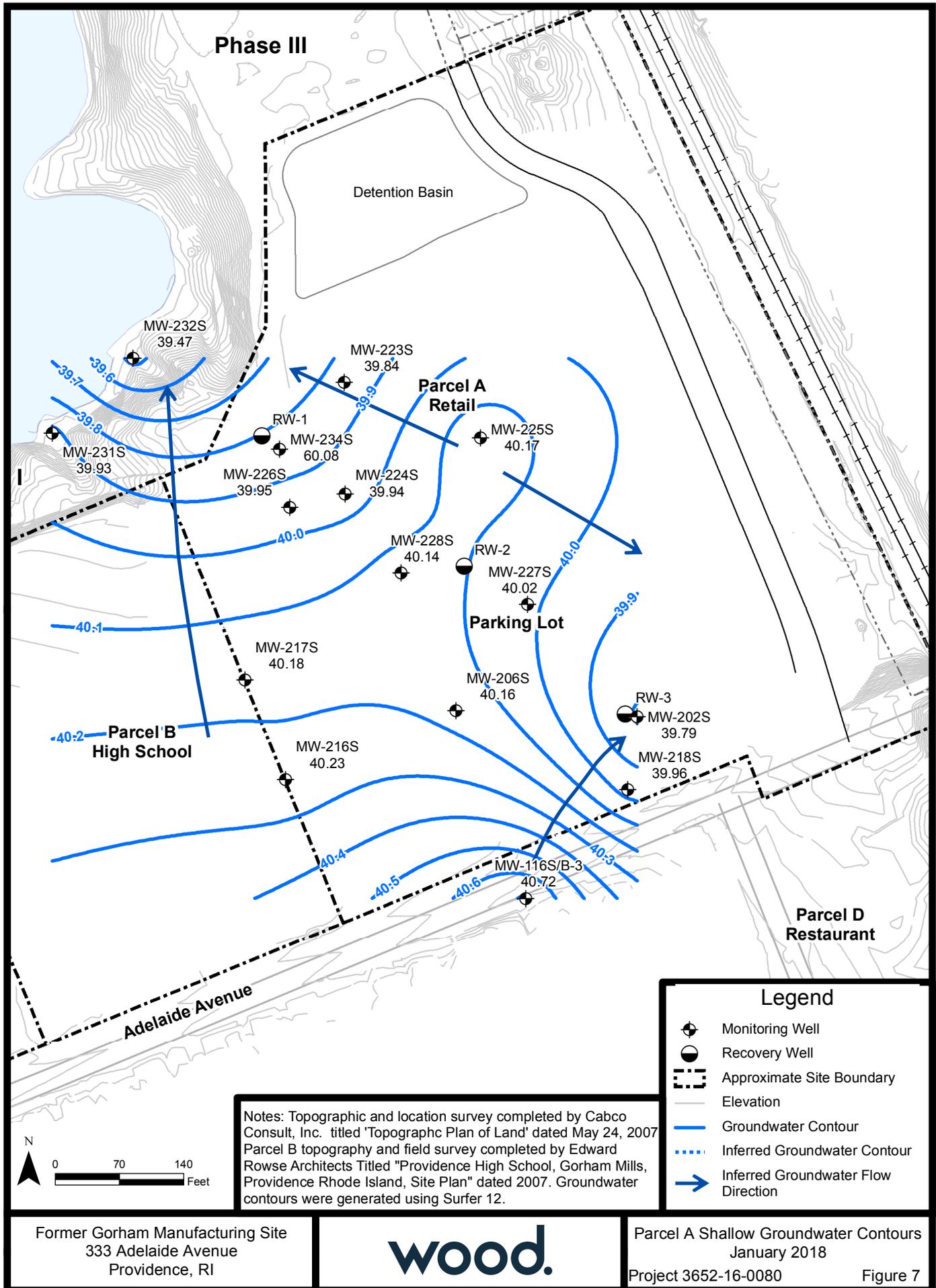
Notes: Topographic and location survey completed by Cabco Consult, Inc. titled "Topographic Plan of Land" dated May 24, 2007. Parcel B topography and field survey completed by Edward Rowse Architects Titled "Providence High School, Gorham Mills, Providence Rhode Island, Site Plan" dated 2007. Groundwater contours were generated using Surfer 12.

Legend	
	Monitoring Well
	Recovery Well
	Approximate Site Boundary
	Elevation
	Groundwater Contour
	Inferred Groundwater Contour
	Inferred Groundwater Flow Direction

Former Gorham Manufacturing Site  
333 Adelaide Avenue  
Providence, RI



Parcel A Deep Groundwater Contours  
January 2018  
Project 3652-16-0080 Figure 6



# Phase III

Detention Basin

Parcel A  
Retail

Parking Lot

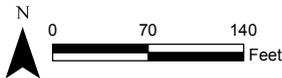
Parcel B  
High School

Parcel D  
Restaurant

Adelaide Avenue

Notes: Topographic and location survey completed by Cabco Consult, Inc. titled "Topographic Plan of Land" dated May 24, 2007  
Parcel B topography and field survey completed by Edward Rowse Architects Titled "Providence High School, Gorham Mills, Providence Rhode Island, Site Plan" dated 2007.

U = Non-Detect Concentration at the reporting limit shown.  
There is no established GB Criteria for 1,1-Dichloroethane.



Legend	
MW-232D 0.001	Well ID Concentration (µg/L)
●	Non-Detect
●	Analyte Detected at Given Concentration
⊙	Recovery Well
⋯	Approximate Site Boundary

Former Gorham Manufacturing Site  
333 Adelaide Avenue  
Providence, RI



Parcel A 1,1-Dichloroethane Results  
January 2018  
Project 3652-16-0080 Figure 8

# Phase III

Detention Basin

Parcel A  
Retail

Parking Lot

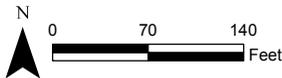
Parcel B  
High School

Parcel D  
Restaurant

Adelaide Avenue

Notes: Topographic and location survey completed by Cabco Consult, Inc. titled "Topographic Plan of Land" dated May 24, 2007  
Parcel B topography and field survey completed by Edward Rowse Architects Titled "Providence High School, Gorham Mills, Providence Rhode Island, Site Plan" dated 2007.

U = Non-Detect Concentration at the reporting limit shown.  
GB GW Criteria = 0.007 µg/L



### Legend

MW-232D 0.001	Well ID Concentration (µg/L)
● (Green)	Non-Detect
● (Yellow)	Analyte Detected at Given Concentration
● (Orange)	Analyte Detected Above GB GW Criteria
● (Black/White)	Recovery Well
⬜ (Dashed)	Approximate Site Boundary

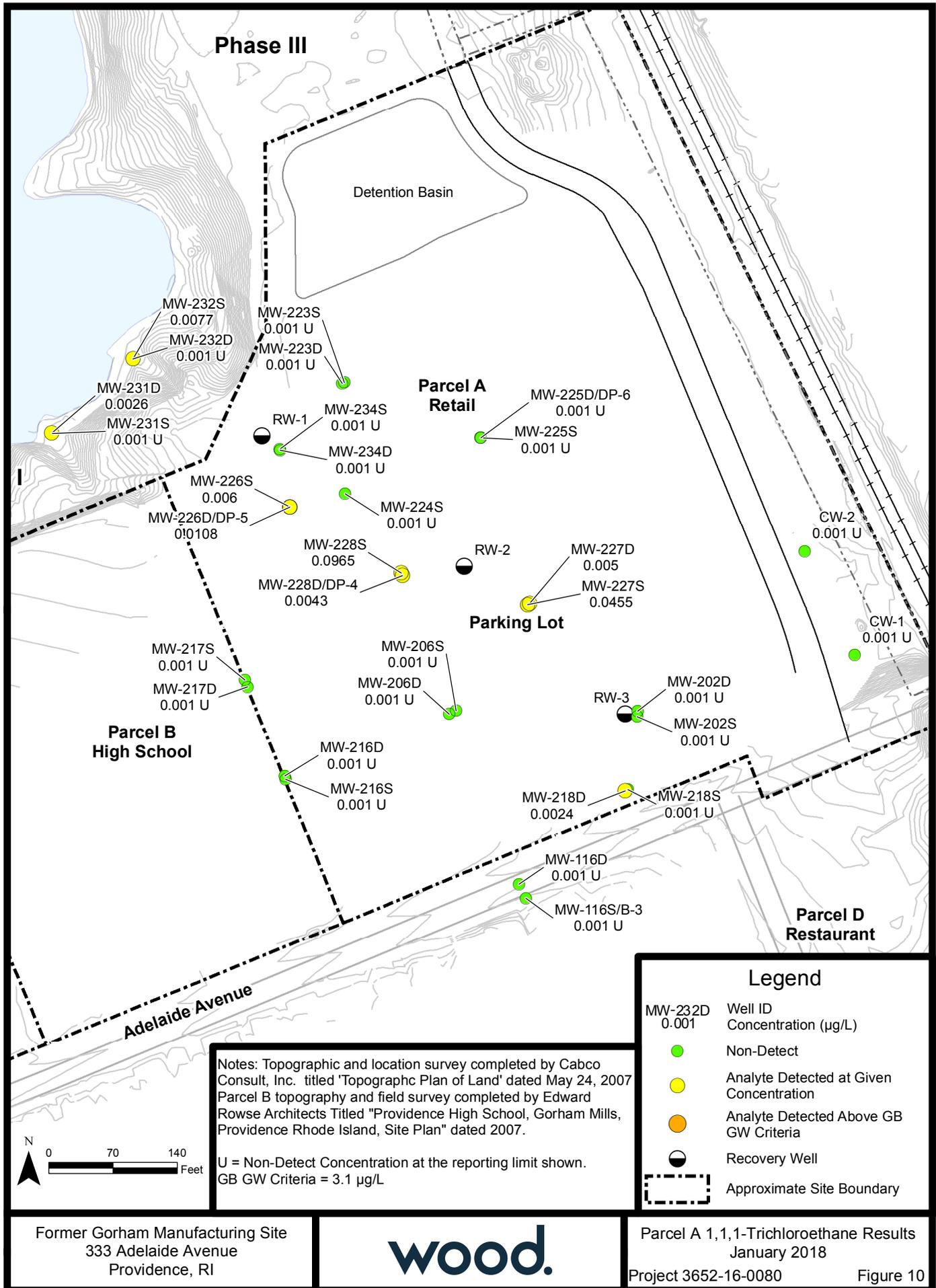
Former Gorham Manufacturing Site  
333 Adelaide Avenue  
Providence, RI



Parcel A 1,1-Dichloroethene Results  
January 2018

Project 3652-16-0080

Figure 9



# Phase III

Detention Basin

Parcel A  
Retail

Parking Lot

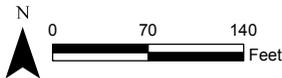
Parcel B  
High School

Parcel D  
Restaurant

Adelaide Avenue

Notes: Topographic and location survey completed by Cabco Consult, Inc. titled "Topographic Plan of Land" dated May 24, 2007  
Parcel B topography and field survey completed by Edward Rowse Architects Titled "Providence High School, Gorham Mills, Providence Rhode Island, Site Plan" dated 2007.

U = Non-Detect Concentration at the reporting limit shown.  
D = Sample was diluted by laboratory.  
GB GW Criteria = 2.4 µg/L



Legend	
MW-232D 0.001	Well ID Concentration (µg/L)
● (Green)	Non-Detect
● (Yellow)	Analyte Detected at Given Concentration
● (Orange)	Analyte Detected Above GB GW Criteria
● (Black and White)	Recovery Well
---	Approximate Site Boundary

Former Gorham Manufacturing Site  
333 Adelaide Avenue  
Providence, RI



Parcel A cis-1,2-Dichloroethene Results  
January 2018

Project 3652-16-0080

Figure 11

# Phase III

Detention Basin

Parcel A  
Retail

Parking Lot

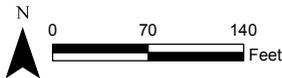
Parcel B  
High School

Parcel D  
Restaurant

Adelaide Avenue

Notes: Topographic and location survey completed by Cabco Consult, Inc. titled "Topographic Plan of Land" dated May 24, 2007  
Parcel B topography and field survey completed by Edward Rowse Architects Titled "Providence High School, Gorham Mills, Providence Rhode Island, Site Plan" dated 2007.

U = Non-Detect Concentration at the reporting limit shown.  
D = Sample was diluted by laboratory.  
GB GW Criteria = 0.15 µg/L



### Legend

MW-232D 0.001	Well ID Concentration (µg/L)
● (Green)	Non-Detect
● (Yellow)	Analyte Detected at Given Concentration
● (Orange)	Analyte Detected Above GB GW Criteria
● (Black/White)	Recovery Well
⋯⋯⋯	Approximate Site Boundary

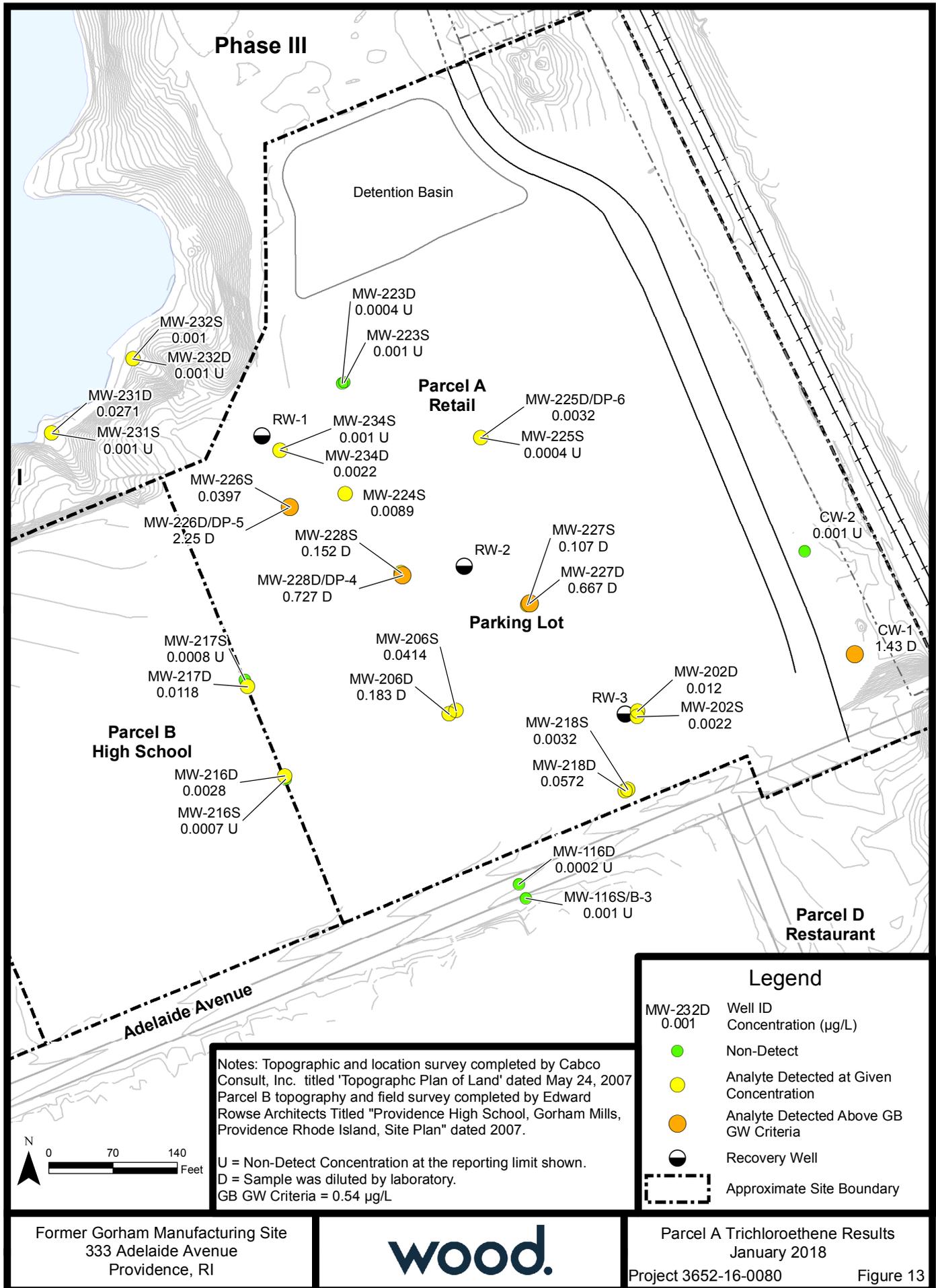
Former Gorham Manufacturing Site  
333 Adelaide Avenue  
Providence, RI

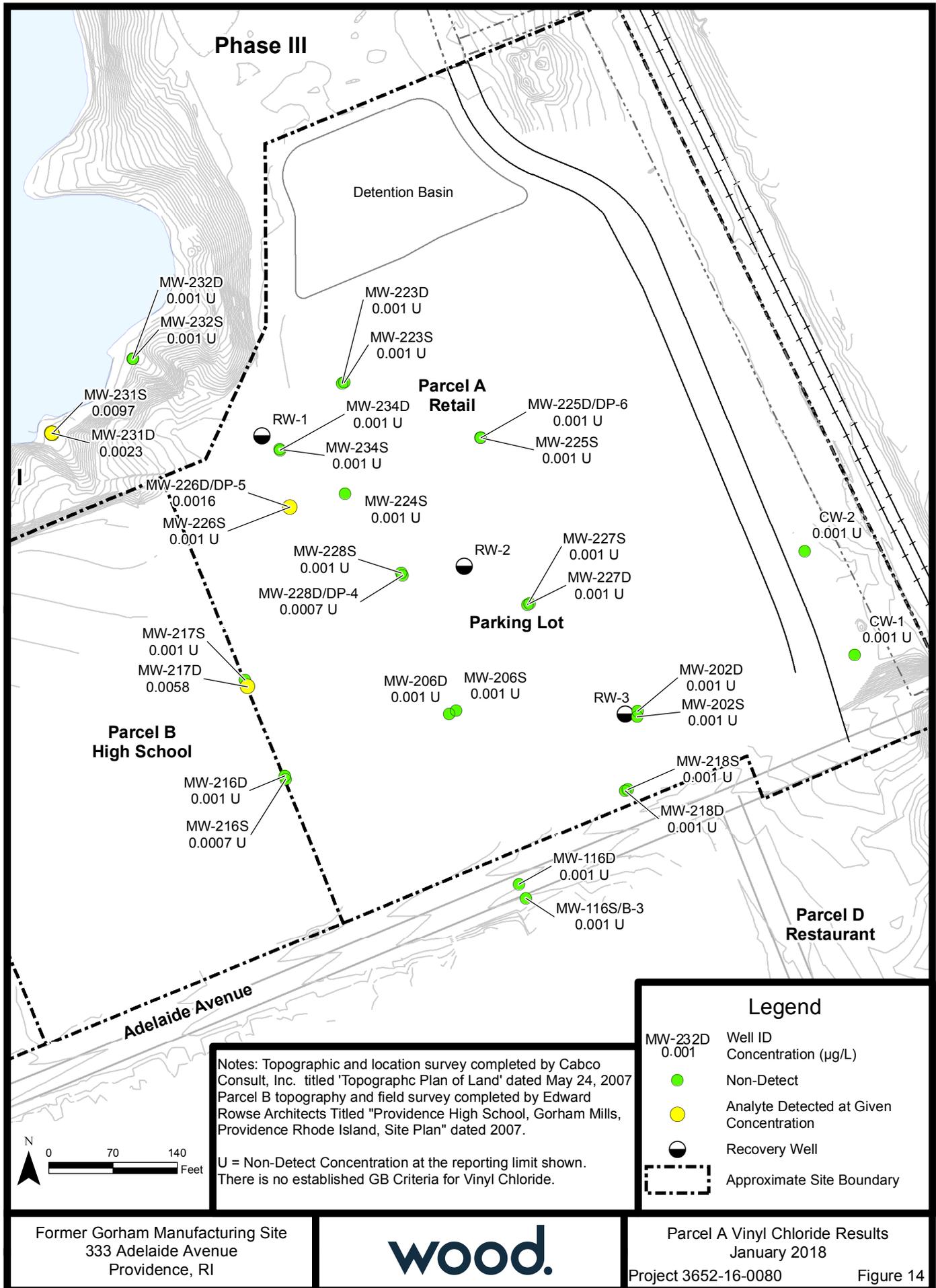


Parcel A Tetrachloroethene Results  
January 2018

Project 3652-16-0080

Figure 12





# LONG-TERM GROUNDWATER MONITORING WELLS

Former Gorham Manufacturing Site

333 Adelaide Avenue  
Providence, Rhode Island

## Legend

-  Monitoring Well
-  Monitoring Well Proposed for Long-Term Groundwater Monitoring
-  Recovery Well
-  Parcel Boundary
-  Structure
-  Mashapoag Pond
-  Groundwater Treatment System Collection Area (Reported)
-  CVOC Plume (Reported)
-  Pavement
-  Railroad

## Location of Site



## Notes & Sources



**wood.**

Wood Environment &  
Infrastructure Solutions, Inc.  
271 Mill Road  
Chelmsford, MA 01824  
(978) 692-9090

FIGURE

15



## **TABLES**

Table 1  
Inventory Results and Proposed Baseline Sampling Wells (Nov 2017)  
Former Gorham Facility  
Providence, RI

Well ID	Gauging Result (11/2/17)		Well Dia (in)	Screen Depth (from MW Construction Diagrams)	Deep/Shallow	Date Installed	Condition of Well	Inventory Comment	Baseline Sampling Rationale
	DTW	DTB							
<b>CW-1</b>				45' - 55'	D	2004		Could not find (fnd 1/2018)	Eastern plume extent*
<b>CW-2</b>	25.45	54.55	2	45' - 55'	D		Acceptable	Found, gauged	Eastern plume extent
<b>CW-6</b>				25' - 35'				Could not find	NP
<b>MW-101D</b>	26.10	46.00	2	38' - 47'	D	1994	Acceptable	Found, gauged	NP
<b>MW-109D</b>	19.00	74.65	2	69' - 79'	D	1994	Acceptable	Found, gauged	NP
<b>MW-112</b>	27.48	34.60	2	23' - 33'	S	1995	stick up	Found, gauged	NP
<b>MW-116S</b>			(4)	20' - 30'	S	1996		(found 1/2018)	S/SE plume margin, potential upgradient*
<b>MW-116D</b>			2	40' - 50'	D	2002		(found 1/2018)	S/SE plume margin, potential upgradient*
<b>MW-201D</b>	25.60	47.36	2	40' - 50'	D	2002	plug no cover	Found, gauged	NP
<b>MW-201S</b>	25.51	29.98	2	20' - 30'	S	2002	Acceptable	Found, gauged	NP
<b>MW-202D</b>				40' - 50'	D	2002		Could not open/gauge 11/2017 (opened 1/2018)	Southeast plume core*
<b>MW-202S</b>	24.83	37.98	1	30' - 40'	S	2002	Acceptable	Found, gauged	Southeast plume core
<b>MW-204D</b>	25.65	48.92	2	40' - 50'	D	2002	Acceptable	Found, gauged	NP
<b>MW-204S</b>	25.58	35.74	2	30' - 40'	S	2002	Acceptable	Found, gauged	NP
<b>MW-206D</b>	25.49	49.56	2	40' - 50'	D	2002	Acceptable	Found, gauged	SE central plume core
<b>MW-206S</b>	25.31	29.05	2	20' - 30'	S	2002	Acceptable	Found, gauged	SE central plume core
<b>MW-207D</b>				45' - 55'	D	2002		Could not open or gauge	NP
<b>MW-207S</b>	25.03	37.40	1	20' - 30'	S	2002	Acceptable	Found, gauged	NP
<b>MW-209D</b>	27.21	62.32	2	55' - 65'	D		Acceptable	Found, gauged	NP
<b>MW-210</b>	26.80	48.20	1		D		Acceptable	Found, gauged	NP
<b>MW-211</b>	25.80	28.38	2	35' - 45', with additional 2' sump (47')	S		Acceptable	Found, gauged	NP
<b>MW-213</b>	25.62	45.30	1	35' - 45'	D		Acceptable	Found, gauged	NP (well loc/ID considered suspect)
<b>MW-216D</b>	26.23	39.35	2	35' - 40'	D		Acceptable	Found, gauged	SW plume margin
<b>MW-216S</b>	26.22	29.60	2	20' - 30'	S		Acceptable	Found, gauged	SW plume margin
<b>MW-217D</b>	25.39	46.71	2	39' - 49'	D		Acceptable	Found, gauged	W plume margin
<b>MW-217S</b>	25.42	26.30	2	20' - 30'	S		Acceptable	Found, gauged	W plume margin
<b>MW-218D</b>	26.49	46.72	2	42' - 52'	D		Acceptable	Found, gauged	S/SE plume margin
<b>MW-218S</b>	26.44	29.50	2	20' - 30'	S		Acceptable	Found, gauged	S/SE plume margin
<b>MW-220S</b>	26.02	31.80	2	22' - 32'	S		Acceptable	Found, gauged	NP
<b>MW-221S</b>		31.76	2	22' - 32'	S	2002	Product in well	Found, gauged	NP
<b>MW-222S</b>		29.77	1	23' - 33'	S		Well is dry	Found, gauged	NP
<b>MW-223D</b>	26.68	53.30	1	49' - 59'	D	2008	Acceptable	Found, gauged	NE plume margin, under commercial building. Evaluate potential for VI pathway
<b>MW-223S</b>	26.60	33.00	1	23' - 33'	S	2008	Acceptable	Found, gauged	NE plume margin, under commercial building. Evaluate potential for VI pathway

Table 1  
Inventory Results and Proposed Baseline Sampling Wells (Nov 2017)  
Former Gorham Facility  
Providence, RI

Well ID	Gauging Result (11/2/17)		Well Dia (in)	Screen Depth (from MW Construction Diagrams)	Deep/Shallow	Date Installed	Condition of Well	Inventory Comment	Baseline Sampling Rationale
MW-224S	27.13	32.49	1	23' - 34'	S		Acceptable	Found, gauged	Plume core, under commercial building. Evaluate potential for VI pathway
MW-225D	26.75	47.29	1	38' -48'	D	2008	Acceptable	Found, gauged	NE plume margin, under commercial building.
MW-225S	26.67	32.27	1	22' - 32'	S	2008	Acceptable	Found, gauged	NE plume margin, under commercial building. Evaluate potential for VI pathway
MW-226D	27.00	55.25	1	46' - 56'	D	2008	Acceptable	Found, gauged	Plume core, under commercial building
MW-226S	27.15	33.62	1	22.5' - 32.5'	S	2008	Acceptable	Found, gauged	Plume core, under commercial building. Evaluate potential for VI pathway. Confirm loc/ID in field.
MW-227D	25.05	58.49	2	50' - 60'	D	2008	cover damaged	Found, gauged	E central plume margin
MW-227S	24.75	29.60	2	20' - 30'	S	2008	Acceptable	Found, gauged	E central plume margin
MW-228D				45' -55'	D	2008		Could not open or gauge 11/2017 (opened 1/2018)	Plume core*
MW-228S				24' -34'	S	2008		Could not open or gauge 11/2017 (opened 1/2018)	Plume core*
MW-229	25.26	70.50	2	229S at 21'-31'; 229D at 50'-60'	D	2008	Acceptable	Found, gauged	NP
MW-231D	3.25	35.70	1	30' - 40'	D	2008	Acceptable	Found, gauged	North/downgradient plume margin
MW-231S	6.94	26.16	1	15' - 25'	S	2008	Acceptable	Found, gauged	North/downgradient plume margin
MW-232D			1	60' -70'	D	2009	Damaged	Could not open or gauge 11/2017 (opened 1/2018)	North/downgradient plume margin*
MW-232S	7.90	48.35	1	30' -40'	S	2009	no plug	Found, gauged	North/downgradient plume margin. Confirm loc/ID in field
MW-234D	23.62	88.52	1	80-90'	D	2009	Acceptable	Found, gauged	Plume core
MW-234S	23.19	31.14	1	22' - 32'	S	2009	Acceptable	Found, gauged	Plume core
MW-308	26.01	46.98	1	30' - 40'	D		no cap or plug	Found, gauged	NP
MW-GZA3	16.88	22.00	2	17' - 22.5'	S		Acceptable	Found, gauged	NP

Notes: Bold wells sampled during baseline sampling event Jan 2018.  
NP = Not proposed for baseline sampling  
D = deep well  
S = shallow well (typically water table well)  
\* = sampling subject to accessing well

Prepared by: HWC 5/4/18  
Reviewed by: TR 5/4/18

Table 2  
Groundwater Gauging Results  
Parcel A, Former Gorham Facility  
Providence, RI

Well	Measuring Point Elevation (ft.)	11/2/2017			1/16/18 - 1/19/18		
		Depth To Water (ft. bgs)	Water Level Elevation (ft.)	Comments	Depth To Water (ft. bgs)	Water Level Elevation (ft.)	Comment
CW-1	65.715	NM		Could not find	25.89	39.825	
CW-2	64.973	25.45	39.523		25.08	39.893	
MW-116D	65.037	NM			25.33	39.707	
MW-116S/B-3	65.385	NM			24.67	40.715	
MW-202D	64.336	NM		Could not open or gauge	24.5	39.836	
MW-202S	64.166	24.83	39.336		24.38	39.786	
MW-206D	65.212	25.49	39.722		25.04	40.172	
MW-206S	65.013	25.31	39.703		24.85	40.163	
MW-216D	66.014	26.23	39.784		25.8	40.214	
MW-216S	66.027	26.22	39.807		25.8	40.227	
MW-217D	65.104	25.39	39.714		24.95	40.154	
MW-217S	65.139	25.42	39.719		24.96	40.179	
MW-218D	65.942	26.49	39.452		26	39.942	
MW-218S	65.91	26.44	39.47		25.95	39.96	
MW-223D	66.401	26.68	39.721		26.4	40.001	
MW-223S	66.429	26.6	39.829		26.59	39.839	
MW-224S	66.534	27.13	39.404		26.59	39.944	
MW-225D/DP-6	66.455	26.75	39.705		26.33	40.125	
MW-225S	66.461	26.67	39.791		26.29	40.171	
MW-226D/DP-5	66.423	27	39.423		26.45	39.973	
MW-226S	66.504	27.15	39.354		26.55	39.954	
MW-227D	64.591	25.05	39.541		24.6	39.991	
MW-227S	64.346	24.75	39.596		24.33	40.016	
MW-228D/DP-4	64.65	NM		Could not open or gauge	24.95	39.7	
MW-228S	64.862	NM		Could not open or gauge	24.72	40.142	
MW-231D	42.479	3.25	39.229		1.54	40.939	
MW-231S	42.817	6.94	35.877		2.89	39.927	
MW-232D	43.223	NM		Could not gauge; riser compromised	2.42	40.803	
MW-232S	43.724	7.9	35.824		4.25	39.474	
MW-234D	63.237	23.62	39.617		22.71	40.527	
MW-234S	62.903	23.19	39.713		2.82	60.083	suspect; do not use

NOTES:

NM = not measured

Prepared by: HWC 2/8/18

Reviewed by: TR 5/4/18

Table 3  
 Summary of Vertical Hydraulic Gradients  
 Parcel A, Former Gorham Facility  
 Providence, RI

Well	11/2/2017						1/16/18 - 1/19/18					
	Water Level Elevation (ft.)	EI Ctr of Sat. Portion of Screen	L	dh	dh/L	Upward or Downward Gradient	Water Level Elevation (ft.)	EI Ctr of Sat. Portion of Screen	L	dh	dh/L	Upward or Downward Gradient
MW-116D	NM						39.707	20.263				
MW-116S/B-3	NM		N/A	N/A	N/A		40.715	37.844	17.58	-1.008	-0.057	D
MW-202D	NM						39.836	19.929				
MW-202S	39.336	30.10	N/A	N/A	N/A		39.786	30.097	10.17	0.05	0.005	U
MW-206D	39.722	20.79					40.172	20.785				
MW-206S	39.703	37.72	16.93	0.02	0.001	U	40.163	37.9475	17.16	0.009	0.001	U
MW-216D	39.784	29.02					40.214	29.016				
MW-216S	39.807	38.13	9.12	-0.02	-0.003	D	40.227	38.3435	9.33	-0.013	-0.001	D
MW-217D	39.714	21.42					40.154	21.419				
MW-217S	39.719	37.54	16.12	-0.01	0.000	D	40.179	37.7705	16.35	-0.025	-0.002	D
MW-218D	39.452	19.33					39.942	19.331				
MW-218S	39.47	37.96	18.63	-0.02	-0.001	D	39.96	38.2045	18.87	-0.018	-0.001	D
MW-223D	39.721	12.86					40.001	12.859				
MW-223S	39.829	36.76	23.90	-0.11	-0.005	D	39.839	36.762	23.90	0.162	0.007	U
MW-225D/DP-6	39.705	23.89					40.125	23.894				
MW-225S	39.791	37.24	13.35	-0.09	-0.006	D	40.171	37.4325	13.54	-0.046	-0.003	D
MW-226D/DP-5	39.423	15.63					39.973	15.634				
MW-226S	39.354	36.74	21.11	0.07	0.003	U	39.954	37.044	21.41	0.019	0.001	U
MW-227D	39.541	9.75					39.991	9.751				
MW-227S	39.596	37.22	27.47	-0.05	-0.002	D	40.016	37.4345	27.68	-0.025	-0.001	D
MW-228D/DP-4	NM						39.7	15.244				
MW-228S	NM		N/A	N/A	N/A		40.142	35.738	20.49	-0.442	-0.022	D
MW-231D	39.229	5.90					40.939	5.898				
MW-231S	35.877	20.87	14.97	3.35	0.224	U	39.927	20.871	14.97	1.012	0.068	U
MW-232D	NM						40.803	-24.053				
MW-232S	35.824	5.97	N/A	N/A	N/A		39.474	5.968	30.02	1.329	0.044	U

NOTES:

Vert Gradient: D indicates downward gradient between paired deep and shallow wells

U indicates upward gradient between paired deep and shallow wells

L: distance between center of saturated portion of paired wells screens, in feet

dh: difference in hydraulic head between paired wells, in feet

dh/L: vertical hydraulic gradient, in feet per foot. Negative sign indicates downward gradient.

NM: Not measured

Prepared by: HWC 3/21/18

Reviewed by: TR 5/4/18

**Table 4**  
**Groundwater Results**  
**Former Gorham Manufacturing Site**  
**Providence, RI**

Analyte:		1,1,1-Trichloroethane	1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride			
Units:		MG/L	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L			
RI GB:		3.1	NS		0.007		2.4		0.15		0.54		NS			
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q		
CW-1	5/4/2016	CW-1	0.05	U	0.05	U	0.05	U	0.094		0.05	U	1.8		0.1	U
	11/1/2016	CW-1	0.04	U	0.04	U	0.04	U	0.18		0.04	U	3.9		0.08	U
	5/17/2017	CW-1	0.02	U	0.02	U	0.02	U	0.36		0.02	U	0.97		0.04	U
	11/28/2017	CW-1	0.02	U	0.02	U	0.02	U	0.8		0.02	U	0.02	U	0.04	U
	1/16/2018	CW-1	0.001	U	0.0005	U	0.0219		0.119	D	0.0006	U	1.43	D	0.001	U
CW-2	5/4/2016	CW-2	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	11/1/2016	CW-2	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	5/17/2017	CW-2	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	11/28/2017	CW-2	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	1/16/2018	CW-2	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U
MW-112/CW-3	2/14/2017	MW-112	0.005	U	0.005	U	0.005	U	0.005	U	0.4		0.032		0.01	U
	5/16/2017	MW-112	0.005	U	0.005	U	0.005	U	0.005	U	0.4		0.0098		0.01	U
	8/17/2017	MW-112	0.005	U	0.005	U	0.005	U	0.005	U	0.18		0.005	U	0.01	U
	11/28/2017	MW-112	0.002	U	0.002	U	0.002	U	0.002	U	0.13		0.011		0.004	U
	2/21/2018	MW-112	0.002	U	0.002	U	0.002	U	0.002	U	0.095		0.015		0.004	U
MW-116D	5/17/2017	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	8/17/2017	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	11/28/2017	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	1/16/2018	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.0002	U	0.001	U
	2/21/2018	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
MW-116S/B-3	5/17/2017	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	8/17/2017	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	11/28/2017	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	1/16/2018	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U
	2/21/2018	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
MW-202D	5/4/2016	MW-202D	0.001	U	0.001	U	0.001	U	0.001	U	0.012		0.001	U	0.002	U
	11/1/2016	MW 202D	0.001	U	0.001	U	0.001	U	0.001	U	0.0068		0.001	U	0.002	U
	5/16/2017	MW-202D	0.001	U	0.001	U	0.001	U	0.001	U	0.028		0.0014		0.002	U
	11/27/2017	MW-202D	0.001	U	0.001	U	0.001	U	0.001	U	0.0047		0.001	U	0.002	U
	1/18/2018	MW-202D	0.001	U	0.001	U	0.001	U	0.001	U	0.039		0.012		0.001	U
MW-202S	5/4/2016	MW-202S	0.001	U	0.001	U	0.001	U	0.001	U	0.042		0.0045		0.002	U
	11/1/2016	MW 202S	0.001	U	0.001	U	0.001	U	0.001	U	0.023		0.0027		0.002	U

**Table 4**  
**Groundwater Results**  
**Former Gorham Manufacturing Site**  
**Providence, RI**

Analyte:		1,1,1-Trichloroethane	1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride			
Units:		MG/L	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L			
RI GB:		3.1	NS		0.007		2.4		0.15		0.54		NS			
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q		
MW-202S	5/16/2017	MW-202S	0.001	U	0.001	U	0.001	U	0.001	U	0.0089		0.001	U	0.002	U
	11/27/2017	MW-202S	0.001	U	0.001	U	0.001	U	0.001	U	0.01		0.001	U	0.002	U
	1/18/2018	MW-202S	0.001	U	0.001	U	0.001	U	0.001	U	0.0114		0.0022		0.001	U
MW-206D	2/22/2006	MW-206D	0.002	U	0.002	U	0.0024		0.0058		0.56		0.26		0.002	U
	5/3/2006	MW-206D	0.0076		0.002	U	0.001	U	0.002	U	0.091		0.18		0.002	U
	8/22/2006	MW-206D	0.02	U	0.02	U	0.01	U	0.02	U	0.27		0.13		0.02	U
	11/28/2006	MW-206D	0.02	U	0.02	U	0.01	U	0.02	U	0.36		0.18		0.02	U
	1/19/2018	MW-206D	0.001	U	0.001	U	0.0032		0.0091		0.121	D	0.183	D	0.001	U
MW-206S	2/22/2006	MW-206S	0.015		0.002	U	0.001	U	0.002	U	0.27		0.29		0.002	U
	5/3/2006	MW-206S	0.002	U	0.002	U	0.001	U	0.002	U	0.0098		0.0032		0.002	U
	8/22/2006	MW-206S	0.011		0.002	U	0.001	U	0.002	U	0.14		0.24		0.002	U
	11/28/2006	MW-206S	0.02	U	0.02	U	0.01	U	0.02	U	0.12		0.22		0.02	U
	1/19/2018	Dup-03	0.001	U	0.001	U	0.001	U	0.001	U	0.0201		0.0401		0.001	U
		MW-206S	0.001	U	0.001	U	0.001	U	0.001	U	0.0206		0.0414		0.001	U
MW-216D	2/28/2011	MW-216D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	8/23/2011	MW-216D	0.002	U	0.002	U	0.001	U	0.003		0.002	U	0.002	U	0.0039	
	2/9/2012	MW-216D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	8/4/2015	MW-216D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.0022		0.002	U
	1/16/2018	MW-216D	0.001	U	0.001	U	0.001	U	0.0006	U	0.001	U	0.0028		0.001	U
MW-216S	2/28/2011	MW-216S	0.002	U	0.002	U	0.001	U	0.066		0.002	U	0.002	U	0.002	U
	8/23/2011	MW-216S	0.002	U	0.002	U	0.001	U	0.052		0.002	U	0.002	U	0.002	U
	2/9/2012	MW-216S	0.002	U	0.002	U	0.001	U	0.062		0.002	U	0.002	U	0.002	U
	8/4/2015	MW-216S	0.002	U	0.002	U	0.002	U	0.11		0.002	U	0.002	U	0.004	U
	1/16/2018	MW-216S	0.001	U	0.0004	U	0.0006	U	0.228	D	0.0009	U	0.0007	U	0.0007	U
MW-217D	2/28/2011	MW-217D	0.002	U	0.002	U	0.001	U	0.028		0.002	U	0.0088		0.002	U
	8/23/2011	MW-217D	0.002	U	0.002	U	0.001	U	0.0091		0.002	U	0.0062		0.002	U
	2/9/2012	MW-217D	0.002	U	0.002	U	0.001	U	0.0046		0.002	U	0.0081		0.002	U
	8/4/2015	MW-217D	0.001	U	0.001	U	0.001	U	0.015		0.001	U	0.0065		0.002	U
	1/16/2018	MW-217D	0.001	U	0.0003	U	0.0007	U	0.0679		0.001	U	0.0118		0.0058	
MW-217S	2/28/2011	MW-217S	0.002	U	0.002	U	0.001	U	0.0068		0.012		0.0024		0.011	
	8/23/2011	MW-217S	0.002	U	0.002	U	0.001	U	0.097		0.004		0.097		0.11	
	2/9/2012	MW-217S	0.002	U	0.002	U	0.001	U	0.0041		0.017		0.002	U	0.002	U

**Table 4**  
**Groundwater Results**  
**Former Gorham Manufacturing Site**  
**Providence, RI**

Analyte:		1,1,1-Trichloroethane	1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride			
Units:		MG/L	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L			
RI GB:		3.1	NS		0.007		2.4		0.15		0.54		NS			
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q		
MW-217S	8/4/2015	MW-217S	0.001	U	0.001	U	0.001	U	0.0074		0.0016		0.001	U	0.0025	
	1/16/2018	MW-217S	0.001	U	0.001	U	0.001	U	0.0002	U	0.0007	U	0.0008	U	0.001	U
MW-218D	8/23/2011	MW-218D	0.002	U	0.002	U	0.001	U	0.002	U	0.3		0.012		0.002	U
	2/8/2012	MW-218D	0.002	U	0.002	U	0.001	U	0.0027		0.23		0.017		0.002	U
	8/4/2015	MW-218D	0.001	U	0.001	U	0.001	U	0.001	U	0.39		0.017		0.002	U
	1/19/2018	MW-218D	0.0024		0.001	U	0.001	U	0.0033		17.2	D	0.0572		0.001	U
	4/18/2018	DUP-01	0.0023		0.001	U	0.0026		0.0127		7.74	D	0.0859		0.001	U
MW-218D		0.002		0.001	U	0.0026		0.0114		7.94	D	0.0791		0.001	U	
MW-218S	8/23/2011	MW-218S	0.002	U	0.002	U	0.001	U	0.002	U	0.0023		0.002	U	0.002	U
	2/8/2012	MW-218S	0.002	U	0.002	U	0.001	U	0.0085		0.0023		0.002	U	0.0045	
	8/4/2015	MW-218S	0.001	U	0.001	U	0.001	U	0.001	U	0.012		0.001	U	0.002	U
	1/19/2018	MW-218S	0.001	U	0.001	U	0.001	U	0.001	U	2.71	D	0.0032		0.001	U
	4/18/2018	MW-218S	0.001	U	0.001	U	0.001	U	0.001	U	0.127	D	0.001	U	0.001	U
MW-223D	3/27/2008	MW223D01	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U
	1/17/2018	MW-223D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.0004	U	0.001	U
MW-223S	11/19/2007	MW-223S	0.0656		0.0023		0.0011		0.001	U	0.001	U	0.0077		0.001	U
	3/27/2008	MW223S01	0.022		0.0012		0.001	U	0.001	U	0.001	U	0.0027		0.001	U
	1/18/2018	MW-223S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U
MW-224S	11/19/2007	MW-224S	1.75	D	0.19	D	0.0525		0.0925	D	0.0021		0.883	D	0.001	U
		MW-224S-Dup	1.96	D	0.19	D	0.0618		0.0955	D	0.0022		0.878	D	0.001	U
	3/28/2008	MW224S01	17.8	D	0.577	D	0.447	D	0.244	D	0.1	UD	6.44	D	0.1	UD
	1/18/2018	MW-224S	0.001	U	0.0014		0.001	U	0.001	U	0.001	U	0.0089		0.001	U
MW-225D/DP-6	3/27/2008	MW225D01	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.0159		0.001	U
	1/17/2018	MW-225D	0.001	U	0.0002	U	0.0003	U	0.0005	U	0.001	U	0.0032		0.001	U
MW-225S	3/27/2008	MW225S01	0.0609		0.0311		0.0033		0.0433		0.001	U	0.0114		0.001	U
	1/17/2018	DUP-01	0.001	U	0.001	U	0.001	U	0.001	U	0.0005	U	0.0005	U	0.001	U
		MW-225S	0.001	U	0.001	U	0.001	U	0.001	U	0.0006	U	0.0004	U	0.001	U
MW-226D/DP-5	4/2/2008	MW 226D01	0.0045		0.0069		0.0798		0.162	D	0.0107		4.87	D	0.003	
	1/18/2018	MW-226D	0.0108		0.0124		0.0688		0.2	D	0.0083		2.25	D	0.0016	
MW-226S	4/2/2008	MW 226S01	0.348	D	0.0632		0.0099		0.014		0.418	D	0.324	D	0.001	U
	1/18/2018	MW-226S	0.006		0.001	U	0.001	U	0.0061		0.331	D	0.0397		0.001	U
MW-227D	3/31/2008	MW 227D01	0.224	D	0.0143		0.158	D	0.0985	D	0.0047		3.94	D	0.001	U

**Table 4  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1- Trichloroethane	1,1- Dichloroethane		1,1- Dichloroethene		cis-1,2- Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride			
Units:		MG/L	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L			
RI GB:		3.1	NS		0.007		2.4		0.15		0.54		NS			
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q		
MW-227D	1/18/2018	MW-227D	0.005		0.0056		0.0074		0.0116		0.0026		0.667	D	0.001	U
MW-227S	3/31/2008	MW 227S01	0.432	D	0.105	D	0.0128		0.0389		0.0221		0.348	D	0.001	U
		MW 227S01 Dup	0.4	D	0.101	D	0.013		0.0384		0.0213		0.312	D	0.001	U
	1/17/2018	MW-227S	0.0455		0.02		0.0027		0.0005	U	0.01		0.107	D	0.001	U
MW-228D/DP-4	4/1/2008	MW 228D01	0.0035		0.0097		0.0422		0.0764		0.0054		0.912	D	0.0019	
	1/16/2018	MW-228D	0.0043		0.0039		0.0203		0.0469		0.0011		0.727	D	0.0007	U
MW-228S	4/1/2008	MW 228S01	0.114	D	0.0443		0.0103		0.0165		3.61	D	0.578	D	0.001	U
		MW 228S01 Dup	0.106	D	0.0432		0.0096		0.0162		3.52	D	0.542	D	0.001	U
	1/17/2018	DUP-02	0.0914		0.0123		0.0217		0.0047		1.16	D	0.152	D	0.001	U
		MW-228S	0.0965		0.0128		0.0232		0.0049		1.19	D	0.152	D	0.001	U
MW-231D	12/1/2009	GWMW231D	0.001	U	0.0024		0.0014		0.0987	D	0.001	U	0.0452		0.0039	
	1/19/2018	MW-231D	0.0026		0.001	U	0.0026		0.0074		0.001		0.0271		0.0023	
MW-231S	12/1/2009	GWMW231S	0.001	U	0.0014		0.0026		0.0342		0.0104		0.0293		0.0203	
	1/19/2018	MW-231S	0.001	U	0.001	U	0.001	U	0.0086		0.001	U	0.001	U	0.0097	
MW-232D	12/1/2009	GWMW232D	0.333	D	0.0317		0.0485		0.0644		0.0008	J	0.601	D	0.0013	
	1/19/2018	MW-232D	0.001	U	0.001	U	0.001	U	0.0011		0.001	U	0.001	U	0.001	U
MW-232S	12/1/2009	GWMW232S	0.189	D	0.0952	D	0.0964		0.118	D	0.0228		1	D	0.0023	
	1/19/2018	MW-232S	0.0077		0.01		0.001	U	0.0047		0.001	U	0.001		0.001	U
MW-234D	12/2/2009	GWMW234D	0.012		0.0037		0.0196		0.0979		0.001	U	0.0232		0.0027	
	1/18/2018	MW-234D	0.001	U	0.001	U	0.0022		0.0158		0.001	U	0.0022		0.001	U
MW-234S	11/30/2009	GWMW234S	1.06	D	0.166	D	0.0371		0.1	D	0.0026		0.489	D	0.0005	J
	1/18/2018	MW-234S	0.001	U	0.0043		0.001	U	0.001	U	0.001	U	0.001	U	0.001	U

Notes:  
mg/L - milligrams per liter  
NS - No Standard Established  
U - Not detected  
J - Estimated Value  
D - Dilution  
Yellow highlighted cells exceed the applicable GB Criteria

Prepared by: AN 5/2/18  
Reviewed by: HWC 5/4/18

Table 5  
Proposed Long-Term Groundwater Monitoring Wells  
Former Gorham Manufacturing Site  
Providence, RI

Well ID	Screen Depth (ft bgs)	Deep or Shallow	Location	Recent CVOC Sampling Frequency/History	Proposed CVOC Sampling Frequency	Comment
<b>CW-1</b>	45' - 55'	D	Eastern plume extent	Semi-annual (GWTS - Nov, May); Jan 2018	Annual	RAWP POC. TCE gradual reduction since 2004
<b>CW-2</b>	45' - 55'	D	Eastern plume extent	Semi-annual (GWTS - Nov, May); Jan 2018	None	RAWP POC. No CVOCs since 11/15, and no GB exceedances since sampling initiated in 2004.
CW-6	25' - 35'		W of retail bldg.	2004, 2009 (GWTS )	None	RAWP POC. Minor detections, all below GB criteria.
MW-101D	38' - 47'	D	SE side of gas station	Semi-annual (GWTS - Nov, May)	None	PCE only CVOC > GB criteria since 2007. PCE < GB criteria in 10 of last 15 events since 2013.
MW-101S		S	SE side of gas station	Semi-annual (GWTS - Nov, May)	Annual	PCE only CVOC > GB criteria since sampling initiated in 1995. PCE > GB criteria in last 7 rounds since 2015. Monitor PCE > GB criteria near S margin of plume.
MW-109D	69' - 79'	D	N, between retail bldg and Pond. Adj to MW-GZA3	Semi-annual (GWTS - Nov, May)	None	RAWP POC. No CVOCs detected in 28 of 29 events initiated in 1994. PCE detected at 0.001 mg/L (the detection limit) in Dec 2017.
MW-112	23' - 33'	S	SE side of gas station	Qtrly (GWTS - Feb, May, Aug, Nov)	Annual	RAWP POC. PCE only GB exceedance since since sampling initiated in 1995 through 83 events. Max PCE concentration 10 mg/L in 2010. PCE < GB criteria in last two events (Nov 2017, Feb 2018). Monitor near S margin of plume.
<b>MW-116S</b>	20' - 30'	S	S/SE plume margin, potential upgradient	Semi-annual (GWTS - Nov, May); Jan 2018	Annual	Very low FOD and concentrations for TCE, PCE. No GB exceedances since sampling initiated in 1996. Potential indoor air risks posed by future increases in CVOCs addressed by SSDS at nearby residences. Sentry well downgradient of plume near residences.
<b>MW-116D</b>	40' - 50'	D	S/SE plume margin, potential upgradient	Semi-annual (GWTS - Nov, May); Jan 2018	None	Very low FOD and concentrations for TCE, PCE. No GB exceedances since sampling initiated in 2002. No potential indoor air risks posed by future increases in CVOCs given depth (and SSDS at nearby residences).
MW-201D	40' - 50'	D	E end former gas station	Semi-annual (GWTS - Nov, May)	Annual	PCE only GB exceedance since 2011 (17 events). PCE concentration ranged from max of 14 mg/L to low of 1.1 mg/L in that period, with avg in 2017 of 6.1 mg/L. Monitor area with historic higher PCE levels.
MW-201S	20' - 30'	S	E end former gas station	8 events from 2002 - 2006	None	Low levels of PCE slightly above GB criteria.
<b>MW-202D</b>	40' - 50'	D	Southeast plume core	Semi-annual (GWTS - Nov, May); Jan 2018	Annual	PCE (principal COC) concentrations have decreased steadily since sampling initiated (2002) from max of 88 mg/L (2006) to low of 0.0089 mg/L (2017). PCE < GB criteria in most recent 6 rounds and 14 of last 20 rounds. Monitor area with historic higher PCE levels. .
<b>MW-202S</b>	30' - 40'	S	SE plume core	Semi-annual (GWTS - Nov, May); Jan 2018	Annual	PCE (principal COC) concentrations have decreased steadily since sampling initiated (2002) from max of 76 mg/L (2006) to low of 0.012 (2016). PCE < GB criteria in most recent 5 rounds and 9 of last 12 rounds . Monitor area with historic higher PCE levels.
<b>MW-206D</b>	40' - 50'	D	SE central plume core	2002 - 2006; Jan 2018	None	2018 PCE < GB criteria. Previously sampled from 2002 - 2006, with low-levels of PCE (max 1.09 mg/L) exceeding the GB criteria
<b>MW-206S</b>	20' - 30'	S	SE central plume core	2002 - 2006; Jan 2018	None	2018 PCE order of magnitude < GB criteria. Previously sampled from 2002 - 2006, with low-levels of PCE (max 0.27 mg/L) sporadically exceeding the GB criteria.

Table 5  
Proposed Long-Term Groundwater Monitoring Wells  
Former Gorham Manufacturing Site  
Providence, RI

Well ID	Screen Depth (ft bgs)	Deep or Shallow	Location	Recent CVOC Sampling Frequency/History	Proposed CVOC Sampling Frequency	Comment
MW-207D	45' - 55'	D	SSE plume core	Semi-annual (GWTS - Nov, May)	None	No CVOC exceedances since 2011 (16 events). PCE only CVOC > GB criteria between first event in 2002 and 2011.
MW-207S	20' - 30'	S	SSE plume core	Qtrly or semi-annually between 2002 and 2015.	None	No CVOC exceedances in 5 events after May 2014.
MW-209D	55' - 65'	D	S of former gas station	Qtrly or semi-annually between 2004 and 2015.	None	RAWP POC. PCE slightly > GB criteria in 22 of 24 events.
<b>MW-216D</b>	35' - 40'	D	SW plume margin	Semi-annual (GWTS - Nov, May); Jan 2018	None	TCE most frequently detected compound. No GB exceedances for all detected analytes in all 19 rounds since sampling initiated in 2006.
<b>MW-216S</b>	20' - 30'	S	SW plume margin	Semi-annual (GWTS - Nov, May); Jan 2018	None	cis-1,2-DCE most frequently detected compound. No GB exceedances for all detected analytes in all 19 rounds since sampling initiated in 2006.
<b>MW-217D</b>	39' - 49'	D	W plume margin	Semi-annual (GWTS - Nov, May); Jan 2018	Annual	PCE & cis-1,2-DCE most frequently detected compounds. No GB exceedances for all detected analytes in all 19 rounds since sampling initiated in 2006. Monitor W margin of plume.
<b>MW-217S</b>	20' - 30'	S	W plume margin	Semi-annual (GWTS - Nov, May); Jan 2018	None	PCE & cis-1,2-DCE most frequently detected compounds, but no GB exceedances in all 19 rounds since sampling initiated in 2006. One anomalous 1,1-DCE result exceeded GB criteria in 2011 sample; all other 18 results ND for 1,1-DCE.
<b>MW-218D</b>	42' - 52'	D	S/SE plume margin	Semi-annual (GWTS - Nov, May); Jan 2018	Semiannual	RAWP POC. Concentrations of TCE, PCE and 1,1-DCE generally decreasing over 19 rounds since sampling initiated in 2006. Since Aug 2009, only PCE has exceeded GB criteria. Anomalous level of PCE (17.2 mg/L) in Jan 2018, significantly higher than all previous rounds. April 2018 confirmatory sample exhibited decrease, but still higher than recent pre-Jan 2018 results. Recommend semi-annual monitoring to evaluate trend.
<b>MW-218S</b>	20' - 30'	S	S/SE plume margin	Semi-annual (GWTS - Nov, May); Jan 2018	Semi-annual	RAWP POC. Concentrations of analytes exhibit general decrease over 19 rounds since sampling initiated in 2006. In 11 rounds since May 2008, no GB exceedances except PCE in 2018 round. Anomalous level of PCE (2.71 mg/L) in Jan 2018, significantly higher than all previous rounds. April 2018 confirmatory sample exhibited decrease, but still higher than recent pre-Jan 2018 results. Recommend semi-annual monitoring to evaluate trend.
<b>MW-223D</b>	49' - 59'	D	NE plume margin, under commercial building.	Sampled in 2008 and Jan 2018	None	No CVOCs detected in 2008 and 2018 events.
<b>MW-223S</b>	23' - 33'	S	NE plume margin, under commercial building.	Sampled in 2007, 2008, and Jan 2018	None	No CVOCs detected in 2018 event. Low levels (< GB criteria) of 3-4 CVOCs detected in 2007/2008.
<b>MW-224S</b>	23' - 34'	S	Plume core, under commercial building.	Sampled in 2007, 2008, and Jan 2018	None	Decrease in both quantity and concentrations of CVOCs since 2007. Two CVOCs, 1,1-DCA and TCE, detected at < GB criteria in 2018. Multiple analytes detected above GB criteria in 2007 and 2008.
<b>MW-225D</b>	38' -48'	D	NE plume margin, under commercial building.	Sampled in 2008 and Jan 2018	None	TCE detected both events 1-2 orders of magnitude below GB criteria. Not a potential source of IA migration.
<b>MW-225S</b>	22' - 32'	S	NE plume margin, under commercial building.	Sampled in 2008 and Jan 2018	None	No CVOCs detected 2018. All five of seven detected analytes in 2008 below GB criteria.

Table 5  
Proposed Long-Term Groundwater Monitoring Wells  
Former Gorham Manufacturing Site  
Providence, RI

Well ID	Screen Depth (ft bgs)	Deep or Shallow	Location	Recent CVOC Sampling Frequency/History	Proposed CVOC Sampling Frequency	Comment
<b>MW-226D</b>	46' - 56'	D	Plume core, under commercial building	Sampled in 2008 and Jan 2018	None	All 7 analytes detected in both events. 1,1-DCE and TCE > GB criteria in 2018 (and 2008).
<b>MW-226S</b>	22.5' - 32.5'	S	Plume core, under commercial building.	Sampled in 2008 and Jan 2018	Annual (winter). Sample at same time as indoor air sampling.	Analytes detected: 6 of 7 in 2008, 4 of 7 in 2018. PCE > GB criteria in 2018. Sample annually for IA migration evaluation, and to represent worst-case IA migration conditions (i.e., winter/heating season).
<b>MW-227D</b>	50' - 60'	D	E central plume margin	Sampled in 2008 and Jan 2018	Annual	Significant decrease in concentrations between 2008 and 2018 events. Two analytes, 1,1-DCE and TCE, slightly exceeded GB criteria in 2018. Monitor E side of middle of plume.
<b>MW-227S</b>	20' - 30'	S	E central plume margin	Sampled in 2008 and Jan 2018	None	Significant decrease in concentrations between 2008 and 2018 events. No GB criteria exceedances in 2018.
<b>MW-228D</b>	45' - 55'	D	Plume core	Sampled in 2008 and Jan 2018	None	Moderate decrease in concentrations between 2008 and 2018 events. Two analytes, 1,1-DCE and TCE, exceeded GB criteria in 2018..
<b>MW-228S</b>	24' - 34'	S	Plume core	Sampled in 2008 and Jan 2018	None	General decrease in concentrations between 2008 and 2018 events. Two analytes, 1,1-DCE and PCE, exceeded GB criteria in 2018.
<b>MW-231D</b>	30' - 40'	D	North/downgradient plume margin	Sampled in 2009 and Jan 2018	Annual	Analytes detected: 5 of 7 in 2009, 6 of 7 in 2018. All detections well below GB criteria. Monitor as downgradient sentry well.
<b>MW-231S</b>	15' - 25'	S	North/downgradient plume margin	Sampled in 2009 and Jan 2018	Annual	Decrease in FOD and concentrations between 2009 and 2018. Analytes detected: 6 of 7 in 2009, 2 of 7 in 2018. All detections well below GB criteria both events. Monitor as downgradient sentry well.
<b>MW-232D</b>	60' - 70'	D	North/downgradient plume margin	Sampled in 2009 and Jan 2018	Annual	Decrease in FOD and concentrations between 2009 and 2018. Analytes detected: 7 of 7 in 2009, 1 of 7 in 2018. 1,1-DCE and TCE > GB criteria in 2009, all detections well below GB criteria in 2018. Monitor as downgradient sentry well.
<b>MW-232S</b>	30' - 40'	S	North/downgradient plume margin	Sampled in 2009 and Jan 2018	Annual	Decrease in FOD and concentrations between 2009 and 2018. Analytes detected: 7 of 7 in 2009, 4 of 7 in 2018. 1,1-DCE and TCE > GB criteria in 2009, all detections well below GB criteria in 2018. Monitor as downgradient sentry well.
<b>MW-234D</b>	80-90'	D	Plume core	Sampled in 2009 and Jan 2018	None	Decrease in FOD and concentrations between 2009 and 2018. Analytes detected: 6 of 7 in 2009, 3 of 7 in 2018. 1,1-DCE and TCE > GB criteria in 2009, all detections well below GB criteria in 2018.
<b>MW-234S</b>	22' - 32'	S	Plume core	Sampled in 2009 and Jan 2018	None	Significant decrease in FOD and concentrations between 2009 and 2018. Analytes detected: 7 of 7 in 2009, 1 of 7 in 2018. 1,1-DCE > GB criteria in 2009. 1,1-DCA detection in 2018 (no criteria available).
MW-GZA3	17' - 22.5'	S	NW plume	Semi-annual (GWTS - Nov, May)	None	RAWP POC. No CVOC exceedances in all 31 events (1986 - 2017)

Notes: **Bolded wells** sampled as part of baseline GW sampling event in Jan 2018.

FOD = frequency of detect (# of detected analytes compared to total # of reported analytes)

CVOC = chlorinated volatile organic compound

GB Criteria = RI groundwater objectives for GB groundwater

mg/L = milligrams per liter

bgs = below ground surface

Prepared by: HWC 5/4/18

Reviewed by: TR 5/4/18

**APPENDIX A**  
**Environmental Land Use Restriction and Soil Management Plan**

### ENVIRONMENTAL LAND USAGE RESTRICTION

This Declaration of Environmental Land Usage Restriction ("Restriction") is made on this 11th day of May, 2015 by the Providence Redevelopment Agency, and its successors and/or assigns (hereinafter, the "Grantor").

#### WITNESSETH:

WHEREAS, the Grantor is the Owner in fee simple of certain real property identified as **Plat 51 Lot 326 (formerly Plat 51, Lot 322 and Portions of Lot 171, and abandoned portions of Alvin Street as depicted on the Class I Survey in Exhibit 2A), 77 Reservoir Avenue located in the City of Providence, Rhode Island (the "Property")**, more particularly described in Exhibit A (Legal Description) which is attached hereto and made a part hereof;

WHEREAS, the Property (or portion thereof identified in the Class I survey which is attached hereto as Exhibit 2A and is made a part hereof) has been determined to contain soil and/or groundwater which is contaminated with certain Hazardous Materials and/or petroleum in excess of applicable **residential and industrial/commercial Direct Exposure Criteria, and GB groundwater objective criteria** pursuant to the Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases ("Remediation Regulations");

WHEREAS, the Grantor and the Department have determined that the environmental land use restrictions set forth below are consistent with the regulations adopted by the Rhode Island Department of Environmental Management ("Department") pursuant to R.I.G.L. § 23-19.141 and that this restriction shall be a Conservation Restriction pursuant to R.I.G.L. § 34-39-1 et. seq. and shall not be subject to the 30 year limitation provided in R.I.G.L. § 34-4-21;

WHEREAS, the Department's written approval of this Restriction is contained in the document entitled: Remedial Decision Letter June 15, 2001, Order of Approval – Short Term Response Action July 24, 2008, Order of Approval Addendum – Short Term Response Action August 7, 2008, and Order of Approval – Remedial Action Work Plan – Groundwater Pump and Treat System December 17, 2012, issued pursuant to the Remediation Regulations;

WHEREAS, to prevent exposure to or migration of Hazardous Substances and to abate hazards to human health and/or the environment, and in accordance with the Remedial Decision Letter June 15, 2001, Order of Approval – Short Term Response Action July 24, 2008, Order of Approval Addendum – Short Term Response Action August 7, 2008, and Order of Approval – Remedial Action Work Plan – Groundwater Pump and Treat System December 17, 2012, the Grantor desires to impose certain restrictions upon the use, occupancy, and activities of and at the **Property (Parcel A)**;

WHEREAS, the Grantor believes that this Restriction will effectively protect public health and the environment from such contamination; and

WHEREAS, the Grantor intends that such restrictions shall run with the land and be binding upon and enforceable against the Grantor and the Grantor's successors and assigns.

NOW, THEREFORE, Grantor agrees as follows:

**A. Restrictions Applicable to the Property (Parcel A):** In accordance with the Remedial Decision Letter June 15, 2001, Order of Approval – Short Term Response Action July 24, 2008, Order of Approval Addendum – Short Term Response Action August 7, 2008, and Order of Approval – Remedial Action Work Plan – Groundwater Pump and Treat System December 17, 2012, the use, occupancy and activity of and at the **Property (Parcel A)** is restricted as follows:

- i. No Residential and institutional (i.e., daycare, childcare, school including adult or college-level students) use of the **Property (Parcel A)** shall be permitted that is contrary to Department approvals and restrictions contained herein;
- ii. No groundwater at the **Property (Parcel A)** shall be used as potable water or non-potable water;
- iii. No soil at the **Property (Parcel A)** shall be disturbed in any manner without written permission of the Department's Office of Waste Management, except as permitted in the Soil Management Plan (SMP) Exhibit B and attached hereto. Since soil in certain areas has been removed or is not contaminated, temporary disturbance of soil is allowed, and compliance with the SMP is not required, when encountering soil for simple maintenance performed in the following areas and depths:
  - Outside of Property (Parcel A) building footprint: from ground surface to a depth of one foot.

The disturbed area is to be returned to a similar condition as existed prior to the temporary disturbance;

- iv. Humans engaged in activities at the **Property (Parcel A)** shall not be exposed to soils containing Hazardous Materials and/or petroleum in concentrations exceeding the applicable Department approved Direct Exposure Criteria set forth in the Remediation Regulations;
- v. Water at the **Property (Parcel A)** shall be prohibited from discharging or infiltrating soils or fill containing Hazardous Materials and/or petroleum in concentrations exceeding the applicable Department approved leachability criteria set forth in the Remediation Regulations, in the area outside the existing building footprint as indicated on Figure 1 of Exhibit B, other than by natural precipitation and infiltration;
- vi. No subsurface structures shall be constructed on the **Property (Parcel A)** over groundwater containing Hazardous Materials and/or petroleum in concentrations exceeding the applicable Department approved GB Groundwater Objectives set forth in the Remediation Regulations;
- vii. The engineered controls at the **Property (Parcel A)** described in the SMP contained in Exhibit B attached hereto shall not be disturbed and shall be properly maintained to prevent humans engaged in **industrial/commercial** activity from being exposed to soils containing Hazardous Materials and/or petroleum in concentrations exceeding the

applicable Department-approved **industrial/commercial** Direct Exposure Criteria in accordance with the Remediation Regulations; and

- viii. The engineered controls at the **Property (Parcel A)** described in the **SMP** contained in Exhibit B attached hereto shall not be disturbed and shall be properly maintained so that water does not infiltrate soils containing Hazardous Materials and/or petroleum in concentrations exceeding the applicable Department-approved leachability criteria set forth in the Remediation Regulations.

Access shall be provided to allow sampling of the compliance monitoring wells, or other actions identified in the Parcel A Groundwater Remedial Action Work Plan (RAWP) dated 10/30/2012 and Addendum/Response to RAWP dated 12/5/2012. Further, the Grantor shall be required to prevent damage to wells, and if such damage does occur (such as during snow removal activities), the Grantor shall repair or replace in a timely manner the damaged well(s) as necessary.

**B. No action shall be taken, allowed, suffered, or omitted at the Property (Parcel A) if such action or omission is reasonably likely to:**

- i. Create a risk of migration of Hazardous Materials and/or petroleum;
- ii. Create a potential hazard to human health or the environment; or
- iii. Result in the disturbance of any engineering controls utilized at the **Property (Parcel A)**, except as permitted in the Department-approved **SMP** contained in Exhibit B.

**C. Emergencies:** In the event of any emergency which presents a significant risk to human health or to the environment, including but not limited to, maintenance and repair of utility lines or a response to emergencies such as fire or flood, the application of Paragraphs A (iii.-viii.) and B above may be suspended, provided such risk cannot be abated without suspending such Paragraphs and the Grantor complies with the following:

- i. Grantor shall notify the Department's Office of Waste Management in writing of the emergency as soon as possible but no more than three (3) business days after Grantor's having learned of the emergency. (This does not remove Grantor's obligation to notify any other necessary state, local or federal agencies.);
- ii. Grantor shall limit both the extent and duration of the suspension to the minimum period reasonable and necessary to adequately respond to the emergency;
- iii. Grantor shall implement reasonable measures necessary to prevent actual, potential, present and future risk to human health and the environment resulting from such suspension;
- iv. Grantor shall communicate at the time of written notification to the Department its intention to conduct the Emergency Response Actions and provide a schedule to complete the Emergency Response Actions;
- v. Grantor shall continue to implement the Emergency Response Actions, on the schedule submitted to the Department, to ensure that the **Property (Parcel A)** is remediated in accordance with the Remediation Regulations (or applicable variance) or restored to its

condition prior to such emergency. Based upon information submitted to the Department at the time the ELUR was recorded pertaining to known environmental conditions at the **Property (Parcel A)**, emergency maintenance and repair of utility lines shall only require restoration of the **Property (Parcel A)** to its condition prior to the maintenance and repair of the utility lines; and

vi. Grantor shall submit to the Department, within ten (10) days after the completion of the Emergency Response Action, a status report describing the emergency activities that have been completed.

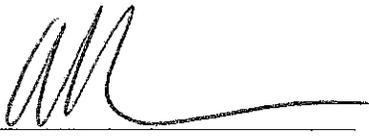
- D. Release of Restriction; Alterations of Subject Area:** The Grantor shall not make, or allow or suffer to be made, any alteration of any kind in, to, or about any portion of the **Property (Parcel A)** inconsistent with this Restriction unless the Grantor has received the Department's prior written approval for such alteration. If the Department determines that the proposed alteration is significant, the Department may require the amendment of this Restriction. Alterations deemed insignificant by the Department will be approved via a letter from the Department. The Department shall not approve any such alteration and shall not release the **Property (Parcel A)** from the provisions of this Restriction unless the Grantor demonstrates to the Department's satisfaction that Grantor has managed the **Property (Parcel A)** in accordance with applicable regulations.
- E. Notice of Lessees and Other Holders of Interests in the Property (Parcel A):** The Grantor, or any future holder of any interest in the **Site**, shall cause any lease, grant, or other transfer of any interest in the **Property (Parcel A)** to include a provision expressly requiring the lessee, grantee, or transferee to comply with this Restriction. The failure to include such provision shall not affect the validity or applicability of this Restriction to the **Property (Parcel A)**.
- F. Enforceability:** If any court of competent jurisdiction determines that any provision of this Restriction is invalid or unenforceable, the Grantor shall notify the Department in writing within fourteen (14) days of such determination.
- G. Binding Effect:** All of the terms, covenants, and conditions of this Restriction shall run with the land and shall be binding on the Grantor, its successors and assigns, and each Owner and any other party entitled to control, possession or use of the **Property (Parcel A)** during such period of Ownership or possession.

**H. Inspection & Non-Compliance:** It shall be the obligation of the Grantor, or any future holder of any interest in the **Property (Parcel A)**, to provide for annual inspections of the **Property (Parcel A)** for compliance with the ELUR in accordance with Department requirements. A qualified environmental professional will, on behalf of the Grantor or future holder of any interest in the **Property (Parcel A)**, evaluate the compliance status of the **Property (Parcel A)** on an annual basis. Upon completion of the evaluation, the environmental professional will prepare and simultaneously submit to the Department and to the Grantor or future holder of any interest in the **Property (Parcel A)** an evaluation report detailing the findings of the inspection, and noting any compliance violations at the **Property (Parcel A)**. If the **Property (Parcel A)** is determined to be out of compliance with the terms of the ELUR, the Grantor or future holder of any interest in the **Property (Parcel A)** shall submit a corrective action plan in writing to the Department within ten (10) days of receipt of the evaluation report, indicating the plans to bring the **Property (Parcel A)** into compliance with the ELUR, including, at a minimum, a schedule for implementation of the plan. In the event of any violation of the terms of this Restriction, which remains uncured more than ninety (90) days after written notice of violation, all Department approvals and agreements relating to the **Property (Parcel A)** may be voided at the sole discretion of the Department.

**I. Terms Used Herein:** The definitions of terms used herein shall be the same as the definitions contained in Section 3 (DEFINITIONS) of the Remediation Regulations.

IN WITNESS WHEREOF, the Grantor has hereunto set (his/her) hand and seal on the day and year set forth above.

PROVIDENCE REDEVELOPMENT AGENCY

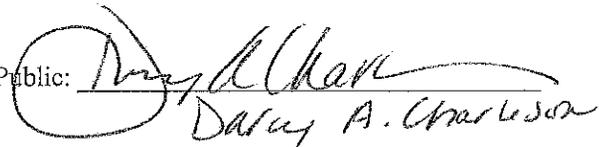
By:   
Grantor

DONALD D. GRALNEK  
Executive Director

STATE OF RHODE ISLAND  
COUNTY OF PROVIDENCE

In Providence, in said County and State, on the 4<sup>th</sup> day of June, 2015, before me personally appeared Donald D. Gralnek, in his capacity as Executive Director of the Providence Redevelopment Agency, to me known and known by me to be the party executing the foregoing instrument and he acknowledged said instrument by him executed to be his free act and deed.

Notary Public:

  
Daray A. Charleson

My Comm. Expires: February 13, 2016

EXHIBIT A  
LEGAL DESCRIPTION

**EXHIBIT A  
LEGAL DESCRIPTION  
FOR PARCEL A REVISED  
A PORTION OF ASSESSOR'S PLAT 51 LOT 170& 171**

That certain tract or parcel of land with all buildings and improvements thereon situated on the northerly side of Adelaide Avenue in the City of Providence, County of Providence, and State of Rhode Island is herein bounded and described;

Beginning at the most southeasterly corner of the herein described parcel, said point being the intersection of the centerline of the abandoned portion of Adelaide Avenue with the westerly line of land now or formerly of National Railroad Passenger Corporation sixty-six (66') foot right of way;

Thence proceeding south  $67^{\circ} 27' 51''$  west along the center line of abandoned Adelaide Avenue a distance of fifty three and  $35/100$  (53.35') feet to a point, bounded southerly by land now or formerly of National Railroad Passenger Corporation;

Thence proceeding south  $25^{\circ} 49' 03''$  east a distance of one hundred seventy two and  $51/100$  (172.51') feet to a point on the northerly street line of Reservoir Avenue, bounded easterly by land now or formerly of National Railroad Passenger Corporation;

Thence proceeding south  $15^{\circ} 34' 51''$  west along the northerly street line of said Reservoir Avenue a distance of one hundred forty two and  $00/100$  (142.00') feet to a point;

Thence proceeding along the arc of a curve with a radius of fifty five and  $00/100$  (55.00') feet and a delta angle of  $57^{\circ} 18' 39''$  a distance of fifty five and  $01/100$  (55.01') feet to a point of reverse curve;

Thence proceeding along the arc of said curve with a radius of one hundred twenty and  $00/100$  (120.00') feet and a delta angle of  $59^{\circ} 20' 17''$  a distance of one hundred twenty four and  $28/100$  (124.28') feet to a point;

Thence proceeding north  $15^{\circ} 21' 27''$  a distance of one hundred nine and  $17/100$  (109.17') feet to a point;

Thence proceeding along the arc of a curve with a radius of sixty and  $00/100$  (60.00') feet and a delta angle of  $16^{\circ} 46' 19''$  a distance of seventeen and  $56/100$  (17.56') feet to a point, on the centerline of the abandoned Adelaide Avenue;

Thence proceeding south  $67^{\circ} 27' 51''$  west a distance of forty nine and  $05/100$  (49.05') feet to a point;

Thence proceeding north  $22^{\circ} 32' 09''$  west a distance of thirty and  $00/100$  (30.00') feet to a point said point being located at the intersection of the easterly street line of Downing Street with the northerly street line of Adelaide Avenue;

**Exhibit A**  
**Legal Description**  
**For Parcel A Revised**  
**A Portion Of Assessor's Plat 51 Lot 170& 171**

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Thence proceeding south  $67^{\circ} 27'49''$  west along the northerly street line of Adelaide Avenue a distance of four hundred seventy four and  $72/100$  (474.72') feet to the most southwesterly corner of the herein described parcel;

Thence proceeding north  $22^{\circ} 32'11''$  west a distance of two hundred ninety seven and  $36/100$  (297.36') feet to a point;

Thence proceeding north  $54^{\circ} 32'43''$  west a distance of fifty eight and  $49/100$  (58.49') feet to a point;

Thence proceeding north  $22^{\circ} 32'11''$  west a distance of one hundred seventy six and  $57/100$  (176.57') feet to a point, the last three courses bounded westerly and southwesterly by Parcel B herein after described;

Thence proceeding north  $64^{\circ} 49'45''$  east a distance of ninety one and  $93/100$  (91.93') feet to a point;

Thence processing north  $24^{\circ} 34'33''$  east a distance of one hundred fifty three and  $23/100$  (153.23') feet to a point;

Thence proceeding north  $00^{\circ} 17'20''$  west a distance of one hundred ninety eight and  $35/100$  (198.35') feet to a point;

Thence proceeding north  $67^{\circ} 33'52''$  east a distance of four hundred eleven and  $45/100$  (411.45') feet to a point on the westerly line of land now or formerly of National Railroad Passenger Corporation, the last four (4) courses bounded northerly, northwesterly, westerly and northerly by Parcel C herein after described;

Thence proceeding south  $25^{\circ} 49'03''$  east along the line of said railroad a distance of eight hundred forty six and  $29/100$  (846.29') feet to the point and place of beginning;

Said parcel contains 552,062 square feet or 12.6 acres more or less.

Said parcel is subject to easements and a cemetery of record and any rights there may be in that portion of abandoned Adelaide Avenue & Downing Street.

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EXHIBIT 2A  
CLASS I SURVEY



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EXHIBIT B  
SOIL MANAGEMENT PLAN

## EXHIBIT B - SOIL MANAGEMENT PLAN - PARCEL A

### 1.0 INTRODUCTION

This Soil Management Plan (SMP) has been prepared to describe the procedures that are necessary to safely manage contaminated soil at Parcel A (Plat 51, Lot 326 [formerly Plat 51 Lot 322, a portion of Lot 171, and a portion of abandoned Alvin Street]) located at 77 Reservoir Avenue (formerly identified as 333 Adelaide Avenue) in Providence, Rhode Island (the Property). The Property consists of approximately 12.6 acres of land that was formerly occupied by the Gorham Manufacturing facility at 333 Adelaide Avenue and abandoned portions of Alvin Street as shown on the plan provided in Exhibit 2A of the Environmental Land Usage Restriction (ELUR).

#### 1.1 *Property Description and Background*

The Gorham Manufacturing Company engaged in the manufacture of silverware, both sterling and plated, and bronze castings from approximately 1890 to 1986. Operations included casting, rolling, polishing, lacquering, forging, plating, annealing, soldering, degreasing, machining and melting. Vapor degreasers reportedly used tetrachloroethylene (PCE), trichloroethylene (TCE) and trichloroethane (TCA) during various periods of operations.

Parcel A refers to the building and surrounding paved areas that are currently used for retail space and parking along the northern side of Adelaide Avenue in Providence, Rhode Island. Parcel A also includes abandoned portions of Alvin and Downing Streets as described in the legal description provided in Exhibit A and shown on the plan provided in Exhibit 2A, of the Environmental Land Usage Restriction (ELUR).

Historic spills and releases of oil and hazardous materials to specific areas of soil and groundwater have occurred at the Property from prior land uses. Remediation activities completed on this Property have isolated contaminants that exceed the applicable Rhode Island Direct Exposure Criteria (RIDEDEC) or UCLs. In general, contaminants that remain in Parcel A soils are as follows:

1. Lead, arsenic, PAHs and dioxin at concentrations that exceed residential and commercial RIDEDEC at various locations.

Groundwater and soil vapor are present in the subsurface of Parcel A that contain volatile organic compounds (VOCs) including the following:

1. PCE, TCE, trichloroethylene (DCE) and TCA in groundwater exceed Remediation Regulation GB criteria.

To prevent exposure, the final remedial action for Parcel A included constructing an engineered barrier (i.e., soil, asphalt, and/or building) to cap all impacted soil, instituting an ELUR to eliminate the potential for direct exposure to contaminated soil, and installing an active sub-slab depressurization system (ASD) to reduce the potential for migration of soil vapor contamination into the on-site buildings via subsurface infiltration. The final remedial action for Parcel A also included the installation and operation of a groundwater remediation system designed to remove and treat VOC-impacted groundwater and to contain the impacted groundwater from migrating into Mashapaug Inner Cove, and implementation of a long-term groundwater monitoring program.

**EXHIBIT B - SOIL MANAGEMENT PLAN - PARCEL A**

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**1.2 Applicability and Purpose of SMP**

This SMP is a component of the ELUR for Parcel A and is intended to address management of impacted soils that may be excavated, temporarily stockpiled, graded, or moved during and after future intrusive activities on Parcel A. Any future intrusive activity conducted on Parcel A is subject to the procedures contained in the ELUR and this SMP. It should be clarified that the procedures contained in this SMP are only necessary for impacted soils located on Parcel A. Clean fill material imported as part of the Parcel A final capping remedy completed in 2002, would not be subject to the SMP requirements. In addition, because soil in certain areas of Parcel A has been removed (e.g., during the Short Term Soil Response Action conducted in 2008) or is not contaminated, the SMP is not required when encountering soil for simple maintenance performed from the ground surface to a depth of one foot below the landscaped or parking lot surface, as shown on the Figure 1 of this SMP. However, any clean soil that is disturbed within or removed from the clean cap soil of Parcel A, must be replaced with soil that is consistent in quality and composition with the existing clean soil cap. Exhibit B, Figure 1 identifies and provides a description of the cap constructed on Parcel A.

**2.0 GOALS**

The goal of and the requirements set forth in this SMP are intended for the handling, stockpiling, and tracking of impacted soil material during future intrusive activities on Parcel A so that the soil is managed properly and handled in a safe manner. Anticipated future Property activities that will require soil management include: excavation for utility installation and repair; re-paving; landscaping; building construction or expansion; and maintenance of components of the Parcel A engineered cap (i.e., soil, asphalt, and/or the building's concrete slab foundation), ASD, and groundwater remediation system.

During all future intrusive activities on Parcel A, the integrity of the engineered cap (i.e., soil, asphalt, and/or the building's concrete slab foundation) must be maintained. Any landscaping, re-paving, and soil re-grading activities must maintain a minimum of 1 foot of clean soil, and demolition of the building's concrete slab foundation is prohibited. Any future building construction or expansion must incorporate design specifications that meet the existing cap conditions, except as prohibited by ELUR Section A Restrictions Applicable to the Property (Parcel A).

**3.0 HEALTH AND SAFETY**

An environmental inspector shall be on Property during any future activity that disturbs (grading, excavation, trenching, drilling, etc.) impacted soil at the Property. Soil that is disturbed during these activities will be physically observed and screened for signs of potential contamination. The environmental inspector will document the soil management actions, perform perimeter and breathing-zone air monitoring (primarily for dust and volatile organics), maintain the operating log, and summarize construction activities into the required progress reports (see Section 5.0 of this SMP).

Worker protection shall be maintained during intrusive activities through air monitoring, dust control measures, and the use of appropriate personal protective equipment (e.g., chemically-resistant gloves).

Standard dust control measures (i.e., water spray) will be instituted during all intrusive activities that have the potential to generate airborne dust. If airborne dust levels cannot be controlled,

## EXHIBIT B - SOIL MANAGEMENT PLAN - PARCEL A

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the intrusive activity generating the dust shall cease until adequate mitigation measures are implemented and dust levels reduced.

### **3.1 Air Monitoring**

Perimeter and breathing-zone monitoring shall be performed during any earthmoving activities involving impacted soil that have the potential to generate airborne dust. Monitoring will primarily focus on dust monitoring to address respirable dust containing non-volatile contaminants (e.g., metals [lead, arsenic], and PAHs). Although considered to be unlikely based on prior investigation activities, inhalation of VOCs is possible from impacted soil or soil vapor and shall be monitored to prevent respiratory exposure. The monitoring will be performed using a hand-held real-time dust meter to measure concentrations of respirable dust and a photo-ionization detector (PID) to measure the concentration of VOCs to ensure the protection of the health of the workers on the Property. The PID shall be equipped with an electron volt (eV) lamp that is capable of detecting the Property contaminants.

Standard breathing zone and perimeter action levels for VOCs and dust shall be developed considering Property-specific contaminant levels in soil and be established in the Health and Safety Plan developed for the intrusive activity.

### **3.2 Security**

During site work, the appropriate precautions will be taken to restrict unauthorized access to the Property.

## **4.0 FUTURE SOIL DISTURBANCE ACTIVITIES**

In accordance with **Section A iii** of the Parcel A ELUR, no soil at the Property is to be disturbed in any manner without prior written permission of the Department's Office of Waste Management, except for minor inspections, maintenance, and landscaping activities that do not disturb the contaminated soil at the Property.

### **4.1 Notification**

This SMP serves to supplement, and will be initiated by, the RIDEM notification requirement established by the ELUR for the property. The notification shall be submitted to the Department no later than 60 days prior to the proposed initiation of the start of property activities.

4.1.1 As part of the notification process, the Property owner shall provide a brief written description of the anticipated Property activity involving soil excavation. The description will include an estimate of the volume of soil to be excavated, the duration of the construction project, a list of the known and anticipated contaminants of concern, a figure clearly identifying the proposed areas to be excavated/disturbed, the proposed location of any temporary storage of the soil, and the proposed disposal location of the soil.

4.1.2 Following written Notification, the Department will determine the post closure reporting requirements. Significant disturbances of regulated soil will require submission of a Closure Report for Department review and approval documenting that the activities were performed in accordance with this SMP and the Department approved ELUR. Minor disturbances of regulated soil may be documented through the annual certification submitted in accordance with **Section H** (Inspection & Non- Compliance) of the Department approved ELUR. The Department will also make a determination regarding

**EXHIBIT B - SOIL MANAGEMENT PLAN – PARCEL A**

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the necessity of performing Public Notice to abutting property owners/tenants concerning the proposed activities. Work associated with the Notification will not commence until written Department approval has been issued. Once Department approval has been issued, the Department will be notified a minimum of two (2) days prior to the start of activities on the Property. Shall any significant alterations to the Department approved plan be necessary, a written description of the proposed deviation, will be submitted to the Department for review and approval prior to initiating such changes.

- 4.1.3 Health and safety procedures will be followed as described in Section 3.0 above and be incorporated into a Property-specific health and safety plan developed for the activity. Excavation or moving of impacted soils will also require that dust suppression measures be available, and that perimeter and breathing-zone monitoring be performed during the course of the activity.

**4.2 Material Handling and Tracking**

The environmental inspector shall keep accurate records of the volumes of soil moved about the Property, the initial location of those volumes of soil, and the final location of the volumes of soil.

- 4.2.1 The excavated soils will either be re-entered to their original location (returned to the excavation) the same day of the removal and will be placed below the applicable engineered control cap, or will be properly stored in a secured location of the Property.
- 4.2.2 To the extent it is necessary during excavation activities, the clean fill material of the engineered cap will be segregated from the regulated soil beneath the cap and stored separately and securely on and under polyethylene sheeting as described in Section 4.3. Best management practices will be utilized to minimize and control generation of dust during excavation, movement or storage of regulated soils in accordance with this SMP and the health and safety plan developed for the activity. Any regulated soil being re-entered will be placed below a RIDEM approved engineered control cap.
- 4.2.3 If the soil cannot be returned to the excavation the same day, then the segregated soils will either be stockpiled separately on polyethylene sheeting (Section 4.3), or stored separately in roll-off type containers. In either case, the segregated material in storage will be covered with secured polyethylene sheeting at the end of each workday. Stockpiled materials will be maintained with appropriate controls and best management practices to limit the loss of the cover and protect against stormwater or wind erosion.
- 4.2.4 If the regulated soil cannot be returned to the original location, then a qualified environmental professional will collect samples of the excavated soils (either during excavation or from stockpiles) for laboratory testing. In the event that regulated soils are generated for which the only effective method of management is off-site disposal, then the testing program will also address the data requirements of the anticipated disposal facility.
- 4.2.5 In the event that certain soils on regulated portions of the Property were not previously characterized, these soils are presumed to be regulated until such time that it is demonstrated to the Department, through sampling and laboratory analysis that they are not regulated.

## **EXHIBIT B - SOIL MANAGEMENT PLAN – PARCEL A**

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- 4.2.6 Excavated soils will be staged and temporarily stored in a designated area of the Property. Within reason, the storage location will be selected to limit the unauthorized access to the materials (i.e., away from public roadways/walkways). No regulated soil will be stockpiled on-property for greater than 60 days without prior Department approval.
- 4.2.7 In the event that stockpiled soils pose a risk or threat of leaching hazardous materials, a proper leak-proof container (i.e., drum or lined roll-off) or secondary containment will be utilized.
- 4.2.8 Soils excavated from the Property may not be re-used as fill on residential property.
- 4.2.9 Soils, which are to be disposed of off-property must be disposed of at a licensed facility in accordance with all local, state, and federal laws. Copies of the material shipping records associated with the disposal of the material shall be maintained by the Property owner and included in the annual inspection report for the Property.
- 4.2.10 Best soil management practices should be employed at all times and regulated soils should be segregated into separate piles (or cells or containers) as appropriate based upon the results of analytical testing, when multiple reuse options are planned (i.e., reuse on-site or disposal at a Department-approved licensed facility).
- 4.2.11 All non-disposable equipment used during the soil disturbance activities will be properly decontaminated as appropriate prior to removal from the Property. All disposable equipment used during the soil disturbance activities will be properly containerized and disposed of following completion of the work. All vehicles utilized during the work shall be properly decontaminated as appropriate prior to leaving the Property as described in the health and safety plan developed for the activity.
- 4.2.12 At the completion of site work, all exposed soils are required to be recapped with Department approved engineered controls consistent or better than the Property surface conditions prior to the work that took place. These measures must also be consistent with the Department approved ELUR recorded on the property.

### **4.3 Polyethylene Barrier**

A polyethylene barrier shall be used to isolate stockpiles (if necessary) from the underlying soils and pavement. The polyethylene shall be a minimum of 6-mil (0.006 inches) thick. At least two layers of polyethylene shall be used to protect the ground surface. At least one layer of 6-mil polyethylene will be used to cover stockpiles at all times; except when modifying stockpiles.

### **4.4 Stockpile Criteria**

Stockpiles of soil exceeding the applicable RIDECS shall be placed on polyethylene sheeting, shall be covered with polyethylene sheeting meeting the requirements of Section 4.3 above, and the sheeting anchored to prevent blowing dust.

## **5.0 REPORTING AND SUBMITTALS**

An annual certification report, and closure report for major activities, will be prepared for all soil management activities at Parcel A.

**EXHIBIT B - SOIL MANAGEMENT PLAN – PARCEL A**

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**5.1 Annual Certification Report**

The qualified environmental professional will evaluate the compliance status of the Property on an annual basis. Upon completion of the evaluation, the environmental professional will prepare and simultaneously submit to the Department and to the Property owner / or future holder of any interest in the Property, an evaluation report detailing the findings of the inspection, and noting any compliance violations at the Property. If the Property is determined to be out of compliance with the terms of the ELUR, the owner / or future holder of any interest in the Property, shall submit a corrective action plan in writing to the Department within ten (10) days of receipt of the evaluation report, indicating the plans to bring the Property into compliance with the ELUR, including, at a minimum, a schedule for implementation of the plan.

In the event of any violation of the terms of this Restriction, which remains uncured more than ninety (90) days after written notice of violation, all Department approvals and agreements relating to the Property may be voided at the sole discretion of the Department.

**5.2 Post-Closure Report**

The post closure reporting requirements will be determined by the Department based on the scope of the proposed activity (Section 4.1.2).

In general, a closure report shall contain the following information:

- i. Summary of material handling and tracking (Section 4.0);
- ii. All analytical results;
- iii. Sampling dates, sample locations with depths;
- iv. Performing Party certification specifying the specific remedial measures completed (i.e. Rule #), and date;
- v. Performing Party certification that public notice to abutters was completed; and
- vi. Details of institutional controls required (ELUR's per Rule 12.06 if required).

Doc No: 00118475  
Book: 11135 Page: 70

EXHIBIT B - FIGURE 1

PARCEL A CAP



**APPENDIX B**  
**Key Figures and Tables from Previously Submitted Reports**



- LEGEND:
- ① - Concrete bunker (former fuel storage)
  - ② - Existing 30,000 gallon fuel oil tanks (2 each)
  - ④ - Former 19,000 gallon fuel oil tanks (2 each)
  - ③ - Former 8,000 gallon fuel oil tanks (3 each)
  - ⑤ - Existing 15,000 gallon fuel oil tanks (2 each)
  - ⑥ - Former 1,000 gallon gasoline tank

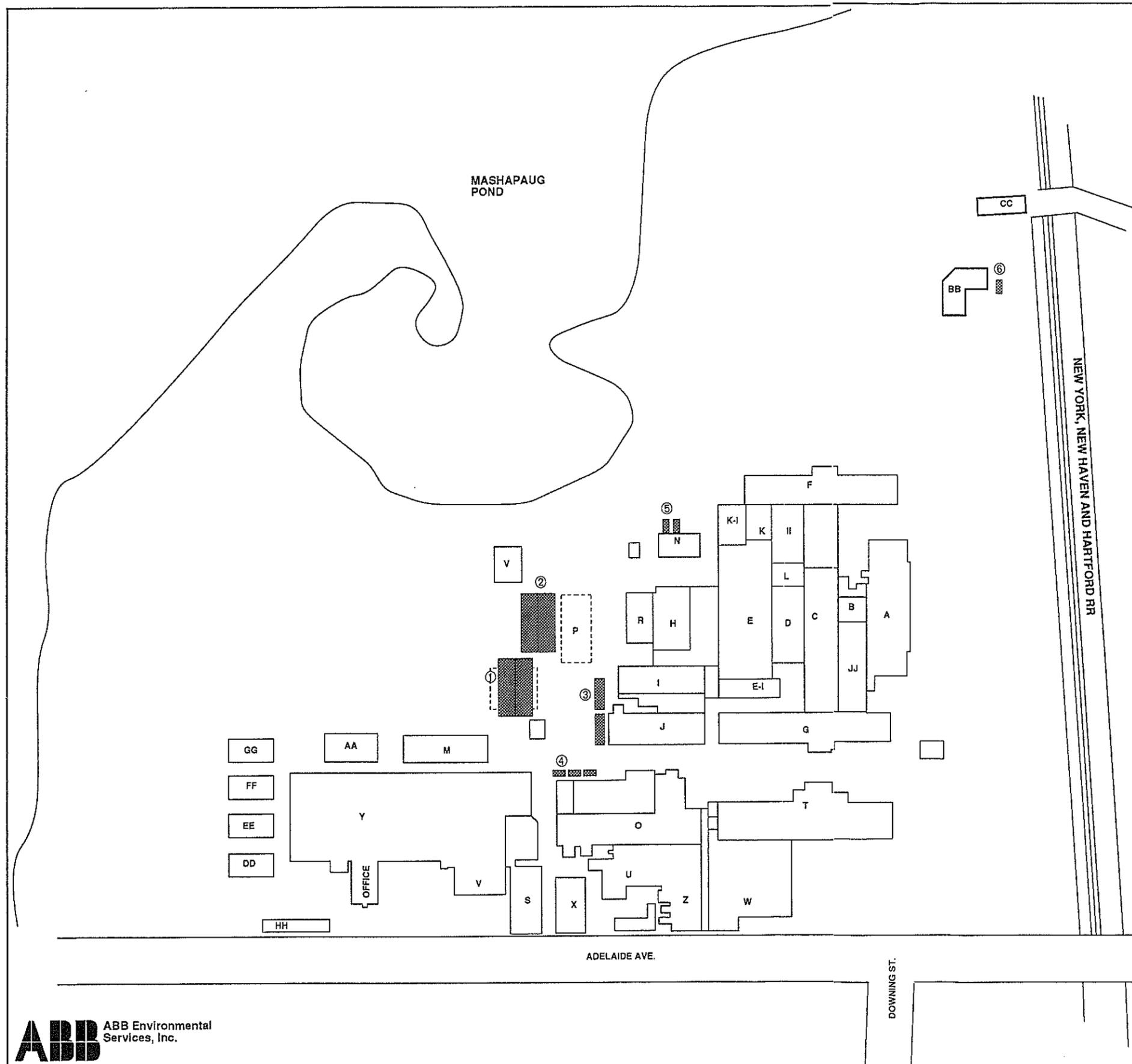
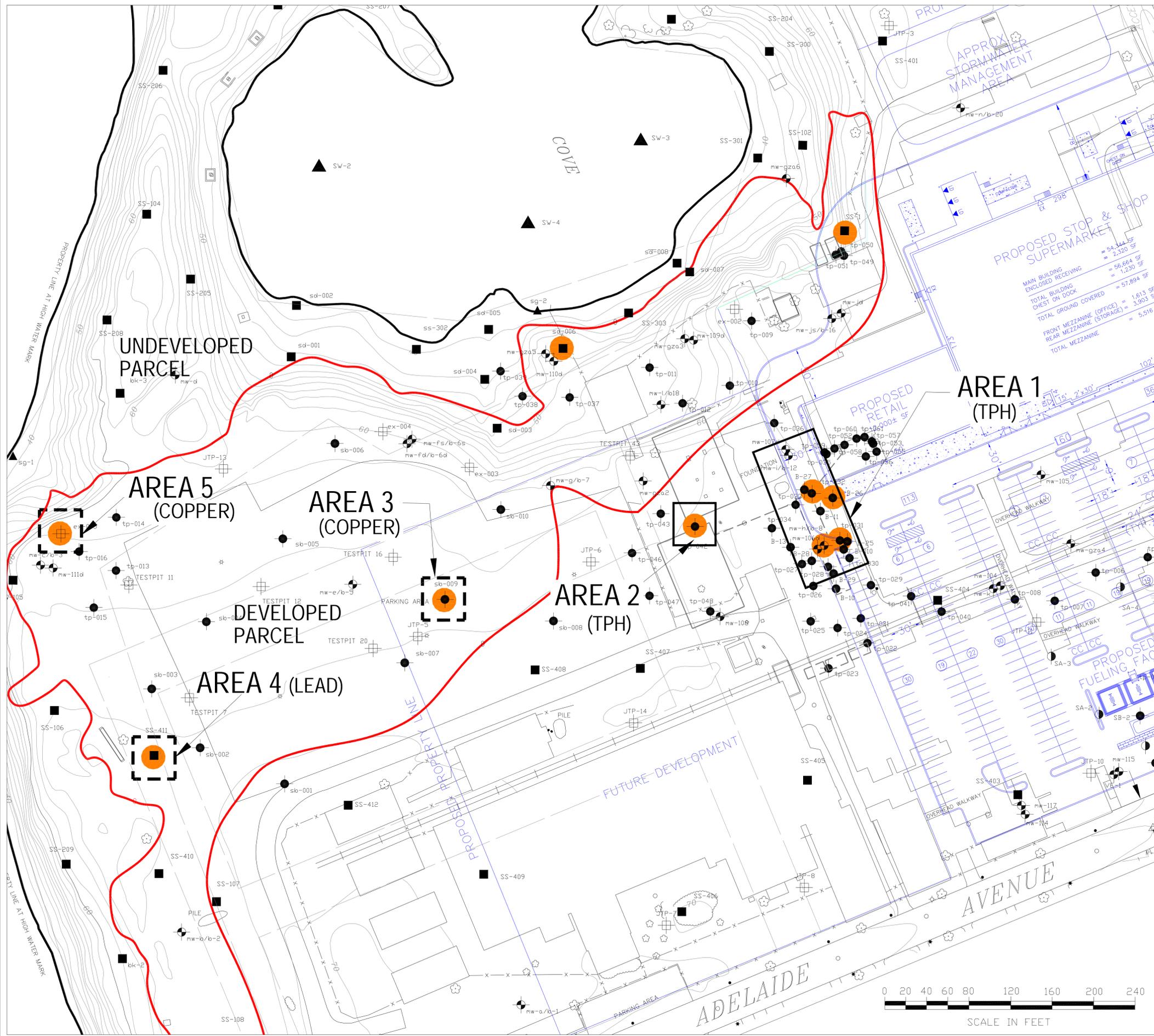


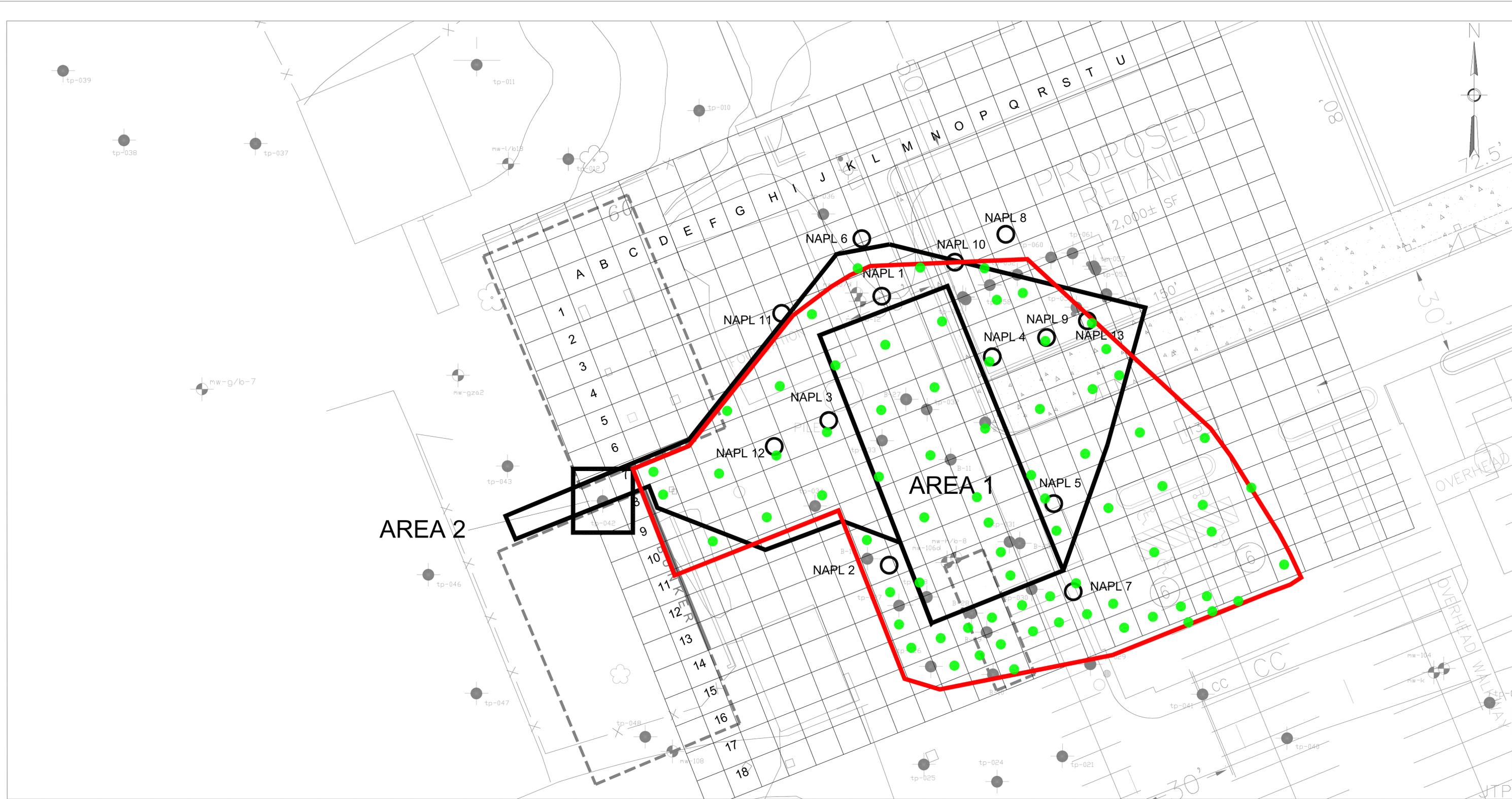
FIGURE 1-2  
SITE MAP WITH EXISTING AND FORMER  
UNDERGROUND STORAGE TANK LOCATIONS  
GORHAM MANUFACTURING SITE  
PROVIDENCE, RHODE ISLAND



**LEGEND:**

- FILL DELINEATION
- SURFACE SOIL SAMPLE
- SOIL BORING
- TEST PIT
- MONITORING WELL
- TEMPORARY SMALL DIAMETER DRIVEN WELL
- UCL EXCEEDANCES
- TPH UCL EXCEEDANCE AREA
- METALS UCL EXCEEDANCE AREA

**FIGURE 1**  
 SOIL AND NAPL TREATMENT AREAS  
 FORMER GORHAM MANUFACTURING FACILITY  
 ADELAIDE AVENUE  
 PROVIDENCE, RI



PREDICTED NAPL PURSUIT AREA  
 ACTUAL NAPL PURSUIT AREA

- NEW MICROWELL LOCATION (w/PRODUCT THICKNESS AND DATE)
- CONFIRMATORY SAMPLE LOCATIONS
- FORMER BORING LOCATION
- FORMER WELL LOCATION



**FIGURE 3**  
 ACTUAL NAPL EXTENT AND SAMPLE LOCATIONS  
 FORMER GORHAM MANUFACTURING FACILITY 333  
 ADELAIDE AVENUE  
 PROVIDENCE, RI  
 PROJECT # 54823



**APPENDIX B-2**

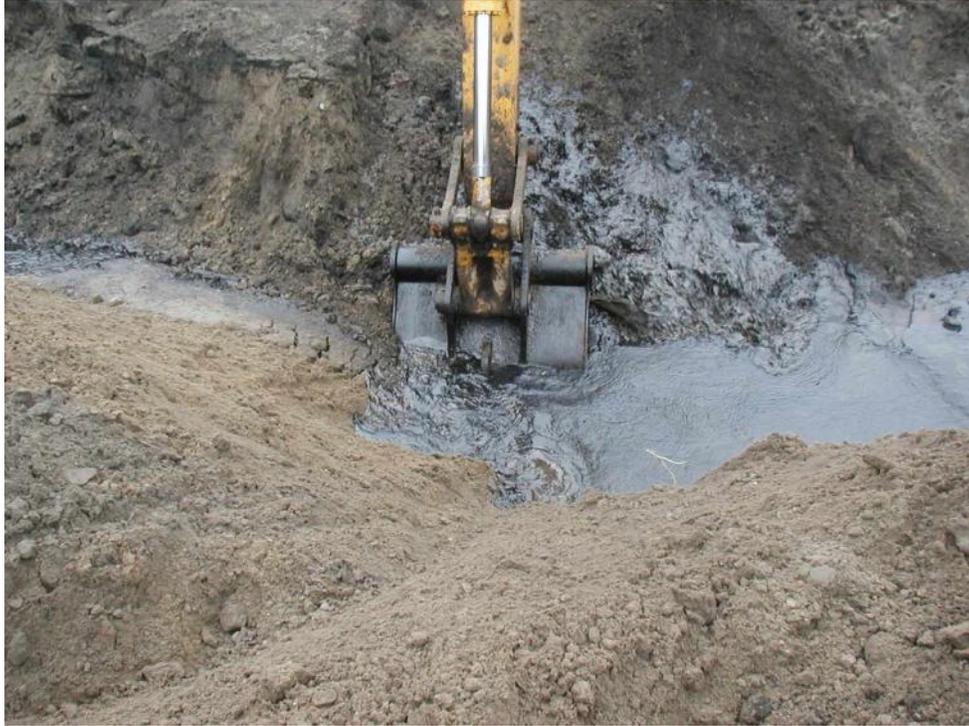
**PHOTOGRAPHS**



**Photo 1. NAPL excavation looking east. Clean backfill on right side, excavation of NAPL soils on the left.**



**Photo 2. Removing NAPL soils.**



**Photo 3. NAPL soil removal below water table.**



**Photo 4. View south. Removal of NAPL soils near concrete bunker at west end of excavation.**



**Photo 5. Backfill and compaction at east end of NAPL excavation.**



**Photo 6. Compaction testing with nuclear density gauge.**



**Photo 7. View west towards concrete bunker prior to removal of foreground soils.**



**Photo 8. View towards northwest with much of the soil on east side of concrete bunker removed.**



**Photo 9.** Clean soil beneath bunker. Note crack developing in bunker wall just to the right of top center in the photo.



**Photo 10.** Clean soils directly beneath bunker. Note staining of underside of bunker floor is not continuous.



**Photo 11. Clean soils directly beneath bunker, with limited staining of underside of bunker floor.**



**Photo 12. Clean soils directly beneath bunker.**



**Photo 13. Clean soils directly beneath bunker.**



**Photo 14. View northwest during backfilling.**



**Photo 15. View northwest during backfilling.**



**Photo 16. View west during backfilling.**



**Photo 17. View east from southwest corner of excavation with backfilling nearly complete.**



**Photo 18. View east from west edge of excavation with backfilling nearly complete.**



**Photo 19. View east after backfilling and site cleanup.**



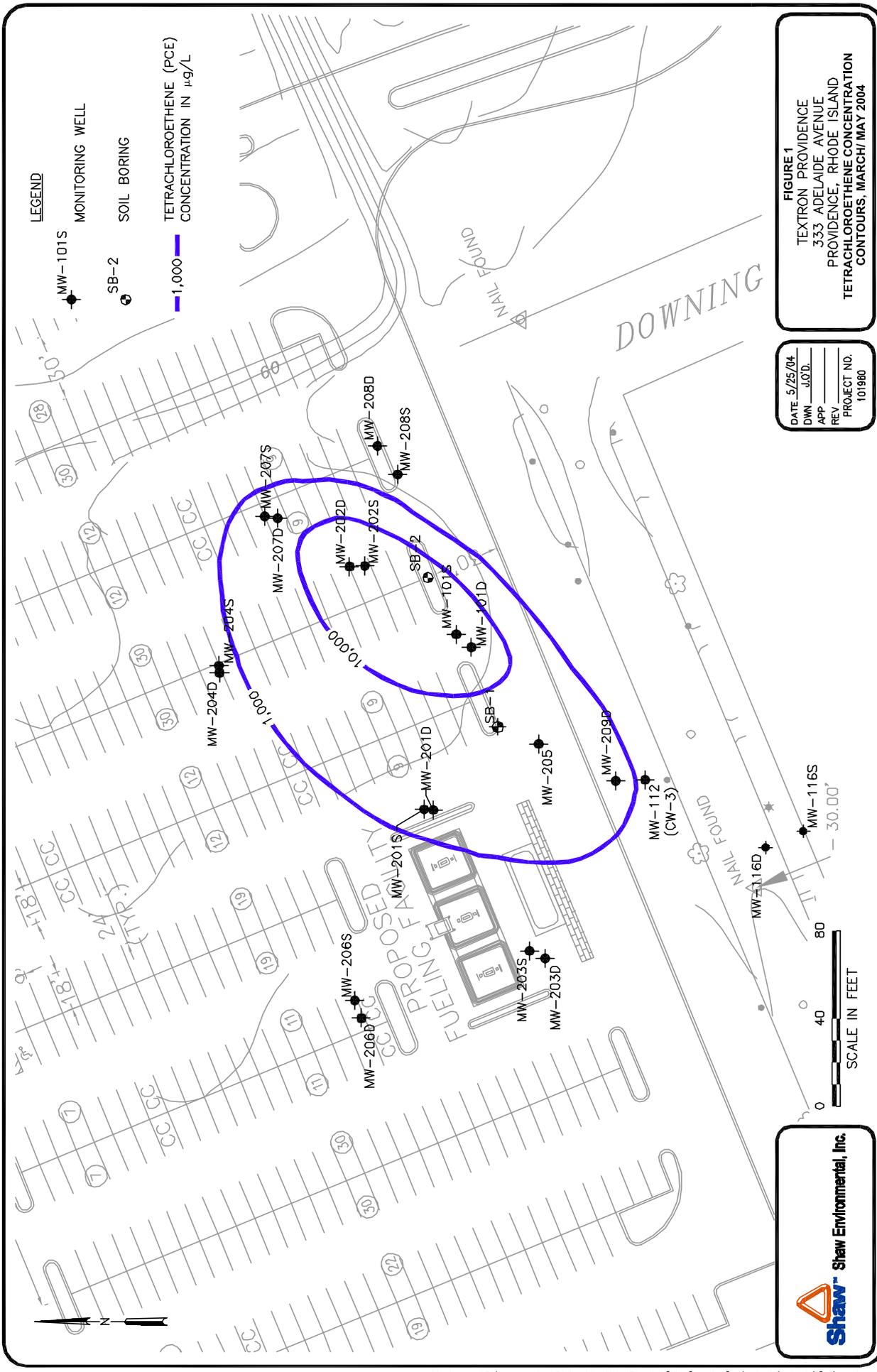
**Photo 20. View north from southwest corner of site after final backfill and demobilization.**



**Photo 21. View northeast from southwest corner of site after final backfill and demobilization.**



**Photo 22. View east from southwest corner of site after final backfill and demobilization.**



**LEGEND**

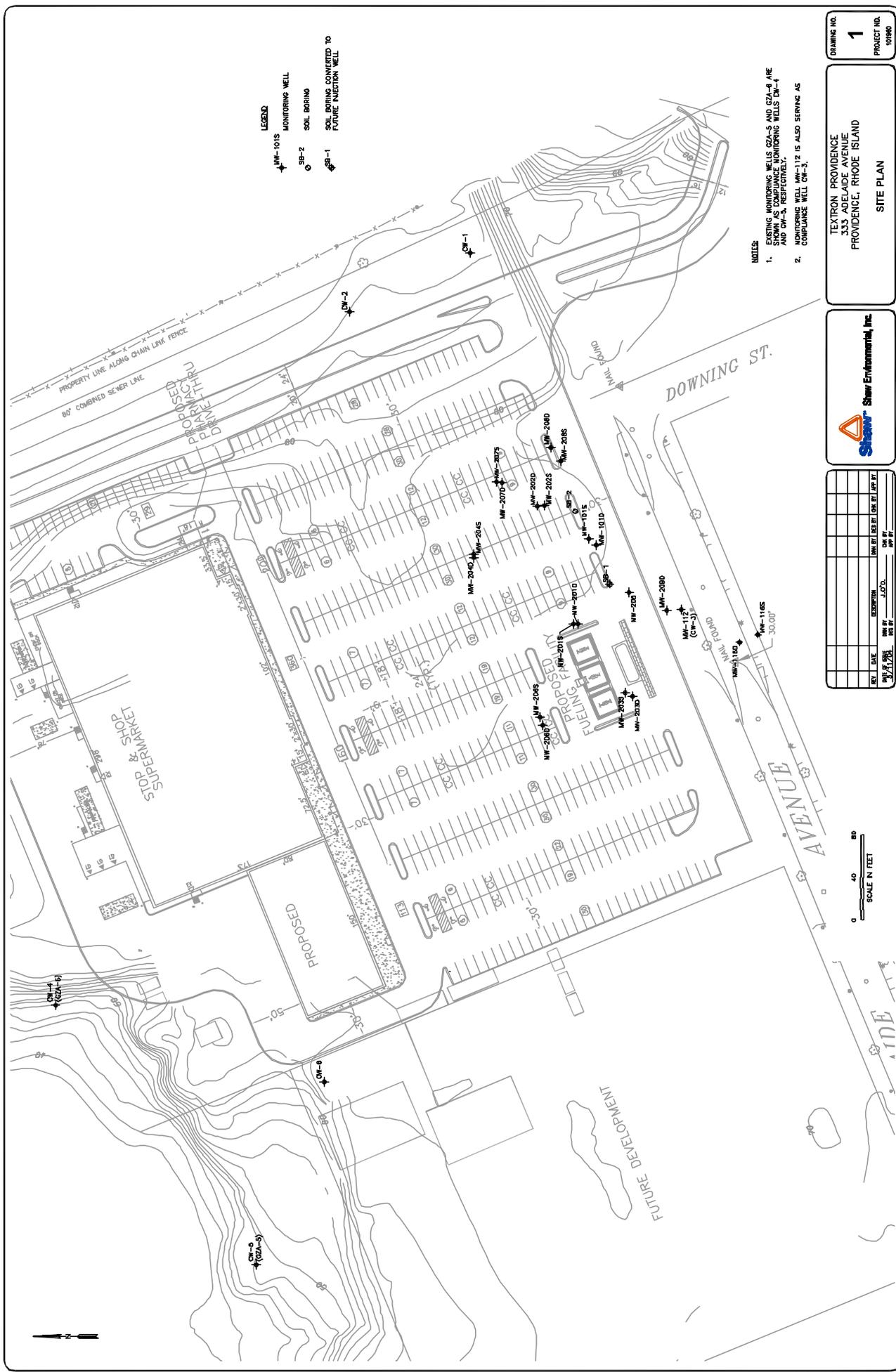
- MW-101S
- SB-2
- TETRACHLOROETHENE (PCE) CONCENTRATION IN µg/L

DATE	5/25/04
DWN	J.O.D.
APP	
REV	
PROJECT NO.	101980

**FIGURE 1**  
 TEXTRON PROVIDENCE  
 333 ADELAIDE AVENUE  
 PROVIDENCE, RHODE ISLAND  
 TETRACHLOROETHENE CONCENTRATION  
 CONTOURS, MARCH/MAY 2004

**Shaw** Shaw Environmental, Inc.





REV.	DATE	DESCRIPTION	BY	CHK'D BY	DATE
1	07/11/2011	ISSUED FOR PERMIT	WJ	WJ	07/11/2011



TEXTRON PROVIDENCE  
 333 ADELAIDE AVENUE  
 PROVIDENCE, RHODE ISLAND

**SITE PLAN**

DRAWING NO. **1**  
 PROJECT NO. 101980

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**APPENDIX C**  
**Parcel A Cap Documents**



### Soil Boring Log

MACTEC  
107 Audubon Road  
Wakefield, MA

<b>Boring Location:</b> DP-1		<b>Page</b> <u>1</u> <b>of</b> <u>4</u>	
<b>Project Name:</b> Gorham	<b>Geologist:</b> PM		
<b>Date Started:</b> 3/12/2008	<b>Drilling Company:</b> Geologic		
<b>Date Completed:</b> 3/13/2008	<b>Drilling Method:</b> Geoprobe 6620		
<b>Total Depth:</b> 72'	<b>Depth to Water:</b> 23'		
<b>Job No. 3650050041.16</b>			

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
0' - 4'	4" asphalt; 2" tan, f to coarse SAND, tr Gravel; 5" dk brown, f to coarse SAND, tr Gravel, tr Brick	4 1/3'	-	-	
	6" tan, f to coarse SAND, tr Gravel; 5" Dk brown f to coarse SAND, tr Gravel, tr brick				
	14" brown, f to coarse SAND, tr Gravel, tr Cobble; refusal @ 6', move 4' west				
4' - 8'	1.5' brown, f to coarse SAND, tr Gravel, tr Brick	4 1/2.8'	0.3 (6 ft)	-	
	6" weathered rock; 6" rock/boulder; 3" tan, med to coarse SAND, some Gravel				

Prepared by: PJM  
Checked by: MAM



### Soil Boring Log

MACTEC  
107 Audubon Road  
Wakefield, MA

Boring Location:

DP-1

Page 2 of 4

Project Name: Gorham

Geologist: PM

Date Started: 3/12/2008

Drilling Company: Geologic

Date Completed: 3/13/2008

Drilling Method: Geoprobe 6620

Total Depth: 72'

Depth to Water: 23'

Job No. 3650050041.16

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
8-12'	10" slough; 28" tan, med to coarse SAND, some Gravel	4'/3.1'	0.3 (10ft)	-	
12-16'	8" same as above; 4" brown and dk brown f. to coarse SAND, tr Gravel, tr Brick, trace grey Silt/Clay	4'/3.3'	0.6 (13 ft)	-	
	26" lt. brown/white med to coarse SAND, tr Gravel				
16-20'	10" lt. brown f to coarse SAND, some f Sand, brown streaks	4'/3.1'		-	
	4" brown f to coarse SAND, tr Gravel; 4" dk brown, f to coarse SAND, tr Gravel and Brick				
	19" lt brown, med to coarse SAND; (2.2 -2.5' lt brown lens of f. SAND)		0.2 (19 ft)		
20-24'	18" brown f to coarse SAND, some Gravel; 20" lt brown f SAND; tip is wet	4'/3.1'	0.2 (22 ft)	-	

Prepared by: PJM  
Checked by: MAM



### Soil Boring Log

MACTEC  
107 Audubon Road  
Wakefield, MA

Boring Location:

DP-1

Page 3 of 4

Project Name: Gorham

Geologist: PM

Date Started: 3/12/2008

Drilling Company: Geologic

Date Completed: 3/13/2008

Drilling Method: Geoprobe 6620

Total Depth: 72'

Depth to Water: 23'

Job No. 3650050041.16

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
24-28'	10" dk brown, f to med SAND, tr Gravel, wet; 6" dk brown, f. SAND, wet	4'/2.8'	0.2 (26 ft)	-	
	17" dk brown, f to coarse SAND, tr Gravel, wet				
28-32'	17" dk brown, f to coarse SAND, tr Gravel, wet; 6" lt brown/iron stained, med to coarse SAND, tr Gravel, wet; 6" dk brown, f to coarse SAND, wet	4'/2.5'	2.2 (30 ft)	-	
32-36'	18" dk brown f SAND, wet; 4" dk brown f to coarse SAND, tr Gravel; 22" lt brown/red/orange f to coarse SAND, tr Gravel, wet	4'/4'	2.0 (35 ft)	-	
36-38'	Liner was managled, soil inside was grey, f SAND, wet		0.1 (37 ft)		
38-42'	20" dk grey f to med SAND, wet; 8" dk grey/black med to coarse SAND, wet; 10" grey f SAND, wet; 8" grey f to med SAND, wet	4'/4'	0.5 (40 ft)		

Prepared by: PJM  
Checked by: MAM



### Soil Boring Log

MACTEC  
107 Audubon Road  
Wakefield, MA

<b>Boring Location:</b> DP-1		<b>Page</b> <u>4</u> <b>of</b> <u>4</u>	
<b>Project Name:</b> Gorham	<b>Geologist:</b> PM		
<b>Date Started:</b> 3/12/2008	<b>Drilling Company:</b> Geologic		
<b>Date Completed:</b> 3/13/2008	<b>Drilling Method:</b> Geoprobe 6620		
<b>Total Depth:</b> 72'	<b>Depth to Water:</b> 23'		
<b>Job No. 3650050041.16</b>			

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
44-48'	48" dk grey, v. fine SAND, some Silt, wet	4/4'	0.2 (46 ft)	-	
48-56'	No sample collected				
56-60'	48" dk grey f SAND, tr Silt, wet	4/4'	0.1 (58 ft)	-	
60-72'	No sample collected. Point placed on rods and driven to dense material. End of boring at 72' bgs.				

Prepared by: PJM  
Checked by: MAM



**Soil Boring Log**

MACTEC  
107 Audubon Road  
Wakefield, MA

**Boring Location:**

**DP-5/MW-226**

Page 1 of 2

**Project Name:** Gorham

**Geologist:** PJM

**Date Started:** 3/17/2008

**Drilling Company:** Geologic

**Date Completed:** 3/18/2008

**Drilling Method:** Geoprobe

**Total Depth:** 56'

**Depth to Water:** 26'

**Job No. 3650050040.16**

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
0-4'	6" concrete slab; 12" olive brown, f to coarse SAND, tr Gravel, tr Silt; 6" brown, f to coarse SAND, tr Gravel, tr Silt	4/2.6'		-	
	11" olive grey, f to coarse SAND, tr Gravel, tr Silt; 2" brown, f to coarse SAND, lens of grey Silt; Tip - black, f to med SAND		3.0 (3 ft)		
4-8'	6" grey, f SAND, some Silt, tr Gravel; 36" brown and lt grey, f to coarse SAND, tr Gravel, tr Cobble, lens of lt grey, f sand at 7.5'	4/3.5'	3.1 (7 ft)	-	
8-12'	10" grey, f to med SAND and SILT; 28" lt brown/tan, f to coarse SAND and GRAVEL	4/3.2'	3.8 (10 ft)	-	
12-16'	10" dk brown, f to med SAND, some coarse Sand, tr Silt; 15" tan, f to coarse SAND, tr Gravel; lens of dk brown f SAND and SILT at 15'; 2" grey f to coarse SAND	4/2.2'	2.7 (14 ft)	-	
16-20'	32" tan and dk brown, f to coarse SAND, tr Gravel, tr Silt	4/2.8'	2.0 (18 ft)	-	
20-24'	42" same as above	4/3.6'	1.6 (22 ft)		

Prepared by: PJM  
Checked by: MAM



### Soil Boring Log

MACTEC  
107 Audubon Road  
Wakefield, MA

Boring Location:

**DP-5/MW-226**

Page 2 of 2

Project Name: Gorham

Geologist: PJM

Date Started: 3/17/2008

Drilling Company: Geologic

Date Completed: 3/18/2008

Drilling Method: Geoprobe

Total Depth: 56'

Depth to Water: 26'

Job No. 3650050040.16

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
24-28'	36" same as above	4'3'	1.3 (27 ft)	-	
28-40'	no samples collected				
40-44'	grey, f to med SAND, wet; tip: black, f SAND, tr Silt, wet	4'3.7'	13.5 (44 ft)		
44-52'	no samples collected				
52-56'	24" grey f SAND and SILT, wet; 24" grey f SAND, some Silt, wet, dense. End of Boring at 56'.	4'4'	4.0 (55 ft)		

Prepared by: PJM  
Checked by: MAM



**Soil Boring Log**

MACTEC  
107 Audubon Road  
Wakefield, MA

<b>Boring Location:</b> DP-6/MW-225		Page <u>1</u> of <u>2</u>	
<b>Project Name:</b> Gorham	<b>Geologist:</b> PJM		
<b>Date Started:</b> 3/20/2008	<b>Drilling Company:</b> Geologic		
<b>Date Completed:</b> 3/20/2008	<b>Drilling Method:</b> Geoprobe		
<b>Total Depth:</b> 48'	<b>Depth to Water:</b> 23'		
<b>Job No. 3650060041.16</b>			

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
0-4'	6" concrete slab; 5" grey SILT; 26" matrix of grey SILT, some f Sand and brown/grey f Sand and Silt, some Gravel, brick fragments at 9" and 2'	4/3'	0.7 (2 ft)	-	
	4" dk brown, f to coarse SAND, some Gravel				
4-8'	17" grey, SILT, some f Sand, tr Gravel; 27" brown/grey f. to coarse SAND and GRAVEL	4/4'	1.5 (5.5 ft)	-	
8-12'	3"dk grey, f to coarse SAND, tr Gravel, tr Silt; 2" FILL (brick and wood fragments mixed with dk brown/black f to coarse SAND, strong foul odor); 8" dk grey, f to coarse SAND and GRAVEL	4/3'	26 (10 ft, in fill section)	-	odor may be creosote
	6" FILL (same as fill above); 8" dk grey, f to coarse SAND and GRAVEL; 8" grey, f SAND				
12-16'	19" matrix of dk grey SILT, f SAND, and FILL (brick and wood fragments w/odor); 24" grey, f to coarse SAND and GRAVEL (includes 2" lens of fill)	4/3.7'	2.4 (14 ft)	-	
16-20'	5" grey, f to coarse SAND and GRAVEL; 11"dk brown f. to coarse SAND, tr Silt, tr Gravel; 17" grey f to med SAND, tr Gravel	4/2.9'	7.3 (18 ft)	-	

Prepared by: PJM  
Checked by: MAM



**Soil Boring Log**

MACTEC  
107 Audubon Road  
Wakefield, MA

<b>Boring Location:</b> DP-6/MW-225		<b>Page</b> <u>2</u> <b>of</b> <u>2</u>	
<b>Project Name:</b> Gorham	<b>Geologist:</b> PJM		
<b>Date Started:</b> 3.20.08	<b>Drilling Company:</b> Geologic		
<b>Date Completed:</b> 3.20.08	<b>Drilling Method:</b> Geoprobe		
<b>Total Depth:</b> 48'	<b>Depth to Water:</b> 23'		
<b>Job No. 3650050041.16</b>			

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
20-24'	8" grey, f to coarse SAND and GRAVEL; 14" dk brown, f to coarse SAND, some Gravel, some Brick and Wood fragments (w/ creosote odor); 14" grey, f SAND, Cobble at 23'	4/3'	3.5 (22 ft)	-	
24-28'	27" grey/brown, f to coarse SAND, tr Gravel, tr Brick; 19" tan, f SAND (golden brown lens @26.5' - med SAND) moist, cobble @28'	4/4'	1.2 (26 ft)	-	
28-32'	11" dk orange, coarse SAND and GRAVEL (lens, stained black @30'), wet; 17" orange, f to coarse SAND, tr Gravel, wet (lens, stained black @31.5')	4/2.4'	0.7 (30 ft)	-	
32-44'	no sample collected.				
44-48'	dk. grey SILT, some Clay, End of Boring at 48'	4/2.4'		-	

Prepared by: PJM  
Checked by: MAM



**Soil Boring Log**

MACTEC  
107 Audubon Road  
Wakefield, MA

<b>Boring Location:</b> MW-223		Page <u>1</u> of <u>2</u>	
<b>Project Name:</b> Gorham	<b>Geologist:</b> PJM		
<b>Date Started:</b> 3/19/2008	<b>Drilling Company:</b> Geologic		
<b>Date Completed:</b> 3/19/2008	<b>Drilling Method:</b> Geoprobe		
<b>Total Depth:</b> 59'	<b>Depth to Water:</b> 26'		
<b>Job No. 3650050041.16</b>			

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
0-4'	6" concrete slab; small amount of material in liner = grey SILT and f SAND, tr Gravel	4'0'		-	
4-8'	18" grey/brown SILT and brown, f to med SAND, tr Gravel, tr Brick; 21" grey and brown SILT	4'3.2'		-	
8-12'	17" grey, SILT and f to med SAND, tr Gravel and Brick; 31" brown, f to coarse SAND, some Gravel	4'4'	1.0 (10 ft)	-	
12-16'	same as above except layer of 11" of grey SILT, some f Sand @ 13.3'-14.2'; wood fragment @16'	4'3.1'			
16-20'	8" grey/brown, f to med SAND, some Silt, some Gravel, tr Brick; 16" lt grey, f to coarse SAND, some Gravel; 10" lt grey, v fine SAND	4'3.3'	0.9 (18 ft)	-	
20-24'	17" grey, v fine to coarse SAND, some Gravel; 31"+brown f to coarse SAND, some Silt, some Gravel, Brick @24'	4'4'		-	

Prepared by: PJM  
Checked by: MAM



### Soil Boring Log

MACTEC  
107 Audubon Road  
Wakefield, MA

Boring Location:

**MW-223**

Page 2 of 2

Project Name: Gorham

Geologist: PJM

Date Started: 3/19/2008

Drilling Company: Geologic

Date Completed: 3/19/2008

Drilling Method: Geoprobe

Total Depth: 59'

Depth to Water: 26'

Job No. 3650050041.16

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
24-28'	34" brown and grey, f to coarse SAND, tr Silt, tr Gravel; 14" brown and dk brown, med to coarse SAND, some Gravel, moist	4'1/4'	1.2 (27 ft)	-	
28-40'	No samples collected.				
40-44'	28" grey w/black flecs, f SAND, wet; 18" grey, f SAND w/orange iron staining, some Silt, wet	4'3.9'		-	
44-52'	No samples collected.				
52-56'	dk grey, SILT, tr f Sand, wet	4'1/4'		-	
56-59'	No Samples collected. Refusal at 59' with 3.25" casing (to set well).				

Prepared by: PJM

Checked by: MAM







  <b>Soil Boring Log</b>  MACTEC 107 Audubon Road Wakefield, MA	Boring Location: <b>SB-6</b>		Page <u>1</u> of <u>3</u>	
	Project Name: Gorham		Geologist: Phil Muller	
	Date Started: <b>5.8.08</b>		Drilling Company: Geologic	
	Date Completed: <b>5.8.08</b>		Drilling Method: Geoprobe	
	Total Depth: <b>28'</b>		Depth to Water: <b>26'</b>	
	Job No. 3650050041.20			

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
0	0 - 0.5' concrete slab 0.5' - 1.3' grey SILT, tr. fine Sand, tr. Gravel 1.3' - 1.8' brown f. to med. SAND	4/3.1	0.1 @ 1.2'	—	
	1.8 - 2.2' grey SILT 2.2 - 2.5' Cobble 2.5 - 3.5' dk grey/brown SILT and f. SAND, tr. Gravel		0.9 @ 2.9'		
4	4 - 4.9' dk. grey/brown SILT and f. SAND, some Gravel 4.9 - 5.3' grey SILT	4/4	1.7 @ 5'	—	
	5.3' - 8' mix of brown tr. Gravel/sand med. to f. SAND, and grey SILT (alternating layers)		1.7 @ 7'		
8	8 - 10.1' brown/grey f. to med. SAND, some silt, tr. Gravel 10.1 - 12 tan, f. to coarse SAND	4/4	2.5 @ 9'	—	SB609
12			0.9 @ 11'		

Prepared by: **PSM**  
 Checked by: **DEW 5/21/08**

  <b>Soil Boring Log</b>  MACTEC 107 Audubon Road Wakefield, MA	Boring Location: <b>SB-6</b>		Page <u>2</u> of <u>3</u>	
	Project Name: Gorham		Geologist: Phil Muller	
	Date Started: 5.8.08		Drilling Company: Geologic	
	Date Completed: 5.8.08		Drilling Method: Geoprobe	
	Total Depth: 28'		Depth to Water: 26'	
	Job No. 3650050041.20			

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
12	12.6-14.2' Medley of brown fi to med. SAND, tr. Gravel; grey SILT and fi SAND; and brown coarse SAND and	4/3.4	1.3 @ 13.8'	-	
	Cobbles				
16	14.2-16 ft grey fi to med. SAND, tr. iron staining		0.1 @ 15'		
	16-17' grey w/ black specs fi to coarse SAND	4/4		-	
	17-17.8' lt. brown fi to med. SAND		0.5 @ 17'		
	17.8-18.3 lt brown fi to coarse SAND, some Gravel		0.9 @ 18'		
	18.3-20 tan f. SAND				
	and <del>ST</del> grey SILT tr. Gravel				
20	20.5-21' grey f. SAND and <del>SILT</del> , some Gravel	4/3.5	2.5 @ 21'	-	
	Some Silty SAND				
	21'-22' dk. grey, fine SAND				
24	22-24' grey/dk. grey very f. SAND		2.1 @ 22.5'		

Prepared by **PSM**  
 Checked by **DEW** 5/12/08

  <b>Soil Boring Log</b>  MACTEC 107 Audubon Road Wakefield, MA	Boring Location: <u>SB-6</u>		Page <u>3</u> of <u>3</u>	
	Project Name: Gorham		Geologist: Phil Muller	
	Date Started: <u>5.8.08</u>		Drilling Company: Geologic	
	Date Completed: <u>5.8.08</u>		Drilling Method: Geoprobe	
	Total Depth: <u>28'</u>		Depth to Water: <u>26'</u>	
	Job No. 3650050041.20			

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
24	24.6 - 26.1 brown and dk brown f. to med. SAND, some Gravel	4/3.4	1.9 @ 25'	—	
	26.1 - 28' grey/dk. grey very fi SAND, moist		0.5 @ 27'		
28	End of boring @ 28'				

Prepared by: PSM  
 Checked by: DEA 5/12/08

**MACTEC**  
**Soil Boring Log**  
 MACTEC  
 107 Audubon Road  
 Wakefield, MA

Boring Location: SB-7 Page 1 of 2  
 Project Name: Gorham Geologist: Phil Muller  
 Date Started: 5.8.08 Drilling Company: Geologic  
 Date Completed: 5.8.08 Drilling Method: Geoprobe  
 Total Depth: 28' Depth to Water: 26'  
 Job No. 3650050041.20

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
0	0 - 0.5' concrete slab 0.5 - <del>1.8'</del> <sup>PM</sup> Grey SILT, <sup>PM</sup> some f. sand, trace Gravel <sup>PM</sup> <del>2.5'</del> 1.8' - 3.3'	4/3.3	0.9 @ 1'	-	
4	light grey SILT, and f. SAND <del>some</del> SAND <sup>PM</sup> lens of brown med. SAND @ 3'		4.4 @ 3'		
8	4.4 - 8' brown fi to coarse SAND, some Gravel lens of grey SILT @ 7.2'	4/3.6	3.2 @ 5' 2.5 @ 7'	-	
	8 - 9.4' brown f. to coarse SAND, some Gravel black stained soil @ 9.2' wood fragment @ 9.2' lens of grey SILT @ 8.8'	4/4	8.7 @ 9.2'		
	and 9.3'				
	9.3 - <del>10.7</del> <del>8.3</del> <sup>PM</sup> brown fi to coarse SAND, some Gravel		5.6 @ 11'		
	10.3 - <del>12'</del> <del>8.3</del> <sup>PM</sup> red/orange f. to coarse SAND, some Gravel				
12	0.4' slough 12.4 - 14.5 red/orange f. to coarse SAND, some Gravel	4/4 <sup>PM</sup> 3.6	9.5 @ 13'	-	SB713
14.5					

Prepared by: PM  
 Checked by: DEW 5/12/08

<b>MACTEC</b>  <b>Soil Boring Log</b>  MACTEC 107 Audubon Road Wakefield, MA	Boring Location: <u>SB-7</u>		Page <u>2</u> of <u>2</u>	
	Project Name: Gorham		Geologist: Phil Muller	
	Date Started: 5.8.08		Drilling Company: Geologic	
	Date Completed: 5.8.08		Drilling Method: Geoprobe	
	Total Depth: 28'		Depth to Water: 26'	
	Job No. 3650050041.20			

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
14.5	(pm) 14.5 - 16 golden brown <del>f. to med.</del> to coarse SAND, tr. Gravel lens of tan f. SAND @ 14.6		3.6 @ 15'		
16	16-17' lt brown f. to coarse SAND, some Gravel 17-17.5' grey f. to med. SAND and SILT	4/4	4.4 @ 17'	—	
20	17.5' - 18.2' golden brown f. SAND 18.2 - 20' red/orange/tan f. to coarse SAND and GRAVEL		2.1 @ 18.5'		
24	20-24' brown/reddish brown f. to coarse SAND and GRAVEL	4/4	7.9 @ 21' 2.5 @ 23'	—	
28	26.4 - 28' dk. grey f. to med. SAND, moist (tip was wet) tr. Gravel, odor	4/1.7	19.1 @ 27.4	—	
	End of boring @ 28'				

Prepared by PM  
 Checked by DEW 5/12/08

**MACTEC**

Boring Location: **SB-8**

Page 1 of 2

**Soil Boring Log**

MACTEC  
107 Audubon Road  
Wakefield, MA

Project Name: Gorham

Geologist: Phil Muller

Date Started: 5-8-08

Drilling Company: Geologic

Date Completed: 5-8-08

Drilling Method: Geoprobe

Total Depth: 28'

Depth to Water: 26'

Job No. 3650050041.20

Depth (feet)	Stratigraphy Description	Penetration/Recovery (feet)	Headspace (ppm)	Blows/6 inches	Sample ID
0	0-0.5' concrete slab 0.5-2.4' grey SILT 2.4-3.1' grey/H. brown f. SAND and SILT, tr. Gravel	4/3.2	0.5 @ 1'	-	
(pm)	3.1-4.3' grey SILT, some f. Sand		0.9 @ 2.5'		
4'	4-5' grey SILT 5'-7' grey/brown f. to med. SAND and SILT, tr. Gravel	t/4	2.5 @ 5'	-	SB805
	7-8' brown f. to coarse SAND, some Gravel		2.5 @ 7'		
8'	8.7-9.5 grey SILT and grey, f. to med. SAND 9.5-10.5 brown, f. to coarse SAND, some Gravel	4/3.3	1.7 @ 9'	-	
(pm)	10.5-11.1 H. grey med. SAND tr. Gravel 11.1-12 f. SAND, grey		1.3 @ 11'		
12	12.6-13.4 brown/grey f. to coarse SAND, tr. Gravel	4/3A	1.3 @ 13'	-	
13.4					

Prepared by: PJM  
Checked by:

DEB 5/12/08

<b>MACTEC</b>  <b>Soil Boring Log</b>  MACTEC 107 Audubon Road Wakefield, MA	Boring Location: <u>SB-8</u>		Page <u>2</u> of <u>2</u>	
	Project Name: Gorham		Geologist: Phil Muller	
	Date Started: <u>5.8.08</u>		Drilling Company: Geologic	
	Date Completed: <u>5.8.08</u>		Drilling Method: Geoprobe	
	Total Depth: <u>28</u>		Depth to Water: <u>26</u>	
	Job No. 3650050041.20			

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
13.4'	13.4 - 14.2' brown/grey f. to med. SAND and grey SILT, tr. Gravel 14.2 - 16' H. brown/grey f. SAND		1.3 @ 15'	<del>1.3</del> Pm	
	cobble @ 15.5				
16'	16-20' lt. brown/grey f. SAND, tr. Gravel  Pm 1/8 lens of coarse SAND + GRAVEL @ 16.9'	4/4	2.1 @ 17'	—	
	lense of SAND and SILT @ 16.7'		1.7 @ 19'		
20'	Pm 20' - 21' - 24' grey/brown f. to med SAND, tr. Gravel	4/3'	0.9 @ 22'	—	
24'	26-28' tan, grey v. f. SAND, wet	4/2'	4.8 @ 26.7	—	
28'	End of boring at 28' bgs				

Prepared by: PJM  
 Checked by: DEW 5/12/08

<b>MACTEC</b>  <b>Soil Boring Log</b>  MACTEC 107 Audubon Road Wakefield, MA	Boring Location: <b>SB-9</b>		Page <u>1</u> of <u>2</u>	
	Project Name: Gorham		Geologist: Phil Muller	
	Date Started: 5-8-08		Drilling Company: Geologic	
	Date Completed: 5-8-08		Drilling Method: Geoprobe	
	Total Depth: 28'		Depth to Water: 26'	
	Job No. 3650050041.20			

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
0	0-0.5' concrete slab 0.5-2.5' grey SILT, some brown f. Sand, tr. Gravel lens of tan f. SAND and	4/3.4'	0.9 @ 1'	—	
	GRAVEL @ 1.3' 2.5-3.6' brick and grey f. to coarse SAND and GRAVEL		0.5 @ 3'		
	Grey SILT in tip				
4'	4-4.4' lt. brown f. to med. SAND 4.4-4.8' grey SILT, some f. Sand	4/4		—	
	4.8-5.2' lt. brown med. SAND, some Gravel 5.2-5.4' grey SILT		1.3 @ 5'		
	5.4-8' medley of lt. brown med. to coarse SAND; grey SILT; brick @ 7.3'		0.9 @ 7'		
8'	8-9.1 brown/grey f. to coarse SAND, some silt tr. brick	4/4	0.9 @ 9'	—	
9.1					

Prepared by: **PSM**  
 Checked by: **DEW** 5/12/08

<b>MACTEC</b>  <b>Soil Boring Log</b>  MACTEC 107 Audubon Road Wakefield, MA	Boring Location: <b>SB-9</b>		Page <b>2</b> of <b>2</b>	
	Project Name: <b>Gorham</b>		Geologist: <b>Phil Muller</b>	
	Date Started: <b>5.8.08</b>		Drilling Company: <b>Geologic</b>	
	Date Completed: <b>PM 28 5.8.08</b>		Drilling Method: <b>Geoprobe</b>	
	Total Depth: <b>28'</b>		Depth to Water: <b>26'</b>	
	Job No. <b>3650050041.20</b>			

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
9.1	9.1 - 12' tan f. to coarse SAND, tr. Gravel		1.3 @ 11'		
12	12 - 14.2' tan f. to coarse SAND, tr. Gravel 14.2 - 16' medley of brown f. to med SAND, grey SILT, tr. Gravel, trace brick	4/4	0.5 @ 13'	—	
16	16 - 20' grey, f. to med. SAND tr. Gravel	4/4	1.3 @ 17'	—	SB917
20	20.9 - 22.3 grey f. to med, tr. Gravel 22.3 - 24 grey v.f. SAND	4/3.1	0.1 @ 21'	—	
24	grey, v.f. SAND (wet trace iron stains)	4/15	0.1 @ 23'	—	
28	End of boring @ 28'		8.3 @ 27'	—	

Prepared by: **PM**  
 Checked by: **DEA 5/12/08**

  <b>Soil Boring Log</b> MACTEC 107 Audubon Road Wakefield, MA	Boring Location: <b>SB-10</b>		Page <u>1</u> of <u>2</u>	
	Project Name: Gorham		Geologist: Phil Muller	
	Date Started: 5.9.08		Drilling Company: Geologic	
	Date Completed: 5.9.08		Drilling Method: Geoprobe	
	Total Depth: 28'		Depth to Water: 26'	
	Job No. 3650050041.20			

Depth (feet)	Stratigraphy Description	Penetration/Recovery (feet)	Headspace (ppm)	Blows/6 inches	Sample ID
0	0 - 0.5' concrete slab 0.5' - 3.6' medley of grey SILT ; f. to coarse SAND, grey/brown, some	4/3.1	0.0 @ 1'	—	
	Gravel, tr. brick		0.1 @ 2.5'		
4	4 - 6.3' grey SILT and f. SAND, some Gravel 6.3 - 7.7' brown, f. to coarse SAND, tr. Gravel, tr. Brick	4/3.7	0.5 @ 5'		
	tr. Silt		2.1 @ 7'		
8	9.5 - 11.1' grey SILT and grey f. to med SAND, tr. Gravel, tr. Brick, odor	4/2.5	2.1 @ 10.2'	—	SB1010
	11.1 - 12' brown, med. to coarse SAND, some Gravel		0.1 @ 11.5'		
12	14 - 14.6' grey SILT and grey/brown f. to med. SAND, tr. Gravel, tr. Brick	4/2	0.5 @ 14.1'	—	
14.6					

Prepared by: **PSM**  
 Checked by: **DEW 5/12/08**

<b>MACTEC</b>  <b>Soil Boring Log</b>  MACTEC 107 Audubon Road Wakefield, MA	Boring Location: <u>SB-10</u>		Page <u>2</u> of <u>2</u>	
	Project Name: Gorham		Geologist: Phil Muller	
	Date Started: <u>5.9.08</u>		Drilling Company: Geologic	
	Date Completed: <u>5.9.08</u>		Drilling Method: Geoprobe	
	Total Depth: <u>28'</u>		Depth to Water: <u>26'</u>	
	Job No. 3650050041.20			

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
14.6	<del>14.6 - 16'</del> tan f. to coarse SAND (finer sand near 14.6', coarser sand near 16') tr. Gravel		0.1 @ 15'		
16	<del>17.6</del> 17.4 - 18.6' tan/brown f. to coarse SAND, tr Gravel 18.6 - 19.1' grey f.	4/2.6	0.1 @ 18'	—	
	SAND, some silt, trace Gravel 19.1 - 20' H. brown f. to coarse SAND, tr. Gravel		0.9 @ 19'		
20	21.3 - 24' lt. grey f. SAND	4/2.7	0.1 @ 22' 0.1 @ 23'	—	
24	25.5 - 27' f. to <sup>coarse</sup> <del>medium</del> SAND w/ <del>layers</del> of coarse <sup>lens</sup> SAND (color ranges from	4/2.5	2.5 @ 26'		
	(lt grey to dk. brown), wet 27 - 28' f. to coarse SAND, wet, black and orange stained		0.1 @ 27.3		
28'	End of boring @ 28'				

Prepared by: PSM  
 Checked by: DEW 5/12/08

<b>MACTEC</b>  <b>Soil Boring Log</b>  MACTEC 107 Audubon Road Wakefield, MA	Boring Location: <b>SB-11</b>		Page <u>1</u> of <u>2</u>	
	Project Name: Gorham		Geologist: Phil Muller	
	Date Started: 5.9.08		Drilling Company: Geologic	
	Date Completed: 5.9.08		Drilling Method: Geoprobe	
	Total Depth: 28'		Depth to Water: <del>26'</del> 24'	
	Job No. 3650050041.20		(PM)	

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
0	0-0.5' concrete slab				
4'	0.5-3.7' grey SILT, trace Gravel, tr. f. SAND lens	4/3.3	0.1 @ 1' 0.0 @ 3'	—	
	4.6-5' grey SILT, tr. f. Sand	4/3.5	0.1 @ 5'	—	
	5-6.1' brown med. to coarse SAND, tr. Gravel				
	6.1'-7.2' grey SILT and brown f. SAND ; cobble @ 6.4' charred wood @ 6.6'		0.5 @ 7'		SB1107
	7.2'-8' dk. brown f. to coarse SAND, tr. Gravel				
8'	8-9.4' medley of tan f. to coarse SAND ; grey SILT	4/4	0.5 @ 9'	—	
	9.4-10.6' brown med to coarse SAND, some Gravel				
	10.6'-12' tan f. SAND tip: orange med to coarse SAND		0.1 @ 11'		
12	12.4-13' tan f. SAND		0.1 @ 13'		
16	13-16' <sup>th. brown</sup> f. to coarse SAND and GRAVEL	4/4 <sup>(PM)</sup> 3.6'	0.0 @ 15'	—	

Prepared by **PM**  
 Checked by **DEW** 5/12/08

  <b>Soil Boring Log</b>  MACTEC 107 Audubon Road Wakefield, MA	Boring Location: <u>S13-11</u>		Page <u>2</u> of <u>2</u>	
	Project Name: Gorham		Geologist: Phil Muller	
	Date Started: <u>5.9.08</u>		Drilling Company: Geologic	
	Date Completed: <u>5.9.08</u>		Drilling Method: Geoprobe	
	Total Depth: <u>28'</u>		Depth to Water: <u>24'</u>	
	Job No. 3650050041.20			

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
16	16.7 - 17.6' lt. brown f. to coarse SAND, tr. Gravel 17.6 - 17.9' grey f. to	4/3.3		—	
	med. SAND, some silt 17.9 - 20' lt. brown, med. to coarse SAND, tr. Gravel		0.1 @ 18' 0.1 @ 19'		
20	20 - 21.6' brown/grey f. to coarse SAND, tr. Gravel, tr. silt (pm) 21.6' - 24' 23' lt. grey	4/4	0.5 @ 21'	—	
	f SAND 23 - 24' grey v.f. SAND moist		0.1 @ 23'		
24	25.5 - 25.9' lt. grey med. SAND, wet 25.9 - 26.5' lt. brown med. SAND, wet	4/2.5		—	
	26.5 - 28' dk. grey/brown med. to coarse SAND, wet		0.1 @ 28'		
28	End of boring @ 28'				

Prepared by: PJM  
 Checked by: Drew 5/12/08

<b>MACTEC</b>  <b>Soil Boring Log</b>  MACTEC 107 Audubon Road Wakefield, MA	Boring Location: <b>SB-12</b>		Page <u>1</u> of <u>2</u>	
	Project Name: Gorham		Geologist: Phil Muller	
	Date Started: 5-9-08		Drilling Company: Geologic	
	Date Completed: 5-9-08		Drilling Method: Geoprobe	
	Total Depth: 28		Depth to Water: 26'	
	Job No. 3650050041.20			

Depth (feet)	Stratigraphy Description	Penetration/Recovery (feet)	Headspace (ppm)	Blows/6 inches	Sample ID
0	0 - 0.5' concrete slab				
	0.5 - 1.3' grey SILT and f. SAND, tr. Gravel, tr. Brick	4/1.8	0.1 @ 1'	-	
4	1.3 - 1.7' brown f. to coarse SAND, tr. Gravel				
	1.7 - 2.3' grey SILT, some f. Sand				
8	4.8 - 8' grey SILT, tr. Gravel. Brick @ 5.3' tan, med. to coarse SAND lens @ 6.9'. moist @ 6.5'	4/3.2	0.5 @ 5' 1.3 @ 7'	-	
	8.4 - 9.4' grey/brown <del>gr</del> SILT and f. SAND	4/3.6	2.5 @ 9'	-	SB1209
	9.4 - 10.2' lt. grey coarse SAND, some Gravel				
12	10.2 - 12' tan/lt grey f. to med. SAND, tr. Gravel		0.5 @ 11		
	13.1 - 13.7' grey f. to med SAND, tr. Gravel	4/2.9	0.1 @ 13.4'	-	
	13.7 - 14.1' grey SILT				
16	tr. Gravel, 14.1 - 16 lt. grey/brown f. to coarse SAND, some Gravel		0.1 @ 15'		

Prepared by: **FJM**  
 Checked by: **DEW** 5/12/08



Soil Boring Log

MACTEC  
107 Audubon Road  
Wakefield, MA

Boring Location: SB-12

Page 2 of 2

Project Name: Gorham

Geologist: Phil Muller

Date Started: 5.9.07

Drilling Company: Geologic

Date Completed: 5.9.07

Drilling Method: Geoprobe

Total Depth: 28'

Depth to Water: 26'

Job No. 3650050041.20

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
16'	16.8 - 17.6' H grey/tan f. to coarse SAND, some Gravel	4/3.2			
	17.6 - 18.3' grey SILT and f. SAND, tr. Gravel		1.3 @ 18'		
	18.3' - 20' dk. grey f. to coarse SAND, tr. Gravel		0.1 @ 19'		
20'	20 - <del>21.5</del> - 22.7' brown/dk grey f. to coarse SAND, tr. Gravel	4/4	0.5 @ 21'		
	22.7 - 24' v.f. SAND, H. grey		0.1 @ 23'		
24'					
	25.7' - 28' H. grey/dk. grey v.f. SAND, wet	4/2.3'	15 @ 27'		
28'	End of boring @ 28'				

Prepared by:  
Checked by:

PJM  
DEL 5/12/08



### Soil Boring Log

MACTEC  
107 Audubon Road  
Wakefield, MA

Boring Location: **SB-13**

Page 1 of 2

Project Name: Gorham

Geologist: Phil Muller

Date Started: 5.9.08

Drilling Company: Geologic

Date Completed: 5.9.08

Drilling Method: Geoprobe

Total Depth: 28'

Depth to Water: 26'

Job No. 3650050041.20

Depth (feet)	Stratigraphy Description	Penetration/ Recovery (feet)	Headspace (ppm)	Blows/ 6 inches	Sample ID
0	0 - 0.5' concrete slab 0.5' - 3.4' brown and dk brown f. to coarse SAND, tr. Gravel	4/2.9	0.0 @ 1' 0.1 @ 2.5'	—	
4'	grey SILT lens @ 2.6' (some iron staining throughout sand)				
8'	4.5 - 8' brown and dk brown f. to coarse SAND, tr. Gravel lt. grey f. SAND lens @ 6.2' (P)	4/3.5 (P)	0.1 @ 5' 0.1 @ 7'	—	
12'	8.8 - 9.5' grey/brown f. to med SAND and SILT 9.5 - 12' lt. grey/brown f. to coarse SAND, some Gravel	4/3.2	0.1 @ 9.5' 0.1 @ 11'	—	
16'	13.0 - 14.4' dk. grey f. to med. SAND 14.4 - 16' lt. grey and black f. to coarse SAND, some Gravel	4/2.2	0.9 @ 14' 0.0 @ 15'	—	SB1314

Prepared by  
Checked by

**PJM**  
**DEJ 5/12/08**

<h1 style="margin:0;">MACTEC</h1>  <h2 style="margin:0;">Soil Boring Log</h2> <p style="margin:0;">MACTEC 107 Audubon Road Wakefield, MA</p>	Boring Location: <b>SB-13</b>		Page <u>2</u> of <u>2</u>	
	Project Name: Gorham		Geologist: Phil Muller	
	Date Started: 5.9.08		Drilling Company: Geologic	
	Date Completed: 5.9.08		Drilling Method: Geoprobe	
	Total Depth: 28'		Depth to Water: 26'	
	Job No. 3650050041.20			

Depth (feet)	Stratigraphy Description	Penetration/Recovery (feet)	Headspace (ppm)	Blows/6 inches	Sample ID
16'	17.7 - 20' grey/brown f. to coarse SAND and GRAVEL	4/2.3	0.1 @ 18' 0.1 @ 19'	0.1 @ 18' 0.1 @ 19'	
20	20.8 - 24' grey/brown f. to coarse SAND and GRAVEL	4/3.2	0.1 @ 21.5' 0.0 @ 23'	0.1 @ 21.5' 0.0 @ 23'	
24	26.4 - 28' grey f. SAND, moist	4/1.0	0.9 @ 27'	0.9 @ 27'	
28	End of Boring @ 28'			(pm)	

Prepared by: **PJM**  
Checked by: **DEM** 5/12/08





# Drilling Log

Monitoring Well **MW-220S**

Page: 1 of 1

Project Former Gorham Manufacturing Facility Owner Textron, Inc.  
 Location 333 Adelaide Avenue, Providence, RI Proj. No. 101960  
 Surface Elev. NA Total Hole Depth 32.0 ft. North \_\_\_\_\_ East \_\_\_\_\_  
 Top of Casing NA Water Level Initial ▽ 25.0 ft. Static NA Diameter 4.25 in.  
 Screen: Dia 2 in. Length 10 ft. Type/Size PVC/0.010 in.  
 Casing: Dia 2 in. Length 22 ft. Type PVC  
 Fill Material Native, bentonite, sand, concrete Rig/Core CME 75/Track Rig  
 Drill Co. Technical Drilling Service Method Hollow Stem Auger  
 Driller Steve Bliss Log By Ben Short Date 2/22/07 Permit # NA  
 Checked By \_\_\_\_\_ License No. \_\_\_\_\_

COMMENTS  
 PPM = Parts per million

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0							Asphalt (4")
0 - 5						SP	Hand cleared to 5' below ground surface. Light brown, medium SAND, fill
5		2.6	50%	0.4		SP	Dark brown, medium SAND, fill material, brick and wood
10		2.1	25%	10 4.5 3.7 10			FILL, wood and brick fragments, some medium brown sand (septic odor at 10')
15		0.4	50%	4 0.4		SP	Wood fragments over light brown, loose, coarse SAND
20		1.0	75%	3 4 4 4		SP	Light brown, loose, medium SAND
25		1.2	85%	2 3 4 4		SP	Light brown, wet, loose, medium SAND over light brown, loose, coarse, SAND
30		0.0	100%	5 6 10 13		SP	Light brown, loose, medium SAND, trace coarse sand
32							End of exploration at 32 feet below surface grade.

SHAW COMMERCIAL Rev 6/12/02 TEXTRON PROVIDENCE GPJ IT, CORP.GDT 3/23/07



# Drilling Log

Monitoring Well **MW-221S**

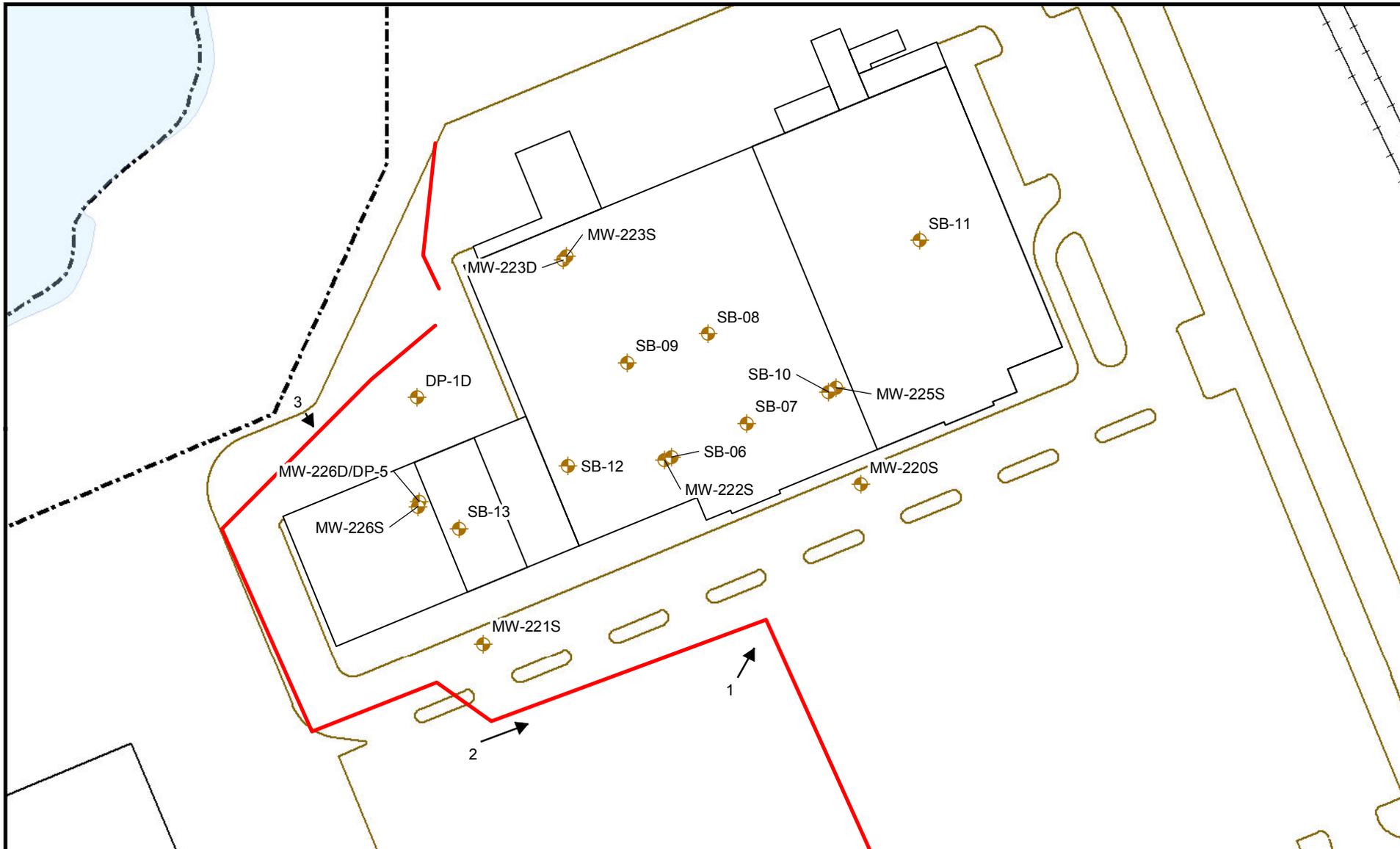
Page: 1 of 1

Project Former Gorham Manufacturing Facility Owner Textron, Inc.  
 Location 333 Adelaide Avenue, Providence, RI Proj. No. 101960  
 Surface Elev. NA Total Hole Depth 32.0 ft. North \_\_\_\_\_ East \_\_\_\_\_  
 Top of Casing NA Water Level Initial ▽ 24.0 ft. Static NA Diameter 4.25 in.  
 Screen: Dia 2 in. Length 10 ft. Type/Size PVC/0.010 in.  
 Casing: Dia 2 in. Length 22 ft. Type PVC  
 Fill Material Native, bentonite, sand, concrete Rig/Core CME 75/Track Rig  
 Drill Co. Technical Drilling Service Method Hollow Stem Auger  
 Driller Steve Bliss Log By Ben Short Date 2/22/07 Permit # NA  
 Checked By \_\_\_\_\_ License No. \_\_\_\_\_

COMMENTS  
 PPM = Parts per million

SHAW COMMERCIAL Rev 6/12/02 TEXTRON PROVIDENCE.GPJ IT\_CORP.GDT 3/23/07

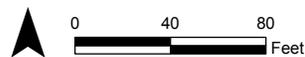
Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description  (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0							Asphalt (4")
0 - 5						SP	Hand cleared to 5' below ground surface. Light brown, medium SAND
5		11.7				SP	Dark-brown, medium SAND and fill material, some brick and concrete fragments
5 - 10		28.1	50%	10 18 21 27		SP	Dark brown, dense, medium SAND, trace gravel and concrete fragments
10							
10 - 15		25.7	90%	5 24 36		SP	Crushed BRICK Dark brown, dense, medium SAND, trace gravel
15							
15 - 20		56.8	65%	10 20 30		SP	Dark brown, dense, medium SAND, trace gravel
20							
20 - 25		3.7	75%	5 10 15		SP	Light grey, loose, medium SAND, some fine sand
25							
25 - 30		70	85%	Wt. of rod		SP	Light olive green, loose, medium and fine SAND, (dark black staining observed) Fine SAND
30							
30 - 32		15.7	100%	5 10		MLS	Light grey, wet, loose, SANDY SILT, (staining and sheen observed)
32							End of exploration at 32 feet below surface grade.
35							
40							



**Notes:**

1. Numbers correspond to photos in Attachment 2D.
2. Arrows indicate direction photo was taken.

N



Prepared/Date: BJR 07/17/14 | Checked/Date: DEH 01/16/14

**Legend**

- Trench
- Current Building
- ◆ Cap Inspection Location
- Pavement Outline

Attachment 2 Figure 1  
Parcel A Cap  
Soil Borings, Monitoring Wells and Groundwater Remediation  
Utility Trenches Installed Post Parcel A Capping  
Retail Complex  
333 Adelaide Avenue  
Providence, Rhode Island



August 28, 2014

Mr. Joseph T. Martella II, Senior Engineer  
RIDEM Office of Waste Management  
Site Remediation Program  
235 Providence Street  
Providence, RI 02908

**RE: Parcel A Environmental Land Usage Restriction  
Former Gorham Manufacturing Facility  
333 Adelaide Avenue, Providence, Rhode Island  
AMEC Project No. 3652130029**

Dear Mr. Martella:

Textron, Inc. (Textron), on behalf of the City of Providence, is submitting the revised Environmental Land Usage Restriction (ELUR) and Soil Management Plan (SMP) for Parcel A of the above referenced site (Figure 1). This completed ELUR will support the completion process under the Remediation Regulations for Parcel A.

We have also enclosed information regarding the capping of Parcel A, as you discussed with Greg Simpson of Textron. The 2001 Remedial Action Work Plan (RAWP) outlined the selected remedial alternative for Parcel A (Harding ESE, 2001). This included an engineered cap consisting 12-inches of soil and/or pavement and building, and institutional controls restricting access to the Site soils. The RIDEM issued the Remedial Approval Letter for the proposed remedy in October 2001.

### **Environmental Land Usage Restriction and Soil Management Plan**

This draft ELUR and SMP (Attachment 1) has been prepared in accordance with the November 2011 Remediation Regulations and the revisions to the ELUR statues (Rhode Island General Law § 34-39--1 et. seq.) as revised on June 28, 2011, and has been reviewed and signed by the Providence Redevelopment Agency (PRA), as the owner of the property. Any future intrusive activity conducted on Parcel A would be subject to the procedures contained in the ELUR and SMP. These documents apply to the management of impacted soils on Parcel A that may be excavated, temporarily stockpiled, graded, or moved during and after future intrusive activities. It should be clarified that the procedures contained in the SMP are only necessary for impacted soils, and do not include clean fill material imported as part of the Parcel A capping remedy. However, any clean soil that is disturbed within or removed from the clean cap soil of Parcel A, must be replaced with soil that is consistent in quality and composition with the existing clean soil cap. Following your review of the Parcel A ELUR, the PRA will file it with the Land Evidence Records of the City of Providence, Rhode Island.

### **Parcel A Cap**

Textron provided the approved 2001 RAWP to the City and its developer Churchill and Banks, Ltd. (C&B). On behalf of the City, C&B implemented the approved soil cap remedy on Parcel A as part of Site development work including the construction of the former Stop & Shop building,

AMEC Environment & Infrastructure, Inc.  
271 Mill Road  
Chelmsford, MA 01824  
Tel +(978) 692-9090  
Fax +(978) 692-6633

[www.amec.com](http://www.amec.com)

Mr. Joseph T. Martella II, Senior Engineer  
August 28, 2014

and construction and paving of the parking lot and associated access roads. C&B did not provide as-built documents or descriptions of the soils and pavement materials used in constructing the cap.

In order to document the construction of the approved cap, AMEC Environment & Infrastructure, Inc. (AMEC) reviewed the logs for soil borings, monitoring wells, soil vapor extraction wells and groundwater treatment system installation completed between 2002 and 2013 (following cap construction). The majority of these logs did not include soil descriptions for the top 4 feet due to drilling methods used to avoid potential buried utilities (e.g., hand digging, air knife, etc.). Logs that did document the construction of the approved cap include the soil borings installed beneath the retail building and a few groundwater monitoring wells on the north and south side of the retail building. We have also enclosed photographs taken during the installation of the piping trench connecting the extraction wells to the groundwater treatment system in 2012. Copies of the well logs (Attachment 2) describe the lithology of soils beneath the former Stop & Shop building and surrounding parking areas. As shown these logs confirm the minimum thickness of 12-inches of cover over the Parcel A soil. Information obtained during the installation of the groundwater extraction system piping confirmed that pavement thicknesses were at least 4" throughout the parking lot areas where trenching work occurred. It should also be noted that 12 years following installation of the cap, there are no apparent integrity issues which suggests specifications were followed and good workmanlike practices were implemented during construction. Attachment 2, Figure 1 presents the location for each of the soil borings, groundwater monitoring wells, and utility trenches that were completed on Parcel A subsequent to the installation of the cap and construction of the Stop & Shop building construction. A description of the cap constructed on Parcel A is included within the SMP (Attachment 1, Exhibit B).

Both the completed ELUR/SMP and the capping documentation, in conjunction with the active soil depressurization (ASD) system and groundwater treatment system operating on Parcel A, will be used to support the future request for an Interim Letter of Compliance for Parcel A.

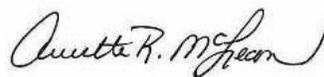
Feel free to contact either Greg Simpson of Textron at (401) 457-2635 or Dave Heislein at (978) 392-5327 with any questions. We are available via conference call to address any questions you may have as part of your review of the ELUR and SMP for Parcel A or the cap construction documents.

Respectfully,

**AMEC Environment and Infrastructure, Inc.**



David E. Heislein  
Senior Project Manager



Annette McLean  
Project Scientist

Attachments: Figure 1 – Parcel A  
Attachment 1 – Parcel A ELUR and SMP  
Attachment 2 – Parcel A Cap Documentation Logs and Photos

AMEC Project File: \\WFD-fs1\projects\old\_Wakefield\_Data\projects\3652130029 - Textron Gorham Updated Cove SIR\4.0 Project Deliverables\4.1 Reports\ELUR Docs\July 2014 Submittal\Final Submittal July 2014\Parcel A Closure Ltr 071814 LCD.docx

**APPENDIX D**  
**Groundwater Treatment System Documents**



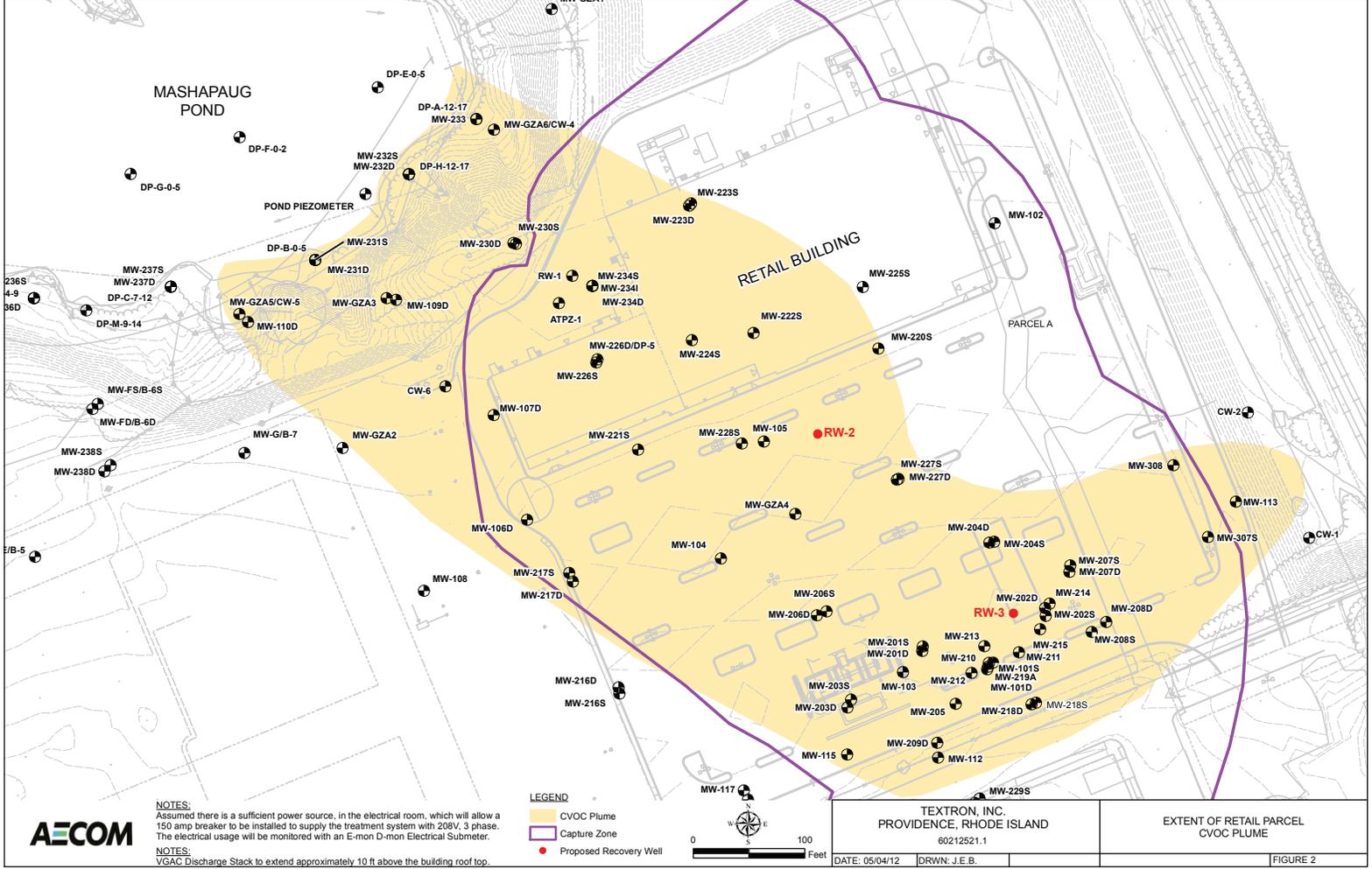
Environment

Prepared for:  
Textron, Inc.  
Providence RI

Prepared by:  
AECOM  
Providence, RI  
October 2012

# Remedial Action Work Plan Former Gorham Manufacturing Facility

Textron  
Providence, RI

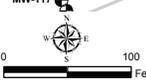


**NOTES:**  
 Assumed there is a sufficient power source, in the electrical room, which will allow a 150 amp breaker to be installed to supply the treatment system with 208V, 3 phase. The electrical usage will be monitored with an E-mon D-mon Electrical Submeter.

**NOTES:**  
 VGAC Discharge Stack to extend approximately 10 ft above the building roof top.

**LEGEND**

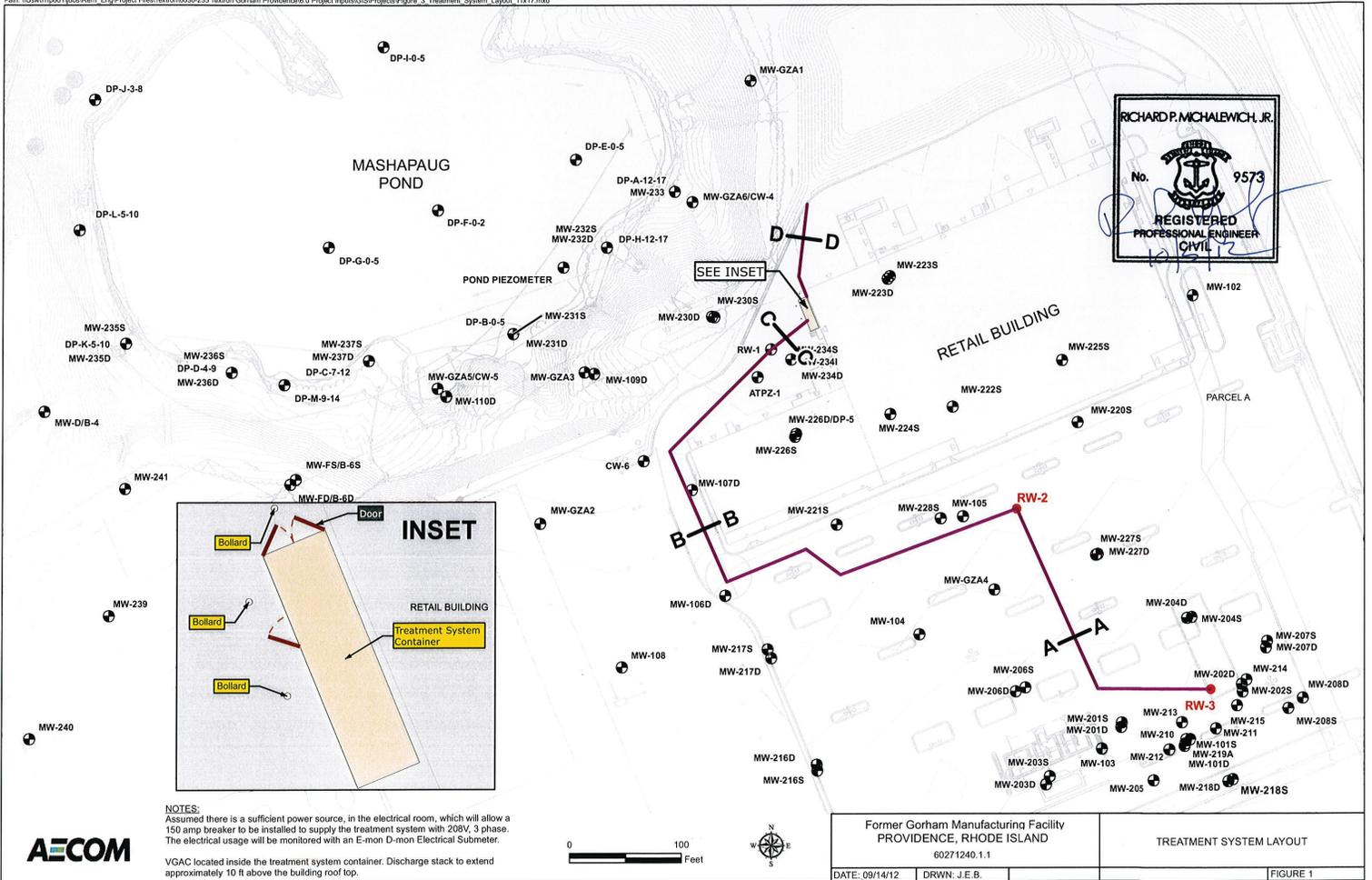
- CVOC Plume
- Capture Zone
- Proposed Recovery Well

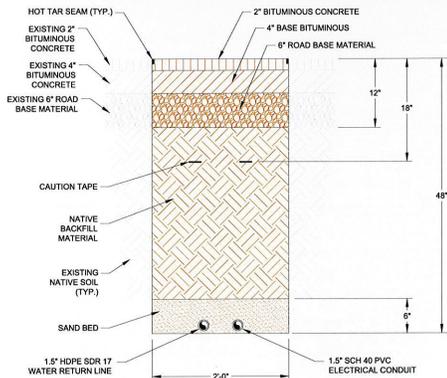


**TEXTRON, INC.**  
 PROVIDENCE, RHODE ISLAND  
 60212521.1

**EXTENT OF RETAIL PARCEL  
 CVOC PLUME**

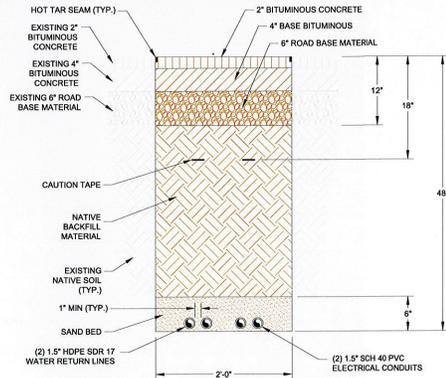






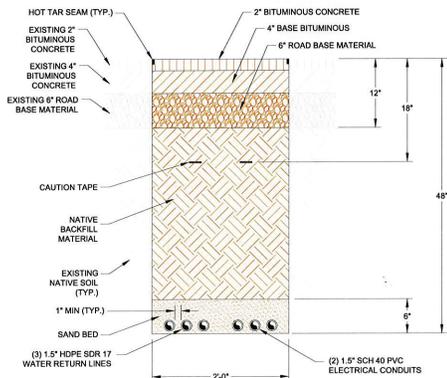
**TRENCH CROSS SECTION A-A'**

N.T.S.



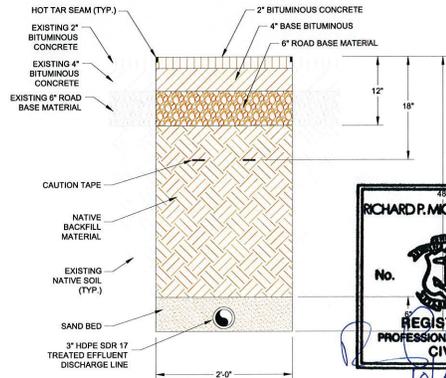
**TRENCH CROSS SECTION B-B'**

N.T.S.



**TRENCH CROSS SECTION C-C'**

N.T.S.



**TRENCH CROSS SECTION D-D'**

N.T.S.



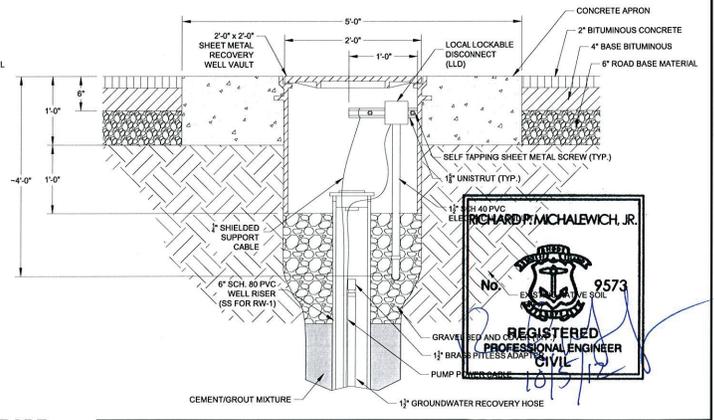
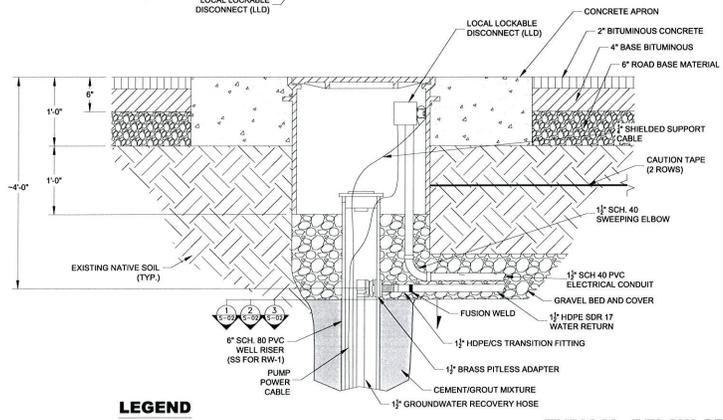
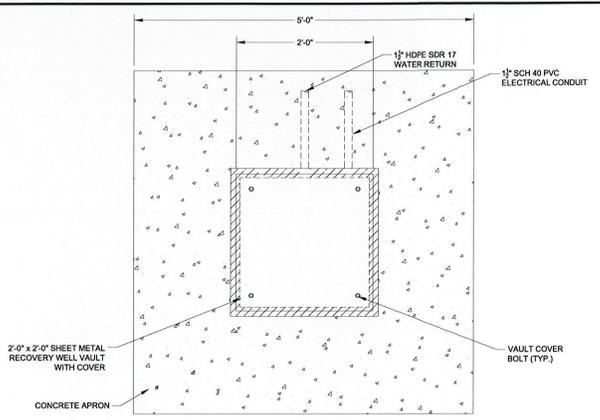
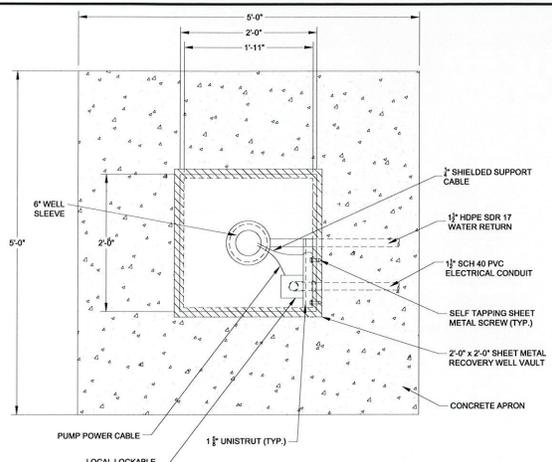
10/5/12

**LEGEND**

HDPE	HIGH DENSITY POLYETHYLENE
SCH	SCHEDULE
SDR	STANDARD DIMENSION RATIO
TYP	TYPICAL

**AECOM**

TETRIX INC PROVIDENCE, RI 60271240		<b>FIGURE 2</b> <b>TRENCH CROSS SECTION DETAILS</b>
DATE: 9/12/12	DRW: R.W.M.	



**LEGEND**

AWG	AMERICAN WIRE GAUGE	SCH	SCHEDULE
BGS	BELOW GROUND SURFACE	SDR	STANDARD DIMENSION RATIO
PVC	POLYVINYL CHLORIDE	SS	STAINLESS STEEL
HDPE	HIGH DENSITY POLYETHYLENE	TBD	TO BE DETERMINED
NTS	NOT TO SCALE	TYP	TYPICAL

**TYPICAL BELOW GRADE RECOVERY WELLHEAD DETAILS**

NTS



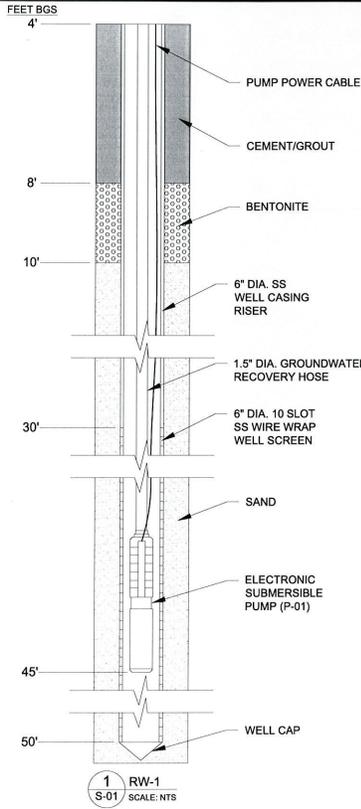
**RICHARD P. MCMALEWICH, JR.**  
 No. 9573  
 REGISTERED PROFESSIONAL ENGINEER  
 CIVIL

TEXTRON INC  
 PROVIDENCE, RI  
 60271240

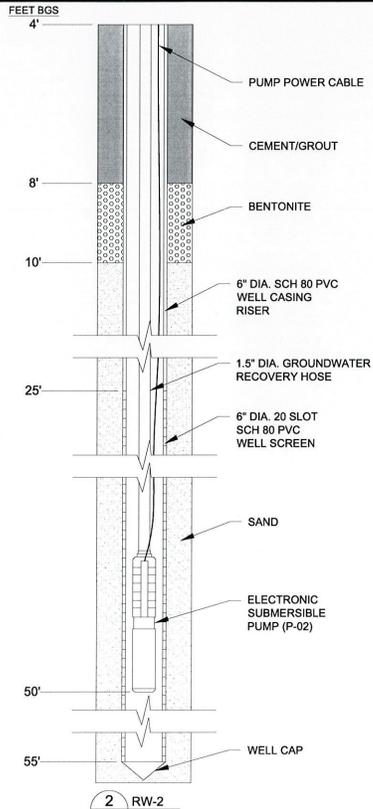
FIGURE 3  
 RECOVERY WELL HEAD DETAILS  
 SHEET 1 OF 2 (S-01)

DATE: 9/12/12

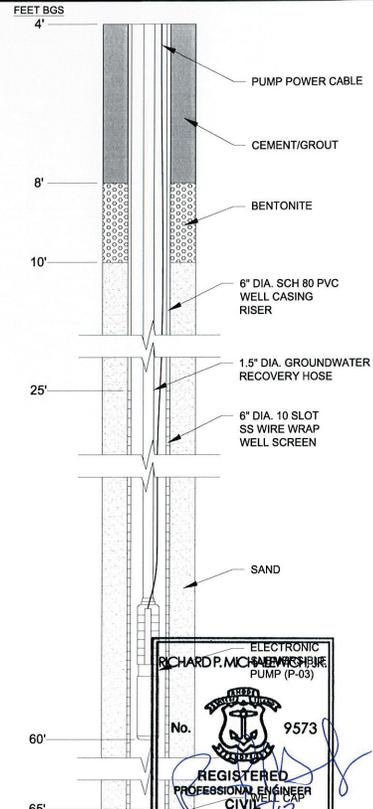
DRAWN: R.W.M.



1 RW-1  
S-01 SCALE: NTS



2 RW-2  
S-01 SCALE: NTS



3 RW-3  
S-01 SCALE: NTS

ELECTRONIC SUBMERSIBLE PUMP (P-03)  
 RICHARD P. MICHAELIS  
 No. 9573  
 REGISTERED PROFESSIONAL ENGINEER  
 CIVIL

**LEGEND**

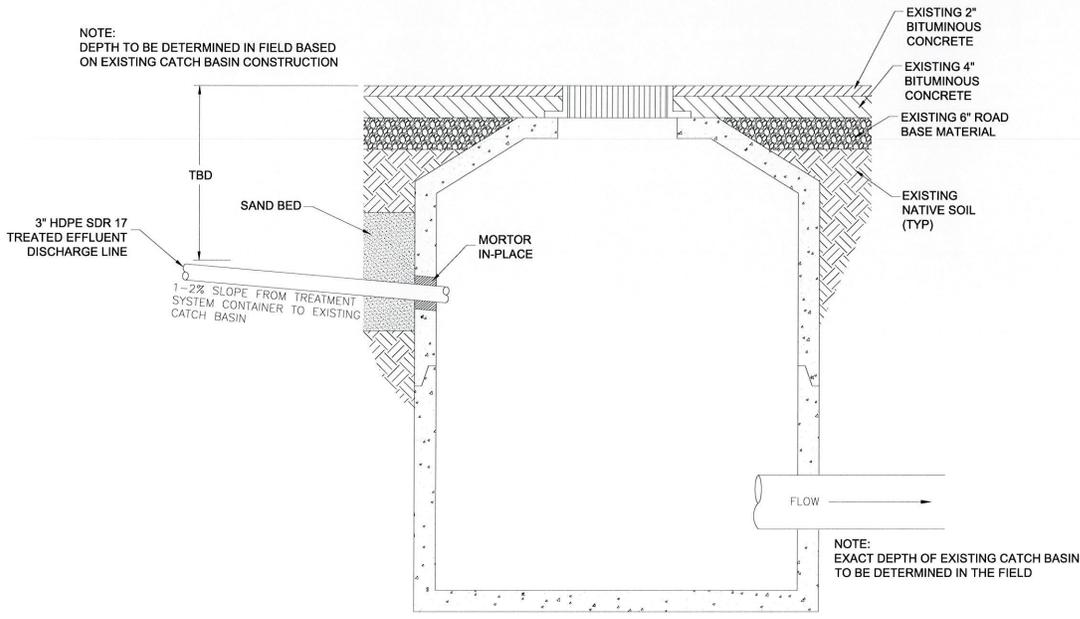
AWG	AMERICAN WIRE GAUGE	SCH	SCHEDULE
BGS	BELOW GROUND SURFACE	SDR	STANDARD DIMENSION RATIO
PVC	POLYVINYL CHLORIDE	SS	STAINLESS STEEL
HDPE	HIGH DENSITY POLYETHYLENE	TBD	TO BE DETERMINED
NTS	NOT TO SCALE	TYP	TYPICAL

**TYPICAL BELOW GRADE RECOVERY WELLHEAD DETAILS (CONT.)**  
NTS

TEXTRON INC  
 PROVIDENCE, RI  
 60271240  
 DATE: 9/12/12 DRAWN: R.W.M.

FIGURE 3  
 RECOVERY WELLHEAD DETAILS  
 SHEET 2 OF 2 (S-02)





**CATCH BASIN TIE-IN DETAIL**

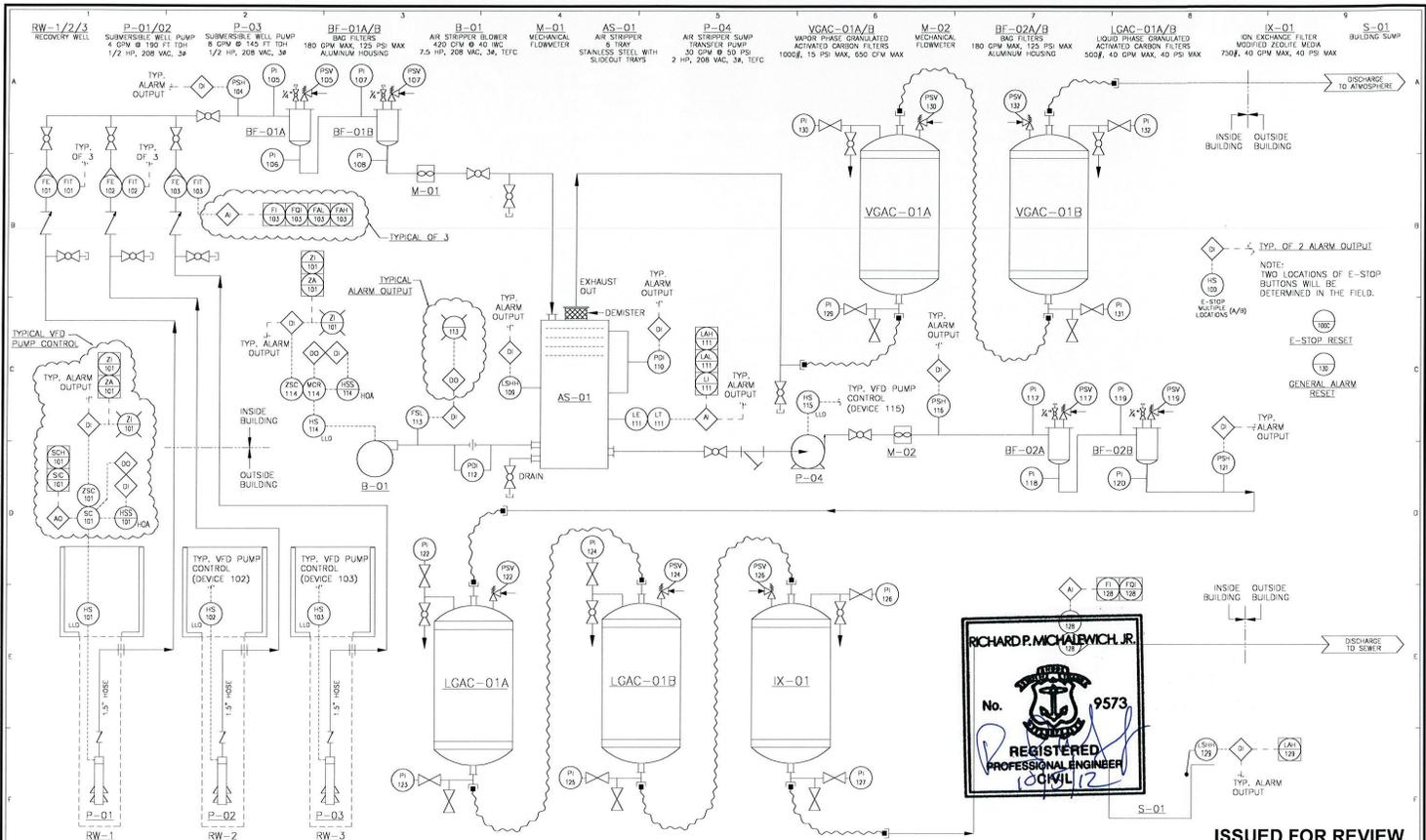
N.T.S.

**LEGEND**

- HDPE HIGH DENSITY POLYETHYLENE
- SDR STANDARD DIMENSION RATIO
- TYP TYPICAL
- TBD TO BE DETERMINED



TEXTON INC PROVIDENCE, RI 60271240		FIGURE 4 EXISTING CATCH BASIN TIE-IN DETAIL
DATE: 9/12/12	DRAWN: R. W. M.	



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ISSUED FOR REVIEW





Environment

Prepared for:  
Textron, Inc.  
Providence RI

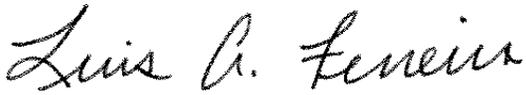
Prepared by:  
AECOM  
Providence, RI  
March 2016

# Groundwater Recovery and Treatment System Installation Report Former Gorham Manufacturing Facility

Textron  
Providence, RI

# Remedial Action Work Plan Former Gorham Manufacturing Facility

Textron  
Providence, RI



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Prepared By  
Luis Ferreira



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Reviewed By  
Patrick Haskell

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## 1.0 Introduction

This Remedial System Installation Report has been prepared by AECOM on behalf of Textron, Inc. (Textron) to document the installation and startup of the groundwater recovery and treatment system addressing chlorinated volatile organic compounds (CVOCs) in groundwater at the former Gorham Silver Facility at 333 Adelaide Avenue in Providence, Rhode Island (the Site, see **Figure 1**). The groundwater recovery and treatment system was installed in 2013 on the retail parcel (Parcel A) of the former Gorham Silver Site.

The objectives of the groundwater treatment system are to:

- Intercept the central portion of the CVOC groundwater plume on the retail parcel to prevent discharge to Mashapaug Pond;
- To capture a portion of the groundwater plume that was discharging to the Narragansett Bay Commission (MBC) sewer main located at the eastern edge of the property; and
- To recover mass from the vicinity of two former CVOC sources located south of the retail building.

To accomplish these activities, AECOM installed two groundwater extraction wells (RW-2 and RW-3, respectively) in the vicinity of a 1,1,1-trichloroethane (1,1,1-TCA) source area immediately south of the retail building and in the vicinity of a former degreaser where tetrachloroethylene (PCE) has been detected in soil and groundwater. AECOM plumbed these two wells, together with existing extraction RW-1, to a groundwater treatment system that AECOM installed adjacent to RW-1 north of the retail building. The treatment system removes CVOCs and other constituents from groundwater via air stripping, liquid-phase carbon adsorption, and an ion exchange (IX) resin with vapor phase carbon adsorption for treatment of the offgas generated by the air stripper. Treated groundwater water is discharged through the facility stormwater handling network to Mashapaug Pond under a Rhode Island Pollution Discharge Elimination System (RIPDES) Permit.

The installation of the groundwater extraction and treatment system components and subsequent modifications to the treatment system are detailed in the following sections.

## 2.0 Site Description

### 2.1 Geology and Hydrogeology

The former Gorham Silver Facility in Providence, Rhode Island consists of multiple parcels. The retail parcel, where the groundwater extraction and treatment system was installed is located southeast of Mashapaug Pond (see Figure 2). The topography of the retail parcel and most of the Site is flat at an elevation of approximately 65 feet above mean sea level. Just north of the paved retail parcel, the topography slopes steeply down to the pond's edge to an elevation of approximately 40 feet above mean sea level.

Overburden geology consists of up to 20 feet of fill, with underlying native soils consisting of approximately 40 to 45 feet outwash comprised of fine-to-coarse sand, interbedded with fine to very fine sand and silt. Below this unit is a very dense, hard silt, fine sand, and clay layer (likely till), observed in several deep wells. Depth to groundwater on the flat portion of the site is approximately 20 to 25 feet, and thus, the average saturated thickness above the till is approximately 40 feet. Depth to bedrock is estimated to be 200 feet below ground surface (MACTEC, 2006).

The regional hydraulic gradient is eastward toward Narragansett Bay (HLA, 1999), however local gradients are impacted by surface water features such as Mashapaug Pond and the lake complex at Roger Williams Park (see **Figure 1**). Over much of the site, groundwater flow is to the northwest toward Mashapaug Pond, resulting in a divide approximately 2,000 feet east and southeast of the site (HLA, 1999). Flow east of the divide is to Narragansett Bay while flow southeast of the divide is towards the lake complex in Roger Williams Park. Flow west and northwest of the divide is primarily to the northwest towards Mashapaug Pond.

Local groundwater flow is further divided across the southeastern portion of the site. A leaking 80 inch NBC sewer main, located adjacent to the railroad tracks east of the site, is thought to be a groundwater sink, which caused groundwater flow on the east and southeastern part of the site to be captured by the sewer (HLA, 1999). This local groundwater flow affected migration of CVOC impacts in these areas, and thus recovery well RW-3 was installed near the southern source area to contain CVOCs in groundwater in that area and inhibit continued migration to the NBC sewer main.

AECOM characterized the hydraulic conductivity of the sand aquifer by a series of aquifer tests. These tests indicated a generally declining hydraulic conductivity with depth and an average hydraulic conductivity of approximately 80 feet per day. The hydraulic conductivity of the underlying till was not directly characterized, because geologic observations suggested that its hydraulic conductivity was several orders of magnitude lower than that of the overlying sand aquifer. Therefore, the till was not considered significant for migration of CVOCs, and groundwater containment focused on the more transmissive overlying aquifer.

### 2.2 Groundwater Plume

There were two CVOC groundwater plumes on Parcel A at the Site, a northern plume originating in the vicinity of the Retail Building and a southern plume originating east of the closed service station facility. The northern plume flows beneath the Retail Building and discharged to Mashapaug Cove.

The southern plume bifurcated, along the on-site groundwater divide, with a portion flowing north to discharge to Mashapaug Cove and another portion flowing northeast toward the 80-inch NBC sewer main that runs parallel to the eastern property boundary.

The northern CVOC plume extended from the area immediately south of the retail building and beneath the retail building north to Mashapaug Pond. The primary CVOCs detected in the northern plume are 1,1,1-TCA and TCE. 1,1,1-TCA impacts are primarily present in the shallow aquifer, whereas TCE impacts in the area extend to approximately 60 feet below ground surface. The primary CVOC in the southern CVOC plume is PCE, which extends to depths of over 60 feet to the top of till. Dense non-aqueous phase liquid (DNAPL) has been observed in soil borings installed in the source area of the southern CVOC plume.

The area of the CVOC plume being addressed by the groundwater extraction and treatment system is presented in **Figure 2**.

## 3.0 Remedial Installation

The following sections detail the installation of the groundwater extraction and treatment system.

### 3.1 Extraction Well Installation

Between April 3 and 5, 2013, AECOM supervised the installation of recovery wells RW-2 and RW-3 by Geosearch, Inc. of Sterling, MA. **Figure 3** depicts the locations of the recovery wells and trench layout. RW-2 was installed in the vicinity of the northern CVOC source area to a depth of 55 feet below surface grade using a 6 inch diameter, schedule 80 PVC well casing. The casing consists of 30 feet of slotted screen and 25 feet of riser pipe. RW-3 was installed in the southern CVOC source area to a depth of 66.5 feet below surface grade using a 6 inch diameter well casing. The casing consists of 40 feet of stainless steel wire wrap and 25 feet of schedule 80 PVC riser pipe. Boring logs are provided in **Appendix A**.

Between April 1 and April 22, 2013, AECOM oversaw the installation of piping and electrical lines between the extraction wells and the treatment system location. Installation was performed by Earthworks Industries of Plainfield, Massachusetts. Groundwater extracted from the recovery wells is transported to the treatment system via three 2-inch high density polyethylene (HDPE DR-11) pipe. **Figure 3** depicts the trench layout. Piping was placed at a depth of 4 feet below ground surface, surrounded with bedding sand, overlain by the electrical conduit, clean backfill, and asphalt and subgrade.

Four-inch Grundfos® electrical submersible pumps were installed in the recovery wells to extract groundwater from the three wells at a combined rate of 16 gallons per minute (gpm), pumping 4 gpm each from recovery wells RW-1 and RW-2 and pumping 8 gpm from recovery well RW-3. A higher pumping rate was specified for recovery well RW-3 to help obtain containment of the southern CVOC plume across both sides of the local groundwater divide and to maximize mass recovery from the area of the highest CVOC concentrations. The treatment system design capture zone is depicted on **Figure 2**.

### 3.2 Groundwater Treatment System Installation

The groundwater treatment system was constructed off-site by National Environmental Systems (NES) of Attleboro, Massachusetts in a 30-foot long cargo container, painted grey, and placed behind the retail building in the vicinity of recovery well RW-1 (see **Figure 3**). The system was delivered to the site as a ready-to-operate system that was pre-wired, piped, and pre-tested. The treatment system has a fusible disconnect located on the outside of the container that feeds the electrical distribution panel, control panel, and variable frequency drives (VFDs), which are mounted on the interior of the treatment building. The groundwater containment system operation involves a variety of analog and digital instruments and a complex of control loops. Control logic is managed via a custom control enclosure that houses a programmable logic control (PLC) and an auto-dialer for remote alarm notification. The system allows for remote monitoring, control, and data acquisition through a standard phone connection. **Appendix B** provides the NES drawings for both the original System Process and Instrumentation Diagram (P&ID) and a System Enclosure Layout and subsequent revised P&IDs that reflect the addition of an ion exchange resin to the treatment train and later addition of cartridge filter media, which were added to the system following the detection of metals in the system effluent at concentrations in excess of RIPDES permit limits.

The individual piping runs from the recovery wells each include a check valve, sample port, flow control valve, and flow transmitter installed in line, prior to being manifolded together inside the system enclosure. The flow transmitters are used in conjunction variable frequency drives (VFDs) to control the operating frequency and thereby the pumping rate of the down-well submersible pumps. The operator sets an individual pumping rate for each down well submersible pumps, and the PLC uses a proportional, integral,

and differential loop to control the VFDs operating frequency to maintain the set pumping rate. The pumps are protected from overheating with a pump saver that will shut the pump off if there is not sufficient water in the recovery well to maintain a minimum flow. However, the design pumping rate corresponds to one to two feet of drawdown in the wells, and thus this condition is not expected to occur.

After being manifolded into a single stream, the extracted groundwater passes through two bag filter housings, fitted with 25-micron bag filters, plumbed in series prior to being treated for CVOCs. (In 2014, as part of system optimization, the second bag filter unit outfitted to a 10-micron filter.) The bag filters are fitted with a pressure switch to monitoring the potential buildup of pressure (i.e., bag filter clogging) and notify the operator that the bags need to be changed prior to triggering a high-pressure system shut down. Regular maintenance is performed such that this alarm is not triggered under normal operating conditions. Following filtration, CVOC treatment is conducted with a stainless steel low profile air stripper, which was sized based on the design influent concentrations presented in Table 1 below. The inlet groundwater design concentrations are based upon an arithmetic mean of the maximum concentrations detected at nearby groundwater monitoring points.

**Table 1 Summary of Design Influent Concentrations in Groundwater**

<b>Compound</b>	<b>Influent Concentration (ppb)</b>	<b>6-Tray Air Stripper Effluent Concentrations (ppb)</b>	<b>RIPDES Permit Discharge Limit Monthly Average / Daily Max (ppb)</b>
Trichloroethylene (TCE)	6,592	<1	5.0/5.0
Tetrachloroethylene (PCE)	5,963	<1	4.24/5.0
cis-1,2-Dichloroethylene	371	<1	NA/70
Vinyl chloride	65	<1	1.92/2.0
1,1,1-Trichloroethane	12,674	<1	NA/200
1,1-Dichloroethane	464	<1	NA/70

The low-profile air stripper is equipped with a differential pressure switch that monitors the pressure across the air-stripper trays to ensure proper treatment is being achieved. If the differential pressure alarm is triggered, due to fouling of the air stripper, the system will be shut down until the air stripper is cleaned and the condition is corrected. Regular maintenance is performed such that this alarm is not triggered under normal operating conditions. The air stripper sump has a sight glass, which is equipped with level controls to operate the air stripper sump transfer pump and a high high-level alarm. If the air stripper sump transfer pump malfunctions or cannot keep up with the water being treated by the air stripper, the high-high-level alarm will turn the down well submersible pumps off until the operator corrects the condition causing back-pressure downstream.

The treated groundwater is then pumped from the air stripper sump, using a transfer pump rated for 30 gpm @ 75 psi, through two bag filter housings plumbed in series. Both bag filter housings have a 10-micron bag filter, to limit the amount of solids being loaded onto the liquid-phase granular activated (LGAC) vessels. Although no CVOCs have been detected in the treated groundwater following air stripping, the treated groundwater passes through two 500-pound LGAC vessels, bedded with virgin charcoal based carbon. These LGAC vessels act as the secondary treatment of the recovered groundwater, consistent with the requirements of the Rhode Island Pollutant Discharge Elimination System (RIPDES) permit. The LGAC vessels are connected via high-pressure hoses and are of sufficient length to allow for lead/lag operations, wherein the order through which the groundwater enters the vessels is varied, if necessary. Pressure

switches are located prior to the bag filters and each LGAC vessel to monitor the operation pressure and alarm the operator if a high pressure is detected. The high pressure alarms will shut the system down, as needed, until the operator addresses the cause of the back pressure (i.e., replaces bag filters or re-beds the LGAC vessels).

Treatment for metals is also performed to help prevent exceedances of RIPDES permit limitations for metals. A third media vessel, following the two LGAC vessels, consisting of a 750-pound IX resin (zeolite media), was included as part of the original system to maintain effluent metals levels below RIPDES requirements. However, results of system sampling indicated that metals concentrations entering the system were greater than concentrations that had been observed during aquifer testing, design, and startup, and upon which the system had been designed and RIPDES permit effluent limitations were exceeded. Therefore, the zeolite media vessel was replaced by two ion exchange vessels, each containing 1,000 pounds of SCU Adsorbent.

### 3.3 Vapor Treatment

Offgas from the air stripper is treated with two 1,000-pound vapor-phase granular active carbon (VGAC) vessels, located inside the system container, and discharged through a four-inch Schedule 80 PVC stack that extends approximately 10 feet above the retail building roof line. The emissions from the air stripper falls under the State of Rhode Island Department of Environmental Management (RIDEM) Air Pollution Control Regulation §9.3.2 (Exemptions), which allow for air pollution control systems used to treat emissions from site remediation operation to maintain compliance simply by reducing emissions of VOCs by at least 95%.

Based on air-stripper modeling performed by AECOM, the design emissions concentrations were expected to utilize approximately 19 pounds of vapor phase carbon per day. Utilizing two 1,000-pound VGAC vessels in series, this would allow for approximately 100 days before carbon re-bedding is required (i.e., quarterly re-bedding). However, based on monitoring of vapor phase carbon influent and effluent, the period of time between carbon re-bedding can be greater and have treatment efficiency remain above 95%. Regular monitoring of vapor discharge is performed to allow evaluation of the actual working lifespan of carbon in the vessels.

### 3.4 Treated Groundwater Discharge

The treated groundwater discharges through a mechanical flow meter prior to exiting the treatment system enclosure. The treated groundwater is discharged under a RIPDES permit to the catch basin behind the building. See Figure 3 for the location of the catch basin. This catch basin discharges to a detention basin that flows into Mashapaug Pond.

### 3.5 Remedial System Monitoring

The remedial system is currently monitored by AECOM personnel during system/site inspections performed twice per month. Alarm conditions that are triggered at the system are communicated to AECOM via email. A system checklist is completed during each on-site system/site inspection. The following parameters are measured and checked during each site visit and monitoring event:

- Pressure, flow rate, and total volume readings from all recovery wells and the system discharge;
- Filter pressures and conditions;
- Depth to water elevations at each recovery well;
- Pressure at each treatment vessel; and

- Air stripper air flow and PID readings in the vapor stream.

Water treatment samples are collected from the influent and effluent of the system twice per month in accordance with RIPDES Remediation General Permit (RGP) requirements. The samples are submitted for laboratory analyses of VOCs using EPA Method 8260, total suspended solids (TSS), and select total metals analysis, which include copper, iron, lead, nickel, silver, zinc.

Air samples were collected from the influent, midpoint and effluent to the VGAC adsorbers once during 2013 to confirm that the concentrations of CVOCs are below the listed RIDEM Air Pollution Control Regulation No. 9, Appendix A, Minimum Quantities (pounds per year) and List of Federal Hazardous Air Pollutants (HAPs) of the air regulations. The air samples were submitted to Eurofins/Air Toxics for analyses of VOCs using EPA method TO-15. Results from the air samples indicate that concentrations are below applicable standards. A copy of the laboratory analysis is provided as **Appendix C**.

General site and equipment conditions are evaluated during each inspection and routine maintenance is performed as needed. Filters are changed out, at a minimum, on a monthly basis or more frequently if warranted based on an inspection and review of the operational data.

<b>Site-Related Permits</b>				
<b>Permit Name</b>	<b>Permit #</b>	<b>Regulatory Oversight By:</b>	<b>Date Issued/ Reissued</b>	<b>Date Expires</b>
RIPDES RGP	#RIG85E004	RIDEM / EPA	11/2/2012*	9/30/2013**
RIPDES RGP	#RIG85E004	RIDEM / EPA	5/23/2014	9/30/2018

\* November 2, 2012 –Remediation General Permit issued by EPA under the Rhode Island Pollutant Discharge Elimination System. In accordance with the requirements of the Rhode Island RGP, each remediation site in the state that filed a notice of intent and/or had an existing NPDES Exclusion Permit was issued a RIPDES RGP with a specific permit number and site-specific monitoring requirements.

\*\* AECOM submitted a Notice of Intent (NOI) to renew RIPDES RGP in 2013, and RIDEM indicated the system could continue to be operated under the old RGP until the new general permit is issued.

## 4.0 System Startup and Modification

On May 15, 2013, the pump and treat system was started. As part of system startup activities, influent, effluent, and related water samples were collected from the groundwater treatment system on the following dates:

- 5/15/2013
- 5/17/2013
- 5/20/2013
- 5/28/2013
- 6/4/2013
- 6/10/2013
- 6/11/2013

During these initial sampling events, nickel and copper exceeded discharge standards. The June 2013 monthly average concentration for nickel was 32.2 micrograms per liter (ug/L), compared to a discharge standard of 12.92 ug/L, and the June 2013 monthly average concentration for copper was 62.6 ug/L compared to a discharge standard of 3 ug/L.

The system was shut down, and the liquid-phase granular activated carbon and zeolite metals treatment media were replaced with virgin materials. When this did not rectify the situation, the system was shutdown to allow evaluation of additional metals treatment alternatives. Following discussions with the RIDEM Office of Water Resources, AECOM temporarily restarted the system for 48 hours to collect samples for treatability analysis.

On September 17, 2013, AECOM submitted a request to perform a system amendment to replace the zeolite media with a proprietary ion exchange media supplied by Siemens (now Evoqua). The amendment was approved and then implemented and the system restarted on September 27, 2013. The startup monitoring schedule was resumed at that time and the system has been operating, except of periods of maintenance since that time. In 2014, AECOM submitted another modification request to RIDEM to propose the addition of cartridge filtration in the treatment stream to further improve metals treatment. The proposal was approved by RIDEM, and the system was modified on September 23, 2014. The final engineer stamped P&ID, detailing these modifications, is provided in **Appendix B**.

Operation and maintenance of the system are being performed by AECOM. A copy of the operations and maintenance manual for the system is provided as **Appendix D**.

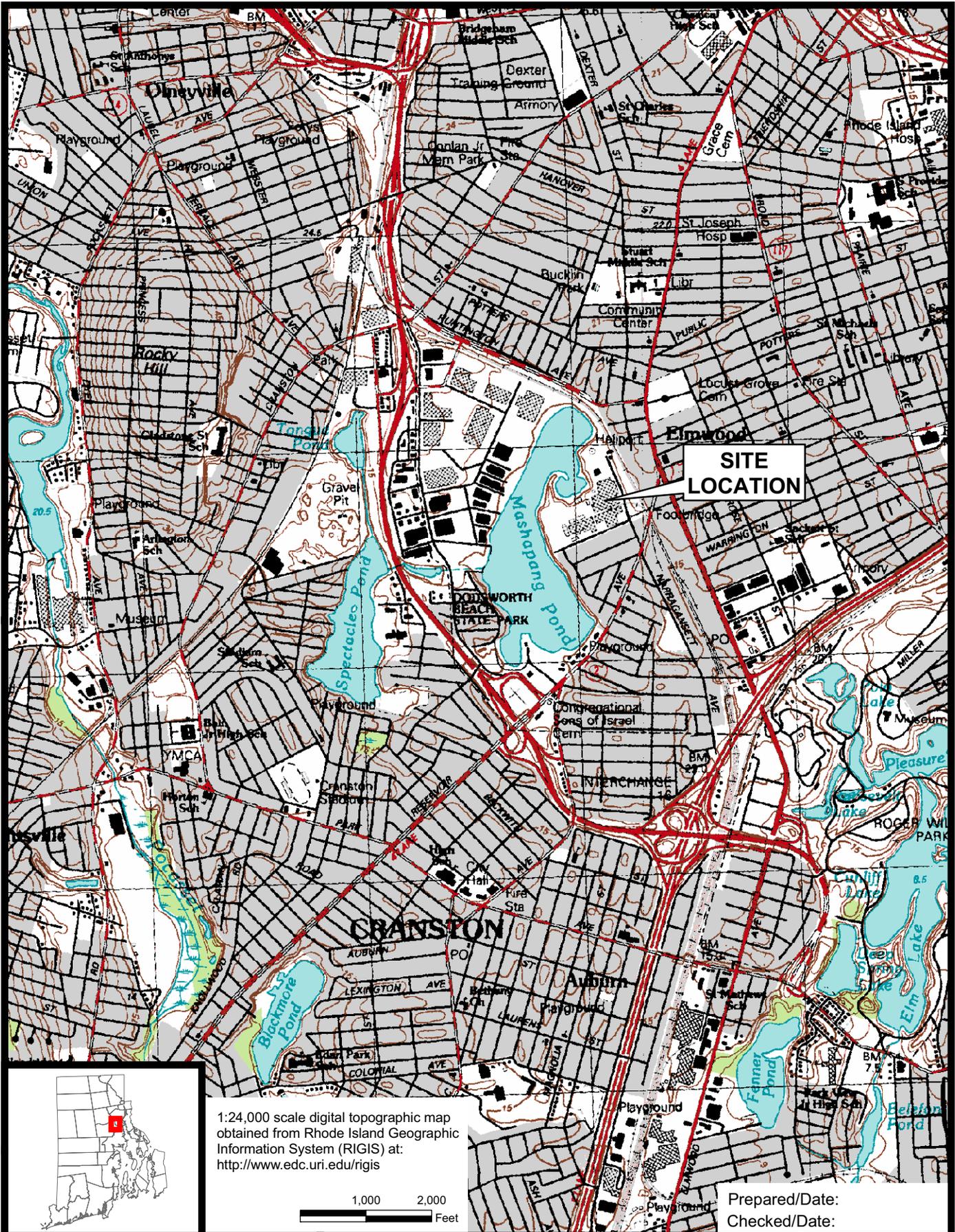
## 5.0 References

AECOM, 2011. Preliminary Hydrogeologic Evaluation of Groundwater Pump and Treat Remediation—Former Gorham Silver Facility, 333 Adelaide Ave., Providence, Rhode Island. December 2011.

Harding Lawson Associates, 1999. Site Investigation Summary and Risk Assessment, Volumes 1 and 2.

MACTEC, 2006. Supplemental Site Investigation Report, Former Gorham Manufacturing Facility.

## Figures



1:24,000 scale digital topographic map  
 obtained from Rhode Island Geographic  
 Information System (RIGIS) at:  
<http://www.edc.uri.edu/rigis>



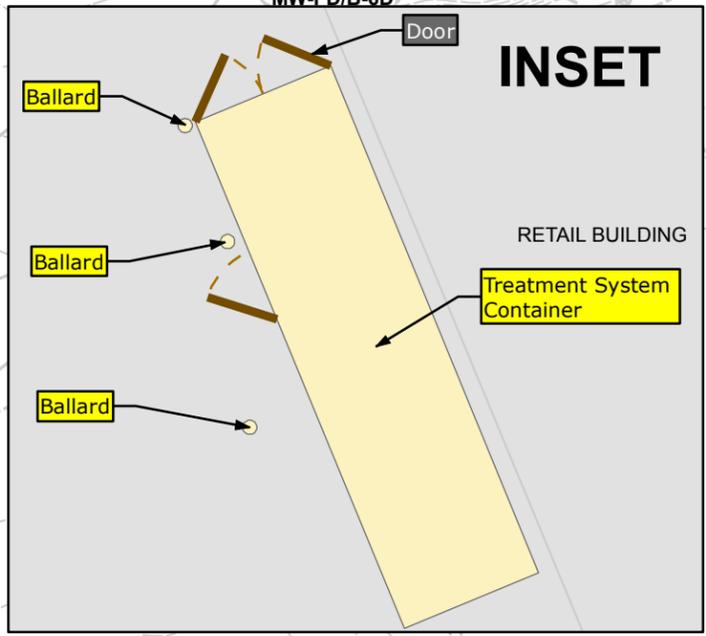
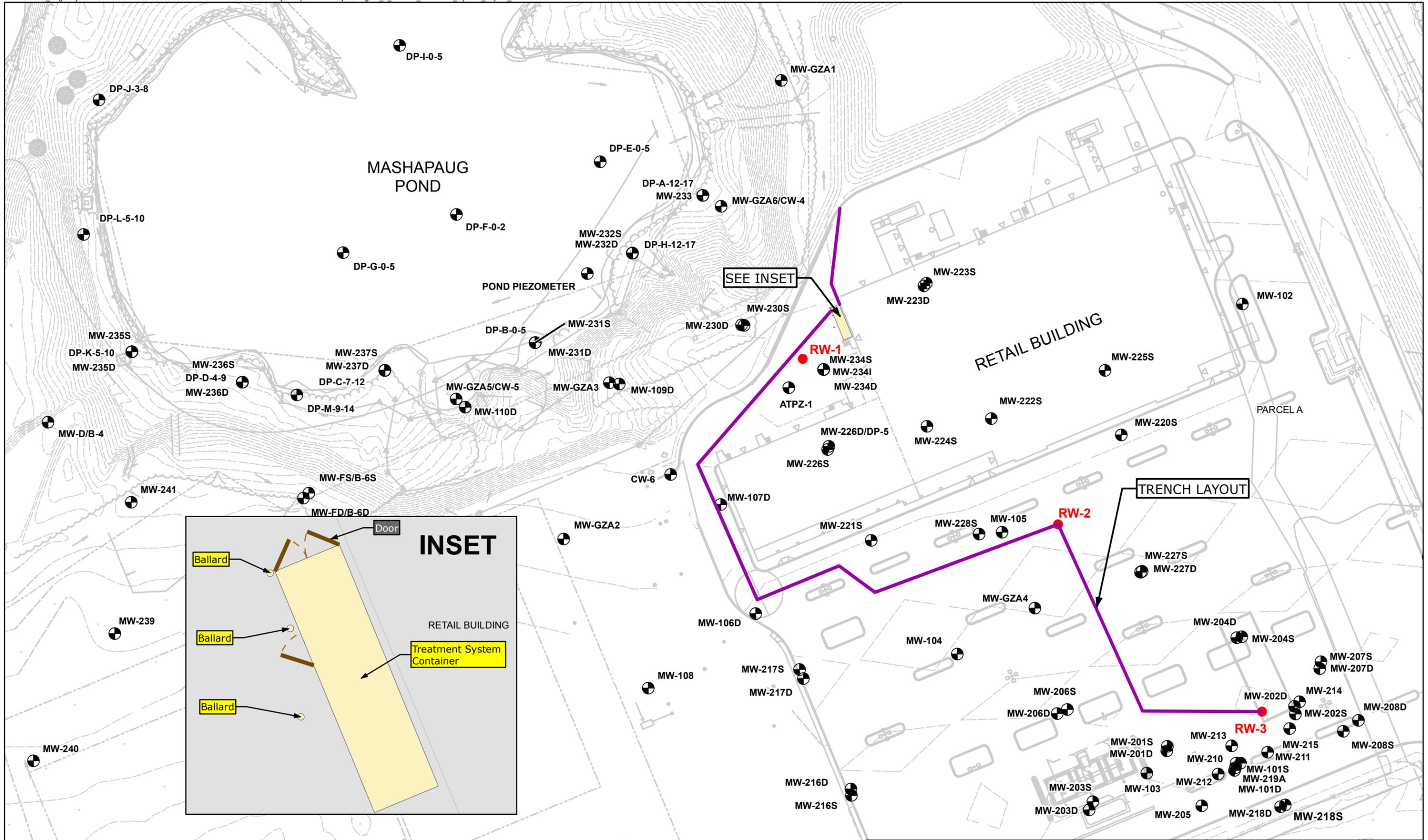
Prepared/Date:  
 Checked/Date:

Former Gorham Manufacturing Site  
 Providence, Rhode Island



Site Location Map  
 Project 60212521  
 Figure 1





**NOTES:**  
 VGAC located inside the treatment system container. Discharge stack to extend approximately 10 ft above the building roof top.



FORMER GORHAM MANUFACTURING FACILITY PROVIDENCE, RHODE ISLAND 60271240.4.4		AS-BUILT TREATMENT SYSTEM LAYOUT
DATE: 2/27/2014	DRWN: JEB/HKM	FIGURE 3



# **Appendix A**

## **Boring Logs**



Client: Textron Gorham Silver

Project Number: 60271240

Site Location: 333 Adeladie Ave, Providence, RI

Well Location: Coords:

Method: Hollow-stem auger

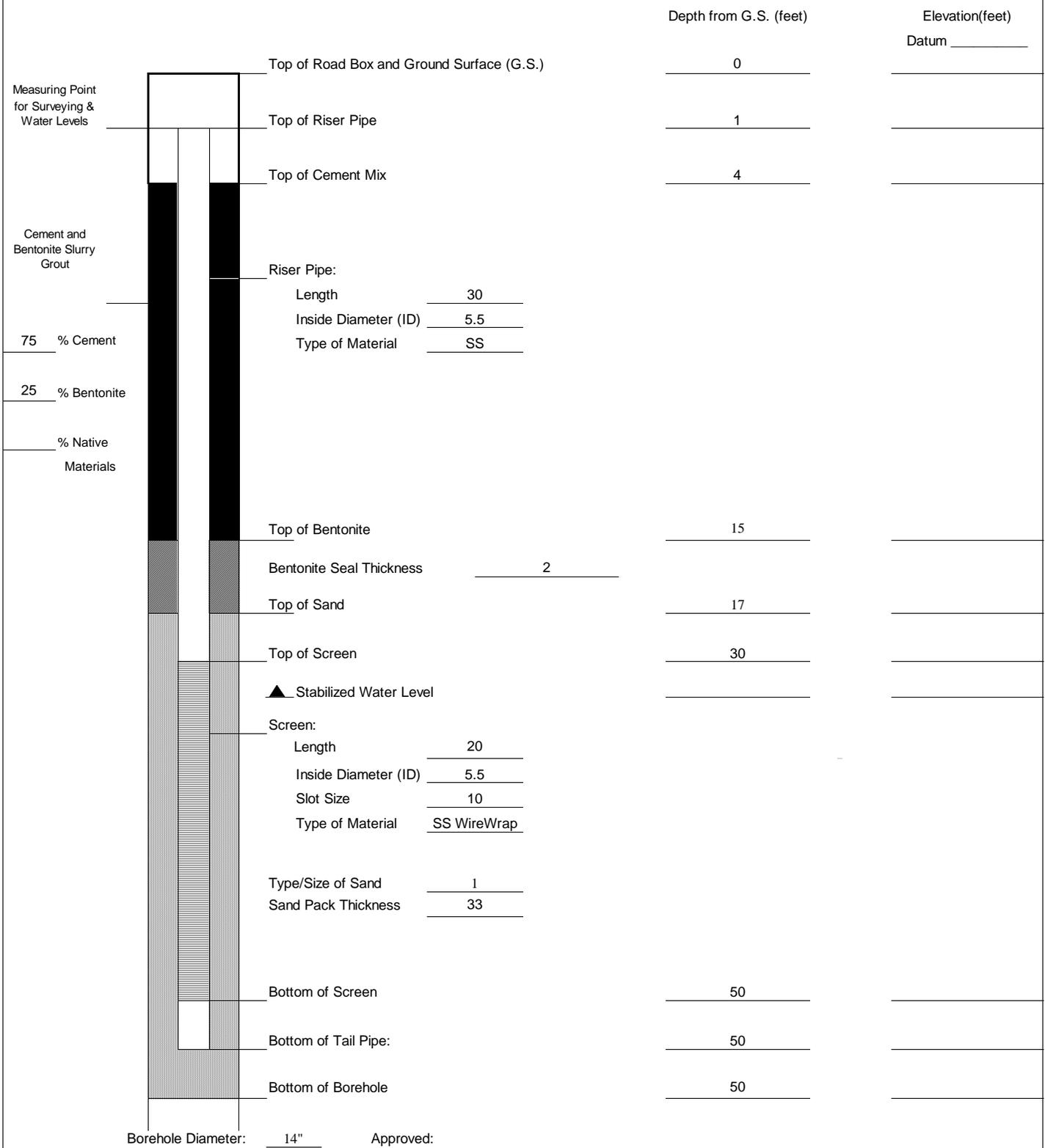
WELL ID: RW-1

Date Installed: 7-6-11

Inspector: Brian Serrdecchia

Contractor: TDS

### MONITORING WELL CONSTRUCTION DETAIL



Describe Measuring Point:

Approved:

Signature

Date



Client: Textron Gorham Silver

Project Number: 60271240

Site Location: 333 Adeladie Ave, Providence, RI

Well Location: \_\_\_\_\_ Coords: \_\_\_\_\_

Method: Hollow-stem auger

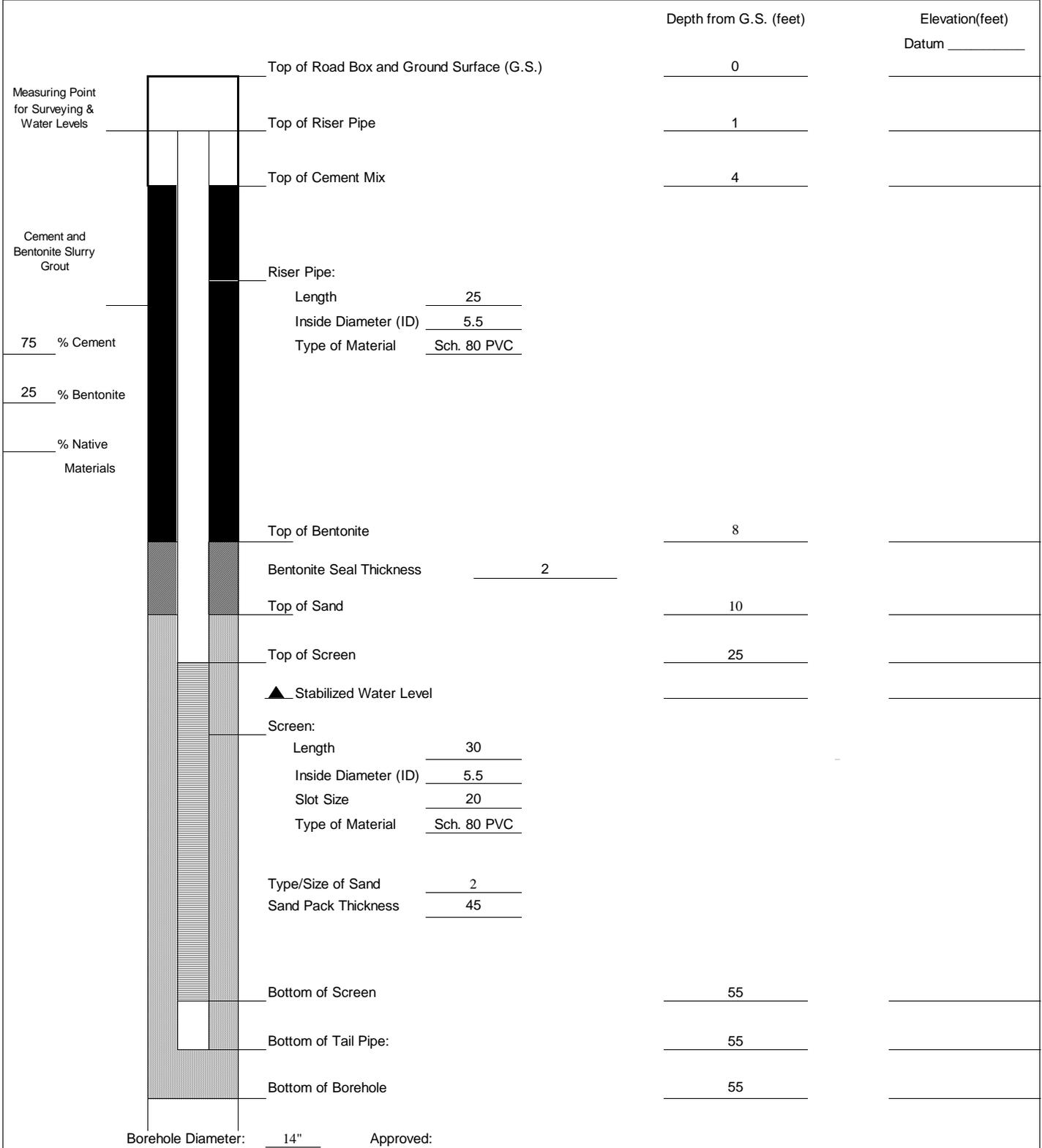
**WELL ID: RW-2**

Date Installed: 4-3-13

Inspector: Luis Ferreira

Contractor: Geosearch

**MONITORING WELL CONSTRUCTION DETAIL**



Describe Measuring Point:

Approved: \_\_\_\_\_  
Signature

\_\_\_\_\_ Date



Client: Textron Gorham Silver

**WELL ID: RW-3**

Project Number: 60271240

Site Location: 333 Adeladie Ave, Providence, RI

Date Installed: 4-5-13

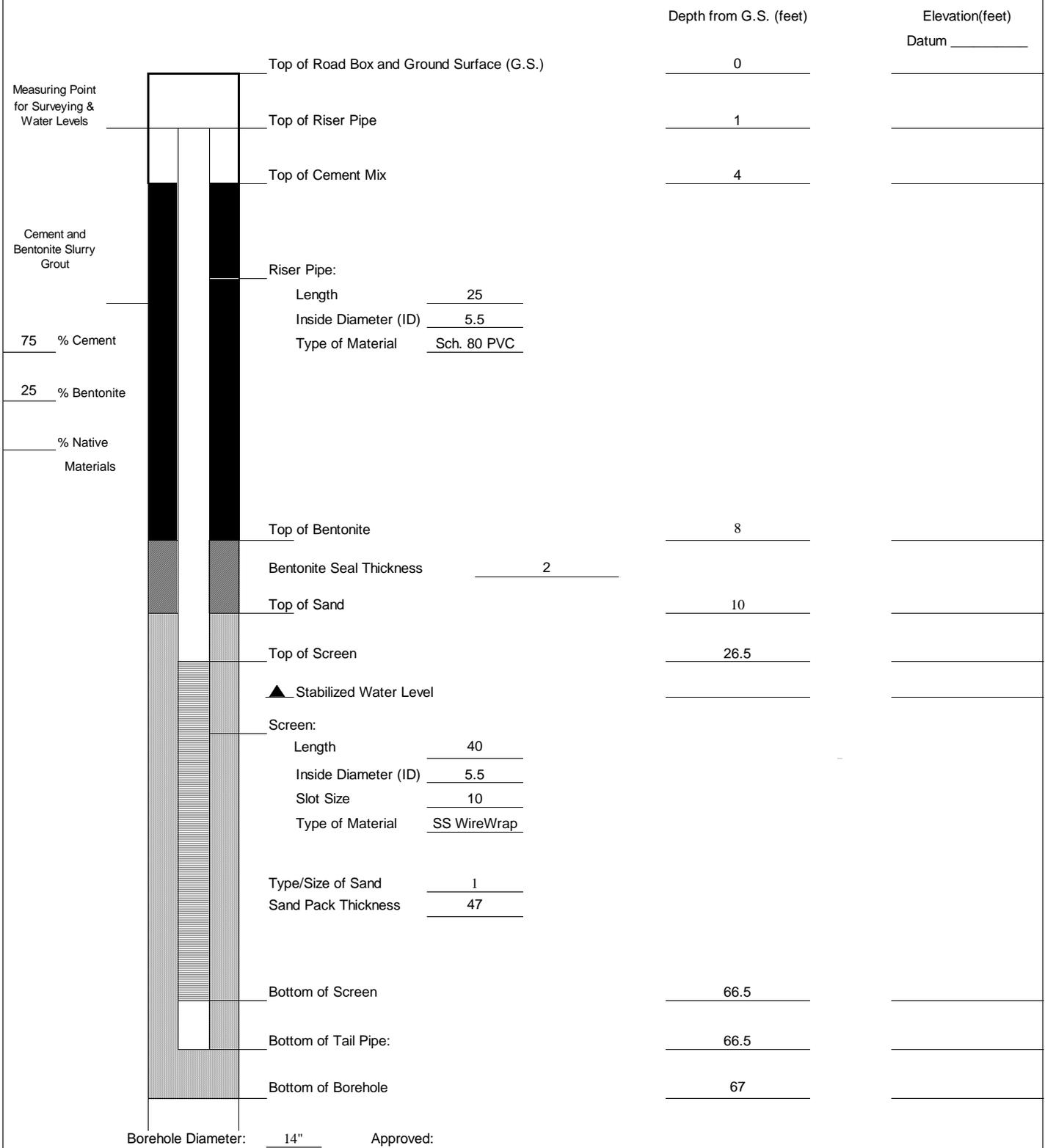
Well Location: \_\_\_\_\_ Coords: \_\_\_\_\_

Inspector: Luis Ferreira

Method: Hollow-stem auger

Contractor: Geosearch

**MONITORING WELL CONSTRUCTION DETAIL**



Borehole Diameter: 14"

Approved: \_\_\_\_\_

Describe Measuring Point: \_\_\_\_\_

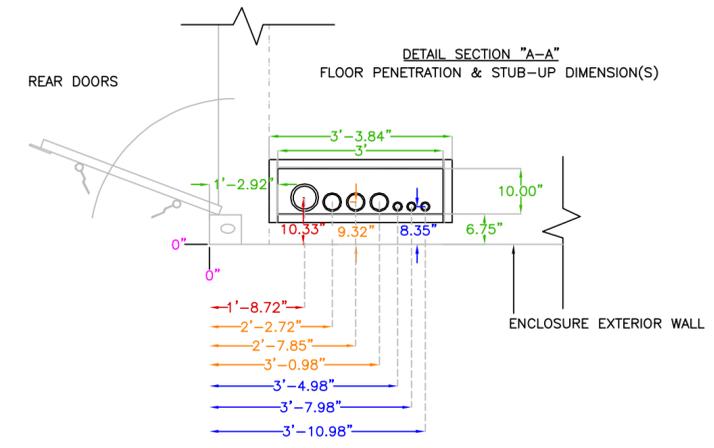
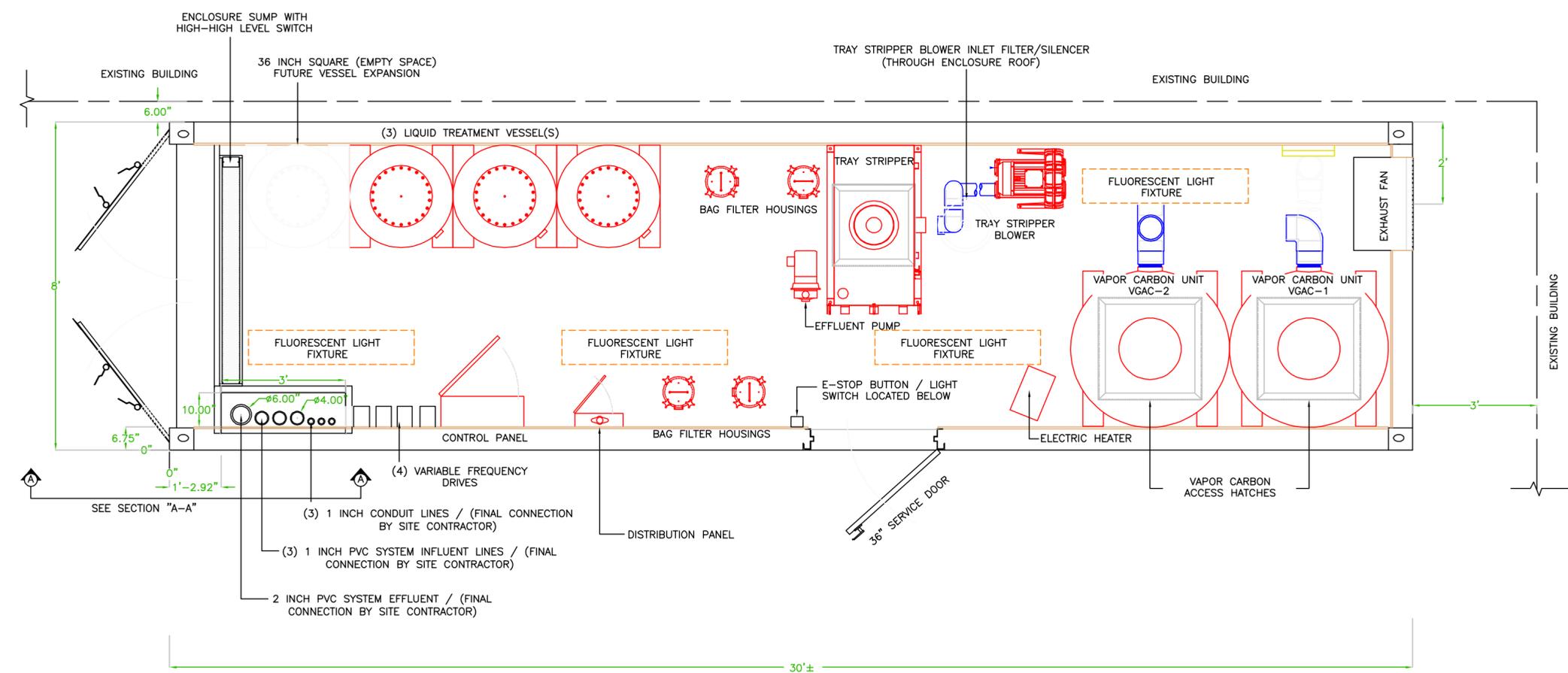
Signature \_\_\_\_\_

Date \_\_\_\_\_

## **Appendix B**

# **System Schematic and Process & Instrumentation Diagrams**

REVISIONS		
A	AS BUILT	04-04-13 EMB



- CONSTRUCTION NOTES:**
- INTERIOR & EXTERIOR OF SYSTEM ENCLOSURE ARE NEC NON-CLASSIFIED.
  - SITE POWER: 208 VAC / 3 PHASE
  - INFLUENT & EFFLUENT PIPING ALONG WITH (3) 1 INCH CONDUITS FOR DOWN-WELL PUMPS WILL ENTER THE SYSTEM ENCLOSURE THROUGH A FLOOR CUT-OUT. TEMPLATE SUPPLIED FOR FIELD CONFIRMATION.
  - EXTERIOR COLOR: GRAY
  - ADDITIONAL SPACE PROVIDED FOR POTENTIAL (4TH) LIQUID MEDIA VESSEL.
  - VGAC VESSEL, TRAY STRIPPER BLOWER INLET FILTER, AND TRAY STRIPPER CONE/DEMISTER REQUIRE ROOF ACCESS. FALL PROTECTION IS THE RESPONSIBILITY OF AECOM.
  - 1 INCH INFLUENT GROUNDWATER RECOVERY LINES AND 2 INCH DISCHARGE LINE TERMINATE 2 FT ABOVE ENCLOSURE FLOOR. FINAL CONNECTIONS TO INFLUENT & EFFLUENT & LINES VIA HOSE (BY OTHERS)
  - TRAY STRIPPER EFFLUENT AIR PIPING WILL EXIT THROUGH THE SYSTEM ROOF AND RE-ENTER THE EAST WALL OF THE ENCLOSURE. THIS PIPING WILL REQUIRE RE-INSTALLATION ON SITE. A DRIP LEG WITH MANUAL DRAIN WILL BE PROVIDED FOR ANY EXCESS MOISTURE ACCUMULATION.

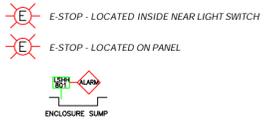
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DRWN BY CJJ		DATE 3-1-13		TITLE GROUNDWATER TREATMENT SYSTEM ENCLOSURE LAYOUT			
CHK BY		DATE		AECOM (MA) TEXTRON - PROVIDENCE, RI		JOB NO. 12-133	
APPR BY		DATE		SCALE N/A	SIZE C	DWG NO. M-2	SHEET 1 OF 2
						REV A	

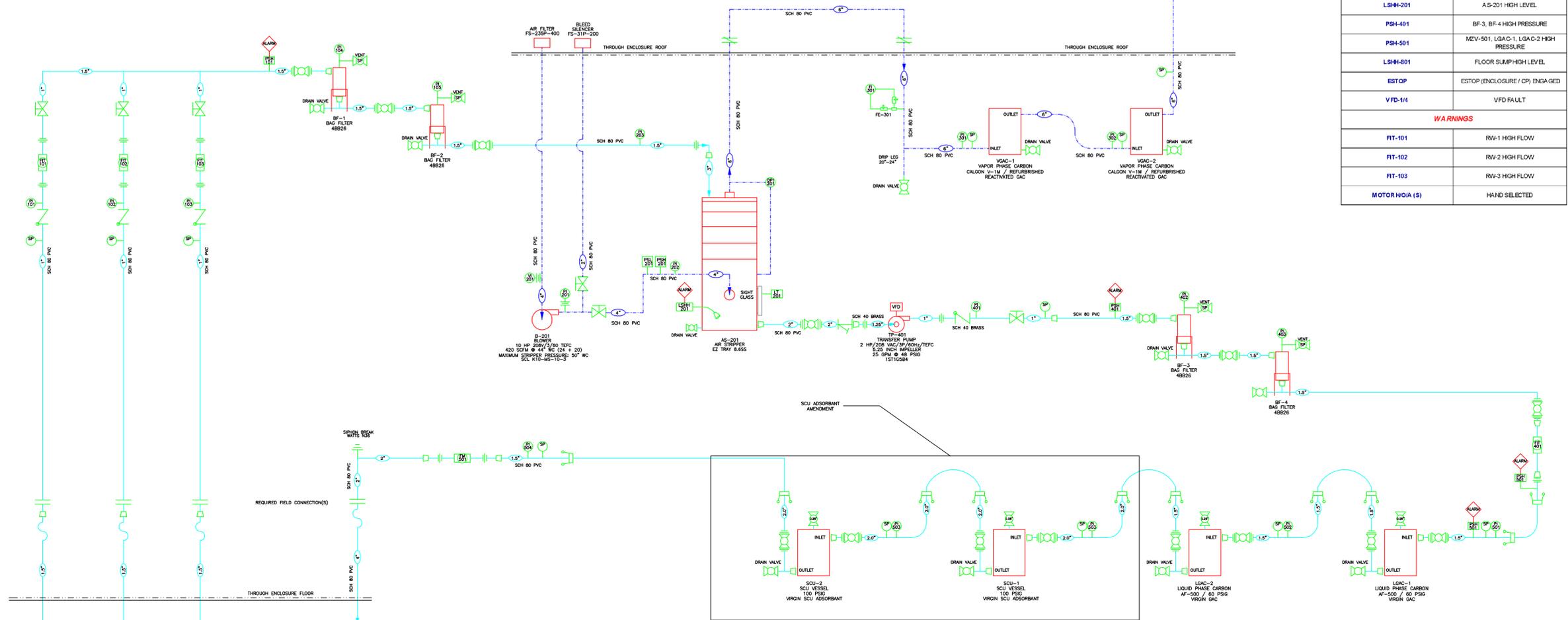


SITE POWER: 208 VAC / 3 Ø / 60 Hz  
 CLASSIFICATION: NON HAZARDOUS INTERIOR & EXTERIOR LOCATION

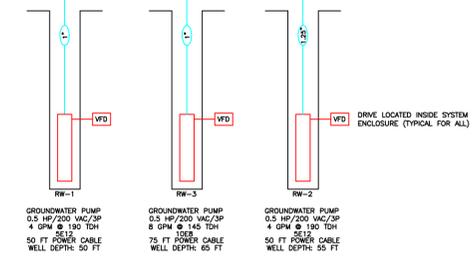
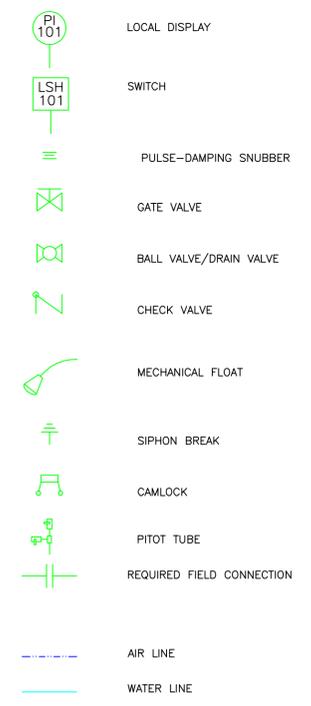


ALARMS	
FIT-101	RW-1 LOW FLOW
FIT-102	RW-2 LOW FLOW
FIT-103	RW-3 LOW FLOW
LT-201	AS-201 LOW LEVEL
LT-201	AS-201 HIGH LEVEL
PSH-101	BF-1, BF-2 HIGH PRESSURE
PSL-201	B-201 LOW PRESSURE
LSHH-201	AS-201 HIGH LEVEL
PSH-401	BF-3, BF-4 HIGH PRESSURE
PSH-501	MZV-501, LGAC-1, LGAC-2 HIGH PRESSURE
LSHH-801	FLOOR SLUMP HIGH LEVEL
ESTOP	ESTOP (ENCLOSURE / CP) ENGA GED
VFD-1/4	VFD FAULT
WARNINGS	
FIT-101	RW-1 HIGH FLOW
FIT-102	RW-2 HIGH FLOW
FIT-103	RW-3 HIGH FLOW
MOTOR H/O/A (S)	HAND SELECTED

LEGEND	
BPI	DIFFERENTIAL PRESSURE INDICATOR
FE	FLOW ELEMENT
FI	FLOW INDICATOR
FIT	FLOW INDICATING TRANSMITTER
FM	FLOW METER
FT	FLOW TOTALIZER
LT	LEVEL TRANSMITTER
LSHH	LEVEL SWITCH HIGH-HIGH
PI	PRESSURE INDICATOR
PSH	PRESSURE SWITCH HIGH
PSL	PRESSURE SWITCH LOW
SP	SAMPLE POINT
VI	VACUUM INDICATOR



TAG No	ITEM	MANUFACTURER	MODEL	SPEC
FIT-101/FIT-103 & FIT-501	FLOW INDICATING TRANSMITTER	GF SIGNET	3-2551-P0-42	MAGMETER, POLY PROPY LENE BODY, 316SS ELECTRODE, GROUNDING RINGS, 0.5 - 4 INCH (DN15 TO DN100) PIPE SIZE WITH DISPLAY, 4-20mA OUTPUT / WITH 1 INCH PVC INSTALLATION TEE (WITH PRE-SECTIONS)
PI-101 / PI-103	PRESSURE GAUGE	MARSH	98152410	0 - 100 PSIG RANGE / 2.5 INCH STAINLESS STEEL CASE / BRASS WETTED PARTS / LIQUID FILLED / 0.25 INCH BOTTOM MOUNT CONNECTION
PI-104 / PI-106	PRESSURE GAUGE	MARSH	98152409	0 - 60 PSIG RANGE / 2.5 INCH STAINLESS STEEL CASE / BRASS WETTED PARTS / LIQUID FILLED / 0.25 INCH BOTTOM MOUNT CONNECTION
PSH-101, PSH-401 & PSH-501	HIGH PRESSURE SWITCH	DWYER	CS-150	10 - 150 PSI RANGE / 5 PSI FREQ DEADBAND / 0.25 INCH BOTTOM CONNECTION PORT / Buna-N & STAINLESS STEEL WETTED MATERIALS / 175 PSIG PRESSURE LIMIT / SPDT SNAP SWITCH / ADJUSTABLE SET POINT
VI-201	VACUUM GAUGE	MILCOO	LP25070210	15 - 0 INCH RANGE / DIA-PH-RAGM GAUGE / 2.5 INCH STAINLESS STEEL CASE / 0.25" BACK CONNECTION
PI-201 & PI-202	PRESSURE GAUGE	MILCOO	LP2507L250	0 - 100 INCH RANGE / DIA-PH-RAGM GAUGE / 2.5 INCH STAINLESS STEEL CASE / 0.25" BOTTOM CONNECTION
PI-203	PRESSURE GAUGE	MILCOO	LP2507L220	0 - 30 INCH RANGE / DIA-PH-RAGM GAUGE / 2.5 INCH STAINLESS STEEL CASE / 0.25" BOTTOM CONNECTION
PSH-201	HIGH PRESSURE SWITCH	DWYER	1952P-2-2F	0.5 TO 2 PSI / 0.3 MAX DEAD BAND / (1) 1/4 TO 1/40 F TEMPERATURE LIMITS / 35 PSI MAX PRESSURE / SPDT SWITCH TYPE 0.125 INCH PROCESS CONNECTION / ADJUSTABLE SET POINT
PSL-201	LOW PRESSURE SWITCH	DWYER	1950-20-2F	4 TO 20 INCH / 0.4 MIN TO 0.6 MAX DEAD BAND / (1) 1/4 TO 1/40 F TEMPERATURE LIMITS / 45 INCHES WATER MAX PRESSURE / SPDT SWITCH TYPE 0.125 INCH PROCESS CONNECTION / ADJUSTABLE SET POINT
DPI-201	DIFFERENTIAL PRESSURE INDICATOR	DWYER	2050	0-50 MFC / 4 INCH / 20 IN HG TO 15 PSIG PRESSURE LIMITS / 20 - 140 F TEMPERATURE RANGE / 0.125" CONNECTION
LSHH-201	HIGH-HIGH LEVEL SWITCH	GMS	MYEL40T	NARROW ANGLE / NORMALLY CLOSED / 40 FEET OF POWER CORD / 2 WIRE / 32 F TO 221 F TEMPERATURE RATING / NON MERCURY
LT-201	LEVEL TRANSMITTER	GMS	XT800-3-BB-BN-13-11-5-7-1300-JH-COLLARS	BRASS CONSTRUCTION / 2 INCH TOP MOUNT FITTING / Buna-N FLOAT / 4 - 20mA OUTPUT
FE-301	FLOW ELEMENT	DWYER	DS-300-9	6 INCH AVERAGING PITOT TUBE / S.S. WITH BRASS ISOLATION VALVE / 0 - 200 F TEMP LIMITS
FI-301	FLOW INDICATOR	DWYER	2201	0-1 INCH / 4 INCH / 20 IN HG TO 15 PSIG PRESSURE LIMITS / 20 - 140 F TEMPERATURE RANGE / 0.125" CONNECTION
PI-301 & PI-302	PRESSURE GAUGE	MILCOO	LP2507L220	0 - 30 INCHES WATER RANGE / 2.5 INCH STEEL CASE / BRASS WETTED PARTS / 0.25 INCH BOTTOM MOUNT CONNECTION
FM-401	FLOW METER	HEPLINE	T10-1	1-50GPM / MECHANICAL FLOW TOTALIZER / LOCAL DISPLAY / BRONZE CONSTRUCTION / 1/2 IN CONNECTIONS / NON RESETTABLE REGISTER
PI-401/PI-403	PRESSURE GAUGE	MARSH	98152410	0 - 100 PSIG RANGE / 2.5 INCH STAINLESS STEEL CASE / BRASS WETTED PARTS / LIQUID FILLED / 0.25 INCH BOTTOM MOUNT CONNECTION
PI-501 & PI-502	PRESSURE GAUGE	MARSH	98152410	0 - 100 PSIG RANGE / 2.5 INCH STAINLESS STEEL CASE / BRASS WETTED PARTS / LIQUID FILLED / 0.25 INCH BOTTOM MOUNT CONNECTION
PI-503	PRESSURE GAUGE	MARSH	98152409	0 - 60 PSIG RANGE / 2.5 INCH STAINLESS STEEL CASE / BRASS WETTED PARTS / LIQUID FILLED / 0.25 INCH BOTTOM MOUNT CONNECTION
PI-504	PRESSURE GAUGE	MARSH	98152408	0 - 30 PSIG RANGE / 2.5 INCH STAINLESS STEEL CASE / BRASS WETTED PARTS / LIQUID FILLED / 0.25 INCH BOTTOM MOUNT CONNECTION
LSHH-801	LEVEL SWITCH	DWYER	F7-5B	LEVEL SWITCH Buna-N & EPOXY W/ 3/16 GS



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TITLE	DATE	DRWN BY	DATE	CHK BY	DATE	APPR BY	DATE	SCALE	SIZE	DWG NO.	SHEET	REV	
GROUNDWATER TREATMENT SYSTEM PROCESS & INSTRUMENTATION DIAGRAM (P&ID)	3-5-13	CJJ	3-5-13					N/A	D	M-1	1 OF 1	B	
AECOM PROVIDENCE, RI		JOB NO. 12-133		TEXTRON		ENB		M-1		1 OF 1		B	
REVISIONS		DATE		APPROVED		DATE		DATE		DATE		DATE	

8 7 6 5 4 3 2 1

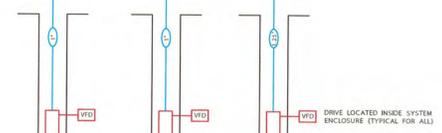
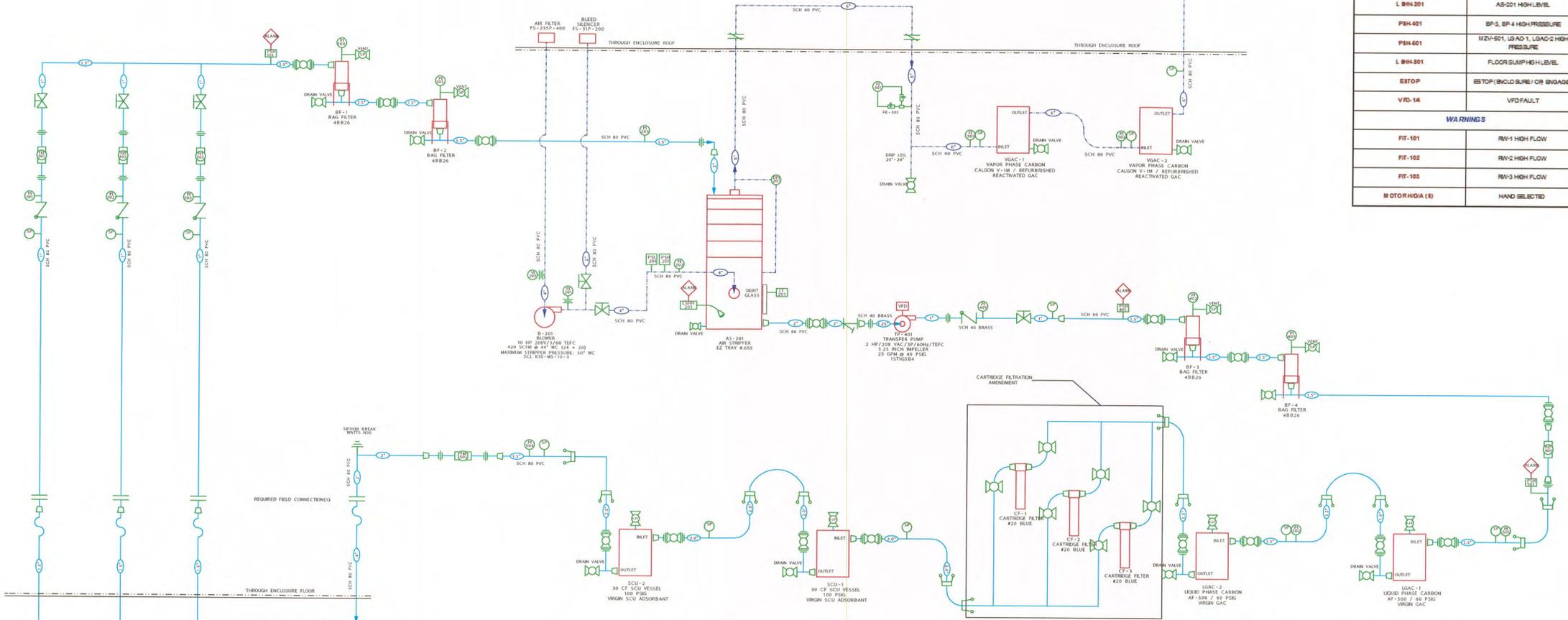
SITE POWER: 208 VAC / 3 Ø / 60 Hz  
 CLASSIFICATION: NON HAZARDOUS INTERIOR & EXTERIOR LOCATION



ALARMS	
FI-101	RM-1 LOW FLOW
FI-102	RM-2 LOW FLOW
FI-103	RM-3 LOW FLOW
LT-201	AS-201 LOW LEVEL
LT-201	AS-201 HIGH LEVEL
PSH-101	BP-1, BP-2 HIGH PRESSURE
PBL-201	B-201 LOW PRESSURE
L 894-201	AS-201 HIGH LEVEL
PSH-401	BP-3, BP-4 HIGH PRESSURE
PSH-601	MZV-501, LBAD-1, LQAD-2 HIGH PRESSURE
L 894-601	FLOOR SUMP HIGH LEVEL
ESTOP	ESTOP (ENCLOSURE) OR ENGAGED
VRD-1A	VFD FAULT

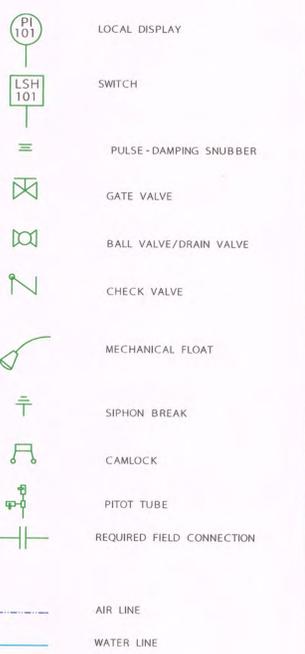
WARNINGS	
FI-101	RM-1 HIGH FLOW
FI-102	RM-2 HIGH FLOW
FI-103	RM-3 HIGH FLOW
NOTOR HDA (S)	HAND SELECTED



TAG NO	ITEM	MANUFACTURER	MODEL	SPEC
FI-101/FI-102 & FI-401	FLOW INDICATING TRANSMITTER	GF SONET	3-2051-10-42	1/2" NPT, POLYPROPYLENE BODY, 316SS ELECTRODE GROUNDING RINGS, 0.5 - 4 INCH (DN15 TO DN50) PIPE SIZE WITH DISPLAY, 4-20MA OUTPUT / WITH 1/2" NPT CONNECTION / WITH 1/2" NPT CONNECTION
PI-101 / PI-102	PRESSURE GAUGE	MARSH	98152410	0 - 100 PSIG RANGE / 2.5 INCH STAINLESS STEEL CASE / BRASS WETTED PARTS / LIQUID FILLED / 0.25 INCH BOTTOM MOUNT CONNECTION
PI-104 / PI-106	PRESSURE GAUGE	MARSH	98152409	0 - 80 PSIG RANGE / 2.5 INCH STAINLESS STEEL CASE / BRASS WETTED PARTS / LIQUID FILLED / 0.25 INCH BOTTOM MOUNT CONNECTION
PSH-101, PSH-401 & PSH-601	HIGH PRESSURE SWITCH	DWYER	CS-150	10 - 150 PSIG RANGE / 5 PSIG DEADBAND / 0.25 INCH NPT CONNECTION PORT / 1/2" NPT STAINLESS STEEL WETTED PARTS / 175 PSIG PRESSURE LIMIT / SPDT SWAP SWITCH / ADJUSTABLE SET POINT
VI-201	VACUUM GAUGE	MILJOD	LP2507210	15 - 0 INCH RANGE / DIAPHRAGM GAUGE / 2.5 INCH STAINLESS STEEL CASE / 0.25" BOTTOM CONNECTION
PI-201 & PI-202	PRESSURE GAUGE	MILJOD	LP2507220	0 - 100 INCH RANGE / DIAPHRAGM GAUGE / 2.5 INCH STAINLESS STEEL CASE / 0.25" BOTTOM CONNECTION
PI-203	PRESSURE GAUGE	MILJOD	LP2507220	0 - 30 INCH RANGE / DIAPHRAGM GAUGE / 2.5 INCH STAINLESS STEEL CASE / 0.25" BOTTOM CONNECTION
PSH-201	HIGH PRESSURE SWITCH	DWYER	1920-20-2F	0.5 TO 2 PSI / 0.3 MAX DEADBAND / 0.45 TO 140 F TEMPERATURE LIMITS / 55 PSIG MAX PRESSURE / SPDT SWITCH TYPE C 125 INCH PROCESS CONNECTION / ADJUSTABLE SET POINT
PBL-201	LOW PRESSURE SWITCH	DWYER	1930-20-2F	1/4 TO 20 INCH / 0.4 INCH TO 0.5 INCH DEADBAND / 70 TO 140 F TEMPERATURE LIMITS / 745 INCHES WATER MAX PRESSURE / SPDT SWITCH TYPE C 1/2 INCH PROCESS CONNECTION / ADJUSTABLE SET POINT
DP-201	DIFFERENTIAL PRESSURE INDICATOR	DWYER	2030	0-50 MCG / 4 INCH / 20 INCH TO 15 PSIG PRESSURE LIMITS / 20 - 140 F TEMPERATURE RANGE / 0.125" CONNECTION / NARROW ANGLE NORMALLY CLOSED / 45 FEET OF POWER CORD / 2 WIRE / 32 F TO 221 F TEMPERATURE RATING / NON MERCURY
L 894-201	HIGH HIGH LEVEL SWITCH	GBIS	MYEL-40T	
LT-201	LEVEL TRANSMITTER	GBIS	XTR03-ER-13-TL-5-T-1300 JH-COLLARS	BRASS CONSTRUCTION / 2 INCH TOP MOUNT FITTING / 1/2" NPT / 4" - 20MA OUTPUT
RE-001	FLOW ELEMENT	DWYER	DS-200-S	6 INCH AVERAGING FLOW TUBE / 5/8" WITH BRASS ISOLATION VALVE / 0 - 200 F TEMPERATURES
FI-301	FLOW INDICATOR	DWYER	2001	0 - 1 INCH / 4 INCH / 1-2 INCH TO 15 PSIG PRESSURE LIMITS / 20 - 140 F TEMPERATURE RANGE / 0.125" CONNECTION
PI-201 & PI-202	PRESSURE GAUGE	MILJOD	LP2507220	0 - 30 INCHES WATER RANGE / 2.5 INCH STAINLESS STEEL CASE / BRASS WETTED PARTS / 0.25 INCH BOTTOM MOUNT CONNECTION
PI-401	FLOW METER	NEPLANE	T10-1	1" BORE / MECHANICAL FLOW TOTALIZER / LOCAL DISPLAY / BRONZE CONSTRUCTION / 1/2" CONNECTIONS / NON RESISTIVE RESISTOR
PI-401PS-403	PRESSURE GAUGE	MARSH	98152410	0 - 100 PSIG RANGE / 2.5 INCH STAINLESS STEEL CASE / BRASS WETTED PARTS / LIQUID FILLED / 0.25 INCH BOTTOM MOUNT CONNECTION
PI-401 & PI-402	PRESSURE GAUGE	MARSH	98152410	0 - 100 PSIG RANGE / 2.5 INCH STAINLESS STEEL CASE / BRASS WETTED PARTS / LIQUID FILLED / 0.25 INCH BOTTOM MOUNT CONNECTION
PI-401	PRESSURE GAUGE	MARSH	98152409	0 - 80 PSIG RANGE / 2.5 INCH STAINLESS STEEL CASE / BRASS WETTED PARTS / LIQUID FILLED / 0.25 INCH BOTTOM MOUNT CONNECTION
PI-404	PRESSURE GAUGE	MARSH	98152408	0 - 30 PSIG RANGE / 2.5 INCH STAINLESS STEEL CASE / BRASS WETTED PARTS / LIQUID FILLED / 0.25 INCH BOTTOM MOUNT CONNECTION
L 894-601	LEVEL SWITCH	DWYER	F7-9B	LEVEL SWITCH / 1/2" NPT / 1/2" NPT / W/316 SS

LEGEND

- DIPI DIFFERENTIAL PRESSURE INDICATOR
- FE FLOW ELEMENT
- FI FLOW INDICATOR
- FI-1 FLOW INDICATING TRANSMITTER
- FM FLOW METER
- FT FLOW TOTALIZER
- LSHH LEVEL SWITCH HIGH-HIGH
- LT LEVEL TRANSMITTER
- PI PRESSURE INDICATOR
- PSH PRESSURE SWITCH HIGH
- PSL PRESSURE SWITCH LOW
- SP SAMPLE PORT
- VI VACUUM INDICATOR



CRAIG W. MACPHEE  
 No. 7171  
 REGISTERED PROFESSIONAL ENGINEER (ENVIRONMENTAL)

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**NES**  
 NATIONAL ENVIRONMENTAL SYSTEMS  
 84 Dunham Street - Attleboro, Massachusetts  
 508-266-1100 (Phone) / 508-266-1180 (Fax)

TITLE: GROUNDWATER TREATMENT SYSTEM PROCESS & INSTRUMENTATION DIAGRAM (P&ID)

DRWN BY: DATE: 3-5-13

CHK BY: DATE: 5-20-14

APPR BY: DATE: 5-20-14

SCALE: N/A

SIZE: D

DWG NO.: M-1

JOB NO.: 12-133

SHEET 1 OF 1

REV B

8 7 6 5 4 3 2 1

# **Appendix C**

## **Air Testing Data**

6/10/2013

David Macone  
AECOM Environment  
250 Apollo Drive

Chelmsford MA 01824

Project Name: Textron-Providence

Project #: 60271240

Workorder #: 1305654

Dear David Macone

The following report includes the data for the above referenced project for sample(s) received on 5/31/2013 at Air Toxics Ltd.

The data and associated QC analyzed by Modified TO-15 are compliant with the project requirements or laboratory criteria with the exception of the deviations noted in the attached case narrative.

Thank you for choosing Air Toxics Ltd. for your air analysis needs. Air Toxics Ltd. is committed to providing accurate data of the highest quality. Please feel free to contact the Project Manager: Ausha Scott at 916-985-1000 if you have any questions regarding the data in this report.

Regards,



Ausha Scott

Project Manager

**WORK ORDER #: 1305654**

Work Order Summary

<b>CLIENT:</b>	David Macone AECOM Environment 250 Apollo Drive Chelmsford, MA 01824	<b>BILL TO:</b>	Accounts Payable-Chelmsford AECOM Environment 250 Apollo Drive Chelmsford, MA 01824
<b>PHONE:</b>	978.905.2100	<b>P.O. #</b>	
<b>FAX:</b>	978.905.2101	<b>PROJECT #</b>	60271240 Textron-Providence
<b>DATE RECEIVED:</b>	05/31/2013	<b>CONTACT:</b>	Ausha Scott
<b>DATE COMPLETED:</b>	06/10/2013		

<u>FRACTION #</u>	<u>NAME</u>	<u>TEST</u>	<u>RECEIPT VAC./PRES.</u>	<u>FINAL PRESSURE</u>
01A	INFLUENT	Modified TO-15	0.8 psi	14.5 psi
02A	EFFLUENT	Modified TO-15	0.6 psi	15.2 psi
03A	Lab Blank	Modified TO-15	NA	NA
04A	CCV	Modified TO-15	NA	NA
05A	LCS	Modified TO-15	NA	NA
05AA	LCSD	Modified TO-15	NA	NA

CERTIFIED BY:   
 Technical Director

DATE: 06/10/13

Certification numbers: AZ Licensure AZ0775, CA NELAP - 12282CA, NY NELAP - 11291,  
 TX NELAP - T104704434-12-4, UT NELAP CA009332012-3, WA NELAP - C935

Name of Accrediting Agency: NELAP/ORELAP (Oregon Environmental Laboratory Accreditation Program)  
 Accreditation number: CA300005, Effective date: 10/18/2012, Expiration date: 10/17/2013.

Eurofins Air Toxics Ltd. certifies that the test results contained in this report meet all requirements of the NELAC standards

This report shall not be reproduced, except in full, without the written approval of Eurofins Air Toxics, Inc.

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA - 9563  
 (916) 985-1000 . (800) 985-5955 . FAX (916) 985-1020



**LABORATORY NARRATIVE**  
**EPA Method TO-15**  
**AECOM Environment**  
**Workorder# 1305654**

Two 1 Liter Summa Canister samples were received on May 31, 2013. The laboratory performed analysis via EPA Method TO-15 using GC/MS in the full scan mode.

This workorder was independently validated prior to submittal using 'USEPA National Functional Guidelines' as generally applied to the analysis of volatile organic compounds in air. A rules-based, logic driven, independent validation engine was employed to assess completeness, evaluate pass/fail of relevant project quality control requirements and verification of all quantified amounts.

**Receiving Notes**

The Chain of Custody (COC) was not relinquished properly. A date was not provided by the field sampler.

**Analytical Notes**

Dilution was performed on sample INFLUENT due to the presence of high level target species.

**Definition of Data Qualifying Flags**

Eight qualifiers may have been used on the data analysis sheets and indicates as follows:

B - Compound present in laboratory blank greater than reporting limit (background subtraction not performed).

J - Estimated value.

E - Exceeds instrument calibration range.

S - Saturated peak.

Q - Exceeds quality control limits.

U - Compound analyzed for but not detected above the reporting limit, LOD, or MDL value. See data page for project specific U-flag definition.

UJ- Non-detected compound associated with low bias in the CCV

N - The identification is based on presumptive evidence.

File extensions may have been used on the data analysis sheets and indicates as follows:

a-File was requantified

b-File was quantified by a second column and detector

r1-File was requantified for the purpose of reissue

**Summary of Detected Compounds  
EPA METHOD TO-15 GC/MS FULL SCAN**

**Client Sample ID: INFLUENT**

**Lab ID#: 1305654-01A**

<b>Compound</b>	<b>Rpt. Limit (ppbv)</b>	<b>Amount (ppbv)</b>	<b>Rpt. Limit (ug/m3)</b>	<b>Amount (ug/m3)</b>
1,1-Dichloroethene	5.4	9.9	21	39
Acetone	54	55	130	130
1,1-Dichloroethane	5.4	16	22	63
cis-1,2-Dichloroethene	5.4	7.6	21	30
Tetrahydrofuran	5.4	11	16	31
Chloroform	5.4	5.5	26	27
1,1,1-Trichloroethane	5.4	150	29	840
Trichloroethene	5.4	110	29	570
Tetrachloroethene	5.4	1400	37	9700

**Client Sample ID: EFFLUENT**

**Lab ID#: 1305654-02A**

<b>Compound</b>	<b>Rpt. Limit (ppbv)</b>	<b>Amount (ppbv)</b>	<b>Rpt. Limit (ug/m3)</b>	<b>Amount (ug/m3)</b>
Tetrahydrofuran	0.98	8.3	2.9	24
Tetrachloroethene	0.98	5.2	6.6	35



Air Toxics

Client Sample ID: INFLUENT

Lab ID#: 1305654-01A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	17060711	Date of Collection:	5/28/13 11:05:00 AM
Dil. Factor:	10.8	Date of Analysis:	6/7/13 01:06 PM

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Freon 12	5.4	Not Detected	27	Not Detected
Freon 114	5.4	Not Detected	38	Not Detected
Chloromethane	54	Not Detected	110	Not Detected
Vinyl Chloride	5.4	Not Detected	14	Not Detected
1,3-Butadiene	5.4	Not Detected	12	Not Detected
Bromomethane	54	Not Detected	210	Not Detected
Chloroethane	22	Not Detected	57	Not Detected
Freon 11	5.4	Not Detected	30	Not Detected
Ethanol	22	Not Detected	41	Not Detected
Freon 113	5.4	Not Detected	41	Not Detected
1,1-Dichloroethene	5.4	9.9	21	39
Acetone	54	55	130	130
2-Propanol	22	Not Detected	53	Not Detected
Carbon Disulfide	22	Not Detected	67	Not Detected
3-Chloropropene	22	Not Detected	68	Not Detected
Methylene Chloride	54	Not Detected	190	Not Detected
Methyl tert-butyl ether	5.4	Not Detected	19	Not Detected
trans-1,2-Dichloroethene	5.4	Not Detected	21	Not Detected
Hexane	5.4	Not Detected	19	Not Detected
1,1-Dichloroethane	5.4	16	22	63
2-Butanone (Methyl Ethyl Ketone)	22	Not Detected	64	Not Detected
cis-1,2-Dichloroethene	5.4	7.6	21	30
Tetrahydrofuran	5.4	11	16	31
Chloroform	5.4	5.5	26	27
1,1,1-Trichloroethane	5.4	150	29	840
Cyclohexane	5.4	Not Detected	18	Not Detected
Carbon Tetrachloride	5.4	Not Detected	34	Not Detected
2,2,4-Trimethylpentane	5.4	Not Detected	25	Not Detected
Benzene	5.4	Not Detected	17	Not Detected
1,2-Dichloroethane	5.4	Not Detected	22	Not Detected
Heptane	5.4	Not Detected	22	Not Detected
Trichloroethene	5.4	110	29	570
1,2-Dichloropropane	5.4	Not Detected	25	Not Detected
1,4-Dioxane	22	Not Detected	78	Not Detected
Bromodichloromethane	5.4	Not Detected	36	Not Detected
cis-1,3-Dichloropropene	5.4	Not Detected	24	Not Detected
4-Methyl-2-pentanone	5.4	Not Detected	22	Not Detected
Toluene	5.4	Not Detected	20	Not Detected
trans-1,3-Dichloropropene	5.4	Not Detected	24	Not Detected
1,1,2-Trichloroethane	5.4	Not Detected	29	Not Detected
Tetrachloroethene	5.4	1400	37	9700
2-Hexanone	22	Not Detected	88	Not Detected



Air Toxics

Client Sample ID: INFLUENT

Lab ID#: 1305654-01A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	17060711	Date of Collection:	5/28/13 11:05:00 AM
Dil. Factor:	10.8	Date of Analysis:	6/7/13 01:06 PM

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Dibromochloromethane	5.4	Not Detected	46	Not Detected
1,2-Dibromoethane (EDB)	5.4	Not Detected	41	Not Detected
Chlorobenzene	5.4	Not Detected	25	Not Detected
Ethyl Benzene	5.4	Not Detected	23	Not Detected
m,p-Xylene	5.4	Not Detected	23	Not Detected
o-Xylene	5.4	Not Detected	23	Not Detected
Styrene	5.4	Not Detected	23	Not Detected
Bromoform	5.4	Not Detected	56	Not Detected
Cumene	5.4	Not Detected	26	Not Detected
1,1,2,2-Tetrachloroethane	5.4	Not Detected	37	Not Detected
Propylbenzene	5.4	Not Detected	26	Not Detected
4-Ethyltoluene	5.4	Not Detected	26	Not Detected
1,3,5-Trimethylbenzene	5.4	Not Detected	26	Not Detected
1,2,4-Trimethylbenzene	5.4	Not Detected	26	Not Detected
1,3-Dichlorobenzene	5.4	Not Detected	32	Not Detected
1,4-Dichlorobenzene	5.4	Not Detected	32	Not Detected
alpha-Chlorotoluene	5.4	Not Detected	28	Not Detected
1,2-Dichlorobenzene	5.4	Not Detected	32	Not Detected
1,2,4-Trichlorobenzene	22	Not Detected	160	Not Detected
Hexachlorobutadiene	22	Not Detected	230	Not Detected

Container Type: 1 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Toluene-d8	98	70-130
1,2-Dichloroethane-d4	87	70-130
4-Bromofluorobenzene	94	70-130



Air Toxics

Client Sample ID: EFFLUENT

Lab ID#: 1305654-02A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	17060710	Date of Collection:	5/28/13 11:15:00 AM
Dil. Factor:	1.95	Date of Analysis:	6/7/13 12:45 PM

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Freon 12	0.98	Not Detected	4.8	Not Detected
Freon 114	0.98	Not Detected	6.8	Not Detected
Chloromethane	9.8	Not Detected	20	Not Detected
Vinyl Chloride	0.98	Not Detected	2.5	Not Detected
1,3-Butadiene	0.98	Not Detected	2.2	Not Detected
Bromomethane	9.8	Not Detected	38	Not Detected
Chloroethane	3.9	Not Detected	10	Not Detected
Freon 11	0.98	Not Detected	5.5	Not Detected
Ethanol	3.9	Not Detected	7.3	Not Detected
Freon 113	0.98	Not Detected	7.5	Not Detected
1,1-Dichloroethene	0.98	Not Detected	3.9	Not Detected
Acetone	9.8	Not Detected	23	Not Detected
2-Propanol	3.9	Not Detected	9.6	Not Detected
Carbon Disulfide	3.9	Not Detected	12	Not Detected
3-Chloropropene	3.9	Not Detected	12	Not Detected
Methylene Chloride	9.8	Not Detected	34	Not Detected
Methyl tert-butyl ether	0.98	Not Detected	3.5	Not Detected
trans-1,2-Dichloroethene	0.98	Not Detected	3.9	Not Detected
Hexane	0.98	Not Detected	3.4	Not Detected
1,1-Dichloroethane	0.98	Not Detected	3.9	Not Detected
2-Butanone (Methyl Ethyl Ketone)	3.9	Not Detected	12	Not Detected
cis-1,2-Dichloroethene	0.98	Not Detected	3.9	Not Detected
Tetrahydrofuran	0.98	8.3	2.9	24
Chloroform	0.98	Not Detected	4.8	Not Detected
1,1,1-Trichloroethane	0.98	Not Detected	5.3	Not Detected
Cyclohexane	0.98	Not Detected	3.4	Not Detected
Carbon Tetrachloride	0.98	Not Detected	6.1	Not Detected
2,2,4-Trimethylpentane	0.98	Not Detected	4.6	Not Detected
Benzene	0.98	Not Detected	3.1	Not Detected
1,2-Dichloroethane	0.98	Not Detected	3.9	Not Detected
Heptane	0.98	Not Detected	4.0	Not Detected
Trichloroethene	0.98	Not Detected	5.2	Not Detected
1,2-Dichloropropane	0.98	Not Detected	4.5	Not Detected
1,4-Dioxane	3.9	Not Detected	14	Not Detected
Bromodichloromethane	0.98	Not Detected	6.5	Not Detected
cis-1,3-Dichloropropene	0.98	Not Detected	4.4	Not Detected
4-Methyl-2-pentanone	0.98	Not Detected	4.0	Not Detected
Toluene	0.98	Not Detected	3.7	Not Detected
trans-1,3-Dichloropropene	0.98	Not Detected	4.4	Not Detected
1,1,2-Trichloroethane	0.98	Not Detected	5.3	Not Detected
Tetrachloroethene	0.98	5.2	6.6	35
2-Hexanone	3.9	Not Detected	16	Not Detected



Air Toxics

Client Sample ID: EFFLUENT

Lab ID#: 1305654-02A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	17060710	Date of Collection:	5/28/13 11:15:00 AM
Dil. Factor:	1.95	Date of Analysis:	6/7/13 12:45 PM

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Dibromochloromethane	0.98	Not Detected	8.3	Not Detected
1,2-Dibromoethane (EDB)	0.98	Not Detected	7.5	Not Detected
Chlorobenzene	0.98	Not Detected	4.5	Not Detected
Ethyl Benzene	0.98	Not Detected	4.2	Not Detected
m,p-Xylene	0.98	Not Detected	4.2	Not Detected
o-Xylene	0.98	Not Detected	4.2	Not Detected
Styrene	0.98	Not Detected	4.2	Not Detected
Bromoform	0.98	Not Detected	10	Not Detected
Cumene	0.98	Not Detected	4.8	Not Detected
1,1,2,2-Tetrachloroethane	0.98	Not Detected	6.7	Not Detected
Propylbenzene	0.98	Not Detected	4.8	Not Detected
4-Ethyltoluene	0.98	Not Detected	4.8	Not Detected
1,3,5-Trimethylbenzene	0.98	Not Detected	4.8	Not Detected
1,2,4-Trimethylbenzene	0.98	Not Detected	4.8	Not Detected
1,3-Dichlorobenzene	0.98	Not Detected	5.9	Not Detected
1,4-Dichlorobenzene	0.98	Not Detected	5.9	Not Detected
alpha-Chlorotoluene	0.98	Not Detected	5.0	Not Detected
1,2-Dichlorobenzene	0.98	Not Detected	5.9	Not Detected
1,2,4-Trichlorobenzene	3.9	Not Detected	29	Not Detected
Hexachlorobutadiene	3.9	Not Detected	42	Not Detected

Container Type: 1 Liter Summa Canister

Surrogates	%Recovery	Method Limits
Toluene-d8	102	70-130
1,2-Dichloroethane-d4	92	70-130
4-Bromofluorobenzene	98	70-130



Air Toxics

Client Sample ID: Lab Blank

Lab ID#: 1305654-03A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	17060706	Date of Collection:	NA
Dil. Factor:	1.00	Date of Analysis:	6/7/13 10:52 AM

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Freon 12	0.50	Not Detected	2.5	Not Detected
Freon 114	0.50	Not Detected	3.5	Not Detected
Chloromethane	5.0	Not Detected	10	Not Detected
Vinyl Chloride	0.50	Not Detected	1.3	Not Detected
1,3-Butadiene	0.50	Not Detected	1.1	Not Detected
Bromomethane	5.0	Not Detected	19	Not Detected
Chloroethane	2.0	Not Detected	5.3	Not Detected
Freon 11	0.50	Not Detected	2.8	Not Detected
Ethanol	2.0	Not Detected	3.8	Not Detected
Freon 113	0.50	Not Detected	3.8	Not Detected
1,1-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Acetone	5.0	Not Detected	12	Not Detected
2-Propanol	2.0	Not Detected	4.9	Not Detected
Carbon Disulfide	2.0	Not Detected	6.2	Not Detected
3-Chloropropene	2.0	Not Detected	6.3	Not Detected
Methylene Chloride	5.0	Not Detected	17	Not Detected
Methyl tert-butyl ether	0.50	Not Detected	1.8	Not Detected
trans-1,2-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Hexane	0.50	Not Detected	1.8	Not Detected
1,1-Dichloroethane	0.50	Not Detected	2.0	Not Detected
2-Butanone (Methyl Ethyl Ketone)	2.0	Not Detected	5.9	Not Detected
cis-1,2-Dichloroethene	0.50	Not Detected	2.0	Not Detected
Tetrahydrofuran	0.50	Not Detected	1.5	Not Detected
Chloroform	0.50	Not Detected	2.4	Not Detected
1,1,1-Trichloroethane	0.50	Not Detected	2.7	Not Detected
Cyclohexane	0.50	Not Detected	1.7	Not Detected
Carbon Tetrachloride	0.50	Not Detected	3.1	Not Detected
2,2,4-Trimethylpentane	0.50	Not Detected	2.3	Not Detected
Benzene	0.50	Not Detected	1.6	Not Detected
1,2-Dichloroethane	0.50	Not Detected	2.0	Not Detected
Heptane	0.50	Not Detected	2.0	Not Detected
Trichloroethene	0.50	Not Detected	2.7	Not Detected
1,2-Dichloropropane	0.50	Not Detected	2.3	Not Detected
1,4-Dioxane	2.0	Not Detected	7.2	Not Detected
Bromodichloromethane	0.50	Not Detected	3.4	Not Detected
cis-1,3-Dichloropropene	0.50	Not Detected	2.3	Not Detected
4-Methyl-2-pentanone	0.50	Not Detected	2.0	Not Detected
Toluene	0.50	Not Detected	1.9	Not Detected
trans-1,3-Dichloropropene	0.50	Not Detected	2.3	Not Detected
1,1,2-Trichloroethane	0.50	Not Detected	2.7	Not Detected
Tetrachloroethene	0.50	Not Detected	3.4	Not Detected
2-Hexanone	2.0	Not Detected	8.2	Not Detected

Client Sample ID: Lab Blank

Lab ID#: 1305654-03A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	17060706	Date of Collection:	NA
Dil. Factor:	1.00	Date of Analysis:	6/7/13 10:52 AM

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Dibromochloromethane	0.50	Not Detected	4.2	Not Detected
1,2-Dibromoethane (EDB)	0.50	Not Detected	3.8	Not Detected
Chlorobenzene	0.50	Not Detected	2.3	Not Detected
Ethyl Benzene	0.50	Not Detected	2.2	Not Detected
m,p-Xylene	0.50	Not Detected	2.2	Not Detected
o-Xylene	0.50	Not Detected	2.2	Not Detected
Styrene	0.50	Not Detected	2.1	Not Detected
Bromoform	0.50	Not Detected	5.2	Not Detected
Cumene	0.50	Not Detected	2.4	Not Detected
1,1,2,2-Tetrachloroethane	0.50	Not Detected	3.4	Not Detected
Propylbenzene	0.50	Not Detected	2.4	Not Detected
4-Ethyltoluene	0.50	Not Detected	2.4	Not Detected
1,3,5-Trimethylbenzene	0.50	Not Detected	2.4	Not Detected
1,2,4-Trimethylbenzene	0.50	Not Detected	2.4	Not Detected
1,3-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
1,4-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
alpha-Chlorotoluene	0.50	Not Detected	2.6	Not Detected
1,2-Dichlorobenzene	0.50	Not Detected	3.0	Not Detected
1,2,4-Trichlorobenzene	2.0	Not Detected	15	Not Detected
Hexachlorobutadiene	2.0	Not Detected	21	Not Detected

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	102	70-130
1,2-Dichloroethane-d4	91	70-130
4-Bromofluorobenzene	99	70-130



Air Toxics

Client Sample ID: CCV

Lab ID#: 1305654-04A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	17060702	Date of Collection: NA
Dil. Factor:	1.00	Date of Analysis: 6/7/13 09:05 AM

Compound	%Recovery
Freon 12	87
Freon 114	92
Chloromethane	100
Vinyl Chloride	100
1,3-Butadiene	98
Bromomethane	103
Chloroethane	101
Freon 11	87
Ethanol	96
Freon 113	90
1,1-Dichloroethene	93
Acetone	96
2-Propanol	87
Carbon Disulfide	98
3-Chloropropene	97
Methylene Chloride	94
Methyl tert-butyl ether	90
trans-1,2-Dichloroethene	95
Hexane	97
1,1-Dichloroethane	94
2-Butanone (Methyl Ethyl Ketone)	94
cis-1,2-Dichloroethene	96
Tetrahydrofuran	93
Chloroform	90
1,1,1-Trichloroethane	84
Cyclohexane	94
Carbon Tetrachloride	84
2,2,4-Trimethylpentane	94
Benzene	89
1,2-Dichloroethane	79
Heptane	86
Trichloroethene	86
1,2-Dichloropropane	91
1,4-Dioxane	90
Bromodichloromethane	84
cis-1,3-Dichloropropene	88
4-Methyl-2-pentanone	89
Toluene	85
trans-1,3-Dichloropropene	82
1,1,2-Trichloroethane	84
Tetrachloroethene	80
2-Hexanone	86

Client Sample ID: CCV

Lab ID#: 1305654-04A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	17060702	Date of Collection: NA
Dil. Factor:	1.00	Date of Analysis: 6/7/13 09:05 AM

Compound	%Recovery
Dibromochloromethane	81
1,2-Dibromoethane (EDB)	82
Chlorobenzene	82
Ethyl Benzene	83
m,p-Xylene	82
o-Xylene	82
Styrene	87
Bromoform	80
Cumene	81
1,1,2,2-Tetrachloroethane	81
Propylbenzene	81
4-Ethyltoluene	80
1,3,5-Trimethylbenzene	79
1,2,4-Trimethylbenzene	80
1,3-Dichlorobenzene	77
1,4-Dichlorobenzene	76
alpha-Chlorotoluene	72
1,2-Dichlorobenzene	77
1,2,4-Trichlorobenzene	77
Hexachlorobutadiene	78

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	105	70-130
1,2-Dichloroethane-d4	95	70-130
4-Bromofluorobenzene	100	70-130



Air Toxics

Client Sample ID: LCS

Lab ID#: 1305654-05A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	17060703	Date of Collection: NA
Dil. Factor:	1.00	Date of Analysis: 6/7/13 09:26 AM

Compound	%Recovery
Freon 12	92
Freon 114	96
Chloromethane	106
Vinyl Chloride	105
1,3-Butadiene	103
Bromomethane	107
Chloroethane	107
Freon 11	90
Ethanol	97
Freon 113	96
1,1-Dichloroethene	102
Acetone	101
2-Propanol	91
Carbon Disulfide	126
3-Chloropropene	113
Methylene Chloride	97
Methyl tert-butyl ether	96
trans-1,2-Dichloroethene	108
Hexane	99
1,1-Dichloroethane	97
2-Butanone (Methyl Ethyl Ketone)	97
cis-1,2-Dichloroethene	100
Tetrahydrofuran	92
Chloroform	94
1,1,1-Trichloroethane	90
Cyclohexane	99
Carbon Tetrachloride	89
2,2,4-Trimethylpentane	96
Benzene	96
1,2-Dichloroethane	85
Heptane	91
Trichloroethene	94
1,2-Dichloropropane	98
1,4-Dioxane	93
Bromodichloromethane	89
cis-1,3-Dichloropropene	94
4-Methyl-2-pentanone	92
Toluene	90
trans-1,3-Dichloropropene	96
1,1,2-Trichloroethane	99
Tetrachloroethene	94
2-Hexanone	98

Client Sample ID: LCS

Lab ID#: 1305654-05A

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	17060703	Date of Collection: NA
Dil. Factor:	1.00	Date of Analysis: 6/7/13 09:26 AM

Compound	%Recovery
Dibromochloromethane	94
1,2-Dibromoethane (EDB)	98
Chlorobenzene	97
Ethyl Benzene	98
m,p-Xylene	98
o-Xylene	97
Styrene	101
Bromoform	93
Cumene	96
1,1,2,2-Tetrachloroethane	99
Propylbenzene	96
4-Ethyltoluene	91
1,3,5-Trimethylbenzene	94
1,2,4-Trimethylbenzene	93
1,3-Dichlorobenzene	91
1,4-Dichlorobenzene	90
alpha-Chlorotoluene	92
1,2-Dichlorobenzene	91
1,2,4-Trichlorobenzene	92
Hexachlorobutadiene	91

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	99	70-130
1,2-Dichloroethane-d4	94	70-130
4-Bromofluorobenzene	94	70-130



Air Toxics

Client Sample ID: LCSD

Lab ID#: 1305654-05AA

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	17060704	Date of Collection: NA
Dil. Factor:	1.00	Date of Analysis: 6/7/13 09:47 AM

Compound	%Recovery
Freon 12	91
Freon 114	96
Chloromethane	106
Vinyl Chloride	105
1,3-Butadiene	102
Bromomethane	107
Chloroethane	105
Freon 11	90
Ethanol	100
Freon 113	95
1,1-Dichloroethene	103
Acetone	100
2-Propanol	91
Carbon Disulfide	125
3-Chloropropene	114
Methylene Chloride	96
Methyl tert-butyl ether	95
trans-1,2-Dichloroethene	109
Hexane	99
1,1-Dichloroethane	98
2-Butanone (Methyl Ethyl Ketone)	98
cis-1,2-Dichloroethene	100
Tetrahydrofuran	91
Chloroform	94
1,1,1-Trichloroethane	89
Cyclohexane	98
Carbon Tetrachloride	89
2,2,4-Trimethylpentane	96
Benzene	93
1,2-Dichloroethane	81
Heptane	89
Trichloroethene	91
1,2-Dichloropropane	95
1,4-Dioxane	90
Bromodichloromethane	86
cis-1,3-Dichloropropene	91
4-Methyl-2-pentanone	90
Toluene	86
trans-1,3-Dichloropropene	91
1,1,2-Trichloroethane	93
Tetrachloroethene	87
2-Hexanone	92



Air Toxics

Client Sample ID: LCSD

Lab ID#: 1305654-05AA

EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	17060704	Date of Collection: NA
Dil. Factor:	1.00	Date of Analysis: 6/7/13 09:47 AM

Compound	%Recovery
Dibromochloromethane	88
1,2-Dibromoethane (EDB)	91
Chlorobenzene	90
Ethyl Benzene	90
m,p-Xylene	92
o-Xylene	89
Styrene	94
Bromoform	86
Cumene	89
1,1,2,2-Tetrachloroethane	92
Propylbenzene	90
4-Ethyltoluene	89
1,3,5-Trimethylbenzene	85
1,2,4-Trimethylbenzene	87
1,3-Dichlorobenzene	85
1,4-Dichlorobenzene	84
alpha-Chlorotoluene	84
1,2-Dichlorobenzene	86
1,2,4-Trichlorobenzene	88
Hexachlorobutadiene	86

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	101	70-130
1,2-Dichloroethane-d4	95	70-130
4-Bromofluorobenzene	98	70-130



## **Appendix D**

# **Operations & Maintenance Manual**



# Operation & Maintenance Manual

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NES PROJECT NUMBER: 12-133 Revision B (May 2013)  
PROJECT NAME: **Groundwater Treatment System**  
**Textron – Providence, RI**

**Prepared for:**

**AECOM Environment**  
**10 Orms Street**  
**Ste 405**  
**Providence, RI 02904**

**Sales: (508)226-1100 Option 2**  
**Technical Support: (508)226-1100 Option 3**



NES Project: 12-133  
GWT – Cargo Box  
AECOM – Textron Providence, RI

## Operation & Maintenance Manual

### ***Section 1 - Installation Guidelines, Equipment List, and Warranty***

Installation Guidelines

Major Component Summary Table

NES Warranty

### ***Section 2 - Mechanical Drawings***

System Process & Instrumentation Diagram

System Enclosure Layout Drawing

### ***Section 3 - Electrical Drawings***

Control Panel Description

Panel Interior / Exterior Layout Drawing

One Line Diagram

Wiring Diagrams

### ***Section 4 - Control Panel Components***

Panel Enclosure - Hoffman Model C-SD302412

Programmable Logic Controller - ADI Model P3000

HMI, 8" Touchscreen - ADI / Cmore Model EA7-T8C

Cellular Interface - Verizon - Sierra Wireless Model V2226E-VA

Cellular Interface Antenna - Wilson Model 301125

### ***Section 5 - Power Distribution Components***

GW Pump Motor VFD, 1.0hp - Square D Model ATV312H075M3

Transfer Pump Motor VFD, 3.0hp - Square D Model ATV312HU22M3

Power Distribution Panel, 100a - Square D Model QO327M100RB

### ***Section 6 - Enclosure Accessories***

Enclosure Heater, 5.0kw - Grainger / Dayton Model 2YU65

Heater Thermostat - White Rodgers Model 2E399

Process Room Exhaust Fan, 18" - Grainger / Dayton Model 10D965



**NES Project: 12-133  
GWT – Cargo Box  
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Fan Thermostat - Honeywell Model T6031A

Interior Lights - NE Lighting Model VT240EBO-UV

Sump Level Switch - Dwyer Model F7-SB

***Section 7 - Downwell Pump Equipment - Model***

Downwell Pump - Grundfos Model 5E05-12

Pollution Recovery Motor, 0.5hp 200VAC – Franklin Model 2345014916

Downwell Pump - Grundfos Model 10E05-12

Pollution Recovery Motor, 0.5hp 200VAC - Franklin Model 2345014916

***Section 8 - Groundwater Treatment Components***

Manifold Magmeters - GF Signet Model 3-2551-P0-42

Magmeter Installation Tees, 1" - GF Signet Model MPV8T010

High Pressure Switch - Dwyer Model CS-150

Bag Filter Housings - Pentek Model 156112-75

Air Stripper, SS, 6-Tray (Refurbished) - QED Model EZ Tray 8.6SS

AS Sump Level Transmitter - Gems Model XT800-3-BR-BN-13-11.5-7.1300-J-H-COLLARS

AS Sump E-High Level Switch - Gems Model MYEL40T

AS Regenerative Blower - FPZ Model SCL K10-MS-10-3

Blower Inlet Filter, 4" - Solberg Model FS-235P-400

Bleed Filter/Silencer, 2" - Solberg Model FS-31P-200

Blower High Pressure Switch - Dwyer Model 1950P-2-2F

Blower Low Pressure Switch - Dwyer Model 1950-20-2F

AS Tray Differential Pressure Indicator - Dwyer Model 2050

Blower Flowmeter Pitot Tube, 6in - Dwyer Model DS-300-6

Pitot Tube Mag Gauge - Dwyer Model 2001

Vapor Phase Carbon Vessels, 1000lb (Refurbished) - Calgon Model V-1M

AS Centrifugal Transfer Pump - Goulds Model 1ST1G5B4

High Pressure Switch - Dwyer Model CS-150

Bag Filter Housings - Pentek Model 156112-75

Mechanical Flowmeter / Totalizer, 1" - Neptune Model T10-1



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Modified Zeolite Vessel - Tetrasolv Model AF-500

8x14 Modified Zeolite - Hydrosil Model HS-200

LGAC Vessel - Tetrasolv Model AF-500

Discharge Magmeter - GF Signet Model 3-2551-P0-42

Magmeter Installation Tee, 1" - GF Signet Model MPV8T010



**NES Project: 12-133**  
**GWT – Cargo Box**  
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***Section 1 - Installation Guidelines, Equipment List, and Warranty***

Installation Guidelines

Major Component Summary Table

NES Warranty



**For Assistance Call: (508)226-1100 Option 3 Technical Support**

## **INSTALLATION GUIDELINES**

1. Inspect exterior and interior of control panel for damage that may have occurred during shipment. Check all interior components within panel for tightness. Vibration during transport may loosen screw terminals, din rail mounted components, hardware, etc. Check motor starter overloads and reset if tripped.

2. Panel and associated wiring should be installed by a qualified, licensed, electrician familiar with remediation/water treatment equipment. All information required for proper installation is contained on the drawings or other documents within this manual. Drawings containing information on panel interior and exterior layout, line diagrams, and process and instrumentation are also included in this section for reference only.

*Many remediation systems are installed in “hazardous locations” and therefore the installer must follow the National Electric Code requirement for these areas. The control panel and associated equipment should only be installed in the area for which it was designed.*

*Many systems utilize a combination of intrinsically safe and non-intrinsically safe circuits. Proper separation and demarcation is required. Please refer to the National Electric Code Article 504 “Intrinsically Safe Systems” and any local codes.*

3. Before applying power to any equipment, the component manufacturers operation and start-up manual (compressor, blower, pump, etc.) should be reviewed. Some equipment cannot be operated in the wrong rotation even momentarily without damage. Verifying proper rotation should only be done after review of the associated equipment manual.

4. As a general rule, all fluid levels, drive components, plumbing attachments, etc. should be inspected. The equipment should be initially started in a no-load condition with non-contaminated process fluid (i.e. SVE vacuum blower started with all recovery wells shut off, and the ambient air dilution valve open fully). **Do not store equipment for more than one month without running it.** Idle blowers, pumps or other items may rust or seize if not run once a month.

5. Once proper operation of all equipment has been verified the system can be started. Turn the selector switches to “auto” or “on”, and press reset if necessary. The system should run automatically.

6. If it is possible, any alarm conditions (i.e. SVE moisture separator high level) should be manually actuated to ensure proper system response.

7. The system can now be adjusted to design flow rates, pressures, etc. All adjustments should be made gradually.



**MAJOR COMPONENT SUMMARY**

Project No.:

12-133 (April 2013)

Project:

AECOM - Groundwater Treatment System Cargo Box / Textron - Providence, RI

Component	TAG	Qty.	Manufacturer	Model	Serial Number(s) if Applicable
<b>Section 4 - Control Panel Components</b>					
		1	NES		UL:
Panel Enclosure		1	Hoffman	C-SD302412	N/A
Programmable Logic Controller		1	ADI	P3000	12Y08F001D
HMI, 8" Touchscreen		1	ADI / Cmore	EA7-T8C	12X09B083
Cellular Interface - Verizon		1	Sierra Wireless	V2226E-VA	12S0757217
Cellular Interface Antenna		1	Wilson	301125	N/A
<b>Section 5 - Power Distribution Components</b>					
GW Pump Motor VFD, 1.0hp		3	Square D	ATV312H075M3	8B1237103043; 8B1146211093; 8B1146211096
Transfer Pump Motor VFD, 3.0hp		1	Square D	ATV312HU22M3	8B1213211038
Power Distribution Panel, 100a		1	Square D	QO327M100RB	N/A
<b>Section 6 - Enclosure Accessories</b>					
Enclosure Heater, 5.0kw		1	Grainger / Dayton	2YU65	121009/054
Heater Thermostat		1	White Rodgers	2E399	N/A
Process Room Exhaust Fan, 18"		1	Grainger / Dayton	10D965	13040813
Fan Thermostat		1	Honeywell	T6031A	N/A
Interior Lights		4	NE Lighting	VT240EBO-UV	N/A
Sump Level Switch	LSH-801	1	Dwyer	F7-SB	N/A
<b>Section 7 - Downwell Pump Equipment</b>					
Downwell Pump	RW-1, RW-2	2	Grundfos	5E05-12	N/A
Pollution Recovery Motor, 0.5hp 200VAC		2	Franklin	2345014916	13A14-28-00957C; 13A14-28-00952C
Downwell Pump	RW-3	1	Grundfos	10E05-12	N/A
Pollution Recovery Motor, 0.5hp 200VAC		1	Franklin	2345014916	12M14-19-02002C
<b>Section 8 - Groundwater Treatment Components</b>					
Manifold Pressure Gauges	PI-101,102,103	3	MARSH	98152409	N/A
Manifold Magmeters	FIT-101,102,103	3	GF Signet	3-2551-P0-42	61211290477; 6130210070; 61212120425
Magmeter Installation Tees, 1"	FIT-101,102,103	3	GF Signet	MPV8T010	61301110078; 61301110084; 61302270540
High Pressure Switch	PSH-101	1	Dwyer	CS-150	N/A
Bag Filter Housings	BF-1,2	2	Pentek	156112-75	N/A
Bag Filter Pressure Gauges,	PI-104,105,106	3	MARSH	98152409	N/A
Air Stripper, SS, 6-Tray (Refurbished)	AS-201	1	QED	EZ Tray 8.6SS XT800-3-BR-BN-13-11.5-7.1300-J- H-COLLARS	N/A 89906
AS Sump Level Transmitter	LT-201	1	Gems	MYEL40T	N/A
AS Sump E-High Level Switch	LSHH-201	1	Gems	MYEL40T	N/A
AS Regenerative Blower	B-201	1	FPZ	SCL K10-MS-10-3	E51186-2013
Blower Motor, 10hp TEFC		1	Lafert	AM112MC42	907223
Blower Inlet Filter, 4"		1	Solberg	FS-235P-400	N/A
Bleed Filter/Silencer, 2"		1	Solberg	FS-31P-200	N/A
Blower Inlet Vacuum Gauge	VI-201	1	MILJOCO	LP25070210	N/A
Blower Discharge Pressure Gauge	PI-201,202	2	MILJOCO	LP2507L250	N/A
Blower High Pressure Switch	PSH-201	1	Dwyer	1950P-2-2F	N/A
Blower Low Pressure Switch	PSL-201	1	Dwyer	1950-20-2F	N/A
AS Tray Differential Pressure Indicator	DPI-201	1	Dwyer	2050	N/A



**MAJOR COMPONENT SUMMARY**

Project No.: 12-133 (April 2013)

Project: AECOM - Groundwater Treatment System Cargo Box / Textron - Providence, RI

Component	TAG	Qty.	Manufacturer	Model	Serial Number(s) if Applicable
Blower Flowmeter Pitot Tube, 6in	FE-301	1	Dwyer	DS-300-6	N/A
Pitot Tube Mag Gauge	FI-301	1	Dwyer	2001	N/A
VGAC Pressure Gauges	PI-301,302	2	MILJOCO	LP2507L220	N/A
Vapor Phase Carbon Vessels, 1000lb (Refurbished)	VGAC-1,2	2	Calgon	V-1M	A1119; A1118
4x10 Regenerated Coal Based VGAC Media	VGAC-1,2	2000lbs	CFS	4x10 Regen VGAC	N/A
AS Centrifugal Transfer Pump	TP-401	1	Goulds	1ST1G5B4	A1218872
Pump Motor, 2.0hp TEFC		1	Bluffton	1313381107	E08C32E2EB3S
High Pressure Switch	PSH-401	1	Dwyer	CS-150	M65927-T104
Bag Filter Housings	BF-3,4	2	Pentek	156112-75	N/A
Bag Filter Pressure Gauges	PI-401,402,403	3	MARSH	98152410	N/A
Mechanical Flowmeter / Totalizer, 1"	BF-3,4	1	Neptune	T10-1	52726473
Media Vessel Pressure Gauges	PI-501,502	2	MARSH	98152410	N/A
Media Vessel Pressure Gauge	PI-503	1	MARSH	98152409	N/A
Media Vessel Pressure Gauge	PI-504	1	MARSH	98152408	N/A
Modified Zeolite Vessel	MZV-1	1	Tetrasolv	AF-500	AA050
8x14 Modified Zeolite		750lbs	Hydrosil	HS-200	N/A
LGAC Vessel	LGAC-1,2	2	Tetrasolv	AF-500	AA051; AA052
8x30 Virgin Coal Based LGAC Media		1000lbs	Tetrasolv	8x30 Virgin	N/A
Discharge Magmeter	FIT-501	1	GF Signet	3-2551-P0-42	61210080495
Magmeter Installation Tee, 1"		1	GF Signet	MPV8T010	61301110103



## WARRANTY

All products not manufactured by RapidTech LLC d/b/a National Environmental Systems, carry the original manufacturer's warranty. Copies are available on request.

RapidTech LLC d/b/a National Environmental Systems, warrants its packaged and manufactured equipment against any defect in material or workmanship, under normal use and storage for a period of twelve (12) months from date of manufacture and invoice, regardless of system start-up date. In the event that products are found to be defective within the warranty period, RapidTech LLC d/b/a National Environmental Systems, sole obligation and remedy shall be the furnishing of replacements for any defective parts, and such replacement parts shall be furnished but not installed by RapidTech LLC d/b/a National Environmental Systems. RAPIDTECH LLC D/B/A NATIONAL ENVIRONMENTAL SYSTEMS, WILL NOT BE LIABLE FOR SPECIAL OR CONSEQUENTIAL DAMAGES IN ANY CLAIM SUIT OR PROCEEDINGS ARISING UNDER WARRANTY, NOR WILL RAPIDTECH LLC D/B/A NATIONAL ENVIRONMENTAL SYSTEMS, ACCEPT ANY LIABILITY FOR CLAIMS FOR LABOR, LOSS OR PROFIT, REPAIRS OR OTHER EXPENSES INCIDENTAL TO REPLACEMENT.

The warranty requires that the purchaser complete all operations and maintenance as detailed in each section of the Operation & Maintenance Manual supplied with the purchased system. In addition installation must comply with nationally recognized electrical and mechanical standards as well as best engineering practices in effect at the time of purchase.

The product warranty expressed above is our only warranty and may not be verbally changed or modified by any representative of RapidTech LLC d/b/a National Environmental Systems. All freight costs incurred in shipping parts to or from RapidTech LLC d/b/a National Environmental Systems, or to the manufacturer if necessary are at the expense of the customer.

RapidTech LLC dba National Environmental Systems, will invoice the cost of any replacement parts. These parts will be credited upon certification the original part was defective and the defective part was returned within one week of notifying RapidTech LLC d/b/a National Environmental Systems, of the malfunction. If the part is found to have been misused no credit will be issued. In order for RapidTech LLC d/b/a National Environmental Systems, to ship a replacement part on account, all outstanding invoices must be current.

RapidTech LLC d/b/a National Environmental Systems, expressly disclaims any warranties, expressed or implied, including any warranty of merchantability or fit for particular purpose or any warranty arising from a course of dealing or usage of trade. Except to the extent required by applicable law. RapidTech LLC d/b/a National Environmental Systems, shall not be liable, in tort, contract or otherwise, for any loss or damage, whether direct, consequential or incidental, of any person or entity arising in connections with the equipment.



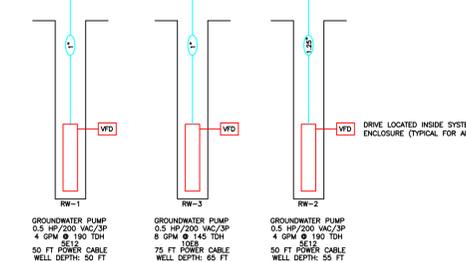
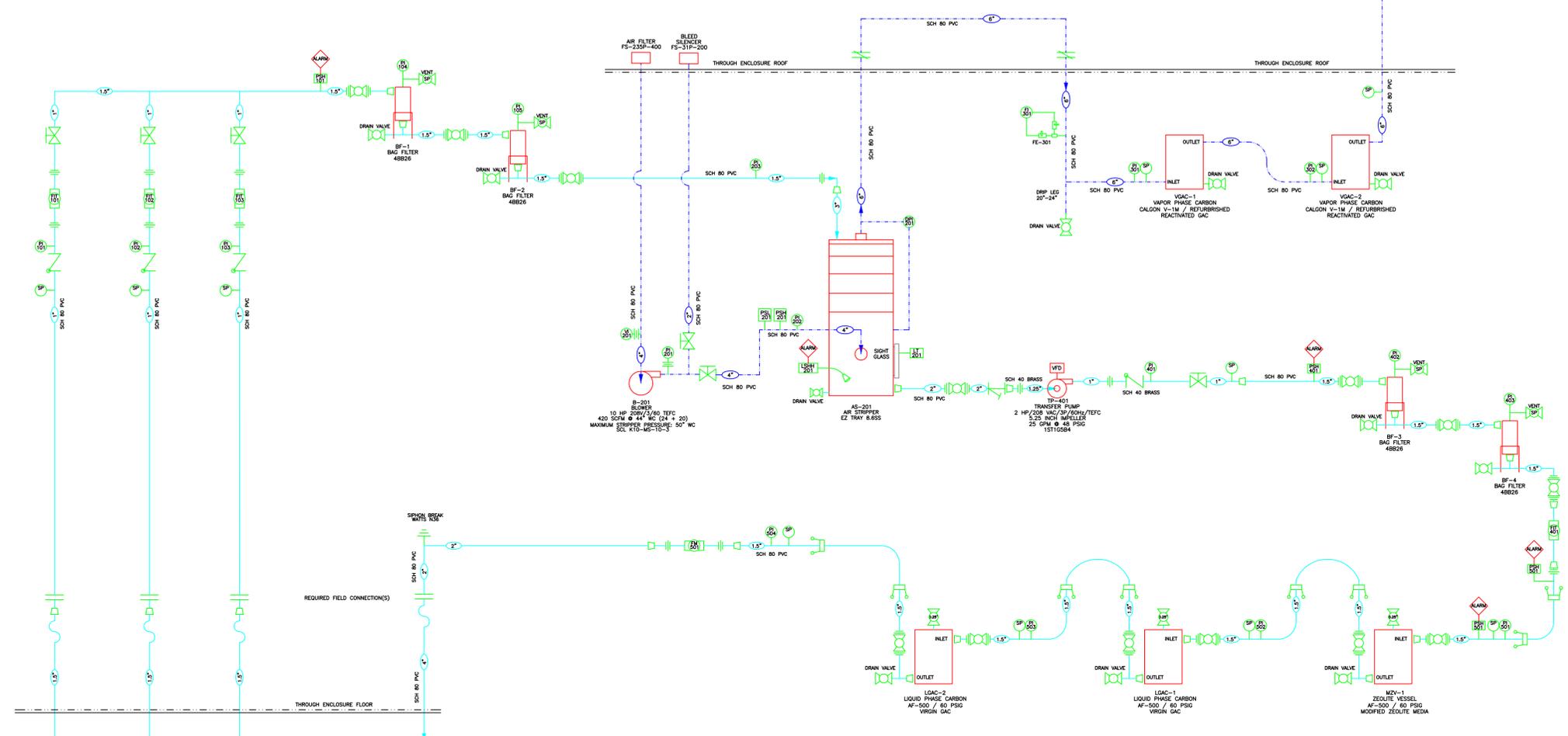
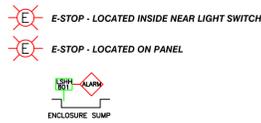
**NES Project: 12-133**  
**GWT – Cargo Box**  
**AECOM – Textron Providence, RI**

***Section 2 - Mechanical Drawings***

System Process & Instrumentation Diagram

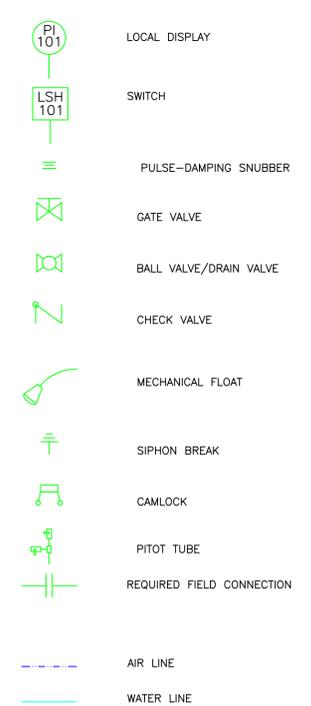
System Enclosure Layout Drawing

SITE POWER: 208 VAC / 3 Ø / 60 Hz  
 CLASSIFICATION: NON HAZARDOUS INTERIOR & EXTERIOR LOCATION



ALARMS	
FIT-101	RW-1 LOW FLOW
FIT-102	RW-2 LOW FLOW
FIT-103	RW-3 LOW FLOW
LT-201	AS-201 LOW LEVEL
LT-201	AS-201 HIGH LEVEL
PSH-101	BF-1, BF-2 HIGH PRESSURE
PSL-201	B-201 LOW PRESSURE
LSHH-201	AS-201 HIGH LEVEL
PSH-401	BF-3, BF-4 HIGH PRESSURE
PSH-501	MZV-501, LGAC-1, LGAC-2 HIGH PRESSURE
LSHH-801	FLOOR SUMP HIGH LEVEL
ESTOP	ESTOP (ENCLOSURE / CP) ENGAGED
VFD-1/4	VFD FAULT
WARNINGS	
FIT-101	RW-1 HIGH FLOW
FIT-102	RW-2 HIGH FLOW
FIT-103	RW-3 HIGH FLOW
MOTOR H/OIA (S)	HAND SELECTED

LEGEND	
BPI	DIFFERENTIAL PRESSURE INDICATOR
FE	FLOW ELEMENT
FI	FLOW INDICATOR
FIT	FLOW INDICATING TRANSMITTER
FM	FLOW METER
FT	FLOW TOTALIZER
LT	LEVEL TRANSMITTER
LSHH	LEVEL SWITCH HIGH-HIGH
LT	LEVEL SWITCH HIGH-LOW
PI	PRESSURE INDICATOR
PSH	PRESSURE SWITCH HIGH
PSL	PRESSURE SWITCH LOW
SP	SAMPLE POINT
VI	VACUUM INDICATOR



TAG No	ITEM	MANUFACTURER	MODEL	SPEC
FIT-101/FIT-103 & FIT-501	FLOW INDICATING TRANSMITTER	GF SIGNET	3-2551-P0-42	MAGNETIC POLYPROPYLENE BODY, 316SS ELECTRODE, GROUNDING RINGS, 0.5 - 4 INCH (DN15 TO DN100) PIPE SIZE WITH DISPLAY, 4-20mA OUTPUT / WITH 1 INCH PVC INSTALLATION TEE (WITH PRE-SECTIONS)
PI-101 / PI-103	PRESSURE GAUGE	MARSH	98152410	0 - 100 PSIG RANGE / 2.5 INCH STAINLESS STEEL CASE / BRASS WETTED PARTS / LIQUID FILLED / 0.25 INCH BOTTOM MOUNT CONNECTION
PI-104 / PI-106	PRESSURE GAUGE	MARSH	98152409	0 - 60 PSIG RANGE / 2.5 INCH STAINLESS STEEL CASE / BRASS WETTED PARTS / LIQUID FILLED / 0.25 INCH BOTTOM MOUNT CONNECTION
PSH-101, PSH-401 & PSH-501	HIGH PRESSURE SWITCH	DWYER	CS-150	10 - 150 PSI RANGE / 5 PSI FIXED DEADBAND / 0.25 INCH BOTTOM CONNECTION PORT / Buna-N & STEEL WETTED MATERIALS / 175 PSIG PRESSURE LIMIT / SPDT SWITCH / ADJUSTABLE SET POINT
VI-201	VACUUM GAUGE	MLJOCO	LP25070210	15 - 0 INCH RANGE / DIA PHRAGM GAUGE / 2.5 INCH STAINLESS STEEL CASE / 0.25" BACK CONNECTION
PI-201 & PI-202	PRESSURE GAUGE	MLJOCO	LP2507L250	0 - 100 INCH RANGE / DIA PHRAGM GAUGE / 2.5 INCH STAINLESS STEEL CASE / 0.25" BOTTOM CONNECTION
PI-203	PRESSURE GAUGE	MLJOCO	LP2507L220	0 - 30 INCH RANGE / DIA PHRAGM GAUGE / 2.5 INCH STAINLESS STEEL CASE / 0.25" BOTTOM CONNECTION
PSH-201	HIGH PRESSURE SWITCH	DWYER	1950P-2-2F	0.5 TO 2 PSI / 0.3 MAX DEAD BAND / (-)40 TO 140 F TEMPERATURE LIMITS / 35 PSI MAX PRESSURE / SPDT SWITCH TYPE / 0.125 INCH PROCESS CONNECTION / ADJUSTABLE SET POINT
PSL-201	LOW PRESSURE SWITCH	DWYER	1950-20-2F	4 TO 20 INCH / 0.4 MIN TO 0.6 MAX DEAD BAND / (-)40 TO 140 F TEMPERATURE LIMITS / 45 INCHES WATER MAX PRESSURE / SPDT SWITCH TYPE / 0.125 INCH PROCESS CONNECTION / ADJUSTABLE SET POINT
DPI-201	DIFFERENTIAL PRESSURE INDICATOR	DWYER	2050	0-50 INCH / 4 INCH / 20 IN Hg TO 15 PSIG PRESSURE LIMITS / 20 - 140 F TEMPERATURE RANGE / 0.125" CONNECTION
LSHH-201	HIGH-HIGH LEVEL SWITCH	GEMS	MYEL40T	NARROW ANGLE / NORMALLY CLOSED / 40 FEET OF POWER CORD / 2 WIRE / 32 F TO 221 F TEMPERATURE RATING / NON MERCURY
LT-201	LEVEL TRANSMITTER	GEMS	XT800-3-BR-BN-13-11-5-7-1300 J-H COLLARS	BRASS CONSTRUCTION / 2 INCH TOP MOUNT FITTING / Buna-N FLOAT / 4 - 20mA OUTPUT
FE-301	FLOW ELEMENT	DWYER	DS-300-6	6 INCH AVERAGING PITOT TUBE / S.S. WITH BRASS ISOLATION VALVE / 0 - 200 F TEMP LIMITS
FI-301	FLOW INDICATOR	DWYER	2001	0-1 INCH / 4 INCH / 20 IN Hg TO 15 PSIG PRESSURE LIMITS / 20 - 140 F TEMPERATURE RANGE / 0.125" CONNECTION
PI-301 & PI-302	PRESSURE GAUGE	MLJOCO	LP2507L220	0 - 30 INCHES WATER RANGE / 2.5 INCH STEEL CASE / BRASS WETTED PARTS / 0.25 INCH BOTTOM MOUNT CONNECTION
FM-401	FLOW METER	NEPTUNE	T10-1	1-50GPM / MECHANICAL FLOW TOTALIZER / LOCAL DISPLAY / BRONZE CONSTRUCTION / 1IN CONNECTIONS / NON RESETTABLE REGISTER
PI-401/PI-403	PRESSURE GAUGE	MARSH	98152410	0 - 100 PSIG RANGE / 2.5 INCH STAINLESS STEEL CASE / BRASS WETTED PARTS / LIQUID FILLED / 0.25 INCH BOTTOM MOUNT CONNECTION
PI-501 & PI-502	PRESSURE GAUGE	MARSH	98152410	0 - 100 PSIG RANGE / 2.5 INCH STAINLESS STEEL CASE / BRASS WETTED PARTS / LIQUID FILLED / 0.25 INCH BOTTOM MOUNT CONNECTION
PI-503	PRESSURE GAUGE	MARSH	98152409	0 - 60 PSIG RANGE / 2.5 INCH STAINLESS STEEL CASE / BRASS WETTED PARTS / LIQUID FILLED / 0.25 INCH BOTTOM MOUNT CONNECTION
PI-504	PRESSURE GAUGE	MARSH	98152408	0 - 30 PSIG RANGE / 2.5 INCH STAINLESS STEEL CASE / BRASS WETTED PARTS / LIQUID FILLED / 0.25 INCH BOTTOM MOUNT CONNECTION
LSHH-801	LEVEL SWITCH	DWYER	F7-SB	LEVEL SWITCH BUNA-N & EPOXY W/ 316 SS

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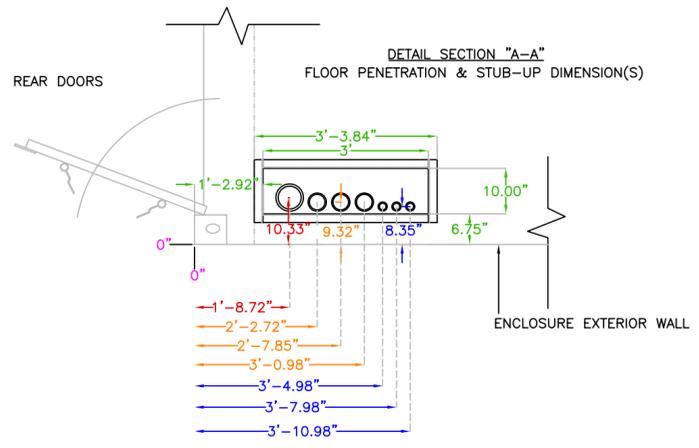
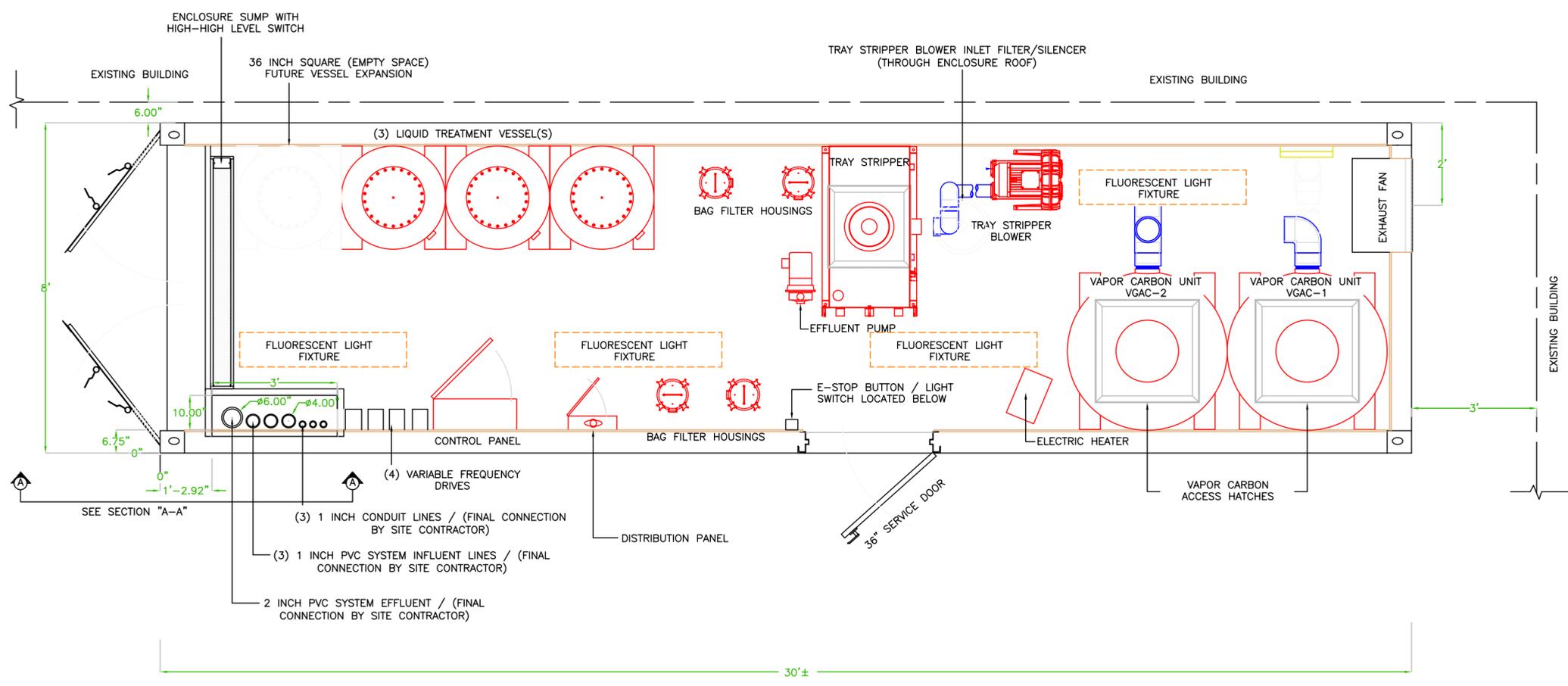


REV	DESCRIPTION	DATE	APPROVED
B	AS INSTALLED	05-22-13	KWB
A	AS BUILT	04-04-13	EMB

DRWN BY	DATE	CHK BY	DATE
CJJ	3-5-13		

TITLE			
GROUNDWATER TREATMENT SYSTEM PROCESS & INSTRUMENTATION DIAGRAM (P&ID)			
AECOM PROVIDENCE, RI		JOB NO. 12-133	
SCALE N/A	SIZE D	DWG NO. M-1	SHEET 1 OF 1
		REV B	

REVISIONS		
A	AS BUILT	04-04-13 EMB



- CONSTRUCTION NOTES:**
- INTERIOR & EXTERIOR OF SYSTEM ENCLOSURE ARE NEC NON-CLASSIFIED.
  - SITE POWER: 208 VAC / 3 PHASE
  - INFLUENT & EFFLUENT PIPING ALONG WITH (3) 1 INCH CONDUITS FOR DOWN-WELL PUMPS WILL ENTER THE SYSTEM ENCLOSURE THROUGH A FLOOR CUT-OUT. TEMPLATE SUPPLIED FOR FIELD CONFIRMATION.
  - EXTERIOR COLOR: GRAY
  - ADDITIONAL SPACE PROVIDED FOR POTENTIAL (4TH) LIQUID MEDIA VESSEL.
  - VGAC VESSEL, TRAY STRIPPER BLOWER INLET FILTER, AND TRAY STRIPPER CONE/DEMISTER REQUIRE ROOF ACCESS. FALL PROTECTION IS THE RESPONSIBILITY OF AECOM.
  - 1 INCH INFLUENT GROUNDWATER RECOVERY LINES AND 2 INCH DISCHARGE LINE TERMINATE 2 FT ABOVE ENCLOSURE FLOOR. FINAL CONNECTIONS TO INFLUENT & EFFLUENT & LINES VIA HOSE (BY OTHERS)
  - TRAY STRIPPER EFFLUENT AIR PIPING WILL EXIT THROUGH THE SYSTEM ROOF AND RE-ENTER THE EAST WALL OF THE ENCLOSURE. THIS PIPING WILL REQUIRE RE-INSTALLATION ON SITE. A DRIP LEG WITH MANUAL DRAIN WILL BE PROVIDED FOR ANY EXCESS MOISTURE ACCUMULATION.

**CONFIDENTIALITY NOTE:**  
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DRWN BY CJJ		DATE 3-1-13		TITLE GROUNDWATER TREATMENT SYSTEM ENCLOSURE LAYOUT			
CHK BY		DATE		AECOM (MA) TEXTRON - PROVIDENCE, RI		JOB NO. 12-133	
APPR BY		DATE		SCALE N/A	SIZE C	DWG NO. M-2	SHEET 1 OF 2
						REV A	



**NES Project: 12-133**  
**GWT – Cargo Box**  
**AECOM – Textron Providence, RI**

***Section 3 - Electrical Drawings***

Control Panel Description

Panel Interior / Exterior Layout Drawing

One Line Diagram

Wiring Diagrams



**CONTROL SYSTEM DESCRIPTION**  
**NES JOB NUMBER: 12-133, Revision B, As Installed**  
**AECOM / Textron (Providence, RI)**

**CONTROLLER** – Automation Direct P3000 PLC-Based with C-More Operator Interface Terminal and cellular modem interface.

**CAPABLE OF CONTROLLING**

(3) Groundwater Pumps (P-01,02,03)	0.5 HP, 200V, 3 Phase submersible
A/S Blower (B-201)	10 HP, 208V, 3 Phase TEFC
A/S Effluent Pump (TP-401)	2.0 HP, 208V, 3 Phase TEFC

**ALARMS (18)** - Manual reset unless noted otherwise

- 1.) RW1 Low Flow
- 2.) RW2 Low Flow
- 3.) RW3 Low Flow
- 4.) Air Stripper Low Level (transmitter)
- 5.) Air Stripper High Level (transmitter)
- 6.) Influent Filters High Pressure
- 7.) Air Stripper Low Pressure
- 8.) Air Stripper High Level (switch)
- 9.) Effluent Filters High Pressure
- 10.) Carbon High Pressure
- 11.) Floor Sump High Level
- 12.) Emergency Stop Active
- 13-16) VFD1- VFD4 Fault
- 17.) Air Stripper Blower Overload
- 18.) Air Stripper High Air Pressure

**WARNINGS (4)** - Manual reset unless noted otherwise

- 1.) RW1 High Flow Warning
- 2.) RW2 High Flow Warning
- 3.) RW3 High Flow Warning
- 4.) Switch in Hand Position Warning (auto reset)

Note: Warnings provide indication and notification only (no motor is stopped).

**NORMAL OPERATION**

Equipment will operate if the panel switch is in the AUTO position and no alarm is present. Equipment will operate if the panel switch is in the HAND position with or without an alarm condition. The only conditions that will stop a motor in the hand position are an overload or emergency stop. Analog alarm set-points and timers have default values. Some can be modified (using the OIT). A password (19) is necessary. The Groundwater Pumps start 7 seconds after the A/S Blower. A PID (proportional, integral and derivative) setting must be entered for each pump motor if a continuous flow (from wells) or level (of A/S sump) is desired to be maintained.

**ALARM OPERATION**



**1.) RW1 Low Flow**

**Panel response** – Groundwater Pump (P-01) is stopped.

**2.) RW2 Low Flow**

**Panel response** – Groundwater Pump (P-02) is stopped.

**3.) RW3 Low Flow**

**Panel response** – Groundwater Pump (P-03) is stopped.

**4.) Air Stripper Low Level (transmitter)**

**Panel response** – All Groundwater Pumps and A/S effluent pump are stopped.

**5.) Air Stripper High Level (transmitter)**

**Panel response** – All Groundwater Pumps are stopped.

**6.) Influent Filters High Pressure**

**Panel response** – All Groundwater Pumps are stopped.

**7.) Air Stripper Low Pressure**

**Panel response** – All Groundwater Pumps are stopped.

**8.) Air Stripper High Level (switch)**

**Panel response** – All Groundwater Pumps are stopped.

**9.) Effluent Filters High Pressure**

**Panel response** – All Groundwater Pumps and the A/S Effluent pump are stopped.

**10.) Carbon High Pressure**

**Panel response** – All Groundwater Pumps and the A/S Effluent pump are stopped.

**11.) Floor Sump High Level**

**Panel response** – All process motors are stopped.

**12.) Emergency Stop Active**

**Panel response**- All process motors are stopped.

**13-16) VFD1- VFD4 Fault**

**Panel response**- Provides notification of fault condition for respective VFD.

**17.) Air Stripper Blower Overload**

**Panel response**- Provides notification of overload for Air Stripper Blower.

**18.) Air Stripper High Pressure**

**Panel response**- All Groundwater Pumps are stopped.

**Notes:** Each alarm or warning condition will turn on the red common alarm light (“Alarm See Screen”) and the alarm message will be posted on the screen. Each process alarm or warning condition will also send an alarm message via email. All alarm emails will have an A prefix (i.e. “A1: RW1 Low Flow”). All warning emails will have a W prefix (i.e. “W1: RW1 High Flow”). The overload alarms are a derived condition (via called to run and failure to get run signal within 2 seconds) and may also indicate a contactor failure. See the manual and drawings for additional information. Contact NES if necessary.

### Summary of Screens

There are several screens developed for this system. The top bar indicates the screen name or title. Navigation to screens (other than the main screen) is provided with the buttons near the title bar. Below is a short summary of what each provides. As noted above some data entries require a password (19).

- 1. Main menu:** Allows navigation to other screens by touching the boxes along the bottom of the screen.
- 2. H-O-A Switches:** Allows operator to control each motor and solenoid. Touch desired box for mode of operation. The selected icon will turn green. The long rectangle above each set of switches will turn green when the motor is on (running), or the solenoid is called open.
- 3. PID Loop Settings:** Allows operator to access proportional, integral and derivative settings for each of 4 motors. The PID (on/off) button must be pressed for the PID function to be active. When the PID is not on, the manual frequency setting (30-60Hz) will be loaded.
- 4. P&ID Graphics:** Provides graphical representation of process. Device icons (motor or solenoid) will turn green when running or called open and gray when closed or not running. Alarm icons will turn red when an alarm exists (or is latched). Warning icons will turn yellow.
- 5. Alarm Timers:** Allows operator to view and adjust alarm timers.
- 6. Analog Setpoints:** Allows operator to view and adjust analog setpoints.
- 7. Alarm History:** Allows operator to view previous alarms. This will log all system alarms whenever they occur with a time and date stamp. Press clear to remove all alarms from the log. To adjust the clock within the screen press the upper left corner of the screen for 5 seconds and go to “settings”. Enter the correct date and time if necessary (this affects the time and date stamp of the alarm history).



**Accessing the system remotely from a web connected computer:**

- 1.) Enter IP address: 166.148.004.217 directly into the Microsoft Internet explorer title bar (do not use a search engine program) and press Enter.
- 2.) When C-More screen comes up, select bottom choice "Remote Access".
- 3.) When connection icons appear choose the lower one ("with Firewall").
- 4.) Run program that pops up.
- 5.) Run another program that pops up (if necessary).

You may save the EACON file to your desktop and run it from there for easier access later.

**A.) Full Access:** A password window appears. Enter the following:

User name: Contacting AECOM Engineer

Password: Contacting AECOM Engineer

After a short delay the screens should appear. This allows complete remote operation.

**B.) Limited Access:** A password window appears. Enter the following:

User name: Contacting AECOM Engineer

Password: Contacting AECOM Engineer

After a short delay the screens should appear. This allows viewing and changing of screens only.

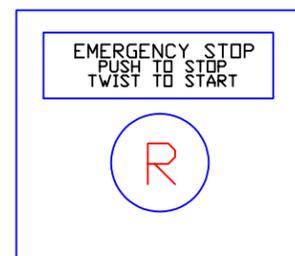
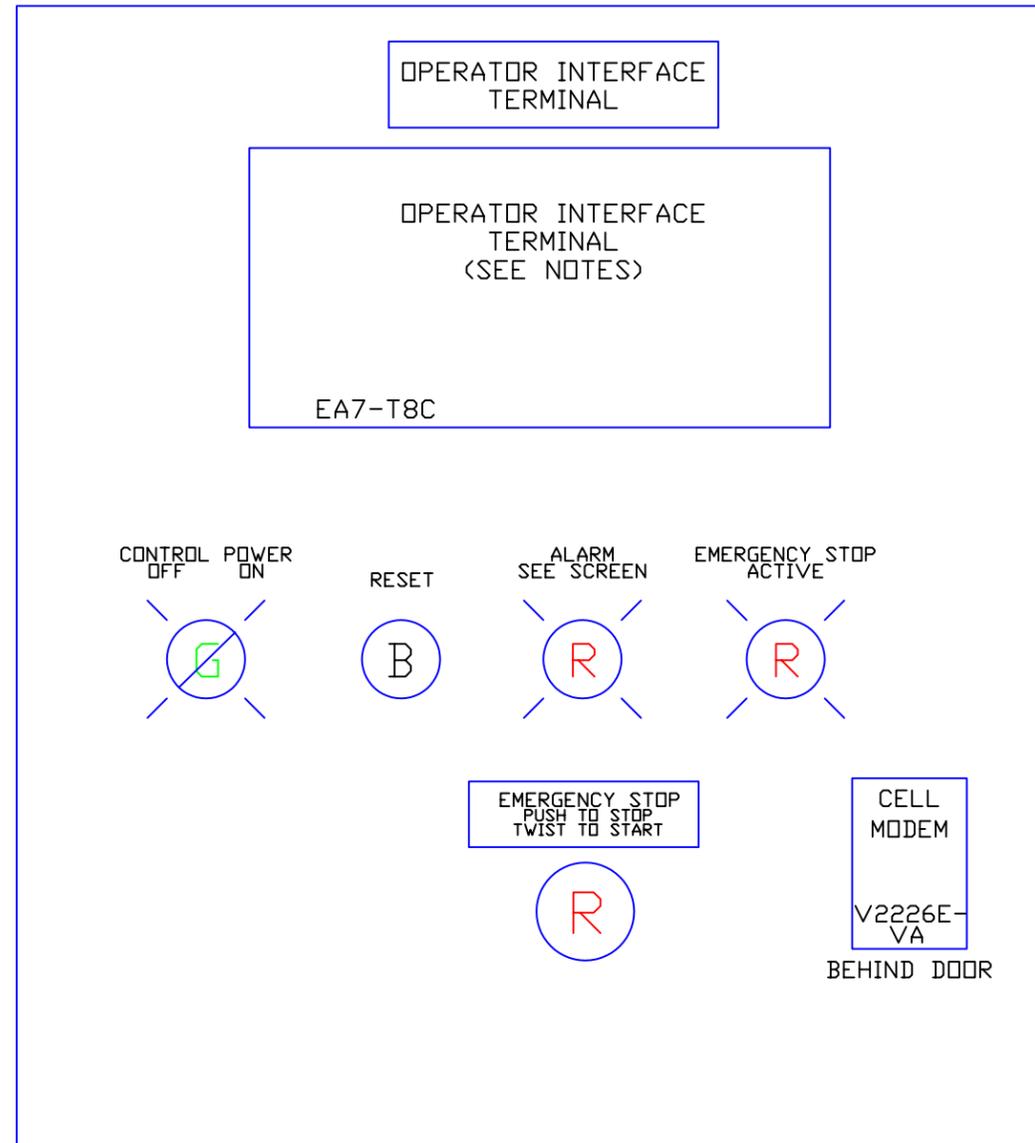
**Downloading Data Log files from a web connected computer:**

- 1.) Enter FTP: //166.148.004.217 directly into the Microsoft Internet explorer title bar (do not use a search engine program) and press Enter.
- 2.) Select log files
- 3.) Select compact flash 1
- 4.) A file with a date and txt extension should appear. Do not open it within explorer. Right Click "target save as", then save it to your desired location. Open with Microsoft excel, Word, notepad or a similar program.

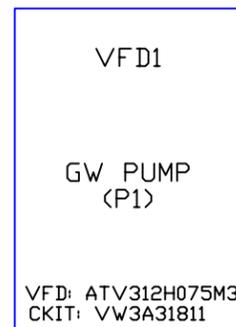


# PANEL EXTERIOR

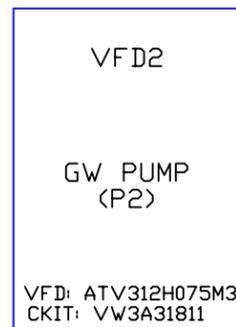
BOX EXTERNAL DIMENSIONS: 30" L X 24" W X 12" D (NEMA4, METAL)



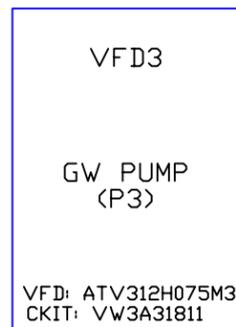
MOUNTED VEAR SERVICE DOOR



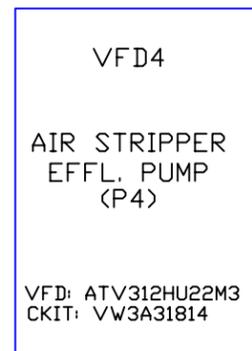
VFD: ATV312H075M3  
CKIT: VW3A31811



VFD: ATV312H075M3  
CKIT: VW3A31811



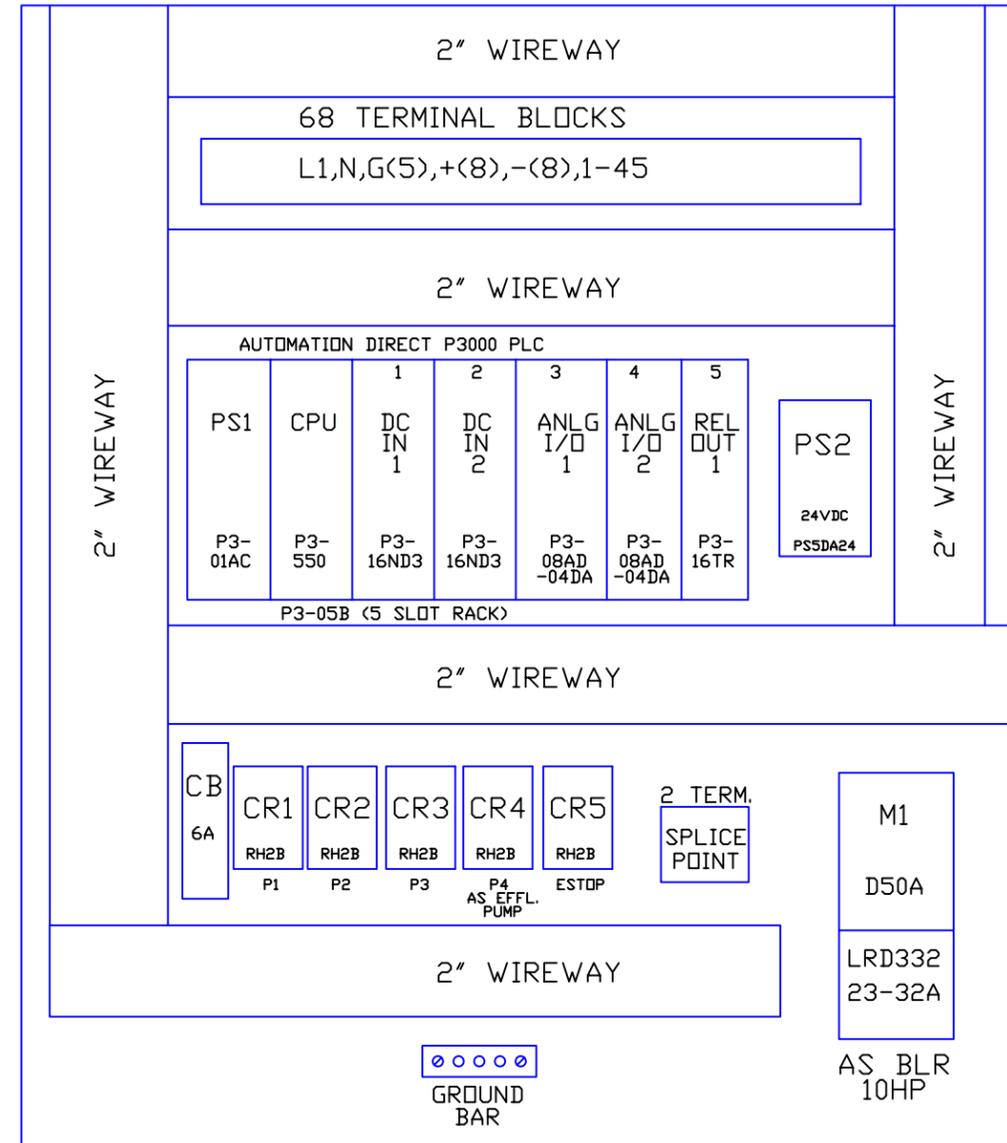
VFD: ATV312H075M3  
CKIT: VW3A31811



VFD: ATV312HU22M3  
CKIT: VW3A31814

ALL VFD'S MOUNTED ON WALL

# PANEL INTERIOR



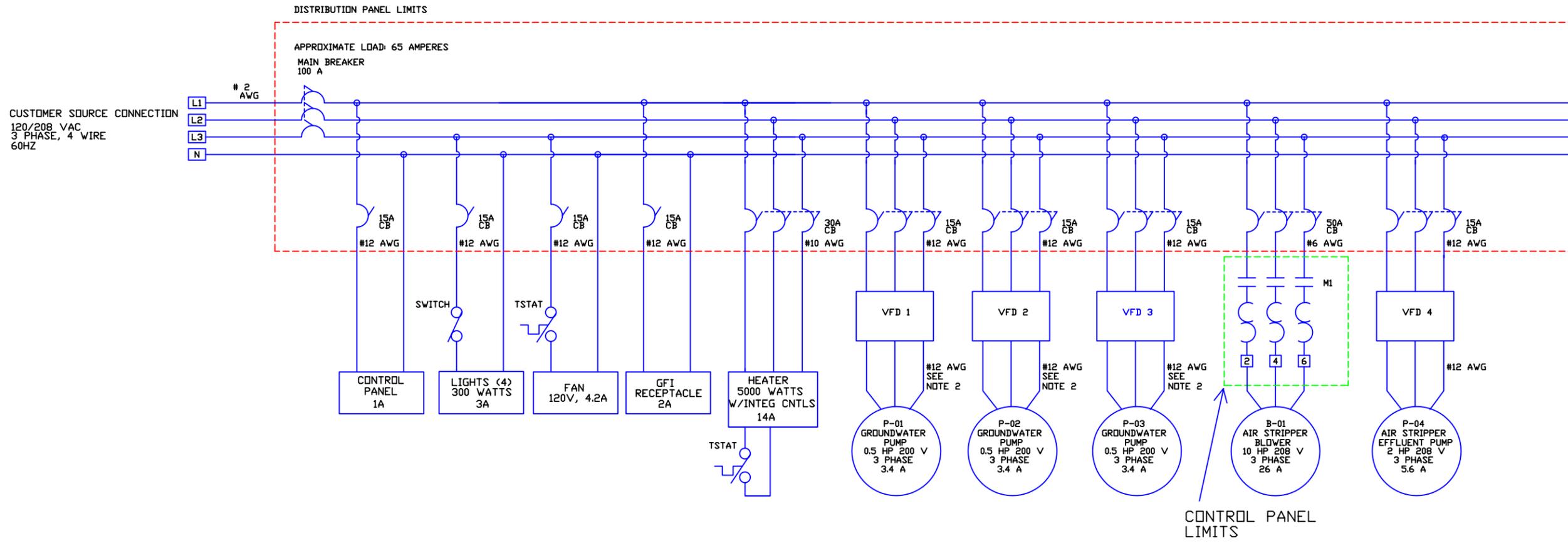
LEGEND	
CB	- CIRCUIT BREAKER
CR	- CONTROL RELAY
HM	- HOUR METER
ISB	- INT. SAFE BARRIER
ISR	- INT. SAFE RELAY
M	- MOTOR STARTER
PLC	- PRDG. LOGIC CONT.
PS	- POWER SUPPLY
VFD	- VARIAB. FREQ. DRIV

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DRWN BY RJD	DATE 3/7/13
CHK BY	DATE
APPR BY	DATE

A	AS BUILT	04-04-13	EMB
REV	DESCRIPTION	DATE	APPR
 NATIONAL ENVIRONMENTAL SYSTEMS 84 Dunham Street - Attleboro, MA. 02703 508-226-1100 (Phone) / 508-226-1180 (Fax) WWW.NES-INC.BIZ			
TITLE		CONTROL PANEL INTERIOR / EXTERIOR LAYOUT	
AECOM PROVIDENCE, RI		JOB NO. 12-133	
SCALE N/A	SIZE B	DWG NO. I-1	SHEET 1 OF 1
		REV A	

**NOTES:**

- 1.) OPERATOR INTERFACE TERMINAL (OIT) WILL BE PROGRAMMED TO PROVIDE HAND-OFF-AUTO CONTROL OF EACH PROCESS MOTOR. ALARM MESSAGES ARE DISPLAYED ON OIT.
- 2.) ANALOG ALARM SETPOINTS TO BE ENTERED USING OIT.
- 3.) ALARM NOTIFICATION (TEXT AND/OR EMAIL) AND DATA-LOGGING TO BE PROVIDED BY OIT.
- 4.) CONTROL PANEL UL 508A LISTED.



NOTES:

- 1.) CONTROL PANEL UL 698A LISTED
- 2.) FIELD WIRING TO BE SIZED FOR APPROPRIATE DISTANCES.

LEGEND	
ABBREV.	DESCRIPTION
M	MOTOR STARTER
DS	DISCONNECT SWITCH
CB	CIRCUIT BREAKER
TSTAT	THERMOSTAT
OL	OVER LOAD
AWG	AMERICAN WIRE GAGE
---	DISTRIBUTION PANEL LIMIT
---	CONTROL PANEL LIMIT

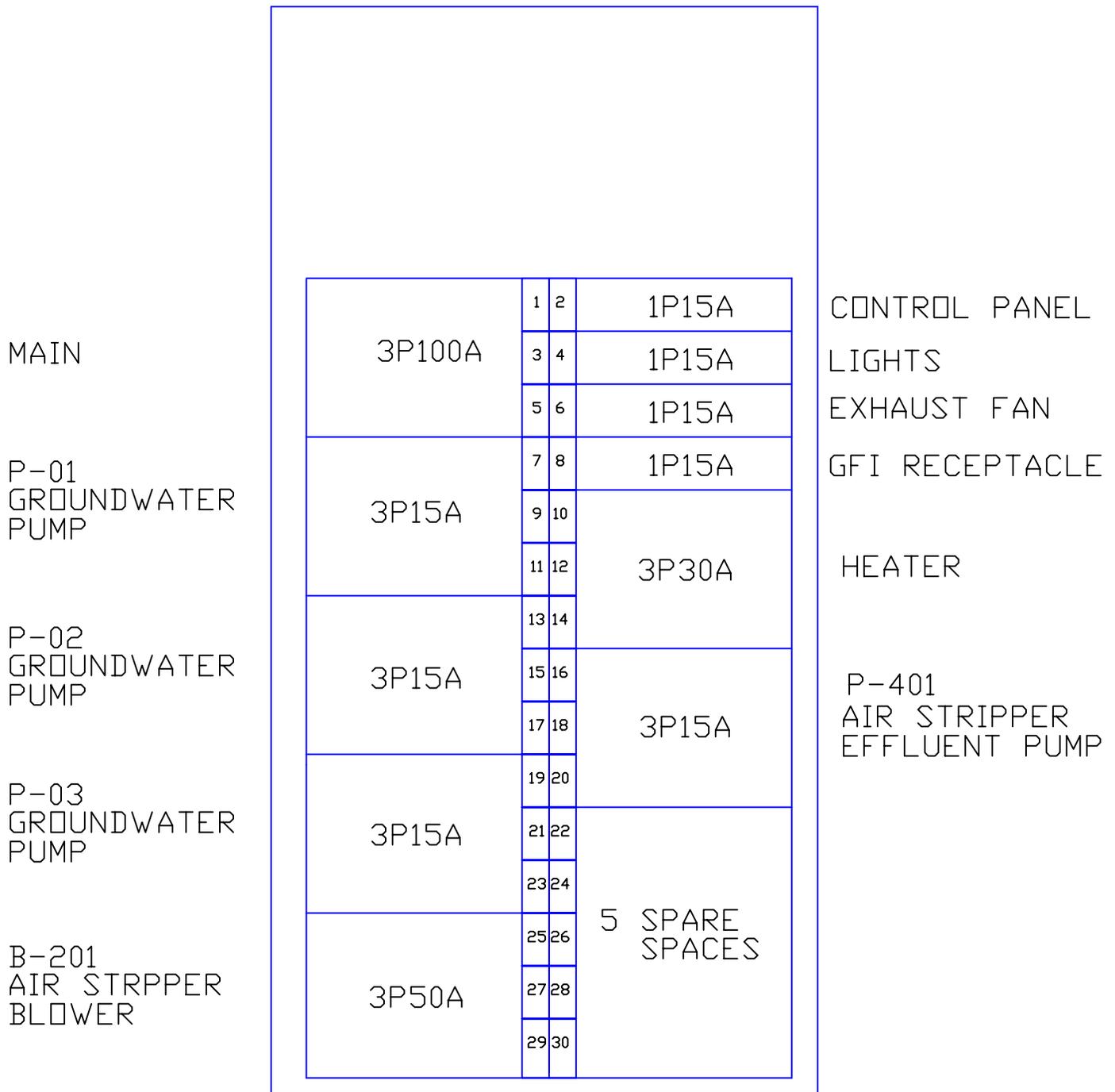
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TITLE				LINE DIAGRAM			
B	AS INSTALLED	05-22-13	RJD	DRWN BY	RJD	DATE	3/7/13
A	AS BUILT	04-04-13	EMB	CHK BY		DATE	
REV	DESCRIPTION	DATE	APPR	APPR BY		DATE	
SCALE		SIZE	DWG NO.	AECOM		JOB NO.	
NTS	B	E-1	PROVIDENCE, RI	12-133		12-133	
SHEET		REV		SHEET		REV	
1 OF 1		B		1 OF 1		B	

# THREE PHASE DISTRIBUTION PANEL

## 120/208 VAC, 100 AMP, 4-WIRE



**NOTES:**

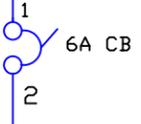
- 1.) BREAKERS INDICATED BY POLE AND AMPERAGE.  
(I.E. 3P20A INDICATES A 3 POLE 20 AMP BREAKER)
- 2.) ONLY PANEL INTERIOR SHOWN. EXTERIOR IS BLANK.

**JOB SPECIFIC INFORMATION:**

EXTERNAL DIMENSIONS: 30"L X 14.75"W X 4.5"D  
 MANUFACTURER: SQUARE D PHASE: 3  
 PART NUMBER: QQ327M100RB MAX AMPS: 100

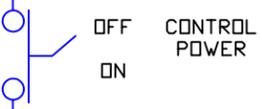
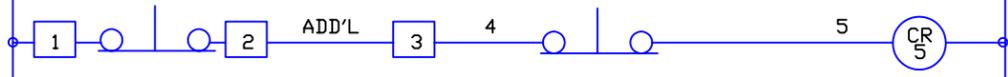
A	AS BUILT	04-04-13	EMB
REV	DESCRIPTION	DATE	APPR
<small>CONFIDENTIALITY NOTE:                  The information contained in this drawing is intended for use only by National Environmental Systems and AECOM. The information is confidential and any copying, distribution or dissemination without the consent of National Environmental Systems is strictly prohibited.</small>		 NATIONAL ENVIRONMENTAL SYSTEMS 84 DUNHAM STREET / ATTLEBORO, MA 02703 508-226-1100 (Phone) / 508-226-1180 (Fax) WWW.NES-INC.BIZ	
DRWN BY RuD	DATE 3/7/13	TITLE POWER DISTRIBUTION PANEL LAYOUT	
CHK BY	DATE	AECOM TEXTRON PROVIDENCE, RI	
APPR BY	DATE	SCALE N/A	SIZE A DWG NO. E-2 SHEET 1 OF 1 REV A
		JOB NO. 12-133	

L1 ← 120 VAC → N

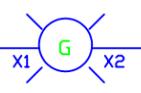
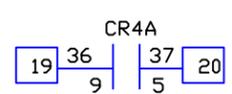
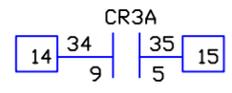
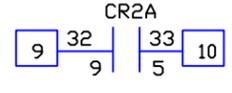
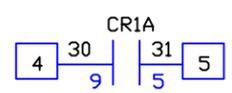


E-STOP 1  
IN SYSTEM

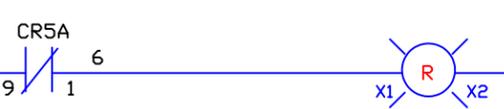
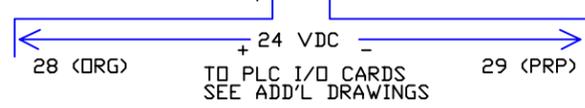
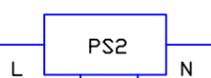
E-STOP 2  
ON PANEL



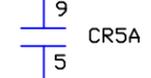
CONTACTS FOR VFD ENABLES



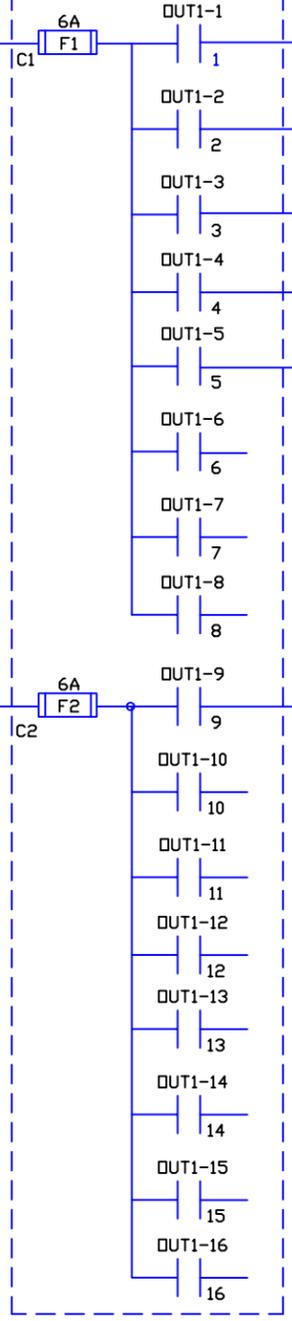
CONTROL POWER



EMERGENCY STOP ACTIVE



PLC RELAY OUTPUT CARD #1



P-01  
GROUNDWATER PUMP (RW1)

P-02  
GROUNDWATER PUMP (RW2)

P-03  
GROUNDWATER PUMP (RW3)

B-201  
AIR STRIPPER  
BLOWER

P-401  
AIR STRIPPER  
EFFLUENT PUMP

PRE-ESTOP  
3

ALARM  
SEE SCREEN

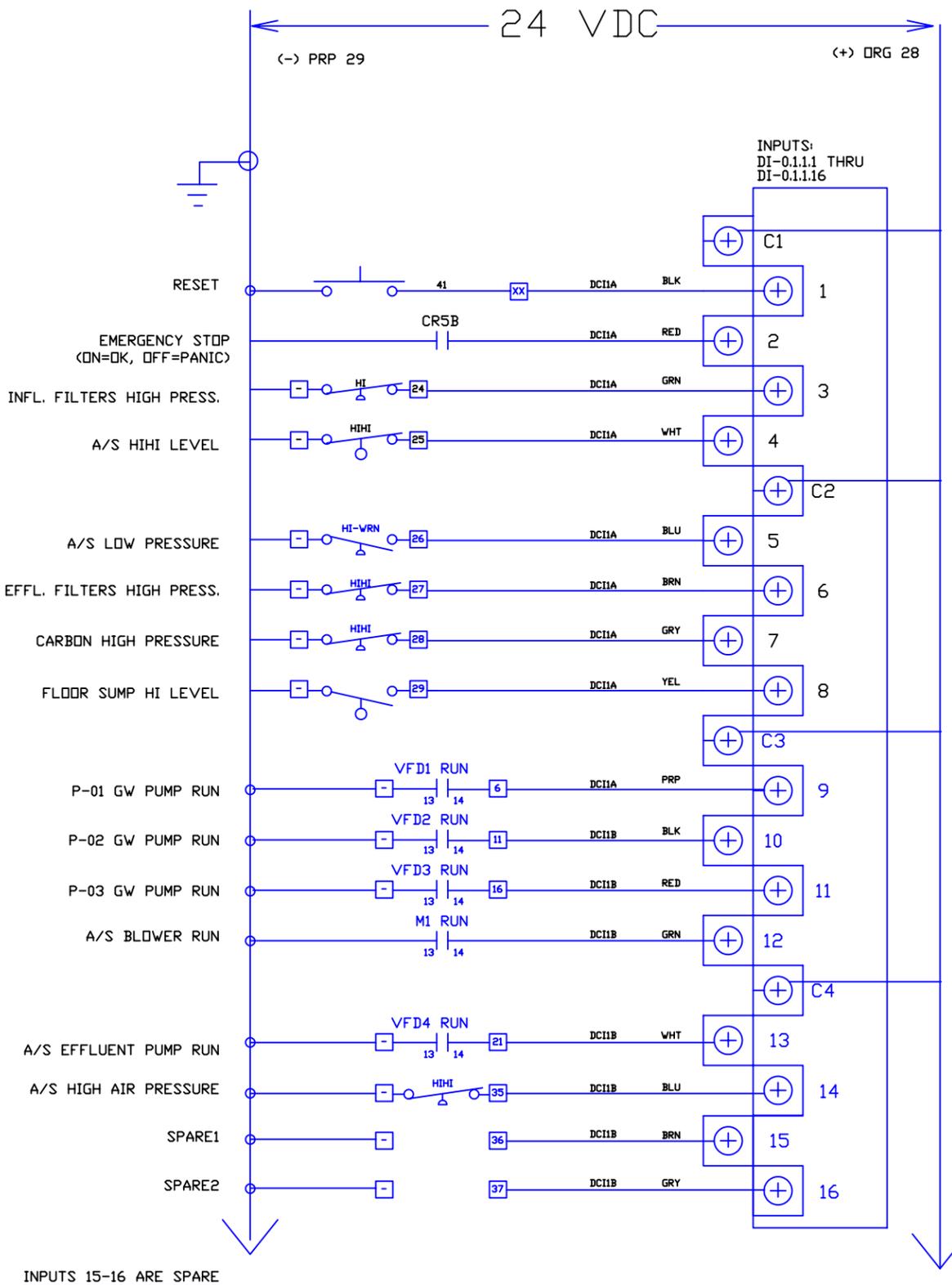
REV	DESCRIPTION	DATE	APPR
A	AS BUILT	04-04-13	DMB

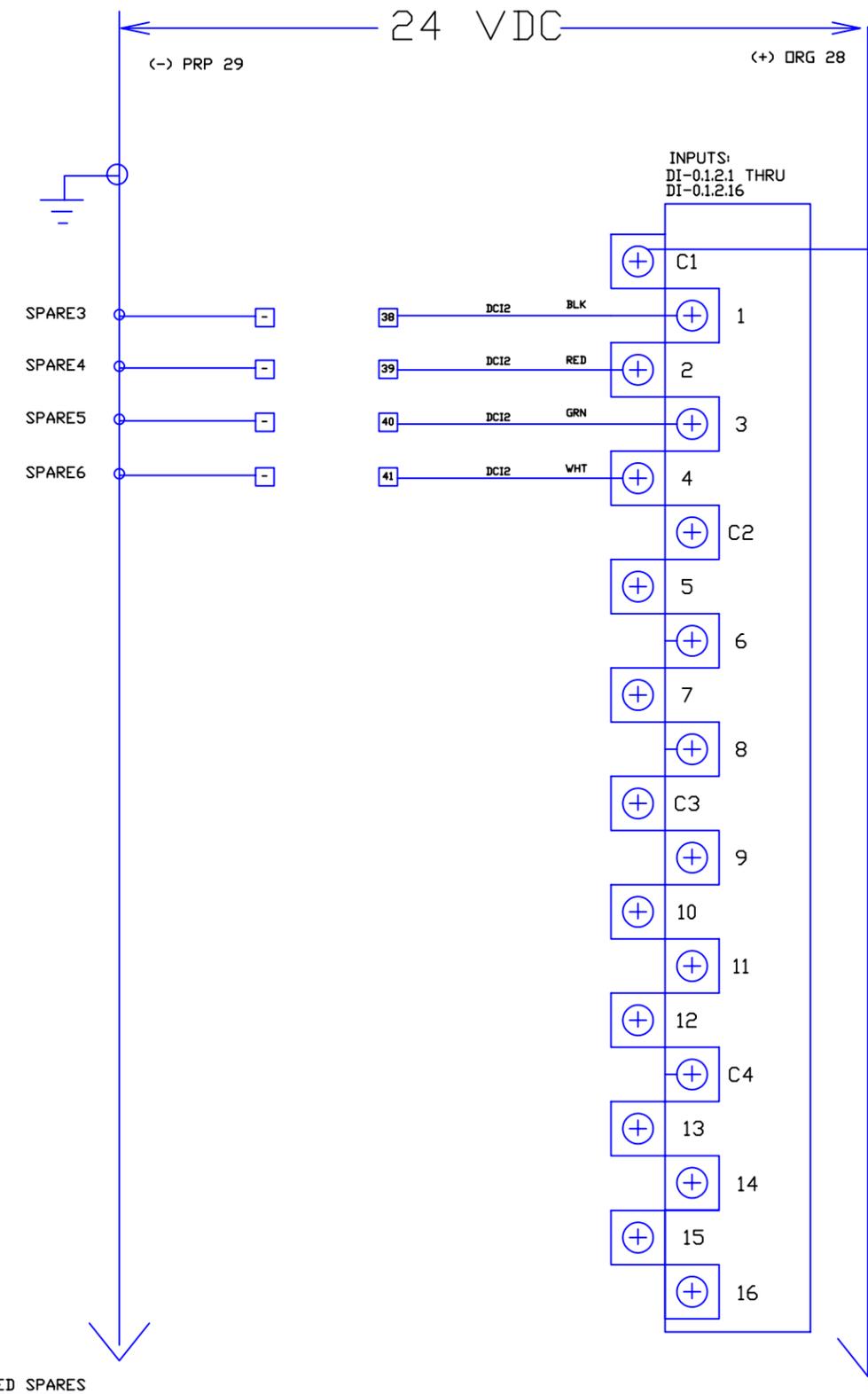
<p>CONFIDENTIALITY NOTE: The information contained in this drawing is intended for use only by National Environmental Systems and AECOM. The information is confidential and any copying, distribution or dissemination without the consent of National Environmental Systems is strictly prohibited.</p>		<p>NATIONAL ENVIRONMENTAL SYSTEMS 84 Dunham Street - Attleboro, MA, 02703 508-226-1100 (Phone) / 508-226-1180 (Fax) WWW.NES-INC.BZ</p>	
DRWN BY	RJD	DATE	3/7/13
CHK BY		DATE	
APPR BY		DATE	
SCALE	N/A	SIZE	B
DWG NO.	I-2	SHEET	1 of 4
TITLE	CONTROL PANEL WIRING DIAGRAM		
JOB NO.	AECOM PROVIDENCE, RI 12-133		

# DC INPUT 1

# DC INPUT 2

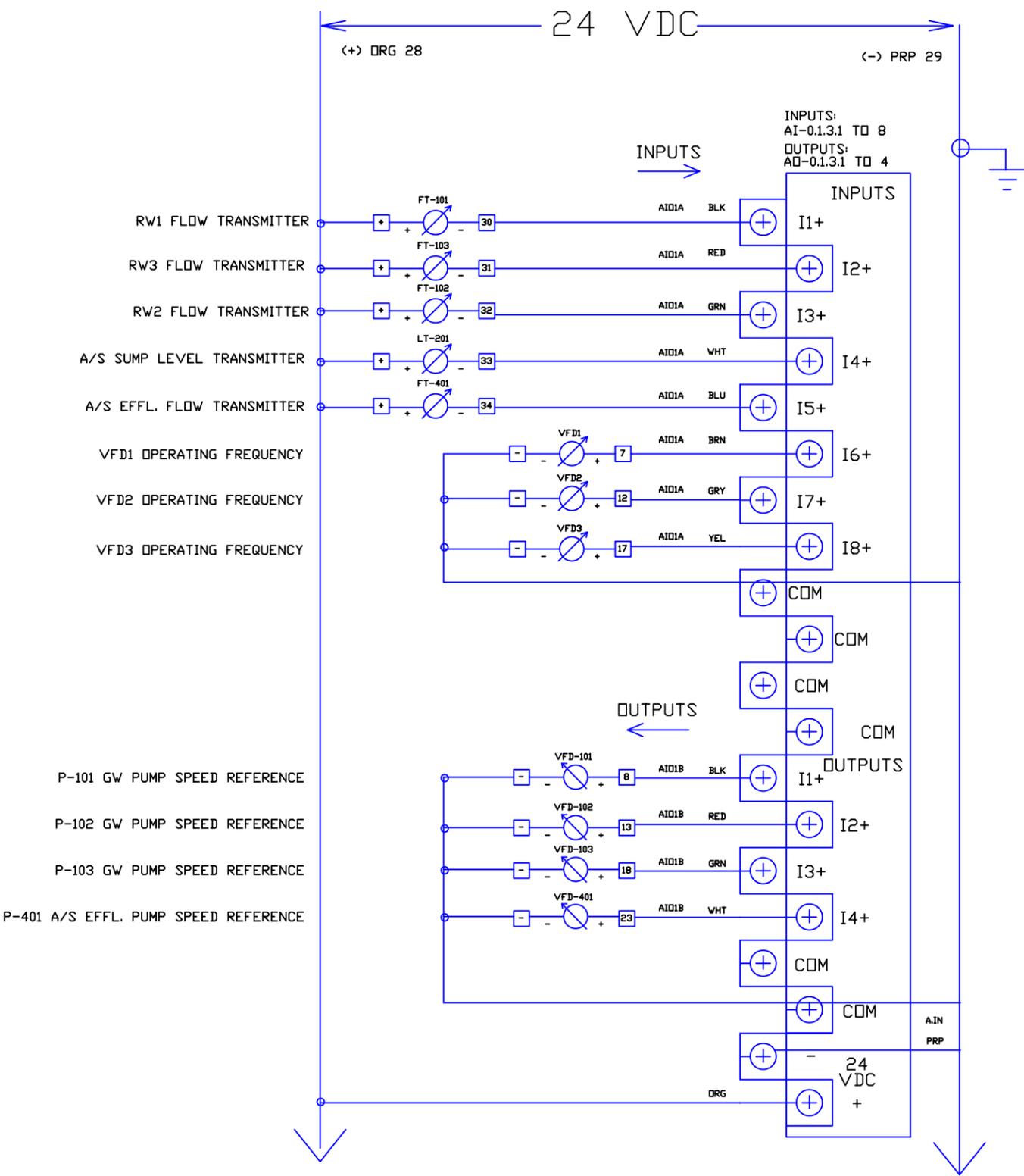


INPUTS 5-16 ARE UNWIRED SPARES

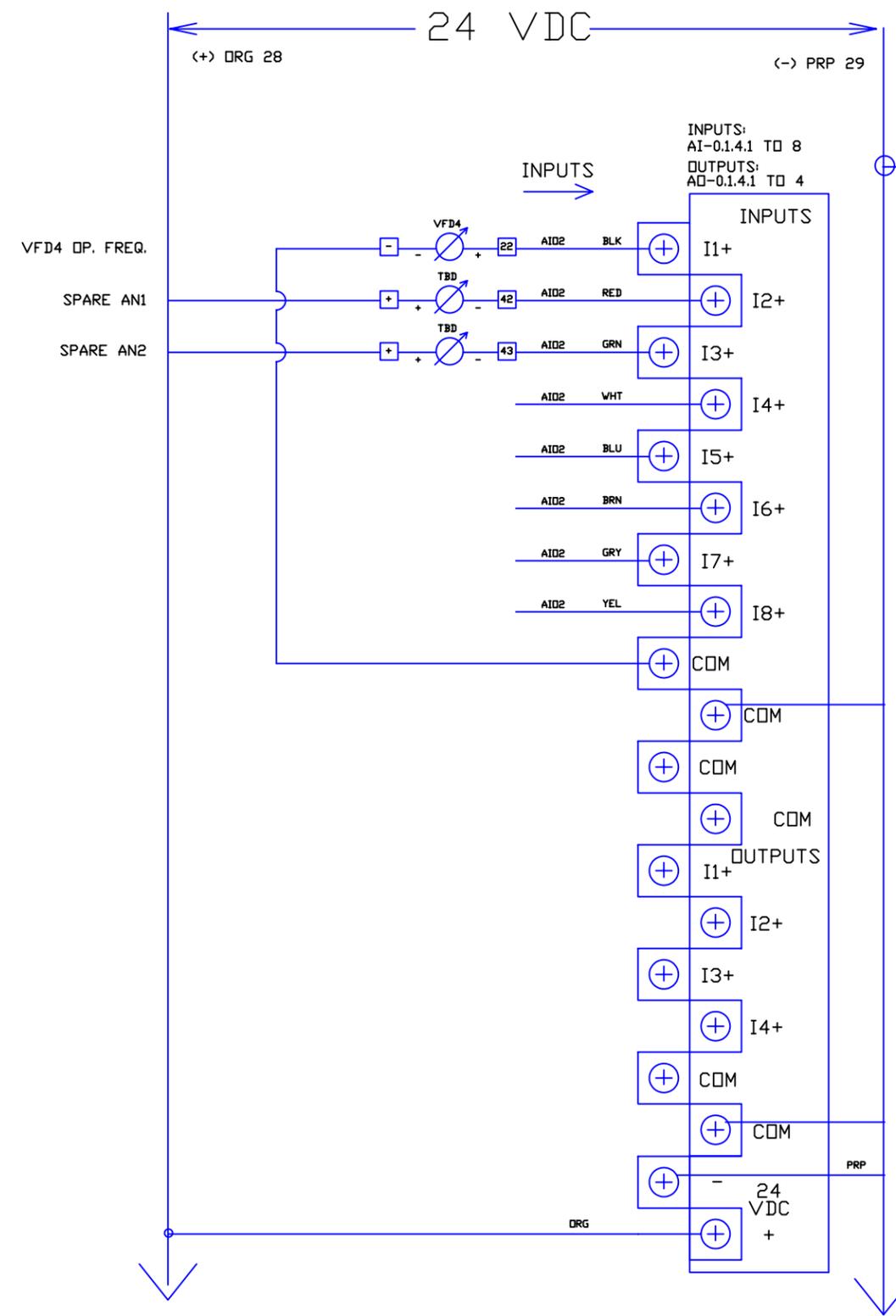


A		AS BUILT	04-04-13	EM
REV	DESCRIPTION	DATE	APPR	
<p><b>CONFIDENTIALITY NOTE:</b> The information contained in this drawing is intended for use only by National Environmental Systems and AECOM. The information is confidential and any copying, distribution or dissemination without the consent of National Environmental Systems is strictly prohibited.</p>				
 <p>NATIONAL ENVIRONMENTAL SYSTEMS 84 Dunham Street - Attleboro, MA, 02703 508-228-1100 (Phone) / 508-228-1180 (Fax) WWW.NES-INC.BIZ</p>		<p>TITLE: CONTROL PANEL WIRING DIAGRAM</p>		
DRWN BY	RJD	DATE	3/7/13	
CHK BY		DATE		
APPR BY		DATE		
SCALE	N/A	SIZE	B	DWG NO. I-2
				JOB NO. 12-133
				SHEET 2 OF 4
				REV A

# ANALOG I/O 1



# ANALOG I/O 2

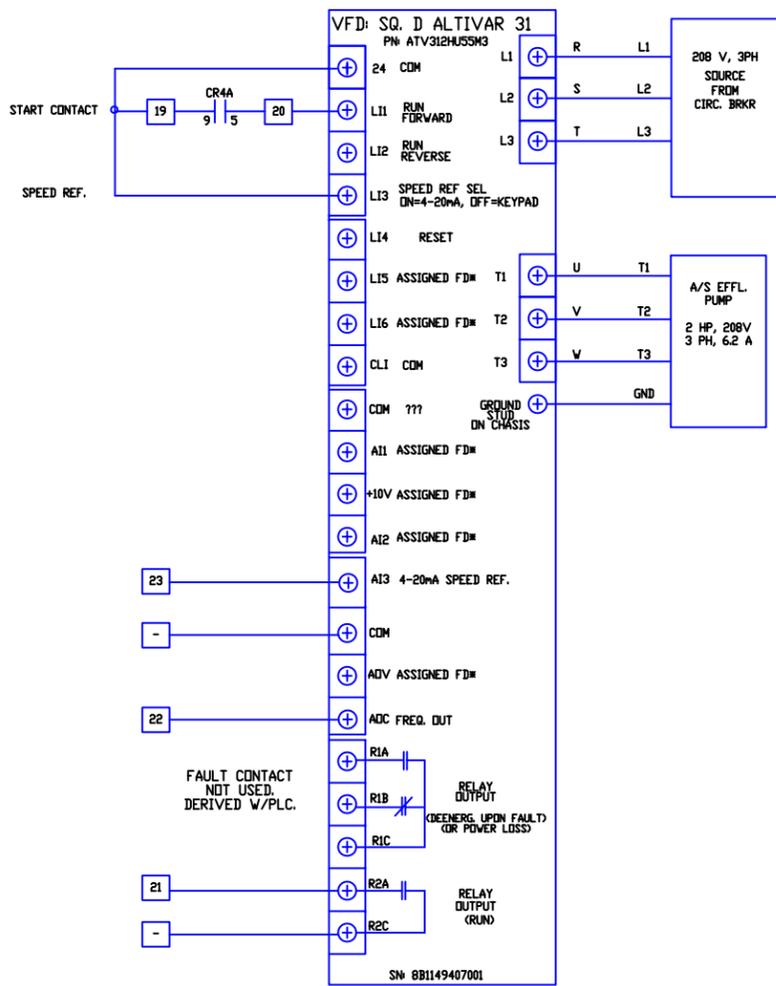
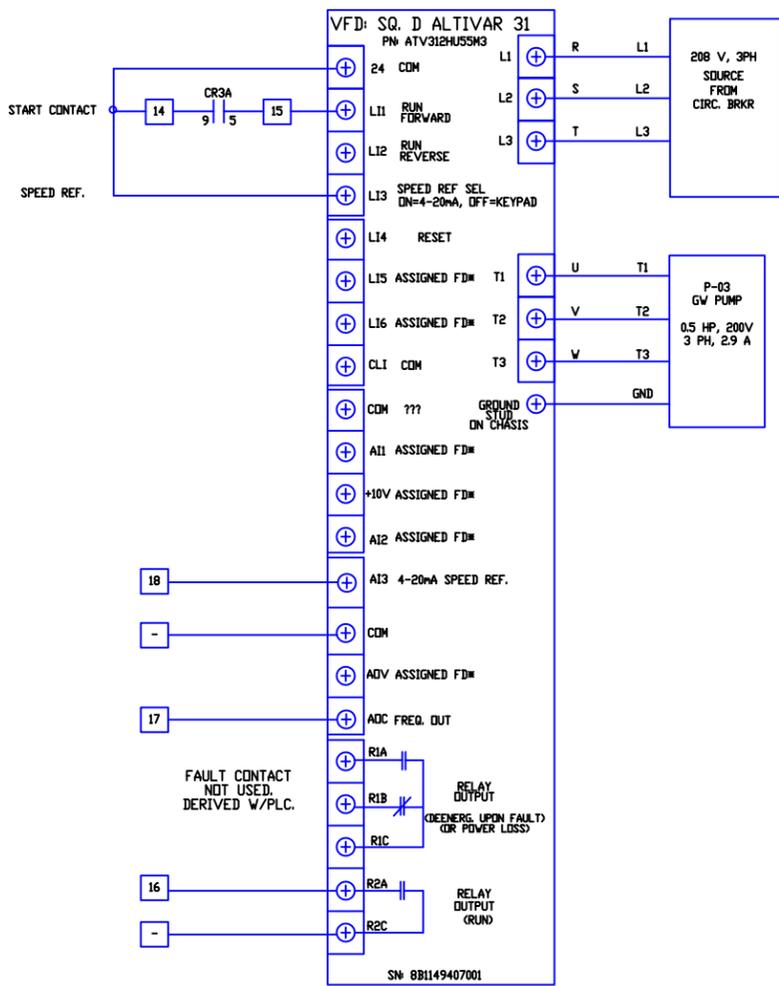
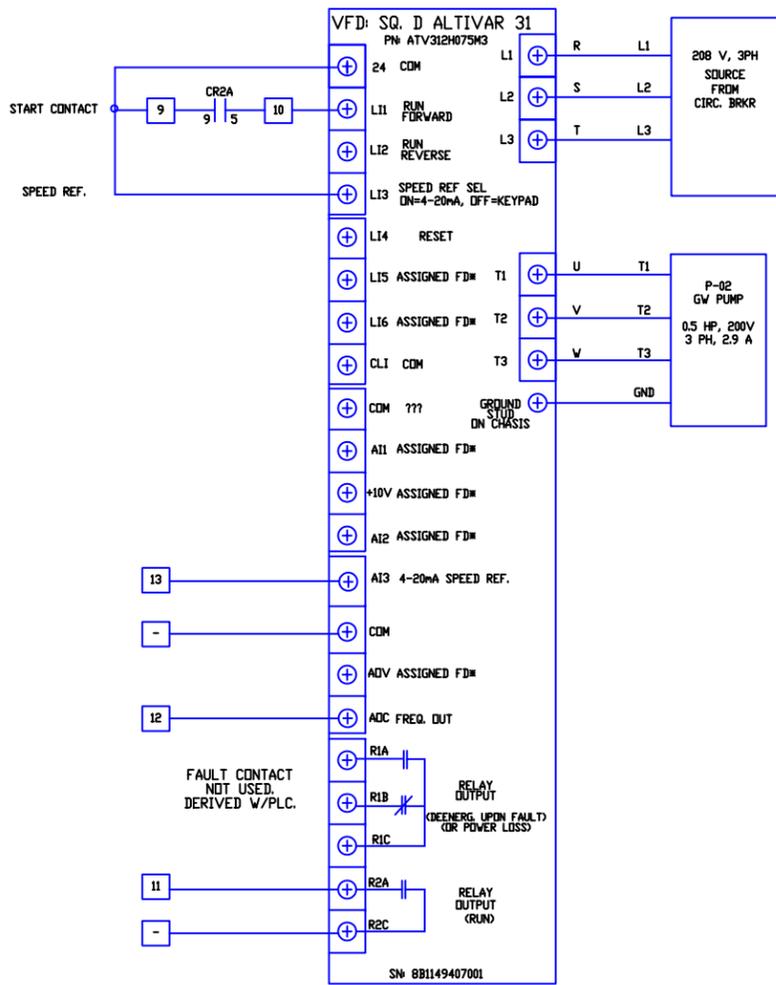
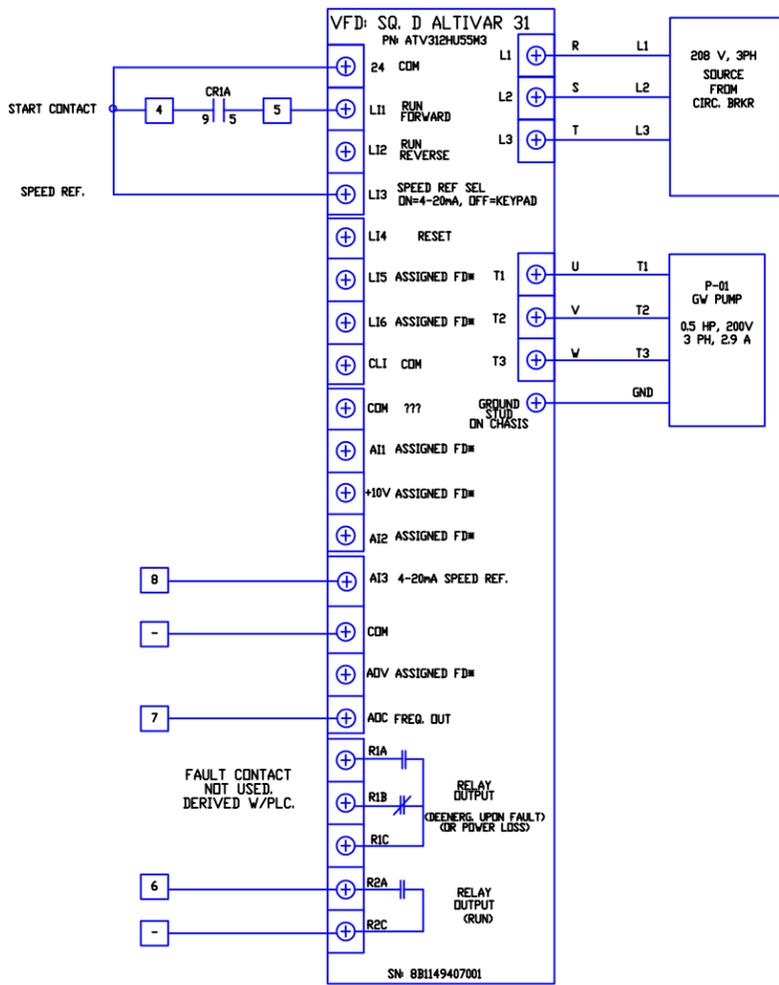


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B	AS INSTALLED	05-21-13	RJD
A	AS BUILT	04-04-13	ENB
REV	DESCRIPTION	DATE	APPR

**NES**  
NATIONAL ENVIRONMENTAL SYSTEMS  
84 Dunham Street - Attleboro, MA 02703  
508-228-1100 (Phone) / 508-228-1180 (Fax)  
WWW.NES-INC.BIZ

DRWN BY	RJD	DATE	3/7/13	TITLE	CONTROL PANEL WIRING DIAGRAM
CHK BY		DATE		AECOM	JOB NO. 12-133
APPR BY		DATE		TEXTRON	PROVIDENCE, RI
SCALE	N/A	SIZE	B	DWG NO.	I-2
				SHEET	3 OF 4
				REV	B



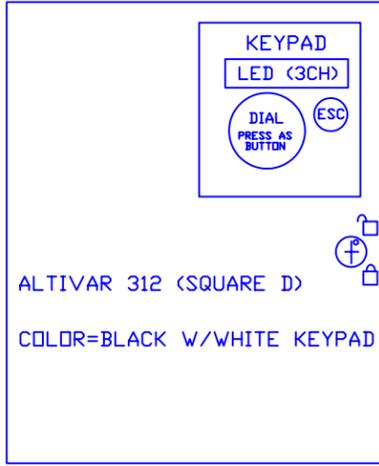
REV	DESCRIPTION	DATE	APPR
A	AS BUILT	04-04-13	EMB

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**NES**  
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84 Dunham Street - Attleboro, MA, 02703  
508-226-1100 (Phone) / 508-226-1180 (Fax)  
WWW.NES-INC.BZ

DRWN BY	DATE	TITLE
RJD	3/7/13	CONTROL PANEL WIRING DIAGRAM
CHK BY	DATE	AECOM PROVIDENCE, RI
APPR BY	DATE	SCALE
		SIZE
		DWG NO.
		1-2
		SHEET
		4 OF 4
		REV
		A

# VFD EXTERIOR



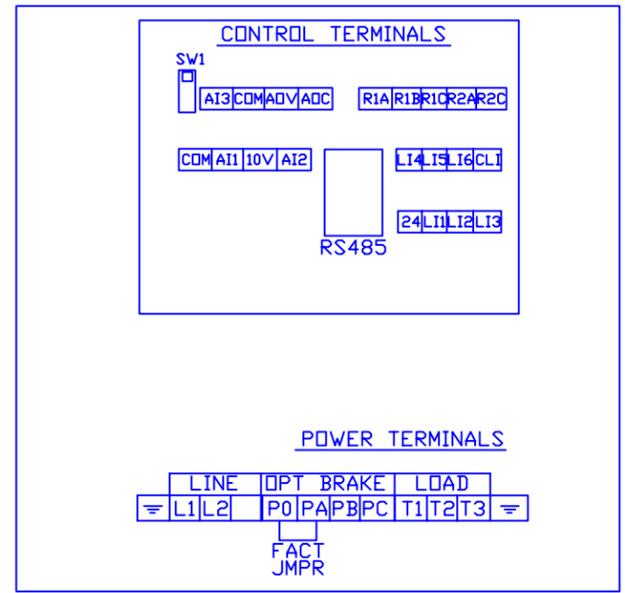
TO OPEN (ONLY LOWER SECTION OPENS):  
 LOOSEN PHILLIPS SCREW 1/4 TURN (UN-LOCK) AND PULL OPEN DOOR  
 DOT ON SCREW AND LOCK SYMBOL INDICATES STATE.

### TO CLEAR FAULTS

1. CORRECT CONDITION CAUSING FAULT THEN CYCLE POWER.
2. PRESS ESC TO CLEAR FAULT. IF FAULT CLEARS (I.E. "OCA")
3. CYCLE STOP/RUN CONTACT (AUTO TO OFF THEN BACK TO AUTO)

# VFD INTERIOR

LOWER SECTION ONLY



# VFD PARAMETER SETTINGS

AS ADJUSTED/PROGRAMMED BY NES

MANUAL PAGE #	MENU	SUB MENU	PARAMETER CODE	DESCRIPTION	SETTINGS BY NES			
					VFD1	VFD2	VFD3	VFD4
					ALL UNDIVIDED SETTINGS ARE SAME IN EACH VFD			
53	FUn	StC	Stt	STOP CONTROL (nST=COAST)	nST			
63	FUn	UPd	Str	SAVE SPEED REF. SETPT (AFT CYCLED)	EEP			
34	ID		ADIt	SET MIN OUTPUT CURRENT TO 4mA.	4A			
34	ID		d0	SETS OUTPUT CURRENT TO FREQ. OUT	0Fr			
34	ID		r2	SETS RELAY 2 TO RUN	rUn			
30	dRc		bFr	MOTOR NAMEPLATE FREQUENCY	60 (HZ)			
30	dRc		FrS	MAX ALLOWABLE OUTPUT FREQUENCY	60 (HZ)			
26	SEt		LSP	MIN OUTPUT FREQUENCY	30 (HZ)			
26	SEt		HSP	MAX OUTPUT FREQUENCY	bFr (<=60 (HZ))			
46	CtL		LAC	SETS USER LEVEL ACCESS	L3			
46	CtL		Fr1	SETS FREQ (SPEED) REF. 1 (KEYPAD)	A1U1			
46	CtL		Fr2	SETS FREQ (SPEED) REF. 2 (PROC, 4-20mA)	AI3			
47	CtL		rFC	SETS SPEED REF SELECTION TO LI3	LI3			
56	FUn	SAI	SA2	DISABLES SUMMING INPUTS	n0			
58	FUn	PSS	PS2	DISABLES FACTORY SPEED REF ASSNGMNT	n0			
58	FUn	PSS	PS4	DISABLES FACTORY SPEED REF ASSNGMNT	n0			
80	FLt		0PL	OUTPUT PHASE LOSS FAULT	yES (see note 3)			
80	FLt		IPL	INPUT PHASE LOSS FAULT	yES (see note 3)			
33	ID		tCt	STARTS AFTER PWR CYCLED (WHEN=LEL)	LEL			
35	ID		SCS	STORES ABOVE CONFIGURATIOIN FOR RECALL	YES (STR1)			
30	dRc		tFr	ANALOG OUTPUT MAX FREQUENCY	60 (HZ)			
52	FUn	rPC	ACC	ACCELERATION TIME (RAMP UP)	3 SEC			
26	SET		ItH	MOTOR FULL LOAD (OVERCURRENT PROT. AMPS)	3.4	3.4	3.4	5.6
43	CtL		ChcF	SPEED REF. AND START/STOP SIGNALS (=SEP)	SEP			
30	dRc		Uft	VOLTS PER HERTZ PATTERN	P (VARIABLE TORQ.)			

### NOTES FOR ABOVE TABLE

1. ALL PARAMETERS NOT LISTED ABOVE REMAIN AT FACTORY DEFAULT SETTINGS.
2. SEE DRAWINGS FOR VFD AND MOTOR SIZES.
3. SET TO "n0" FOR BENCH TESTING

### TO PROGRAM VFD (USE DIAL/BUTTON):

1. TURN DIAL DISPLAY GOES TO **SET** FOR MENU TREE SEE MANUAL P19
2. PRESS DIAL TO GO TO DESIRED MENU (NO PASSWORD REQ'D).
3. PRESS DIAL TO GO TO DESIRED SUB MENU OR PARAMETER.
4. TURN DIAL TO REVEAL PARAMETER SELECTIONS (SCREEN BLINKS).
6. PRESS DIAL TO SAVE PARAMETER CHOICE. (SCREEN BLINKS). (HOLD TIL FLASH IF NECESSARY-LAC)

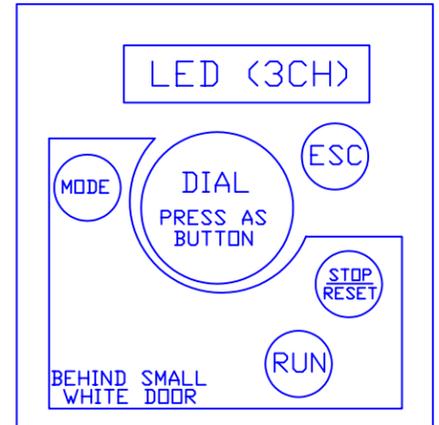
### MONITORING VALUES IN "SUP" MENU

1. TURN DIAL CLOCKWISE UNTIL DISPLAY SHOWS **SUP**
2. TURN TO DESIRED PARAMETER (SEE P85)  
 LCr = MOTOR CURRENT  
 LFt = LAST FAULT  
 rTH = RUN TIME HOURS

3. PRESS DIAL, DISPLAY SHOWS PARAMETER VALUE

NOTE: SEE SQUARE D ALTIVAR FULL MANUAL FOR ADDITIONAL INFORMATION IF NECESSARY. PAGE REFERENCES REFER TO THIS MANUAL.

# INTEGRAL KEYPAD



### COMMON (LED) DISPLAYS:

- DRIVE STOPPED DISPLAY READS: **rDy**
- DRIVE RUNNING DISPLAY READS: **60.0**  
 (OUTPUT FREQUENCY)
- DRIVE FAULT DISPLAY READS: **OLF**  
 (FLASHING)  
 OLF=MOTOR OVERLOAD FAULT

### FOR MANUAL ADJUSTMENT OF MOTOR SPEED (VFD FREQUENCY)

#### OPTION 1:

ENTER DESIRED FREQUENCY AT HMI SCREEN (PID1-4)

#### OPTION 2: USE LOCAL VFD KEYPAD

- a.) Open VFD and disconnect wire on LI3 (Keypad now ref).
- b.) From DRIVE MENU, PRESS DIAL.
- c.) Select SPEED REFERENCE, PRESS DIAL.
- d.) In Speed Reference select IMAGE INPUT A1V1, PRESS DIAL.
- e.) TURN DIAL to adjust Speed (Display in per cent). PRESS DIAL if necessary.
- f.) Press ESC to return to Frequency Ref (HZ).

B	5-22-13	AS INSTALLED	RJD
A	4-1-13	AS BUILT	ELJ
REV	DATE	DESCRIPTION	BY
CONFIDENTIALITY NOTE: The information contained in this drawing is intended for use only by National Environmental Systems and AECOM. The information is confidential and any copying, distribution or dissemination without the consent of National Environmental Systems is strictly prohibited.		 NATIONAL ENVIRONMENTAL SYSTEMS 84 DUNHAM STREET / ATTLEBORO, MA 02703 508-226-1100 (Phone) / 508-226-1180 (Fax) WWW.NES-INC.BIZ	
DRWN BY	DATE	TITLE	
RJD	3-25-13	VFD LCD AND SETTINGS	
CHK BY	DATE	AECOM TEXTRON - PROVIDENCE, RI	JOB NO. 12-133
APPR BY	DATE	SCALE N/A	SIZE B
		DWG NO. 13	SHEET 1 OF 1
			REV B



**NES Project: 12-133**  
**GWT – Cargo Box**  
**AECOM – Textron Providence, RI**

***Section 4 - Control Panel Components***

Panel Enclosure - Hoffman Model C-SD302412

Programmable Logic Controller - ADI Model P3000

HMI, 8" Touchscreen - ADI / Cmore Model EA7-T8C

Cellular Interface - Verizon - Sierra Wireless Model V2226E-VA

Cellular Interface Antenna - Wilson Model 301125

## CONCEPT® Wall-Mount Enclosures

## CONCEPT®, Type 4 and 12

**Industry Standards**

Wall-mounting brackets required to maintain UL/CSA external mounting requirement.

**CONCEPT solid single-door, door with window and flush-mount models**

UL 508A Listed; Type 4, 12; File No. E61997  
cUL Listed per CSA C22.2 No. 94; Type 4, 12; File No. E61997

NEMA/EEMAC Type 4, 12, 13  
CSA, File No. 42186; Type 4, 12  
VDE IP66  
IEC 60529, IP66

**CONCEPT two-door models**

UL 508A Listed; Type 12; File No. E61997  
cUL Listed per CSA C22.2 No. 94; Type 12; File No. E61997

NEMA/EEMAC Type 12  
CSA, File No. 42186, Type 12  
VDE IP 55  
IEC 60529, IP55

**Application**

CONCEPT® Enclosures are ideal for machine control applications. With streamlined styling, flush quarter-turn latches and an attractive, durable finish. Available in solid or window single-door and two-door landscape, flush-mount and sloped-top versions for application and mounting flexibility. Two-door landscape models provide full-width access and easy panel installation.

**Specifications**

- 14, 16 or 18 gauge steel (see table)
- Seams continuously welded and ground smooth
- Corner-formed doors
- Simple easy-to-remove and install hinge pins with built-in captivation clip
- High-torque threadless studs and fasteners on door
- Minimum-width body flange provides maximum door opening (210 degrees)
- External formed body flange
- Panel mounting studs fit optional CONCEPT panels and other accessories
- Mounting holes in back of body for optional external wall-mount brackets
- Hidden hinges
- Doors are interchangeable and easily removed by pulling clip-style hinge pins
- Seamless foam-in-place gasket
- Quarter-turn slotted latch(es)
- Door alignment device on doors wider than 30 in.
- Four hinges on 60-in.-high enclosures
- Grounding stud on body; bonding provision on door (except window-door models)
- Provisions for thermoplastic data pocket (right-hand hinged door on two-door models)
- Hardware kit with panel mounting nuts, panel grounding hardware and sealing washers
- Single-door enclosures have a three-point latch system on enclosures where A is equal to or greater than 42-in. with quarter-turn, slotted latch
- Window-door enclosures have a clear polycarbonate window flush with door surface
- Mounting frame on flush-mount enclosures extends completely around enclosure
- Two-door enclosures have an overlapping door design which provides full-width access
- Two door enclosures have a three-point latch system on right-hand hinged door furnished with flush slotted insert
- Illustrated instruction sheet

**Finish**

Two standard finishes are available: ANSI 61 gray or RAL 7035 textured light-gray polyester powder paint inside and out.

**Accessories**

Door Stop Kit  
Handles  
Lock Inserts  
CONCEPT® Panels  
Mounting-Bracket Kits

**Modification and Customization**

Hoffman excels at modifying and customizing products to your specifications. Contact your local Hoffman sales office or distributor for complete information.

Bulletin: CW1

### CONCEPT® Wall-Mount Enclosures

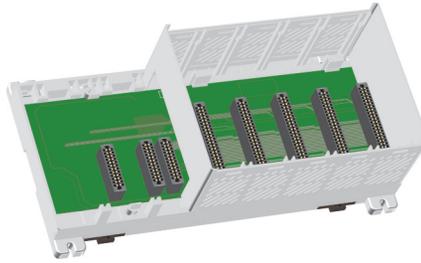
Catalog Number	AxBxC in./mm	Finish	Door Ga.	Body Ga.	CONCEPT Panel	Conductive CONCEPT Panel	Panel Size D x E in./mm	Mounting G x H in./mm	Latches qty.	Latches style	J in./mm
CSD303010LG	30.00 x 30.00 x 10.00 762 x 762 x 254	RAL 7035 Lt. Gray	14	14	CP3030	CP3030G	28.20 x 28.20 716 x 716	28.50 x 28.50 724 x 724	2	Quarter-turn	5.00 127
CSD362410	36.00 x 24.00 x 10.00 914 x 610 x 254	ANSI 61 Gray	14	16	CP3624	CP3624G	34.20 x 22.20 869 x 564	34.50 x 22.50 876 x 572	2	Quarter-turn	5.00 127
CSD362410LG	36.00 x 24.00 x 10.00 914 x 610 x 254	RAL 7035 Lt. Gray	14	16	CP3624	CP3624G	34.20 x 22.20 869 x 564	34.50 x 22.50 876 x 572	2	Quarter-turn	5.00 127
CSD363010	36.00 x 30.00 x 10.00 914 x 762 x 254	ANSI 61 Gray	14	14	CP3630	CP3630G	34.20 x 28.20 869 x 716	34.50 x 28.50 876 x 724	2	Quarter-turn	5.00 127
CSD363010LG	36.00 x 30.00 x 10.00 762 x 762 x 254	RAL 7035 Lt. Gray	14	14	CP3630	CP3630G	34.20 x 28.20 869 x 716	34.50 x 28.50 876 x 724	2	Quarter-turn	5.00 127
CSD363610	36.00 x 36.00 x 10.00 914 x 914 x 254	ANSI 61 Gray	14	14	CP3636	CP3636G	34.20 x 34.20 869 x 869	34.50 x 34.50 876 x 876	2	Quarter-turn	5.00 127
CSD363610LG	36.00 x 36.00 x 10.00 914 x 914 x 254	RAL 7035 Lt. Gray	14	14	CP3636	CP3636G	34.20 x 34.20 869 x 869	34.50 x 34.50 876 x 876	2	Quarter-turn	5.00 127
CSD423610	42.00 x 36.00 x 10.00 1067 x 914 x 254	ANSI 61 Gray	14	14	CP4236	CP4236G	40.20 x 34.20 1021 x 869	40.50 x 34.50 1029 x 876	1	3-point	21.00 533
CSD423610LG	42.00 x 36.00 x 10.00 1067 x 914 x 254	RAL 7035 Lt. Gray	14	14	CP4236	CP4236G	40.20 x 34.20 1021 x 869	40.50 x 34.50 1029 x 876	1	3-point	21.00 533
CSD482410	48.00 x 24.00 x 10.00 1219 x 610 x 254	ANSI 61 Gray	14	14	CP4824	CP4824G	46.20 x 22.20 1173 x 564	46.50 x 22.50 1181 x 572	1	3-point	24.00 610
CSD482410LG	48.00 x 24.00 x 10.00 1219 x 610 x 254	RAL 7035 Lt. Gray	14	14	CP4824	CP4824G	46.20 x 22.20 1173 x 564	46.50 x 22.50 1181 x 572	1	3-point	24.00 610
CSD483610	48.00 x 36.00 x 10.00 1219 x 914 x 254	ANSI 61 Gray	14	14	CP4836	CP4836G	46.20 x 34.20 1173 x 869	46.50 x 34.50 1181 x 876	1	3-point	24.00 610
CSD483610LG	48.00 x 36.00 x 10.00 1219 x 914 x 254	RAL 7035 Lt. Gray	14	14	CP4836	CP4836G	46.20 x 34.20 1173 x 869	46.50 x 34.50 1181 x 876	1	3-point	24.00 610
CSD603610	60.00 x 36.00 x 10.00 1524 x 914 x 254	ANSI 61 Gray	14	14	CP6036	CP6036G	58.20 x 34.20 1478 x 869	58.50 x 34.50 1486 x 876	1	3-point	30.00 762
CSD603610LG	60.00 x 36.00 x 10.00 1524 x 914 x 254	RAL 7035 Lt. Gray	14	14	CP6036	CP6036G	58.20 x 34.20 1478 x 869	58.50 x 34.50 1486 x 876	1	3-point	30.00 762
CSD202012	20.00 x 20.00 x 12.00 508 x 508 x 305	ANSI 61 Gray	16	16	CP2020	CP2020G	18.20 x 18.20 462 x 462	18.50 x 18.50 470 x 470	1	Quarter-turn	10.00 254
CSD202012LG	20.00 x 20.00 x 12.00 508 x 508 x 305	RAL 7035 Lt. Gray	16	16	CP2020	CP2020G	18.20 x 18.20 462 x 462	18.50 x 18.50 470 x 470	1	Quarter-turn	10.00 254
CSD242012	24.00 x 20.00 x 12.00 610 x 508 x 305	ANSI 61 Gray	16	16	CP2420	CP2420G	22.20 x 18.20 564 x 462	22.50 x 18.50 572 x 470	1	Quarter-turn	12.00 305
CSD242012LG	24.00 x 20.00 x 12.00 610 x 508 x 305	RAL 7035 Lt. Gray	16	16	CP2420	CP2420G	22.20 x 18.20 564 x 462	22.50 x 18.50 572 x 470	1	Quarter-turn	12.00 305
CSD242412	24.00 x 24.00 x 12.00 610 x 610 x 305	ANSI 61 Gray	14	16	CP2424	CP2424G	22.20 x 22.20 564 x 564	22.50 x 22.50 572 x 572	2	Quarter-turn	5.00 127
CSD242412LG	24.00 x 24.00 x 12.00 610 x 610 x 305	RAL 7035 Lt. Gray	14	16	CP2424	CP2424G	22.20 x 22.20 564 x 564	22.50 x 22.50 572 x 572	2	Quarter-turn	5.00 127
CSD302412	30.00 x 24.00 x 12.00 762 x 610 x 305	ANSI 61 Gray	14	16	CP3024	CP3024G	28.20 x 22.20 716 x 564	28.50 x 22.50 724 x 572	2	Quarter-turn	5.00 127
CSD302412LG	30.00 x 24.00 x 12.00 762 x 610 x 305	RAL 7035 Lt. Gray	14	16	CP3024	CP3024G	28.20 x 22.20 716 x 564	28.50 x 22.50 724 x 572	2	Quarter-turn	5.00 127
CSD303012	30.00 x 30.00 x 12.00 762 x 762 x 305	ANSI 61 Gray	14	14	CP3030	CP3030G	28.20 x 28.20 716 x 716	28.50 x 28.50 724 x 724	2	Quarter-turn	5.00 127
CSD303012LG	30.00 x 30.00 x 12.00 762 x 762 x 305	RAL 7035 Lt. Gray	14	14	CP3030	CP3030G	28.20 x 28.20 716 x 716	28.50 x 28.50 724 x 724	2	Quarter-turn	5.00 127
CSD362412	36.00 x 24.00 x 12.00 914 x 610 x 305	ANSI 61 Gray	14	16	CP3624	CP3624G	34.20 x 22.20 869 x 564	34.50 x 22.50 876 x 572	2	Quarter-turn	5.00 127
CSD362412LG	36.00 x 24.00 x 12.00 914 x 610 x 305	RAL 7035 Lt. Gray	14	16	CP3624	CP3624G	34.20 x 22.20 869 x 564	34.50 x 22.50 876 x 572	2	Quarter-turn	5.00 127
CSD363012	36.00 x 30.00 x 12.00 914 x 762 x 305	ANSI 61 Gray	14	14	CP3630	CP3630G	34.20 x 28.20 869 x 716	34.50 x 28.50 876 x 724	2	Quarter-turn	5.00 127
CSD363012LG	36.00 x 30.00 x 12.00 914 x 762 x 305	RAL 7035 Lt. Gray	14	14	CP3630	CP3630G	34.20 x 28.20 869 x 716	34.50 x 28.50 876 x 724	2	Quarter-turn	5.00 127
CSD363612	36.00 x 36.00 x 12.00 914 x 914 x 305	ANSI 61 Gray	14	14	CP3636	CP3636G	34.20 x 34.20 869 x 869	34.50 x 34.50 876 x 876	2	Quarter-turn	5.00 127
CSD363612LG	36.00 x 36.00 x 12.00 914 x 914 x 305	RAL 7035 Lt. Gray	14	14	CP3636	CP3636G	34.20 x 34.20 869 x 869	34.50 x 34.50 876 x 876	2	Quarter-turn	5.00 127
CSD423612	42.00 x 36.00 x 12.00 1067 x 914 x 305	ANSI 61 Gray	14	14	CP4236	CP4236G	40.20 x 34.20 1021 x 869	40.50 x 34.50 1029 x 876	1	3-point	21.00 533
CSD423612LG	42.00 x 36.00 x 12.00 1067 x 914 x 305	RAL 7035 Lt. Gray	14	14	CP4236	CP4236G	40.20 x 34.20 1021 x 869	40.50 x 34.50 1029 x 876	1	3-point	21.00 533
CSD482412	48.00 x 24.00 x 12.00 1219 x 610 x 305	ANSI 61 Gray	14	14	CP4824	CP4824G	46.20 x 22.20 1173 x 564	46.50 x 22.50 1181 x 572	1	3-point	24.00 610
CSD482412LG	48.00 x 24.00 x 12.00 1219 x 610 x 305	RAL 7035 Lt. Gray	14	14	CP4824	CP4824G	46.20 x 22.20 1173 x 564	46.50 x 22.50 1181 x 572	1	3-point	24.00 610
CSD483612	48.00 x 36.00 x 12.00 1219 x 914 x 305	ANSI 61 Gray	14	14	CP4836	CP4836G	46.20 x 34.20 1173 x 869	46.50 x 34.50 1181 x 876	1	3-point	24.00 610
CSD483612LG	48.00 x 36.00 x 12.00 1219 x 914 x 305	RAL 7035 Lt. Gray	14	14	CP4836	CP4836G	46.20 x 34.20 1173 x 869	46.50 x 34.50 1181 x 876	1	3-point	24.00 610
CSD603612	60.00 x 36.00 x 12.00 1524 x 914 x 305	ANSI 61 Gray	14	14	CP6036	CP6036G	58.20 x 34.20 1478 x 869	58.50 x 34.50 1486 x 876	1	3-point	30.00 762



# Productivity3000 Overview

## Bases

Four bases are available, with 3, 5, 8, and 11 slots.



Productivity3000 Bases		
Part Number	Description	Price
<b>P3-03B</b>	3-slot base	<--->
<b>P3-05B</b>	5-slot base	<--->
<b>P3-08B</b>	8-slot base	<--->
<b>P3-11B</b>	11-slot base	<--->

## Power Supplies

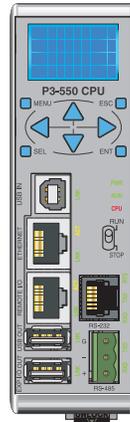
Two power supplies are available; one accepts AC input and one accepts DC input.



Productivity3000 Power Supplies		
Part Number	Description	Price
<b>P3-01AC</b>	Power supply (powered from AC source)	<--->
<b>P3-01DC</b>	Power supply (powered from DC source)	<--->

## CPU Module

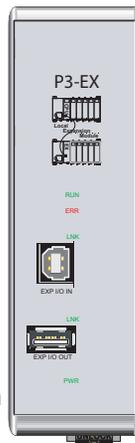
One CPU module is currently available.



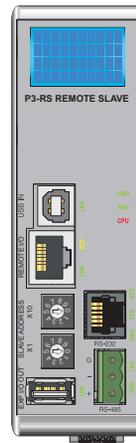
Productivity3000 CPU Module		
Part Number	Description	Price
<b>P3-550</b>	CPU module	<--->

## Expansion and Remote Slave Modules

One local expansion module and one remote slave module are available.



**P3-EX**  
Expansion  
Module



**P3-RS**  
Remote  
Slave Module

Productivity3000 Expansion, Remote Slave Modules		
Part Number	Description	Price
<b>P3-EX</b>	Expansion module	<--->
<b>P3-RS</b>	Remote slave module	<--->

# Productivity3000 Overview

## Discrete I/O Modules

Seven discrete input and fourteen discrete output modules are available.



Discrete Input Modules		
Part Number	Description	Price
<b>P3-16SIM</b>	Input Simulator	<-->
<b>P3-08ND3S</b>	Isolated Sinking/Sourcing Input	<-->
<b>P3-16ND3</b>	Sinking/Sourcing DC Input	<-->
<b>P3-32ND3</b>	Sinking/Sourcing Input	<-->
<b>P3-64ND3</b>	Sinking/Sourcing Input	<-->
<b>P3-08NAS</b>	Isolated AC Input	<-->
<b>P3-16NA</b>	AC input	<-->

Discrete Output Modules		
Part Number	Description	Price
<b>P3-08TD1S</b>	Isolated Sinking Output	<-->
<b>P3-08TD2S</b>	Isolated Sourcing Output	<-->
<b>P3-16TD1</b>	Sinking Output	<-->
<b>P3-16TD2</b>	Sourcing Output	<-->
<b>P3-32TD1</b>	Sinking Output	<-->
<b>P3-32TD2</b>	Sourcing Output	<-->
<b>P3-64TD1</b>	Sinking Output	<-->
<b>P3-64TD2</b>	Sourcing Output	<-->
<b>P3-08TAS</b>	Isolated AC Out	<-->
<b>P3-16TA</b>	AC Output	<-->
<b>P3-08TRS</b>	Isolated Relay Output	<-->
<b>P3-08TRS-1</b>	Isolated Relay Output	<-->
<b>P3-16TR</b>	Relay Output	<-->
<b>P3-16TD3P</b>	Sinking/Sourcing Protected Output	<-->

## Analog I/O Modules

Six analog input, seven analog output, and two analog input/output modules are available.



Analog Input Modules		
Part Number	Description	Price
<b>P3-04ADS</b>	Isolated Analog Input	<-->
<b>P3-08AD</b>	Analog Input	<-->
<b>P3-16AD-1</b>	Analog Current Input	<-->
<b>P3-16AD-2</b>	Analog Voltage Input	<-->
<b>P3-08RTD</b>	Analog RTD Input	<-->
<b>P3-08THM</b>	Analog Thermocouple	<-->

Analog Output Modules		
Part Number	Description	Price
<b>P3-04DA</b>	Analog Output	<-->
<b>P3-08DA-1</b>	Analog Current Output	<-->
<b>P3-08DA-2</b>	Analog Voltage Output	<-->
<b>P3-06DAS-1</b>	Isolated Analog Current Output	<-->
<b>P3-06DAS-2</b>	Isolated Analog Voltage Output	<-->
<b>P3-16DA-1</b>	Analog Current Output	<-->
<b>P3-16DA-2</b>	Analog Voltage Output	<-->

Analog Input/Output Modules		
Part Number	Description	Price
<b>P3-8AD4DA-1</b>	Analog Input/Output	<-->
<b>P3-8AD4DA-2</b>	Analog Input/Output	<-->

## Specialty Modules

The two specialty modules available are the high-speed input and high-speed output modules.



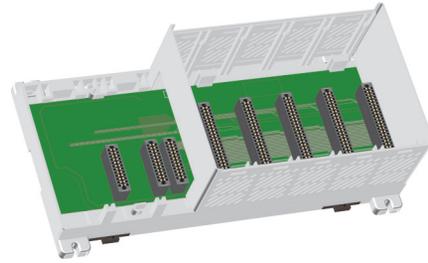
Specialty Modules		
Part Number	Description	Price
<b>P3-HSI</b>	High-Speed Input	<-->
<b>P3-HSO</b>	High-Speed Output	<-->

# Productivity3000 Overview

## What you'll need:

Of course, what you'll need for your system depends on your particular application, but this overview shows you what you'll need for a simple system.

### 1. Select your base.



### 2. Select a 24 VDC or 120 VAC power supply.



### 3. Order a P3-550 CPU module.

### 4. Order and install the Productivity Suite programming software in your PC.



### 5. Select and order your I/O modules.

At the same time, select and order your ZIPLink wiring system or removable terminal blocks.



### 6. Select your PC-to-PAC programming cable.

You will need a standard USB or Ethernet cable for programming, depending on whether you use the USB or Ethernet programming port on the P3-550 CPU.



### 7. Select tools, wire, and provide power.

Screwdriver  
DN-SS1



Wire Strippers  
DN-WS



Hookup Wire



# Programming Software

**P3-PGMSW FREE**  
(\$495 value)

Productivity Suite is user-friendly programming software designed to allow quick and easy programming of ladder logic programs for the Productivity3000 PAC.

The online help file provides information that will help you get acquainted with the software quickly.



## PC Requirements

Productivity Suite programming software works with Windows® 2000 Service Pack 4, XP (Home or Professional), Vista (Home, Basic, Premium, 32 or 64-bit) or Windows 7 (Home, Professional, Ultimate, 32 or 64-bit). These are the minimum system requirements:

- Windows 2000 or XP Personal Computer with a 333 MHz or higher processor (CPU) clock speed recommended; Intel Pentium/Celeron family or AMD K6/Athlon/Duron family, or compatible processor recommended
- Vista or Windows 7 Personal Computer with a 800 MHz or higher processor (CPU) clock speed recommended; Intel Pentium/Celeron family or AMD K6/Athlon/Duron family, or compatible processor recommended
- SVGA 800x600 pixels resolution (1024x768 pixels resolution recommended)
- 300MB free hard-disk space
- Windows2000 or XP; 128MB free RAM (512MB recommended)
- Vista or Windows 7; 512MB free RAM (1GB recommended).
- CD-ROM or DVD drive for installing software from the CD
- USB or Ethernet port for project transfer to PAC



## Main window

The Main Window is displayed when the program opens. It is divided into Menus, Toolbars, and Windows that work together to make project development as simple as possible.

## Programming Cable

You will need a standard USB or Ethernet cable for programming, depending on whether you use the USB or Ethernet programming port on the P3-550 CPU.

We recommend using a USB programming cable; just plug it in and it works. We sell these A-to-B USB cables:

- USB-CBL-AB3 (3 ft.)
- USB-CBL-AB6 (6 ft.)
- USB-CBL-AB10 (10 ft.)
- USB-CBL-AB15 (15 ft.)

**Application Tool Panel**

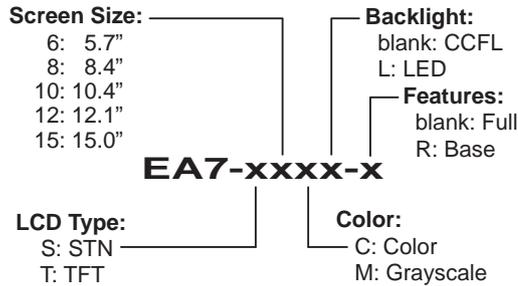
**Task Management Panel**

**Ladder Editor Window**

**Instruction Panel Window**

# C-more Operator Panels Overview

## Touch Panel Part Number Key:



## Getting started

Installing the software and configuring the **C-more** panel is simple. You will need the following to successfully connect and configure a project for the panel:

- **C-more** touch panel - 6", 8", 10", 12" or 15" model
- **C-more** Programming Software, p/n EA-PGMSW
- **C-more** programming cable, USB or Ethernet
- 24 VDC switching power supply (min. 1.5A, switching) or the optional **C-more** AC Power Adapter
- Personal Computer - to run **C-more** programming software
- PLC communications cable (serial or Ethernet) to connect the **C-more** Touch Panel to your controller

Part Number	Description	Price
<b>EA7-S6M-R</b>	6-inch <b>C-more</b> grayscale STN touch panel (5.7 inch viewable screen), 15 shades of gray, 320 x 240 pixel QVGA screen resolution, 333 MHz CPU, 24 VDC (20.4-28.8 VDC operating range), NEMA 4/4X, IP65 (when mounted correctly; for indoor use only), non-replaceable backlight, 50,000 hour half-life. *Base Model: Built-in USB, no Ethernet or Compact Flash support.	<--->
<b>EA7-T6CL-R</b>	6-inch <b>C-more</b> color TFT touch panel (5.7 inch viewable screen), 64K colors, 320 x 240 pixel QVGA screen resolution, 333 MHz CPU, 24 VDC (20.4-28.8 VDC operating range), NEMA 4/4X, IP65 (when mounted correctly; for indoor use only), non-replaceable LED backlight, 50,000 hour half-life. Built-in USB, no Ethernet or Compact Flash support.	<--->
<b>EA7-S6M</b>	6-inch <b>C-more</b> grayscale STN touch panel (5.7 inch viewable screen), 15 shades of gray, 320 x 240 pixel QVGA screen resolution, 333 MHz CPU, 24 VDC (20.4-28.8 VDC operating range), NEMA 4/4X, IP65 (when mounted correctly; for indoor use only), non-replaceable backlight, 50,000 hour half-life. Built-in Ethernet and USB; supports Compact Flash.	<--->
<b>EA7-T6CL</b>	6-inch <b>C-more</b> color TFT touch panel (5.7 inch viewable screen), 64K colors, 320 x 240 pixel QVGA screen resolution, 333 MHz CPU, 24 VDC (20.4-28.8 VDC operating range), NEMA 4/4X, IP65 (when mounted correctly; for indoor use only), non-replaceable LED backlight, 50,000 hour half-life. Built-in Ethernet and USB; supports Compact Flash.	<--->
<b>EA7-T8C</b>	8-inch <b>C-more</b> color TFT touch panel (8.4 inch viewable screen), 64K colors, 640 x 480 pixel VGA screen resolution, 400 MHz CPU, 24 VDC (20.4-28.8 VDC operating range), NEMA 4/4X, IP65 (when mounted correctly; for indoor use only), user replaceable backlight, 50,000 hour half-life. Built-in Ethernet and USB; supports Compact Flash.	<--->
<b>EA7-T10C</b>	10-inch <b>C-more</b> color TFT touch panel (10.4 inch viewable screen), 64K colors, 640 x 480 pixel VGA screen resolution, 400 MHz CPU, 24 VDC (20.4-28.8 VDC operating range), NEMA 4/4X, IP65 (when mounted correctly; for indoor use only), user replaceable backlight, 50,000 hour half-life. Built-in Ethernet and USB; supports CompactFlash.	<--->
<b>EA7-T12C</b>	12-inch <b>C-more</b> color TFT touch panel (12.1 inch viewable screen), 64K colors, 800 x 600 pixel SVGA screen resolution, 400 MHz CPU, 24 VDC (20.4-28.8 VDC operating range), NEMA 4/4X, IP65 (when mounted correctly; for indoor use only), user replaceable backlight, 50,000 hour half-life. Built-in Ethernet and USB; supports CompactFlash.	<--->
<b>EA7-T15C</b>	15-inch <b>C-more</b> color TFT touch panel (15.0 inch viewable screen), 64K colors, 1024 x 768 XGA screen resolution, 400 MHz CPU, 24 VDC (20.4-28.8 VDC operating range), NEMA 4/4X, IP65 (when mounted correctly; for indoor use only), user replaceable backlight, 50,000 hour half-life. Built-in Ethernet and USB; supports CompactFlash.	<--->
<b>EA-PGMSW</b>	<b>C-more</b> touch panel Windows-based configuration software. Requires Windows 2000 (Service Pack 4), XP Home or Professional (Service Pack 2) or Vista. Includes software installation guide and CD-ROM. Requires USB 1.1 or Ethernet connection to touch panel. Cables sold separately.	<--->
<b>USB-CBL-AB3</b>	Standard 3-ft. (0.9m) USB 2.0 cable, A-type connector to B-type connector, used to connect personal computer to any <b>C-more</b> touch panel for setup and programming. (Note: Touch panels require a 24 VDC power source for configuration and operation.)	<--->
<b>USB-CBL-AB6</b>	Standard 6-ft. (1.8m) USB 2.0 cable, A-type connector to B-type connector, used to connect personal computer to any <b>C-more</b> touch panel for setup and programming. (Note: Touch panels require a 24 VDC power source for configuration and operation.)	<--->
<b>USB-CBL-AB10</b>	Standard 10-ft (3 meter) USB 2.0 cable, A-type connector to B-type connector, used to connect personal computer to any <b>C-more</b> touch panel for setup and programming. (Note: Touch panels require a 24 VDC power source for configuration and operation.)	<--->
<b>USB-CBL-AB15</b>	Standard 15-ft. (4.6m) USB 2.0 cable, A-type connector to B-type connector, used to connect personal computer to any <b>C-more</b> touch panel for setup and programming. (Note: Touch panels require a 24 VDC power source for configuration and operation.)	<--->

# C-more Selection Guide & Specifications

Model	8" TFT color w/ full features	10" TFT color w/ full features	12" TFT color w/ full features	15" TFT color w/ full features
<b>Specification</b>				
<b>Part Number</b>	<b>EA7-T8C</b>	<b>EA7-T10C</b>	<b>EA7-T12C</b>	<b>EA7-T15C</b>
				
<b>Price</b>	<--->	<--->	<--->	<--->
<b>Display Actual Size and Type</b>	8.4" TFT color	10.4" TFT color	12.1" TFT color	15.0" TFT color
<b>Color Scale</b>	65,536 colors			
<b>Display Viewing Area</b>	6.73" x 5.05" [170.9 mm x 128.2 mm]	8.31" x 6.24" [211.2 mm x 158.4 mm]	9.47" x 7.62" [240.6 mm x 184.5 mm]	11.97" x 8.98" [304.1 mm x 228.1 mm]
<b>Screen Pixels</b>	640 x 480 (VGA)		800 x 600 (SVGA)	1024 x 768 (XGA)
<b>Display Brightness</b>	300 cd/m <sup>2</sup> (NITS)	270 cd/m <sup>2</sup> (NITS)	260 cd/m <sup>2</sup> (NITS)	220 cd/m <sup>2</sup> (NITS)
<b>LCD Panel Dot Pitch</b>	0.267 mm x 0.267 mm	0.33 mm x 0.33 mm	0.267 mm x 0.267 mm	0.297 mm x 0.297 mm
<b>Backlight Average Lifetime*</b>	Approximately 50,000 hours			
<b>Backlight User Replaceable</b>	Yes – Correct replacement bulb is dependent on the panel serial no, see C-more Replacement Parts section for complete details			
<b>Touch Panel Type</b>	Analog Resistive (10-bit resolution, 1024 x 1024 touch area)		Analog Resistive (12-bit resolution, 4096 x 4096 touch area)	
<b>CPU Type</b>	32-Bit RISC CPU (400 MHz)		32-Bit RISC CPU (400 MHz) Plus Graphic Accelerator Chip	
<b>Battery</b>	Replaceable battery – ADC Part # D2-BAT-1 (Manufacturer Part # CR2354)			
<b>System Memory</b>	SDRAM 32 MBytes		SDRAM 64 MBytes	
<b>System Flash Memory</b>	FLASH 32 MBytes		FLASH 64 MBytes	
<b>Backup Memory (SRAM)</b>	Control data backup memory (SRAM) 256 KBytes			
<b>Logging Data Memory</b>	CompactFlash Memory Card p/n EA-CF-CARD, industrial grade, high speed (Optional) or USB Pen Drive p/n SDCZ4-2048-A10 (Optional)			
<b>Number of Screens</b>	Up to 999 – limited by available project memory (10 MBytes)		Up to 999 – limited by available project memory (40 MBytes)	
<b>Realtime Clock</b>	Built into panel (PLC clock is still accessible if available)			
<b>Calendar – Month/Day/Year</b>	Yes - battery backup			
<b>Screen Saver</b>	Yes, backlight turns off after a 30–1500 minute adjustable time, or can be disabled			
<b>Serial PLC Interface</b>	Serial PLC Port: RS-232C/422/485 15-Pin D-sub (female)			
<b>USB Port – Type B</b>	Download/Program – USB Port – type B (ver. 1.2)			
<b>USB Port – Type A</b>	Port for USB device options – type A (ver. 1.2)			
<b>Ethernet Port</b>	Ethernet 10/100 Base-T			
<b>Audio Line Out</b>	Audio Line Out, 1 Volt rms, stereo – requires amplifier and speaker(s)			
<b>CF Card – Slot #1</b>	Optional: CompactFlash Memory Card p/n EA-CF-CARD, industrial grade, high speed, CF slot #1 located on top side of touch panel.			
<b>Expansion Assembly (p/n EA-EXP-OPT)</b>	Optional: Use the CF Card Interface Module p/n EA-CF-IF in the right slot of the Expansion Assembly for installing CF card - Slot #2. The left slot of the Expansion Assembly is for future options.			
<b>Supply Power</b>	24 VDC, -15%, +20% (20.4–28.8 VDC operating range) (Use an AC Power Adapter, p/n EA-AC, to power the touch panel from a 100–240 VAC, 50/60 Hz. power source.)			
<b>Power Consumption</b>	15 W @ 24 VDC	17 W @ 24 VDC	20 W @ 24 VDC	33 W @ 24 VDC
<b>Recommended Input Fuse</b>	3.0 A DC slow blow			
<b>Operating Temperature</b>	0 to 50°C (32 to 122°F) Max surrounding air temperature rating: 50°C			
<b>Storage Temperature</b>	–20 to +60°C (–4 to +140°F)			
<b>Humidity</b>	10–85% RH, non-condensing			
<b>Noise Immunity</b>	Noise voltage: 1000 Vp-p, Pulse width: 1 µs, Rise time: 1 ns			
<b>Withstand Voltage</b>	1000 VDC for 1 minute, between DC power supply input terminal and safety ground			
<b>Insulation Resistance</b>	Over 20 MΩ between DC power supply input terminal and safety ground			
<b>Vibration</b>	IEC61131-2 compliant, 10–57 Hz: 0.075 mm amplitude, 57–150 Hz 1.0 G: 10 sweep cycles per axis on each of 3 mutually perpendicular axes			
<b>Shock</b>	15 G peak, 11 ms duration, 2 shocks per axis, on 3 mutually perpendicular axes			
<b>Enclosure</b>	IP65 Meets UL Type 4X when mounted correctly. For indoor use only.			
<b>Environment</b>	For use in Pollution Degree 2 Environment			
<b>Agency Approvals</b>	UL, cUL, CE, CSA; UL file 157382, CSA file 234884			
<b>Dimensions</b>	8.748" x 10.894" x 2.053" [222.2 mm x 276.7 mm x 52.1 mm]	10.669" x 13.661" x 2.079" [271.0 mm x 347.0 mm x 52.8 mm]	11.024" x 13.366" x 2.075" [280.0 mm x 339.5 mm x 52.7 mm]	13.000" x 16.748" x 2.048" [330.2 mm x 425.4 mm x 52.0 mm]
<b>Weight</b>	2.60 lb. [1,180g]	3.55 lb. [1,610g]	4.59 lb. [2,080g]	7.01 lb. [3,180g]
* NOTE: The backlight average lifetime is defined as the average usage time it takes before the brightness becomes 50% of the initial brightness. The lifetime of the backlight depends on the ambient temperature. The lifetime will decrease under low or high temperature usage.				

# C-more 8" TFT Color Touch Panel - Full Model

Part No. EA7-T8C

8-inch **C-more** color TFT touch panel (8.4 inch viewable screen), 64K colors, 640 x 480 pixel VGA screen resolution, 400 MHz CPU, 24 VDC (20.4-28.8 VDC operating range), NEMA 4/4X, IP-65 (when mounted correctly; for indoor use only), user replaceable backlight, 50,000 hour half-life. Built-in Ethernet and USB; supports Compact Flash.

## Features

- 8.4" diagonal color TFT (Thin Film Transfer) LCD display with 64K colors
- 640 x 480 pixel resolution
- 300 NITS display brightness
- 50,000 hour average backlight lifetime, user replaceable
- Analog resistive (1024 X 1024) touch screen allowing unlimited touch areas
- USB port B (program/download) and USB port A (USB device options)
- Ethernet 10/100 Base-T port (program/download & PLC comm)
- Remote Internet Access
- Serial PLC interface (RS-232/422/485)
- CompactFlash card slot, built-in
- Expansion assembly (optional) for CompactFlash devices (use with optional CF Card Interface Module)
- 24 VDC powered, 110 VAC power adapter (optional)
- Audio Line Out, stereo - requires amplifier and speaker(s)
- 10 MByte project memory
- Data logging
- 0 to 50°C (32 to 122°F) operating temperature range
- NEMA 4/4X, IP65 compliant when mounted correctly, indoor use only
- Slim design saves panel space
- UL, cUL, CSA & CE agency approvals
- 2-year warranty from date of purchase

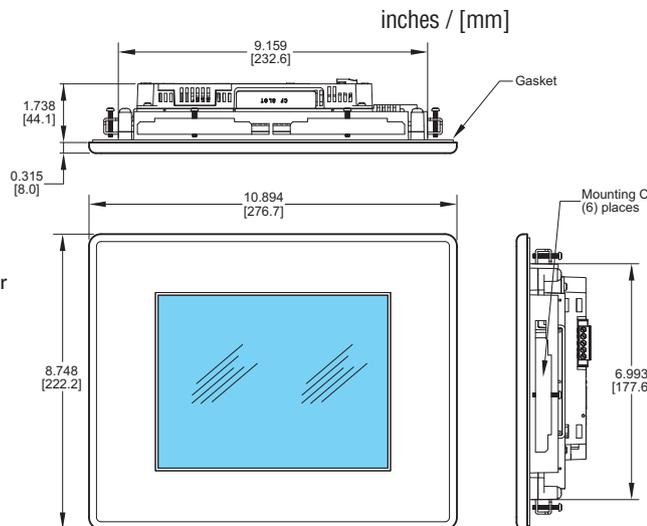
Function	Available	Associated Features
Ethernet	Yes	FTP - Email - Web Server
USB	Yes	Data Logging
Compact Flash	Yes	Data Logging/Project
Expansion Assembly	Yes	CF Module & future modules
Audio Out	Yes	Speaker/Amplifier Connection
Ethernet	Yes	Remote access over Internet



<--->

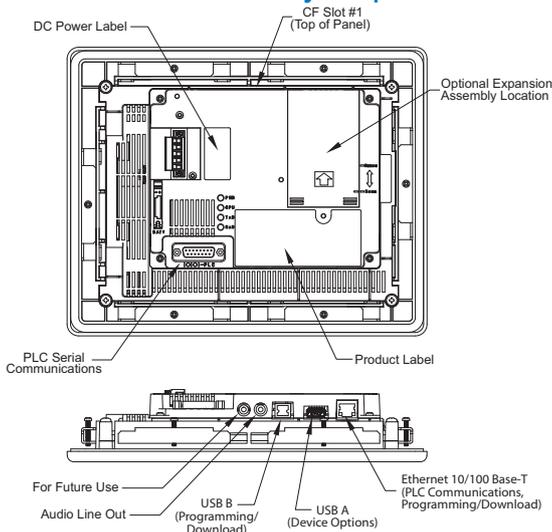


## Dimensions

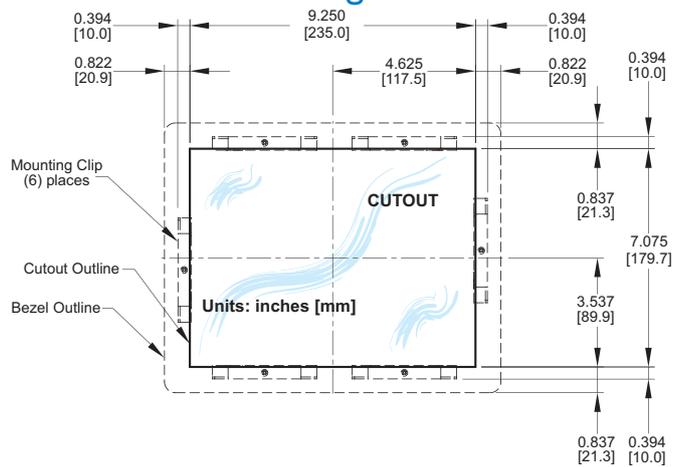


PLC Drivers	
Serial	Avail.
Productivity3000	Yes
AutomationDirect CLICK	Yes
Direct LOGIC K-sequence	Yes
Direct NET	Yes
Modbus (Koyo Addressing)	Yes
Allen-Bradley DF1 Full & Half Duplex	Yes
Allen-Bradley PLC5 DF1	Yes
Allen-Bradley DH-485	Yes
Allen-Bradley DF1 Full & Half Duplex - Tag Based (ControlLogix™ and CompactLogix™)	Yes
Modbus RTU	Yes
Entivity Modbus RTU	Yes
GE SNXP (90/30, 90/70), Micro 90, VersaMax Micro	Yes
Omron Host Link C200 Adapter CS00	Yes
Omron FINS (CJ1, CS1)	Yes
Mitsubishi FX	Yes
Mitsubishi Q02, Q02H, Q06H, Q12H, Q25H	Yes
Mitsubishi Q, QnA Serial	Yes
Siemens PPI (S7-200 CPU)	Yes
Ethernet	
Productivity3000	Yes
Direct LOGIC Ethernet	Yes
Modbus TCP/IP	Yes
Entivity Modbus TCP/IP	Yes
Allen-Bradley EtherNet/IP™ Server - Generic I/O Messaging*	Yes
Allen-Bradley EtherNet/IP Client - Tag Based (ControlLogix™ and CompactLogix™)	Yes
Allen-Bradley EtherNet/IP Client - MicroLogix 1100 & SLC 5/05 via native Ethernet port; MicroLogix 1000, 1100, 1200, 1400, 1500 & SLC 5-03, 04, 05 via AB ENI Adapter	Yes
Omron FINS	Yes
Mitsubishi Q, QnA Ethernet	Yes
Siemens (S7-200 CPU, S7-300 CPU)	Yes

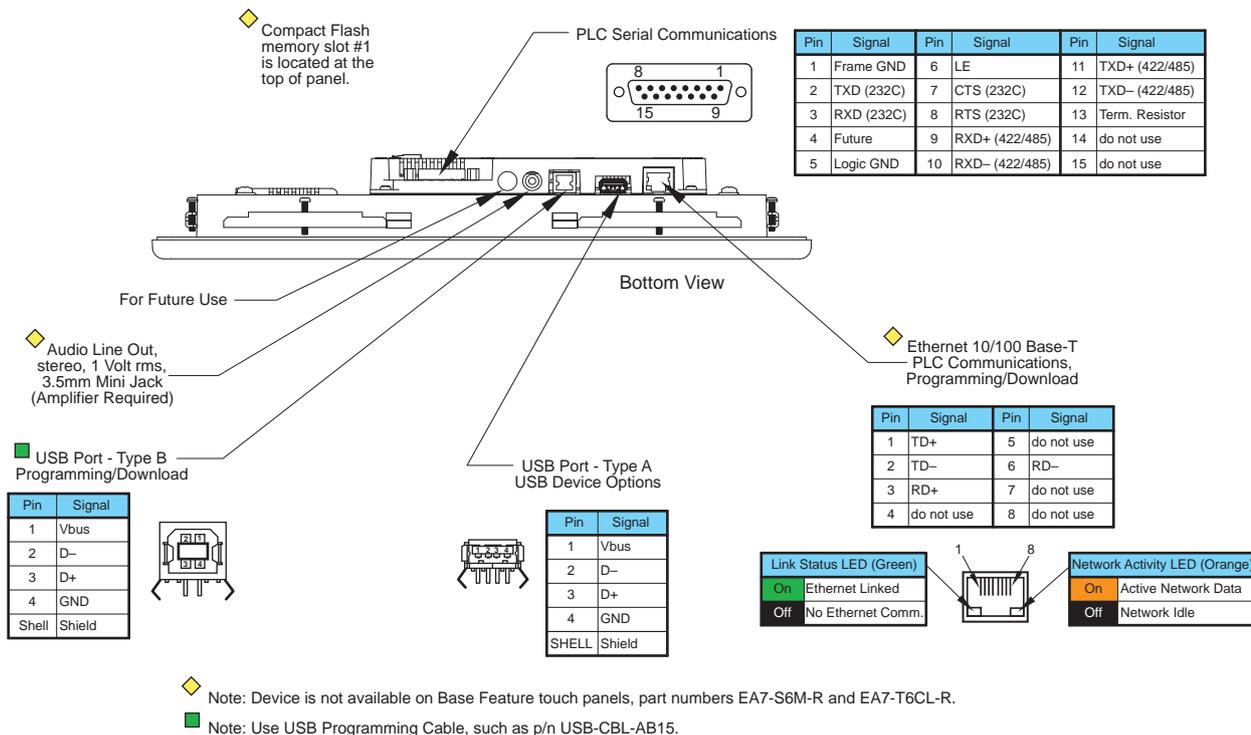
## Ports & Memory Expansion



## Mounting Cutout



# C-more Communication Ports



## Ethernet Port

The Ethernet port has several uses:

- Download program to panel
- Communicate to PLCs/PCs
- Send e-mail
- Access FTP server
- Act as a Web server
- Remote Internet Access

The Ethernet port has an RJ-45 8-wire modular connector with green and orange LEDs.

- The orange LED indicates the Ethernet communication status. It illuminates when there is data activity on the network.
- The green LED indicates link status and illuminates when a link is established.

Ethernet connections:

- Productivity3000
- **Direct**LOGIC Ethernet
- Modbus TCP/IP
- Allen-Bradley EtherNet/IP™ Server - Generic I/O Messaging (ControlLogix™, CompactLogix™, and FlexLogix™)
- Allen-Bradley EtherNet/IP Client - Tag Based (ControlLogix, CompactLogix, and FlexLogix™)
- Allen-Bradley EtherNet/IP Client - MicroLogix 1100 & SLC 5/05, both via native Ethernet port
- Allen-Bradley MicroLogix 1000, 1100, 1200, 1500, SLC 5-03/04/05, all via ENI Adapter
- Entivity Modbus TCP/IP
- Omron Ethernet FINS
- Siemens Ethernet ISO over TCP

Note: The base panels (-R part numbers) do not include an Ethernet port, and do not have these capabilities.

## USB Port B

Program **C-more** via the USB programming port. It's fast and easy, with no baud rate settings, parity, or stop bits to worry about. We stock standard USB cables for your convenience. USB Port B can be used to upload or download projects to and from a PC.

## USB Port A

The Universal Serial Bus (USB) Port A is a standard feature for all models and can be used to connect various USB HID (Human Input Device) devices to the panel, such as:

- USB pen drives, (SDCZ4-2048-A10)
- USB keyboards
- USB barcode scanners
- USB card scanners

**C-more** can log data to the USB pen drive as well as load projects to the panel from the pen drive. You can also back up project files and panel firmware.

## Sound Interface (Audio Line Out)

When attached to an amplifier and speaker(s), **C-more** can play warning sounds or pre-recorded messages such as: "conveyor is jammed". **C-more** supports WAV type files. The output is stereo.

## Serial Port

The serial port is an RS-232, RS-422 or RS-485 female 15-pin D-sub connector. Use this port for serial connections to PLCs. The port supports the following PLC protocols:

All AutomationDirect.com PLCs:  
Productivity3000  
**Direct**LOGIC K-sequence  
**Direct**NET  
Modbus (Koyo Addressing)  
CLICK

Allen Bradley:  
DF1 Full & Half Duplex  
DF1 Full & Half Duplex - Tag Based  
PLC5 DF1  
DH485

Modbus RTU  
Entivity Modbus RTU  
GE SNPX (90/30, 90/70, Micro 90, VersaMax Micro)

Omron:  
Host Link (C200 Adapter, C500)  
FINS (CJ1, CS1)

Mitsubishi:  
Melsec FX  
Q/QnA  
Siemens PPI (S7-200 CPU)

# C-more Communication Protocols & Cables

Compatibility Table			
PLC Family	Model	Protocols	
<b>Allen-Bradley</b>	MicroLogix 1000/1100/1200/1400/1500, SLC 5-01/02/03, PLC5	DH485/AIC/AIC+	
	MicroLogix 1000, 1100, 1200 and 1500 SLC 5-03/04/05	DF1 Half Duplex; DF1 Full Duplex	
	ControlLogix™, CompactLogix™, FlexLogix™ PLC-5	DF1 Full Duplex	
	ControlLogix, CompactLogix, FlexLogix - Tag Based	DF1 Half Duplex; DF1 Full Duplex	
	ControlLogix, CompactLogix, FlexLogix - Generic I/O Messaging	EtherNet/IP Server	
	ControlLogix, CompactLogix, FlexLogix - Tag Based	EtherNet/IP Client	
	MicroLogix 1100 & SLC 5/05, both via native Ethernet port		
	MicroLogix 1000, 1100, 1200, 1400, 1500 & SLC 5-03/04/05, all via ENI Adapter		
<b>Modbus TCP/IP</b>	Modbus TCP/IP devices	Modbus TCP/IP	
<b>GE</b>	90/30, 90/70, Micro 90, VersaMax Micro	SNPX	
<b>Mitsubishi</b>	FX Series	FX Direct	
	Q02, Q02H, Q06H, Q12H, Q25H	Q CPU	
	Q, QnA Serial	QnA Serial	
	Q, QnA Ethernet	QnA Ethernet	
<b>Omron</b>	C200 Adapter, C500	Host Link	
	CJ1/CS1 Serial, CJ1/CS1 Ethernet	FINs	
<b>Modicon</b>	984 CPU, Quantum 113 CPU, AEG Modicon Micro Series 110 CPU: 311-xx, 411-xx, 512-xx, 612-xx	Modbus RTU	
<b>Siemens</b>	S7-200 CPU, RS-485 Serial	PPI	
	S7-200 CPU, S7-300 CPU; Ethernet	Ethernet ISO over TCP	
<b>Productivity3000</b>	Productivity3000 Serial (P3-550)	AutomationDirect P3000 Serial	
	Productivity3000 Ethernet (P3-550)	AutomationDirect P3000 Ethernet	
<b>CLICK</b>	all	AutomationDirect Modbus (CLICK)	
<b>DirectLOGIC</b>	DL05/DL06	all	K-Sequence <b>DirectNET</b> Modbus (Koyo addressing)
		H0-ECOM/H0-ECOM100	<b>DirectLOGIC</b> Ethernet
	DL105	all	K-Sequence
		D2-230	K-Sequence
	DL205	D2-240	K-Sequence <b>DirectNET</b>
		D2-250/D2-250-1/D2-260	K-Sequence <b>DirectNET</b>
			Modbus (Koyo addressing)
		D2-240/D2-250-1/D2-260 Using DCM	<b>DirectNET</b>
			Modbus (Koyo addressing)
		H2-ECOM/H2-ECOM100	<b>DirectLOGIC</b> Ethernet
	DL305	D3-330/330P (Requires the use of a Data Communications Unit)	<b>DirectNET</b>
		D3-340	<b>DirectNET</b>
		D3-350	K-Sequence <b>DirectNET</b>
			Modbus (Koyo addressing)
		D3-350 DCM	<b>DirectNET</b> Modbus (Koyo addressing)
	DL405	D4-430	K-Sequence <b>DirectNET</b>
		D4-440	K-Sequence <b>DirectNET</b>
		D4-450	K-Sequence <b>DirectNET</b>
			Modbus (Koyo addressing)
		All with DCM	<b>DirectNET</b> Modbus (Koyo addressing)
	H4-ECOM/H4-ECOM100	<b>DirectLOGIC</b> Ethernet	
	H2-WinPLC (Think & Do) Live V5.2 or later and Studio any version		Think & Do Modbus RTU (serial port)
	H2-WinPLC (Think & Do) Live V5.5.1 or later and Studio V7.2.1 or later		Think & Do Modbus TCP/IP (Ethernet port)

Cable Description	Cable Part Number	Price
Productivity3000 AutomationDirect CLICK, <b>DirectLOGIC</b> PLC RJ-12 port, DL05, DL06, DL105, DL205, D3-350, D4-450 & H2-WinPLC (RS-232C)	<b>EA-2CBL</b>	<--->
<b>DirectLOGIC</b> (VGA Style) 15-pin port, DL06, D2-250 (250-1), D2-260 (RS-232C)	<b>EA-2CBL-1</b>	<--->
<b>DirectLOGIC</b> PLC RJ-11 port, D3-340 (RS-232C)	<b>EA-3CBL</b>	<--->
<b>DirectLOGIC</b> DL405 PLC 15-pin D-sub port, DL405 (RS-232C)	<b>EA-4CBL-1</b>	<--->
<b>DirectLOGIC</b> PLC 25-pin D-sub port, DL405, D3-350, DL305, DCU and all DCMs (RS-232C)	<b>EA-4CBL-2</b>	<--->
Allen-Bradley MicroLogix 1000, 1100, 1200, 1400 & 1500 (RS-232C)	<b>EA-MLOGIX-CBL</b>	<--->
Allen-Bradley SLC 5-03/04/05 ControlLogix, CompactLogix, FlexLogix, DF1 port (RS-232C)	<b>EA-SLC-232-CBL</b>	<--->
Allen-Bradley PLC-5 DF1 port (RS-232C)	<b>EA-PLC5-232-CBL</b>	<--->
Allen-Bradley SLC 500 DH485 port (RS-485A)	<b>EA-DH485-CBL</b>	<--->
GE 90/30, 90/70, Micro 90, VersaMax Micro 15-pin D-sub port (RS-422A)	<b>EA-90-30-CBL</b>	<--->
mitsubishi FX Series 25-pin port (RS-422A)	<b>EA-MITSU-CBL</b>	<--->
mitsubishi FX Series 8-pin mini-DIN (RS-422A)	<b>EA-MITSU-CBL-1</b>	<--->
OMRON Host Link C200 Adapter, C500 (RS-232C)	<b>EA-OMRON-CBL</b>	<--->

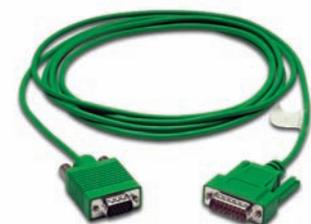


**NOTE: EZTouch serial PLC communication cables are compatible with C-more touch panels.**

**EA-2CBL**



**EA-2CBL-1**



# C-more Computer Programming Connections

Using the **C-more** Programming Software for project development, the touch panel can be connected to a PC (personal computer) in one of several ways:

- Connect a USB Programming Cable such as (USB-CBL-AB15) from a USB port type A on the PC to the USB type B programming port on the C-more touch panel. The USB connection is for direct connection only and does not support USB hubs.
- Connect the **C-more** touch panel to a PC via an Ethernet hub or switch, and CAT5 Ethernet cables (full feature panels only). Multiple panels can be programmed in this configuration.
- Use an Ethernet crossover cable directly between the **C-more** touch panel's Ethernet port and the PC Ethernet port (full feature panels only).

Following are the minimum system requirements for running **C-more** Programming Software (p/n EA-PGMSW) on a PC:

- Personal Computer with a 333 MHz or higher processor (CPU) clock speed recommended; Intel® Pentium/Celeron family, or AMD® K6/Athlon/Duron family, or compatible processor recommended
- Keyboard and Mouse or compatible pointing device
- Super VGA color video adapter and monitor with at least 800 x 600 pixels resolution (1024 x 768 pixels recommended) 64K color minimum
- 300 MB free hard-disk space
- 128 MB free RAM (512 MB recommended); 512 MB free RAM (1 GB recommended) for Vista
- CD-ROM or DVD drive for installing software from the CD
- USB port or Ethernet 10/100 Mbps port for project transfer from software to touch panel (Ethernet port not available on -R models)
- Operating System - Windows® Vista, Windows® XP Home / Professional Edition or Windows® 2000 with Service Pack 4.

## USB Programming Cable



**Part No. USB-CBL-AB15**



Other lengths available see USB-CBL-AB3, USB-CBL-AB6, USB-CBL-AB10 on page 9-27

## Stride™ Ethernet Switch



**Part No. SE-SW5U**



## Ethernet Configuration Kit

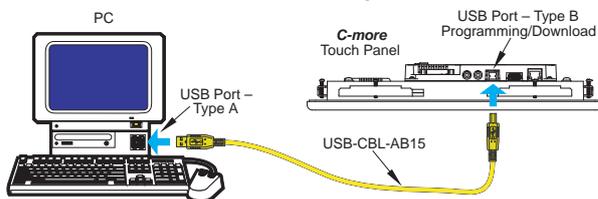


**Part No. RT-CNFGKIT**

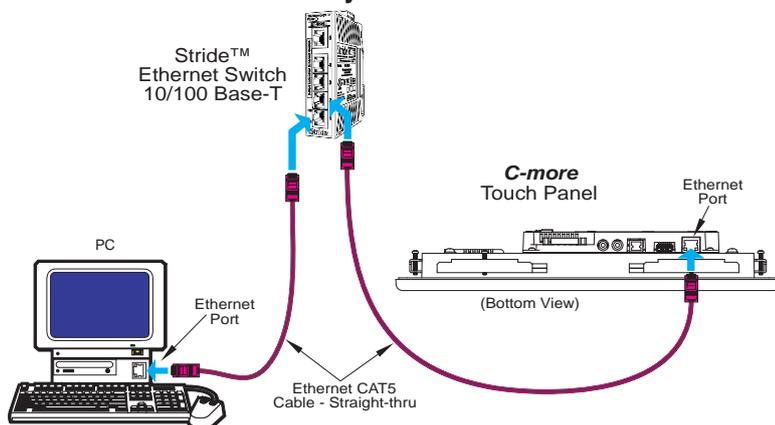


The Ethernet Configuration Kit includes a five-port 10/100 Base-T Ethernet switch, four straight-through cables, and one crossover cable. (The cables are at least five feet in length.) The kit provides a great convenience for configuring systems, demonstration systems or basic control projects using Ethernet.

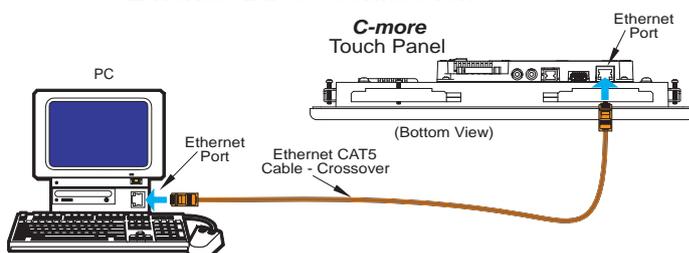
### USB Connectivity



### Ethernet Connectivity via a Hub or Switch



### Ethernet Direct Connection

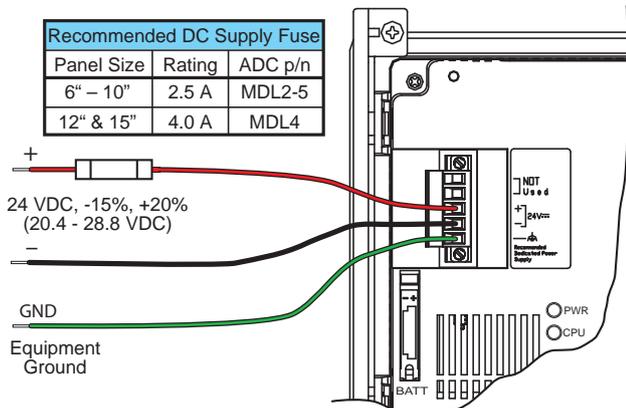


# C-more Power Connection Wiring

## Providing Power to the Touch Panel

- Connect a dedicated 24 VDC switching power supply rated for a minimum of 1.5 Amps to the DC connector on the rear of the **C-more** touch panel. Connect the ground terminal to a proper equipment ground.
- or, install a **C-more** AC Power Adapter (EA-AC) to the rear of the touch panel and connect an AC voltage source of 100-240 VAC, 50/60Hertz, to its AC connector.
- then, turn on the power source and check the LED status indicators on the rear of the **C-more** touch panel for proper operation.

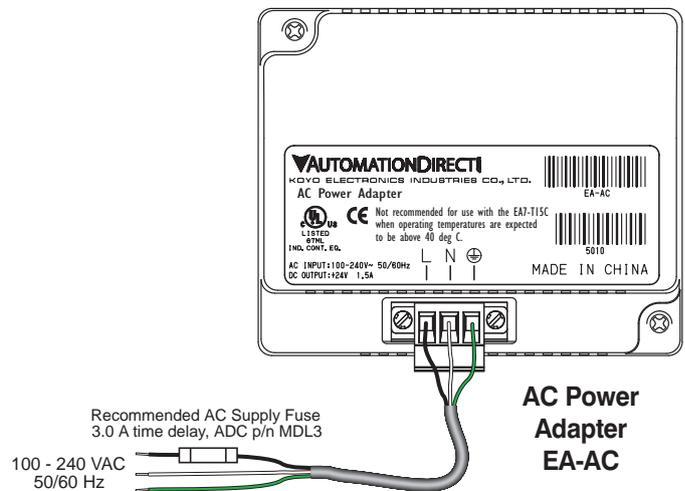
### DC Wiring



**Recommended Power Supply:**  
AutomationDirect Part No. PS24-050D

Tightening Torque	
Power supply cable torque	71 - 85 oz-in (0.5 - 0.6 Nm)
Power connector mounting torque	71 - 85 oz-in (0.5 - 0.6 Nm)
Mounting flange screw torque	57 - 71 oz-in (0.4 - 0.5 Nm)

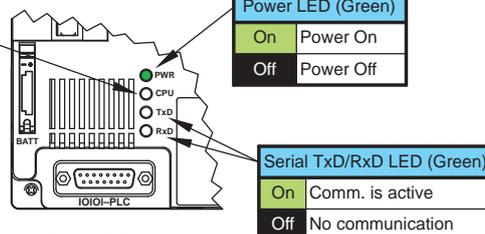
### AC Wiring



**NOTE:** The AC/DC Power Adapter is not recommended for use with the EA7-T15C touch panel when operating temperatures are expected to exceed 40 °C [104 °F].

## C-more LED Status Indicators

CPU Status LED (Green, Orange & Red)	
Off	Power Off
Green	Normal – CPU Run State
Red	Memory Error
Blinking Red	Operating System not found
Blinking Orange	LCD Backlight Failure
Blinking Green	Power Loss Detection



Rear View



**WARNING:** To minimize the risk of potential safety problems, you should follow all applicable local and national codes that regulate the installation and operation of your equipment. These codes vary from area to area and it is your responsibility to determine which codes should be followed, and to verify that the equipment, installation, and operation are in compliance with the latest revision of these codes.

Equipment damage or serious injury to

personnel can result from the failure to follow all applicable codes and standards. We do not guarantee the products described in this publication are suitable for your particular application, nor do we assume any responsibility for your product design, installation, or operation.

If you have any questions concerning the installation or operation of this equipment, or if you need additional information, please call us at 1-800-633-0405 or 770-844-4200.

This publication is based on information that was available at the time it was printed.

At AutomationDirect.com® we constantly strive to improve our products and services, so we reserve the right to make changes to the products and/or publications at any time without notice and without obligation. This publication may also discuss features that may not be available in certain revisions of the product.

# C-more Replacement Parts

The optional replacement parts can be used to replace damaged, worn or lost **C-more** components.

Part Number	Description	Price
<b>EA-15-BULB*</b> <b>EA-15-BULB2*</b>	15" Panel Backlight Bulb Replacement	<-->
<b>EA-12-BULB*</b> <b>EA-12-BULB2*</b>	12" Panel Backlight Bulb Replacement	<-->
<b>EA-10-BULB*</b> <b>EA-10-BULB2*</b>	10" Panel Backlight Bulb Replacement	<-->
<b>EA-8-BULB*</b> <b>EA-8-BULB2*</b>	8" Panel Backlight Bulb Replacement	<-->
<b>EA-DC-CON</b>	DC Panel Power Connector Replacement	<-->
<b>EA-AC-CON</b>	AC Power Adapter Connector Replacement	<-->
<b>D2-BAT-1</b>	Replacement Battery	<-->
<b>EA-BRK-1</b>	6" Panel Mounting Clip Replacements (2 per pk.)	<-->
<b>EA-BRK-2</b>	8"-15" Panel Mounting Clip Replacements (8 per pk.)	<-->
<b>EA-15-BEZEL</b>	15" Panel Bezel Replacement	<-->
<b>EA-12-BEZEL</b>	12" Panel Bezel Replacement	<-->
<b>EA-10-BEZEL</b>	10" Panel Bezel Replacement	<-->
<b>EA-8-BEZEL</b>	8" Panel Bezel Replacement	<-->
<b>EA-15-GSK</b>	15" Panel Gasket Replacement	<-->
<b>EA-12-GSK</b>	12" Panel Gasket Replacement	<-->
<b>EA-10-GSK</b>	10" Panel Gasket Replacement	<-->
<b>EA-8-GSK</b>	8" Panel Gasket Replacement	<-->
<b>EA-6-GSK</b>	6" Panel Gasket Replacement	<-->
<b>EA-6-ADPTR-GSK</b>	6" Adapter Plate Gasket Replacement	<-->

## Replacement parts at a glance:

**Battery:**  
D2-BAT-1

**6-inch mounting clips:**  
EA-BRK-1 (pk of 2)

**8 - 15 inch mounting clips:**  
EA-BRK-2 (pk of 8)

**DC power connector:**  
EA-DC-CON

**AC power connector:**  
EA-AC-CON

**15-inch backlight:**  
EA-15-BULB  
EA-15-BULB2

**12-inch backlight:**  
EA-12-BULB  
EA-12-BULB2

**10-inch backlight:**  
EA-10-BULB  
EA-10-BULB2

**8-inch backlight:**  
EA-8-BULB  
EA-8-BULB2

**15-inch gasket:**  
EA-15-GSK

**12-inch gasket:**  
EA-12-GSK

**10-inch gasket:**  
EA-10-GSK

**8-inch gasket:**  
EA-8-GSK

**6-inch gasket:**  
EA-6-GSK

**15-inch Bezel:**  
EA-15-BEZEL (gasket not included)

**12-inch Bezel:**  
EA-12-BEZEL (gasket not included)

**10-inch Bezel:**  
EA-10-BEZEL (gasket not included)

**8-inch Bezel:**  
EA-8-BEZEL (gasket not included)

Note: 6-inch bezel is not user replaceable.

**6-inch Adapter Plate replacement gasket**  
EA-6-ADPTR-GSK

**PLEASE REFER TO THE INDIVIDUAL DATA SHEET INSERTS THAT ARE INCLUDED WITH EACH REPLACEMENT PART FOR ADDITIONAL DETAILS.**

*C-more Replacement Bulbs		
C-more Model	Bulb Model	C-more Serial Number
<b>EA7-T8C</b>	<b>EA-8-BULB</b>	EA7-T8C+10Z15B020 and older
	<b>EA-8-BULB2</b>	EA7-T8C+10Z15B021 and newer
<b>EA7-T10C</b>	<b>EA-10-BULB</b>	EA7-T10C+10Z11B080 and older
	<b>EA-10-BULB2</b>	EA7-T10C+10Z11B081 and newer
<b>EA7-T12C</b>	<b>EA-12-BULB</b>	EA7-T12C+10Z29B019 and older
	<b>EA-12-BULB2</b>	EA7-T12C+10Z29B020 and newer
<b>EA7-T15C</b>	<b>EA-15-BULB</b>	EA7-T15C+10Z22B120 and older
	<b>EA-15-BULB2</b>	EA7-T15C+10Z22B121 and newer

**Part No.**  
**EA-8-BULB, EA-8-BULB2,**  
**EA-10-BULB, EA-10-BULB2,**  
**EA-12-BULB, EA-12-BULB2,**  
**EA-15-BULB, & EA-15-BULB2**  
**see table**



Backlight assembly, customer replaceable, for **C-more** 8", 10", 12" and 15" touch panels. The 8", 10" and 15" touch panels use two bulbs per panel and the 12" touch panels use one bulb per panel. The bulbs are packaged two per box for the 8", 10" and 15" touch panels and one per box for the 12" touch panels.

Serial Number = [Part Number]+[YYMDDFNNN]

Date Code = **YYMF**

**YY:** Year (05-99 --- e.g. 05 = 2005)  
**M:** Month (1-9, X, Y, Z --- e.g. X = Oct.)  
**DD:** Day (1-31)  
**F:** Manufacturing Site (0-9, A-Z)  
**NNN:** Sequence number for the date listed (000-999)

# C-more Replacement Parts



MAINTENANCE AND ACCESSORY INSTRUCTION SHEETS CAN BE VIEWED AND DOWNLOADED ONLINE AT:  
[HTTP://WWW.AUTOMATIONDIRECT.COM/STATIC/MANUALS/EAUSERM/EAUSERM.HTML](http://www.automationdirect.com/static/manuals/EAUSERM/EAUSERM.HTML)

## DC Power Connector Part No. EA-DC-CON



Replacement 5-terminal DC power connector for **C-more** touch panels.

## AC Power Connector Part No. EA-AC-CON



Replacement 3-terminal AC power connector for **C-more** touch panel AC Power Adapters.

## Replacement Battery Part No. D2-BAT-1



Backup Battery (supplied with new panels)  
**C-more** panels use battery backed RAM to store retentive values for internal tags. This battery will last for up to two years, and is easy to replace. You can even set up an alarm condition, and let **C-more** remind you when the battery needs replacing. The **C-more** panels come with the D2-BAT-1 already installed.

NOTE: The D2-BAT-1 is the same battery used in our DL06, D2-250(-1), D2-260 and D3-350 PLC products.

## 6" Panel Mounting Clips Part No. EA-BRK-1



Spare panel mounting clips for 6-inch **C-more** touch panels. Package of 2 clips with 4 screws.

## 8"-15" Panel Mounting Clips Part No. EA-BRK-2



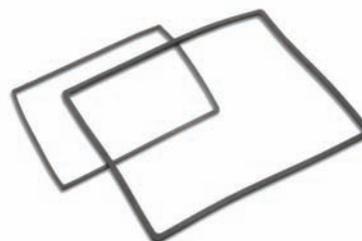
Spare panel mounting clips for the 8-inch through 15-inch **C-more** touch panels. Package of 8 clips with 8 screws.

## Part No. EA-8-BEZEL, EA-10-BEZEL, EA-12-BEZEL and EA-15-BEZEL



NEMA 4/4X bezel, customer replaceable, for **C-more** 8", 10", 12" and 15" touch panels. Gasket not included.

## Part No. EA-6-GSK, EA-8-GSK, EA-10-GSK, EA-12-GSK and EA-15-GSK



Replacement NEMA 4/4X touch panel gaskets for **C-more** 6", 8", 10", 12" and 15" touch panels.

## Part No. EA-6-ADPTR-GSK



6-inch replacement NEMA 4/4X gasket for the **C-more** touch panel adapter plate.



**CAUTION - The battery used in this device may present a risk of fire or chemical burn if mistreated. Do not recharge, disassemble, heat above 100 °C (212 °F) or incinerate. Replace battery with AutomationDirect part number D2-BAT-1 or CR2354 only. Use of another battery may present a risk of fire or explosion. Dispose of used battery properly. Keep away from children. Perchlorate Material, special disposal handling may apply.**

# Quick Start Guide

**Base Feature STN and TFT displays**

- 6" STN grayscale EA7-S6M-R
- 6" TFT color EA7-T6CLR

**Full Feature STN displays**

- 6" grayscale EA7-S6M

**Full Feature TFT displays**

- 6" color EA7-T6CL
- 8" color EA7-T8C
- 10" color EA7-T10C

**Full Feature and very large TFT displays**

- 12" color EA7-T12C
- 15" color EA7-T15C

### General Description

The **C-more** series of Touch Panels provides excellent capabilities and expanded features with their enhanced graphical programming software, rugged hardware, and convenient accessories. Engineered into the product design to provide excellent hardware and software are features such as those listed below. Some features are not available on the base feature panels.

- Analog touch screen (no touch cell boundaries)
- Overlapping active devices on the screen
- Screen resolutions up to 1024 X 768 pixels
- Serial RS232, RS422/485 and Ethernet 10/100Base-T communications
- Optional AC/DC Power Adapter (EA-AC)
- Animation of bitmaps and objects
- 4,000 built-in symbols, classic fonts: 6x8, 8x16, 8x32, 8x64, 16x16, 16x32, 32x16, 32x32, 32x64, and Windows fonts
- Event Manager to trigger actions based on assigned state changes, schedules, PLC tag names, etc., setup in a database environment. The event can also trigger a sound byte, initiate a screen capture, send a data file (FTP), send an E-mail, etc.
- Select unique background for each screen
- Built-in FTP client/server, E-mail client, and Web server
- Audio output port, stereo - requires amplifier and speaker(s)
- Plenty of memory and methods to get data in/out of the panel
- 65,536 colors for enhanced graphics
- Built-in project simulation, test on PC while developing
- Programming via USB or Ethernet (Ethernet on full feature only)
- User replaceable bulbs and bezels on 8", 10", 12" & 15" panels
- PID face plate, trending, alarming and a recipe database
- Trend Data logging
- Internet Remote Access

A table of complete specifications for all touch panels is located on the back of this Quick Start Guide. Touch panel and accessory dimension and mounting information is also located on the back. Please refer to the individual data sheet inserts that are included with each accessory for additional details.

### Accessories (sold separately)

AC/DC Power Adapter: EA-AC	6 inch Adapter Plate: EA-6-ADPTR (Used to retrofit new C-more 6" touch panel into existing EZTouch non-slim panel cutout.)	Non glare 15 inch screen cover: EA-15-COV2 (pk of 3)
Expansion Assembly: EA-EXP-OPT	D-Sub 15 pin 90 degree Comm Port Adapter: EA-ADPTR-4	Non glare 12 inch screen cover: EA-12-COV2 (pk of 3)
CF Card Interface Module: EA-CF-IF	D-Sub 15 pin to Terminal Block Adapter: EA-COMCON-3	Non glare 10 inch screen cover: EA-10-COV2 (pk of 3)
CompactFlash Memory Card: EA-CF-CARD	USB Pen Drive, 2 GB: SDC24-2048-A10	Non glare 8 inch screen cover: EA-8-COV2 (pk of 3)
		Non glare 6 inch screen cover: EA-6-COV2 (pk of 3)

### Safety Information

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### Agency Approvals

Name	UL/CUL	UL508	CSA	CE	ISO-9000
C-more Touch Panels & Accessories	E157382	PLR File # E157382	234884	EN61131-2	✓

UL, CE, SA logos

### Before you begin...

Minimum items required to create a working system:

- C-more Touch Panel - 6", 8", 10", 12" or 15" model
- C-more Programming Software, p/n EA-PGMSW
- C-more USB Programming Cable, p/n USB-CBL-AB15 or Ethernet connectivity between PC and Touch Panel
- Power source: C-more AC/DC Power Adapter, p/n EA-AC or a dedicated 24 VDC (20.4 - 28.8 VDC) switching power supply @ 1.5 A minimum
- Personal computer - to run the C-more programming software
- Communications Cable (serial or Ethernet) - to connect the C-more Touch Panel to your controller

### 1 Unpack and Inspect

Unpack the C-more Touch Panel from its shipping carton. Included in the carton is the C-more Touch Panel, cutout template, mounting clips, temporary support stand, DC power connector, gasket, and this Quick Start Guide.

Unpack any accessories that have been ordered, such as: AC/DC Power Adapter, Expansion Assembly, CompactFlash memory, programming cable, communications cable, etc.

Inspect all equipment for completeness. If anything is missing or damaged, immediately call the AutomationDirect returns department @ 1-800-633-0405.

**Shipping Carton Contents**

- AC/DC Power Adapter EA-AC
- Expansion Assembly EA-EXP-OPT

### 2 Assemble Temporary Support Stand

#### 6" & 8" Touch Panel - Temporary Stand

- Remove shipping carton packing material.
- Remove the touch panel from the shipping carton.
- Remove the temporary support stand from the shipping carton.
- Insert the touch panel into the temporary support stand.
- Secure the touch panel to the temporary support stand using the mounting clips.
- Remove the touch panel from the temporary support stand.
- Remove the touch panel from the temporary support stand.
- Remove the touch panel from the temporary support stand.

#### 10", 12" & 15" Touch Panel - Temporary Stand

- Remove shipping carton packing material.
- Remove the touch panel from the shipping carton.
- Remove the temporary support stand from the shipping carton.
- Insert the touch panel into the temporary support stand.
- Secure the touch panel to the temporary support stand using the mounting clips.
- Remove the touch panel from the temporary support stand.
- Remove the touch panel from the temporary support stand.
- Remove the touch panel from the temporary support stand.

### 3 Install Optional Hardware Accessories (sold separately)

**Compact Flash Memory Card EA-CF-CARD**

**CF Card Interface Module EA-CF-IF**

**Expansion Assembly EA-EXP-OPT**

**AC/DC Power Adapter EA-AC**

**USB Pen Drive SDC24-2048-A10**

**6" Adapter Plate EA-6-ADPTR**

**Serial Port Adapter EA-ADPTR-4**

**Serial Port Adapter EA-COMCON-3**

### 4 Available Communication Ports

Compact Flash memory slot #1 is located at the top of panel.

Audio Line Out, stereo, 1 Volt rms, 3.5mm Mini Jack (Amplifier Required)

Ethernet 10/100 Base-T PLC Communications, Programming/Download

USB Port - Type B Programming/Download

USB Port - Type A USB Device Options

Link Status LED (Green)

Ethernet Linked

No Ethernet Connect

Network Activity LED (Change)

Active Network Data

Network Vibe

Note: Device is not available on Base Feature touch panels, part numbers EA7-S6M-R and EA7-T6CLR.

Note: Use USB Programming Cable, p/n USB-CBL-AB15.

### 5 Install the Software and Develop a Project

Following are the minimum system requirements for running C-more Programming Software, p/n EA-PGMSW, on a PC:

- Personal Computer with a 333 MHz or higher processor (CPU) clock speed recommended; Intel Pentium/Celeron family, or AMD K6/Althon/Duron family, or compatible processor recommended
- Keyboard and Mouse or compatible pointing device
- Super VGA color video adapter and monitor with at least 800 x 600 pixels resolution (1024 x 768 pixels recommended)
- 64K color minimum
- 300 MB free hard-disk space
- 128 MB free RAM (512 MB recommended); 512 MB free RAM (1 GB recommended) for Vista
- CD-ROM or DVD drive for installing software from the CD
- USB port or Ethernet 10/100 Mbps port for project transfer from software to touch panel (Ethernet port not available on -R models)
- Operating System - Windows XP Home / Professional Edition Service Pack 2 (32 bit), Windows 2000 with Service Pack 4, Windows Vista (32 or 64 bit) or Windows 7 (32 or 64 bit)

Note: To check your computer system information, go to the Start Menu - All Programs and select Accessories, then System Tools, and finally System Information.

Insert the supplied CD-ROM into the PC's CD-ROM drive and follow the instructions. If you need assistance during the software installation, please refer to the supplied Software Installation Guide or call the AutomationDirect Technical Support team @ 770-844-4200.

### 6 Connect Touch Panel to Computer

Connect a USB Programming Cable, p/n USB-CBL-AB15, from a USB port type A on the PC to the USB type B programming port on the C-more touch panel.

or connect the C-more touch panel and PC together via an Ethernet hub or switch, and Ethernet cables (full feature panels only)

or use an Ethernet crossover cable directly between the C-more touch panel Ethernet port and the PC Ethernet port (full feature panels only)

**Ethernet via Crossover Cable**

**Ethernet via Hub or Switch**

### 7 Provide Power to the Touch Panel

Wired a dedicated 24 VDC (20.4 - 28.8 VDC) power source rated at a minimum of 1.5 Amps to the DC connector on the rear of the C-more touch panel. Include wiring the ground terminal to a proper equipment ground. The recommended power supply is AutomationDirect P/N: P524-050D

or install a C-more AC/DC Power Adapter, p/n EA-AC, to the rear of the touch panel and wire an AC voltage source of 100-240 VAC, 50/60Hz, to its AC connector

then turn on the power source and check the LED status indicators on the rear of the C-more touch panel for proper indication

**DC Wiring**

Recommended DC Supply Fuse

Panel Size: 6" - 10" 2.5 A MDL2.5  
12" & 15" 4.0 A MDL4

24 VDC, -15%, +20% (20.4 - 28.8 VDC)

Equipment Ground

**AC Wiring EA-AC**

Warning: The AC/DC Power Adapter should not be used with the EA7-T15C touch panel when operating temperatures are expected to exceed 40 °C (104 °F).

C-more LED Status Indicators

Power LED (Green)

On: Power On  
Off: Power Off

Comm. LED (Green)

On: Comm. is active  
Off: No communication

Serial Tx/Rx LED (Green)

On: Serial Tx/Rx is active  
Off: No communication

### 8 Accessing the Touch Panel Setup Screens

Access the Main Menu of the touch panel setup screens by pressing the extreme upper left corner of the panel display area for three (3) seconds as shown below.

Adjust the time and date for the panel by pressing the Setting button on the Main Menu, then press the Adjust Clock button on the Setting screen.

Use the right pointing arrows for the time or date display to select the unit to change. Use the up and down arrows to increment or decrement the value for the selected unit.

Press OK when done to accept the changes to the time and date that is retained in the touch panel's battery backed memory, or press Cancel to exit the Adjust Clock setup screen without making any changes.

Press the Main Menu button on the Setting screen and then the Exit button on the Main Menu screen to return to the application screen.

### 9 Touch Panel to PLC Communication Protocols & Cables

PLC Family	Model	PLC Compatibility Table	Protocols
Allen-Bradley	MicroLogix 1000, 1100, 1200, 1400, 1500, SLC 5-030/045 PLCs		DH485/AI/AIC+
	ControlLogix 1000, 1200, 1400, 1500, SLC 5-030/045		DF1 Half Duplex, DF1 Full Duplex
	ControlLogix™, CompactLogix™, FlexLogix™		DF1 Full Duplex
	ControlLogix, CompactLogix, FlexLogix - Iq Based, ControlLogix, CompactLogix, FlexLogix - Generic I/O Messaging		DF1 Half Duplex, DF1 Full Duplex
Modbus TCP/IP	Modbus TCP/IP devices		Modbus TCP/IP
	Modbus TCP/IP devices		SNMP
Mitsubishi	FX Series		Q CPU
	Q, QnA Ethernet		QnA Serial
Omron	CJ1CS1 Series		Host Link
	CJ1CS1 Series		FINES
Siemens	884 CPU, Omron T13 CPU, AEG Modicon Micro Series T10 CPU, 311-xx, 411-xx, 312-xx, 612-xx		Modbus RTU
	S7-200 CPU, RS-485 Serial		PPI
Productivity 3000	S7-200 CPU, S7-300 CPU, Ethernet		ISO over TCP
	Productivity3000 Series (P3-550)		AutomationDirect Prod. 3000 Serial
CLICK	Productivity3000 Ethernet (P3-550)		AutomationDirect Prod. 3000 Ethernet
	all		AutomationDirect Modbus (CLICK)
AutomationDirect Direct LOGIC	DL05/DL06	all	DirectNET
	DL105	all	DirectNET
	DL205	02-230	K-Sequence
		02-240	K-Sequence
		02-242	K-Sequence
		02-250/02-250-1/02-260	K-Sequence
		02-260/02-260-1/02-260	K-Sequence
		02-260/02-260-1/02-260 Using DCM	K-Sequence
		03-330/330P	DirectNET
		03-340	DirectNET
	03-350	K-Sequence	
	03-350 DCM	K-Sequence	
	04-430	K-Sequence	
	04-440	K-Sequence	
	04-450	K-Sequence	
	All with DCM	K-Sequence	
	H4-ECOMH4-ECOM100	DirectNET	
	H2-WinPLC (Think & Do) Live V5.2 or later and Studio any version	Think & Do Modbus RTU (Ethernet port)	
	H2-WinPLC (Think & Do) Live V5.3.1 or later and Studio V7.2.1 or later	Think & Do Modbus TCP/IP (Ethernet port)	

**EA-2CBL-1**

Note: EZTouch serial PLC communication cables are compatible with C-more touch panels.

### 10 Connect Touch Panel to PLC

Connect the serial communications cable between the C-more touch panel and the PLC.

or connect the C-more touch panel and PLC together via an Ethernet hub or switch, and Ethernet cables (full feature panels only)

or use an Ethernet crossover cable directly between the C-more Ethernet port and the PLC Ethernet port (full feature panels only)

**Ethernet via Crossover Cable**

**Ethernet via Hub or Switch**

### Additional Help and Support

For product support, specifications, and installation troubleshooting, a Hardware User Manual can be downloaded from the On-line Documentation area of the AutomationDirect Web site or purchased through the AutomationDirect Sales team @ 1-800-633-0405 as part number EA-USER-M.

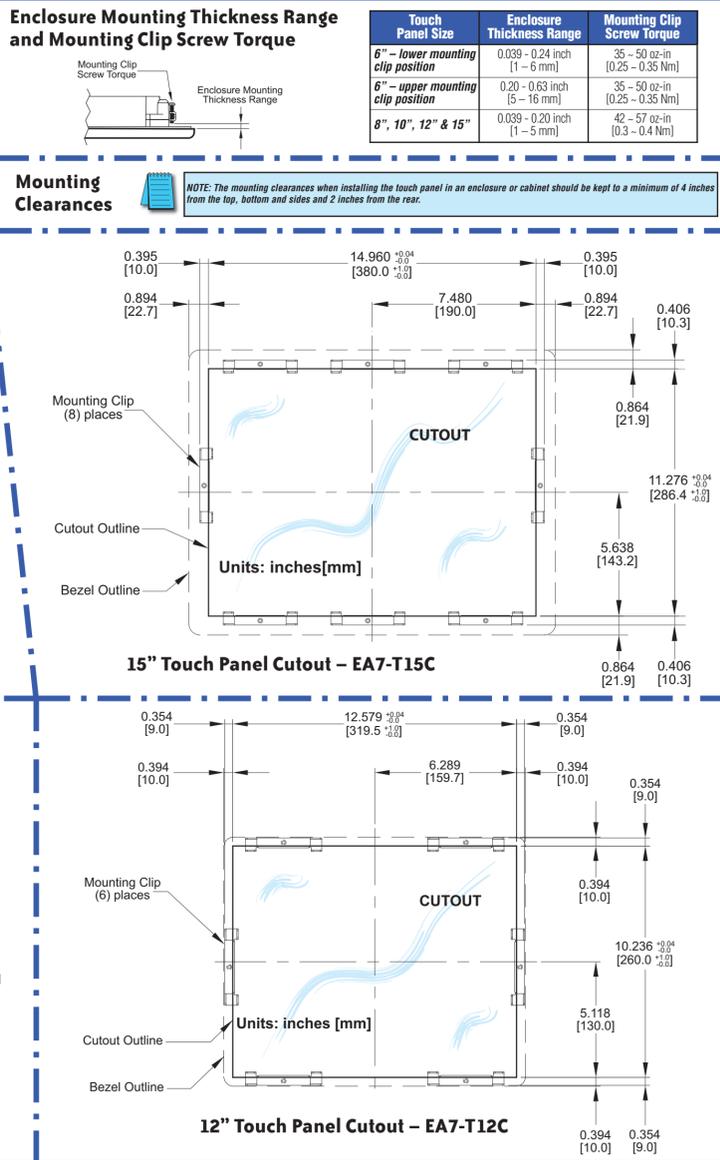
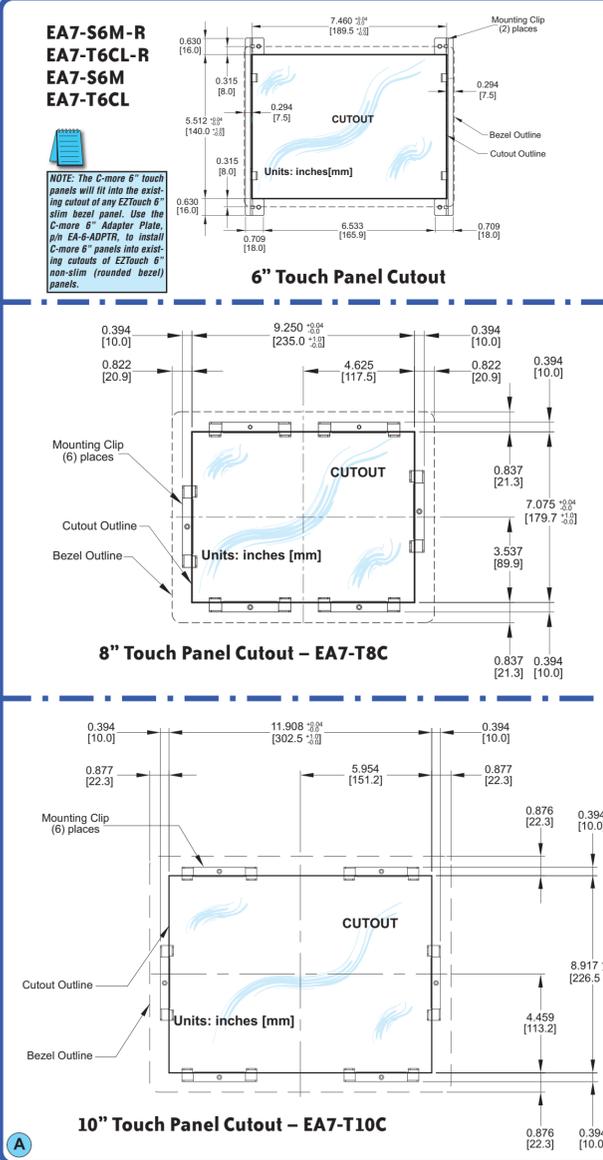
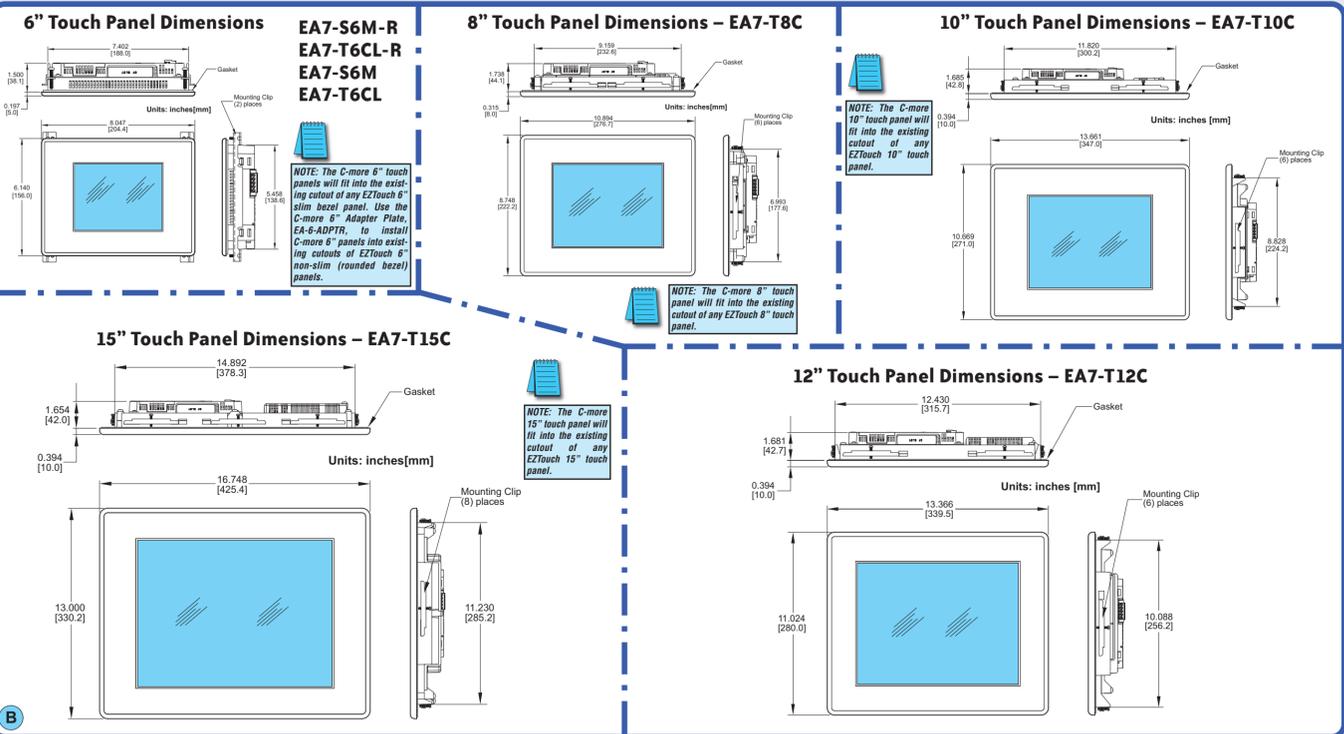
For software programming help, refer to the C-more Programming Software on-line embedded help.

Refer to demos of the product at: [http://c-more.automationdirect.com/software/software\\_demo.html](http://c-more.automationdirect.com/software/software_demo.html)

For additional technical support and questions, call our Technical Support team @ 1-800-633-0405 or 770-844-4200.

Specification	Model	6" STN grayscale w/ base features	6" TFT color w/ base features	6" STN grayscale w/ full features	6" TFT color w/ full features	8" TFT color w/ full features	10" TFT color w/ full features	12" TFT color w/ full features	15" TFT color w/ full features
Part Number		EAT-56M-R	EAT-76CL-R	EAT-56M	EAT-76CL	EAT-78C	EAT-710C	EAT-712C	EAT-715C
Display Actual Size and Type		5.7" STN grayscale	5.7" TFT color	5.7" STN grayscale	5.7" TFT color	8.4" TFT color	10.4" TFT color	12.1" TFT color	15.0" TFT color
Color Scale		15 shades of gray	65,536 colors	15 shades of gray	65,536 colors	15 shades of gray	65,536 colors	15 shades of gray	65,536 colors
Display Viewing Area		4.54" x 3.4" [115.2 mm x 86.4 mm]		4.54" x 3.4" [115.2 mm x 86.4 mm]		6.73" x 5.05" [170.9 mm x 128.2 mm]	8.31" x 6.24" [211.2 mm x 158.4 mm]	9.47" x 7.62" [240.6 mm x 193.5 mm]	11.97" x 8.88" [304.1 mm x 226.1 mm]
Screen Pixels		320 x 240 (CVGA)	320 x 240 (CVGA)	320 x 240 (CVGA)	320 x 240 (CVGA)	640 x 480 (VGA)	800 x 600 (SVGA)	1024 x 768 (XGA)	1280 x 800 (UXGA)
Display Brightness		150 cd/m <sup>2</sup> (NTS)	270 cd/m <sup>2</sup> (NTS)	150 cd/m <sup>2</sup> (NTS)	270 cd/m <sup>2</sup> (NTS)	300 cd/m <sup>2</sup> (NTS)	270 cd/m <sup>2</sup> (NTS)	270 cd/m <sup>2</sup> (NTS)	1024 cd/m <sup>2</sup> (NTS)
LCD Panel Dot Pitch		0.36 mm x 0.36 mm		0.36 mm x 0.36 mm		0.267 mm x 0.267 mm	0.33 mm x 0.33 mm	0.267 mm x 0.267 mm	0.297 mm x 0.297 mm
Backlight Average Lifetime**		Approximately 50,000 hours		Approximately 50,000 hours		Approximately 50,000 hours		Approximately 50,000 hours	
Backlight User Replaceable		No		No		Yes - Correct replacement bulb is dependent on the panel serial number, see C-more User Manual for complete details.		Yes - Correct replacement bulb is dependent on the panel serial number, see C-more User Manual for complete details.	
Touch Panel Type		Analog Resistive (10-bit resolution, 1024 x 1024 touch area)		Analog Resistive (10-bit resolution, 1024 x 1024 touch area)		Analog Resistive (12-bit resolution, 4096 x 4096 touch area)		Analog Resistive (12-bit resolution, 4096 x 4096 touch area)	
CPU Type		32-Bit RISC CPU (333 MHz)		32-Bit RISC CPU (333 MHz)		32-Bit RISC CPU (400 MHz)		32-Bit RISC CPU (400 MHz) Plus Graphic Accelerator Chip	
Battery		Rechargeable battery - ADC Part # D2-BAT-1 (Manufacturer Part # CR2354)		Rechargeable battery - ADC Part # D2-BAT-1 (Manufacturer Part # CR2354)		Rechargeable battery - ADC Part # D2-BAT-1 (Manufacturer Part # CR2354)		Rechargeable battery - ADC Part # D2-BAT-1 (Manufacturer Part # CR2354)	
System Memory		SRAM 32 Mbytes		SRAM 32 Mbytes		SRAM 32 Mbytes		SRAM 64 Mbytes	
System Flash Memory		FLASH 32 Mbytes		FLASH 32 Mbytes		FLASH 32 Mbytes		FLASH 64 Mbytes	
Backup Memory (SRAM)		Control data backup memory (SRAM) 256 Kbytes		Control data backup memory (SRAM) 256 Kbytes		Control data backup memory (SRAM) 256 Kbytes		Control data backup memory (SRAM) 256 Kbytes	
Logging Data Memory		USB Pen Drive p/n SDC24-2048-A10 (Optional)		CompactFlash Memory Card p/n EA-CF-CARD, industrial grade, high speed (Optional) or USB Pen Drive p/n SDC24-2048-A10 (Optional)		CompactFlash Memory Card p/n EA-CF-CARD, industrial grade, high speed (Optional) or USB Pen Drive p/n SDC24-2048-A10 (Optional)		CompactFlash Memory Card p/n EA-CF-CARD, industrial grade, high speed (Optional) or USB Pen Drive p/n SDC24-2048-A10 (Optional)	
Number of Screens		Up to 9999 with ver. 2.40 and later - limited by available project memory (10 Mbytes)		Up to 9999 with ver. 2.40 and later - limited by available project memory (10 Mbytes)		Up to 9999 with ver. 2.40 and later - limited by available project memory (10 Mbytes)		Up to 9999 with ver. 2.40 and later - limited by available project memory (10 Mbytes)	
Realtime Clock		Built into panel (PLC clock is still accessible if available)		Built into panel (PLC clock is still accessible if available)		Built into panel (PLC clock is still accessible if available)		Built into panel (PLC clock is still accessible if available)	
Calendar - Month/Day/Year		Yes - battery backup		Yes - battery backup		Yes - battery backup		Yes - battery backup	
Screen Saver		Yes, backlight turns off after a 30-1500 minute adjustable time, or can be disabled		Yes, backlight turns off after a 30-1500 minute adjustable time, or can be disabled		Yes, backlight turns off after a 30-1500 minute adjustable time, or can be disabled		Yes, backlight turns off after a 30-1500 minute adjustable time, or can be disabled	
Serial PLC Interface		Serial PLC Port: RS-232C/422/485 15-Pin D-sub (female)		Serial PLC Port: RS-232C/422/485 15-Pin D-sub (female)		Serial PLC Port: RS-232C/422/485 15-Pin D-sub (female)		Serial PLC Port: RS-232C/422/485 15-Pin D-sub (female)	
USB Port - Type B		Download/Program - USB Port - type B		Download/Program - USB Port - type B		Download/Program - USB Port - type B		Download/Program - USB Port - type B	
USB Port - Type A		Port for USB 1.1 device options - type A		Port for USB 1.1 device options - type A		Port for USB 1.1 device options - type A		Port for USB 1.1 device options - type A	
Ethernet Port		Ethernet 10/100 Base-T		Ethernet 10/100 Base-T		Ethernet 10/100 Base-T		Ethernet 10/100 Base-T	
Audio Line Out		Audio Line Out, 1 Volt rms, stereo - requires amplifier and speaker(s)		Audio Line Out, 1 Volt rms, stereo - requires amplifier and speaker(s)		Audio Line Out, 1 Volt rms, stereo - requires amplifier and speaker(s)		Audio Line Out, 1 Volt rms, stereo - requires amplifier and speaker(s)	
CF Card - Slot #1		Optional: CompactFlash Memory Card p/n EA-CF-CARD, CF slot #1 located on top side of touch panel.		Optional: CompactFlash Memory Card p/n EA-CF-CARD, CF slot #1 located on top side of touch panel.		Optional: CompactFlash Memory Card p/n EA-CF-CARD, CF slot #1 located on top side of touch panel.		Optional: CompactFlash Memory Card p/n EA-CF-CARD, CF slot #1 located on top side of touch panel.	
Expansion Assembly (p/n EA-EXP-OPT)		Optional: Use the CF Card Interface Module p/n EA-CF-IF in the right slot of the Expansion Assembly for installing CF card - Slot #2. The left slot of the Expansion Assembly is for future options.		Optional: Use the CF Card Interface Module p/n EA-CF-IF in the right slot of the Expansion Assembly for installing CF card - Slot #2. The left slot of the Expansion Assembly is for future options.		Optional: Use the CF Card Interface Module p/n EA-CF-IF in the right slot of the Expansion Assembly for installing CF card - Slot #2. The left slot of the Expansion Assembly is for future options.		Optional: Use the CF Card Interface Module p/n EA-CF-IF in the right slot of the Expansion Assembly for installing CF card - Slot #2. The left slot of the Expansion Assembly is for future options.	
Supply Power		24 VDC, -15%, ±20% (20.4-28.8 VDC operating range p/n PS24-060D) (Use an AC Power Adapter, p/n EA-AC, to power the touch panel from a 100-240 VAC, 50/60 Hz, power source.)		24 VDC, -15%, ±20% (20.4-28.8 VDC operating range p/n PS24-060D) (Use an AC Power Adapter, p/n EA-AC, to power the touch panel from a 100-240 VAC, 50/60 Hz, power source.)		24 VDC, -15%, ±20% (20.4-28.8 VDC operating range p/n PS24-060D) (Use an AC Power Adapter, p/n EA-AC, to power the touch panel from a 100-240 VAC, 50/60 Hz, power source.)		24 VDC, -15%, ±20% (20.4-28.8 VDC operating range p/n PS24-060D) (Use an AC Power Adapter, p/n EA-AC, to power the touch panel from a 100-240 VAC, 50/60 Hz, power source.)	
Power Consumption		9 W @ 24 VDC	9 W @ 24 VDC	10 W @ 24 VDC	11 W @ 24 VDC	15 W @ 24 VDC	17 W @ 24 VDC	20 W @ 24 VDC	33 W @ 24 VDC
Recommended DC Supply Fuse		2.5 A time delay, ADC p/n MDL2.5		2.5 A time delay, ADC p/n MDL2.5		2.5 A time delay, ADC p/n MDL2.5		2.5 A time delay, ADC p/n MDL2.5	
Operating Temperature		0 to 50 °C (32 to 122 °F); Maximum surrounding air temperature rating: 50 °C (122 °F)		0 to 50 °C (32 to 122 °F); Maximum surrounding air temperature rating: 50 °C (122 °F)		0 to 50 °C (32 to 122 °F); Maximum surrounding air temperature rating: 50 °C (122 °F)		0 to 50 °C (32 to 122 °F); Maximum surrounding air temperature rating: 50 °C (122 °F)	
Storage Temperature		-20 to +60 °C (-4 to +140 °F)		-20 to +60 °C (-4 to +140 °F)		-20 to +60 °C (-4 to +140 °F)		-20 to +60 °C (-4 to +140 °F)	
Humidity		10-85% RH, non-condensing		10-85% RH, non-condensing		10-85% RH, non-condensing		10-85% RH, non-condensing	
Noise Immunity		Noise voltage: 1000 Vp-p, Pulse width: 1 μs, Rise time: 1 ns		Noise voltage: 1000 Vp-p, Pulse width: 1 μs, Rise time: 1 ns		Noise voltage: 1000 Vp-p, Pulse width: 1 μs, Rise time: 1 ns		Noise voltage: 1000 Vp-p, Pulse width: 1 μs, Rise time: 1 ns	
Withstand Voltage		Over 20 MQ between DC power supply input terminal and safety ground		Over 20 MQ between DC power supply input terminal and safety ground		Over 20 MQ between DC power supply input terminal and safety ground		Over 20 MQ between DC power supply input terminal and safety ground	
Insulation Resistance		IEC61131-2 compliant, 10-57 Hz, 0.75 mm amplitude, 57-150 Hz 1.0 G; 10 sweep cycles per axis on each of 3 mutually perpendicular axes		IEC61131-2 compliant, 10-57 Hz, 0.75 mm amplitude, 57-150 Hz 1.0 G; 10 sweep cycles per axis on each of 3 mutually perpendicular axes		IEC61131-2 compliant, 10-57 Hz, 0.75 mm amplitude, 57-150 Hz 1.0 G; 10 sweep cycles per axis on each of 3 mutually perpendicular axes		IEC61131-2 compliant, 10-57 Hz, 0.75 mm amplitude, 57-150 Hz 1.0 G; 10 sweep cycles per axis on each of 3 mutually perpendicular axes	
Vibration		15 G peak, 11 ms duration, 2 shocks per axis, on 3 mutually perpendicular axes		15 G peak, 11 ms duration, 2 shocks per axis, on 3 mutually perpendicular axes		15 G peak, 11 ms duration, 2 shocks per axis, on 3 mutually perpendicular axes		15 G peak, 11 ms duration, 2 shocks per axis, on 3 mutually perpendicular axes	
Shock		For use in Pollution Degree 2 Environment		For use in Pollution Degree 2 Environment		For use in Pollution Degree 2 Environment		For use in Pollution Degree 2 Environment	
Environment		Meets UL Type 4X, when mounted correctly. For indoor use only.		Meets UL Type 4X, when mounted correctly. For indoor use only.		Meets UL Type 4X, when mounted correctly. For indoor use only.		Meets UL Type 4X, when mounted correctly. For indoor use only.	
Enclosure		UL, cUL, CSA, CE		UL, cUL, CSA, CE		UL, cUL, CSA, CE		UL, cUL, CSA, CE	
Agency Approvals		UL, cUL, CSA, CE		UL, cUL, CSA, CE		UL, cUL, CSA, CE		UL, cUL, CSA, CE	
Dimensions		6.140" x 8.047" x 1.697" [156.0 mm x 204.4 mm x 43.1 mm]	6.140" x 8.047" x 1.697" [156.0 mm x 204.4 mm x 43.1 mm]	8.748" x 10.894" x 2.053" [222.2 mm x 276.5 mm x 52.1 mm]	8.748" x 10.894" x 2.053" [222.2 mm x 276.5 mm x 52.1 mm]	10.669" x 13.661" x 2.075" [271.0 mm x 348.0 mm x 52.7 mm]	10.669" x 13.661" x 2.075" [271.0 mm x 348.0 mm x 52.7 mm]	11.024" x 13.366" x 2.075" [281.0 mm x 339.5 mm x 52.7 mm]	11.024" x 13.366" x 2.075" [281.0 mm x 339.5 mm x 52.7 mm]
Weight		1.46 lb. [660 g]	1.43 lb. [650 g]	1.50 lb. [680 g]	1.48 lb. [670 g]	2.60 lb. [1,180 g]	3.55 lb. [1,610 g]	4.50 lb. [2,080 g]	7.01 lb. [3,180 g]

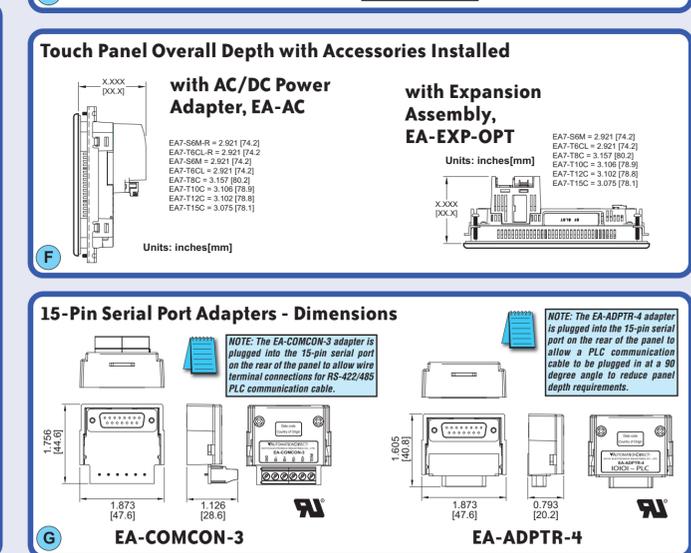
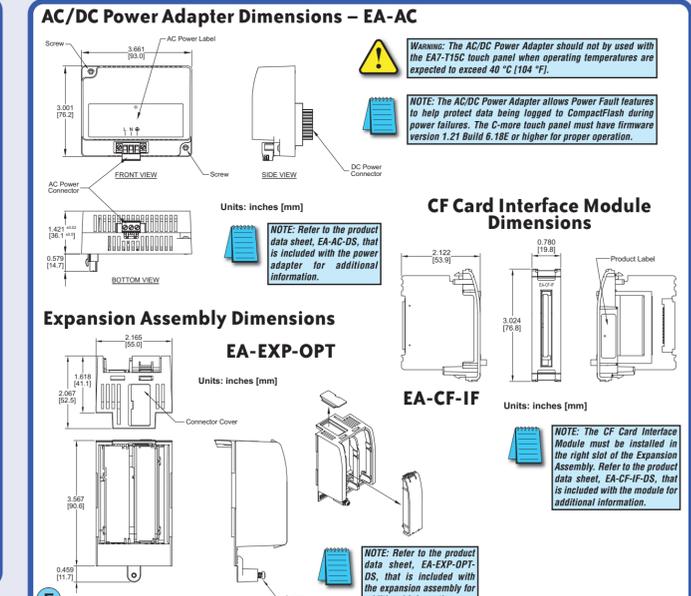
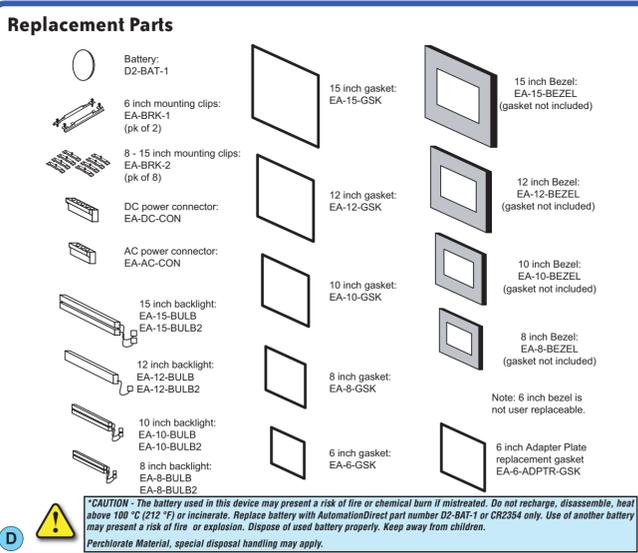
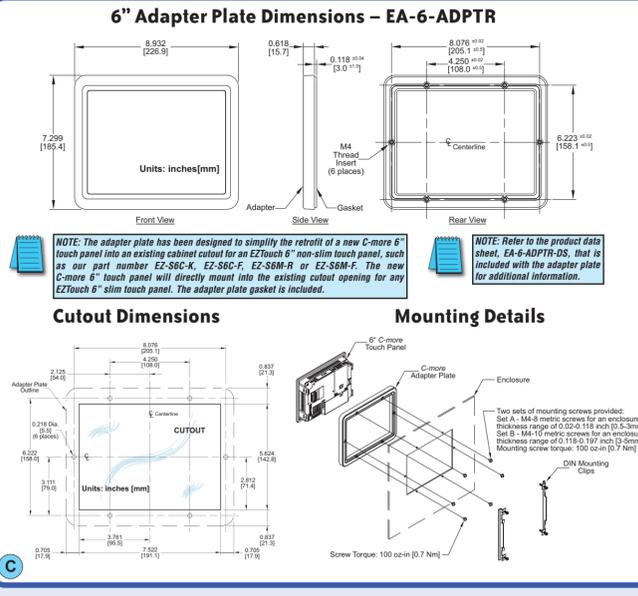
\* NOTE 1: The backlight average lifetime is defined as the average usage time it takes before the brightness becomes 50% of the initial brightness. The lifetime of the backlight depends on the ambient temperature. The lifetime will decrease under low or high temperature usage.



### Enclosure Mounting Thickness Range and Mounting Clip Screw Torque

Touch Panel Size	Enclosure Thickness Range	Mounting Clip Screw Torque
6" - lower mounting clip position	0.039 - 0.24 inch [1 - 6 mm]	35 - 50 oz-in [0.25 - 0.35 Nm]
6" - upper mounting clip position	0.20 - 0.63 inch [5 - 16 mm]	35 - 50 oz-in [0.25 - 0.35 Nm]
8", 10", 12" & 15"	0.039 - 0.20 inch [1 - 5 mm]	42 - 57 oz-in [0.3 - 0.4 Nm]

**Mounting Clearances**  
NOTE: The mounting clearances when installing the touch panel in an enclosure or cabinet should be kept to a minimum of 4 inches from the top, bottom and sides and 2 inches from the rear.



# AirLink™ Raven XE Intelligent 3G Gateway

## Rugged Design and Advanced Security for Fixed and Portable Wireless Communication

The AirLink™ Raven XE is a superior and secure Ethernet gateway with a compact and sleek form factor, ideal for enterprise customers requiring 24/7 unmanned operation of remote assets and broadband connectivity. The Raven XE is powered by ALEOS™ embedded intelligence and managed by the AirLink Software Suite, which together drastically reduce total cost of ownership by reducing field visits to remote equipment.

The intelligent gateway, with simple installation and configuration requirements, is designed to handle robust fixed and portable applications requiring broadband communication speeds and bandwidth.

### RUGGED INTELLIGENCE AND MANAGEMENT

Powered by ALEOS technology, the long-standing industry benchmark for reliable and feature-rich intelligence, the Raven XE features embedded machine and routing protocols, ease of integration and advanced security features like IPsec VPN and GRE tunneling.

The AirLink Software Suite is a comprehensive set of device management tools that enable enterprises to perform remote device configuration, administration and control. AirLink Software is tightly integrated with ALEOS embedded intelligence to provide a cohesive experience for the various stakeholders who use, support and manage remote deployments of fixed or mobile industrial and enterprise solutions enabled by AirLink gateways and routers.

### IDEAL FOR BROADBAND DATA APPLICATIONS

The Raven XE is a versatile tool for myriad broadband commercial fixed or portable network connectivity and business continuity data applications. Its small form factor enables integration into close quarters, such as ATMs, kiosks and media servers, while its rugged design makes it an ideal option for surveillance and digital signage. Multiple levels of security ensure data is safe from unauthorized access and enable the Raven XE to be part of a PCI compliant solution for payment applications. Furthermore, its routing features, like NAT and Port Forwarding, enable the Raven XE to be connected to a switch for a routing solution.



### KEY BENEFITS:

- Easy integration with customer equipment
- Consistent user experience across multiple wireless network technologies
- Ethernet connectivity for easy setup
- Remote management and troubleshooting
- IPsec VPN to protect your data from unauthorized access



# AirLink™ Raven XE Intelligent 3G Gateway

## Technical Specifications

### PRODUCT FEATURES

- Persistent 3G Network Connectivity
- Low Power Consumption
- Compact Size for Easy Integration
- Rugged Aluminum Case
- Certified for Hazardous Environments
- Remote Management and Configuration

### HIGHLY INTELLIGENT

- Security
  - IPsec VPN
  - GRE Tunneling
- Events Reporting Engine
- Routing Protocols
- Highly Configurable

### TECHNOLOGY

- HSUPA with fallback to: HSDPA, UMTS, EDGE, GPRS, GSM
- or
- CDMA EV-DO Rev. A with fallback to: CDMA 1x, CDMA IS-95

### BANDS

- Tri-Band UMTS/HSDPA/HSUPA 850, 1900, 2100 MHz
- Quad-Band GPRS/EDGE 850, 900, 1800, 1900 MHz
- or
- Dual-Band EV-DO Rev. A 800, 1900 MHz

### ENVIRONMENTAL

- Operating Temperature: -30° to +70°C / -22° to +158°F
- Storage Temperature: -40° to +85°C / -40° to +185°F

### DIMENSIONS

- 75 mm x 27 mm x 103 mm  
3.0 in x 1.0 in x 4.1 in
- 185 grams  
6.5 oz

### STANDARDS/APPROVALS

- FCC
- Industry Canada
- Class I Div 2
- RoHS
- Carrier Specific Approvals
- PTCRB
- CE
- A-Tick

### HOST INTERFACES

- Ethernet: 10BaseT RJ-45
- USB Type B5 Pin Mini
- Antenna Connections:
  - Cellular - 50 Ohm SMA
  - Receive Diversity - 50 Ohm SMA
- I/O Ports: 2

### APPLICATION INTERFACES

- TCP/IP, UDP/IP, DHCP, HTTP, SNMP, SMTP, SMS, MSCI, Modbus

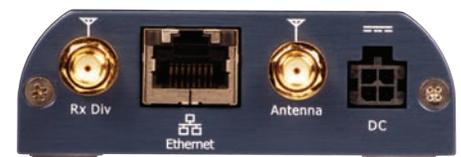
### LED INDICATORS

- Network
- Signal
- Activity
- Power



### APPLICATIONS:

- Surveillance
- Retail/POS
- Vending/Kiosk
- Banking/ATM
- Digital Signage
- Remote Monitoring
- Business Continuity



# Dual-Band Magnet Mount Installation Instructions

## 1. Antenna Adapter Required (Sold Separately)

In order to attach your antenna to your cell phone you will need an adapter. The adapter connects the phone to the antenna cable and transfers power to and from the antenna. If you need help locating an adapter for your phone, call Wilson toll-free at 1-866-294-6996.

## 2. Installing the Magnet Mount Antenna

Attach the Magnet Mount Antenna to any metal area on top of the roof of the vehicle. The best location is clear of obstacles and as high on the vehicle as possible. Although small, the rare earth magnet is quite strong and won't fall off at high speeds. Make sure the area under the magnet is clean so as not to damage the vehicle's paint and to ensure a strong connection. Bring the cable into the vehicle through a door frame - the cable is protected by the doors rubber molding. **Do not run the cable through a window** because when the window is rolled up and the door is opened the antenna's cable will be pulled - this is likely to destroy your antenna and/or scratch your paint. Connect the magnet mount antenna's cable to the adapter cable.

# Technical Support

Additional help may be obtained at [tech@wilsonelectronics.com](mailto:tech@wilsonelectronics.com) or by calling Toll-Free 866-294-1660 Monday through Friday between 7:00 AM and 6:00 PM Mountain Time. Wilson Electronics is closed Saturday, Sunday, and Holidays.

# 90 Day Warranty

The Wilson Electronics Dual-Band Magnet Mount is warranted for 90 days against defects in workmanship and/or materials and will be repaired or replaced, at the discretion of the manufacturer, to the original purchaser with dated sales receipt. The antenna and a copy of the receipt must be sent to the factory at purchaser's expense where it will be repaired or replaced and returned shipping paid. Warranty does not cover damages caused by abuse, misuse, negligence, improper installation, etc. These are considered to be avoidable circumstances and are not covered by warranty. All Wilson warranties are limited to the specific Wilson product only and do not include phone, vehicle or other external product.



## Item List

- Various examples of Adapters are shown - yours may vary.  
(Adapter Sold Separately)

### Items for Magnet Mount

- 1 - Magnet Mount Antenna
- 2 - Antenna Adapter (Sold Separately)





**NES Project: 12-133**  
**GWT – Cargo Box**  
**AECOM – Textron Providence, RI**

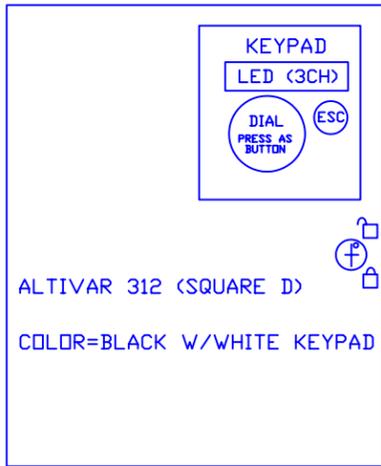
***Section 5 - Power Distribution Components***

GW Pump Motor VFD, 1.0hp - Square D Model ATV312H075M3

Transfer Pump Motor VFD, 3.0hp - Square D Model ATV312HU22M3

Power Distribution Panel, 100a - Square D Model QO327M100RB

# VFD EXTERIOR



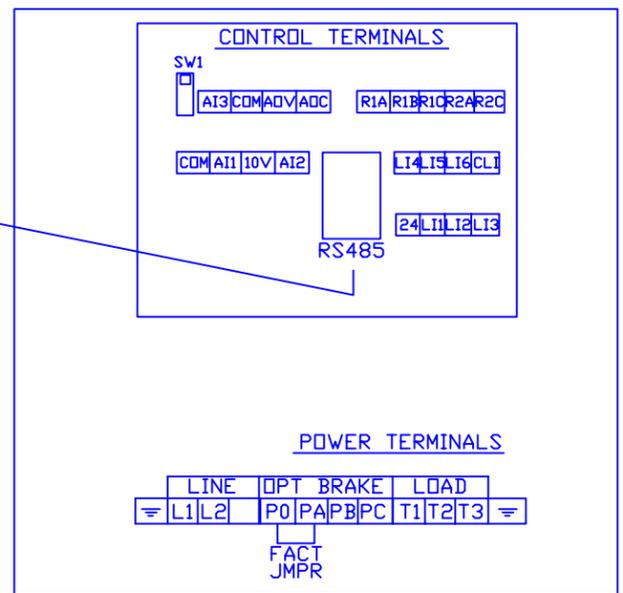
TO OPEN (ONLY LOWER SECTION OPENS):  
 LOOSEN PHILLIPS SCREW 1/4 TURN (UN-LOCK) AND PULL OPEN DOOR  
 DOT ON SCREW AND LOCK SYMBOL INDICATES STATE.

### TO CLEAR FAULTS

1. CORRECT CONDITION CAUSING FAULT THEN CYCLE POWER.
2. PRESS ESC TO CLEAR FAULT. IF FAULT CLEARS (I.E. "OCA")
3. CYCLE STOP/RUN CONTACT (AUTO TO OFF THEN BACK TO AUTO)

# VFD INTERIOR

LOWER SECTION ONLY

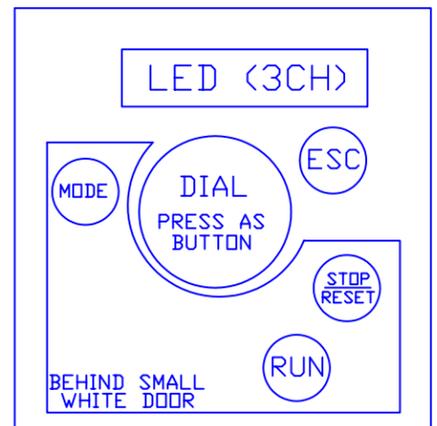


# VFD PARAMETER SETTINGS

AS ADJUSTED/PROGRAMMED BY NES

MANUAL PAGE #	MENU	SUB MENU	PARAMETER CODE	DESCRIPTION	SETTINGS BY NES			
					VFD1	VFD2	VFD3	VFD4
						N/A	N/A	N/A
53	FUn	StC	Stt	STOP CONTROL (nST=COAST)	nST			
63	FUn	UPd	Str	SAVE SPEED REF. SETPT (AFT CYCLED)	EEP			
34	ID		ADIt	SET MIN OUTPUT CURRENT TO 4mA.	4A			
34	ID		d0	SETS OUTPUT CURRENT TO FREQ. OUT	0Fr			
34	ID		r2	SETS RELAY 2 TO RUN	rUn			
30	dRc		bFr	MOTOR NAMEPLATE FREQUENCY	60 (HZ)			
30	dRc		FrS	MAX ALLOWABLE OUTPUT FREQUENCY	60 (HZ)			
26	SEt		LSP	MIN OUTPUT FREQUENCY	0 (HZ)			
26	SEt		HSP	MAX OUTPUT FREQUENCY	bFr (<=60 (HZ))			
46	CtL		LAC	SETS USER LEVEL ACCESS	L3			
46	CtL		Fr1	SETS FREQ (SPEED) REF. 1 (KEYPAD)	A1U1			
46	CtL		Fr2	SETS FREQ (SPEED) REF. 2 (PROC, 4-20mA)	AI3			
47	CtL		rFC	SETS SPEED REF SELECTION TO LI3	LI3			
56	FUn	SAI	SA2	DISABLES SUMMING INPUTS	n0			
58	FUn	PSS	PS2	DISABLES FACTORY SPEED REF ASSNGMNT	n0			
58	FUn	PSS	PS4	DISABLES FACTORY SPEED REF ASSNGMNT	n0			
80	FLt		0PL	OUTPUT PHASE LOSS FAULT	yES (see note 3)			
80	FLt		IPL	INPUT PHASE LOSS FAULT	yES (see note 3)			
33	ID		tCt	STARTS AFTER PWR CYCLED (WHEN=LEL)	LEL			
35	ID		SCS	STORES ABOVE CONFIGURATIOIN FOR RECALL	YES (STR1)			
30	dRc		tFr	ANALOG OUTPUT MAX FREQUENCY	60 (HZ)			
52	FUn	rPC	ACC	ACCELERATION TIME (RAMP UP)	3 SEC			
26	SET		ItH	MOTOR FULL LOAD (OVERCURRENT PROT.)	2.8,2.8,2.8,5.6 (AMPS)			
43	CtL		ChcF	SPEED REF. AND START/STOP SIGNALS (=SEP)	SEP			

# INTEGRAL KEYPAD



### NOTES FOR ABOVE TABLE

1. ALL PARAMETERS NOT LISTED ABOVE REMAIN AT FACTORY DEFAULT SETTINGS.
2. SEE DRAWINGS FOR VFD AND MOTOR SIZES.
3. SET TO "n0" FOR BENCH TESTING

### TO PROGRAM VFD (USE DIAL/BUTTON):

1. TURN DIAL DISPLAY GOES TO **SET** FOR MENU TREE SEE MANUAL P19
2. PRESS DIAL TO GO TO DESIRED MENU (NO PASSWORD REQ'D).
3. PRESS DIAL TO GO TO DESIRED SUB MENU OR PARAMETER.
4. TURN DIAL TO REVEAL PARAMETER SELECTIONS (SCREEN BLINKS).
6. PRESS DIAL TO SAVE PARAMETER CHOICE. (SCREEN BLINKS). (HOLD TIL FLASH IF NECESSARY-LAC)

### MONITORING VALUES IN "SUP" MENU

1. TURN DIAL CLOCKWISE UNTIL DISPLAY SHOWS **SUP**
2. TURN TO DESIRED PARAMETER (SEE P85)  
 LCr = MOTOR CURRENT  
 Lft = LAST FAULT  
 rTH = RUN TIME HOURS

3. PRESS DIAL, DISPLAY SHOWS PARAMETER VALUE

NOTE: SEE SQUARE D ALTIVAR FULL MANUAL FOR ADDITIONAL INFORMATION IF NECESSARY. PAGE REFERENCES REFER TO THIS MANUAL.

### COMMON (LED) DISPLAYS:

- DRIVE STOPPED DISPLAY READS: **rDy**
- DRIVE RUNNING DISPLAY READS: **60.0**  
 (OUTPUT FREQUENCY)
- DRIVE FAULT DISPLAY READS: **OLF**  
 (FLASHING)  
 OLF=MOTOR OVERLOAD FAULT

### FOR MANUAL ADJUSTMENT OF MOTOR SPEED (VFD FREQUENCY)

- Option 1:  
 USE ANALOG OUTPUT OF PROCONTROL with ProView Software
- Option 2:  
 USE ANALOG OUTPUT OF PROCONTROL with Local Keypad  
 a.) While on VF DSP output, Press SET LO/HI  
 b.) Press Up, Down, or Field to Enter desired per cent (0-100%).  
 c.) Press Enter (keep sounds).
- OPTION 3: USE LOCAL VFD KEYPAD (on Swing Panel)  
 a.) Open VFD and disconnect wire on LI3 (Keypad now ref).  
 b.) From DRIVE MENU, PRESS DIAL.  
 c.) Select SPEED REFERENCE, PRESS DIAL.  
 d.) In Speed Reference select IMAGE INPUT A1V1, PRESS DIAL.  
 e.) TURN DIAL to adjust Speed (Display in per cent).  
 PRESS DIAL if necessary.  
 f.) Press ESC to return to Frequency Ref (HZ).

A	4-1-13	AS BUILT	ELJ
REV	DATE	DESCRIPTION	BY
CONFIDENTIALITY NOTE: The information contained in this drawing is intended for use only by National Environmental Systems and AECOM. The information is confidential and any copying, distribution or dissemination without the consent of National Environmental Systems is strictly prohibited.		 NATIONAL ENVIRONMENTAL SYSTEMS 84 DUNHAM STREET / ATTLEBORO, MA 02703 508-226-1100 (Phone) / 508-226-1180 (Fax) WWW.NES-INC.BIZ	
DRWN BY	DATE	TITLE	
RJD	3-25-13	VFD LCD AND SETTINGS	
CHK BY	DATE	AECOM TEXTRON - PROVIDENCE, RI	JOB NO. 12-133
APPR BY	DATE	SCALE N/A	SIZE B
		DWG NO. 13	SHEET 1 OF 1
			REV A

# ATV312H075M3

variable speed drive ATV312 - 0.75kW - 2.2kVA - 55W - 200..240 V- 3-phase supply



Price\*: 325.00 USD



## Main

Commercial Status	Commercialised
Range of product	Altivar 312
Product or component type	Variable speed drive
Product destination	Asynchronous motors
Product specific application	Simple machine
Assembly style	With heat sink
Component name	ATV312
Motor power kW	0.75 kW
Motor power hp	1 hp
[Us] rated supply voltage	200...240 V (- 15...10 %)
Supply frequency	50...60 Hz (- 5...5 %)
Network number of phases	3 phases
Line current	6.4 A for 200 V, 1 kA 5.6 A for 240 V
EMC filter	Without EMC filter
Apparent power	2.2 kVA
Maximum transient current	7.2 A for 60 s
Power dissipation in W	55 W at nominal load
Speed range	1...50
Asynchronous motor control profile	Factory set : constant torque Sensorless flux vector control with PWM type motor control signal
Electrical connection	L1, L2, L3, U, V, W, PA, PB, PA/+, PC/- terminal 0 in <sup>2</sup> (2.5 mm <sup>2</sup> ) AWG 14 AI1, AI2, AI3, AOV, AOC, R1A, R1B, R1C, R2A, R2B, LI1...LI6 terminal 0 in <sup>2</sup> (2.5 mm <sup>2</sup> ) AWG 14
Supply	Internal supply for reference potentiometer (2.2 to 10 kOhm) at 10...10.8 V <= 10 mA for overload and short-circuit protection Internal supply for logic inputs at 19...30 V <= 100 mA for overload and short-circuit protection
Communication port protocol	CANopen Modbus
IP degree of protection	IP41 on upper part IP31 on upper part IP21 on connection terminals IP20 on upper part without cover plate
Option card	Profibus DP communication card Modbus TCP communication card Fipio communication card DeviceNet communication card CANopen daisy chain communication card

The information provided in this documentation contains general descriptions and/or technical characteristics of the performance of the products contained herein. This documentation is not intended as a substitute for and is not to be used for determining suitability or reliability of these products for specific user applications. It is the duty of any such user or integrator to perform the appropriate and complete risk analysis, evaluation and testing of the products with respect to the relevant specific application or use thereof. Neither Schneider Electric Industries SAS nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information contained herein. \*Prices are indicative

## Complementary

Supply voltage limits	170...264 V
Network frequency limits	47.5...63 Hz
Prospective line I <sub>sc</sub>	1 kA
Continuous output current	4.8 A at 4 kHz
Speed drive output frequency	0.5...500 Hz
Nominal switching frequency	4 kHz
Switching frequency	2...16 kHz adjustable
Transient overtorque	170...200 % of nominal motor torque
Braking torque	100 % without braking resistor 150 % with braking resistor for 60 s 100 % with braking resistor continuously
Regulation loop	Frequency PI regulator
Motor slip compensation	Adjustable Automatic whatever the load Suppressable
Output voltage	<= power supply voltage
Tightening torque	7.08 lbf.in (0.8 N.m) L1, L2, L3, U, V, W, PA, PB, PA+, PC- 5.31 lbf.in (0.6 N.m) AI1, AI2, AI3, AOV, AOC, R1A, R1B, R1C, R2A, R2B, LI1...LI6
Insulation	Electrical between power and control
Analogue input number	3
Analogue input type	AI3 configurable current 0...20 mA, impedance 250 Ohm AI2 configurable voltage +/- 10 V, input voltage 30 V max, impedance 30000 Ohm AI1 configurable voltage 0...10 V, input voltage 30 V max, impedance 30000 Ohm
Sampling duration	LI1...LI6 4 ms for discrete AI1, AI2, AI3 8 ms for analog
Response time	R1A, R1B, R1C, R2A, R2B 8 ms for discrete AOV, AOC 8 ms for analog
Linearity error	+/- 0.2 % for output
Analogue output number	2
Analogue output type	AOV configurable voltage 0...10 V, impedance 470 Ohm, resolution 8 bits AOC configurable current 0...20 mA, impedance 800 Ohm, resolution 8 bits
Discrete input logic	(LI1...LI6)Positive logic (source) state 0 < 5 V state 1 > 11 V (LI1...LI6)Negative logic (source) state 0 > 19 V (LI1...LI4)Logic input not wired state 1 < 13 V
Discrete output number	2
Discrete output type	(R2A, R2B) configurable relay logic NC, electrical durability 100000 cycles (R1A, R1B, R1C) configurable relay logic 1 NO + 1 NC, electrical durability 100000 cycles
Minimum switching current	R1-R2 10 mA at 5 V DC
Maximum switching current	R1-R2 on resistive load, 5 A at 30 V DC, cos phi = 1, L/R = 0 ms R1-R2 on resistive load, 5 A at 250 V AC, cos phi = 1, L/R = 0 ms R1-R2 on inductive load, 2 A at 30 V DC, cos phi = 0.4, L/R = 7 ms R1-R2 on inductive load, 2 A at 250 V AC, cos phi = 0.4, L/R = 7 ms
Discrete input number	6
Discrete input type	(LI1...LI6) programmable, 24 V 0...100 mA with PLC, impedance 3500 Ohm
Acceleration and deceleration ramps	Linear adjustable separately from 0.1 to 999.9 s S, U or customized
Braking to standstill	By DC injection
Protection type	Thermal protection motor Short-circuit between motor phases drive Overheating protection drive Overcurrent between output phases and earth (on power up only) drive Motor phase breaks drive Line supply phase loss safety function, for three phases supply drive Line supply overvoltage and undervoltage safety circuits drive Input phase breaks drive
Insulation resistance	>= 500 mOhm at 500 V DC for 1 minute

Local signalling	Four 7-segment display units for CANopen bus status 1 LED red for drive voltage
Time constant	5 ms for reference change
Frequency resolution	Display unit 0.1 Hz Analog input 0.1...100 Hz
Type of connector	1 RJ45 Modbus/CANopen
Physical interface	RS485 multidrop serial link
Transmission frame	RTU
Transmission rate	4800, 9600 or 19200 bps Modbus 10, 20, 50, 125, 250, 500 kbps or 1 Mbps CANopen
Number of addresses	1...247 Modbus 1...127 CANopen
Number of drive	31 Modbus 127 CANopen
Marking	CE
Operating position	Vertical +/- 10 degree
Height	5.71 in (145 mm)
Width	2.83 in (72 mm)
Depth	5.2 in (132 mm)
Product weight	2.87 lb(US) (1.3 kg)

## Environment

Dielectric strength	2880 V AC between control and power terminals 2040 V DC between earth and power terminals
Electromagnetic compatibility	Radiated radio-frequency electromagnetic field immunity test conforming to IEC 61000-4-3 level 3 Electrostatic discharge immunity test conforming to IEC 61000-4-2 level 3 Electrical fast transient/burst immunity test conforming to IEC 61000-4-4 level 4 1.2/50 µs - 8/20 µs surge immunity test conforming to IEC 61000-4-5 level 3
Standards	IEC 61800-5-1
Product certifications	CSA C-Tick GOST NOM UL
Pollution degree	2
Protective treatment	TC
Vibration resistance	1.5 mm (f = 3...13 Hz) conforming to EN/IEC 60068-2-6 1 gn (f = 13...150 Hz) conforming to EN/IEC 60068-2-6
Shock resistance	15 gn for 11 ms conforming to EN/IEC 60068-2-27
Relative humidity	5...95 % without dripping water conforming to IEC 60068-2-3 5...95 % without condensation conforming to IEC 60068-2-3
Ambient air temperature for storage	-13...158 °F (-25...70 °C)
Ambient air temperature for operation	14...140 °F (-10...60 °C) with derating factor without protective cover on top of the drive 14...122 °F (-10...50 °C) without derating with protective cover on top of the drive
Operating altitude	3280.84...9842.52 ft (1000...3000 m) with current derating 1 % per 100 m <= 3280.84 ft (1000 m) without derating

## Ordering and shipping details

Category	22152 - ATV312 / ATV32 (.25 THRU 7.5 HP)
Discount Schedule	CP4B
GTIN	00785901594123
Nbr. of units in pkg.	1
Package weight(Lbs)	3.40
Returnability	Y
Country of origin	ID

# ATV312HU22M3

variable speed drive ATV312 - 2.2kW - 5.2kVA - 114W - 200..240 V- 3-phase supply



Price\*: 478.00 USD



## Main

Commercial Status	Commercialised
Range of product	Altivar 312
Product or component type	Variable speed drive
Product destination	Asynchronous motors
Product specific application	Simple machine
Assembly style	With heat sink
Component name	ATV312
Motor power kW	2.2 kW
Motor power hp	3 hp
[Us] rated supply voltage	200...240 V (- 15...10 %)
Supply frequency	50...60 Hz (- 5...5 %)
Network number of phases	3 phases
Line current	14.9 A for 200 V, 1 kA 13 A for 240 V
EMC filter	Without EMC filter
Apparent power	5.2 kVA
Maximum transient current	16.5 A for 60 s
Power dissipation in W	114 W at nominal load
Speed range	1...50
Asynchronous motor control profile	Factory set : constant torque Sensorless flux vector control with PWM type motor control signal
Electrical connection	L1, L2, L3, U, V, W, PA, PB, PA/+, PC/- terminal 5 mm <sup>2</sup> AWG 10 AI1, AI2, AI3, AOV, AOC, R1A, R1B, R1C, R2A, R2B, LI1...LI6 terminal 0 in <sup>2</sup> (2.5 mm <sup>2</sup> ) AWG 14
Supply	Internal supply for reference potentiometer (2.2 to 10 kOhm) at 10...10.8 V <= 10 mA for overload and short-circuit protection Internal supply for logic inputs at 19...30 V <= 100 mA for overload and short-circuit protection
Communication port protocol	CANopen Modbus
IP degree of protection	IP41 on upper part IP31 on upper part IP21 on connection terminals IP20 on upper part without cover plate
Option card	Profibus DP communication card Modbus TCP communication card Fipio communication card DeviceNet communication card CANopen daisy chain communication card

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## Complementary

Supply voltage limits	170...264 V
Network frequency limits	47.5...63 Hz
Prospective line I <sub>sc</sub>	1 kA
Continuous output current	11 A at 4 kHz
Speed drive output frequency	0.5...500 Hz
Nominal switching frequency	4 kHz
Switching frequency	2...16 kHz adjustable
Transient overtorque	170...200 % of nominal motor torque
Braking torque	30 % without braking resistor 150 % with braking resistor for 60 s 100 % with braking resistor continuously
Regulation loop	Frequency PI regulator
Motor slip compensation	Adjustable Automatic whatever the load Suppressable
Output voltage	<= power supply voltage
Tightening torque	1.2 N.m L1, L2, L3, U, V, W, PA, PB, PA/+, PC/- 5.31 lbf.in (0.6 N.m) AI1, AI2, AI3, AOV, AOC, R1A, R1B, R1C, R2A, R2B, LI1...LI6
Insulation	Electrical between power and control
Analogue input number	3
Analogue input type	AI3 configurable current 0...20 mA, impedance 250 Ohm AI2 configurable voltage +/- 10 V, input voltage 30 V max, impedance 30000 Ohm AI1 configurable voltage 0...10 V, input voltage 30 V max, impedance 30000 Ohm
Sampling duration	LI1...LI6 4 ms for discrete AI1, AI2, AI3 8 ms for analog
Response time	R1A, R1B, R1C, R2A, R2B 8 ms for discrete AOV, AOC 8 ms for analog
Linearity error	+/- 0.2 % for output
Analogue output number	2
Analogue output type	AOV configurable voltage 0...10 V, impedance 470 Ohm, resolution 8 bits AOC configurable current 0...20 mA, impedance 800 Ohm, resolution 8 bits
Discrete input logic	(LI1...LI6)Positive logic (source) state 0 < 5 V state 1 > 11 V (LI1...LI6)Negative logic (source) state 0 > 19 V (LI1...LI4)Logic input not wired state 1 < 13 V
Discrete output number	2
Discrete output type	(R2A, R2B) configurable relay logic NC, electrical durability 100000 cycles (R1A, R1B, R1C) configurable relay logic 1 NO + 1 NC, electrical durability 100000 cycles
Minimum switching current	R1-R2 10 mA at 5 V DC
Maximum switching current	R1-R2 on resistive load, 5 A at 30 V DC, cos phi = 1, L/R = 0 ms R1-R2 on resistive load, 5 A at 250 V AC, cos phi = 1, L/R = 0 ms R1-R2 on inductive load, 2 A at 30 V DC, cos phi = 0.4, L/R = 7 ms R1-R2 on inductive load, 2 A at 250 V AC, cos phi = 0.4, L/R = 7 ms
Discrete input number	6
Discrete input type	(LI1...LI6) programmable, 24 V 0...100 mA with PLC, impedance 3500 Ohm
Acceleration and deceleration ramps	Linear adjustable separately from 0.1 to 999.9 s S, U or customized
Braking to standstill	By DC injection
Protection type	Thermal protection motor Short-circuit between motor phases drive Overheating protection drive Overcurrent between output phases and earth (on power up only) drive Motor phase breaks drive Line supply phase loss safety function, for three phases supply drive Line supply overvoltage and undervoltage safety circuits drive Input phase breaks drive
Insulation resistance	>= 500 mOhm at 500 V DC for 1 minute

Local signalling	Four 7-segment display units for CANopen bus status 1 LED red for drive voltage
Time constant	5 ms for reference change
Frequency resolution	Display unit 0.1 Hz Analog input 0.1...100 Hz
Type of connector	1 RJ45 Modbus/CANopen
Physical interface	RS485 multidrop serial link
Transmission frame	RTU
Transmission rate	4800, 9600 or 19200 bps Modbus 10, 20, 50, 125, 250, 500 kbps or 1 Mbps CANopen
Number of addresses	1...247 Modbus 1...127 CANopen
Number of drive	31 Modbus 127 CANopen
Marking	CE
Operating position	Vertical +/- 10 degree
Outer dimension	143 x 105 x 130 mm
Height	5.63 in (143 mm)
Width	4.21 in (107 mm)
Depth	5.98 in (152 mm)
Product weight	3.75 lb(US) (1.7 kg)

## Environment

Dielectric strength	2880 V AC between control and power terminals 2040 V DC between earth and power terminals
Electromagnetic compatibility	Radiated radio-frequency electromagnetic field immunity test conforming to IEC 61000-4-3 level 3 Electrostatic discharge immunity test conforming to IEC 61000-4-2 level 3 Electrical fast transient/burst immunity test conforming to IEC 61000-4-4 level 4 1.2/50 µs - 8/20 µs surge immunity test conforming to IEC 61000-4-5 level 3
Standards	IEC 61800-3 IEC 61800-5-1
Product certifications	CSA C-Tick GOST NOM UL
Pollution degree	2
Protective treatment	TC
Vibration resistance	1.5 mm (f = 3...13 Hz) conforming to EN/IEC 60068-2-6 1 gn (f = 13...150 Hz) conforming to EN/IEC 60068-2-6
Shock resistance	15 gn for 11 ms conforming to EN/IEC 60068-2-27
Relative humidity	5...95 % without dripping water conforming to IEC 60068-2-3 5...95 % without condensation conforming to IEC 60068-2-3
Ambient air temperature for storage	-13...158 °F (-25...70 °C)
Ambient air temperature for operation	14...140 °F (-10...60 °C) with derating factor without protective cover on top of the drive 14...122 °F (-10...50 °C) without derating with protective cover on top of the drive
Operating altitude	3280.84...9842.52 ft (1000...3000 m) with current derating 1 % per 100 m <= 3280.84 ft (1000 m) without derating

## Ordering and shipping details

Category	22152 - ATV312 / ATV32 (.25 THRU 7.5 HP)
Discount Schedule	CP4B
GTIN	00785901689317
Nbr. of units in pkg.	1
Package weight(Lbs)	4.00



# Altivar® 31

## Adjustable Speed Drive Controllers

## Variadores de velocidad ajustable

## Variateurs de vitesse



Start-Up Guide  
Guía de puesta en marcha  
Guide de mise en service

Retain for future use.  
Conservar para uso futuro.  
À conserver pour usage ultérieur.



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Altivar® 31 Adjustable Speed Drive Controllers  
Start-Up Guide

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ENGLISH

Variadores de velocidad ajustable Altivar® 31  
Guía de puesta en marcha

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ESPAÑOL

Variateurs de vitesse Altivar® 31  
Guide de mise en service

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FRANÇAIS



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## BEFORE YOU BEGIN

Read and follow these instructions before beginning any procedure with this drive controller.

### DANGER

#### HAZARDOUS VOLTAGE

- Read and understand this start-up guide before installing or operating the Altivar 31 drive controller. Installation, adjustment, repair, and maintenance must be performed by qualified personnel.
- For more information on Altivar 31 drive controllers, see the *Altivar 31 Installation Manual*, VVDED303041US, and the *Altivar 31 Programming Manual*, VVDED303042US. Both manuals are provided on the CD-ROM shipped with the drive controller. They are also available from [www.us.SquareD.com](http://www.us.SquareD.com) or from your Schneider Electric representative.
- The user is responsible for conforming to all applicable code requirements with respect to grounding all equipment.
- Many parts in this drive controller, including printed wiring boards, operate at line voltage. **DO NOT TOUCH.** Use only electrically insulated tools.
- **DO NOT** touch unshielded components or terminal strip screw connections with voltage present.
- **DO NOT** short across terminals PA and PC or across the DC capacitors.
- Install and close all covers before applying power or starting and stopping the drive controller.
- Before servicing the drive controller:
  - Disconnect all power.
  - Place a “DO NOT TURN ON” label on the drive controller disconnect.
  - Lock the disconnect in the open position.
- Disconnect all power including external control power that may be present before servicing the drive controller. **WAIT 3 MINUTES** for the DC bus capacitors to discharge. Then follow the DC bus voltage measurement procedure on page 19 to verify that the DC voltage is less than 45 Vdc. The drive controller LEDs are not accurate indicators of the absence of DC bus voltage.

**Electric shock will result in death or serious injury.**

## CAUTION

### DAMAGED EQUIPMENT

Do not operate or install any drive controller that appears damaged.

**Failure to follow this instruction can result in injury or equipment damage.**

## About this Document

This Start-Up Guide describes the minimum steps necessary for bringing an Altivar 31 (ATV31) drive controller into service. The CD-ROM supplied with the drive controller contains the following additional documentation:

- *Altivar 31 Installation Manual*, VVDED303041US
- *Altivar 31 Programming Manual*, VVDED303042US

The operations, parameters, and faults described in this guide assume factory configuration in the CtL-, FU-, FL-, and CON- menus. The drive controller may behave differently if modifications are made to the factory settings in these menus.

Consult the *ATV31 Programming Manual* for the CtL-, FU-, FL-, and CON- menus and for complete programming information. Consult the *ATV31 Installation Manual* for complete installation instructions.

*NOTE: Throughout this guide, a dash appears after menu codes to differentiate them from parameter codes. For example, SET- is a menu, but ACC is a parameter.*

## PRELIMINARY RECOMMENDATIONS

### Precautions

Before powering up and configuring the drive controller, read and observe the following precautions.

#### CAUTION

##### INCOMPATIBLE LINE VOLTAGE

Before powering up and configuring the drive controller, ensure that the line voltage is compatible with the supply voltage range of the drive controller. The drive controller may become damaged if the line voltage is not compatible.

**Failure to follow this instruction can result in equipment damage.**

#### DANGER

##### UNINTENDED EQUIPMENT OPERATION

- Before powering up and configuring the drive controller, ensure that the logic inputs are switched off (State 0) to prevent unintended starting.
- An input assigned to the run command may cause the motor to start immediately on exiting the configuration menus.

**Failure to follow these instructions will result in death or serious injury.**

## Adjustment and Extension of Functions

### DANGER

#### UNINTENDED EQUIPMENT OPERATION

- Ensure that changes to the current operating settings do not present any danger.
- It is recommended that changes to the current operating settings be made with the drive controller stopped.

**Failure to follow these instructions will result in death or serious injury.**

The following menus are covered in this start-up guide:

- SEt- Settings Menu (page 31)
- drC- Drive Control Menu (page 35)
- I-O- I/O Menu (page 39)
- SUP- Display Menu (page 41)

If necessary, use the display to modify the drive configuration and extend the functions. It is always possible to **return to the factory settings** by setting the FCS parameter to "InI" in the drC- menu. See page 38.

### Power Up After a Manual Fault Reset or Stop Command

With the factory configuration, when the drive controller is powered up after a manual fault reset or a stop command, the forward and reverse commands must be reset for the drive controller to start. If they have not been reset, the drive controller will display "nSt" and will not start.

### Test on a Low Power Motor or Without a Motor

With the factory configuration, motor phase loss detection is active. To check the drive controller in a test or maintenance environment without having to switch to a motor with the same rating as the drive controller, disable motor phase loss detection and configure the voltage/frequency ratio (UFt) to L, constant torque (see page 36). Refer to the *ATV31 Programming Manual* for more information.

## Operation on an Impedance Grounded System

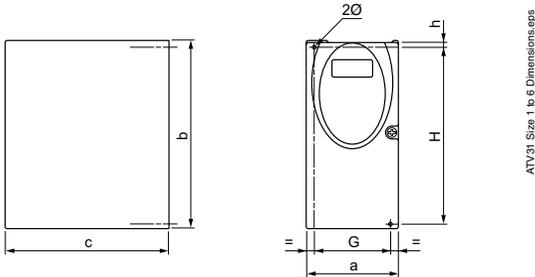
When using the drive controller on a system with an isolated or impedance grounded neutral, use a permanent insulation monitor compatible with non-linear loads.

ATV31•••M2 and N4 drive controllers feature built-in radio frequency interference (RFI) filters which have capacitors to ground. These filters can be disconnected from ground when using the drive controller on an impedance grounded system to increase the operating life of their capacitors. Refer to the *ATV31 Installation Manual* for more information.

## START-UP

1. Mount the drive controller (pages 15–18).
2. Make the following connections to the drive controller (pages 19–26):
  - Connect the grounding conductors.
  - Connect the line supply. Ensure that it is within the voltage range of the drive controller.
  - Connect the motor. Ensure that its rating corresponds to the drive controller's voltage.
3. Power up the drive controller, but do not give a run command.
4. Configure the following parameters in the SET- menu (pages 31–34):
  - bFr (motor nominal frequency), if it is other than 50 Hz. bFr appears on the display the first time the drive controller is powered up. It can be accessed in the drC- menu (page 35) anytime.
  - ACC (acceleration) and dEC (deceleration)
  - LSP (low speed when the reference is zero) and HSP (high speed when the reference is at its maximum)
  - lTh (motor thermal protection)
  - SP2, SP3, SP4 (preset speeds 2, 3, and 4)
5. If the factory configuration is not suitable for the application, configure the parameters and I/O assignments in the drC- (page 35) and I-O- (page 39) menus.
6. Remove power from the drive controller, follow the bus voltage measurement procedure on page 19, then connect the control wiring to the logic and analog inputs.
7. Power up the drive controller, then issue a run command via the logic input (see page 26).
8. Adjust the speed reference.

## DIMENSIONS



ATV31 Size 1 to 6 Dimensions.eps

**Table 1: Frame Sizes 1–6**

ATV31..... <sup>[1]</sup>	Frame Size	a mm (in.)	b mm (in.)	c <sup>[2]</sup> mm (in.)	G <sup>[3]</sup> mm (in.)	h mm (in.)	H <sup>[3]</sup> mm (in.)	Ø mm (in.)	Weight kg (lb.)
H018M3X, H037M3X	1	72 (2.83)	145 (5.71)	120 (4.72)	60 (2.36)	5 (0.20)	121.5 (4.78)	2 x 5 (0.20)	0.9 (1.99)
H055M3X, H075M3X	2	72 (2.83)	145 (5.71)	130 (5.12)	60 (2.36)	5 (0.20)	121.5 (4.78)	2 x 5 (0.20)	0.9 (1.99)
H018M2, H037M2	3	72 (2.83)	145 (5.71)	130 (5.12)	60 (2.36)	5 (0.20)	121.5 (4.78)	2 x 5 (0.20)	1.05 (2.32)
H055M2, H075M2	4	72 (2.83)	145 (5.71)	140 (5.51)	60 (2.36)	5 (0.20)	121.5 (4.78)	2 x 5 (0.20)	1.05 (2.32)
HU11M3X, HU15M3X	5	105 (4.13)	143 (5.63)	130 (5.12)	93 (3.66)	5 (0.20)	121.5 (4.78)	2 x 5 (0.20)	1.25 (2.76)
HU11M2, HU15M2, HU22M3X, H037N4, H055N4, H075N4, HU11N4, HU15N4, H075S6X, HU15S6X	6	105 (4.13)	143 (5.63)	150 (5.91)	93 (3.66)	5 (0.20)	121.5 (4.78)	2 x 5 (0.20)	1.35 (2.92)

[1] Throughout this guide, the symbol "\*" in a catalog number indicates the part of the number that varies with controller size or rating.

[2] For controllers with a potentiometer and Run/Stop button, add 8 mm (0.31 in.) for the potentiometer.

[3] The values for this dimension are ±1 mm (0.04 in.).

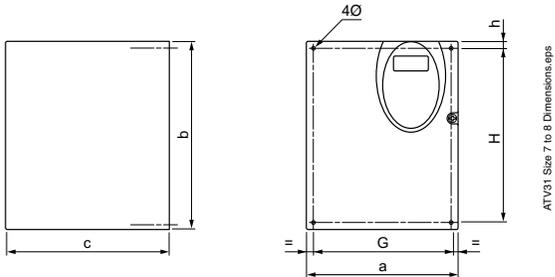


Table 2: Frame Sizes 7–9

ATV31***** <sup>[1]</sup>	Frame Size	a mm (in.)	b mm (in.)	c <sup>[2]</sup> mm (in.)	G <sup>[3]</sup> mm (in.)	h mm (in.)	H <sup>[3]</sup> mm (in.)	Ø mm (in.)	Weight kg (lb.)
HU22M2, HU30M3X, HU40M3X, HU22N4, HU30N4, HU40N4, HU22S6X, HU40S6X	7	140 (5.51)	184 (7.24)	150 (5.91)	126 (4.96)	6.5 (0.26)	157 (6.18)	4 x 5 (0.20)	2.35 (5.19)
HU55M3X, HU75M3X, HU55N4, HU75N4, HU55S6X, HU75S6X	8	180 (7.09)	232 (9.13)	170 (6.69)	160 (6.30)	5 (0.20)	210 (8.27)	4 x 5 (0.20)	4.70 (10.39)
HD11M3X, HD15M3X, HD11N4, HD15N4, HD11S6X, HD15S6X	9	245 (9.65)	330 (13.0)	190 (7.48)	225 (8.86)	7 (1.93)	295 (11.61)	4 x 6 (0.24)	9.0 (19.89)

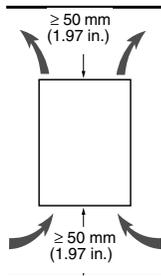
[1] Throughout this guide, the symbol “\*” in a catalog number indicates the part of the number that varies with controller size or rating.

[2] For controllers with a potentiometer and Run/Stop button, add 8 mm (0.31 in.) for the potentiometer.

[3] The values for this dimension are ±1 mm (0.04 in.).

## MOUNTING

### Clearances



Install the drive controller vertically,  $\pm 10^\circ$ .

Do not place the drive controller close to heating sources.

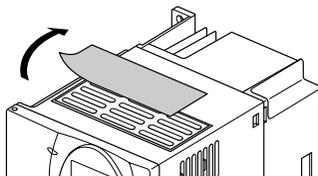
Leave sufficient free space around the drive controller to ensure that air can circulate from the bottom to the top of the unit.

Leave a minimum of 10 mm (0.4 in.) of free space in front of the drive controller.

ATV31 Clearances.eps

### Removing the Protective Cover

When IP20 protection is adequate, remove the protective cover on top of the drive controller as shown below. Consult pages 16–18 to determine the type of mounting appropriate for your application before removing the protective cover from the drive controller.

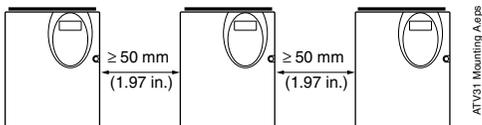


Example: ATV31HU11M3X

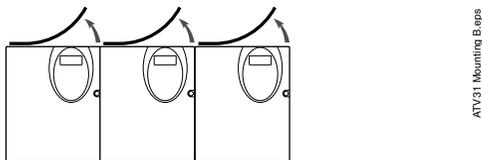
ATV31 Protective Cover.eps

## Mounting Methods

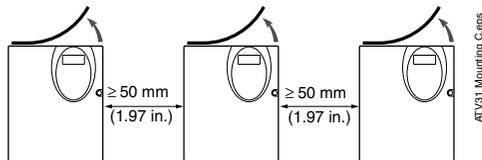
**Type A Mounting** Free space  $\geq 50$  mm (1.97 in.) on each side, with the protective cover in place.



**Type B Mounting** Drive controllers mounted side-by-side, with the protective cover removed (degree of protection becomes IP20).



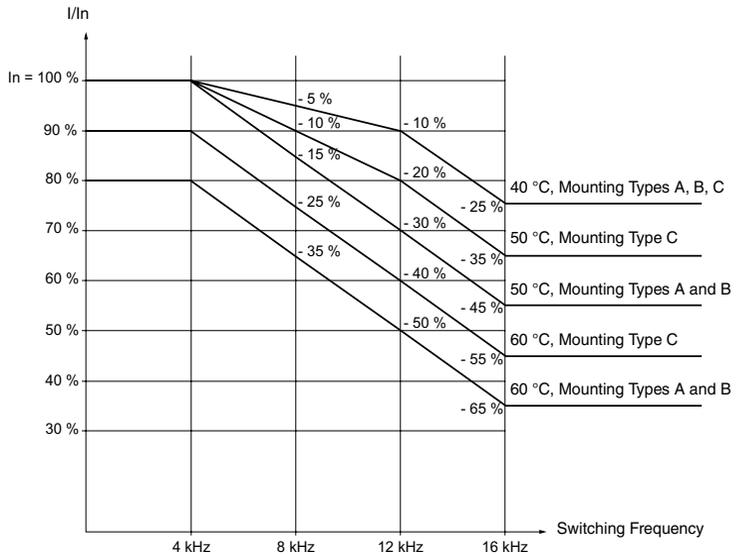
**Type C Mounting** Free space  $\geq 50$  mm (1.97 in.) on each side, with the protective cover removed (degree of protection becomes IP20).



## Derating Curves

The figure below illustrates derating curves for the drive current ( $I_n$ ) as a function of temperature, switching frequency, and type of mounting. For intermediate temperatures, such as 55 °C, interpolate between two curves.

ATV31 drive controllers can be used at altitudes up to 3,300 ft. (1000 m) without derating. Derate by 1% for each additional 330 ft (100 m).



ATV31 Derating.eps

## Minimum Air Flow Rates

If you are installing the drive controller in an enclosure, provide an air flow at least equal to the value listed in Table 3 for your drive controller.

**Table 3: Minimum Air Flow Rates**

ATV31..... [1]	Flow Rate	
	m <sup>3</sup> /hour	CFM
H018M2, H037M2, H055M2, H018M3X, H037M3X, H055M3X, H037N4, H055N4, H075N4, HU11N4 H075S6X, HU15S6X	18	10.6
H075M2, HU11M2, HU15M2 H075M3X, HU11M3X, HU15M3X HU15N4, HU22N4 HU22S6X, HU40S6X	33	19.4
HU22M2, HU22M3X, HU30M3X, HU40M3X HU30N4, HU40N4 HU55S6X, HU75S6X	93	54.8
HU55M3X HU55N4, HU75N4 HD11S6X	102	60.1
HU75M3X, HD11M3X, HD11N4, HD15N4 HD15S6X	168	99.0
HD15M3X	216	127.2

[1] Throughout this guide, the symbol “\*” in a catalog number indicates the part of the number that varies with controller size or rating.

## BUS VOLTAGE MEASUREMENT PROCEDURE

### DANGER

#### HAZARDOUS VOLTAGE

Read and understand the precautions on page 7 before performing this procedure.

**Failure to follow these instructions will result in death or serious injury.**

The bus voltage can exceed 1000 Vdc. Use appropriately rated measuring equipment when performing this procedure. To measure the bus capacitor voltage:

1. Disconnect all power from the drive controller.
2. Wait 3 minutes to allow the DC bus to discharge.
3. Measure the DC bus voltage between the PA (+) and PC (-) terminals to verify that the DC voltage is less than 45 Vdc. Refer to the *ATV31 Installation Manual* for the power terminal locations. **It may take up to 15 minutes for the DC bus voltage to discharge.**
4. If the bus capacitors are not fully discharged, contact your local Schneider Electric representative—do not service or operate the drive controller.

## ELECTRICAL INSTALLATION

Ensure that the electrical installation of this drive controller conforms to the appropriate national and local codes.

- Verify that the voltage and frequency of the input supply line and the voltage, frequency, and current of the motor match the rating on the drive controller nameplate.

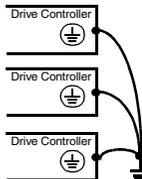
### DANGER

#### HAZARDOUS VOLTAGE

Ground equipment using the provided ground connecting point as shown in the figure on page 20. The drive controller panel must be properly grounded before power is applied.

**Electric shock will result in death or serious injury.**

- Verify that resistance to ground is one ohm or less. Ground multiple controllers as shown to the right. Do not loop the ground cables or connect them in series.



- Provide overcurrent protection. To achieve the short-circuit current rating listed on the drive controller nameplate, install the line power fuses recommended on the drive controller nameplate.

## **⚠ WARNING**

### **INADEQUATE OVERCURRENT PROTECTION**

- Overcurrent protective devices must be properly coordinated.
- The National Electrical Code requires branch circuit protection. Use the fuses recommended on the drive controller nameplate to achieve published short-circuit current ratings.
- Do not connect the drive controller to a power feeder whose short-circuit capacity exceeds the drive controller short-circuit current rating listed on the drive controller nameplate.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

- Do not use mineral-impregnated cables. Select motor cabling with low phase-to-phase and phase-to-ground capacitance.
- Motor cables must be at least 0.5 m (20 in.) long.
- Do not run control, power, or motor wiring in the same conduit. Do not run motor wiring from different drive controllers in the same conduit. Separate metallic conduit carrying power wiring from metallic conduit carrying control wiring by at least 8 cm (3 in.). Separate non-metallic conduits or cable trays used to carry power wiring from metallic conduit carrying control wiring by at least 31 cm (12 in.). Always cross power and control wiring at right angles.

## WARNING

### IMPROPER WIRING CONNECTIONS

- The drive controller will be damaged if input line voltage is applied to the output terminals (U, V, W).
- Check the power connections before energizing the drive controller.
- If replacing another drive controller, verify that all wiring connections to the ATV31 drive controller comply with all wiring instructions in this manual.

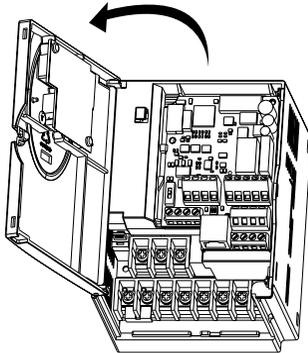
**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

- Do not immerse motor cables in water.
- Do not use lightning arrestors or power factor correction capacitors on the output of the drive controller.
- Equip all inductive circuits near the drive controller (such as relays, contactors, and solenoid valves) with electrical noise suppressors, or connect them to a separate circuit.

## WIRING

### Access to Terminals

To access the terminals, open the cover as shown below.



Example ATV31HU11M2

ATV31\_Terminals.eps

### Power Terminals

Connect the power terminals before connecting the control terminals.

**Table 4: Power Terminal Characteristics**

ATV31..... <sup>[1]</sup>	Maximum Connection Capacity		Tightening Torque in N•m (lb-in)
	AWG	mm <sup>2</sup>	
H018M2, H037M2, H055M2, H075M2, H018M3X, H037M3X, H055M3X, H075M3X, HU11M3X, HU15M3X	14	2.5	0.8 (7.08)
HU11M2, HU15M2, HU22M2, HU22M3X, HU30M3X, HU40M3X, H037N4, H055N4, H075N4, HU11N4, HU15N4, HU22N4, HU30N4, HU40N4 H075S6X, HU15S6X, HU22S6X, HU40S6X	10	5	1.2 (10.62)

**Table 4: Power Terminal Characteristics (Continued)**

ATV31..... <sup>[1]</sup>	Maximum Connection Capacity		Tightening Torque in N•m (lb-in)
	AWG	mm <sup>2</sup>	
HU55M3X, HU75M3X, HU55N4, HU75N4, HU55S6X, HU75S6X	6	16	2.2 (19.47)
HD11M3X, HD15M3X, HD11N4, HD15N4, HD11S6X, HD15S6X	3	25	4 (35.40)

[1] Throughout this guide, the symbol "\*" in a catalog number indicates the part of the number that varies with controller size or rating.

**Table 5: Power Terminal Functions**

Terminal	Function	On ATV31 Drive Controllers
⊥	Ground terminal	All ratings
R/L1 S/L2	Power supply	ATV31....M2 <sup>[1]</sup>
R/L1 S/L2 T/L3		ATV31....M3X <sup>[1]</sup> ATV31....N4 <sup>[1]</sup> ATV31....S6X <sup>[1]</sup>
PO		All ratings
PA/+	Output to braking resistor (+ polarity)	All ratings
PB	Output to braking resistor	All ratings
PC/-	DC bus - polarity	All ratings
U/T1 V/T2 W/T3	Outputs to the motor	All ratings

[1] Throughout this guide, the symbol "\*" in a catalog number indicates the part of the number that varies with controller size or rating.

**NOTE:** Never remove the common link between PO and PA/+.

## Control Terminals

**Table 6: Control Terminal Characteristics**

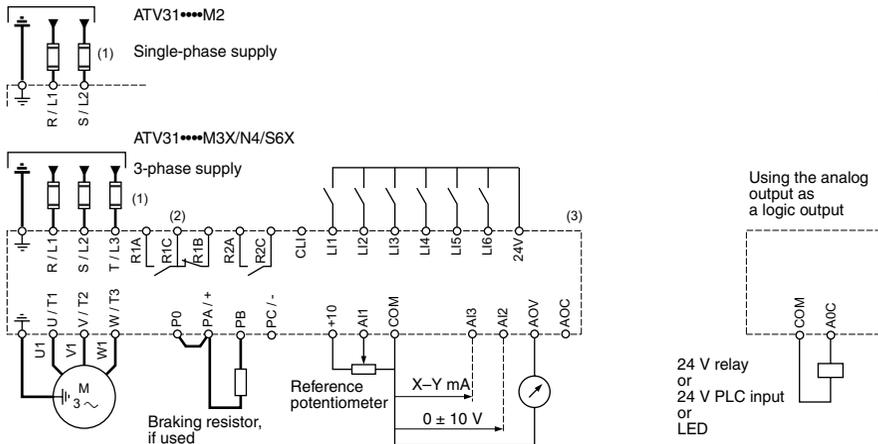
Terminal	Function	Electrical characteristics
R1A R1B R1C	R1A is a N.O. contact. R1B is a N.C. contact. R1C is common.  R1 is a programmable relay, factory set as a fault relay. As a fault relay, R1A is closed and R1B is open when the controller is powered with no fault.	<ul style="list-style-type: none"> <li>• Min. switching capacity: 10 mA for 5 V c</li> <li>• Max. switching capacity on a resistive load (power factor = 1 and L/R time constant = 0 ms): 5 A for 250 V a and 30 V c</li> <li>• Max. switching capacity on an inductive load (power factor = 0.4 and L/R time constant = 7 ms): 1.5 A for 250 V a and 30 V c</li> <li>• Sampling time: 8 ms</li> <li>• Service life: 100,000 operations at max. switching power 1,000,000 operations at min. switching power</li> </ul>
R2A R2C	N.O. contact of programmable relay R2	
COM	Analog I/O common	0 V
A11	Analog voltage input	<p>Analog input 0 to +10 V (max. safe voltage is 30 V)</p> <ul style="list-style-type: none"> <li>• Impedance: 30 k<math>\Omega</math></li> <li>• Resolution: 0.01 V, 10-bit converter</li> <li>• Precision: <math>\pm</math> 4.3% of max. value</li> <li>• Linearity: <math>\pm</math> 0.2% of max. value</li> <li>• Sampling time: 8 ms</li> <li>• Operation with a shielded cable: 100 m max.</li> </ul>
10 V	Power supply for setpoint potentiometer 1 to 10 k $\Omega$	+10 V (+ 8%, - 0%), 10 mA max, protected against short circuits and overloads
A12	Analog voltage input	<p>Bipolar analog input 0 to <math>\pm</math>10 V (max. safe voltage is <math>\pm</math>30 V) <b>The + or - polarity of the voltage on A12 affects the direction of the setpoint and therefore the direction of operation.</b></p> <ul style="list-style-type: none"> <li>• Impedance: 30 k<math>\Omega</math></li> <li>• Resolution: 0.01 V, 10-bit + sign converter</li> <li>• Precision: <math>\pm</math> 4.3% of max. value</li> <li>• Linearity: <math>\pm</math> 0.2% of max. value</li> <li>• Sampling time: 8 ms</li> <li>• Operation with shielded cable: 100 m max.</li> </ul>

**Table 6: Control Terminal Characteristics (Continued)**

Terminal	Function	Electrical characteristics
AI3	Analog current input	Analog input X to Y mA; X and Y are programmable from 0–20 mA <ul style="list-style-type: none"> <li>• Impedance: 250 Ω</li> <li>• Resolution: 0.02 mA, 10-bit converter</li> <li>• Precision: ± 4.3% of max. value</li> <li>• Linearity: ± 0.2% of max. value</li> <li>• Sampling time: 8 ms</li> </ul>
COM	Analog I/O common	0 V
AOV or AOC	Analog voltage output AOV or Analog current output AOC or Logic voltage output on AOC  Either AOV or AOC can be assigned, but not both.	Analog output 0 to 10 V with a min. load impedance of 470 Ω or Analog output X to Y mA, with X and Y programmable from 0–20 mA and with a max. load impedance of 800 Ω: <ul style="list-style-type: none"> <li>• Resolution: 8 bits [1]</li> <li>• Precision: ± 1% [1]</li> <li>• Linearity: ± 0.2% [1]</li> <li>• Sampling time: 8 ms</li> </ul> or AOC can be configured as a 24 V logic output with a min. load impedance of 1.2 kΩ.
24 V	Logic input power supply	+ 24 V protected against short circuits and overloads, min. 19 V, max. 30 V Max. available current is 100 mA.
LI1 LI2 LI3 LI4 LI5 LI6	Logic inputs	Programmable logic inputs <ul style="list-style-type: none"> <li>• + 24 V power supply (max. 30 V)</li> <li>• Impedance: 3.5 kΩ</li> <li>• State 0 if the voltage difference between LI and CLI is &lt; 5 V, State 1 if the voltage difference between LI and CLI is &gt; 11 V</li> <li>• Sampling time: 4 ms</li> </ul>
CLI	Logic input common	Refer to the <i>ATV31 Installation Manual</i> for the logic input switch.

[1] Characteristics of the digital/analog converter.

## Wiring Diagram for Factory Settings



**NOTE:** The line supply terminals are shown at the top and the motor terminals are shown at the bottom. Connect the power terminals before connecting the control terminals. Install surge suppressors on all inductive circuits located near the drive controller or coupled to the same circuit.

- (1) Refer to the drive controller nameplate for recommended fuses. Fast acting or time delay Class J fuses can be used.
- (2) Fault relay contacts for remote indication of drive controller status.
- (3) Internal +24 V. If an external source is used (30 V max.), connect the 0 V of the source to the COM terminal, and do not use the +24 V terminal on the drive controller.

## Logic Input Switch

### **WARNING**

#### **UNINTENDED EQUIPMENT OPERATION**

The logic input switch is factory set for source logic. Do not change the position of the logic input switch without consulting the *ATV31 Installation Manual*.

**Failure to follow this instruction can result in injury or equipment damage.**

This switch assigns the logic input common link to 0 V, 24 V, or floating. Refer to the *ATV31 Installation Manual*, VVDED303041US, for more information.

## PROGRAMMING

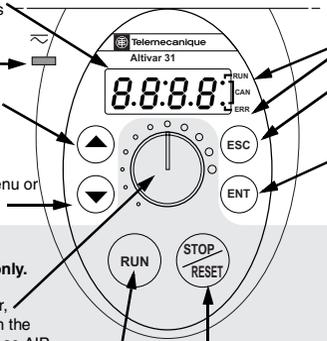
# ⚠ DANGER

## UNQUALIFIED USER

- This equipment must be installed, programmed, and serviced only by qualified personnel.
- Qualified personnel performing diagnostics or troubleshooting that requires electrical conductors to be energized must comply with NFPA 70 E - Standard for Electrical Safety Requirements for Employee Workplaces and OSHA Standards - 29 CFR Part 1910 Subpart S Electrical.

**Failure to follow these instructions will result in death or serious injury.**

## Display Functions

- 
- Four 7-segment displays
  - Red LED DC bus ON
  - Returns to the previous menu or parameter, or increases the displayed value
  - Advances to the next menu or parameter, or decreases the displayed value
  - 2 CANopen status LEDs
  - Exits a menu or parameter, or clears the displayed value to return to the previous stored value
  - Enters a menu or a parameter, or saves the displayed parameter or value. *Some parameters require that you hold the ENT key for 2 seconds to store the change.*

### Shaded features are for ATV31\*\*\*\*A controllers only.

- Reference potentiometer, active if parameter Fr1 in the CtL- menu is configured as AIP
- RUN button: Starts the motor in forward direction if parameter tCC in the I-O- menu is configured as LOC
- STOP/RESET button
  - Used to reset faults
  - Stops the motor:
    - If ICC (I-O- menu) is not configured as LOC, pressing the STOP/RESET key commands a freewheel stop.
    - If ICC (I-O- menu) is configured as LOC, stopping is on a ramp, but if injection braking is in progress, a freewheel stop takes place.

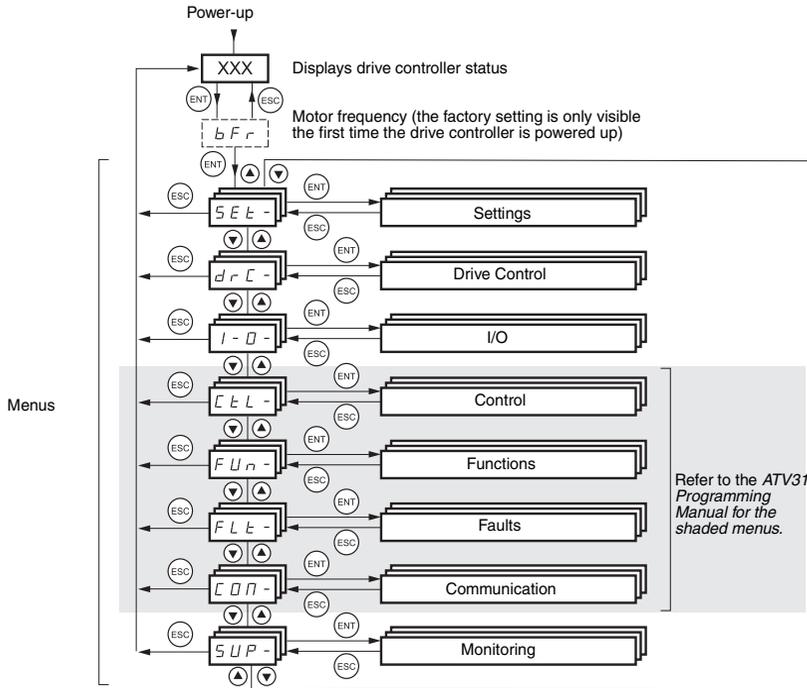
- Press and hold down (longer than 2 seconds) the  or  keys to scroll through the data quickly.
- Pressing  or  does not store the selection.
- To store the selection, press the  key. The display flashes when a value is stored.

A normal display with no fault present and no run command shows:

- The value of one of the monitoring parameters (see page 41). The default display is motor frequency, for example 43.0. In current limiting mode, the display flashes.
- init: Initialization sequence
- rdY: Drive ready
- dcb: DC injection braking in progress
- nSt: Freewheel stop
- FSt: Fast stop
- tUn: Auto-tuning in progress

If a fault is present, the display flashes.

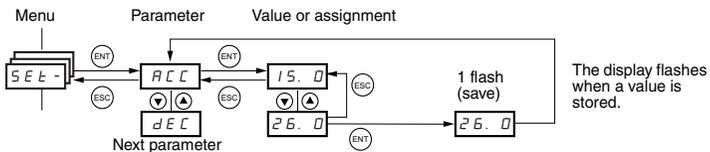
## Access to Menus



ATV31 Menu Access.eps

A dash appears after menu codes to differentiate them from parameter codes. For example, SEt- is a menu, but ACC is a parameter.

- To store the selection, press the (ENT) key.



ATV31 AccParam.eps

## bFr Parameter

Code	Description	Adjustment Range	Factory Setting
bFr	Motor frequency	50 or 60 Hz	50 Hz
	<p>This is the first parameter displayed when the drive controller is powered up or after a factory reset. bFr can be modified at any time in the drC- menu.</p> <p>This parameter modifies the preset values of the following parameters: HSP (page 32), Ftd (page 34), FrS (page 35), and tFr (page 37).</p>		

## Settings Menu SEt-

### DANGER

#### UNINTENDED EQUIPMENT OPERATION

- Ensure that changes to the current operating settings do not present any danger.
- It is recommended that changes be made with the drive controller stopped.

**Failure to follow these instructions will result in death or serious injury.**

### CAUTION

#### MOTOR OVERHEATING

- This drive controller does not provide direct thermal protection for the motor.
- Use of a thermal sensor in the motor may be required for protection at all speeds or loading conditions.
- Consult the motor manufacturer for the thermal capability of the motor when operated over the desired speed range.

**Failure to follow these instructions can result in equipment damage.**

## Settings Menu SEt-

Code	Assignment	Adjustment Range	Factory Setting
<i>A C C</i>	Acceleration ramp time for the motor to go from 0 Hz to FrS (nominal frequency, see page 35).	0.0 to 999.9 s	3 s
<i>d E C</i>	Deceleration ramp time for the motor to go from FrS to 0 Hz. Ensure that dEC is not set too low for the load.	0.0 to 999.9 s	3 s
<i>L S P</i>	Low speed (minimum reference)	0 to HSP	0 Hz
<i>H S P</i>	High speed (maximum reference). Ensure that this setting is appropriate for the motor and the application.	LSP to tFr	bFr
<i>I E H</i>	Current used for motor thermal protection. Set lTh to the nominal current indicated on the motor nameplate. To disable thermal protection, refer to the <i>ATV31 Programming Guide</i> .	0 to 1.15 In <sup>[1]</sup>	According to the controller rating
<i>U F r</i>	IR compensation/voltage boost Used to optimize torque at low speeds. Increase UFr if the torque is insufficient. To avoid operating instability, ensure that the value of UFr is not too high for a warm motor. <i>NOTE: Modifying UFr (page 36) will cause UFr to return to the factory setting (20%).</i>	0 to 100%	20%
<i>F L G</i>	Frequency loop gain Used only in n and nLd ratios (see page 36). This parameter adjusts the speed ramp based on the inertia of the driven load. If the value is too low, the response time is longer. If the value is too high, overspeed or operating instability can result.	0 to 100%	20%
<i>S E R</i>	Frequency loop stability Used only in n and nLd ratios (see page 36). If the value is too low, overspeed or operating instability can result. If the value is too high, the response time is longer.	1 to 100%	20%

[1] In is the nominal drive controller current shown on the drive controller nameplate.

**Settings Menu SEt- (Continued)**

Code	Assignment	Adjustment Range	Factory Setting
SLP	Slip compensation Used only in n and nLd ratios (see page 36). Adjusts slip compensation for fine tuning of speed regulation. If slip setting < actual slip, the motor is not rotating at the correct speed in steady state. If the slip setting > actual slip, the motor is overcompensated and the speed is unstable.	0 to 150%	100
t d C	Automatic DC injection time	0.1 to 30 s	0.5 s
S d C	Level of automatic DC injection current  <div style="border: 1px solid black; padding: 5px; margin: 5px 0;"> <p style="text-align: center;"><b>⚠ WARNING</b></p> <p><b>NO HOLDING TORQUE</b></p> <ul style="list-style-type: none"> <li>DC injection braking does not provide holding torque at zero speed.</li> <li>DC injection braking does not function during a loss of power or during a drive controller fault.</li> <li>When required, use a separate brake for holding torque.</li> </ul> <p><b>EXCESSIVE DC INJECTION BRAKING</b></p> <ul style="list-style-type: none"> <li>Application of DC injection braking for long periods of time can cause motor overheating and damage.</li> <li>Protect the motor from extended periods of DC injection braking.</li> </ul> <p><b>Failure to follow these instructions can result in death, serious injury, or equipment damage.</b></p> </div>	0 to 1.2 In <sup>[1]</sup>	0.7 In <sup>[1]</sup>
t d C 2	Second automatic DC injection time Refer to the <i>ATV31 Programming Manual</i> for more information.	0 to 30 s	0 s
S d C 2	Second level of DC injection current Refer to the <i>ATV31 Programming Manual</i> for more information.	0 to 1.2 In <sup>[1]</sup>	0.5 In <sup>[1]</sup>
JPF	Skip frequency Skip frequency prevents prolonged operation at a frequency range of ± 1 Hz around JPF. This function avoids a critical speed which leads to resonance. Setting the function to 0 renders it inactive.	0 to 500 Hz	0 Hz

[1] In is the nominal drive controller current shown on the drive controller nameplate.

Settings Menu SEt- (Continued)

Code	Assignment	Adjustment Range	Factory Setting
JF2	Second skip frequency Prevents prolonged operation at a frequency range of $\pm 1$ Hz around JF2. This function avoids a critical speed which leads to resonance. Setting the function to 0 renders it inactive.	0 to 500 Hz	0 Hz
SP2	Second preset speed	0 to 500 Hz	10 Hz
SP3	Third preset speed	0 to 500 Hz	15 Hz
SP4	Fourth preset speed	0 to 500 Hz	20 Hz
CL1	Current limiting	0.25 to 1.5 In <sup>[1]</sup>	1.5 In <sup>[1]</sup>
L5	Low speed operating time This parameter defines a period for operation at LSP (see page 32). After the programmed time has elapsed, the motor is stopped automatically. When the frequency reference is greater than LSP and a run command is still present, the motor will restart. Setting the function to 0 renders it inactive.	0 to 999.9 s	0 (no limit)
Ftd	Refer to the <i>ATV31 Programming Manual</i> .		
ltd	Refer to the <i>ATV31 Programming Manual</i> .		
Ctd	Refer to the <i>ATV31 Programming Manual</i> .		
sd5	Refer to the <i>ATV31 Programming Manual</i> .		
Sfr	Switching frequency This parameter can also be accessed in the drC- menu. See page 37.	2.0 to 16 kHz	4 kHz

[1] In is the nominal drive controller current shown on the drive controller nameplate.

## Drive Control Menu drC-

With the exception of tUn, which can power up the motor, drive control parameters can only be modified when the drive controller is stopped and no run command is present. Drive controller performance can be optimized by:

- Setting the drive control parameters to the values on the motor nameplate
- Performing an auto-tune operation (on a standard asynchronous motor)

## Drive Control Menu drC-

Code	Assignment	Adjustment Range	Factory Setting
<i>bFr</i>	Motor frequency This parameter modifies the presets of the following parameters: HSP (page 32), Ftd (page 34), FrS (page 35), and tFr (page 37)	50 or 60 Hz	50 Hz
<i>UnS</i>	Nominal motor voltage indicated on the nameplate	According to the drive controller rating	According to the drive controller rating
<i>FrS</i>	Nominal motor frequency indicated on the nameplate. The factory setting is 50 Hz, or 60 Hz if bFr is set to 60 Hz.	10 to 500 Hz	50 Hz
<i>nIr</i>	Nominal motor current indicated on the nameplate	0.25 to 1.5 In <sup>[1]</sup>	According to the drive controller rating
<i>nSP</i>	Nominal motor speed indicated on the nameplate. 0 to 9999 rpm, then 10.00 to 32.76 krpm. If nominal speed is not listed on the nameplate, refer to the <i>ATV31 Programming Manual</i> .	0 to 32760 rpm	According to the drive controller rating
<i>cos</i>	Motor power factor indicated on the nameplate	0.5 to 1	According to the drive controller rating

[1] In is the nominal drive controller current shown on the drive controller nameplate.

Drive Control Menu drC- (Continued)

Code	Assignment	Adjustment Range	Factory Setting
<i>tUn</i>	<p>Auto-tuning</p> <p>Before performing an auto-tune, ensure that all of the drive control parameters (UnS, FrS, nCr, nSP, COS) are configured correctly.</p> <p><i>nO</i>: auto-tune not performed</p> <p><i>yE S</i>: Auto-tuning is performed as soon as possible, then the parameter automatically switches to dOnE or, in the event of a fault, to nO. The nF fault is displayed.</p> <p><i>dOnE</i>: Auto-tuning is completed and the measured stator resistance will be used to control the motor.</p> <p><i>rUn</i>: Auto-tuning is performed each time a run command is sent.</p> <p><i>POn</i>: Auto-tuning is performed each time the controller is powered up.</p> <p><i>L I I</i> to <i>L I S</i>: Auto-tuning is performed when the logic input assigned to this function transitions from 0 to 1.</p> <p><i>Note: Auto-tuning will only be performed if no run or braking command has been activated. Auto-tuning may last for 1 to 2 seconds. Do not interrupt the auto-tune! Wait for the display to change to dOnE or nO. During auto-tune, the motor operates at nominal current.</i></p>		nO
<i>tU5</i>	<p>Auto-tuning status</p> <p><i>tAb</i>: The default stator resistance value is used to control the motor.</p> <p><i>PE n d</i>: Auto-tuning has been requested, but not yet performed.</p> <p><i>P r O G</i>: Auto-tuning in progress.</p> <p><i>F F I L</i>: Auto-tuning has failed.</p> <p><i>dOnE</i>: The stator resistance measured by the auto-tuning function will be used to control the motor.</p>		tAb
<i>UFt</i>	<p>Selection of the voltage/frequency ratio</p> <p><i>L</i>: Constant torque (for motors connected in parallel or special motors)</p> <p><i>P</i>: Variable torque (pump and fan applications)</p> <p><i>n</i>: Sensorless flux vector control (for constant torque applications)</p> <p><i>nL d</i>: Energy savings (for variable torque applications not requiring high dynamics. This behaves in a way similar to the P ratio at no-load and the n ratio with load.) Modifying UFt will cause UFt to return to the factory setting of 20%.</p>		n

[1] In is the nominal drive controller current shown on the drive controller nameplate.

### Drive Control Menu drC- (Continued)

Code	Assignment	Adjustment Range	Factory Setting
<i>n r d</i>	Random switching frequency This function randomly modulates the switching frequency to reduce motor noise. <i>Y E S</i> : Function active <i>n D</i> : Function inactive		YES
<i>S F r</i>	Switching frequency Adjust the setting to reduce audible motor noise. If the switching frequency is set to a value higher than 4 kHz, in the event of excessive temperature rise the drive controller will automatically reduce the switching frequency. It will increase it again when the temperature returns to normal. Refer to page 17 for derating curves. SFr can also be accessed in the SEt- menu. See page 34.	2 to 16 kHz	4.0 kHz
<i>t F r</i>	Maximum output frequency The factory setting is 60 Hz, or 72 Hz if bFr is set to 60 Hz.	10 to 500 Hz	60 Hz
<i>S S L</i>	Suppression of the speed loop filter <i>n D</i> : The speed loop filter is active (prevents the reference from being exceeded). <i>Y E S</i> : The speed loop filter is suppressed (in position control applications, this reduces the response time but the reference may be exceeded.)		nO
<i>S C S</i>	Saving the parameter configurations <i>n D</i> : Function inactive <i>S t r I</i> : Saves the current configuration (but not the result of auto-tuning) to EEPROM. SCS automatically switches to nO as soon as the save has been performed. Use this function to keep a backup configuration in addition to the current configuration. The drive controller ships with both the current configuration and the backup configuration initialized to the factory settings.		nO

[1] In is the nominal drive controller current shown on the drive controller nameplate.

Drive Control Menu drC- (Continued)

Code	Assignment	Adjustment Range	Factory Setting
F C 5	<p>Return to factory settings/Restore the configuration</p> <p>n O : Function inactive</p> <p>r E C I : Replaces the current configuration with the backup configuration previously saved by SCS. rECI is visible only if the backup has been carried out. FCS automatically switches to nO as soon as this action has been performed.</p> <p>I n I : Replaces the current configuration with the factory settings. FCS automatically switches to nO as soon as this action has been performed.</p> <p><i>Note: For rECI and InI to be taken into account, the ENT key must be held down for 2 seconds.</i></p>		nO

[1] In is the nominal drive controller current shown on the drive controller nameplate.

## I/O Menu I-O-

These parameters can only be modified when the drive controller is stopped and no run command is present.

### I/O Menu I-O-

Code	Assignment	Factory Setting
ℰ ℰ ℰ	<p>Configuration of terminal block control:</p> <p>ℰ ℰ : 2-wire control</p> <p>ℰ ℰ : 3-wire control</p> <p>ℰ ℰ ℰ : Local control</p> <p>2-wire control (maintained contact): The state of the input (open or closed) controls running or stopping.</p> <p>3-wire control (momentary contact): A forward or reverse pulse is needed to control start-up. A stop pulse is sufficient to control stopping. See the <i>ATV31 Programming Manual</i> for more information.</p> <p>On ATV31*****A controllers, reconfiguring tCC to 2C reassigns the LI1 (forward) and LI2 (reverse) inputs. Although this renders the RUN button on the drive controller inactive, the potentiometer still provides the speed reference. The potentiometer can be deactivated and the speed reference assigned to analog input AI1 by configuring parameter Fr1 to AI1 in the CTL- menu. Refer to the <i>ATV31 Programming Manual</i> for more information.</p> <p><i>Note: To change the assignment of tCC, press the ENT key for 2 seconds. This causes rrS, tCt, and all functions affecting logic inputs to return to their factory setting.</i></p>	<p>2C</p> <p>ATV31*****A:</p> <p>LOC</p>
ℰ ℰ ℰ	<p>Type of 2-wire control (parameter only accessible if tCC is set to 2C)</p> <p>ℰ ℰ ℰ : If the forward or reverse input is high when the drive controller is powered up, the drive controller will start the motor. If both inputs are high on power up, the controller will run forward.</p> <p>ℰ ℰ ℰ : The forward or reverse input must transition from low to high before the drive controller will start the motor. If the forward or reverse input is high when the drive controller is powered up, the input must be cycled before the drive controller will start the motor.</p> <p>ℰ ℰ ℰ : Same as LEL, but the forward input has priority over the reverse input. If forward is activated while the controller is running in reverse, the controller will run forward.</p>	<p>trn</p>

I/O Menu I-O- (Continued)

Code	Assignment	Factory Setting
r r 5	Reverse operation via logic input r 0: Not assigned to a logic input. Reverse operation may still be commanded by another means, such as negative voltage on AI2 or a serial link command. L 1 2: Logic input LI2 can be accessed if tCC is set to 2C L 1 3: Logic input LI3 L 1 4: Logic input LI4 L 1 5: Logic input LI5 L 1 6: Logic input LI6	
[ r L 3 [ r H 3 R 0 t d 0 r 1 r 2	Refer to the <i>ATV31 Programming Manual</i> .	
S C 5 F C 5	Identical to the drC- menu, see pages 37 and 38.	

## Display Menu SUP-

Display parameters can be accessed with the drive controller running or stopped. Some functions have numerous associated parameters. To clarify programming and keep parameter lists short, these functions have been grouped together in sub-menus. Like menus, sub-menus are identified by a dash after their code, for example LIF-.

When the drive controller is running, the value of one of the monitoring parameters is displayed. The factory setting is output frequency (rFr).

To change the parameter displayed, scroll to the desired monitoring parameter and press the ENT key. To retain your selection as the new default, press and hold the ENT key again for 2 seconds. The value of this parameter will be displayed during operation, even after power to the drive controller has been cycled. If the new choice is not confirmed by pressing the ENT key a second time, the drive controller will return to the previous parameter after power is cycled.

## Display Menu SUP-

Code	Description	Range
	Shaded parameters only appear if the function has been enabled.	
L F r	Frequency reference for control via integrated terminal or remote terminal.	0 to 500 Hz
r P I	Internal PI reference	0 to 100%
F r H	Frequency reference (absolute value)	0 to 500 Hz
r F r	Output frequency applied to the motor	- 500 Hz to + 500 Hz
5 P d	Output value in customer units Refer to the <i>ATV31 Programming Manual</i> .	
L C r	Motor current (A)	
□ P r	Motor power 100% = Nominal motor power	
U L n	Line voltage calculated from the measured voltage on the DC bus (Vac).	

Display Menu SUP- (Continued)

Code	Description	Range
<i>ℓ H r</i>	Motor thermal state 100% = Nominal thermal state 118% = OLF threshold (motor overload, see page 45)	
<i>ℓ H d</i>	Drive thermal state 100% = Nominal thermal state 118% = OHF threshold (drive overload, see page 45)	
<i>L F ℓ</i>	Last fault See "Troubleshooting" on page 43	
<i>∅ ℓ r</i>	Motor torque 100% = Nominal motor torque	
<i>r ℓ H</i>	Operating time Total time the motor has been powered up: 0 to 9999 (hours), then 10.00 to 65.53 (khours). Can be reset to zero by the rPr parameter in the FLt- menu (refer to the <i>ATV31 Programming Manual</i> .)	0 to 65530 hours
<i>ℓ ∅ d</i>	Terminal locking code Please refer to the <i>ATV31 Programming Manual</i> .	
<i>ℓ U S</i>	Auto-tuning status (refer to page 36 for auto-tuning parameters.) <i>ℓ R b</i> : The default stator resistance value is used to control the motor. <i>P E n d</i> : Auto-tuning has been requested but not yet performed. <i>P r ∅ G</i> : Auto-tuning in progress. <i>F R ℓ L</i> : Auto-tuning has failed. <i>d ∅ n E</i> : The stator resistance measured by the auto-tuning function will be used to control the motor.	
<i>U d P</i>	Indicates the ATV31 software version For example, 1102 = V 1.1IE02	
<i>L I F -</i>	Logic input functions Refer to the <i>ATV31 Programming Manual</i> .	
<i>R I F -</i>	Analog input functions Refer to the <i>ATV31 Programming Manual</i> .	

## TROUBLESHOOTING

### Fault Display

If a problem occurs during setup or operation, ensure that all ambient environment, mounting, and connection recommendations have been followed.

The first fault detected is stored and displayed, flashing, on the screen. The drive controller locks and the fault relay (R1A-R1C or R2A-R2C) contact opens.

### Drive Controller Does Not Start, No Display

If the drive controller will not start and there is no display indication, check the power supply to the drive controller. Refer to the *ATV31 Programming Manual* for more troubleshooting information.

### Faults Which Cannot be Automatically Reset

Faults which cannot be automatically reset are listed in the table beginning on page 44. To clear these faults:

1. Remove power from the drive controller.
2. Wait for the display to go off completely.
3. Determine the cause of the fault and correct it.
4. Reapply power.

CrF, SOF, tnF, bLF, and OPF can also be reset remotely via a logic input (rSF parameter in the FLt- menu, see the *ATV31 Programming Manual*).

### Faults Which Cannot be Automatically Reset

Fault	Probable Cause	Remedy
<i>b l F</i> Brake sequence	Brake release current not reached	<ul style="list-style-type: none"> <li>• Check the drive controller and motor connections.</li> <li>• Check the motor windings.</li> <li>• Check the Ibr setting in the FUn-menu. Refer to the <i>ATV31 Programming Manual</i>.</li> </ul>
<i>Cr F</i> Precharge circuit fault	Precharge circuit damaged	<ul style="list-style-type: none"> <li>• Reset the drive controller.</li> <li>• Replace the drive controller.</li> </ul>
<i>In F</i> Internal fault	<ul style="list-style-type: none"> <li>• Internal fault</li> <li>• Internal connection fault</li> </ul>	<ul style="list-style-type: none"> <li>• Remove sources of electromagnetic interference.</li> <li>• Replace the drive controller.</li> </ul>
<i>OC F</i> Overcurrent	<ul style="list-style-type: none"> <li>• Incorrect parameter settings in the SET- and drc- menus</li> <li>• Acceleration too rapid</li> <li>• Drive controller and/or motor undersized for load</li> <li>• Mechanical blockage</li> </ul>	<ul style="list-style-type: none"> <li>• Check the SET- and drc- parameters.</li> <li>• Ensure that the size of the motor and drive controller is sufficient for the load.</li> <li>• Clear the mechanical blockage.</li> </ul>
<i>SC F</i> Motor short circuit	<ul style="list-style-type: none"> <li>• Short circuit or grounding at the drive controller output</li> <li>• Significant ground leakage current at the drive controller output if several motors are connected in parallel</li> </ul>	<ul style="list-style-type: none"> <li>• Check the cables connecting the drive controller to the motor, and check the motor insulation.</li> <li>• Reduce the switching frequency.</li> <li>• Connect output filters in series with the motor.</li> </ul>
<i>OD F</i> Overspeed	<ul style="list-style-type: none"> <li>• Instability</li> <li>• Overhauling load</li> </ul>	<ul style="list-style-type: none"> <li>• Check the motor, gain, and stability parameters.</li> <li>• Add a braking resistor.</li> <li>• Check the size of the motor, drive controller, and load.</li> </ul>
<i>En F</i> Auto-tuning fault	<ul style="list-style-type: none"> <li>• Motor or motor power not suitable for the drive controller</li> <li>• Motor not connected to the drive controller</li> </ul>	<ul style="list-style-type: none"> <li>• Use the L or the P ratio (see UfT on page 36).</li> <li>• Check the presence of the motor during auto-tuning.</li> <li>• If a downstream contactor is being used, close it during auto-tuning.</li> </ul>

## Faults Which Can be Reset With the Automatic Restart Function

After the cause of the fault has been removed, the following faults can be reset:

- With the automatic restart function (Atr parameter in the FLT- menu, see the *ATV31 Programming Manual*),
- Via a logic input (rSF parameter in the FLT- menu, see the *ATV31 Programming Manual*),
- By cycling power to the drive controller.

## Faults Which Can be Reset With Automatic Restart

Fault	Probable Cause	Remedy
<b>C O F</b> Serial link failure CANopen	Loss of communication between drive controller and communication device or remote keypad.	<ul style="list-style-type: none"> <li>• Check the communication bus.</li> <li>• Refer to the product-specific documentation.</li> </ul>
<b>E P F</b> External fault	User defined	User defined
<b>L F F</b> Loss of 4-20 mA follower	Loss of the 4-20 mA reference on input AI3	Check the connection on input AI3.
<b>O b F</b> Overvoltage during deceleration	<ul style="list-style-type: none"> <li>• Braking too rapidly</li> <li>• Overhauling load</li> </ul>	<ul style="list-style-type: none"> <li>• Increase the deceleration time.</li> <li>• Install a braking resistor if necessary.</li> <li>• Activate the brA function if it is compatible with the application. Refer to the <i>ATV31 Programming Manual</i>.</li> </ul>
<b>O H F</b> Drive overload	<ul style="list-style-type: none"> <li>• Drive controller or ambient temperature are too high.</li> <li>• Continuous motor current load is too high.</li> </ul>	Check the motor load, the drive controller ventilation, and the environment. Wait for the drive controller to cool before restarting.
<b>O L F</b> Motor overload	<ul style="list-style-type: none"> <li>• Thermal trip due to prolonged motor overload</li> <li>• Motor power rating too low for the application</li> </ul>	Check the lth setting (motor thermal protection, page 32), check the motor load. Allow the motor to cool before restarting.

### Faults Which Can be Reset With Automatic Restart (Continued)

Fault	Probable Cause	Remedy
<p><i>DPF</i>            Motor phase failure</p>	<ul style="list-style-type: none"> <li>• Loss of phase at drive controller output</li> <li>• Downstream contactor open</li> <li>• Motor not connected</li> <li>• Instability in the motor current</li> <li>• Drive controller oversized for motor</li> </ul>	<ul style="list-style-type: none"> <li>• Check the connections from the drive controller to the motor.</li> <li>• If a downstream contactor is being used, set OPL to OAC. Refer to the <i>ATV31 Programming Manual</i>, FLt-menu.</li> <li>• Test the drive controller on a low power motor or without a motor: set OPL to nO. Refer to the <i>ATV31 Programming Manual</i>, FLt- menu.</li> <li>• Check and optimize the UFr (page 32), UnS (page 35), and nCr (page 35) parameters and perform auto-tuning (page 36).</li> </ul>
<p><i>DSF</i>            Overvoltage during steady state operation or during acceleration</p>	<ul style="list-style-type: none"> <li>• Line voltage too high</li> <li>• Line supply transients</li> </ul>	<ul style="list-style-type: none"> <li>• Check the line voltage. Compare with the drive controller nameplate rating.</li> <li>• Reset the drive controller.</li> </ul>
<p><i>PHF</i>            Input phase failure</p>	<ul style="list-style-type: none"> <li>• Input phase loss, blown fuse</li> <li>• 3-phase drive controller used on a single phase line supply</li> <li>• Input phase imbalance</li> <li>• Transient phase fault</li> </ul> <p><i>Note: This protection only operates with the drive controller running under load.</i></p>	<ul style="list-style-type: none"> <li>• Check the connections and the fuses.</li> <li>• Disable the fault by setting IPL to nO. Refer to the <i>ATV31 Programming Manual</i>.</li> <li>• Verify that the input power is correct.</li> <li>• Supply 3-phase power if needed.</li> </ul>
<p><i>SLF</i>            Serial link failure            Modbus</p>	<p>Loss of connection between drive controller and communication device or remote keypad.</p>	<ul style="list-style-type: none"> <li>• Check the communication connection.</li> <li>• Refer to the product-specific documentation.</li> </ul>

## Faults That Will Be Reset As Soon As the Fault is Cleared

Fault	Probable Cause	Remedy
<i>FFF</i> Configuration fault	The parameter configurations are not suited to the application.	Restore the factory settings or load the backup configuration, if it is valid. See parameter FCS in the drC- menu, page 38.
<i>CFI</i> Configuration fault via serial link	The parameter configurations loaded in the drive controller via the serial link are not suited to the application.	<ul style="list-style-type: none"> <li>• Check the configuration loaded previously.</li> <li>• Load a compatible configuration.</li> </ul>
<i>USF</i> Undervoltage	<ul style="list-style-type: none"> <li>• Line supply too low</li> <li>• Transient voltage dip</li> <li>• Damaged precharge resistor</li> </ul>	<ul style="list-style-type: none"> <li>• Check the line voltage.</li> <li>• Check the setting of the UNS parameter (see page 35).</li> <li>• Replace the drive controller.</li> </ul>







by Schneider Electric

List Price \$1,185.00 USD

Availability **Stock Item: This item is normally stocked in our distribution facility.**

**Technical Characteristics**

Ampere Rating	100A
Approvals	UL Listed
Enclosure Type	Outdoor/Rainproof
Cover Type	Surface
Application	Designed to meet residential, commercial and industrial requirements to protect electrical systems, equipment and people.
Box Number	6R
Bus Material	Tin Plated Copper
Short Circuit Current Rating	25kA
Maximum Tandem Circuit Breakers	0
Phase	3-Phase
Main Type	Convertible Mains - Breaker
Spaces	27
Enclosure Rating	NEMA 3R
Maximum Single Pole Circuits	27
Grounding Bar	Order separately
Voltage Rating	208Y/120 Vac - 240/120 Vac Delta - 240 Vac Delta
Wire Size	#4 to 2/0 AWG(Al/Cu)
Wiring Configuration	4-Wire

**Notes:** Side hinge door device allow 1.25 inches on the left side for door to open.

**Shipping and Ordering**

Category	00017 - Load Centers, 3 phase, Outdoor
Discount Schedule	DE3
GTIN	00785901295488
Package Quantity	1
Weight	32.41 lbs.
Availability Code	Stock Item: This item is normally stocked in our distribution facility.
Returnability	Y
Country of Origin	US

As standards, specifications, and designs change from time to time, please ask for confirmation of the information given in this document.

# Instruction Bulletin

Replaces 40269-469-01 03/1983

## QO® Circuit Breaker Load Centers

Retain for future use.

### INSTALLATION

## ⚠ DANGER

### HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.
- This equipment must only be installed and serviced by qualified electrical personnel.
- Turn off all power supplying this equipment before working on or inside equipment.
- Always use a properly rated voltage sensing device to confirm power is off.
- Replace all devices, doors and covers before turning on power to this equipment.

**Failure to follow these instructions will result in death or serious injury.**

### Remove Knockouts

1. Turn off all power supplying this equipment before working on or inside equipment.
2. Drive center knockout inward and alternately pry up or drive in outer rings, one at a time.



### Mount Box

Position box so  $\overset{\text{Line}}{\text{out}}$  marking is up for top feed and down for bottom feed.

### Pull Conductors Into Box

*NOTE: Conductors must enter the box through approved wire clamps, conduit bushing or by other methods approved for the purpose, to prevent damage to conductor insulation.*

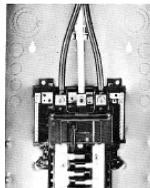
**Figure 1: Wire Mains and Neutral**



Main Lugs (125 A Max.)



Main Circuit Breaker (125 A Max.)



Main Lugs (225 A Max.)



Main Circuit Breaker (225 A Max.)

## INSTALLATION AND WIRING BRANCH CIRCUIT BREAKERS

### **⚠ WARNING**

#### **HAZARD OF EQUIPMENT DAMAGE**

- This equipment is designed and tested by Square D® to performance levels which exceed Underwriter's Laboratories Standards.
- Use of other than Square D® circuit breakers may adversely affect user safety and impair reliability. Schneider Electric disclaims all liability for damage, injury or non-performance caused by the use or failure of non-Square D circuit breakers.

**Failure to follow these instructions can result in death or serious injury.**

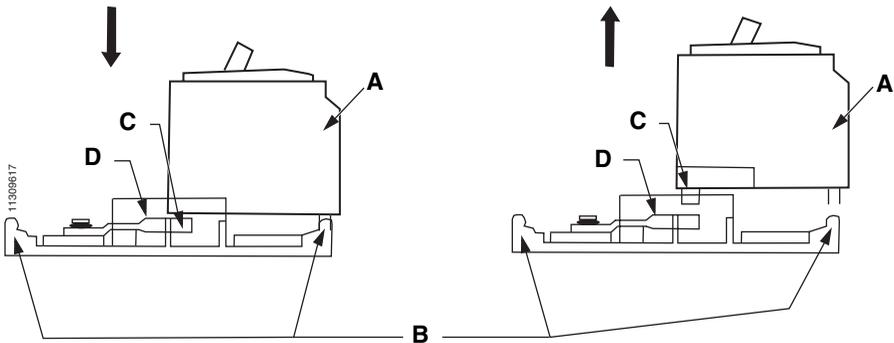
#### **Installing Circuit Breaker**

1. Turn OFF (O) circuit breaker.
2. Snap wire terminal end (A) of circuit breaker onto mounting rail (B).
3. Push circuit breaker inward until plug-on jaws (C) plug securely onto bus bar connector (D).
4. Install wire(s).

#### **Removing Circuit Breaker**

1. Turn OFF (O) circuit breaker.
2. Remove wire(s).
3. Disconnect plug-on jaws (C) from connector by pulling circuit breaker outward until it disengages from mounting rail (B).

**Figure 2: Installing and Removing Circuit Breaker**



## INSTALLATION FOR QOT CIRCUIT BREAKERS

*NOTE: Square D® Class CTL load centers are designed to restrict the installation of more overcurrent devices than that number for which each was designed, rated and approved. To accomplish this, the mounting means for QOT® circuit breakers is different from QO® and Q1® circuit breakers.*

### CAUTION

#### HAZARD OF EQUIPMENT DAMAGE

- Before energizing load center, turn main and branch circuit breakers to OFF (O) position. After power is turned on to load center, turn main circuit breaker ON (I) and then turn on branch circuit breakers.
- See lug data chart on load center wire diagram for lug torque specifications.
- See circuit breaker marking for circuit breaker lug torque specifications.
- The QOT mounting cam is thick, hardened steel. Excessive force to improperly install a tandem circuit breaker where no mounting slot is provided will destroy the circuit breaker case.

**Failure to follow these instructions may result in equipment damage.**

### Installation

*NOTE: Type QOT tandem circuit breakers may be installed only in load centers where the mounting rail has a slot at the center line of the desired pole place.*

1. Turn OFF (O) circuit breaker.
2. Hold QOT circuit breaker at a 30° angle and insert mounting cam (A) in mounting rail (B) as far as possible.
3. Rotate circuit breaker until plug-on jaws (C) plug securely onto bus bar connector (D).

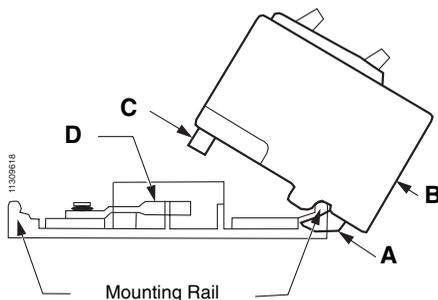
*NOTE: Bottom of circuit breaker case should remain against mounting rail.*

4. Install wires.

### Removal

1. Turn OFF (O) circuit breaker.
2. Remove wires.
3. Disconnect circuit breaker by rotating the plug-on jaws (C) away from bus bar connector (D) until the jaws disengage.
4. Remove circuit breaker from the mounting rail (B).

**Figure 3: Tandem Circuit Breaker Mounting and Removal**



## REMOVE COVER TWISTOUTS

# CAUTION

### HAZARD OF EQUIPMENT DAMAGE

Remove main circuit breaker twistout only when main circuit breaker is installed. Close unused circuit breaker openings with filler plates.

**Failure to follow this instruction will result in equipment damage.**

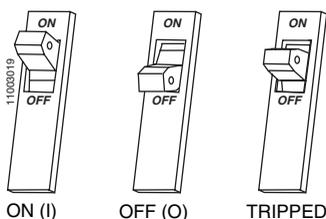
*NOTE: Remove only those twistouts which match installed circuit breakers by twisting out with pliers at center of twistout.*

**Table 1: Filler Plates**

Type	Usage
QOFP	Closes 1-pole branch circuit breaker opening.
QOM1FP	Closes 70–125 A main circuit breaker opening.
QOM2FP	Closes 150–225 A main circuit breaker opening.

## IDENTIFY CIRCUITS

1. Identify branch circuits on directory label.
2. Handle at mid-position and red Visi-Trip® indicator show circuit breaker is tripped.
3. To reset, move handle to OFF (O) position, then to ON (I) position.



*NOTE: If load center is used as service equipment, apply "Service Disconnect" label to cover near main circuit breaker handle. If load center is not used as service equipment, apply "Main" label to cover near main circuit breaker handle.*

### Schneider Electric USA

1601 Mercer Road  
Lexington, KY 40511 USA  
1-888-SquareD (1-888-778-2733)  
www.us.SquareD.com

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

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**NES Project: 12-133**  
**GWT – Cargo Box**  
**AECOM – Textron Providence, RI**

***Section 6 - Enclosure Accessories***

Enclosure Heater, 5.0kw - Grainger / Dayton Model 2YU65

Heater Thermostat - White Rodgers Model 2E399

Process Room Exhaust Fan, 18" - Grainger / Dayton Model 10D965

Fan Thermostat - Honeywell Model T6031A

Interior Lights - NE Lighting Model VT240EBO-UV

Sump Level Switch - Dwyer Model F7-SB

Please read and save these instructions. Read carefully before attempting to assemble, install, operate or maintain the product described. Protect yourself and others by observing all safety information. Failure to comply with instructions could result in personal injury and/or property damage! Retain instructions for future reference.

# Dayton® Heavy-Duty Electric Unit Heaters

## Description

Dayton Heavy-Duty Electric Heaters are designed for continuous or intermittent use in factories, warehouses, public buildings, stock rooms, service stations, any large or exposed areas, or additions. Can be installed for use in downflow or horizontal applications.

### FEATURES:

- Units 5 thru 15 kW are field convertible from single to three phase
- 24 volt low voltage control circuit is standard except on 3 and 5 kW 208, 240/208, and 277V units which have line voltage control
- Heavy-duty totally enclosed motors
- Aluminum finned, copper clad steel sheath heating element
- Advanced inlet louver design draws cool air across heating element for more efficient operation
- Automatic reset linear thermal protector
- Venturi outlet with large dynamically balanced fan blade
- Heavy gauge die-formed steel housing
- Optional vertical and horizontal brackets available

## Specifications

Model	kW Rating	BTU/HR (1,000's)	Heater/Motor Voltage	Control Phase Voltage	Amps Per Phase	-Fan Motor- HP RPM	CFM at Outlet	FPM at Outlet	Air Temp. Rise (°F)	Air Throw (Horiz)	
2YU58*	3.0/2.2	10.2/7.5	240/208	1	240/208	12.5/11.0	1/100 1600	350	800	27	12'
2YU59	3.0	10.2	480	3	24	3.6	1/100 1600	350	800	27	12
2YU60*	3.0	10.2	277	1	277	11.0	1/100 1600	350	800	27	12
2YU61*	3.0	10.2	208	1	208	14.5	1/100 1600	350	800	27	12
2YU62*	5.0/3.7	17.0/12.6	240/208	1-3	240/208	21.0/18.0	1/100 1600	350	800	45	12
2YU63	5.0	17.0	480	3	24	6.0	1/100 1600	350	800	45	12
2YU64*	5.0	17.0	277	1	277	18.0	1/100 1600	350	800	45	12
2YU65*	5.0	17.0	208	1-3	208	24.0	1/100 1600	350	800	45	12
2YU66	7.5/5.6	25.6/19.1	240/208	1-3	24	31.3/27.0	1/30 1600	650	970	37	18
2YU67	7.5	25.6	480	3	24	9.0	1/30 1600	650	970	37	18
2YU68	7.5	25.6	208	1-3	24	36.0	1/30 1600	650	970	37	18
2YU69	10.0/7.5	34.1/25.6	240/208	1-3	24	42.0/36.0	1/30 1600	650	970	49	18
2YU70	10.0	34.1	480	3	24	12.0	1/30 1600	650	970	49	18
2YU71	10.0	34.1	208	1-3	24	48.0	1/30 1600	650	970	49	18
2YU72	15.0/11.2	51.2/38.2	240/208	3	24	36.1/33.3	1/20 1530	910	1640	52	35
2YU73	15.0	51.2	480	3	24	18.0	1/20 1530	910	1640	52	35
2YU74	15.0	51.2	208	1-3	24	72.0	1/20 1530	910	1640	52	35
2YU75	20.0/15.0	68.2/51.2	240/208	3	24	48.0/41.2	1/10 1500	1320	2060	48	41
2YU76	20.0	68.2	480	3	24	24.0	1/10 1500	1320	2060	48	41
3END3	25	85.2	480	3	24	30	1/4 1600/1375	2100/1800	2100/2030	45/53	50
2YU77	30.0/22.5	102/77	240/208	3	24	72.0/63.0	1/4 1600/1375	2100/1800	2100/2030	45/53	50
2YU78	30.0	102.3	480	3	24	36.0	1/4 1600/1375	2100/1800	2100/2030	45/53	50
2YU79	30.0	102.3	208	3	24	84.0	1/4 1600/1375	2100/1800	2100/2030	45/53	50
3END4	40	136.4	480	3	24	48	1/2 1524/1420	3000/2600	3260/2900	49/42	60
2YU80	50.0/37.5	170/127	240/208	3	24	120.4/104.2	1/2 1525/1420	3000/2600	3260/2900	53/61	60
2YU81	50.0	170.5	480	3	24	60.2	1/2 1525/1420	3000/2600	3260/2900	53/61	60

(\*) These models are wired for direct line voltage control.

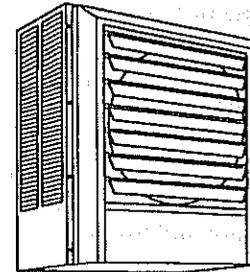


Figure 1



File #E154218

## Unpacking

Remove the heater from the box and inspect it for any damage. If it appears to be damaged, immediately return.

Check the contents of the box to make sure it contains one heating unit.

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# Dayton® Heavy-Duty Electric Unit Heaters

## General Safety Information

**⚠ WARNING** To prevent electrical shock, disconnect all power coming to heater at main service panel before wiring or servicing.

- All wiring must be in accordance with the National and Local Electrical Codes in the United States and the heater must be grounded as a precaution against possible electric shock.
- Verify the power supply voltage coming to heater matches the ratings printed on the heater nameplate before energizing.
- This heater is hot when in use. To avoid burns, do not let bare skin touch hot surfaces.
- Do not insert or allow foreign objects to enter any ventilation or exhaust opening, as this may cause an electric shock, fire, or damage to the heater.
- To prevent a possible fire, do not block air intakes or exhaust in any manner. Keep combustible materials, such as crates, drapes, etc., away from heater. Do not install behind door, furniture, towels, or boxes.
- A heater has hot and arcing or sparking parts inside. Do not use it in areas where gasoline, paint or flammable liquids are used or stored, or where volatile gases are present.
- Use this heater only as described in the manual. Any other use not recommended by the manufacturer may cause fire, electric shock, or injury to persons.
- This heater is not approved for use in corrosive atmospheres such as marine, green house or chemical storage areas.

**⚠ CAUTION** All built-in thermostats: If the heater is used to prevent piping or liquids from freezing, and if the thermostat is set below 45°F (7°C), the fan must run continuously.

## Installation

### LOCATION

**⚠ CAUTION** Heater must be mounted at least 7 feet above the floor to prevent accidental contact with the fan blade which could cause injury.

**⚠ CAUTION** To prevent possible overheating or damage due to overheating, keep at least a 5 foot clearance in front of the heater. Refer to Table 1 for side, top and back clearance requirements.

- Arrange units so their discharge air streams are subjected to a minimum of interference from columns and partitions.
- Direct air stream away from room occupants in comfort heating.
- Air streams should wipe exposed wall without blowing directly at them.
- Direct air stream along the windward side of a room when installed in a building exposed to a prevailing wind.
- If using a remote thermostat, locate thermostat approximately 5 feet above the floor on the interior

partition walls or posts away from cold drafts, internal heat sources, and away from heater discharge air streams.

- Large rooms require multi-unit installations. Arrange units to provide perimeter air circulation where each unit supports the air stream from another.

## MOUNTING

GENERAL (See Table 3, page 5, for Mounting Accessories)

- Position the heater so access door can be opened to provide access to the wiring and control compartment. If the heater is to be mounted with the access door facing a wall, the heater must be mounted far enough from that wall to allow full opening of the access door. (Approximately equal to the depth of the heater.) Refer to Table 1 below.
- Heater may be mounted for vertical or horizontal discharge by the use of threaded rods. Refer to Table 2.
- Optional mounting brackets permit horizontal pivoting of heater.
- Louvers may be positioned to direct heated air in desired direction. For horizontal discharge, louvers should direct air either straight ahead or downward.

Table 1 – Wall and Ceiling Clearance, inches (mm) / Mounting Brackets

Unit	Discharge	Ceiling	Side Wall	Back Wall	Optional Mounting Brackets
3 & 5 kW	Horiz.	2 (50.8)	6 (152.4)	9 (228.6)	2YV16
	Vert.	6 (152.4)	18 (457.2)	18 (457.2)	2YU84
7.5 to 10 kW	Horiz.	6 (152.4)	6 (152.4)	13 (330.2)	2YV16
	Vert.	6 (152.4)	24 (609.6)	24 (609.6)	2YU84
15 to 20 kW	Horiz.	6 (152.4)	9 (228.6)	12½ (317.5)	2YV17
	Vert.	6 (152.4)	24 (609.6)	24 (609.6)	2YU84
25 to 50 kW	Horiz.	16 (406.4)	12 (304.8)	18½ (470.0)	2YU91 & 2YU92
	Vert.	12 (304.8)	36 (914.4)	36 (914.4)	2YU85

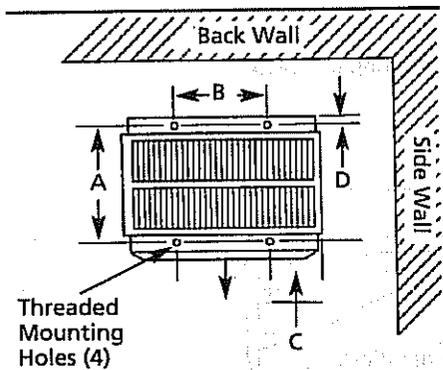
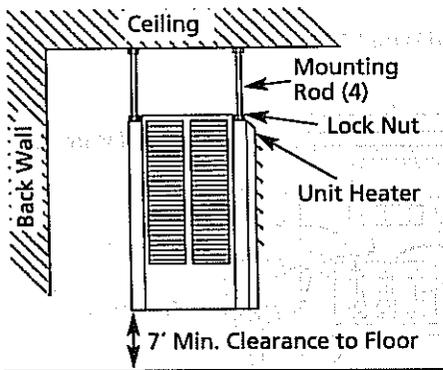
# Models 2YU58 thru 2YU81, 3END3 and 3END4

## Installation (Continued)

### ROD MOUNTING

#### HORIZONTAL DISCHARGE

1. Install four threaded mounting rods in the threaded holes and secure in place using lock nuts. (See Table 2).
2. Securely attach the four mounting rods to the ceiling. (Refer to Table 1 for wall and ceiling clearances, and Table 2 for mounting rod spacing).



**Figure 2 - Horizontal Discharge Mounting and Spacing**

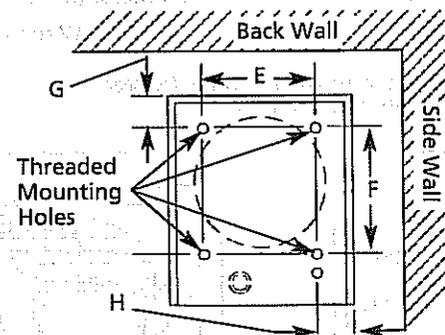
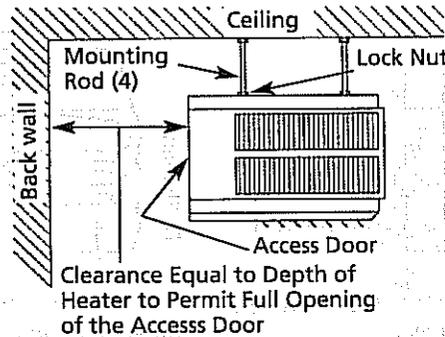
#### VERTICAL DISCHARGE

1. Remove bolts from the threaded holes in the back of the heaters.
2. Install four threaded mounting rods in the threaded holes and secure in place using lock nuts.

**Table 2 - Mounting Rod Spacing**

Unit	Rod Thread Type	(Figure 2) Horizontal				(Figure 3) Vertical			
		A	B	C	D	E	F	G	H
3 - 5kW	5/16-18	6 1/16"	6"	4 1/16"	3/4"	6"	9 3/4"	2"	4 3/16"
7.5 - 10	5/16-18	6 1/16	8 7/8	5 1/8	3/4	8 7/8	14 5/8	2	5 1/8
15 - 20	5/16-18	11 3/8	8 7/8	5 1/8	3/4	8 7/8	14 7/8	2	5 1/8
25 - 30	3/8-16	10 9/16	14 1/2	6 3/16	5/8	14 1/2	21 1/4	2 3/16	6 3/16
40 - 50	3/8-16	15 9/16	14 1/2	6 3/16	5/8	—	—	—	—

3. Securely attach the four mounting rods to the ceiling. (Refer to Table 1 for wall and ceiling clearances, and Table 2 for mounting rod spacing dimensions.)



**Figure 3 - Vertical Discharge Mounting and Rod Spacing**

### WIRING

#### BRANCH CIRCUIT (POWER)

1. Connect heater only to the voltage, amperage and frequency specified on the nameplate.

2. Field wiring must be properly sized to carry the amperage in accordance with the NEC.
3. The access door is hinged. There are either one or two screws accessible from the bottom that must be removed to gain access.
4. A knockout is provided in the back of the heater close to the power terminal board. The control terminal board knockout is 1/2 inch conduit size. The power terminal block knockout is multiple diameter. Use the diameter that fits the required conduit size.
5. A ground terminal is provided near the power terminal board. The ground wire should be connected before other connections are made.
6. The power terminal board is equipped with box terminals sized to accept the correct size power supply wire. Wire rated at 600V and 60°C is satisfactory for the heater branch circuit. Either aluminum or copper wire is satisfactory for connection to the heater power terminal board box terminal. Copper wire is recommended.
7. Each heater has a wiring diagram affixed to the inside of the access door. Consult this diagram before making any field connections.

# Dayton® Heavy-Duty Electric Unit Heaters

## Installation (Continued)

8. Single or three-phase connections may be used with heater models 2YU65, 2YU62, 2YU68, 2YU66, 2YU71, 2YU69, and 2YU74. These units are factory wired for single phase operation. If these heaters are for use with three-phase power, reconnect the wires as indicated in the wiring diagram attached to the heater. Additional information can be found

by looking at the wiring illustrations in Figures 4a and 4b and following the directions on next page.

On Models 2YU62, 2YU65, 2YU68, 2YU66, 2YU71, and 2YU69 (Figure 4a), move only the two wires marked "A1" and marked "B1"; do not move or change any other wiring. The element lead wire marked "B1" which is factory connected to the power terminal block (terminal

located closest to the elements) must be moved to terminal "B" on the three-phase terminal block.

The relay (contactor lead wire "A1") must be moved from the end terminal of the power terminal block (terminal closest to the contactor or control terminal board) to the "A" terminal of the lower terminal block (center terminal).

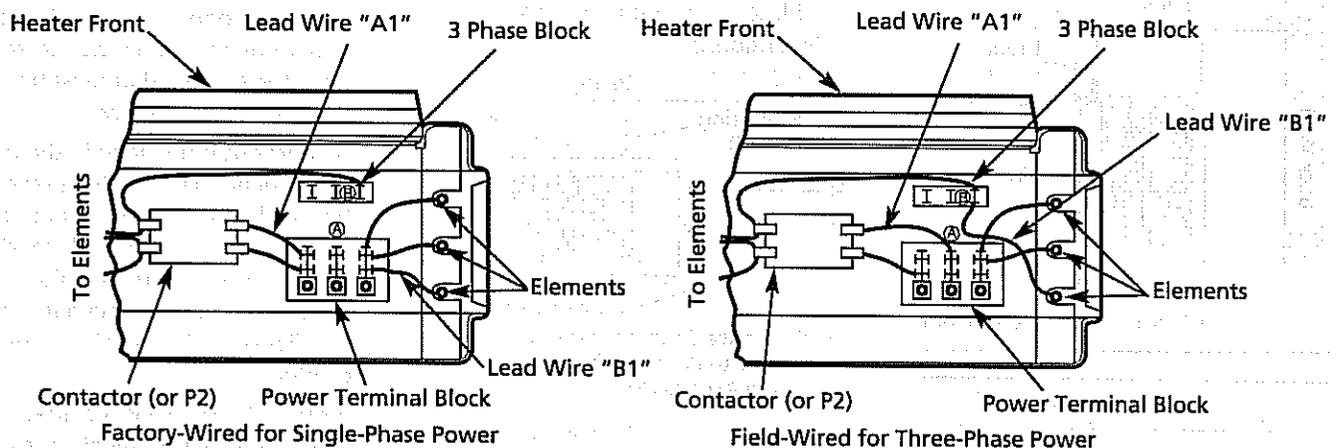


Figure 4a - Wiring Connections for Single-Phase and Three-Phase Power (2YU62, 2YU65, 2YU66, 2YU68, 2YU69 and 2YU71)

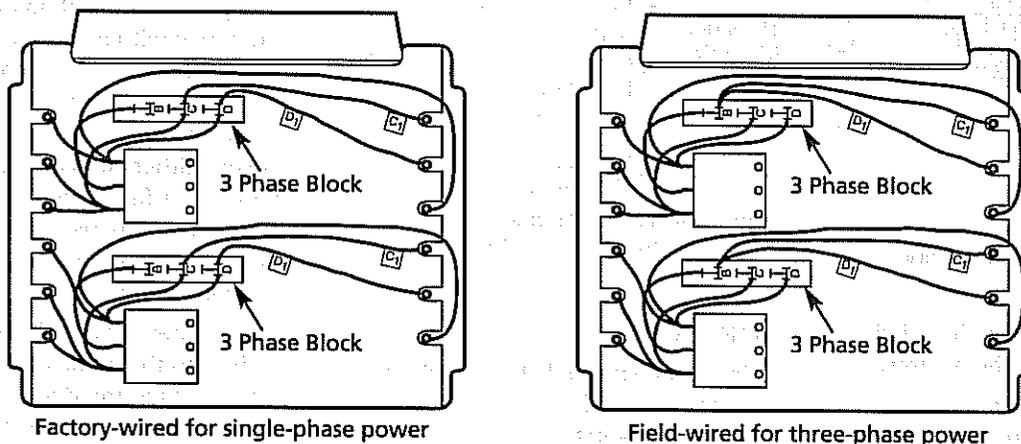


Figure 4b - Wiring Connections for Single-Phase and Three-Phase Power (2YU74)

# Models 2YU58 thru 2YU81, 3END3 and 3END4

## Installation (Continued)

Model 2YU74 (Figure 4b) has two three-phase terminal blocks located adjacent to the relays (contactors). Move only the two wires marked "C1" and "D1" on each of these two three-phase terminal blocks to terminal "B". Do not move or change any other wires.

9. Electrical Accessories, either kits or factory-installed options, are shown connected by a dashed line on the heater wiring diagram.

10. 208/240 VOLT HEATER. Interchange transformer red and black primary

leads (see wiring diagram on heater door) when the heater is to be connected to 208 volt supply.

### CONTROL WIRING

**⚠ WARNING** *Line voltage is present on some of the terminals on the control terminal board. Always disconnect the power from the heater before making any connections to the control board to prevent hazard.*

1. Use min. 600 volt, NEC Class 1 insulated wire for all control circuit wiring.
2. Use a crimp-on type fork terminal on the wire ends that attach to the

control terminal board if more than one connection is to be made under the terminal screw.

3. On units not provided with internal contactor (3 kW), refer to Figure 5, page 6, for wiring diagram.

**NOTE:** Thermostat and control circuit wiring must be suitable to handle the full load of the heater (example 2YU61 is rated 24 amps).

4. On units provided with internal contactor (units rated 5 kW and higher) refer to Figure 6, page 6 for wiring diagram. Control wiring must be rated minimum 18 AWG.

Table 3 – Optional Accessories

Electrical Accessory	Description	Product Compatibility Notes
2YU33	Single pole internal thermostat Temp range 40 F - 85 F	All Dayton Unit heaters
2YU95	Two stage internal thermostat Temp range 40 F - 85 F	Can only be used on 2YU58, 2YU60, 2YU61, 2YU74, 2YU77, 2YU79, 2YU80, and 2YU81.
2YU82	Internal Summer Fan Switch	All Dayton Unit heaters
2YU90	Internal Heat Recovery thermostat with relay (24 V coil - single pole normally open)	All Dayton Unit heaters except 2YU58, 2YU60, 2YU61, and 2YU64
2YU93	25 amp 3 pole power disconnect switch rated 25 Amps resistive @ 600 volts	Use only on 2YU58, 2YU59, 2YU60, 2YU61, 2YU62, 2YU63, 2YU64, 2YU65, 2YU67, 2YU70, 2YU73, 2YU76.
2YU94	60 amp 3 pole power disconnect switch rated 60 Amps resistive @ 600 volts	Use only on 2YU74 (when wired for 3 phase), 2YU66, 2YU69, 2YU72, 2YU76, 3END3, 3END4 and 2YU78
Mechanical Accessory	Description	Product Compatibility Notes
2YU34	Radial Diffuser Kit	Use only on 7.5 thru 20kW heaters (2YU66 thru 2YU76)
2YU83	Vertical Discharge Ceiling Mounting Bracket Kit	Use only on 3 and 5kW heaters (2YU58 thru 2YU65)
2YU84	Vertical Discharge Ceiling Mounting Bracket Kit	Use only on 7.5 thru 20kW heaters (2YU66 thru 2YU76)
2YU85	Vertical Discharge Ceiling Mounting Bracket Kit	Use only on 25 thru 50kW heaters (2YU77 thru 2YU81, 3END3 and 3END4)
2YV16	Universal Wall and Ceiling Mounting Bracket Kit	Use only on 3 thru 10kW heaters (2YU58 thru 2YU71)
2YV17	Universal Wall and Ceiling Mounting Bracket Kit	Use only on 15 and 20kW heaters (2YU72 thru 2YU76)
2YU91	Universal Wall and Ceiling Mounting Bracket Kit	Use only on 25kW and 30kW heaters (3END3, 2YU77, 2YU78, and 2YU79)
2YU92	Universal Wall and Ceiling Mounting Bracket Kit	Use only on 40kW and 50kW heaters (3END4, 2YU80 and 2YU81)

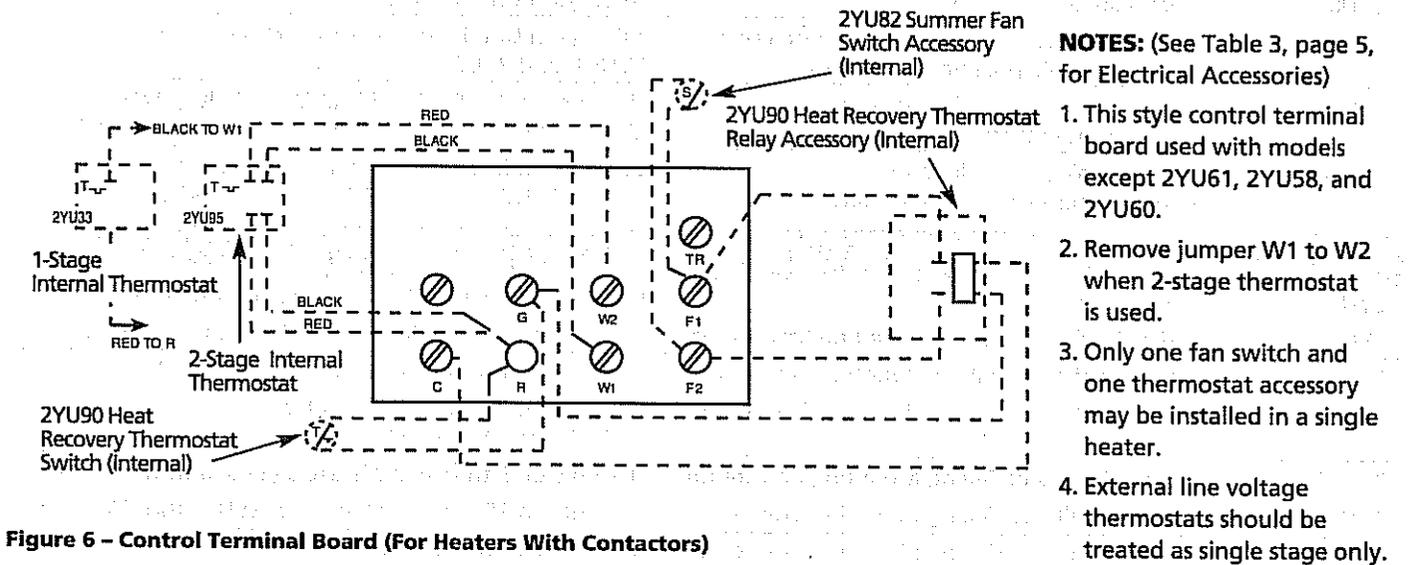
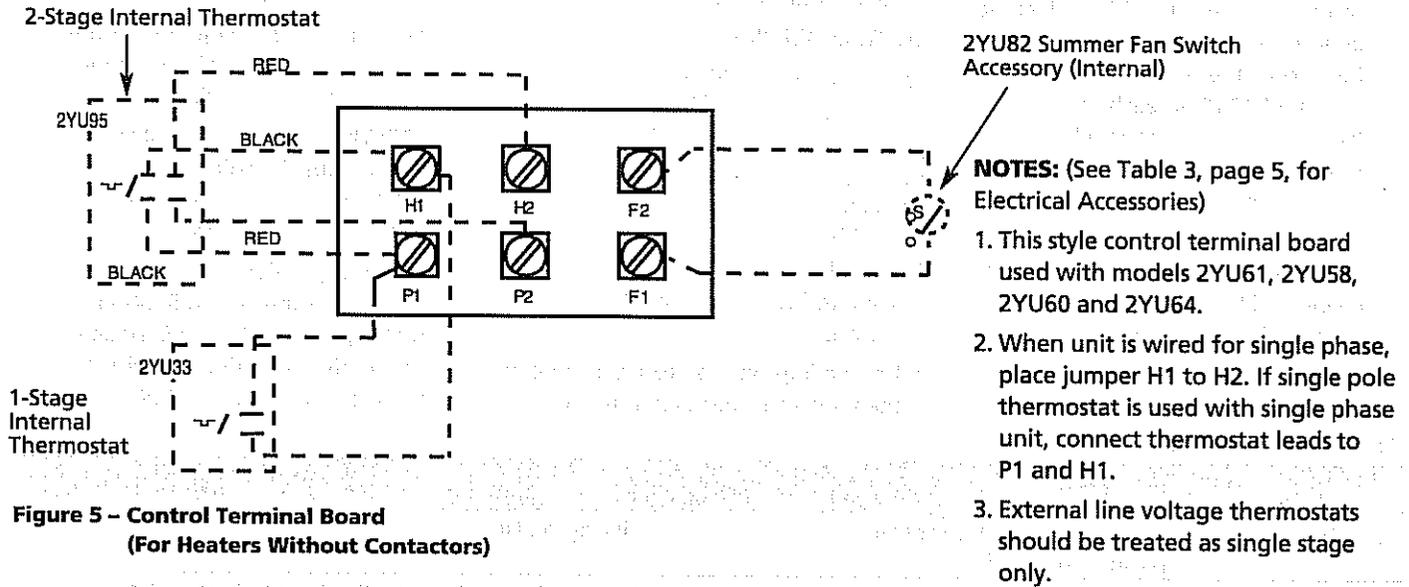
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# Dayton® Heavy-Duty Electric Unit Heaters

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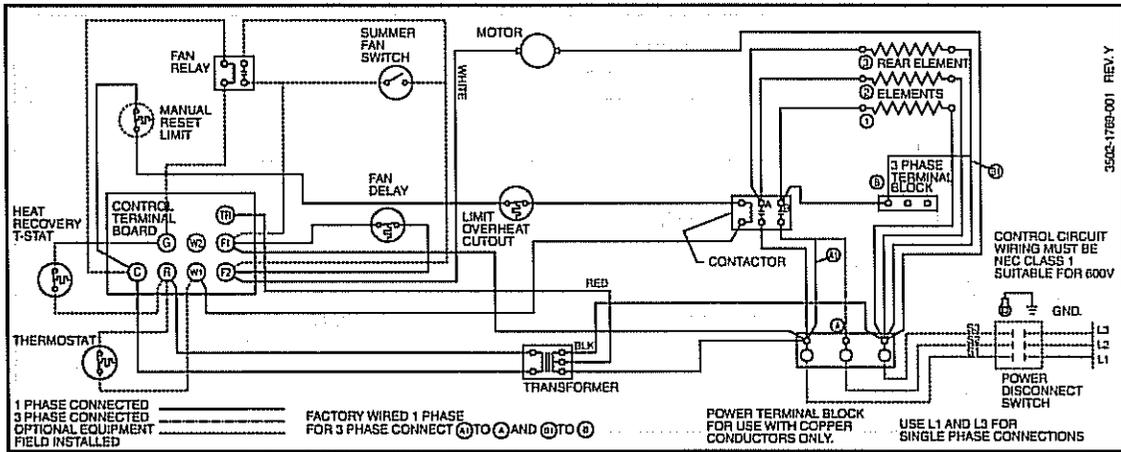
## Installation (Continued)



# Models 2YU58 thru 2YU81, 3END3 and 3END4

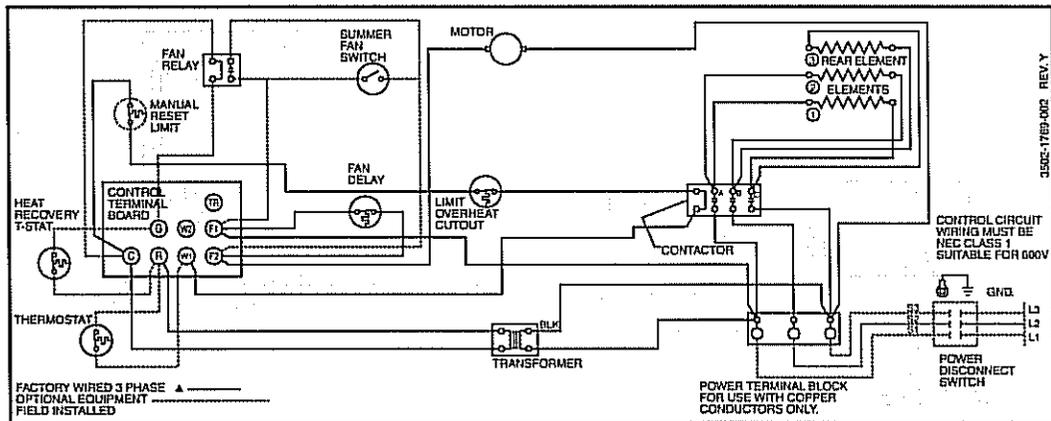
## Wiring Diagrams

Diagram 1



3 Element, Single and Three Phase (Models 2YU66 and 2YU69)

Diagram 2



3 Element, Three Phase (Models 2YU59, 2YU63, 2YU67 and 2YU70)

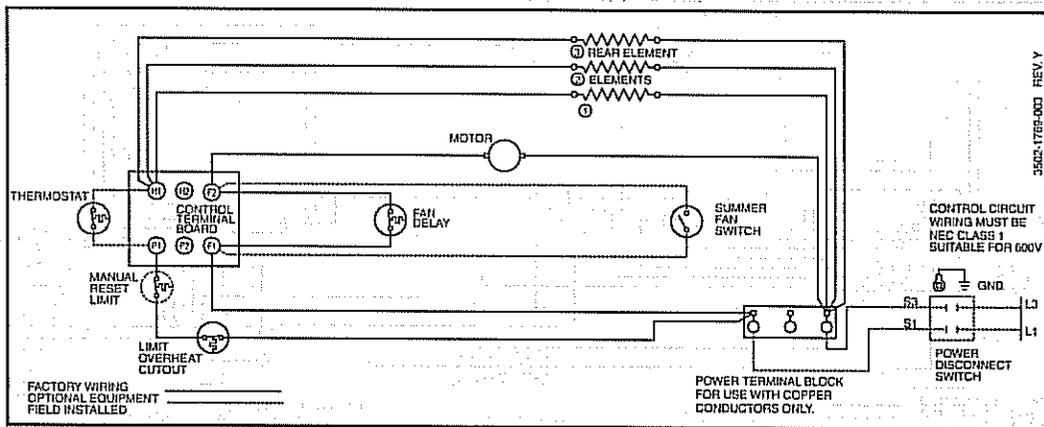
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# Dayton® Heavy-Duty Electric Unit Heaters

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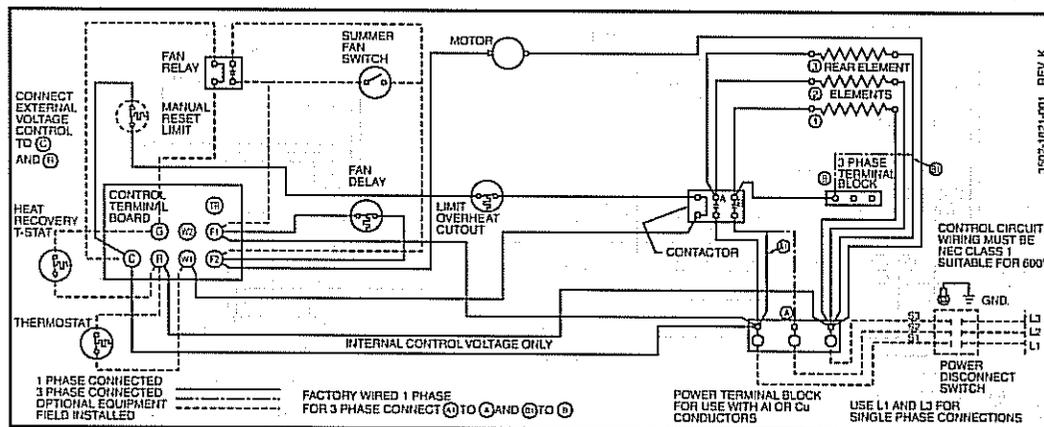
## Wiring Diagrams (Continued)

Diagram 3



3 Element, Single Phase (Models 2YU58, 2YU60, 2YU61 and 2YU64)

Diagram 4

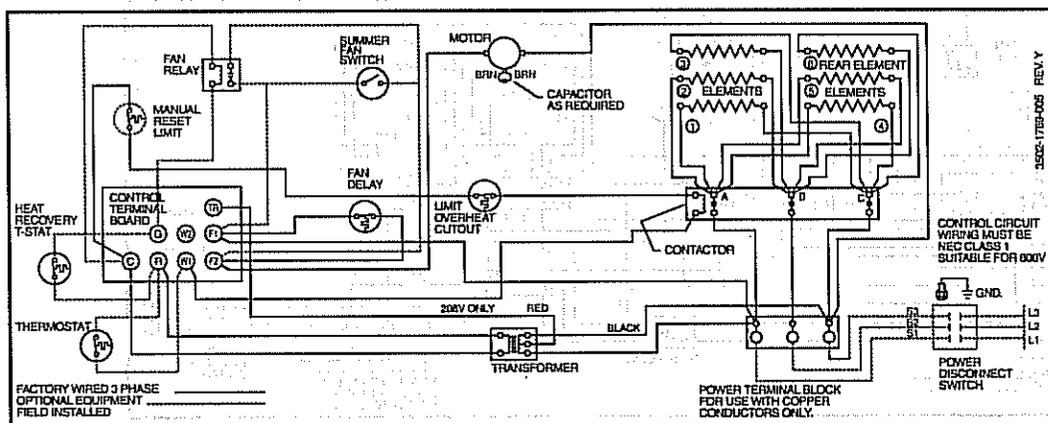


3 Element, Single and Three Phase (Models 2YU62 and 2YU65)

# Models 2YU58 thru 2YU81, 3END3 and 3END4

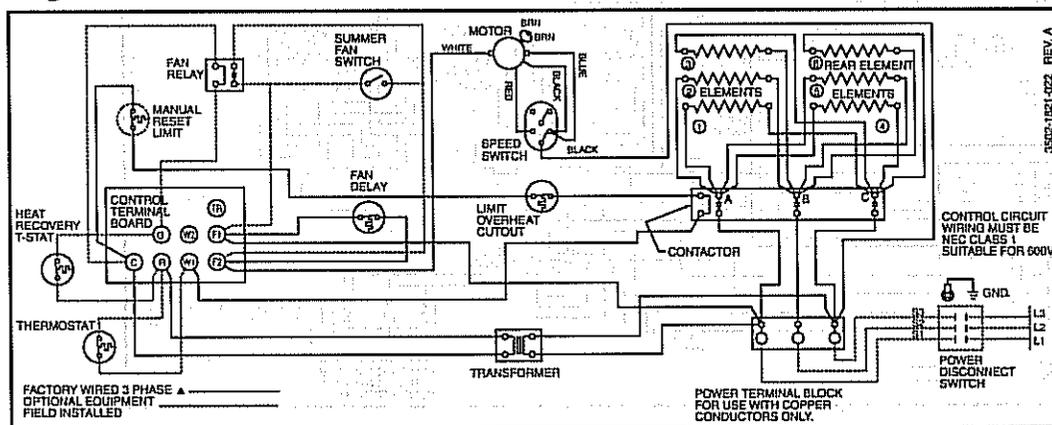
## Wiring Diagrams (Continued)

Diagram 5



6 Element, Three Phase (Models 2YU72, 2YU73, 2YU75 and 2YU76)

Diagram 6



6 Element, Three Phase (Model 3END3 and 2YU78)

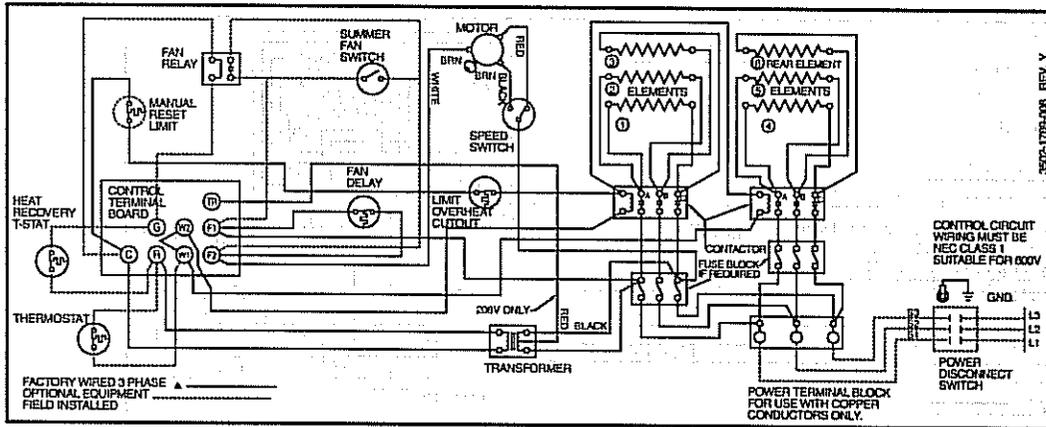
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# Dayton® Heavy-Duty Electric Unit Heaters

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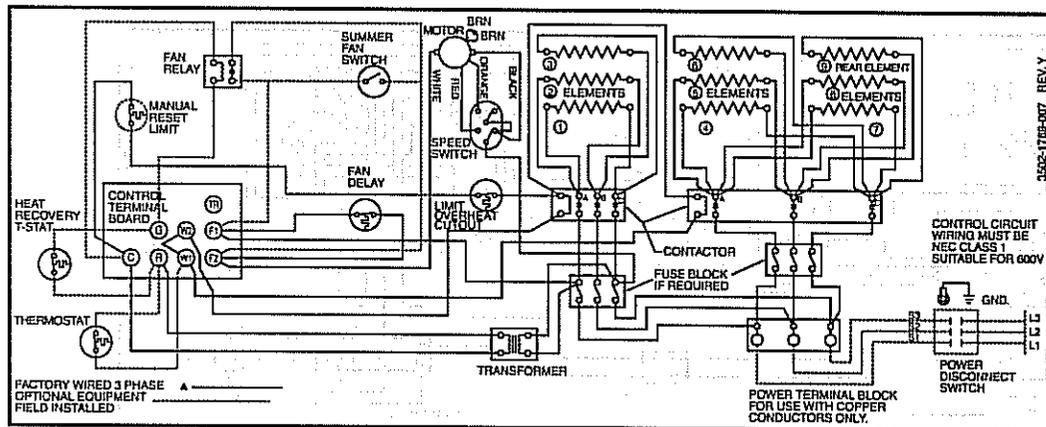
## Wiring Diagrams (Continued)

Diagram 7



6 Element, 2 Contactor, Three Phase (Model 2YU77)

Diagram 8

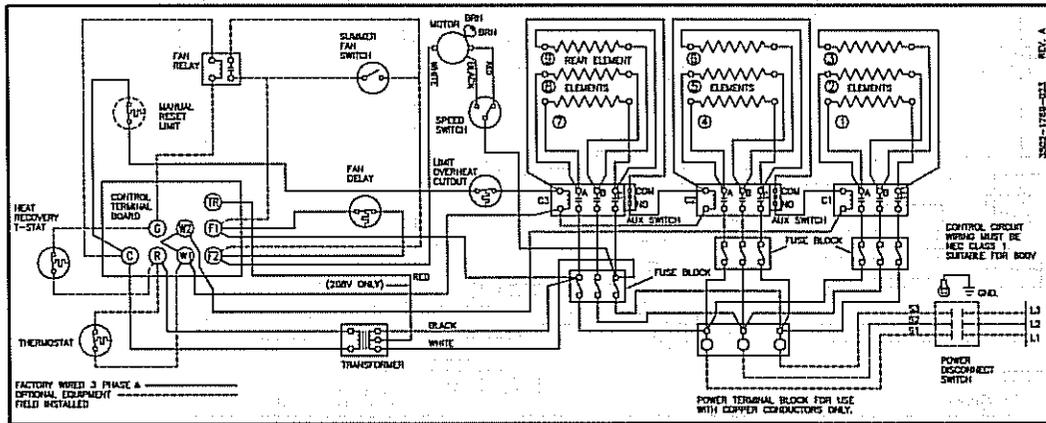


9 Element, 2 Contactor, Three Phase (Model 3END4 and 2YU81)

# Models 2YU58 thru 2YU81, 3END3 and 3END4

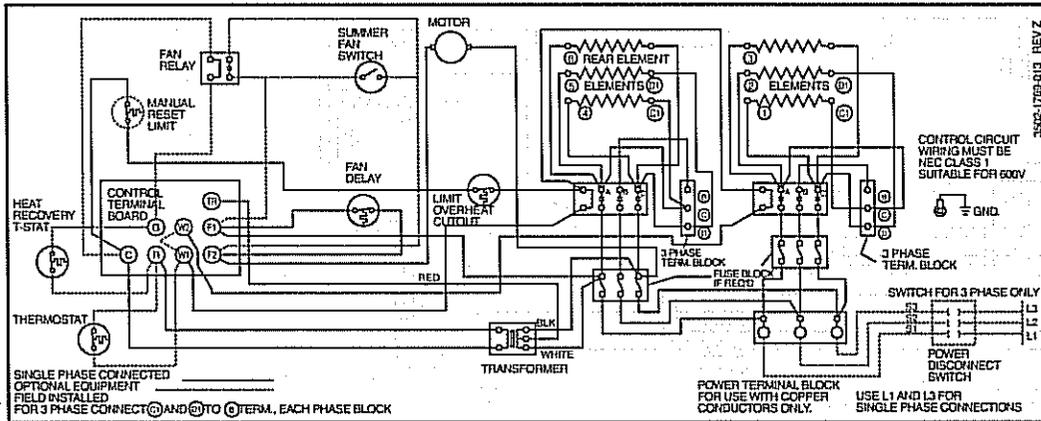
## Wiring Diagrams (Continued)

Diagram 9



9 Element, 3 Contactor, Three Phase (Model 2YU80)

Diagram 10



6 Element, 2 Contactor, Single and Three Phase (Model 2YU74)

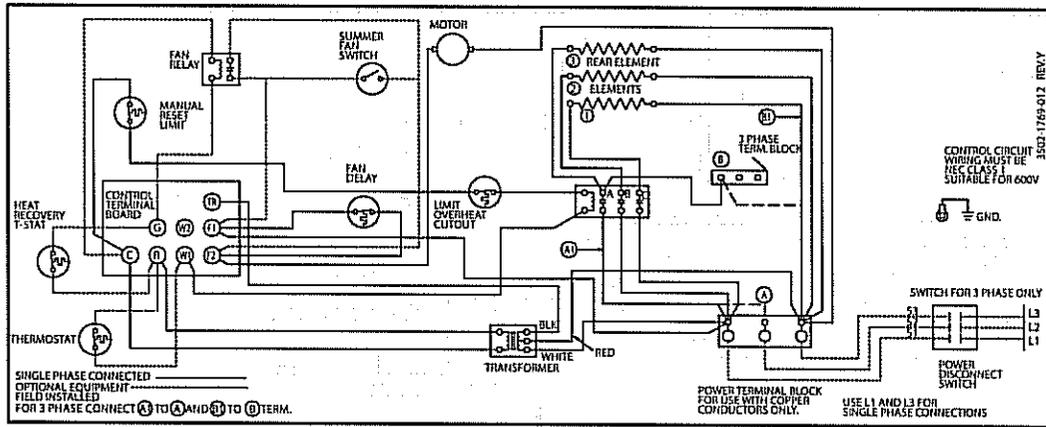
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# Dayton® Heavy-Duty Electric Unit Heaters

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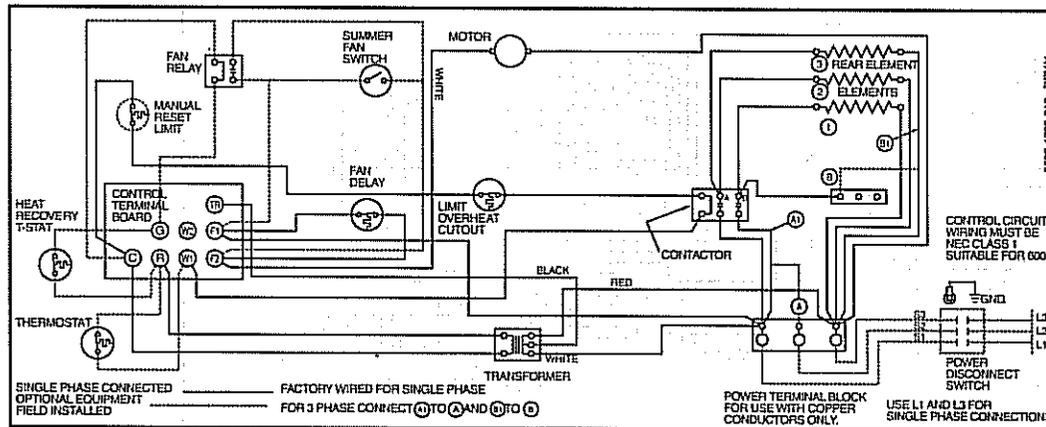
## Wiring Diagrams (Continued)

Diagram 11



3 Element, Single and Three Phase (Model 2YU71)

Diagram 12

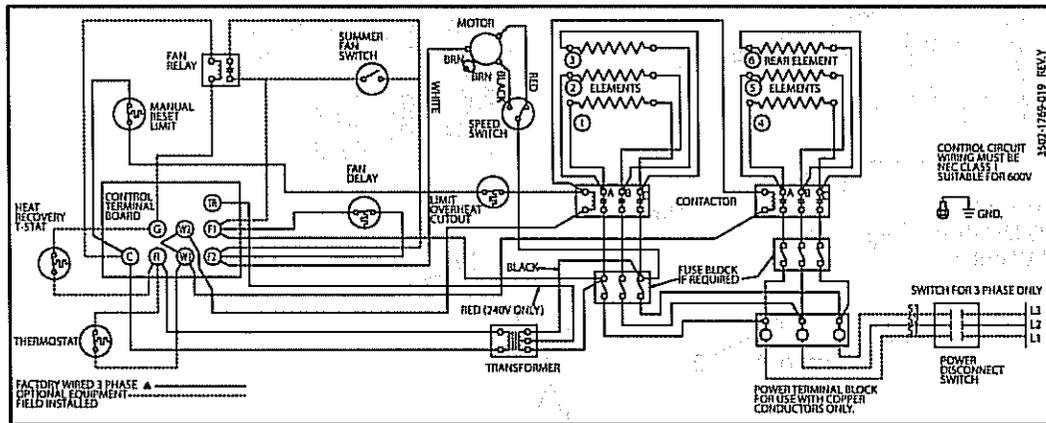


3 Element, Single and Three Phase (Model 2YU68)

# Models 2YU58 thru 2YU81, 3END3 and 3END4

## Wiring Diagrams (Continued)

Diagram 13



### 6 Element, 2 Contactor, Three Phase (Model 2YU79)

#### Maintenance

**▲ WARNING** *Make certain that the power source is disconnected before attempting to service or disassemble any component. If the power disconnect is out of the line of sight, lock it in the open position and tag it to prevent the application of power.*

#### ELECTRICAL

1. Once a year inspect the control panel wiring to make certain insulation is intact and all connections are tight. Inspect all heater and relay contacts. If the contacts appear badly pitted or burned, replace the contactor/relay.

2. For proper heater protection during operation, the correct size fuse must be used. The parts list contains the fuse size for all 30 and 50 kW units.

#### CLEANING

Clean the unit casing, fan and motor once a year. A dirty motor will tend to run hot and eventually will be damaged internally. Any rust spots on the casing should be cleaned and repainted.

#### LUBRICATION

All units up to 20 kW have fan motors that are permanently lubricated so that only occasional cleaning is required. Units above 20 kW have fan motors lubricated for 5 years of continuous duty or 10 years of intermittent operation. When required, remove the oil access plug on back of heater at motor intake grill, open oil cap, fill with S.A.E. No. 10 electric motor oil, replace plugs and access plug. Ensure that power is disconnected before attempting lubrication.

# For Repair Parts, call 1-800-323-0620

24 hours a day – 365 days a year

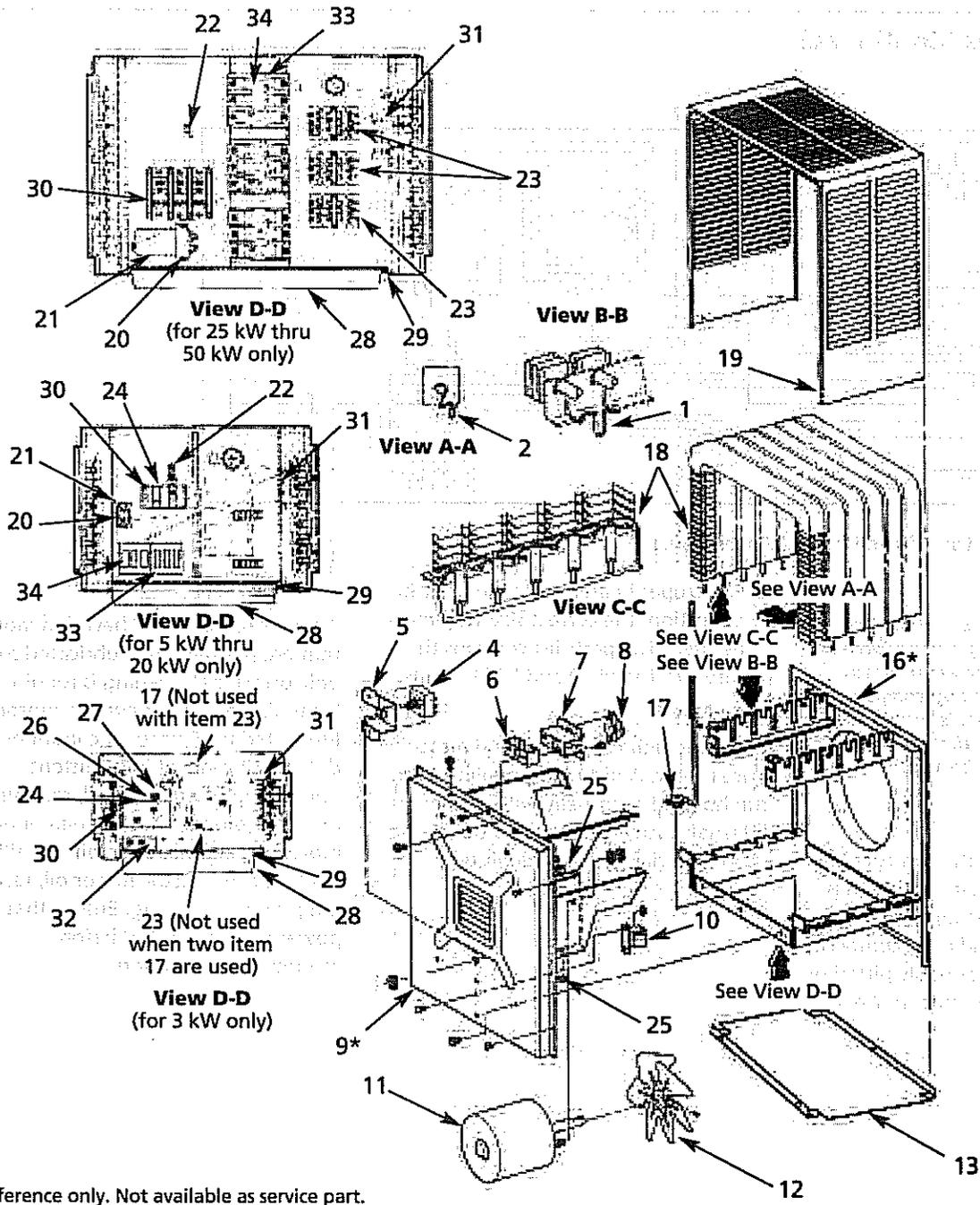
Please provide following information:

- Model number
- Serial number (if any)
- Part description and number as shown in parts list

Address parts correspondence to:

Grainger Parts  
 P.O. Box 3074  
 1657 Shermer Road  
 Northbrook, IL 60065-3074 U.S.A.

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(\* Reference only. Not available as service part.)

Figure 7 – Repair Parts Illustration for Heavy-Duty Electric Unit Heaters

# Repair Parts List for Heavy-Duty Electric Unit Heaters

E N G L I S H

Model	Ref. 1 Element Spring	Ref. 2 Capillary Tube Spring	Ref. 3 Element Retainer	Ref. 4 Switch	Ref. 5 Mounting Bracket	Ref. 6 Bracket Extension	Ref. 7 Switch Bracket	Ref. 8 Fan Delay	Ref. 10 Transformer
2YU58	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	—	4520 0010 000	—
2YU59	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	—	4520 0010 000	5814 0003 002
2YU60	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	—	4520 0010 000	—
2YU61	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	—	4520 0010 000	—
2YU62	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	—	4520 0010 000	—
2YU63	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	—	4520 0010 000	5814 0003 002
2YU64	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	—	4520 0010 000	—
2YU65	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	—	4520 0010 000	—
2YU66	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	—	4520 0010 000	5814 0003 000
2YU67	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	1215 0256 000	4520 0010 000	5814 0003 002
2YU68	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	1215 0256 000	4520 0010 000	5814 0003 000
2YU69	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	1215 0256 000	4520 0010 000	5814 0003 000
2YU70	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	1215 0256 000	4520 0010 000	5814 0003 002
2YU71	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	1215 0256 000	4520 0010 000	5814 0003 000
2YU72	5208 0073 000	5208 0072 000	5208 0074 000	—	—	1215 0282 000	1215 0256 000	4520 0010 000	5814 0003 000
2YU73	5208 0073 000	5208 0072 000	5208 0074 000	—	—	1215 0282 000	1215 0256 000	4520 0010 000	5814 0003 002
2YU74	5208 0073 000	5208 0072 000	5208 0074 000	—	—	1215 0282 000	1215 0256 000	4520 0010 000	5814 0003 000
2YU75	5208 0073 000	5208 0072 000	5208 0074 000	—	—	1215 0282 000	1215 0256 000	4520 0010 000	5814 0003 000
2YU76	5208 0073 000	5208 0072 000	5208 0074 000	—	—	1215 0282 000	1215 0256 000	4520 0010 000	5814 0003 002
2YU77	5208 0073 001	5208 0072 000	5208 0074 000	5216 2053 000	1215 2258 000	—	1215 0256 000	4520 0010 000	5814 0003 000
3END3	5208 0073 001	5208 0072 000	5208 0074 000	5216 2053 000	1215 2258 000	—	1215 0256 000	4520 0010 000	5814 0003 002
2YU78	5208 0073 001	5208 0072 000	5208 0074 000	5216 2053 000	1215 2258 000	—	1215 0256 000	4520 0010 000	5814 0003 002
2YU79	5208 0073 001	5208 0072 000	5208 0074 000	5216 2053 000	1215 2258 000	—	1215 0256 000	4520 0010 000	5814 0003 000
3END4	5208 0073 001	5208 0072 000	5208 0074 000	5216 2053 000	1215 2258 000	1215 0282 000	1215 0256 000	4520 0010 000	5814 0003 002
2YU80	5208 0073 001	5208 0072 000	5208 0074 000	5216 2053 000	1215 2258 000	1215 0282 000	1215 0256 000	4520 0010 000	5814 2021 001
2YU81	5208 0073 001	5208 0072 000	5208 0074 000	5216 2053 000	1215 2258 000	1215 0282 000	1215 0256 000	4520 0010 000	5814 0003 002

Model	Ref. 11 Motor	Ref. 12 Fan Blade	Ref. 13 Cover	Ref. 17 Linear Limit Protector	Ref. 18 Element Assy.	Ref. 19 Element Guard	Ref. 20 Clamp	Ref. 21 Capacitor	Ref. 22 Ground Lug
2YU58	3900 2002 006	1210 2000 000	1402 2166 001	4520 0011 000	1802 0087 000	1402 2163 001	—	—	—
2YU59	3900 2005 000	1210 2000 000	1402 2166 001	4520 0011 000	1802 0087 002	1402 2163 001	—	—	—
2YU60	3900 2002 007	1210 2000 000	1402 2166 001	4520 0011 000	1802 0087 001	1402 2163 001	—	—	—
2YU61	3900 2002 006	1210 2000 000	1402 2166 001	4520 0011 000	1802 0087 024	1402 2163 001	—	—	—
2YU62	3900 2002 006	1210 2000 000	1402 2166 001	4520 0011 000	1802 0087 003	1402 2163 001	—	—	—
2YU63	3900 2005 000	1210 2000 000	1402 2166 001	4520 0011 000	1802 0087 005	1402 2163 001	—	—	—
2YU64	3900 2002 007	1210 2000 000	1402 2166 001	4520 0011 000	1802 0087 004	1402 2163 001	—	—	—
2YU65	3900 2002 006	1210 2000 000	1402 2166 001	4520 0011 000	1802 0087 025	1402 2163 001	—	—	—
2YU66	3900 2014 004	1210 0090 000	1402 2167 002	4520 0011 001	1802 0087 006	1402 2164 002	—	—	3504 7002 001
2YU67	3900 0347 005	1210 0090 000	1402 2167 002	4520 0011 001	1802 0087 008	1402 2164 002	—	—	3504 7002 001
2YU68	3900 2014 004	1210 0090 000	1402 2167 002	4520 0011 001	1802 0087 031	1402 2164 002	—	—	3504 7002 001
2YU69	3900 2014 004	1210 0090 000	1402 2167 002	4520 0011 001	1802 0087 031	1402 2164 002	—	—	3504 7002 001
2YU70	3900 0347 005	1210 0090 000	1402 2167 002	4520 0011 001	1802 0087 011	1402 2164 002	—	—	3504 7002 001
2YU71	3900 2014 004	1210 0090 000	1402 2167 002	4520 0011 001	1802 0087 036	1402 2164 002	—	—	3504 7002 001
2YU72	3900 0361 000	1210 0090 001	1402 2167 003	4520 0011 001	1802 0087 012	1402 2164 003	—	—	3504 7002 001
2YU73	3900 0361 001	1210 0090 001	1402 2167 003	4520 0011 001	1802 0087 013	1402 2164 003	—	—	3504 7002 001
2YU74	3900 0361 000	1210 0090 001	1402 2167 003	4520 0011 001	1802 0087 037	1402 2164 003	—	—	3504 7002 001
2YU75	3900 0362 000	1210 0096 000	1402 2167 003	4520 0011 001	1802 0087 037	1402 2164 003	1417 5004 000	1432 0002 003	3504 7002 001
2YU76	3900 0362 001	1210 0096 000	1402 2167 003	4520 0011 001	1802 0087 015	1402 2164 003	1417 5004 000	1432 0002 003	3504 7002 001
2YU77	3900 0364 000	1210 0098 000	1402 2168 002	4520 0011 002	1802 0087 018	1402 2165 002	1417 5004 000	1432 0002 003	3504 7002 001
3END3	3900 2065 000	1210 0098 000	1402 2168 002	4520 0011 002	1802 0087 017	1402 2165 002	1417 5004 000	1432 0002 001	3504 7002 001
2YU78	3900 2065 000	1210 0098 000	1402 2168 002	4520 0011 002	1802 0087 019	1402 2165 002	1417 5004 000	1432 0002 001	3504 7002 001
2YU79	3900 0364 000	1210 0098 000	1402 2168 002	4520 0011 002	1802 0087 028	1402 2165 002	1417 5004 000	1432 0002 001	3504 7002 001
3END4	3900 0350 001	1210 0097 000	1402 2168 003	4520 0011 002	1802 0087 021	1402 2165 003	1417 5004 000	1432 0002 004	3504 7002 001
2YU80	3900 0350 000	1210 0097 000	1402 2168 003	4520 0011 002	1802 0087 022	1402 2165 003	1417 5004 000	1432 0002 004	3504 7002 001
2YU81	3900 0350 001	1210 0097 000	1402 2168 003	4520 0011 002	1802 0087 023	1402 2165 003	1417 5004 000	1432 0002 004	3504 7002 001

**NOTE:** 9 and 16 reference only. Not available as a service part.



# For Repair Parts, call 1-800-323-0620

24 hours a day - 365 days a year

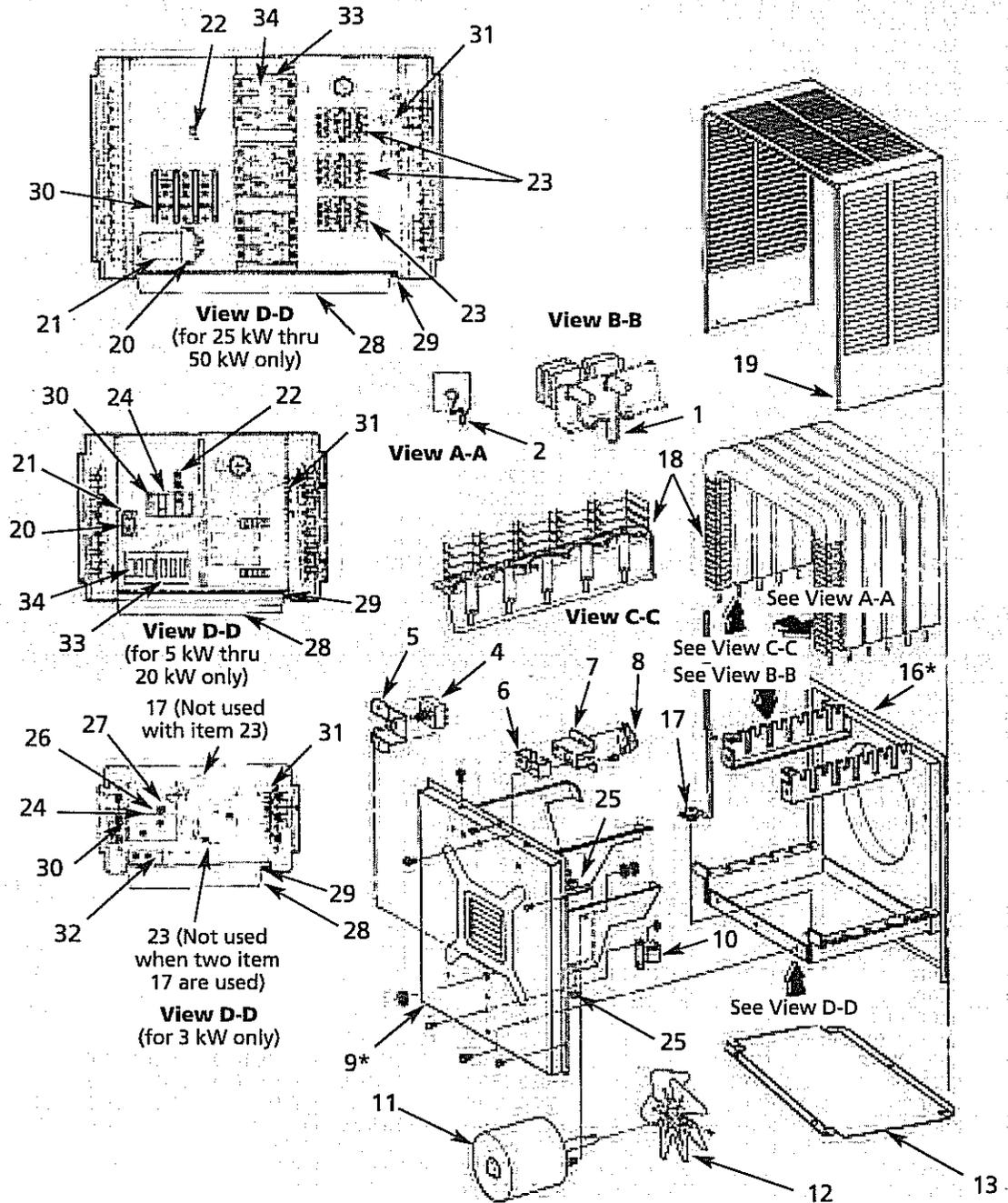
Please provide following information:

- Model number
- Serial number (if any)
- Part description and number as shown in parts list

Address parts correspondence to:

Grainger Parts  
 P.O. Box 3074  
 1657 Shermer Road  
 Northbrook, IL 60065-3074 U.S.A.

ENGLISH



(\*). Reference only. Not available as service part.

Figure 8 - Repair Parts Illustration for Heavy-Duty Electric Unit Heaters (Continued)

# Repair Parts List for Heavy-Duty Electric Unit Heaters (Continued)

Model	Ref. 23 Relay	Ref. 24 Insulator	Ref. 25 Bushing	Ref. 26 Ground Washer	Ref. 27 Ground Screw	Ref. 28 Louver	Ref. 29 Spring Louver	Ref. 30 Terminal Block, Power	Ref. 31 Terminal Block, Control
2YU58	—	—	—	6401 0084 000	5202 0290 002	3503 2004 003	5208 7005 001	5823 0004 000	5823 0001 000
2YU59	5018 0004 100	2900 0030 000	—	6401 0084 000	5202 0290 002	3503 2004 003	5208 7005 001	5823 0004 000	5823 0002 000
2YU60	—	2900 0030 000	—	6401 0084 000	5202 0290 002	3503 2004 003	5208 7005 001	5823 0004 000	5823 0001 000
2YU61	—	—	—	6401 0084 000	5202 0290 002	3503 2004 003	5208 7005 001	5823 0004 000	5823 0001 000
2YU62	5018 0003 002	—	—	6401 0084 000	5202 0290 002	3503 2004 003	5208 7005 001	5823 0004 000	5823 0002 000
2YU63	5018 0004 100	2900 0030 000	—	6401 0084 000	5202 0290 002	3503 2004 003	5208 7005 001	5823 0004 000	5823 0002 000
2YU64	—	2900 0030 000	—	6401 0084 000	5202 0290 002	3503 2004 003	5208 7005 001	5823 0004 000	5823 0002 000
2YU65	5018 0003 002	—	—	6401 0084 000	5202 0290 002	3503 2004 003	5208 7005 001	5823 0004 000	5823 0002 000
2YU66	5018 0003 000	—	—	—	—	3503 2004 004	5208 7005 001	5823 0004 000	5823 0002 000
2YU67	5018 0004 100	2900 0030 000	—	—	—	3503 2004 004	5208 7005 001	5823 0004 000	5823 0002 000
2YU68	5018 0003 000	—	—	—	—	3503 2004 004	5208 7005 001	5823 0004 000	5823 0002 000
2YU69	5018 0003 000	—	—	—	—	3503 2004 004	5208 7005 001	5823 0004 000	5823 0002 000
2YU70	5018 0004 100	2900 0030 000	—	—	—	3503 2004 004	5208 7005 001	5823 0004 000	5823 0002 000
2YU71	5018 0004 100	—	—	—	—	3503 2004 004	5208 7005 001	5823 0004 000	5823 0002 000
2YU72	5018 0005 004	—	—	—	—	3503 2004 004	5208 7005 001	5823 0004 001	5823 0002 000
2YU73	5018 0004 100	2900 0030 000	—	—	—	3503 2004 004	5208 7005 001	5823 0004 000	5823 0002 000
2YU74	5018 0005 004	—	—	—	—	3503 2004 004	5208 7005 001	5823 0004 003	5823 0002 000
2YU75	5018 0006 000	—	—	—	—	3503 2004 004	5208 7005 001	5823 0004 002	5823 0002 000
2YU76	5018 0004 100	2900 0030 000	—	—	—	3503 2004 004	5208 7005 001	5823 0004 000	5823 0002 000
2YU77	5018 0005 004	—	25221-60131	—	—	3503 2004 005	5208 7005 001	5823 0004 003	5823 0002 000
3END3	5018 0005 004	2900 0030 000	25221-60131	—	—	3503 2004 005	5208 7005 001	5823 0004 001	5823 0002 000
2YU78	5018 0005 004	2900 0030 000	25221-60131	—	—	3503 2004 005	5208 7005 001	5823 0004 001	5823 0002 000
2YU79	5018 0006 000	—	25221-60131	—	—	3503 2004 005	5208 7005 001	5823 0005 000	5823 0002 000
3END4	5018 0005 004	2900 0030 000	25221-60131	—	—	3503 2004 005	5208 7005 001	5823 0004 002	5823 0002 000
2YU80	5018 0005 004	—	25221-60131	—	—	3503 2004 005	5208 7005 001	5823 0005 000	5823 0002 000
2YU81	*	2900 0030 000	25221-60131	—	—	3503 2004 005	5208 7005 001	5823 0004 002	5823 0002 000

Model	Ref. 32 Terminal Block 3 Phase	Ref. 33 Fuse Block	Ref. 34 Fuse
2YU58	—	—	—
2YU59	—	—	—
2YU60	—	—	—
2YU61	—	—	—
2YU62	5823 0003 000	—	—
2YU63	—	—	—
2YU64	—	—	—
2YU65	5823 0003 000	—	—
2YU66	5823 0003 000	—	—
2YU67	—	—	—
2YU68	5823 0003 000	—	—
2YU69	5823 0003 000	—	—
2YU70	—	—	—
2YU71	5823 0003 000	—	—
2YU72	—	—	—
2YU73	—	—	—
2YU74	5823 0003 000	2025 0002 000	2019 0007 010
2YU75	—	—	—
2YU76	—	—	—
2YU77	—	2025 7002 000	2019 7008 079
3END3	—	—	—
2YU78	—	—	—
2YU79	—	2025 7002 000	2019 7008 080
3END4	—	—	—
2YU80	—	2025 7002 000	2019 7008 080
2YU81	—	—	—

(\*) Two relays are used: 35A relay P/N, 5018 0004 100, and 50A relay, P/N 5018 0006 000.

## For Repair Parts, call 1-800-323-0620

24 hours a day – 365 days a year

Please provide following information:

- Model number
- Serial number (if any)
- Part description and number as shown in parts list

Address parts correspondence to:

Grainger Parts  
P.O. Box 3074  
1657 Shermer Road  
Northbrook, IL 60065-3074 U.S.A.

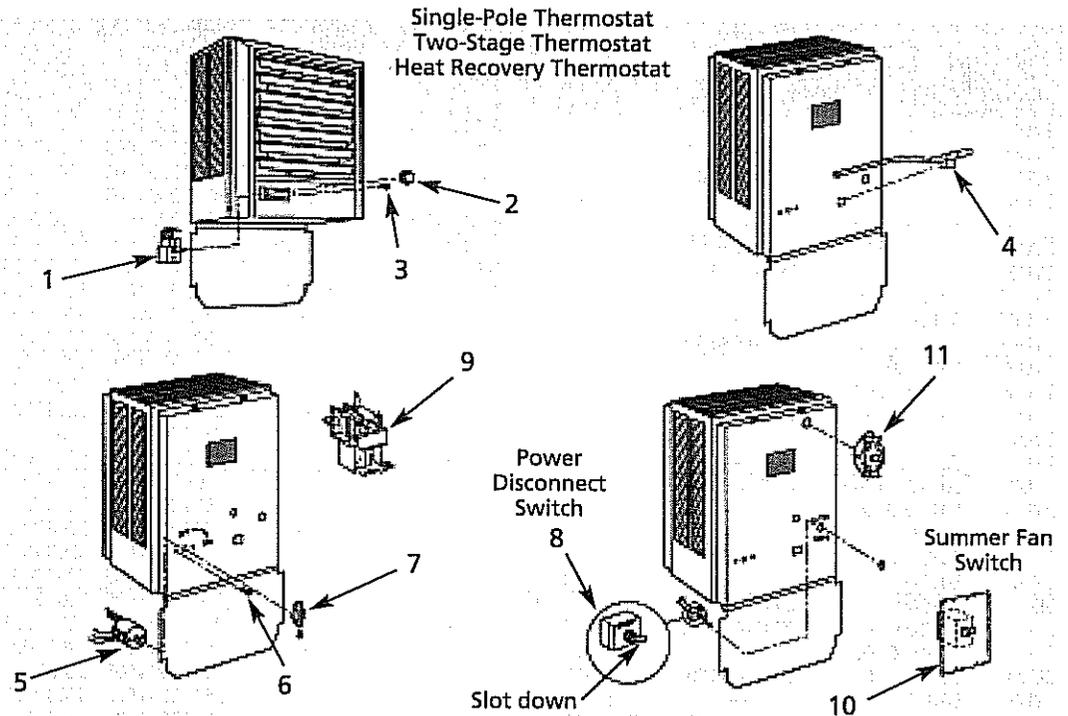


Figure 9 – Repair Parts Illustration for Heavy-Duty Electric Unit Heaters

### Repair Parts List for Heavy-Duty Electric Unit Heaters

Reference Number	Description	Part Number	Quantity
1	One Pole Thermostat	5813 0036 000	1
1	Two Stage Thermostat	5813 0035 000	1
2	Thermostat Knob	3301 2020 0051	1
3	Screws	5202 7009 021	2
4	Thermostat Clip	1403 0041 000	1
5	25A, OEM Switch	5216 0132 000	1
5	25A, K & N Switch	5216 0204 000	1
5	63A, OEM Switch	5216 0131 000	1
5	63A, K & N Switch	5216 0200 000	1
6	Screw, M4 x 10, Rd. Hd. (25A)		1
6	Screw, 63A, M5 x 16, Rd. Hd.		1
7	Knob, 25A, OEM "T1"	OEM "T1"	1
7	Knob, 25A, K & N	K & N S1B 6001	1
7	Knob, 63A, OEM	OEM "S4"	1
7	Knob, 63A, K & N	K & N S2B G001	1
8	Switch, Toggle, 600V	5216 2011 000	1
9	Relay, Fan 24V Coil	5018 0008 000	1
10	Switch Assembly	5216 0199 000	1
11	Manual Reset Limit	4520 0012 000	1

# Models 2YU58 thru 2YU81, 3END3 and 3END4

## Troubleshooting Chart

Symptom	Possible Cause(s)	Corrective Action
Thermostat calls for heat, but heater does not function	<ol style="list-style-type: none"> <li>1. Open (blown) fuse</li> <li>2. Incorrect wiring</li> <li>3. Thermal cut-out open, de-energizing heater element and control circuit</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace fuses, check for cause (See Repair Parts List for fuse size)</li> <li>2. Check wiring connections</li> <li>3. Check for the following: Correct supply volts &amp; phase Correct control wiring (heater control must be thru thermostat control wiring section only) Power interruption to heater during heater operation Restriction of air around heater 1-5 minute fan purge after thermostat off</li> </ol>
Fan motor runs "hot"	<ol style="list-style-type: none"> <li>1. Dust accumulation or excessive dirt on fan motor</li> <li>2. Dirt accumulation</li> <li>3. Motor needs lubrication</li> </ol>	<ol style="list-style-type: none"> <li>1. Clean fan motor and casing of grease and oil accumulation</li> <li>2. Clean louvers and between heating elements</li> <li>3. See Maintenance</li> </ol>
Fan motor runs, but no heat	<ol style="list-style-type: none"> <li>1. Element contact not operating correctly</li> <li>2. Element fuse blown</li> </ol>	<ol style="list-style-type: none"> <li>1. Check wiring for open circuit. Replace contactor if defective</li> <li>2. Replace fuses, check for cause.</li> </ol>

# Dayton® Heavy-Duty Electric Unit Heaters

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## LIMITED WARRANTY

Dayton One-Year Limited Warranty. Dayton® Heavy-Duty Electric Unit Heaters, Models covered in this manual, are warranted by Dayton Electric Mfg. Co. (Dayton) to the original user against defects in workmanship or materials under normal use for one year after date of purchase. Any part which is determined to be defective in material or workmanship and returned to an authorized service location, as Dayton designates, shipping costs prepaid, will be, as the exclusive remedy, repaired or replaced at Dayton's option. For limited warranty claim procedures, see PROMPT DISPOSITION below. This limited warranty gives purchasers specific legal rights which vary from jurisdiction to jurisdiction.

**LIMITATION OF LIABILITY.** To the extent allowable under applicable law, Dayton's liability for consequential and incidental damages is expressly disclaimed. Dayton's liability in all events is limited to and shall not exceed the purchase price paid.

**WARRANTY DISCLAIMER.** Dayton has made a diligent effort to provide product information and illustrate the products in this literature accurately; however, such information and illustrations are for the sole purpose of identification, and do not express or imply a warranty that the products are MERCHANTABLE, or FIT FOR A PARTICULAR PURPOSE, or that the products will necessarily conform to the illustrations or descriptions. Except as provided below, no warranty or affirmation of fact, expressed or implied, other than as stated in the "LIMITED WARRANTY" above is made or authorized by Dayton.

**PRODUCT SUITABILITY.** Many jurisdictions have codes and regulations governing sales, construction, installation, and/or use of products for certain purposes, which may vary from those in neighboring areas. While Dayton attempts to assure that its products comply with such codes, it cannot guarantee compliance, and cannot be responsible for how the product is installed or used. Before purchase and use of a product, review the product applications, and all applicable national and local codes and regulations, and be sure that the product, installation, and use will comply with them.

Certain aspects of disclaimers are not applicable to consumer products; e.g., (a) some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you; (b) also, some jurisdictions do not allow a limitation on how long an implied warranty lasts, consequentially the above limitation may not apply to you; and (c) by law, during the period of this Limited Warranty, any implied warranties of implied merchantability or fitness for a particular purpose applicable to consumer products purchased by consumers, may not be excluded or otherwise disclaimed.

**PROMPT DISPOSITION.** Dayton will make a good faith effort for prompt correction or other adjustment with respect to any product which proves to be defective within limited warranty. For any product believed to be defective within limited warranty, first write or call dealer from whom the product was purchased. Dealer will give additional directions. If unable to resolve satisfactorily, write to Dayton at address below, giving dealer's name, address, date, and number of dealer's invoice, and describing the nature of the defect. Title and risk of loss pass to buyer on delivery to common carrier. If product was damaged in transit to you, file claim with carrier.

Manufactured for Dayton Electric Mfg. Co., 5959 W. Howard St., Niles, Illinois 60714 U.S.A.



**WHITE-RODGERS**

## TEMPERATURE CONTROL SPDT Remote Bulb INSTALLATION INSTRUCTIONS

**Operator: Save these instructions for future use!**

**FAILURE TO READ AND FOLLOW ALL INSTRUCTIONS CAREFULLY  
BEFORE INSTALLING OR OPERATING THIS CONTROL COULD CAUSE  
PERSONAL INJURY AND/OR PROPERTY DAMAGE.**

### DESCRIPTION

This control is designed for use on equipment that requires a closed circuit for both rise and fall in temperature. The single pole, double throw switch action offers both open-on-rise terminals as well as close-on-rise terminals.

This control has capillary tubing between the temperature sensitive bulb and the switch mechanism, permitting the switch mechanism to be mounted at any convenient location while the temperature sensitive bulb is located in the fluid or medium being controlled.

### PRECAUTIONS

THIS CONTROL MUST BE INSTALLED BY A QUALIFIED INSTALLER.

All wiring must conform to local and national electrical codes and ordinances.

This control is a precision instrument, and should be handled carefully. Rough handling or distorting components could cause the control to malfunction.

This control has been accurately calibrated at the factory. Any attempt to calibrate this control will void the White-Rodgers warranty.

#### **⚠ WARNING**

**Do not use on circuits exceeding specified voltages. Higher voltages will damage control and could cause shock or fire hazard.**

**If in doubt about whether your wiring is millivolt, low or line voltage, have it inspected by a qualified heating and air conditioning contractor or a licensed electrician.**

#### **⚠ CAUTION**

**To prevent electrical shock and/or equipment damage, disconnect electric power to system at main fuse or circuit breaker box until installation is complete.**

**Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation.**

**Following installation or replacement, follow appliance manufacturers' recommended installation/service instructions to insure proper operation.**

### INSTALLATION

The switch mechanism of this control may be mounted in any location, provided that the temperature and humidity of the air in which it is located do not cause a condensation on the switch parts.

The sensitive element, or "bulb", should be located in the **average temperature** of the controlled area.

Capillary tubing should be led over a path that protects it from damage from blows, cuts, etc., and should be installed without kinking or twisting. The tubing should be

attached to some surface at frequent intervals along its length, and should not hang loosely. Excess tubing should be coiled and secured at a convenient protected location close to the switch mechanism.

The bulb should be handled with reasonable care, as a dent or sharp bend may change the calibration and cause the control to cycle at a temperature different from the dial setting.



WHITE-RODGERS DIVISION  
EMERSON ELECTRIC CO.  
9797 REAVIS RD., ST. LOUIS, MO. 63123-5398  
(314) 577-1300, FAX (314) 577-1517  
9999 HWY. 48, MARKHAM, ONT. L3P 3J3  
(905) 475-4653, FAX (905) 475-4625

Printed in U.S.A.

**PART NO. 37-1637C**

Replaces 37-1637B

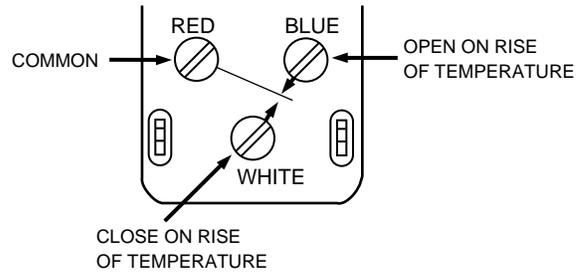
9722

## Wiring

All wiring must conform to local and national electrical codes and ordinances.

Connect in accordance with the wiring diagrams provided by the equipment manufacturer.

This control has a single-pole, double-throw, snap-action switch. The top left-hand terminal (red) is the common terminal. The top right-hand terminal (blue) has an open-on-rise switch action. The bottom center terminal (white) has close-on-rise switch action.

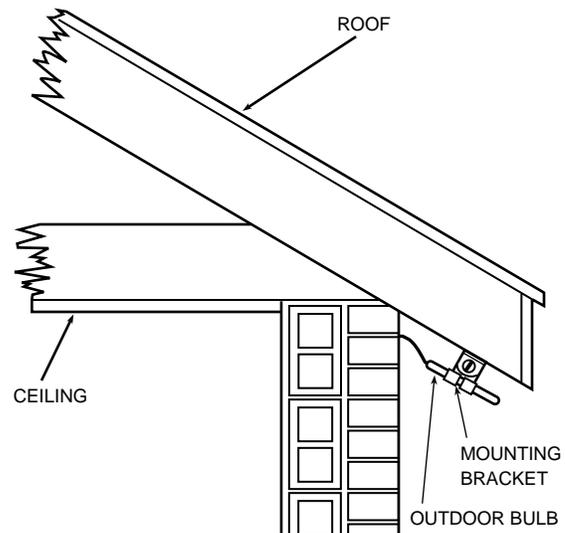


## INSTALLATION AS AN OUTDOOR BULB

When used as a changeover control or outdoor thermostat, the bulb of this control should be located to measure the actual outdoor air temperature. A mounting bracket is provided for mounting the bulb.

The mounting bracket should be fastened to some convenient outside part of the building that is shielded from the direct rays of the sun, the direct fall of rain and snow, and sufficiently above ground to keep it out of snow and ice.

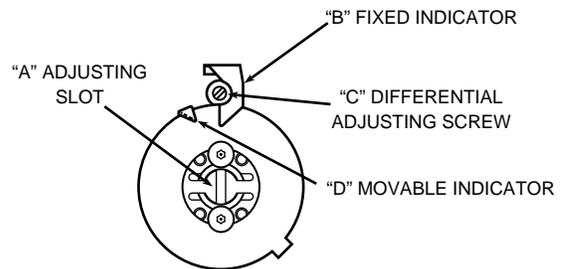
The underside of the eaves or overhang of a NORTH or NORTHEAST roof is a good location. It should be exposed to the circulation of air and wind.



## SETTING THE DIAL

The fixed indicator (B) points to temperature at which the "R-B" contacts close and the "R-W" contacts open. Follow these instructions to set the dial.

1. Insert a screwdriver in the adjusting slot (A) and turn the dial until the fixed indicator (B) points to the lowest temperature of the cycle.
2. Turn the differential adjusting screw (C) until the moveable indicator (D) points to the highest temperature of the cycle.



**Please read and save these instructions.** Read carefully before attempting to assemble, install, operate or maintain the product described. Protect yourself and others by observing all safety information. Failure to comply with instructions could result in personal injury and/or property damage! Retain instructions for future reference.

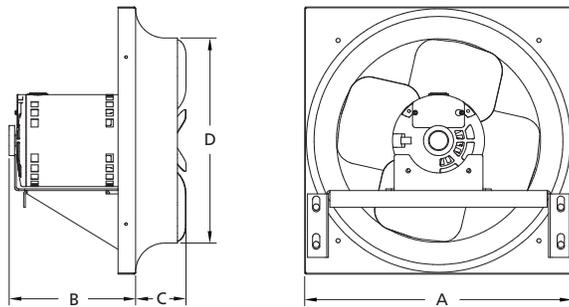
# Dayton® Direct-Drive Exhaust Fans

## Description

Dayton exhaust fans are designed for commercial and industrial applications. Commercial units quietly exhaust high volumes of air for ventilating schools, offices, storage facilities and light manufacturing and assembly areas. Industrial units exhaust larger volumes of air at higher static pressures for ventilating factories, foundries and other industrial environments. Mount in vertical or horizontal position (vertical only for fans with intake guards). Construction includes galvanized steel frame, pre-punched mounting holes, and aluminum propeller. Motor is totally enclosed air over, with Class B insulation and ball bearings, except sleeve bearings on 10D952 thru 10D956. All fans have a maximum ambient temperature of 104°F and are UL/cUL Listed Standard 705.

## Optional Accessories

Description	General or UL 705 Model No.'s
Aluminum Wall Shutter:	4C555-4C559, 3C308-3C310
Fan Guard:	1WBT8, 1WBT9, 1WBU1-1WBU5
Wall Collar:	3FKF3, 1WBV1-1WBV3
Wall Housing:	3FKF4-3FKF9, 3FKG1
Speed Control (For 115V):	1DGV1, 1DGV2



Dayton Electric Mfg. Co. certifies that the fans shown herein are licensed to bear the AMCA seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and AMCA Publication 311 and comply with the requirements of the AMCA Certified Ratings Program.

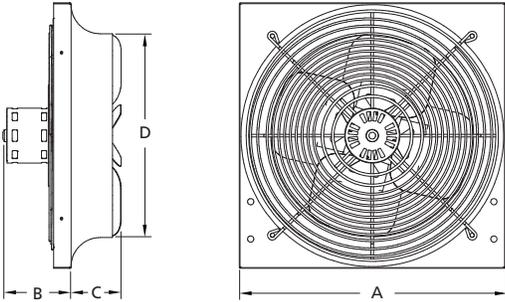
Figure 1 — Quiet-Design and Commercial Dimensions

## Dimensions and Specifications

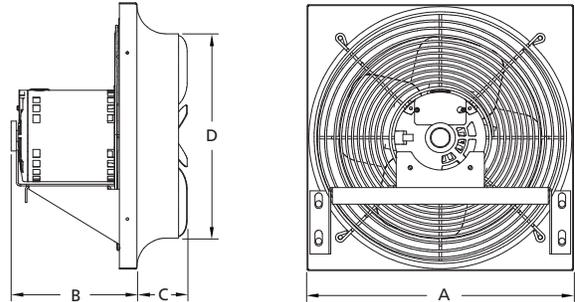
Model	Prop. Dia.	Shaft Dia.	A	B	C	D	Blades	Recommended Wall Opening	
								Direct to Wall	Wall Collar, Wall Collar & Guard, or Wall Housing
<b>QUIET-DESIGN AND COMMERCIAL (See Figure 1)</b>									
10E039	12"	1/2"	16"	4 1/2"	3"	12 1/4"	3	14 1/2 x 14 1/2"	17 1/4 x 17 1/4"
10D971	12	1/2	16	4 1/2	3	12 1/4	4	14 1/2 x 14 1/2	17 1/4 x 17 1/4
10E040, 10E041	16	1/2	20	7	3 1/4	16 1/2	3	18 1/2 x 18 1/2	21 1/4 x 21 1/4
10D972	16	1/2	20	7	3 1/4	16 1/2	4	18 1/2 x 18 1/2	21 1/4 x 21 1/4
10D973, 10D974	18	1/2	22	7	3 1/8	18 1/2	3	20 1/2 x 20 1/2	23 1/4 x 23 1/4
10E042	18	1/2	22	7	3 1/8	18 1/2	4	20 1/2 x 20 1/2	23 1/4 x 23 1/4
10E043	18	1/2	22	6	3 1/8	18 1/2	4	20 1/2 x 20 1/2	23 1/4 x 23 1/4
10D975, 10E045	20	1/2	24	7	3 3/4	20 1/2	3	22 1/2 x 22 1/2	25 5/8 x 25 5/8
10D976, 10D977, 10E044	20	1/2	24	7 1/2	3 3/4	20 1/2	3	22 1/2 x 22 1/2	25 5/8 x 25 5/8
10E046	24	1/2	28	9 1/2	3 7/8	24 1/2	3	26 1/2 x 26 1/2	29 5/8 x 29 5/8
10E047	24	5/8	28	8	3 7/8	20 1/2	3	26 1/2 x 26 1/2	29 5/8 x 29 5/8
10D978, 10D979, 10D980	24	1/2	28	8 3/4	3 7/8	24 1/2	3	26 1/2 x 26 1/2	29 5/8 x 29 5/8
10E048	24	5/8	28	9	3 7/8	24 1/2	3	26 1/2 x 26 1/2	29 5/8 x 29 5/8
10D981, 10D982	30	5/8	34	8 3/4	4 3/4	30 1/2	3	32 1/2 x 32 1/2	35 5/8 x 35 5/8
10E049	30	5/8	34	9	4 3/4	30 3/8	3	32 1/2 x 32 1/2	35 5/8 x 35 5/8

# Dayton® Direct-Drive Exhaust Fans

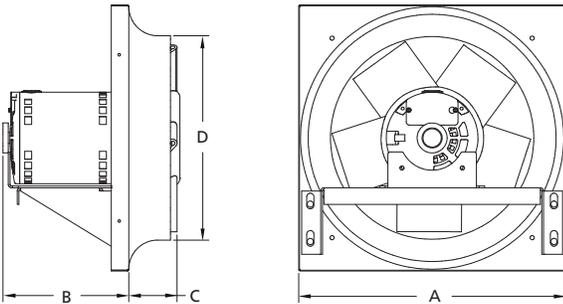
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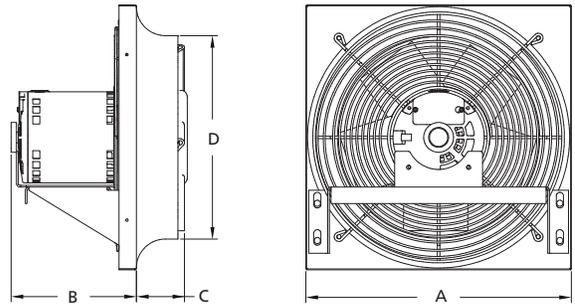
**Figure 2 — Commercial With Intake Guard 8-18 Dimensions**



**Figure 3 — Commercial With Intake Guard 20-24 Dimensions**



**Figure 4 — Industrial Dimensions**



**Figure 5 — Industrial With Intake Guard Dimensions**

## Dimensions and Specifications (Continued)

Model	Prop. Dia.	Shaft Dia.	A	B	C	D	Blades	Recommended Wall Opening	
								Direct to Wall	Wall Collar, Wall Collar & Guard, or Wall Housing
<b>COMMERCIAL WITH INTAKE GUARD 8-18 (See Figure 2)</b>									
10D952	8"	5/16"	12"	4"	3"	8¼"	5	10½ x 10½"	13¼ x 13¼"
10D953	10	5/16	14	4	3½	10¼	5	12½ x 12½	15¼ x 15¼
10D954	12	5/16	16	4½	3	12¼	3	14½ x 14½	17¼ x 17¼
10D955	14	5/16	18	4	3¼	14¼	3	16½ x 16½	19¼ x 19¼
10D956	16	5/16	20	4	3¼	16½	3	18½ x 18½	21¼ x 21¼
10D957	18	1/2	22	7	3⅛	18½	3	20½ x 20½	23¼ x 23¼
10D960	18	1/2	22	7½	3⅛	18½	3	20½ x 20½	23¼ x 23¼
<b>COMMERCIAL WITH INTAKE GUARD 20-24 (See Figure 3)</b>									
10D958, 10D961	20	1/2	24	7	3¾	20½	3	22½ x 22½	25⅝ x 25⅝
10D959, 10D962	24	1/2	28	7	7⅞	24½	3	26½ x 26½	29⅞ x 29⅞

# Models 10D952 thru 10D994, 10E039 thru 10E049

## Dimensions and Specifications (Continued)

Model	Prop. Dia.	Shaft Dia.	A	B	C	D	Blades	Recommended Wall Opening		
								Direct to Wall	Wall Collar & Guard, or Wall Housing	Wall Collar & Guard, or Wall Housing
<b>INDUSTRIAL (See Figure 4)</b>										
10D983, 10D984	16"	1/2"	20"	7"	3¼"	16½"	3	18½ x 18½"	21¼ x 21¼"	
10D985, 10D986	18	1/2	22	7	3⅝	18½	3	20½ x 20½	23¼ x 23¼	
10D987, 10D988	20	5/8	24	7	3¾	20½	4	22½ x 22½	25⅝ x 25⅝	
10D989	24	1/2	28	8¾	3⅞	24½	6	26½ x 26½	29⅝ x 29⅝	
10D990, 10D991	24	5/8	28	8¾	3⅞	24½	3	26½ x 26½	29⅝ x 29⅝	
10D992, 10D993	30	5/8	34	9	4¾	30⅝	3	32½ x 32½	35⅝ x 35⅝	
10D994	36	5/8	40	9	5¼	36⅝	3	38½ x 38½	41⅝ x 41⅝	
<b>INDUSTRIAL WITH INTAKE GUARD (See Figure 5)</b>										
10D963	12"	1/2	16"	4½"	3"	12¼"	5	14½ x 14½"	17¼ x 17¼"	
10D964	16	1/2	20	7	3¼	16½	3	18½ x 18½	21¼ x 21¼	
10D965	18	1/2	22	7	3⅝	18½	3	20½ x 20½	23¼ x 23¼	
10D966, 10D967	20	1/2	24	7	3¾	20½	3	22½ x 22½	25⅝ x 25⅝	
10D968	20	5/8	24	7½	3¾	20½	3	22½ x 22½	25⅝ x 25⅝	
10D969	24	1/2	28	7	7⅞	24½	3	26½ x 26½	29⅝ x 29⅝	
10D970	24	1/2	28	7½	3⅞	24½	6	26½ x 26½	29⅝ x 29⅝	

## Performance

Model		Prop. Dia.	HP	Fan RPM	Sones @ 0.000" SP @ 5Ft.	CFM Air Delivery @ Static Pressure Shown				
1-Phase 115/230V	3-Phase 208-230/460V					0.000"	0.125"	0.250"	0.375"	0.500"
<b>QUIET-DESIGN</b>										
10E039	—	12	1/4	1750	9.8	1311	1167	—	—	—
10E040	10E041	16	1/4	1750	14.8	2432	2212	1945	—	—
10E042	10E043	18	1/3	1750	19.4	2979	2810	2608	2374	—
10E044	10E045	20	1/2	1140	13.9	4509	4112	3590	2888	—
10E046	—	24	1/2	1140	17.9	5703	5293	4833	4287	—
10E047	10E048	24	3/4	1140	19.0	6236	5854	5390	4818	—
—	10E049	30	3/4	1140	24	8865	8358	7708	6970	—
<b>COMMERCIAL</b>										
10D971	—	12	1/4	1750	12.0	1590	1432	1220	1007	—
10D972	—	16	1/4	1725	16.6	2483	2335	2147	1913	—
10D973	10D974	18	1/3	1725	22	3194	3007	2805	2561	—
10D975	—	20	1/3	1140	14.6	3717	3319	2803	1959	—
10D976	10D977	20	1/2	1140	13.9	4509	4112	3590	2888	—
10D978	—	24	1/3	1140	16.5	4632	4196	3664	2835	—
10D979	10D980	24	1/2	1140	17.0	4686	4363	3953	3394	—
10D981	10D982	30	3/4	1140	27	9203	8505	7742	6879	—

Performance certified is for installation type A: Free inlet, Free outlet. Performance ratings do not include the effects of appurtenances (accessories). Speed (RPM) shown is nominal. Performance is based on actual speed of test. The sound ratings shown are loudness values in fan sones at 5 ft. (1.5 m) in a hemispherical free field calculated per AMCA Standard 301. Values shown are for installation type A: Free inlet hemispherical sone levels.

# Dayton® Direct-Drive Exhaust Fans

## Performance (Continued)

Model		Prop. Dia.	HP	Fan RPM	Sones @ 0.000" SP @ 5Ft.	CFM Air Delivery @ Static Pressure Shown				
1-Phase 115/230V	3-Phase 208-230/460V					0.000"	0.125"	0.250"	0.375"	0.500"
<b>COMMERCIAL, WITH INTAKE GUARD († 115V, * Speed Controllable)</b>										
10D952†*	—	8	1/30	1725	6.9	454	319	170	—	—
10D953†*	—	10	1/30	1600	8.8	730	624	381	—	—
10D954†*	—	12	1/30	1600	6.4	889	733	509	—	—
10D955†*	—	14	1/20	1550	13.5	1066	878	601	—	—
10D956†*	—	16	1/20	1550	12.0	1201	934	594	—	—
10D957†*	—	18	1/4	1140	11.1	2627	2290	1818	1022	—
10D960	—	18	1/3	1725	19.6	3126	2953	2746	2503	—
10D958†*	—	20	1/4	1140	12.2	3491	3060	2502	1394	—
10D961†	—	20	1/4	1140	12.2	3491	3060	2502	1394	—
10D959†*	—	24	1/4	1160	15.8	3533	3023	2403	1722	—
10D962	—	24	1/3	1140	16.3	4430	3974	3417	2499	—
<b>INDUSTRIAL</b>										
10D983	10D984	16	1/4	1750	14.1	2476	2288	2061	1769	1350
10D985	10D986	18	1/3	1750	18.5	3354	3097	2805	2468	2003
10D987	10D988	20	3/4	1750	23	4557	4254	3919	3542	3101
10D989	—	24	1/2	1140	23	5892	5471	4961	4315	3593
10D990	10D991	24	3/4	1725	31	6978	6499	5905	5184	4412
10D992	10D993	30	3/4	1140	25	9308	8461	7556	6428	4998
—	10D994	36	3/4	1140	33	12,363	10,425	8453	6207	2895
<b>INDUSTRIAL, WITH INTAKE GUARD</b>										
10D963	—	12	1/4	1750	11.2	1286	1192	1022	902	666
10D964	—	16	1/4	1725	15.6	2847	2591	2314	1951	1265
10D965	—	18	1/4	1725	14.5	2989	2751	2469	2108	1555
10D966	—	20	1/4	1750	18.6	3198	2847	2495	2091	1579
10D967	—	20	1/3	1750	19.6	3745	3449	3109	2716	2195
10D968	—	20	3/4	1750	22	4590	4240	3843	3381	2675
10D969	—	24	1/3	1750	30	3984	3400	2867	2296	1706
10D970	—	24	1/2	1140	17.0	5438	5049	4573	3922	3242

Performance certified is for installation type A: Free inlet, Free outlet. Performance ratings do not include the effects of appurtenances (accessories). Speed (RPM) shown is nominal. Performance is based on actual speed of test. The sound ratings shown are loudness values in fan sones at 5 ft. (1.5 m) in a hemispherical free field calculated per AMCA Standard 301. Values shown are for installation type A: Free inlet hemispherical sone levels.

# Models 10D952 thru 10D994, 10E039 thru 10E049

## Unpacking

1. Inspect for any damage that may have occurred during transit.
2. Shipping damage claim must be filed with carrier.
3. Check all bolts, screws, set-screws, etc. for looseness that may have occurred during transit. Retighten as required. Rotate propeller by hand to be sure it turns freely.

## General Safety Information

**⚠ DANGER** Do not depend on any switch as the sole means of disconnecting power when installing or servicing the fan. Always disconnect, lock and tag power source before installing or servicing. Failure to disconnect power source can result in fire, shock or serious injury. Motor will restart without warning after thermal protector trips. Do not touch operating motor, it may be hot enough to cause injury.

**⚠ DANGER** Do not place any body parts or objects in fan, motor openings or drives while motor is connected to power source.

**⚠ WARNING** Do not use this equipment in explosive atmospheres!

1. Read and follow all instructions and cautionary markings. Make sure electrical power source conforms to requirements of equipment and local codes.
2. Fans should be assembled, installed and serviced by a qualified technician. Have all electrical work performed by a qualified electrician.
3. Follow all local electrical and safety codes in the United States and Canada, as well as the National Electrical Code (NEC) and the Occupational Safety and Health Act

(OSHA) in the United States. Ground motor in accordance with NEC Article 250 (grounding). Follow the Canadian Electric Code (CEC) in Canada.

**⚠ CAUTION** To reduce the risk of injury to persons, observe the following:

**OSHA requires OSHA complying guards when fan is installed within 7 feet of floor or working level.**

**ULcUL Standards require OSHA complying guards when fan is installed within 8 feet of floor or working level.**

4. All moving parts should be guarded.
5. Do not kink power cable or allow it to come in contact with sharp objects, oil, grease, hot surfaces or chemicals. Replace damaged cords immediately.
6. Make certain that the power source conforms to the requirements for the equipment.
7. Motor must be securely and adequately grounded. This can be accomplished by wiring with a grounded, metal-clad race way system by using a separate ground wire connected to the bare metal of the motor frame, or other suitable means.

## Installation

**⚠ WARNING** Installation, troubleshooting and parts replacement is to be performed only by qualified personnel.

### WALL MOUNTING

1. Move fan to the desired location and determine the method by which the fan is to be mounted as shown in Figures 6, 7, 8 and 9. Optional wall collar (Figure 7), wall collar and guard (Figure 8) or wall housing (Figure 9) provide a convenient means of mounting sidewall fans.

**NOTE:** Wall shutter must be motorized to open during fan operation in either direction.

2. Cut an appropriate sized hole in the wall using the Dimensions table.

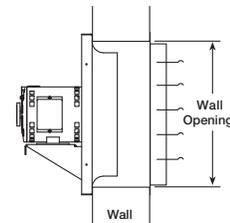


Figure 6 — Direct to Wall Installation

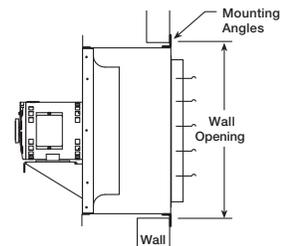


Figure 7 — Wall Collar Installation

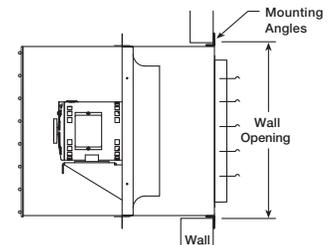


Figure 8 — Wall Collar & Guard Installation

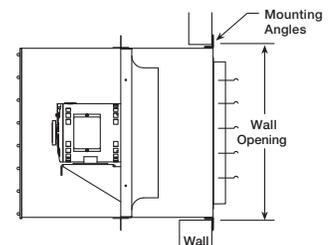


Figure 9 — Wall Housing Installation

# Dayton® Direct-Drive Exhaust Fans

## Installation (Continued)

**NOTE:** Fans mounted to the wall require a different opening size than those mounted in collars or housings.

**NOTE:** Wall opening size and propeller-to-shutter distance are two important dimensions for fan installation.

3. The fan should be securely mounted within a rigid framework to prevent flexing or movement of the fan frame during operation. The fan frame should be equally supported on all sides within the framework and caution should be taken to avoid twisting of the fan frame during installation.

**NOTE:** Allowing the fan frame to flex or move during operation will create harmful vibrations which may damage the unit.

4. Fans should be mounted in opening with 1/4" clearance around perimeter. Framing should be secured to building structure utilizing corrosion resistant fasteners (by others). Fasteners should be used in all pre-punched mounting holes in the fan panel.
5. Install remaining components (shutter, intake guard, etc.).
6. Check all fasteners and set screws for tightness.
7. Rotation direction of the propeller should be checked by momentarily turning the unit on. Rotation should be in the same direction as the rotation decal affixed to the unit. For 3-phase installations, fan rotation can be reversed by interchanging any two of the three electrical leads. For single phase installations follow the wiring diagram located on the motor.

## ELECTRICAL CONNECTION

**NOTE:** Refer to motor nameplate for wiring procedures.

1. Motor and fan must be securely grounded (bare metal) to a suitable electric ground, such as a grounded water pipe or ground wire system.

**▲ WARNING** *Comply with all local and national safety codes including the National Electrical Code (NEC) and National Fire Protection Act (NFPA).*

2. Wire motor for desired voltage per wiring diagram on motor.
3. Wire control switches at ground level.
4. Before activating fan, inspect to be sure that there are no obstructions or debris that would interfere with the propeller.

## Operation

1. Before starting up or operating your new Dayton fan, check all fasteners for tightness. In particular, check set screws in propeller hub. While in the OFF position, or before connecting the fan to power, turn the fan propeller by hand to be sure it is not striking the orifice or any obstacle.
2. Start the fan up and shut it off immediately to check rotation of the propeller with directional arrow on the fan panel.
3. When the fan is started, observe the operation and check for any unusual noises.
4. Motor amperage should be checked to avoid overloading of the motor. With the system in full operation measure current input to the motor and compare with the nameplate rating to determine if the BHP is operating under safe load conditions.

5. Keep inlets and approaches to fan clean and free from obstruction.

## Maintenance

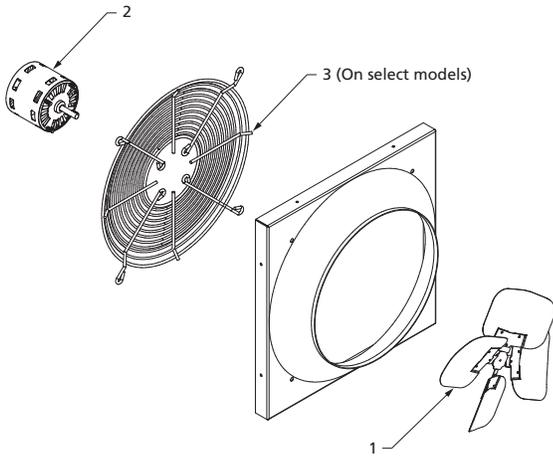
**▲ WARNING** *Always disconnect, lock and tag power source before installing or servicing. Failure to disconnect power source can result in fire, shock or serious injury.*

**▲ CAUTION** *Uneven cleaning of the propeller will produce an out of balance condition that will cause vibration in the fan.*

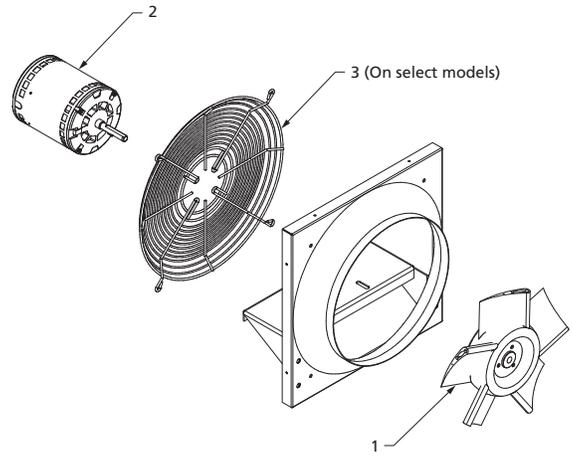
1. Depending on the usage and severity of the contaminated air, a regularly scheduled inspection for cleaning the fan propeller, housing and surrounding areas should be established.
2. Check for unusual noises when fan is running.
3. Periodically inspect and tighten set-screws.
4. Follow motor manufacturer's instructions for motor lubrication.
5. For disassembly refer to the parts illustration.
6. For critical applications, a spare motor should be available.

# Models 10D952 thru 10D994, 10E039 thru 10E049

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**Figure 10 — Repair Parts Illustration for Quiet-Design and Commercial Fans**



**Figure 11 — Repair Parts Illustration for Industrial Fans**

## Repair Parts List for Direct-Drive Exhaust Fans

Reference Number	Description	Part Number For Models:										Qty.
		10D952	10D953	10D954	10D955	10D956	10D957	10D958	10D959	10D960	10D960	
1	Propeller	52J327	52J331	52J332	52J333	52J334	52J335	51D529	52J336	52J337	1	
2	Motor	52J370	52J370	52J370	52J374	52J374	52J371	52J371	52J371	52J382	1	
3	Guard	52J395	52J396	52J397	52J398	52J399	52J400	52J400	52J401	52J400	1	
Reference Number	Description	Part Number For Models:										Qty.
		10D961	10D962	10D963	10D964	10D965	10D966	10D967	10D968	10D969	10D969	
1	Propeller	51D529	53A457	52J354	52J356	52J358	52J360	52J361	52J362	52J369	1	
2	Motor	52J371	52J375	52J372	52J372	52J372	52J372	52J382	52J381	52J382	1	
3	Guard	52J400	52J401	52J397	52J399	52J400	52J400	52J400	52J400	52J401	1	
Reference Number	Description	Part Number For Models:										Qty.
		10D970	10D971	10D972	10D973	10D974	10D975	10D976	10D977	10D978	10D978	
1	Propeller	52J363	52J339	52J328	52J337	52J337	51D529	52J340	52J340	51N719	1	
2	Motor	52J377	52J372	52J372	52J382	52J383	52J375	52J377	52J376	52J375	1	
3	Guard	52J401	—	—	—	—	—	—	—	—	1	
Reference Number	Description	Part Number For Models:										Qty.
		10D979	10D980	10D981	10D982	10D983	10D984	10D985	10D986	10D987	10D987	
1	Propeller	52J329	52J329	53H245	53H245	52J355	52J355	52J359	52J359	53A457	1	
2	Motor	52J377	52J376	52J379	52J378	52J372	52J373	52J382	52J383	52J381	1	
Reference Number	Description	Part Number For Models:										Qty.
		10D988	10D989	10D990	10D991	10D992	10D993	10D994	10E039	10E040	10E040	
1	Propeller	52J362	52J367	52J367	52J367	52J364	52J364	52J365	52J353	52J330	1	
2	Motor	52J380	52J377	52J381	52J380	52J378	52J378	52J378	52J372	52J372	1	
Reference Number	Description	Part Number For Models:										Qty.
		10E041	10E042	10E043	10E044	10E045	10E046	10E047	10E048	10E049	10E049	
1	Propeller	52J330	52J338	52J338	52J340	52J340	52J341	52J343	52J343	52J342	1	
2	Motor	52J373	52J382	52J383	52J377	52J376	52J377	52J379	52J378	52J378	1	



# Dayton® Direct-Drive Exhaust Fans

## Troubleshooting Chart

Symptom	Possible Cause(s)	Corrective Action
Fan inoperative	<ol style="list-style-type: none"> <li>1. Blown fuse or breaker</li> <li>2. Defective motor</li> <li>3. Incorrectly wired</li> <li>4. Electricity turned off</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace or repair</li> <li>2. Replace or repair</li> <li>3. Shut power OFF and check wiring for proper connections</li> <li>4. Contact local power company</li> </ol>
Airflow - Insufficient	<ol style="list-style-type: none"> <li>1. Damper (shutter) stuck shut</li> </ol>	<ol style="list-style-type: none"> <li>1. Inspect/repair damper</li> </ol>
Airflow - Reversed air	<ol style="list-style-type: none"> <li>3. Propeller rotation reversed</li> </ol>	<ol style="list-style-type: none"> <li>3. Reverse motor rotation, rewire motor</li> </ol>
Airflow - Too much air	<ol style="list-style-type: none"> <li>4. Insufficient static pressure</li> </ol>	<ol style="list-style-type: none"> <li>4. Check static pressure calculation</li> </ol>
Excessive noise or vibration	<ol style="list-style-type: none"> <li>1. Foreign material inside bearing</li> <li>2. Loose propeller</li> <li>3. Crooked or damaged propeller</li> <li>4. Fan not securely anchored</li> <li>5. Fan propeller out of balance</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace bearing</li> <li>2. Tighten set screws or taper bushing screws</li> <li>3. Replace propeller</li> <li>4. Secure properly</li> <li>5. Replace propeller</li> </ol>
Motor overloads or overheats	<ol style="list-style-type: none"> <li>1. Shorted motor winding</li> <li>2. Incorrect propeller rotation</li> <li>3. Over/Under line voltage</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace motor</li> <li>2. Check motor wiring</li> <li>3. Contact Power Company</li> </ol>

### LIMITED WARRANTY

**DAYTON ONE-YEAR LIMITED WARRANTY.** DAYTON® DIRECT-DRIVE EXHAUST FANS, MODELS COVERED IN THIS MANUAL, ARE WARRANTED BY DAYTON ELECTRIC MFG. CO. (DAYTON) TO THE ORIGINAL USER AGAINST DEFECTS IN WORKMANSHIP OR MATERIALS UNDER NORMAL USE FOR ONE YEAR AFTER DATE OF PURCHASE. ANY PART WHICH IS DETERMINED TO BE DEFECTIVE IN MATERIAL OR WORKMANSHIP AND RETURNED TO AN AUTHORIZED SERVICE LOCATION, AS DAYTON DESIGNATES, SHIPPING COSTS PREPAID, WILL BE, AS THE EXCLUSIVE REMEDY, REPAIRED OR REPLACED AT DAYTON'S OPTION. FOR LIMITED WARRANTY CLAIM PROCEDURES, SEE "PROMPT DISPOSITION" BELOW. THIS LIMITED WARRANTY GIVES PURCHASERS SPECIFIC LEGAL RIGHTS WHICH VARY FROM JURISDICTION TO JURISDICTION.

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Certain aspects of disclaimers are not applicable to consumer products; e.g., (a) some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you; (b) also, some jurisdictions do not allow a limitation on how long an implied warranty lasts, consequently the above limitation may not apply to you; and (c) by law, during the period of this Limited Warranty, any implied warranties of implied merchantability or fitness for a particular purpose applicable to consumer products purchased by consumers, may not be excluded or otherwise disclaimed.

**Prompt Disposition.** A good faith effort will be made for prompt correction or other adjustment with respect to any product which proves to be defective within limited warranty. For any product believed to be defective within limited warranty, first write or call dealer from whom the product was purchased. Dealer will give additional directions. If unable to resolve satisfactorily, write to Dayton at address below, giving dealer's name, address, date, and number of dealer's invoice, and describing the nature of the defect. Title and risk of loss pass to buyer on delivery to common carrier. If product was damaged in transit to you, file claim with carrier.

Manufactured for Dayton Electric Mfg. Co.



T6031A1136

## T4031A,B,P; T6031A,B Refrigeration Temperature Controllers

### PRODUCT DATA



### GENERAL

The T4031A,B,P and T6031A,B are temperature controllers used in a variety of cooling applications where remote mounting of the sensing element in the controlled medium is required.

### FEATURES

- Wide control temperature range is suitable for controlling ducts, tanks, freezers, coolers, display cases, and defrost termination.
- Universal mounting bracket is available for easy replacement of other controllers.
- Models are available with various control ranges.
- Control setpoint is dial-knob adjustable.
- Models are available with fixed or adjustable temperature differentials.
- Capillary lengths are 5, 8, or 20 ft (1.5, 2.4, 6.1m) depending on model.
- Reliable snap-acting spst or spdt switch.
- Ambient temperature compensated.
- Insert supplied with TRADELINE® models replaces setpoint knob to discourage tampering.

### Contents

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## SPECIFICATIONS

### IMPORTANT

The specifications given in this publication do not include normal manufacturing tolerances. Therefore, this unit may not exactly match the specifications listed. Also, this product is tested and calibrated under closely controlled conditions, and some minor differences in performance can be expected if those conditions are changed.

### TRADELINE® Models

TRADELINE® models are selected and packaged to provide ease of stocking, ease of handling, and maximum replacement value. TRADELINE® model specifications are the same as those of standard models except as noted below.

### TRADELINE® Model Available:

T6031A Refrigeration Temperature Controller-spdt switch, adjustable temperature differential, tamper-resistant insert.

### Capillary Length:

8 ft (2.4m)

### Additional Features:

TRADELINE® pack with cross reference label and special instructions

### Standard Models

T4031A Refrigeration Temperature Controller-spst switch makes on temperature rise; fixed differential

T4031B Refrigeration Temperature Controller—same as T4031A but less case

T4031P Refrigeration Temperature Controller—same as T4031A but uses screw, not knob, to adjust setpoint

T6031A Refrigeration Temperature Controller-spdt switch, fixed or adjustable temperature differential

T6031B Refrigeration Temperature Controller—same as T6031A but less case

### Switch Action:

T4031A,B,P spst switch makes R to W on temperature rise

T6031A,B spdt switch makes R to W on temperature rise, R to B on temperature fall

### Capillary Lengths and Temperature Ranges:

Model	Copper Capillary Tube Length		Setting Range <sup>a</sup>		Differential	
	ft	m	°F	°C	°F	°C
T4031A,B	5	1.5	-30 to 50	-34 to 10	Fixed at 3.5	Fixed at 1.6
	20	6.1				
T4031P	8	2.4	-30 to +90	-34 to +32	3.5 to 16	1.6 to 9
T6031A,B	5	1.5	-15 to +90	-9 to +32	Fixed at 3.5 or Adjust. from 3.5 to 12	Fixed at 1.6 or Adjust. from 1.6 to 7
	20	6.1				
	5	1.5	-30 to +50	-34 to +10		
	20	6.1				
	8	2.4	-30 to +90	-34 to +32		

<sup>a</sup> Dial scale markings in degrees Fahrenheit

## ORDERING INFORMATION

When purchasing replacement and modernization products from your TRADELINE® wholesaler or your distributor, refer to the TRADELINE® catalog or price sheets for complete ordering number, or specify:

1. Order number.
2. Setting range.
3. Fixed or adjustable differential (T6031).
4. Length of copper capillary tube.
5. Accessories, if desired.

If you have additional questions, need further information, or would like to comment on our products or services, please write or phone:

1. Your local Honeywell Home and Building Control Sales office (check white pages of your phone directory).
2. Home and Building Control Customer Relations  
Honeywell, 1885 Douglas Drive North  
Minneapolis, Minnesota 55422-4386

In Canada—Honeywell Limited/Honeywell Limitée, 35 Dynamic Drive, Scarborough, Ontario M1V 4Z9. International Sales and Service Offices in all principal cities of the world.

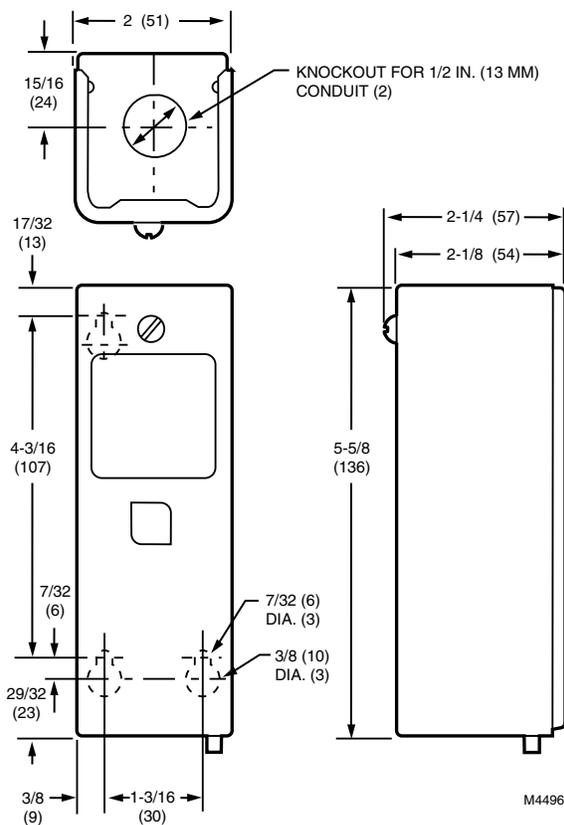
**Electrical Ratings:**

	120 Vac		240 Vac	
	Normally Closed	Normally Open <sup>a</sup>	Normally Closed	Normally Open <sup>a</sup>
Full Load Amp	8	16	5.1	8
Locked Rotor Amp	48	80	30.6	40

<sup>a</sup> Makes on temperature rise.

**Pilot Duty:**  
125 VA

**Dimensions:**  
See Fig. 1



**Fig. 1. Dimensions of T4031, T6031 in in. (mm).**

**Underwriters Laboratories Inc.:**  
Listed

**Maximum Ambient Operating Temperature:**  
125°F (52°C)

- Accessories:**
- 112622AA Immersion Well—short-necked, 1/2 in. NPT, copper
  - 7617ABY Compression Fitting—50 psi water, 15 psi air
  - 107324A Bulb Holder—for duct installation
  - 105900 T-strap—for strapping bulb to pipe

- 7617ABZ Bag Assembly—for mounting controller to fan coil units
  - 801534 Calibration Wrench
  - 7640HY Standoff Bracket Bag Assembly—to mount controller to an insulated duct
  - 130883 Universal Mounting Bracket
  - 194899 Tamper-resisting Insert Button
- Celsius Scaleplates:**
- 194486 D: -15°C to +35°C replaces (0°F to 100°F) scaleplate
  - 194486H: 15°C to 75°C replaces (55°F to 175°F)
  - 194486F: 75°C to 125°C replaces (160°F to 260°F)

**INSTALLATION**

**When Installing this Product...**

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete, check out product operation as provided in these instructions.

**! CAUTION**

- Disconnect power supply before installation to prevent electrical shock and equipment damage.
- Do not damage or change shape of capsule. Deformed capsule will cause calibration offset.

**Mounting**

Install controller in any convenient location. Make sure that the sensing bulb reaches the system to be controlled. The ambient temperature must not exceed 125°F (52°C) in the area where the controller is installed.

Install the sensing element where it can sense the average temperature. Avoid sharp bends or kinks in the capillary tubing that can affect the accuracy of the controller. Carefully coil the excess capillary tubing and leave it directly beneath the controller.

The 130883 Mounting Plate furnished with TRADELINE® models allows the control to be mounted in existing mounting holes.

**Duct Installation**

Position the sensing bulb in the duct to sense the average air temperature. Avoid mounting the bulb close to hot pipes, cooling coils, etc.

The 107324A Bulb Holder is available for suspending the bulb in a duct. See Fig. 2.

T6031A1136

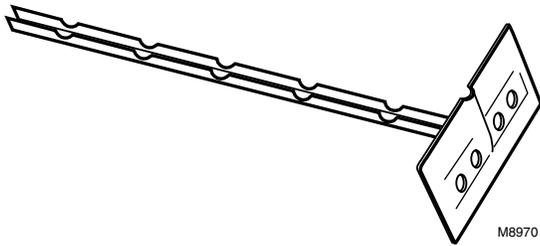


Fig. 2. 107324A bulb holder.

**To install duct:**

1. Make a hole in duct wall to admit sensing bulb into holder.
2. Using holder as template, mark and drill mounting holes.
3. Break off bulb holder to required length. (Be sure holder is long enough to hold sensing bulb away from duct wall and in freely circulating air.)
4. Place capillary tubing in bulb holder channel, with bulb at inner end of holder. Pinch together top edges of channel segments.
5. Insert assembled bulb and holder into duct, and fasten to duct wall with screws supplied.

**Tank Installation**

The sensing bulb can be inserted directly into a tank using a compression fitting; or the bulb can be inserted into an immersion well (order separately), which is screwed into a tank or boiler.

Select a location where liquid of average temperature can circulate freely around the sensing bulb.

**Using Compression Fitting (Fig. 3)**

1. Drain system. Screw boiler plug into properly sized and threaded boiler or pipe tapping.
2. Place packing nut on capillary tubing.
3. Slide sensing bulb completely through boiler plug.
4. Place composition disc and the four slotted brass washers on capillary tubing.
5. Slide assembly into boiler plug and tighten packing nut.
6. Refill system and check for leaks. Neatly coil excess capillary tubing.

**Using Immersion Well (Fig. 4)**

1. Drain system. Screw the well into threaded fitting.
2. Refill system and check for leaks.
3. Insert sensing bulb into well until it bottoms.
4. Fit bulb retaining clamp over immersion well flange and capillary tubing, and tighten screw.

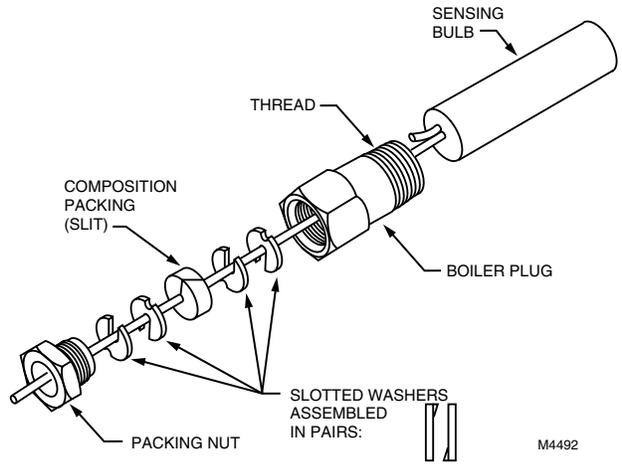


Fig. 3. Compression fitting installation.

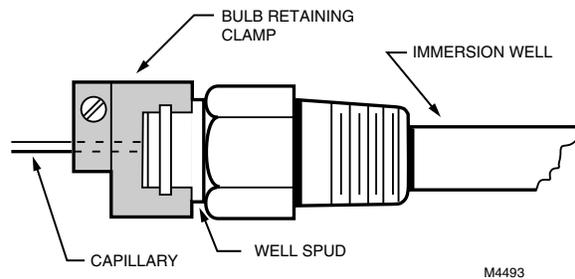


Fig. 4. Immersion well installation.

**Cold Room Installation**

Locate the bulb in freely circulating air in the controlled area or on the suction side of a refrigerant line, and secure the bulb in position.

**Wiring (Fig. 5)**

All wiring must comply with local electrical codes and ordinances.

Two knockouts are provided, one at the top and one at the bottom of the case for 1/2 in. conduit. Follow the wiring instructions furnished with the heating or cooling system. For replacement, make sure the new control is wired into the system to operate the same as the old control.

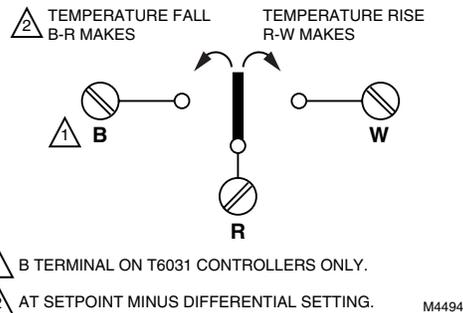
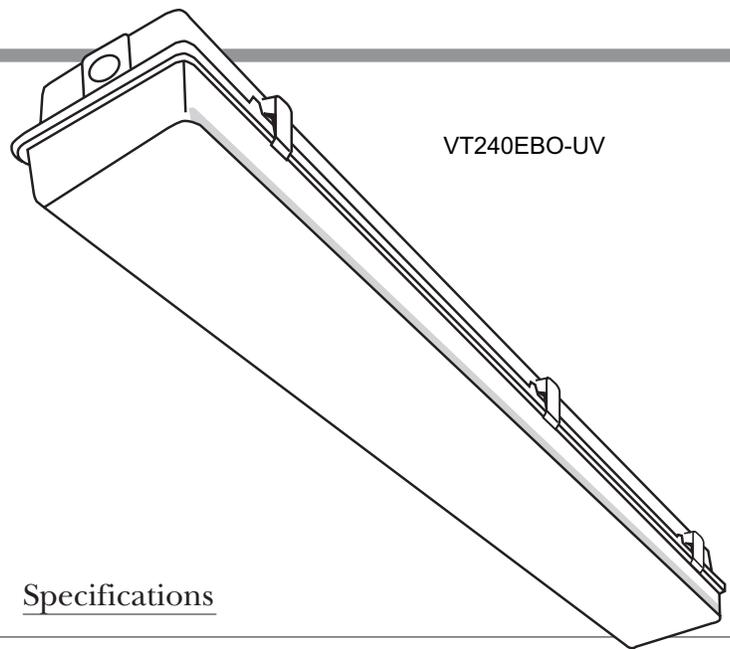


Fig. 5. Wiring terminals on T4031 and T6031 temperature controllers.

# VT SERIES

VT Series is designed for heavy duty service in areas subjected to moisture and chemicals. Ideally suited for food processing areas also.



VT240EBO-UV

## Ordering Information

### Magnetic

CATALOG#	LAMP	NOMINAL LENGTH
<b>430 MA</b>		
VT120	1-F20T12	2'
VT220	2-F20T12	2'
VT140ES	1-F40	4'
VT240ES	2-F40	4'
VT240TES	4-F40	8'
VT196	1-F96T12	8'
VT296ES	2-F96T12	8'
<b>800 MA</b>		
VT124HO	1-F24T12HO	2'
VT224HO	2-F24T12HO	2'
VT148HO	1-F48T12HO	4'
VT248HO	2-F48T12HO	4'
VT196HO	1-F96T12HO	8'
VT296HO	2-F96T12HO	8'

All Ballast Standard Low Temperature (-20 F)

### Electronic Octron

CATALOG#	LAMP	NOMINAL LENGTH
VT120EBO	1-FO17T8	2'
VT220EBO	2-FO17T8	2'
VT140EBO	1-FO32T8	4'
VT240EBO	2-FO32T8	4'
VT240TEBO	4-FO32T8	8'
VT196EBO	1-FO96T8	8'
VT296EBO	2-FO96T8	8'

Consult Factory for other options

## Specifications

**Mounting:** Units may be either surface or pendant mounted. Housing provided with adequate amount of knockouts which must be drilled on job site to insure proper sealing.

**Construction:** A one piece housing molded from ABS material with a smooth white exterior. ABS cam-lock latches provide both a positive lock between lens and housing and self hinging for lamp replacement. A self-adhesive, closed-cell polyethylene gasket on housing forms a continuous seal with diffuser. Internal metal is die-formed from heavy gauge cold-rolled steel.

**Finish:** External housing to be smooth white. All internal metal parts are cleaned and treated to prevent rust with a phosphate coating applied automatically in a five-stage process. Surfaces are then sprayed with high quality baked white enamel to provide a minimum reflectance of 87%.

**Diffuser:** Lens is crepe acrylic.

**Wiring:** Standard ballast are ETL-CBM, Class "P" 120 volt. All 800 MA and 1500 ballast are low temperature (-20°F).

**Approval:** All units are Underwriter's Laboratories (UL) approved.

NEW ENGLAND  
  
 LIGHTING  
 INCORPORATED

# VT SERIES

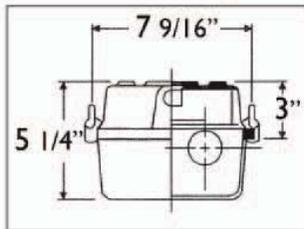
## Options and Accessories

<b>EB</b>	Electronic T12	<b>PA</b>	Prismatic Lens
<b>*CW</b>	Low Temperature (0) Ballast	<b>RFI</b>	Radio Interference Filter
<b>*DIM</b>	Dimming Ballast	<b>FS</b>	External Fuse and Holder
<b>EM</b>	Emergency Ballast (1 lamp)	<b>REF</b>	Internal Polished Aluminum Reflector
<b>*EM/2</b>	Emergency Ballast (2 lamp)	<b>REFS</b>	Internal Specular Silver Reflector
<b>HOEBO</b>	800MA Electronic T8	<b>SSL</b>	Stainless Steel Latches
<b>HUBS</b>	Fitting Assembly for 1/2" Rigid Contour	<b>SSLTP</b>	Stainless Steel Latches Tamper Proof
<b>LEX</b>	Polycarbonite lens	<b>WL</b>	Wet Location Rating
		<b>BRK</b>	Mounting Bracket

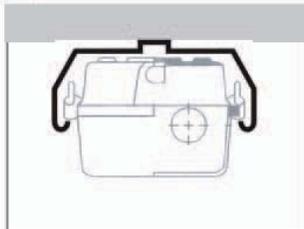
\*Available Magnetic T12 or Electronic T8

•Note: Consult Factory on Compatibility EM/2 Option

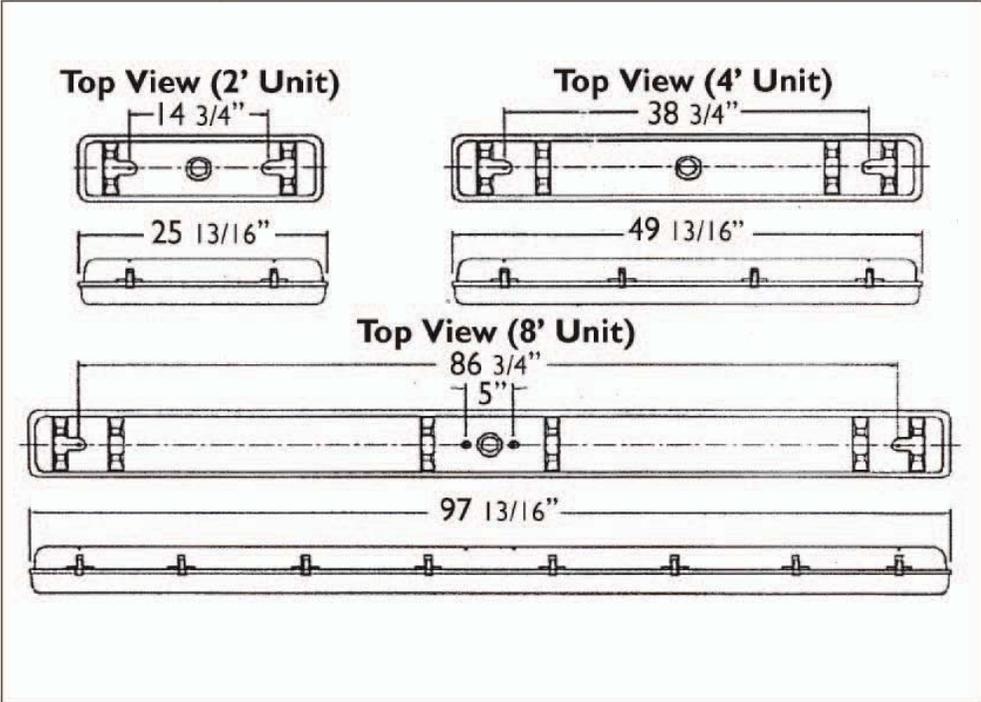
### Dimensional Data



### Mounting Bracket- Optional



### Installation Data



### Photometrics

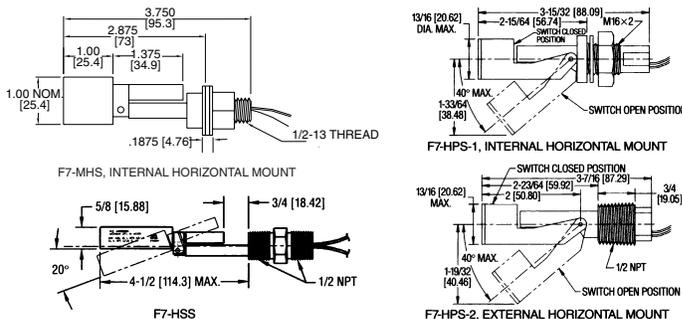
**Photometric Information**  
available upon request.

NEW ENGLAND  
**LIGHTING**  
INCORPORATED



**SERIES F7 LIQUID LEVEL SWITCHES**

**Specifications – Installation and Operating Instructions**



Series F7 Level Switches provide simple, inexpensive control of liquid level within tanks or similar vessels. Switch ratings are suitable for many solid state control systems and monitors or alarms. Simple relay interfaces can be used for higher current applications. Two basic styles offer a choice of vertical or horizontal mounting. Hermetically sealed reed switches are actuated by magnets permanently bonded inside the float and can be easily adapted to open or close a circuit on rising or falling levels.

**SWITCH ACTION (Normally open/Normally closed)**

**Vertical Models**

Vertical mount models are shipped with normally open switch contacts which close as the float rises toward the mounting threads. Reverse switch action by removing the float, rotating it end-for-end and replacing it on the stem.

**Horizontal Models**

Horizontal models are in the normally open position when the indicating arrow points up (float is down), and normally closed when the arrow points down (float is up).

**INSTALLATION**

Choose a location away from fill pipes, drains, or other areas where turbulence or wave motion might occur. Turbulence will cause false actuation and shorten contact life. Excess contaminants in fluid may inhibit float operation and occasional wipe-down may be necessary. Care should be taken that switches are always operated within electrical ratings. Read and understand all safety precautions on back of this sheet before installing.

**MOUNTING**

Install vertical mount models in an appropriate 1/8" NPT fitting. Vertical models mount internally, oriented within 30° of vertical, or select optional fittings for external mounting. Models F7-HPS-1 and F7-MHS must be mounted internally, which means the switch must be secured to the wall of the tank or vessel from the inside. Install horizontal model F7-HPS-1 in a 5/8" (16 mm) hole or model F7-MHS in a 1/2" (12.7 mm) hole. Secure into place with the nut provided. Tank wall should not exceed 1/8" (3 mm). Model F7-HPS-2 requires a horizontal 1/2" NPT female fitting and can be fitted to the tank or vessel from the outside. Model F7-HSS requires a horizontal 1/2" NPT female fitting and can be mounted from the inside or outside (internally or externally) of the tank or vessel.

**SPECIFICATIONS**

**Electrical Rating (Maximum):**

- F7-SB, -SS2 AC: 25VA, 1.0A, 200 V DC: 10W, 1.0A, 200V
  - F7-PP, -BT, -HSS, -MHS AC: 25VA, 1.0A, 200 V DC: 10W, 1.0A, 200V
  - F7-HPS-1, -2 AC: 25VA, 1.0A, 200 V DC: 10W, 1.0A, 200V
- (F7-HSS is rated explosion-proof for Class I, Groups A, B, C, D; Class II, Groups E, F, G; Class III).

**Mounting Connection:** 1/8" NPTM (all vertical mount), 1/2" NPTM (F7-HPS-2, F7-HSS), M16 x 2 (F7-HPS-1), 1/2" x 13 thread (F7-MHS)

**Wire leads:** 22 AWG x 18" (46 cm), vertical mount models; 22 AWG x 39" (1 m), models F7-HPS-1, -2; 22 AWG x 24" (61 cm), models F7-HSS, -MHS.

**Magnet:** Alnico (F7-SB, -PP, -BT, -HPS), ceramic (F7-SS2, -HSS, -MHS).

**Weight:** 2 oz. (58 g), F7-SB; 1.2 oz. (34g), F7-SS2; 0.8 oz. (23 g), F7-PP; 0.7 oz.. (20 g), F7-BT; 1.5 oz. (43 g), F7-HPS-1; 2 oz. (57 g), F7-HPS-2 and -MHS; 3 oz. (94 g), F7-HSS.

**DIMENSIONS, INCHES (MM) - Vertical Mount**

Model Number	(A) Stem Length	(B) Float Diameter	(C) Float Height	(D) Actuation from HEX*
F7-SB	2.75 (70)	1.13 (29)	1.38 (35)	1.2 (31)
F7-SS2	2.06 (52)	1.0 (25)	1.0 (25)	0.73 (19)
F7-PP	2.18 (55)	1.18 (30)	1.0 (25)	0.69 (18)
F7-BT	2.18 (55)	1.18 (30)	1.0 (25)	0.69 (18)

\*Distance between HEX and liquid (S.G. = 1) level @ actuation pt. will vary with specific gravity changes.

**PHYSICAL DATA**

Model Number	Material Float/Stem	Max. Temp.	Max. Press.	Min. S.G.	Approx. Deadband
<b>Vertical Mount</b>					
F7-SB	Buna-N & Epoxy/ 316SS	220°F 105°C	150 psig 10 bar	0.60	1/16" 2 mm
F7-SS2	316/SS (CVC)/ 316SS	300°F 149°C	450 psig 31 bar	0.75	1/16" 2 mm
F7-PP	Polypropylene & Epoxy/ Polypropylene	220°F 105°C	100 psig 6.89 bar	0.60	1/8" 4 mm
F7-BT	Buna-N & Epoxy/ PBT*	220°F 105°F	150 psig 10 bar	0.45	1/8" 4 mm
<b>Horizontal Mount</b>					
F7-HPS -1, -2	Polysulfone/ Polysulfone	185°F 85°C	150 psig 10 bar	0.85	3/16" 5 mm
F7-HSS	316SS/316SS	392°F 200°C	300 psig 20.7 bar	0.60	1/8" 4 mm
F7-MHS	316 SS/316SS	392°F 200°C	100 psig 6.89 bar	0.70	3/16" 5 mm

\* PBT - Polybutylene Terephthalate

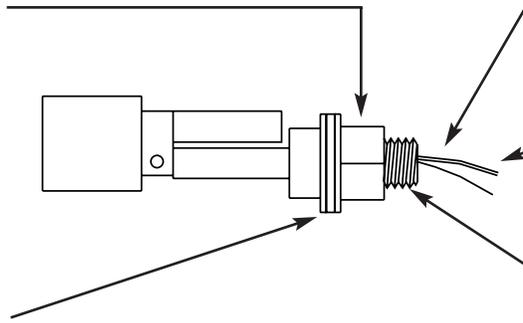
## Installation Notes-

Do not subject reed switch controls to excessive shock or vibration or any of the following:

- Bending or placing force loads on reed switch housing.
- Over-torquing fittings on reed switch housing.
- Placing pull-out force on lead wires.

Do not exceed 1.5 pounds/foot (2 N/m) tightening torque. Excessive torque may cause premature switch element or housing failure.

Gasket seal for internal mounting units should be pre-assembled before insertion through tank wall. Wall thickness should not exceed 1/8" (3mm).



Avoid installations where wiring entering the device is submerged or exposed to excessive amounts of liquid or humidity condensate.

When preparing wires for termination, avoid pulling against the resin seal or end plug of the float switch.

Units with tapered pipe threads should be treated with Teflon® based thread compound or tape before insertion in fitting. Sufficient torque is achieved at hand-tight plus one half turn.

## CIRCUIT INFORMATION FOR REED SWITCH PROTECTION

### READ INFORMATION BELOW BEFORE INSTALLING YOUR NEW REED SWITCH CONTROL!

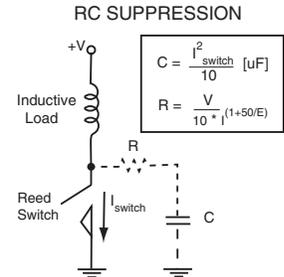
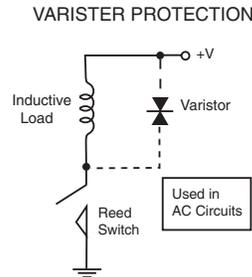
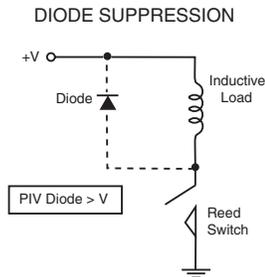
Exceeding the current capacity of this Reed Switch control may cause **FAULTY OPERATION!** Be aware of the inductive and capacitive or lamp loads you may be placing on your Reed Switch Control. The circuits below outline possible solutions to preventing overloads due to inrush or surge currents exceeding maximum or when the switch current and product of the inductive back EMF exceed the switch's power rating. Also, the circuit for prevention of overload when switching filament lamps (low "cold" resistance) is outlined below. Failure to follow these measures to protect Reed Switch Contacts may cause the contacts to weld together or result in premature wear.

### Possible Circuit Solutions Indicated by Dashed Lines

#### Inductive Loads

*Possible causes-*

An electromagnetic relay, electromagnetic solenoid, electromagnetic counter with inductive component as circuit load.

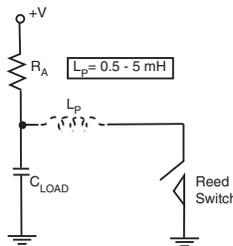


#### Capacitive Loads

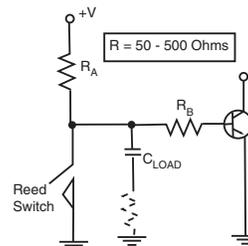
*Possible causes-*

A capacitor connected in series or parallel with Reed Switch Control. In a closed circuit, a cable length (usually greater than 50m [162.5 ft]) used to connect reed switch may also introduce static capacitance.

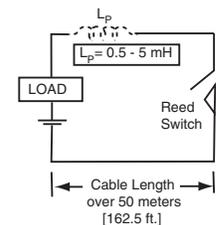
**SURGE LIMITER FOR CAPACITANCE IN SERIES**



**RESISTOR PROTECTION FOR CAPACITIVE LOAD**



**INDUCTIVE PROTECTION FOR CABLE LENGTH CAPACITANCE**

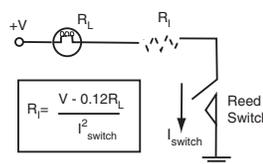


#### Lamp Loads

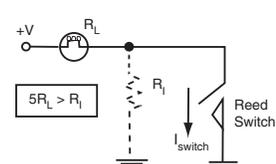
*Possible causes-*

A tungsten filament lamp load.

**CURRENT LIMITING RESISTOR IN SERIES**



**CURRENT LIMITING RESISTOR IN PARALLEL**





**NES Project: 12-133**  
**GWT – Cargo Box**  
**AECOM – Textron Providence, RI**

***Section 7 - Downwell Pump Equipment - Model***

Downwell Pump - Grundfos Model 5E05-12

Pollution Recovery Motor, 0.5hp 200VAC – Franklin Model 2345014916

Downwell Pump - Grundfos Model 10E05-12

Pollution Recovery Motor, 0.5hp 200VAC - Franklin Model 2345014916

## Redi-Flo4 Environmental Submersible Pumps

### Submittal Data

### 3450 RPM

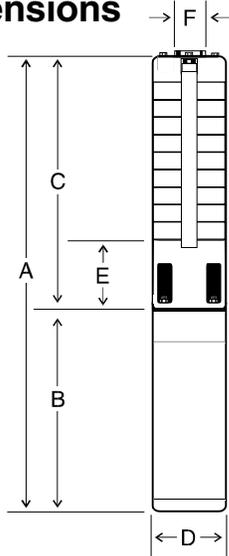
### 60 Hertz



JOB or CUSTOMER:	
ENGINEER:	
CONTRACTOR:	
SUBMITTED BY:	DATE:
APPROVED BY:	DATE:
ORDER NO:	DATE:
SPECIFICATION REF:	

QUANTITY	TAG NO.	MODEL NO.	GPM	FEET	VOLT	PHASE	COMMENTS

#### Dimensions



#### Technical Data

**FLOW RANGE:** 1.2 to 7 U.S. GPM

**MOTORS:** Grundfos MS402E Environmental Submersible Motor (Standard)  
 Maximum Operating Temperature: 104°F (40°C)  
 Maximum Submergence Pressure: 220 PSI  
 Maximum Number of Starts Per Hour: 100  
 Minimum Recommended Flow Past Motor: 0.25 ft./sec.

(NOTE: Franklin Pollution Recovery motor is optional.)

**DISCHARGE SIZE:** 1" NPT

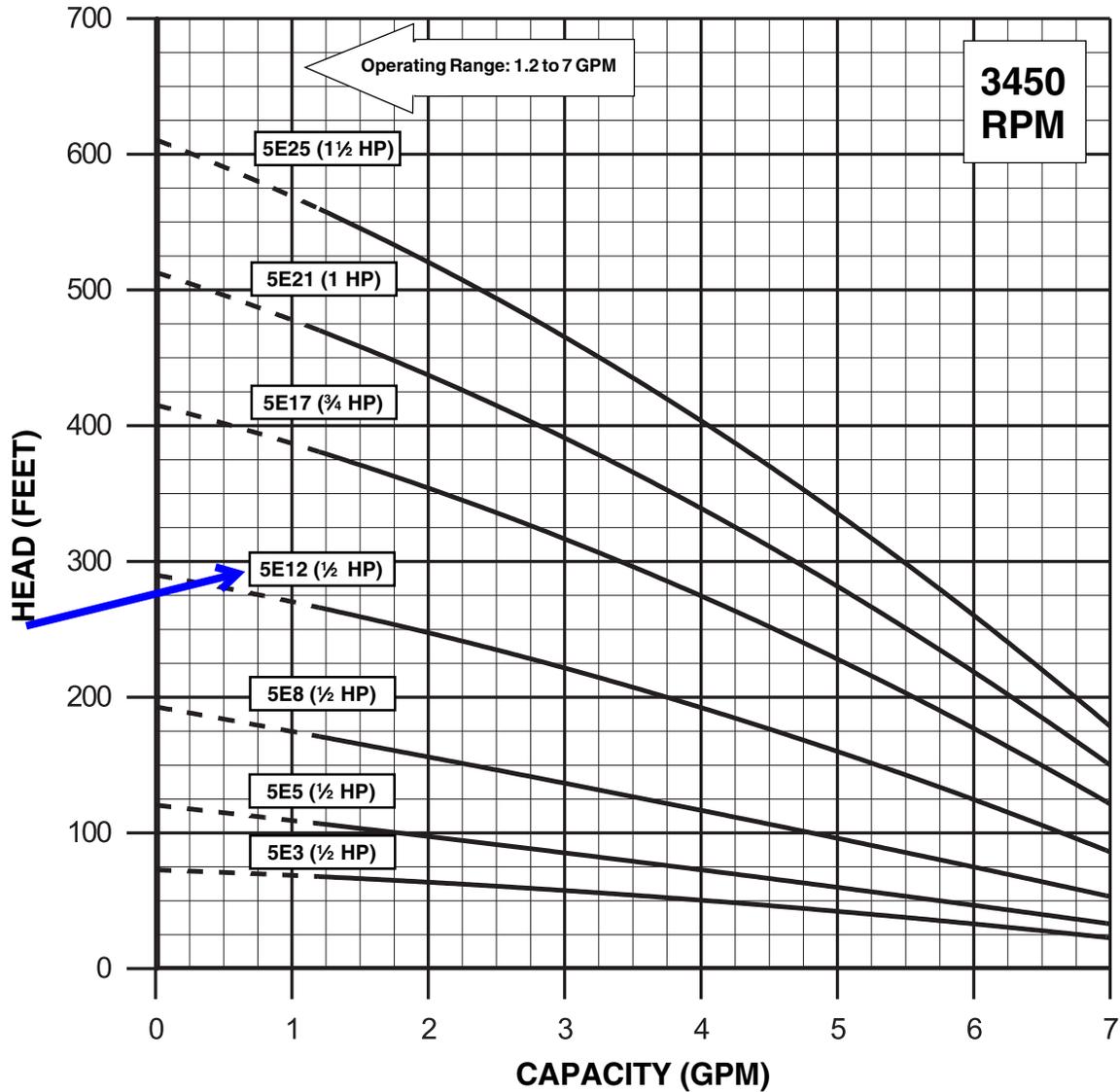
**MATERIALS OF CONSTRUCTION:** See reverse side.

**INSTALLATION:** Unit to be installed vertically for submerged operation.

### Electrical Data, Dimensions, and Weights ①

Pump Type	Motors				DIMENSIONS IN INCHES							
	HP	SF	PH	Volts	Overall Length A	Motor Length B	Pump End Length C	Max. Dia. D	Inlet E	Disch. Pipe Size (NPT) F	Net Weight (Lbs.) <sup>②</sup>	Ship. Weight (Lbs.) <sup>②</sup>
5E3	½	1.60	1	230	19 ¾	10 13/16	8 9/16	3 31/32	3 ¼	1	24	26
5E5	½	1.60	1	230	21 1/8	10 13/16	10 5/16	3 31/32	3 ¼	1	25	27
5E8	½	1.60	1	230	23 9/16	10 13/16	12 ¾	3 31/32	3 ¼	1	27	28
5E12	½	1.60	1	230	26 13/16	10 13/16	16	3 31/32	3 ¼	1	28	29
5E17	¾	1.50	1	230	31 7/16	11 3/8	20 3/16	3 31/32	3 ¼	1	31	32
5E21	1	1.40	1	230	35 7/16	12	23 7/16	3 31/32	3 ¼	1	33	35
5E25	1 ½	1.30	1	230	40 5/16	13 9/16	26 ¾	3 31/32	3 ¼	1	35	37

① Data for Grundfos MS402E motors. ② Does not include motor leads.



## Materials of Construction

### REDI-FLO4 PUMP END

Description	Material
Check Valve Housing, Check Valve, Diffuser Chamber, Impeller, Suction Interconnector, Inlet Screen, Pump Shaft, Straps, Cable Guard, Priming Inducer	304 SS
Check Valve Seat	304 SS & Teflon®
Impeller Seal Ring	Teflon®
Coupling	316/431 SS
Intermediate Bearings	Teflon®

### GRUNDFOS ENVIRONMENTAL MOTOR LEADS

Description	Material
Connector Sleeve	304 SS
Connector Potting	Scotch Cast #4® Epoxy w/FPM Cap
Connector Plug	FPM
Lead Insulation	Teflon®
Conductor	Stranded Copper, 12 AWG

**NOTES:** Specifications are subject to change without notice.  
 Teflon® is a registered trademark of DuPont.  
 Scotch Cast #4® is a registered trademark of 3M Company.

### GRUNDFOS ENVIRONMENTAL MOTOR

Description	Material
NEMA Top, Studs & Fasteners, Stator Housing, Fill Plug Screw	304 SS
Nuts	316 SS
Sand Slinger	FPM
Shaft Extension	431 SS
Diaphragm	FPM
Fill Plug Washer	Teflon®



**GRUNDFOS Pumps Corporation** • 3131 N. Business Park Ave. Fresno, CA 93727  
**Customer Service Centers:** Allentown, PA • Fresno, CA  
**Phone: (800)333-1366 • Fax: (800)333-1363**  
**Canada: Oakville, Ontario • Mexico: Apodaca, N.L.**

# SPE

## Stainless steel submersible pump for environmental applications

Installation and operating instructions



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**Warning**

*Prior to installation, read these installation and operating instructions. Installation and operation must comply with local regulations and accepted codes of good practice.*

*This booklet should be left with the owner of the pump for future reference and information regarding its operation.*

**1. Limited warranty**

Products manufactured by GRUNDFOS PUMPS CORPORATION (Grundfos) are warranted to the original user only to be free of defects in material and workmanship for a period of 24 months from date of installation, but not more than 30 months from date of manufacture. Grundfos' liability under this warranty shall be limited to repairing or replacing at Grundfos' option, without charge, F.O.B. Grundfos' factory or authorized service station, any product of Grundfos' manufacture. Grundfos will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by Grundfos are subject to the warranty provided by the manufacturer of said products and not by Grundfos' warranty. Grundfos will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with Grundfos' printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of Grundfos' products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact Grundfos or an authorized service station for instructions.

Any defective product to be returned to Grundfos or a service station must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed. GRUNDFOS WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE, OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages and some jurisdictions do not allow limit actions on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.

## 2. Symbols used in this document



### Warning

*If these safety instructions are not observed, it may result in personal injury!*

### Caution

*If these safety instructions are not observed, it may result in malfunction or damage to the equipment!*

### Note

*Notes or instructions that make the job easier and ensure safe operation.*

## 3. Introduction

### Warning

*The use of this product requires experience with and knowledge of the product. Persons with reduced physical, sensory or mental capabilities must not use this product, unless they are under supervision or have been instructed in the use of the product by a person responsible for their safety.*

*Children must not use or play with this product.*

Your Grundfos SPE environmental pump is of the utmost quality. Combined with proper installation, your Grundfos pump will give you many years of reliable service.

To ensure the proper installation of the pump, carefully read the complete manual before attempting to install the pump.

### 3.1 Delivery and handling

#### 3.1.1 Delivery

##### Shipment inspection

Examine the components carefully to make sure no damage has occurred to the pump end, motor, or cable during shipment.

### Caution

*The pumps should remain in the packing until they are placed in vertical position during installation.*

The shipping carton should contain:

- pump end
- motor
- cable
- these installation and operating instructions.

#### 3.1.2 Handling

This Grundfos SPE environmental pump should remain in its shipping carton until it is ready to be installed. The carton is specially designed to protect it from damage.

During unpacking and prior to installation, **make sure that the pump is not contaminated, dropped or mishandled.**

### Caution

*The motor is equipped with an electrical cable. Under no circumstance should the electrical cable be used to support the weight of the pump.*

You will find a loose data plate wired to the pump. It should be securely mounted at the well or attached to the control box.

## 3.2 Applications

### 3.2.1 Pumped liquids

SPE pumps are designed for pumping cold groundwater that is free of air or gasses. Decreased pump performance and life expectancy can occur if the groundwater is not cold or contains air or gasses.

## 4. Operating conditions

Flow (Q):	Max. 50 gpm (11.4 m <sup>3</sup> /h)
Head (H):	Max. 500 ft (152 m)
Liquid temp:	+32 °F to +104 °F (0 °C to 40 °C)

## 5. Installation

### 5.1 Pre-installation checks

Before beginning installation, the following checks should be made. They are all critical for the proper installation of this submersible pump.

#### 5.1.1 Condition of the well

If the pump is to be installed in a new well, the well should be fully developed and bailed or blown free of cuttings and sand. Dispose of discharged materials in accordance with the specific job site requirements. The stainless steel construction of the SPE Environmental Pump makes it resistant to abrasion; however, no pump, made of any material, can forever withstand the destructive wear that occurs when constantly pumping sandy groundwater.

Determine the maximum depth of the well, and the drawdown level at the pump's maximum capacity. Pump selection and setting depth should be based on this data.

#### Diameter of well casing

The inside diameter of the well casing should be checked to ensure that it is not smaller than the size of the pump and motor.

#### 5.1.2 Condition of the water

SPE pumps are designed for pumping cold groundwater that is free of air or gasses. Decreased pump performance and life expectancy can occur if the groundwater is not cold or contains air or gasses.

### 5.1.3 Installation depth

Pumping sand or well sediment can occur when the pump motor is installed lower than the top of the well screen or within 5 ft of the well bottom. This can reduce the performance and life expectancy of the pump and should be avoided.

If the pump is to be installed in a lake, containment pond, tank or large diameter well, the water velocity passing over the motor must be sufficient to ensure proper motor cooling.

The minimum recommended water flow rates which ensure proper cooling are listed in section 9.1 *Minimum water flow requirements for submersible pump motors* on p. 13.

### 5.1.4 Electrical supply

The motor voltage, phase and frequency indicated on the motor nameplate should be checked against the actual electrical supply.

### 5.1.5 Wire cable type

The wire cable used between the pump and control box or panel should be approved for submersible pump applications. The conductor insulation should have a continuous Teflon® jacket with no splices and must be suitable for use with submersible pumps.

## 5.2 Mechanical installation

### 5.2.1 Riser pipe or hose

The riser pipe or hose should be properly sized and selected based on estimated flow rates and friction-loss factors.

A back-up wrench should be used when attaching a riser pipe or metallic nipple to the pump. The pump should only be gripped by the flats on the top of the discharge chamber. **The body of the pump, cable guard or motor should not be gripped under any circumstance.**

### 5.2.2 If a steel riser pipe is used

An approved pipe thread compound should be used on all joints. Make sure the joints are adequately tightened in order to resist the tendency of the motor to loosen the joints when stopping and starting.

**When tightened, the first section of the riser pipe must not come in contact with the check valve retainer in the discharge chamber of the pump.**

**Caution**

After the first section of the riser pipe has been attached to the pump, the lifting cable or elevator should be clamped to the pipe. **Do not clamp the pump.**

When raising the pump and riser section, be careful not to place bending stress on the pump by picking it up by the pump-end only.

**Make sure that the electrical cables are not cut or damaged in any way when the pump is being lowered in the well.**

**Caution**

The drop cable should be secured to the riser pipe at frequent intervals to prevent sagging, looping or possible cable damage.

### 5.2.3 If plastic or flexible riser pipe is used

Use the correct compound recommended by the pipe manufacturer or specific job specifications. Make sure that joints are securely fastened. Besides making sure that joints are securely fastened, the use of a torque arrester is recommended when using these types of pipe.

**Do not connect the first plastic or flexible riser section directly to the pump.**

**Always attach a metallic nipple or adapter into the discharge chamber of the pump. When tightened, the threaded end of the nipple or adapter must not come in contact with the check valve retainer in the discharge chamber of the pump.**

The drop cable should be secured to the riser pipe at frequent intervals using an approved clip or tape to prevent sagging, looping and possible cable damage.

**Important — plastic and flexible pipe tend to stretch under load.**

**This stretching must be taken into account when securing the cable to the riser pipe.**

**Note**

Leave enough slack between tie points to allow for this stretching. This tendency for plastic and flexible pipe to stretch will also affect the calculation of the pump setting depth. If the depth setting is critical, check with the manufacturer of the pipe to determine how to compensate for pipe stretch.

When these types of pipe are used, it is recommended that a safety cable be attached to the pump to lower and raise it. The discharge piece of SPE submersibles is designed to accommodate this cable; see fig. 1.



**Fig. 1** SPE submersible with safety cable attached

TM05 0853 1711

### 5.2.4 Protect the well from contamination

While installing the pump, proper care should be used not to introduce foreign objects or contaminants into the well. The well should be finished off above grade to protect against surface water from entering the well, causing contamination.

### 5.3 Electrical installation

#### Warning

**To reduce the risk of electrical shock during operation of this pump requires the provision of acceptable grounding. If the means of connection to the supply connected box is other than grounded metal conduit, ground the pump back to the service by connecting a copper conductor, at least the size of the circuit supplying the pump, to the grounding screw provided within the wiring compartment.**

**All electrical work should be performed by a qualified electrician in accordance with the latest edition of the National Electrical Code, local codes and regulations.**

Verification of the electrical supply should be made to ensure the voltage, phase and frequency match that of the motor. Motor voltage, phase, frequency and full-load current information can be found on the nameplate attached to the motor. Motor electrical data can be found in section 9.3 *Electrical data* on p. 13.

#### Caution

**If voltage variations are larger than  $\pm 10\%$ , do not operate the pump.**

Direct on-line starting is used due to the extremely fast run-up time of the motor (0.1 second maximum), and the low moment of inertia of the pump and motor. Direct on-line starting current (locked rotor amp) is between 4 and 6.5 times the full-load current.

#### 5.3.1 Engine-driven generators

If the SPE pump is going to be operated using an engine driven generator, Grundfos suggests the manufacturer of the generator be contacted to ensure the proper generator is selected and used. See section 5.3.1 *Engine-driven generators* on p. 13 for generator sizing guide.

#### 5.3.2 Control box/panel wiring

Single-phase motors must be connected as indicated in the motor control box. See fig 2.

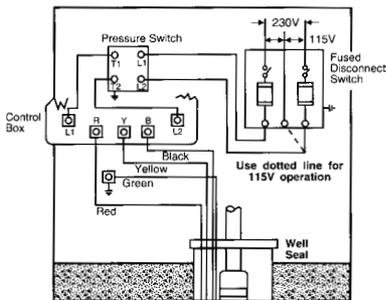


Fig. 2 Typical single-phase wiring diagram for Grundfos control boxes

#### 5.3.3 High voltage surge arresters

A high voltage surge arrester should be used to protect the motor against lightning and switching surges. The correct voltage rated surge arrester should be installed on the supply (line) side of the control box; see fig. 3.

**The surge arrester must be grounded in accordance with the National Electric Code, local codes and regulations.**

#### Caution

**The surge arrester must be grounded in accordance with the National Electric Code, local codes and regulations.**

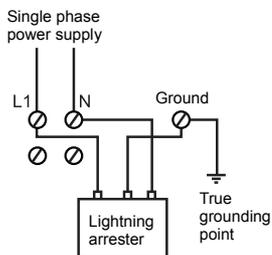


Fig. 3 Single-phase hookup with surge arrester

#### 5.3.4 Control box and surge arrester grounding

**The control box shall be permanently grounded in accordance with the National Electrical Code and local codes or regulations.**

#### Caution

The ground wire should be a bare copper conductor at least the same size as the drop cable wire size. The ground wire should be run as short a distance as possible and be securely fastened to a true grounding point.

True grounding points are considered to be:

- a grounding rod driven into the water strata
- steel well casing submerged into the water lower than the pump setting level
- steel discharge pipes without insulating couplings.

TM05 0037 0611

TM05 0039 0611

If plastic discharge pipe and well casing are used, a properly sized bare copper wire should be connected to a stud on the motor and run to the control panel.

**Caution** *Do not ground to a gas supply line.*

Connect the grounding wire to the ground point first and then to the terminal in the control box or panel.

### 5.3.5 Wiring checks

Before making the final wiring connections of the drop cable to the control box terminal, it is a good practice to check the insulation resistance to ensure that the cable is good.

Measurements for a new installation must be at least 1,000,000 ohm. Do not start the pump if the measurement is less than this. If it is higher, finish wiring and verify that all electrical connections are made in accordance with the wiring diagram. Check to ensure the control box and high voltage surge arrester have been grounded.

## 6. Startup

After the pump has been set into the well and the wiring connections have been made, the following procedures should be performed:

1. Attach a temporary horizontal length of pipe with installed gate valve to the riser pipe.
2. If required, make provisions to capture discharged fluids for disposal.
3. Adjust the gate valve one-third open.
4. Start the pump and let it operate until the water runs clear of sand and silt.
5. As the water clears, slowly open the gate valve in small increments until the desired flow rate of clear water is reached. The pump should not be operated beyond its maximum flow rating and should not be stopped until the groundwater runs clear.
6. If the groundwater is clean and clear when the pump is first started, the valve should still be opened until the desired flow rate is reached.
7. Disconnect the temporary piping arrangements and complete the final piping connections.
8. **Under no circumstances should the pump be operated for any prolonged period of time with the discharge valve closed.** This can result in motor damage due to overheating. A properly sized relief valve should be installed at the well head to prevent the pump from running against a closed valve.
9. Start the pump and test the system. Check and record the voltage and current draw on each motor lead.

## 7. Operation

The pump and system should be periodically checked for water quantity, pressure, drawdown, periods of cycling, and operation of controls.

**Under no circumstances should be the pump be operated for any prolonged periods of time with the discharge valve closed. This can result in motor and pump damage due to overheating.**

**Caution**

A properly sized relief valve should be installed at the well head to prevent the pump from running against a closed valve.

If the pump fails to operate, or there is a loss of performance, refer to section 8. *Troubleshooting.*

For additional information, refer to the MP1, SPE VFD (Variable Frequency Drive) Installation and Operating Instructions manual.

## 8. Troubleshooting

### Warning

**WHEN WORKING WITH ELECTRICAL CIRCUITS, USE CAUTION TO AVOID ELECTRICAL SHOCK. It is recommended that rubber gloves and boots be worn and that care is taken to have metal control boxes and motors grounded to power supply ground or steel drop pipe or casing extending into the well.**



### Warning

**Submersible motors are intended for operation in a well. When not operated in a well, failure to connect motor frame to power supply ground may result in a serious electrical shock.**



The majority of problems that develop with submersible pumps are electrical, and most of these problems can be corrected without pulling the pump from the well. The following charts cover most of the submersible service work. As with any troubleshooting procedure, start with the simplest solution first; always make all the above-ground checks before pulling the pump from the well.

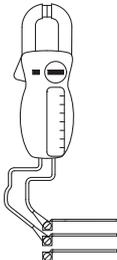
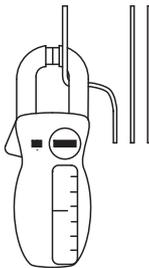
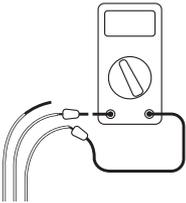
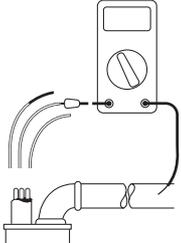
Usually only two instruments are needed — a combination voltmeter/ammeter, and an ohmmeter. These are relatively inexpensive and can be obtained from most water systems suppliers.

## 8.1 Checking pump performance

The troubleshooting chart in section 8.2 *Troubleshooting chart* on p. 10 may require that you test the pump's performance against its curve. To do so, perform these steps:

1. Install pressure gauge
2. Start pump
3. Gradually close the discharge valve
4. Read pressure at shut-off.
5. After taking reading, open valve to its previous position.
6. To calculate pump performance, first convert psi reading to feet.  
(For water:  $\text{psi} \times 2.31 = \text{ft.}$ ).
7. Add this to the total vertical distance from the pressure gauge to the water level in the well while the pump is running.
8. Refer to the specific pump curve for the shut-off head for that pump model. If the measured head is close to the curve, pump is probably OK.

## 8.1.1 Preliminary tests

Test	How to measure	What it means
Supply voltage  TM00 1371 5092	<p>By means of a voltmeter, which has been set to the proper scale, measure the voltage at the control box.</p> <ul style="list-style-type: none"> <li>• <b>On single-phase units,</b> measure between line and neutral.</li> </ul>	<p>When the motor is under load, the voltage should be within <math>\pm 10\%</math> of the nameplate voltage. Larger voltage variation may cause winding damage.</p> <p>Large variations in the voltage indicate a poor electrical supply and the pump should not be operated until these variations have been corrected.</p> <p>If the voltage constantly remains high or low, the motor should be changed to the correct supply voltage.</p>
Current  TM00 1372 5082	<ul style="list-style-type: none"> <li>• By use of an ammeter, set on the proper scale, measure the current on each power lead at the control box or starter. See section 9.3 <i>Electrical data</i> on p. 13 for motor amp draw information.</li> <li>• Current should be measured when the pump is operating at a constant discharge pressure with the motor fully loaded.</li> </ul>	<p>If the amp draw exceeds the listed service factor amps (SFA) check for the following:</p> <ul style="list-style-type: none"> <li>• Burnt contacts on motor starter.</li> <li>• Loose terminals in starter or control box or possible cable defect. Check winding and insulation resistances.</li> <li>• Supply voltage too high or low.</li> <li>• Motor windings are shorted.</li> <li>• Pump is damaged, causing a motor overload.</li> </ul>
Winding resistance  TM05 0028 0511	<ul style="list-style-type: none"> <li>• Turn off power and disconnect the drop cable leads in the control box.</li> <li>• Using an ohmmeter, set the scale selectors to Rx1 for values under 10 ohms and Rx10 for values over 10 ohms.</li> <li>• Zero-adjust the meter and measure the resistance between leads. Record the values.</li> <li>• Motor resistance values can be found in section 9.3 <i>Electrical data</i> on p. 13. Cable resistance values can be found in section 9.3.1 <i>Total resistance of drop cable (Ohms)</i> on p. 14.</li> </ul>	<p>If all the ohm values are normal, and the cable colors correct, the windings are not damaged.</p> <p>If any one ohm value is less than normal, the motors may be shorted.</p> <p>If any one ohm value is greater than normal, there is a poor cable connection or joint. The windings or cable may also be open.</p> <p>If some of the ohm values are greater than normal and some less, the drop cable leads are mixed. To verify lead colors, see resistance values in section 9.3 <i>Electrical data</i> on p. 13.</p>
Insulation resistance  TM05 0029 0511	<ul style="list-style-type: none"> <li>• Turn off power and disconnect the drop cable leads in the control box.</li> <li>• Using an ohm or mega ohmmeter, set the scale selector to Rx 100K and zeroadjust the meter.</li> <li>• Measure the resistance between the lead and ground (discharge pipe or well casing, if steel).</li> </ul>	<p>For ohm values, refer to 8.1.2 <i>Ohm value chart</i> on p. 9.</p> <p>Motors of all hp, voltage, phase and cycle duties have the same value of insulation resistance.</p>

## 8.1.2 Ohm value chart

Ohm value chart			
	Ohm value	Megaohm value	Condition of motor and leads/ recommended procedure
Motor not yet installed	2,000,000 (or more)	2.0	New motor.
	1,000,000 (or more)	1.0	Used motor which can be reinstalled in the well.
Motor in well (Ohm readings are for drop cable plus motor)	500,000 - 1,000,000	0.5 - 1.0	A motor in reasonably good condition.
	20,000 - 500,000	0.02 - 0.5	A motor which may have been damaged by lightning or with damaged leads. Do not pull the pump for this reason.
	10,000 - 20,000	0.01 - 0.02	A motor which definitely has been damaged or with damaged cable. The pump should be pulled and repairs made to the cable or the motor replaced. The motor will still operate, but probably not for long.
	Less than 10,000	0 - 0.01	A motor which has failed or with completely destroyed cable insulation.
			The pump must be pulled and the cable repaired or the motor replaced. The motor will not run in this condition.

## 8.2 Troubleshooting chart

Problem	Possible cause/how to check	Possible remedy
1. Pump does not run.	a) No power at pump panel.  How to check: Check for voltage at panel.	If no voltage at panel, check feeder panel for tripped circuits.
	b) Fuses are blown or circuit breakers are tripped.  How to check: Remove fuses and check for continuity with ohmmeter.	Replace blown fuses or reset circuit breaker. If new fuses blow or circuit breaker trips, the electrical installation and motor must be checked.
	c) Defective controls.  How to check: Check all safety and pressure switches for operation. Inspect contacts in control devices.	Replace worn or defective parts.
	d) Motor and/or cable are defective.  How to check: Turn off power. Disconnect motor leads from control box. Measure the lead-to-lead resistances with the ohmmeter (Rx1). Measure lead-to-ground values with ohmmeter (Rx100K). Record measured values.	If open motor winding or ground is found, remove pump and recheck values at the surface. Repair or replace motor or cable.
	e) Defective capacitor (single-phase only).  How to check: Turn off the power, then discharge capacitor. Check with an ohmmeter (Rx100K). When meter is connected, the needle should jump forward and slowly drift back.	If there is no ohmmeter needle movement, replace the capacitor.

<b>Problem</b>	<b>Possible cause/how to check</b>	<b>Possible remedy</b>
2. Pump runs but does not deliver water.	a) Groundwater level in well is too low or well is collapsed.  How to check: Check well draw-down.	Lower pump if possible. If not, throttle discharge valve and install water level control.
	b) Integral pump check valve is blocked.  How to check: Check the pump's performance against its curve; see section <i>8.1 Checking pump performance</i> on p. 7.	If the pump is not operating close to the pump curve, remove pump and inspect discharge section. Remove blockage, repair valve and valve seat if necessary. Check for other damage. Rinse out pump and re-install.
	c) Inlet strainer is clogged.  How to check: Check the pump's performance against its curve; see section <i>8.1 Checking pump performance</i> on p. 7.	If pump is not operating close to the pump curve, remove pump and inspect. Clean strainer, inspect integral check valve for blockage, rinse out pump and re-install.
	d) Pump is damaged.  How to check: Check the pump's performance against its curve; see section <i>8.1 Checking pump performance</i> on p. 7.	If pump is damaged, repair as necessary. Rinse out pump and re-install.
3. Pump runs but at reduced capacity.	a) Draw-down is larger than anticipated.  How to check: Check draw-down during pump operation.	Lower the pump if possible. If not, throttle discharge valve and install water level control.
	b) Discharge piping or valve leaking.  How to check: Examine system for leaks.	Repair leaks.
	c) Pump strainer or check valve are clogged.  How to check: Remove pump and inspect.	Clean, repair, rinse out pump and reinstall.
	d) Pump is worn.  How to check: Check the pump's performance against its curve; see section <i>8.1 Checking pump performance</i> on p. 7.	If not close to pump curve, remove pump and inspect.

<b>Problem</b>	<b>Possible cause/how to check</b>	<b>Possible remedy</b>
4. Pump cycles too much.	a) Pressure switch is not properly adjusted or is defective.  How to check: Check pressure setting on switch and operation. Check voltage across closed contacts.	Re-adjust switch or replace if defective.
	b) Level control is not properly set or is defective.  How to check: Check setting and operation.	Re-adjust setting (refer to manufacturer data.) Replace if defective.
	c) Plugged snifter valve or bleed orifice.  How to check: Examine valve and orifice for dirt or corrosion.	Clean and/or replace snifter valve or bleed orifice if defective.
5. Fuses blow or circuit breakers trip	a) High or low voltage.  How to check: Check voltage at pump panel. If not within $\pm 10\%$ , check wire size and length of run to pump panel.	If wire size is correct, contact power company. If not, correct and/or replace as necessary.
	b) Control box wiring and components.  How to check: Check that control box parts match the parts list. Check to see that wiring matches wiring diagram. Check for loose or broken wires or terminals.	Correct as required.
	c) Defective capacitor.  How to check: Turn off power and discharge capacitor. Check using an ohmmeter (Rx100K). When the meter is connected, the needle should jump forward and slowly drift back.	If there is no ohmmeter needle movement, replace the capacitor.
	d) Starting relay (Franklin single-phase motors only).  How to check: Check resistance of relay coil with an ohmmeter (Rx1000K). Check contacts for wear.	Replace defective starting relay.

## 9. Technical data

### 9.1 Minimum water flow requirements for submersible pump motors

Motor diameter	Casing or sleeve I.D. [inches]	Min. flow past the motor [gpm]
4"	4	1.2
	5	7
	6	13
	7	21
	8	30

#### Notes:

- A flow inducer or sleeve must be used if the water enters the well above the motor or if there is insufficient water flow past the motor.
- The minimum recommended water velocity over 4" motors is 0.25 feet (0.08 m) per second.

### 9.2 Guide for engine-driven generators in submersible pump applications

Motor [hp]	Minimum kilowatt rating of generator for three-wire submersible pump motors [kW]	
	Externally regulated	Internally regulated
0.33	1.5	1.2
0.5	2.0	1.5
0.75	3.0	2.0
1	4.0	2.5
1.5	5.0	3.0

#### Notes:

- Table is based on typical 176 °F (80 °C) rise continuous duty generators with 35 % maximum voltage dip during start-up of single-phase motors.
- Contact the manufacturer of the generator to assure the unit has adequate capacity to run the submersible motor.
- If the generator rating is in KVA instead of kilowatts, multiply the above ratings by 1.25 to obtain KVA.

### 9.3 Electrical data

Grundfos submersible pump motors - 60 Hz  
4-inch, single phase, 2-wire motors (control box not required)

Hp	Ph	Volt [V]	S.F.	Amperage			Full load		Line-to-line resistance [ohms]		KVA code **	Max. thrust (lbs)
				Full load	Lock rotor	S.F. amps	Eff.	Power factor	Blk.-Yel.	Red-Yel.		
0.5	1	230	1.60	4.5	34.5	6.0	62.0	76.0	5.2 - 6.3		R	770
0.75	1	230	1.50	6.9	40.5	8.4	62.0	75.0	3.2 - 3.8		N	770
1	1	230	1.40	8.0	48.4	9.8	63.0	82.0	2.5 - 3.1		M	770
1.5	1	230	1.30	10.0	62.0	13.1	64.0	85.0	1.9 - 2.3		L	770

Grundfos submersible pump motors - 60 Hz  
4-inch, single phase, 3-wire motors

Hp	Ph	Volt [V]	S.F.	Amperage			Full load		Line-to-line resistance [ohms]		KVA code **	Max. thrust (lbs)
				Full load	Lock rotor	S.F. amps	Eff.	Power factor	Blk.-Yel.	Red-Yel.		
0.5	1	230	1.60	4.5	21.5	6.0	62.0	76.0	4.7 - 5.7	15.8 - 19.6	L	770
0.75	1	230	1.50	6.9	31.4	8.4	62.0	75.0	3.2 - 3.9	14 - 17.2	L	770
1	1	230	1.40	8.0	38.0	9.8	63.0	82.0	2.6 - 3.1	10.3 - 12.5	K	770
1.5	1	230	1.30	9.4	45.9	11.6	69.0	89.0	1.9 - 2.3	7.8 - 9.6	H	770

### 9.3.1 Total resistance of drop cable (Ohms)

The values shown in this table are for copper conductors. Values are for the total resistance of drop cable from the **control box to the motor and back**.

To determine the resistance:

1. Disconnect the drop cable leads from the control box or panel.
2. Record the size and length of drop cable.
3. Determine the cable resistance from the table.
4. Add drop cable resistance to motor resistance. Motor resistances can be found in section 9.3 *Electrical data* on p. 13.
5. Measure the resistance between each drop cable lead using an ohmmeter. Meter should be set on Rx1 and zero-balanced for this measurement.
6. The measured values should be approximately equal to the calculated values.

Distance from control box to pump motor [ft]	12 AWG wire resistance [ohms]	14 AWG wire resistance [ohms]
10	0.03	0.05
20	0.06	0.10
30	0.10	0.15
40	0.13	0.21
50	0.16	0.26
60	0.19	0.31
70	0.23	0.36
80	0.26	0.41
90	0.29	0.46
100	0.32	0.51
110	0.36	0.57
120	0.39	0.62
130	0.42	0.67
140	0.45	0.72
150	0.49	0.77
160	0.52	0.82
170	0.55	0.87
180	0.58	0.93
190	0.62	0.98
200	0.65	1.03

## 10. Disposal

### Warning

*Adherence to environmental regulations — when handling and operating the SPE environmental pump, all environmental regulations concerning the handling of hazardous materials must be observed. When the pump is taken out of operation, great care should be taken to ensure that the pump contains no hazardous materials that might cause injury to human health or to the environment.*



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FRANKLIN ELECTRIC  
**2011 AIM MANUAL**



# **SUBMERSIBLE MOTORS**

**Application • Installation • Maintenance**

60 Hz, Single-Phase and Three-Phase Motors



**Franklin Electric**

**ATTENTION!**  
**IMPORTANT INFORMATION FOR INSTALLERS OF THIS EQUIPMENT!**

THIS EQUIPMENT IS INTENDED FOR INSTALLATION BY TECHNICALLY QUALIFIED PERSONNEL. FAILURE TO INSTALL IT IN COMPLIANCE WITH NATIONAL AND LOCAL ELECTRICAL CODES, AND WITHIN FRANKLIN ELECTRIC RECOMMENDATIONS, MAY RESULT IN ELECTRICAL SHOCK OR FIRE HAZARD, UNSATISFACTORY PERFORMANCE, AND EQUIPMENT FAILURE. FRANKLIN INSTALLATION INFORMATION IS AVAILABLE FROM PUMP MANUFACTURERS AND DISTRIBUTORS, AND DIRECTLY FROM FRANKLIN ELECTRIC. CALL FRANKLIN TOLL FREE 800-348-2420 FOR INFORMATION.

**WARNING**

SERIOUS OR FATAL ELECTRICAL SHOCK MAY RESULT FROM FAILURE TO CONNECT THE MOTOR, CONTROL ENCLOSURES, METAL PLUMBING, AND ALL OTHER METAL NEAR THE MOTOR OR CABLE, TO THE POWER SUPPLY GROUND TERMINAL USING WIRE NO SMALLER THAN MOTOR CABLE WIRES. TO REDUCE RISK OF ELECTRICAL SHOCK, DISCONNECT POWER BEFORE WORKING ON OR AROUND THE WATER SYSTEM. DO NOT USE MOTOR IN SWIMMING AREAS.

**ATTENTION!**  
**INFORMATIONS IMPORTANTES POUR L'INSTALLATEUR DE CET EQUIPEMENT.**

CET EQUIPEMENT DOIT ETRE INTALLE PAR UN TECHNICIEN QUALIFIE. SI L'INSTALLATION N'EST PAS CONFORME AUX LOIS NATIONALES OU LOCALES AINSI QU'AUX RECOMMANDATIONS DE FRANKLIN ELECTRIC, UN CHOC ELECTRIQUE, LE FEU, UNE PERFORMANCE NON ACCEPTABLE, VOIRE MEME LE NON-FONCTIONNEMENT PEUVENT SURVENIR. UN GUIDE D'INSTALLATION DE FRANKLIN ELECTRIC EST DISPONIBLE CHEZ LES MANUFACTURIERS DE POMPES, LES DISTRIBUTEURS, OU DIRECTEMENT CHEZ FRANKLIN. POUR DE PLUS AMPLES RENSEIGNEMENTS, APPELEZ SANS FRAIS LE 800-348-2420.

**AVERTISSEMENT**

UN CHOC ELECTRIQUE SERIEUX OU MEME MORTEL EST POSSIBLE, SI L'ON NEGLIGE DE CONNECTER LE MOTEUR, LA PLOMBERIE METALLIQUE, BOITES DE CONTROLE ET TOUT METAL PROCHE DU MOTEUR A UN CABLE ALLANT VERS UNE ALIMENTATION D'ENERGIE AVEC BORNE DE MISE A LA TERRE UTILISANT AU MOINS LE MEME CALIBRE QUE LES FILS DU MOTEUR. POUR REDUIRE LE RISQUE DE CHOC ELECTRIQUE. COUPER LE COURANT AVANT DE TRAVAILLER PRES OU SUR LE SYSTEM D'EAU. NE PAS UTILISER CE MOTEUR DANS UNE ZONE DE BAIGNADE.

**ATENCION!**  
**INFORMACION PARA EL INSTALADOR DE ESTE EQUIPO.**

PARA LA INSTALACION DE ESTE EQUIPO, SE REQUIERE DE PERSONAL TECNICO CALIFICADO. EL NO CUMPLIR CON LAS NORMAS ELECTRICAS NACIONALES Y LOCALES, ASI COMO CON LAS RECOMENDACIONES DE FRANKLIN ELECTRIC DURANTE SU INSTALACION, PUEDE OCASIONAR, UN CHOQUE ELECTRICO, PELIGRO DE UN INCENDIO, OPERACION DEFECTUOSA E INCLUSO LA DESCOMPOSTURA DEL EQUIPO. LOS MANUALES DE INSTALACION Y PUESTA EN MARCHA DE LOS EQUIPOS, ESTAN DISPONIBLES CON LOS DISTRIBUIDORES, FABRICANTES DE BOMBAS O DIRECTAMENTE CON FRANKLIN ELECTRIC. PUEDE LLAMAR GRATUITAMENTE PARA MAYOR INFORMACION AL TELEFONO 800-348-2420.

**ADVERTENCIA**

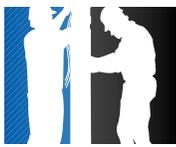
PUEDE OCURRIR UN CHOQUE ELECTRICO, SERIO O FATAL DEBIDO A UNA ERRONEA CONECCION DEL MOTOR, DE LOS TABLEROS ELECTRICOS, DE LA TUBERIA, DE CUALQUIER OTRA PARTE METALICA QUE ESTA CERCA DEL MOTOR O POR NO UTILIZAR UN CABLE PARA TIERRA DE CALIBRE IGUAL O MAYOR AL DE LA ALIMENTACION. PARA REDUCIR EL RIESGO DE CHOQUE ELECTRIC, DESCONECTAR LA ALIMENTACION ELECTRICA ANTES DE INICIAR A TRABAJAR EN EL SISTEMA HIDRAULICO. NO UTILIZAR ESTE MOTOR EN ALBERCAS O AREAS EN DONDE SE PRACTIQUE NATACION.

## **Commitment to Quality**

Franklin Electric is committed to provide customers with defect free products through our program of continuous improvement. Quality shall, in every case, take precedence over quantity.







## SUBMERSIBLE MOTORS

# 60 Hz, Single-Phase and Three-Phase

## Application • Installation • Maintenance Manual

The submersible motor is a reliable, efficient and trouble-free means of powering a pump. Its needs for a long operational life are simple. They are:

1. A suitable operating environment
2. An adequate supply of electricity
3. An adequate flow of cooling water over the motor
4. An appropriate pump load

All considerations of application, installation, and maintenance of submersible motors relating to these four areas are presented in this manual. Franklin Electric's web page, [www.franklin-electric.com](http://www.franklin-electric.com), should be checked for the latest updates.

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## Storage

Franklin Electric submersible motors are a water-lubricated design. The fill solution consists of a mixture of deionized water and Propylene Glycol (a non-toxic antifreeze). The solution will prevent damage from freezing in temperatures to -40 °F (-40 °C); motors should be stored in areas that do not go below this temperature. The solution will partially freeze below 27 °F (-3 °C), but no damage occurs. Repeated freezing and thawing should be avoided to prevent possible loss of fill solution.

There may be an interchange of fill solution with well water during operation. Care must be taken with motors removed from wells during freezing conditions to prevent damage.

When the storage temperature does not exceed 100 °F (37 °C), storage time should be limited to two years. Where temperatures reach 100° to 130 °F, storage time should be limited to one year.

Loss of a few drops of liquid will not damage the motor as an excess amount is provided, and the filter check valve will allow lost liquid to be replaced by filtered well water upon installation. If there is reason to believe there has been a considerable amount of leakage, consult the factory for checking procedures.

## Frequency of Starts

The average number of starts per day over a period of months or years influences the life of a submersible pumping system. Excessive cycling affects the life of control components such as pressure switches, starters, relays and capacitors. Rapid cycling can also cause motor spline damage, bearing damage, and motor overheating. All these conditions can lead to reduced motor life.

The pump size, tank size and other controls should be selected to keep the starts per day as low as practical for longest life. The maximum number of starts per 24-hour period is shown in table 3.

Motors should run a minimum of one minute to dissipate heat build up from starting current. Six inch and larger motors should have a minimum of 15 minutes between starts or starting attempts.

**Table 3 Number of Starts**

MOTOR RATING		MAXIMUM STARTS PER 24 HR PERIOD	
HP	KW	SINGLE-PHASE	THREE-PHASE
Up to 0.75	Up to 0.55	300	300
1 thru 5.5	0.75 thru 4	100	300
7.5 thru 30	5.5 thru 22	50	100*
40 and over	30 and over	-	100

\* Keeping starts per day within the recommended numbers provides the best system life. However, when used with a properly configured Reduced Voltage Starter (RVS) or Variable Frequency Drive (VFD), 7.5 thru 30 hp three-phase motors can be started up to 200 times per 24 hour period.

## Mounting Position

Franklin submersible motors are designed primarily for operation in the vertical, shaft-up position.

During acceleration, the pump thrust increases as its output head increases. In cases where the pump head stays below its normal operating range during startup and full speed condition, the pump may create upward thrust. This creates upward thrust on the motor upthrust bearing. This is an acceptable operation for short periods at each start, but running continuously with upthrust will cause excessive wear on the upthrust bearing.

With certain additional restrictions as listed in this section and the Inline Booster Pump Systems sections of this manual, motors are also suitable for operation in positions

from shaft-up to shaft-horizontal. As the mounting position becomes further from vertical and closer to horizontal, the probability of shortened thrust bearing life increases. For normal motor life expectancy with motor positions other than shaft-up, follow these recommendations:

1. Minimize the frequency of starts, preferably to fewer than **10** per 24-hour period. Six and eight inch motors should have a minimum of 20 minutes between starts or starting attempts
2. Do not use in systems which can run even for short periods at full speed without thrust toward the motor.



## Transformer Capacity - Single-Phase or Three-Phase

Distribution transformers must be adequately sized to satisfy the kVA requirements of the submersible motor. When transformers are too small to supply the load, there is a reduction in voltage to the motor.

Table 4 references the motor horsepower rating, single-phase and three-phase, total effective kVA required, and

the smallest transformer required for open or closed three-phase systems. Open systems require larger transformers since only two transformers are used.

Other loads would add directly to the kVA sizing requirements of the transformer bank.

**Table 4 Transformer Capacity**

MOTOR RATING		TOTAL EFFECTIVE KVA REQUIRED	SMALLEST KVA RATING-EACH TRANSFORMER	
HP	KW		OPEN WYE OR DELTA 2- TRANSFORMERS	CLOSED WYE OR DELTA 3- TRANSFORMERS
1.5	1.1	3	2	1
2	1.5	4	2	1.5
3	2.2	5	3	2
5	3.7	7.5	5	3
7.5	5.5	10	7.5	5
10	7.5	15	10	5
15	11	20	15	7.5
20	15	25	15	10
25	18.5	30	20	10
30	22	40	25	15
40	30	50	30	20
50	37	60	35	20
60	45	75	40	25
75	55	90	50	30
100	75	120	65	40
125	93	150	85	50
150	110	175	100	60
175	130	200	115	70
200	150	230	130	75

**NOTE:** Standard kVA ratings are shown. If power company experience and practice allows transformer loading higher than standard, higher loading values may be used to meet total effective kVA required, provided correct voltage and balance is maintained.

## Effects of Torque

During starting of a submersible pump, the torque developed by the motor must be supported through the pump, delivery pipe or other supports. Most pumps rotate in the direction which causes unscrewing torque on right-handed threaded pipe or pump stages. All threaded joints, pumps and other parts of the pump support system must be capable of withstanding the maximum torque repeatedly without loosening or breaking. Unscrewing joints will break electrical cable and may cause loss of the pump-motor unit.

To safely withstand maximum unscrewing torques with a minimum safety factor of 1.5, tightening all threaded joints to at least 10 lb-ft per motor horsepower is recommended (table 4A). It may be necessary to tack or strap weld pipe joints on high horsepower pumps, especially at shallower settings.

**Table 4A Torque Required (Examples)**

MOTOR RATING		MINIMUM SAFE TORQUE-LOAD
HP	KW	
1 hp & Less	0.75 kW & Less	10 lb-ft
20 hp	15 kW	200 lb-ft
75 hp	55 kW	750 lb-ft
200 hp	150 kW	2000 lb-ft



## Use of Engine Driven Generators - Single-Phase or Three-Phase

Table 5 lists minimum generator sizes based on typical 80 °C rise continuous duty generators, with 35% maximum voltage dip during starting, for Franklin's three-wire motors, single- or three-phase.

This is a general chart. The generator manufacturer should be consulted whenever possible, especially on larger sizes.

There are two types of generators available: externally and internally regulated. Most are externally regulated. They use an external voltage regulator that senses the output voltage. As the voltage dips at motor start-up, the regulator increases the output voltage of the generator.

Internally regulated (self-excited) generators have an extra winding in the generator stator. The extra winding senses the output current to automatically adjust the output voltage.

Generators must be sized to deliver at least 65% of the rated voltage during starting to ensure adequate starting torque. Besides sizing, generator frequency is important as the motor speed varies with the frequency (Hz). Due to pump affinity laws, a pump running at 1 to 2 Hz below motor nameplate frequency design will not meet its performance curve. Conversely, a pump running at 1 to 2 Hz above may trip overloads.

### Generator Operation

Always start the generator before the motor is started and always stop the motor before the generator is shut down. The motor thrust bearing may be damaged if the generator is allowed to coast down with the motor running. This same condition occurs when the generator is allowed to run out of fuel.

Follow generator manufacturer's recommendations for de-rating at higher elevations or using natural gas.

## Use of Check Valves

It is recommended that one or more check valves always be used in submersible pump installations. If the pump does not have a built-in check valve, a line check valve should be installed in the discharge line within 25 feet of the pump and below the draw down level of the water supply. For deeper settings, check valves should be installed per the manufacturer's recommendations. More than one check valve may be required, but more than the recommended number of check valves should not be used.

Swing type check valves are **not** acceptable and should never be used with submersible motors/pumps. Swing type check valves have a slower reaction time which can cause water hammer (see next page). Internal pump check valves or spring loaded check valves close quickly and help eliminate water hammer.

Check valves are used to hold pressure in the system when the pump stops. They also prevent backspin, water

**Table 5 Engine Driven Generators**

**NOTE:** This chart applies to 3-wire or 3-phase motors. For best starting of 2-wire motors, the minimum generator rating is 50% higher than shown.

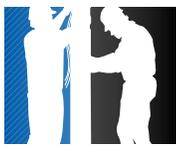
MOTOR RATING		MINIMUM RATING OF GENERATOR			
HP	KW	EXTERNALLY REGULATED		INTERNALLY REGULATED	
		KW	KVA	KW	KVA
1/3	0.25	1.5	1.9	1.2	1.5
1/2	0.37	2	2.5	1.5	1.9
3/4	0.55	3	3.8	2	2.5
1	0.75	4	5.0	2.5	3.13
1.5	1.1	5	6.25	3	3.8
2	1.5	7.5	9.4	4	5
3	2.2	10	12.5	5	6.25
5	3.7	15	18.75	7.5	9.4
7.5	5.5	20	25.0	10	12.5
10	7.5	30	37.5	15	18.75
15	11	40	50	20	25
20	15	60	75	25	31
25	18.5	75	94	30	37.50
30	22	100	125	40	50
40	30	100	125	50	62.5
50	37	150	188	60	75
60	45	175	220	75	94
75	55	250	313	100	125
100	75	300	375	150	188
125	93	375	469	175	219
150	110	450	563	200	250
175	130	525	656	250	313
200	150	600	750	275	344

**WARNING:** To prevent accidental electrocution, automatic or manual transfer switches must be used any time a generator is used as standby or back up on power lines. Contact power company for use and approval.

hammer and upthrust. Any of these can lead to early pump or motor failure.

**NOTE:** Only positive sealing check valves should be used in submersible installations. Although drilling the check valves or using drain-back check valves may prevent back spinning, they create upthrust and water hammer problems.

- A. Backspin** - With no check valve or a failed check valve, the water in the drop pipe and the water in the system can flow down the discharge pipe when the motor stops. This can cause the pump to rotate in a reverse direction. If the motor is started while it is backspinning, an excessive force is placed across the pump-motor assembly that can cause impeller damage, motor or pump shaft breakage, excessive bearing wear, etc.
- B. Upthrust** - With no check valve, a leaking check valve, or drilled check valve, the unit starts under



# APPLICATION All Motors

a zero head condition. This causes an uplifting or upthrust on the impeller-shaft assembly in the pump. This upward movement carries across the pump-motor coupling and creates an upthrust condition in the motor. Repeated upthrust can cause premature failure of both the pump and the motor.

- C. **Water Hammer** - If the lowest check valve is more than 30 feet above the standing (lowest static) water level, or a lower check valve leaks and the check valve above holds, a vacuum is created in

the discharge piping. On the next pump start, water moving at very high velocity fills the void and strikes the closed check valve and the stationary water in the pipe above it, causing a hydraulic shock. This shock can split pipes, break joints and damage the pump and/or motor. Water hammer can often be heard or felt. When discovered, the system should be shut down and the pump installer contacted to correct the problem.

## Wells – Large Diameter, Uncased, Top Feeding and Screened Sections

Franklin Electric submersible motors are designed to operate with a cooling flow of water over and around the full length of the motor.

If the pump installation does not provide the minimum flow shown in table 6, a flow inducer sleeve (flow sleeve) must be used. The conditions requiring a flow sleeve are:

- Well diameter is too large to meet table 6 flow requirements.
- Pump is in an open body of water.
- Pump is in a rock well or below the well casing.
- The well is “top-feeding” (a.k.a. cascading)
- Pump is set in or below screens or perforations.

## Water Temperature and Flow

Franklin Electric’s standard submersible motors, except Hi-Temp designs (see note below), are designed to operate up to maximum service factor horsepower in water up to 86 °F (30 °C). A flow of 0.25 ft/s for 4” motors rated 3 hp and higher, and 0.5 ft/s for 6” and 8” motors is required for proper cooling. Table 6 shows minimum flow rates, in gpm, for various well diameters and motor sizes.

If a standard motor is operated in water over 86 °F (30 °C), water flow past the motor must be increased to maintain safe motor operating temperatures. See HOT WATER APPLICATIONS on page 7.

**NOTE:** Franklin Electric offers a line of Hi-Temp motors designed to operate in water at higher temperatures or lower flow conditions. Consult factory for details.

**Table 6 Required Cooling Flow**

MINIMUM GPM REQUIRED FOR MOTOR COOLING IN WATER UP TO 86 °F (30 °C).			
CASING OR SLEEVE ID INCHES (MM)	4" MOTOR (3-10 HP) 0.25 FT/S GPM (L/M)	6" MOTOR 0.50 FT/S GPM (L/M)	8" MOTOR 0.50 FT/S GPM (L/M)
4 (102)	1.2 (4.5)	-	-
5 (127)	7 (26.5)	-	-
6 (152)	13 (49)	9 (34)	-
7 (178)	20 (76)	25 (95)	-
8 (203)	30 (114)	45 (170)	10 (40)
10 (254)	50 (189)	90 (340)	55 (210)
12 (305)	80 (303)	140 (530)	110 (420)
14 (356)	110 (416)	200 (760)	170 (645)
16 (406)	150 (568)	280 (1060)	245 (930)

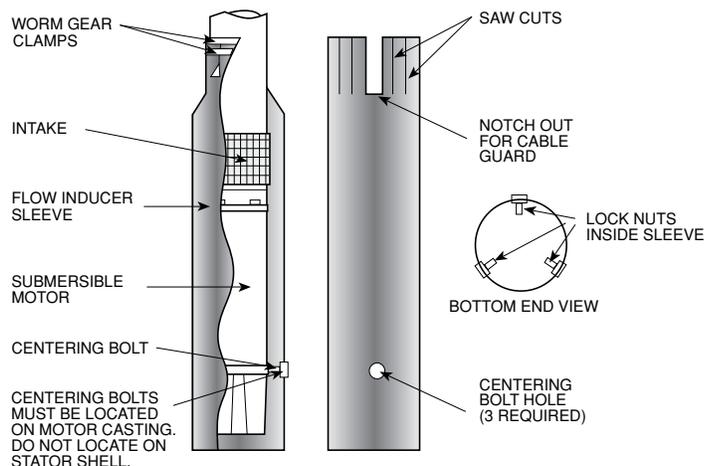
0.25 ft/s = 7.62 cm/sec    0.50 ft/s = 15.24 cm/sec  
1 inch = 2.54 cm

## Flow Inducer Sleeve

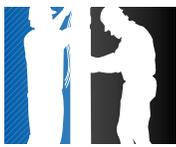
If the flow rate is less than specified, then a flow inducer sleeve must be used. A flow sleeve is always required in an open body of water. FIG. 1 shows a typical flow inducer sleeve construction.

**EXAMPLE:** A 6" motor and pump that delivers 60 gpm will be installed in a 10" well.

From table 6, 90 gpm would be required to maintain proper cooling. In this case adding an 8" or smaller flow sleeve provides the required cooling.



**FIG. 1**



## Head Loss From Flow Past Motor

Table 7 lists the approximate head loss due to flow between an average length motor and smooth casing or flow inducer sleeve.

**Table 7 Head Loss in Feet (Meters) at Various Flow Rates**

MOTOR DIAMETER		4"	4"	4"	6"	6"	6"	8"	8"
CASING ID IN INCHES (MM)		4 (102)	5 (127)	6 (152)	6 (152)	7 (178)	8 (203)	8.1 (206)	10 (254)
Flow Rate in gpm (l/m)	25 (95)	0.3 (.09)							
	50 (189)	1.2 (.37)							
	100 (378)	4.7 (1.4)	0.3 (.09)		1.7 (.52)				
	150 (568)	10.2 (3.1)	0.6 (.18)	0.2 (.06)	3.7 (1.1)				
	200 (757)		1.1 (.34)	0.4 (.12)	6.3 (1.9)	0.5 (.15)		6.8 (2.1)	
	250 (946)		1.8 (.55)	0.7 (.21)	9.6 (2.9)	0.8 (.24)		10.4 (3.2)	
	300 (1136)		2.5 (.75)	1.0 (.30)	13.6 (4.1)	1.2 (.37)	0.2 (.06)	14.6 (4.5)	
	400 (1514)				23.7 (7.2)	2.0 (.61)	0.4 (.12)	24.6 (7.5)	
	500 (1893)					3.1 (.94)	0.7 (.21)	37.3 (11.4)	0.6 (0.2)
	600 (2271)					4.4 (1.3)	1.0 (.30)	52.2 (15.9)	0.8 (0.3)
	800 (3028)								1.5 (0.5)
1000 (3785)								2.4 (0.7)	

## Hot Water Applications (Standard Motors)

Franklin Electric offers a line of Hi-Temp motors which are designed to operate in water with various temperatures up to 194 °F (90 °C) without increased flow. When a standard pump-motor operates in water hotter than 86 °F (30 °C), a flow rate of at least 3 ft/s is required. When selecting the motor to drive a pump in over 86 °F (30 °C) water, the motor horsepower must be de-rated per the following procedure.

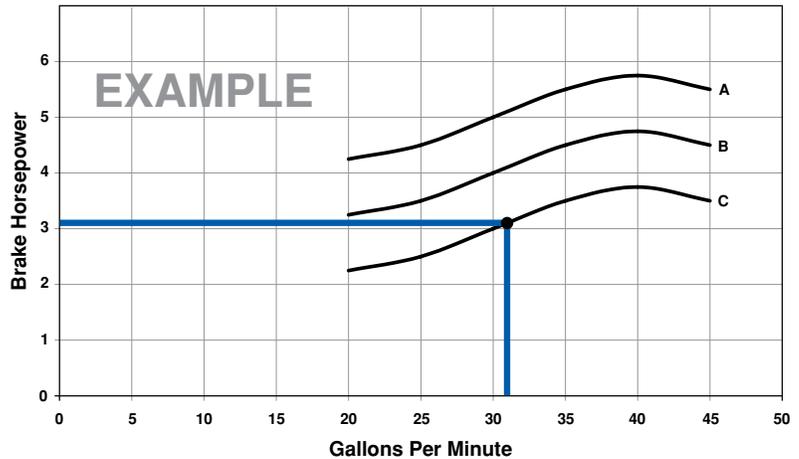
- Using table 7A, determine pump gpm required for different well or sleeve diameters. If necessary, add a flow sleeve to obtain at least 3 ft/s flow rate.

**Table 7A Minimum gpm (l/m) Required for 3 ft/s (.91 m/sec) Flow Rate**

CASING OR SLEEVE ID		4" HIGH THRUST MOTOR		6" MOTOR		8" MOTOR	
INCHES	(MM)	GPM	(L/M)	GPM	(L/M)	GPM	(L/M)
4	(102)	15	(57)				
5	(127)	80	(303)				
6	(152)	160	(606)	52	(197)		
7	(178)			150	(568)		
8	(203)			260	(984)	60	(227)
10	(254)			520	(1970)	330	(1250)
12	(305)					650	(2460)
14	(356)					1020	(3860)
16	(406)					1460	(5530)



- Determine pump horsepower required from the pump manufacturer's curve.



**FIG. 2 MANUFACTURER'S PUMP CURVE**

- Multiply the pump horsepower required by the heat factor multiplier from table 8.

**Table 8 Heat Factor Multiplier at 3 ft/s (.91 m/sec) Flow Rate**

MAXIMUM WATER TEMPERATURE	1/3 - 5 HP .25 - 3.7 KW	7 1/2 - 30 HP 5.5 - 22 KW	OVER 30 HP OVER 22 KW
140 °F (60 °C)	1.25	1.62	2.00
131 °F (55 °C)	1.11	1.32	1.62
122 °F (50 °C)	1.00	1.14	1.32
113 °F (45 °C)	1.00	1.00	1.14
104 °F (40 °C)	1.00	1.00	1.00
95 °F (35 °C)	1.00	1.00	1.00

- Select a rated hp motor on table 8A whose Service Factor Horsepower is at least the value calculated in Item 3.

**Table 8A Service Factor Horsepower**

HP	KW	SFHP	HP	KW	SFHP	HP	KW	SFHP	HP	KW	SFHP
1/3	0.25	0.58	3	2.2	3.45	25	18.5	28.75	100	75	115.00
1/2	0.37	0.80	5	3.7	5.75	30	22.0	34.50	125	93	143.75
3/4	0.55	1.12	7.5	5.5	8.62	40	30.0	46.00	150	110	172.50
1	0.75	1.40	10	7.5	11.50	50	37.0	57.50	175	130	201.25
1.5	1.10	1.95	15	11.0	17.25	60	45.0	69.00	200	150	230.00
2	1.50	2.50	20	15.0	23.00	75	55.0	86.25			

## Hot Water Applications - Example

**EXAMPLE:** A 6" pump end requiring 39 hp input will pump 124 °F water in an 8" well at a delivery rate of 140 gpm. From table 7A, a 6" flow sleeve will be required to increase the flow rate to at least 3 ft/s.

Using table 8, the 1.62 heat factor multiplier is selected because the hp required is over 30 hp and water

temperature is above 122 °F. Multiply 39 hp x 1.62 (multiplier), which equals 63.2 hp. This is the minimum rated service factor horsepower usable at 39 hp in 124 °F. Using table 8A, select a motor with a rated service factor horsepower above 63.2 hp. A 60 hp motor has a service factor horsepower of 69, so a 60 hp motor may be used.



## Drawdown Seals

Allowable motor temperature is based on atmospheric pressure or higher surrounding the motor. "Drawdown seals," which seal the well to the pump above its intake

to maximize delivery, are not recommended, since the suction created can be lower than atmospheric pressure.

## Grounding Control Boxes and Panels

The National Electrical Code requires that the control box or panel-grounding terminal always be connected to supply ground. If the circuit has no grounding conductor and no metal conduit from the box to supply panel, use a wire at least as large as line conductors and connect as required by the National Electrical Code, from the grounding terminal to the electrical supply ground.

**WARNING:** Failure to ground the control frame can result in a serious or fatal electrical shock hazard.

## Grounding Surge Arrestors

An above ground surge arrestor must be grounded, metal to metal, all the way to the lowest draw down water strata for the surge arrestor to be effective. GROUNDING THE ARRESTOR TO THE SUPPLY GROUND OR TO A DRIVEN GROUND ROD PROVIDES LITTLE OR NO SURGE PROTECTION FOR THE MOTOR.

## Control Box, Pumptec Products and Panel Environment

Franklin Electric control boxes, Pumptec products and three-phase panels meet UL requirements for NEMA Type 3R enclosures. They are suitable for indoor and outdoor applications within temperatures of +14 °F (-10 °C) to 122 °F (50 °C). Operating control boxes below +14 °F can cause reduced starting torque and loss of overload protection when overloads are located in control boxes.

Control boxes, Pumptec products and three-phase panels should never be mounted in direct sunlight or

high temperature locations. This will cause shortened capacitor life (where applicable) and unnecessary tripping of overload protectors. A ventilated enclosure painted white to reflect heat is recommended for an outdoor, high temperature location.

A damp well pit, or other humid location, accelerates component failure from corrosion.

Control boxes with voltage relays are designed for vertical upright mounting only. Mounting in other positions will affect the operation of the relay.

## Equipment Grounding

**WARNING:** Serious or fatal electrical shock may result from failure to connect the motor, control enclosures, metal plumbing and all other metal near the motor or cable to the power supply ground terminal using wire no smaller than motor cable wires.

The primary purpose of grounding the metal drop pipe and/or metal well casing in an installation is safety. It is done to limit the voltage between nonelectrical (exposed metal) parts of the system and ground, thus minimizing dangerous shock hazards. Using wire at least the size of the motor cable wires provides adequate current-carrying capability for any ground fault that might occur. It also provides a low resistance path to ground, ensuring that the current to ground will be large enough to trip any overcurrent device designed to detect faults (such as a ground fault circuit interrupter, or GFCI).

Normally, the ground wire to the motor would provide the

primary path back to the power supply ground for any ground fault. There are conditions, however, where the ground wire connection could become compromised. One such example would be the case where the water in the well is abnormally corrosive or aggressive. In this example, a grounded metal drop pipe or casing would then become the primary path to ground. However, the many installations that now use plastic drop pipes and/or casings require further steps to be taken for safety purposes, so that the water column itself does not become the conductive path to ground.

When an installation has abnormally corrosive water AND the drop pipe or casing is plastic, Franklin Electric recommends the use of a GFCI with a 10 mA set-point. In this case, the motor ground wire should be routed through the current-sensing device along with the motor power leads. Wired this way, the GFCI will trip only when a ground fault has occurred AND the motor ground wire is no longer functional.



### 3-Wire Control Boxes

Single-phase three-wire submersible motors require the use of control boxes. Operation of motors without control boxes or with incorrect boxes can result in motor failure and voids warranty.

Control boxes contain starting capacitors, a starting relay, and, in some sizes, overload protectors, running capacitors and contactors.

Ratings through 1 hp may use either a Franklin Electric solid state QD or a potential (voltage) type starting relay, while larger ratings use potential relays.

#### Potential (Voltage) Relays

Potential relays have normally closed contacts. When power is applied, both start and main motor windings are energized, and the motor starts. At this instant, the voltage across the start winding is relatively low and not

enough to open the contacts of the relay.

As the motor accelerates, the increasing voltage across the start winding (and the relay coil) opens the relay contacts. This opens the starting circuit and the motor continues to run on the main winding alone, or the main plus run capacitor circuit. After the motor is started the relay contacts remain open.

**CAUTION:** The control box and motor are two pieces of one assembly. Be certain that the control box and motor hp and voltage match. Since a motor is designed to operate with a control box from the same manufacturer, we can promise warranty coverage only when a Franklin control box is used with a Franklin motor.

### 2-Wire Motor Solid State Controls

#### BIAC Switch Operation

When power is applied the bi-metal switch contacts are closed, so the triac is conducting and energizes the start winding. As rpm increases, the voltage in the sensor coil generates heat in the bi-metal strip, causing the bi-metal strip to bend and open the switch circuit. This removes the starting winding and the motor continues to run on the main winding alone.

Approximately 5 seconds after power is removed from the motor, the bi-metal strip cools sufficiently to return to its closed position and the motor is ready for the next start cycle.

#### Rapid Cycling

The BIAC starting switch will reset within approximately 5 seconds after the motor is stopped. If an attempt is made

**CAUTION:** Restarting the motor within 5 seconds after power is removed may cause the motor overload to trip.

to restart the motor before the starting switch has reset, the motor may not start; however, there will be current in the main winding until the overload protector interrupts the circuit. The time for the protector to reset is longer than the reset of the starting switch. Therefore, the start switch will have closed and the motor will operate.

A waterlogged tank will cause fast cycling. When a waterlogged condition does occur, the user will be alerted to the problem during the off time (overload reset time) since the pressure will drop drastically. When the waterlogged tank condition is detected, the condition should be corrected to prevent nuisance tripping of the overload protector.

#### Bound Pump (Sandlocked)

When the motor is not free to turn, as with a sandlocked pump, the BIAC switch creates a “reverse impact torque” in the motor in either direction. When the sand is dislodged, the motor will start and operate in the correct direction.

### QD Relays (Solid State)

There are two elements in the relay: a reed switch and a triac. The reed switch consists of two tiny rectangular blade-type contacts, which bend under magnetic flux. It is hermetically sealed in glass and is located within a coil, which conducts line current. When power is supplied to the control box, the main winding current passing through the coil immediately closes the reed switch contacts. This turns on the triac, which supplies voltage to the start winding, thus starting the motor.

Once the motor is started, the operation of the QD relay is an interaction between the triac, the reed switch and

the motor windings. The solid state switch senses motor speed through the changing phase relationship between start winding current and line current. As the motor approaches running speed, the phase angle between the start current and the line current becomes nearly in phase. At this point, the reed switch contacts open, turning off the triac. This removes voltage from the start winding and the motor continues to run on the main winding only. With the reed switch contacts open and the triac turned off, the QD relay is ready for the next starting cycle.



# APPLICATION

## Single-Phase Motors

### 2- or 3-Wire Cable, 60 Hz (Service Entrance to Motor - Maximum Length In Feet)

Table 11

60 °C

MOTOR RATING			60 °C INSULATION - AWG COPPER WIRE SIZE												
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000
115	1/2	.37	100	160	250	390	620	960	1190	1460	1780	2160	2630	3140	3770
	1/2	.37	400	650	1020	1610	2510	3880	4810	5880	7170	8720			
230	3/4	.55	300	480	760	1200	1870	2890	3580	4370	5330	6470	7870		
	1	.75	250	400	630	990	1540	2380	2960	3610	4410	5360	6520		
	1.5	1.1	190	310	480	770	1200	1870	2320	2850	3500	4280	5240		
	2	1.5	150	250	390	620	970	1530	1910	2360	2930	3620	4480		
	3	2.2	<b>120</b>	190	300	470	750	1190	1490	1850	2320	2890	3610		
	5	3.7	0	0	<b>180</b>	280	450	710	890	1110	1390	1740	2170	2680	
	7.5	5.5	0	0	0	<b>200</b>	310	490	610	750	930	1140	1410	1720	
	10	7.5	0	0	0	0	<b>250</b>	390	490	600	750	930	1160	1430	1760
	15	11	0	0	0	0	<b>170</b>	<b>270</b>	340	430	530	660	820	1020	1260

Table 11A

75 °C

MOTOR RATING			75 °C INSULATION - AWG COPPER WIRE SIZE												
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000
115	1/2	.37	100	160	250	390	620	960	1190	1460	1780	2160	2630	3140	3770
	1/2	.37	400	650	1020	1610	2510	3880	4810	5880	7170	8720			
230	3/4	.55	300	480	760	1200	1870	2890	3580	4370	5330	6470	7870	9380	
	1	.75	250	400	630	990	1540	2380	2960	3610	4410	5360	6520	7780	9350
	1.5	1.1	190	310	480	770	1200	1870	2320	2850	3500	4280	5240	6300	7620
	2	1.5	150	250	390	620	970	1530	1910	2360	2930	3620	4480	5470	6700
	3	2.2	<b>120</b>	190	300	470	750	1190	1490	1850	2320	2890	3610	4470	5550
	5	3.7	0	<b>110</b>	180	280	450	710	890	1110	1390	1740	2170	2680	3330
	7.5	5.5	0	0	<b>120</b>	200	310	490	610	750	930	1140	1410	1720	2100
	10	7.5	0	0	0	<b>160</b>	250	390	490	600	750	930	1160	1430	1760
	15	11	0	0	0	0	<b>170</b>	270	340	430	530	660	820	1020	1260

1 Foot = .3048 Meter

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors 60 °C or 75 °C in free air or water, not in magnetic enclosures, conduit or direct buried.

Lengths NOT in bold meet the NEC ampacity requirements for either individual conductors or jacketed 60 °C or 75 °C cable and can be in conduit or direct buried. Flat molded and web/ribbon cable are considered jacketed cable.

If any other cable is used, the NEC and local codes should be observed.

Cable lengths in tables 11 & 11A allow for a 5% voltage drop running at maximum nameplate amperes. If 3% voltage drop is desired, multiply table 11 and 11A lengths by 0.6 to get maximum cable length.

The portion of the total cable length, which is between the supply and single-phase control box with a line contactor, should not exceed 25% of total maximum allowable to ensure reliable contactor operation. Single-phase control boxes without line contactors may be connected at any point in the total cable length.

Tables 11 & 11A are based on copper wire. If aluminum wire is used, it must be two sizes larger than copper wire and oxidation inhibitors must be used on connections.

**EXAMPLE:** If tables 11 & 11A call for #12 copper wire, #10 aluminum wire would be required.

Contact Franklin Electric for 90 °C cable lengths. See pages 15, 49, and 50 for applications using 230 V motors on 208 V power systems.



# APPLICATION

## Single-Phase Motors

### Two or More Different Cable Sizes Can Be Used

Depending on the installation, any number of combinations of cable may be used.

For example, in a replacement/upgrade installation, the well already has 160 feet of buried #10 cable between the service entrance and the wellhead. A new 3 hp, 230-volt, single-phase motor is being installed to replace a smaller motor. The question is: Since there is already 160 feet of #10 AWG installed, what size cable is required in the well with a 3 hp, 230-volt, single-phase motor setting at 310 feet?

From tables 11 & 11A, a 3 hp motor can use up to 300 feet of #10 AWG cable.

The application has 160 feet of #10 AWG copper wire installed.

Using the formula below, 160 feet (actual) ÷ 300 feet (max allowable) is equal to 0.533. This means 53.3% (0.533 x 100) of the allowable voltage drop or loss, which is allowed between the service entrance and the motor,

occurs in this wire. This leaves us 46.7% (1.00 - 0.533 = 0.467) of some other wire size to use in the remaining 310 feet “down hole” wire run.

The table shows #8 AWG copper wire is good for 470 feet. Using the formula again, 310 feet (used) ÷ 470 feet (allowed) = 0.660; adding this to the 0.533 determined earlier; 0.533 + 0.660 = 1.193. This combination is greater than 1.00, so the voltage drop will not meet US National Electrical Code recommendations.

Tables 11 & 11A show #6 AWG copper wire is good for 750 feet. Using the formula, 310 ÷ 750 = 0.413, and using these numbers, 0.533 + 0.413 = 0.946, we find this is less than 1.00 and will meet the NEC recommended voltage drop.

This works for two, three or more combinations of wire and it does not matter which size wire comes first in the installation.

Formula:  $\frac{\text{Actual Length}}{\text{Max Allowed}} + \frac{\text{Actual Length}}{\text{Max Allowed}} = 1.00$

**EXAMPLE:** 3 hp, 230-Volt, Single-Phase Motor

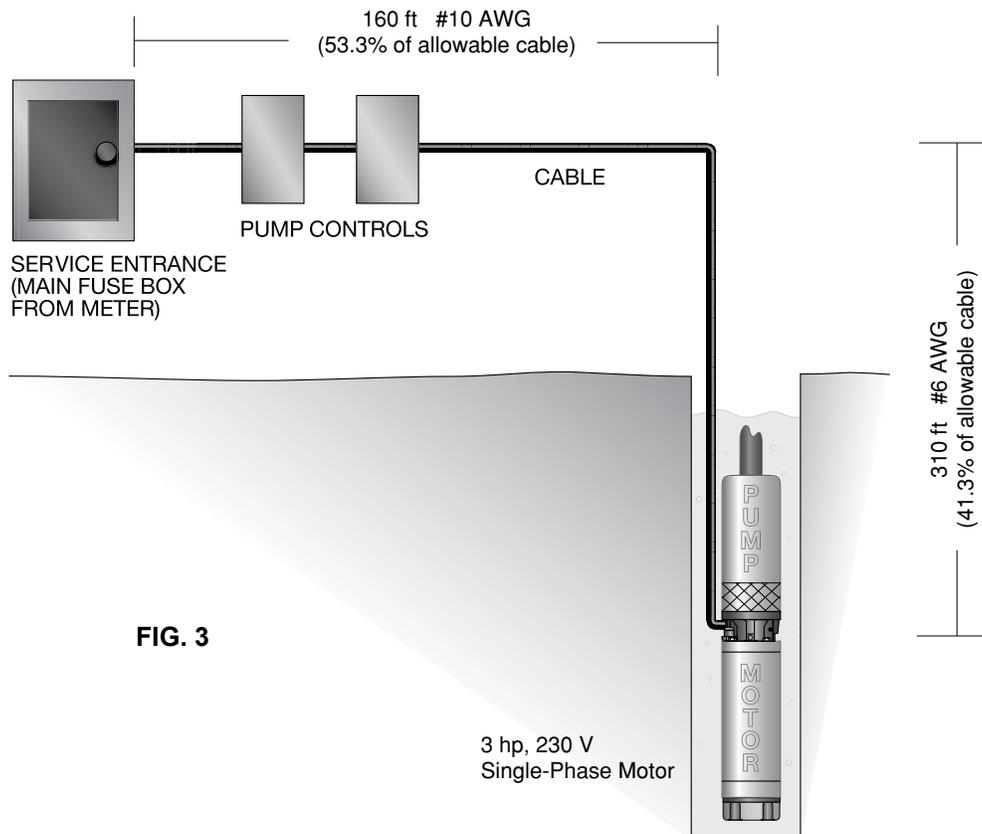


FIG. 3



# APPLICATION

## Single-Phase Motors

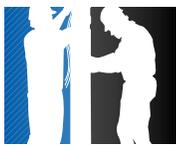
**Table 13 Single-Phase Motor Specifications (60 Hz) 3450 rpm**

TYPE	MOTOR MODEL PREFIX	RATING					FULL LOAD		MAXIMUM LOAD		WINDING (1) RES. IN OHMS		EFFICIENCY %		POWER FACTOR %		LOCKED ROTOR AMPS	KVA CODE
		HP	KW	VOLTS	HZ	S.F.	(2) AMPS	WATTS	(2) AMPS	WATTS	M=MAIN RES. S=START RES.	S.F.	F.L.	S.F.	F.L.			
4" 2-WIRE	244504	1/2	0.37	115	60	1.6	10.0	670	12.0	960	1.0-1.3	62	56	73	58	64.4	R	
	244505	1/2	0.37	230	60	1.6	5.0	670	6.0	960	4.2-5.2	62	56	73	58	32.2	R	
	244507	3/4	0.55	230	60	1.5	6.8	940	8.0	1310	3.0-3.6	64	59	74	62	40.7	N	
	244508	1	0.75	230	60	1.4	8.2	1210	10.4	1600	2.2-2.7	65	62	74	63	48.7	N	
	244309	1.5	1.1	230	60	1.3	10.6	1770	13.1	2280	1.5-2.1	64	63	83	76	66.2	M	
4" 3-WIRE	214504	1/2	0.37	115	60	1.6	Y10.0 B10.0 R0	670	Y12.0 B12.0 R0	960	M1.0-1.3 S4.1-5.1	62	56	73	58	50.5	M	
	214505	1/2	0.37	230	60	1.6	Y5.0 B5.0 R0	670	Y6.0 B6.0 R0	960	M4.2-5.2 S16.7-20.5	62	56	73	58	23	M	
	214507	3/4	0.55	230	60	1.5	Y6.8 B6.8 R0	940	Y8.0 B8.0 R0	1310	M3.0-3.6 S10.7-13.1	64	59	74	62	34.2	M	
	214508	1	0.75	230	60	1.4	Y8.2 B8.2 R0	1210	Y10.4 B10.4 R0	1600	M2.2-2.7 S9.9-12.1	65	62	74	63	41.8	L	
4" 3-WIRE W/CRC CB	214505	1/2	0.37	230	60	1.6	Y3.6 B3.7 R2.0	655	Y4.3 B4.0 R2.0	890	M4.2-5.2 S16.7-20.5	67	57	90	81	23	M	
	214507	3/4	0.55	230	60	1.5	Y4.9 B5.0 R3.2	925	Y5.7 B5.2 R3.1	1220	M3.0-3.6 S10.7-13.1	69	60	92	84	34.2	M	
	214508	1	0.75	230	60	1.4	Y6.0 B5.7 R3.4	1160	Y7.1 B6.2 R3.3	1490	M2.2-2.7 S9.9-12.1	70	64	92	86	41.8	L	
4" 3-WIRE	214508 W/1-1.5 CB	1	0.75	230	60	1.4	Y6.6 B6.6 R1.3	1130	Y8.0 B7.9 R1.3	1500	M2.2-2.7 S9.9-12.1	70	66	82	72	43	L	
	224300	1.5	1.1	230	60	1.3	Y10.0 B9.9 R1.3	1620	Y11.5 B11.0 R1.3	2080	M1.7-2.1 S7.5-9.2	70	69	85	79	51.4	J	
	224301	2	1.5	230	60	1.25	Y10.0 B9.3 R2.6	2025	Y13.2 B11.9 R2.6	2555	M1.8-2.3 S5.5-7.2	73	74	95	94	53.1	G	
	224302 (3)	3	2.2	230	60	1.15	Y14.0 B11.2 R6.1	3000	Y17.0 B12.6 R6.0	3400	M1.1-1.4 S4.0-4.8	75	75	99	99	83.4	H	
	224303 (4)	5	3.7	230	60	1.15	Y23.0 B15.9 R11.0	4830	Y27.5 B19.1 R10.8	5500	M.71-.82 S1.8-2.2	78	77	100	100	129	G	
6"	226110 (5)	5	3.7	230	60	1.15	Y23.0 B14.3 R10.8	4910	Y27.5 B17.4 R10.5	5570	M.55-.68 S1.3-1.7	77	76	100	99	99	E	
	226111	7.5	5.5	230	60	1.15	Y36.5 B34.4 R5.5	7300	Y42.1 B40.5 R5.4	8800	M.36-.50 S.88-1.1	73	74	91	90	165	F	
	226112	10	7.5	230	60	1.15	Y44.0 B39.5 R9.3	9800	Y51.0 B47.5 R8.9	11300	M.27-.33 S.80-.99	76	77	96	96	204	E	
	226113	15	11	230	60	1.15	Y62.0 B52.0 R17.5	13900	Y75.0 B62.5 R16.9	16200	M.17-.22 S.68-.93	79	80	97	98	303	E	

- Main winding - yellow to black  
Start winding - yellow to red
- Y = Yellow lead - line amps  
B = Black lead - main winding amps  
R = Red lead - start or auxiliary winding amps
- Control Boxes date coded 02C and older have **35 MFD** run capacitors. Current values should be Y14.0 @ FL and Y17.0 @ Max Load.  
B12.2                      B14.5  
R4.7                         R4.5

- Control Boxes date coded 01M and older have **60 MFD** run capacitors and the current values on a 4" motor will be Y23.0 @ FL - Y27.5 @ Max Load.  
B19.1                      B23.2  
R8.0                         R7.8
- Control Boxes date coded 01M and older have **60 MFD** run capacitors and the current values on a 6" motor will be Y23.0 @ FL - Y27.5 @ Max Load.  
B18.2                      B23.2  
R8.0                         R7.8

**Performance is typical, not guaranteed, at specified voltages and specified capacitor values. Performance at voltage ratings not shown is similar, except amps vary inversely with voltage.**



# APPLICATION

## Single-Phase Motors

**Table 14 Single-Phase Motor Fuse Sizing**

TYPE	MOTOR MODEL PREFIX	RATING			CIRCUIT BREAKERS OR FUSE AMPS			CIRCUIT BREAKERS OR FUSE AMPS		
					(MAXIMUM PER NEC)			(TYPICAL SUBMERSIBLE)		
		HP	KW	VOLTS	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER
4" 2-WIRE	244504	1/2	0.37	115	35	20	30	30	15	30
	244505	1/2	0.37	230	20	10	15	15	8	15
	244507	3/4	0.55	230	25	15	20	20	10	20
	244508	1	0.75	230	30	20	25	25	11	25
	244309	1.5	1.1	230	35	20	30	35	15	30
4" 3-WIRE	214504	1/2	0.37	115	35	20	30	30	15	30
	214505	1/2	0.37	230	20	10	15	15	8	15
	214507	3/4	0.55	230	25	15	20	20	10	20
	214508	1	0.75	230	30	20	25	25	11	25
4" 3-WIRE W/CRC CB	214505	1/2	0.37	230	20	10	15	15	8	15
	214507	3/4	0.55	230	25	15	20	20	10	20
	214508	1	0.75	230	30	20	25	25	11	25
4" 3-WIRE	214508 W/ 1-1.5 CB	1	0.75	230	30	20	25	25	11	25
	224300	1.5	1.1	230	35	20	30	30	15	30
	224301	2	1.5	230	30	20	25	30	15	25
	224302	3	2.2	230	45	30	40	45	20	40
	224303	5	3.7	230	80	45	60	70	30	60
6"	226110	5	3.7	230	80	45	60	70	30	60
	226111	7.5	5.5	230	125	70	100	110	50	100
	226112	10	7.5	230	150	80	125	150	60	125
	226113	15	11	230	200	125	175	200	90	175



# APPLICATION

## Single-Phase Motors

### Auxiliary Running Capacitors

Added capacitors must be connected across “Red” and “Black” control box terminals, in parallel with any existing running capacitors. The additional capacitor(s) should be mounted in an auxiliary box. The values of additional running capacitors most likely to reduce noise are given below. The tabulation gives the **max.** S.F. amps normally in each lead with the added capacitor.

**Although motor amps decrease when auxiliary run capacitance is added, the load on the motor does not. If a motor is overloaded with normal capacitance, it still will be overloaded with auxiliary run capacitance, even though motor amps may be within nameplate values.**

**Table 15 Auxiliary Capacitor Sizing**

MOTOR RATING		NORMAL RUNNING CAPACITOR(S)	AUXILIARY RUNNING CAPACITORS FOR NOISE REDUCTION			MAXIMUM AMPS WITH RUN CAP		
HP	VOLTS	MFD	MFD	MIN. VOLTS	FRANKLIN PART	YELLOW	BLACK	RED
1/2	115	0	60(1)	370	TWO 155327101	8.4	7.0	4.0
1/2	230	0	15(1)	370	ONE 155328101	4.2	3.5	2.0
3/4		0	20(1)	370	ONE 155328103	5.8	5.0	2.5
1		0	25(1)	370	ONE EA. 155328101 155328102	7.1	5.6	3.4
1.5		10	20	370	ONE 155328103	9.3	7.5	4.4
2		20	10	370	ONE 155328102	11.2	9.2	3.8
3		45	NONE	370		17.0	12.6	6.0
5		80	NONE	370		27.5	19.1	10.8
7.5		45	45	370	ONE EA. 155327101 155328101	37.0	32.0	11.3
10		70	30	370	ONE 155327101	49.0	42.0	13.0
15		135	NONE			75.0	62.5	16.9

- (1) Do not add running capacitors to 1/3 through 1 hp control boxes, which use solid state switches or QD relays. Adding capacitors will cause switch failure. If the control box is converted to use a voltage relay, the specified running capacitance can be added.

### Buck-Boost Transformers

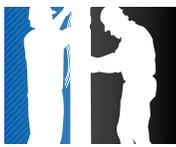
When the available power supply voltage is not within the proper range, a buck-boost transformer is often used to adjust voltage to match the motor. The most common usage on submersible motors is boosting a 208 volt supply to use a standard 230 volt single-phase submersible motor and control. While tables to give a

wide range of voltage boost or buck are published by transformer manufacturers, the following table shows Franklin’s recommendations. The table, based on boosting the voltage 10%, shows the minimum rated transformer kVA needed and the common standard transformer kVA.

**Table 15A Buck-Boost Transformer Sizing**

MOTOR HP	1/3	1/2	3/4	1	1.5	2	3	5	7.5	10	15
LOAD KVA	1.02	1.36	1.84	2.21	2.65	3.04	3.91	6.33	9.66	11.70	16.60
MINIMUM XFMR KVA	0.11	0.14	0.19	0.22	0.27	0.31	0.40	0.64	0.97	1.20	1.70
STANDARD XFMR KVA	0.25	0.25	0.25	0.25	0.50	0.50	0.50	0.75	1.00	1.50	2.00

Buck-Boost transformers are power transformers, not control transformers. They may also be used to lower voltage when the available power supply voltage is too high.



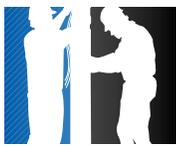
# APPLICATION Three-Phase Motors

Table 16 Three-Phase 60 °C Cable, 60 Hz (Service Entrance to Motor) Maximum Length in Feet

**60 °C**

MOTOR RATING			60 °C INSULATION - AWG COPPER WIRE SIZE													MCM COPPER WIRE SIZE					
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500	
200 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	710	1140	1800	2840	4420														
	3/4	0.55	510	810	1280	2030	3160														
	1	0.75	430	690	1080	1710	2670	4140	5140												
	1.5	1.1	310	500	790	1260	1960	3050	3780												
	2	1.5	240	390	610	970	1520	2360	2940	3610	4430	5420									
	3	2.2	180	290	470	740	1160	1810	2250	2760	3390	4130									
	5	3.7	<b>110</b>	170	280	440	690	1080	1350	1660	2040	2490	3050	3670	4440	5030					
	7.5	5.5	0	0	200	310	490	770	960	1180	1450	1770	2170	2600	3150	3560					
	10	7.5	0	0	0	<b>230</b>	370	570	720	880	1090	1330	1640	1970	2390	2720	3100	3480	3800	4420	
	15	11	0	0	0	<b>160</b>	<b>250</b>	390	490	600	740	910	1110	1340	1630	1850	2100	2350	2570	2980	
	20	15	0	0	0	0	<b>190</b>	<b>300</b>	380	460	570	700	860	1050	1270	1440	1650	1850	2020	2360	
	25	18.5	0	0	0	0	0	<b>240</b>	<b>300</b>	<b>370</b>	460	570	700	840	1030	1170	1330	1500	1640	1900	
	30	22	0	0	0	0	0	0	<b>250</b>	<b>310</b>	<b>380</b>	470	580	700	850	970	1110	1250	1360	1590	
230 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	930	1490	2350	3700	5760	8910													
	3/4	0.55	670	1080	1700	2580	4190	6490	8060	9860											
	1	0.75	560	910	1430	2260	3520	5460	6780	8290											
	1.5	1.1	420	670	1060	1670	2610	4050	5030	6160	7530	9170									
	2	1.5	320	510	810	1280	2010	3130	3890	4770	5860	7170	8780								
	3	2.2	240	390	620	990	1540	2400	2980	3660	4480	5470	6690	8020	9680						
	5	3.7	<b>140</b>	230	370	590	920	1430	1790	2190	2690	3290	4030	4850	5870	6650	7560	8460	9220		
	7.5	5.5	0	<b>160</b>	260	420	650	1020	1270	1560	1920	2340	2870	3440	4160	4710	5340	5970	6500	7510	
	10	7.5	0	0	<b>190</b>	310	490	760	950	1170	1440	1760	2160	2610	3160	3590	4100	4600	5020	5840	
	15	11	0	0	0	<b>210</b>	330	520	650	800	980	1200	1470	1780	2150	2440	2780	3110	3400	3940	
	20	15	0	0	0	0	<b>250</b>	400	500	610	760	930	1140	1380	1680	1910	2180	2450	2680	3120	
	25	18.5	0	0	0	0	0	<b>320</b>	400	500	610	750	920	1120	1360	1540	1760	1980	2160	2520	
	30	22	0	0	0	0	0	<b>260</b>	<b>330</b>	<b>410</b>	510	620	760	930	1130	1280	1470	1650	1800	2110	
380 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	2690	4290	6730																
	3/4	0.55	2000	3190	5010	7860															
	1	0.75	1620	2580	4060	6390	9980														
	1.5	1.1	1230	1970	3100	4890	7630														
	2	1.5	870	1390	2180	3450	5400	8380													
	3	2.2	680	1090	1710	2690	4200	6500	8020	9830											
	5	3.7	400	640	1010	1590	2490	3870	4780	5870	7230	8830									
	7.5	5.5	270	440	690	1090	1710	2640	3260	4000	4930	6010	7290	8780							
	10	7.5	<b>200</b>	<b>320</b>	510	800	1250	1930	2380	2910	3570	4330	5230	6260	7390	8280	9340				
	15	11	0	0	<b>370</b>	590	920	1430	1770	2170	2690	3290	4000	4840	5770	6520	7430	8250	8990		
	20	15	0	0	0	<b>440</b>	700	1090	1350	1670	2060	2530	3090	3760	4500	5110	5840	6510	7120	8190	
	25	18.5	0	0	0	<b>360</b>	570	880	1100	1350	1670	2050	2510	3040	3640	4130	4720	5250	5740	6590	
	30	22	0	0	0	0	<b>470</b>	730	910	1120	1380	1700	2080	2520	3020	3430	3920	4360	4770	5490	
	40	30	0	0	0	0	0	<b>530</b>	660	820	1010	1240	1520	1840	2200	2500	2850	3170	3470	3990	
	50	37	0	0	0	0	0	0	0	<b>540</b>	<b>660</b>	820	1000	1220	1480	1770	2010	2290	2550	2780	3190
	60	45	0	0	0	0	0	0	0	0	<b>560</b>	<b>690</b>	850	1030	1250	1500	1700	1940	2150	2350	2700
	75	55	0	0	0	0	0	0	0	0	0	<b>570</b>	<b>700</b>	<b>860</b>	1050	1270	1440	1660	1850	2030	2350
100	75	0	0	0	0	0	0	0	0	0	0	<b>510</b>	<b>630</b>	<b>760</b>	910	1030	1180	1310	1430	1650	
125	93	0	0	0	0	0	0	0	0	0	0	0	0	<b>620</b>	<b>740</b>	<b>840</b>	<b>950</b>	1060	1160	1330	
150	110	0	0	0	0	0	0	0	0	0	0	0	0	0	<b>620</b>	<b>700</b>	<b>790</b>	<b>880</b>	<b>960</b>	1090	
175	130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<b>650</b>	<b>750</b>	<b>840</b>	<b>920</b>	1070	
200	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<b>630</b>	<b>700</b>	<b>760</b>	<b>880</b>	

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors in free air or water. Lengths NOT in bold meet NEC ampacity requirements for either individual conductors or jacketed cable. See page 11 for additional details.



# APPLICATION Three-Phase Motors

Table 17 Three-Phase 60 °C Cable (Continued)

**60 °C**

MOTOR RATING			60 °C INSULATION - AWG COPPER WIRE SIZE													MCM COPPER WIRE SIZE					
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500	
460 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	3770	6020	9460																
	3/4	0.55	2730	4350	6850																
	1	0.75	2300	3670	5770	9070															
	1.5	1.1	1700	2710	4270	6730															
	2	1.5	1300	2070	3270	5150	8050														
	3	2.2	1000	1600	2520	3970	6200														
	5	3.7	590	950	1500	2360	3700	5750													
	7.5	5.5	420	680	1070	1690	2640	4100	5100	6260	7680										
	10	7.5	310	500	790	1250	1960	3050	3800	4680	5750	7050									
	15	11	0	<b>340</b>	540	850	1340	2090	2600	3200	3930	4810	5900	7110							
	20	15	0	0	<b>410</b>	650	1030	1610	2000	2470	3040	3730	4580	5530							
	25	18.5	0	0	0	<b>530</b>	830	1300	1620	1990	2450	3010	3700	4470	5430						
	30	22	0	0	0	<b>430</b>	680	1070	1330	1640	2030	2490	3060	3700	4500	5130	5860				
	40	30	0	0	0	0	<b>500</b>	790	980	1210	1490	1830	2250	2710	3290	3730	4250				
	50	37	0	0	0	0	0	<b>640</b>	800	980	1210	1480	1810	2190	2650	3010	3420	3830	4180	4850	
	60	45	0	0	0	0	0	<b>540</b>	<b>670</b>	<b>830</b>	1020	1250	1540	1850	2240	2540	2890	3240	3540	4100	
	75	55	0	0	0	0	0	0	0	<b>680</b>	<b>840</b>	1030	1260	1520	1850	2100	2400	2700	2950	3440	
	100	75	0	0	0	0	0	0	0	0	<b>620</b>	<b>760</b>	<b>940</b>	1130	1380	1560	1790	2010	2190	2550	
	125	93	0	0	0	0	0	0	0	0	0	0	<b>740</b>	<b>890</b>	<b>1000</b>	1220	1390	1560	1700	1960	
	150	110	0	0	0	0	0	0	0	0	0	0	0	<b>760</b>	<b>920</b>	<b>1050</b>	<b>1190</b>	1340	1460	1690	
175	130	0	0	0	0	0	0	0	0	0	0	0	0	<b>810</b>	<b>930</b>	<b>1060</b>	<b>1190</b>	1300	1510		
200	150	0	0	0	0	0	0	0	0	0	0	0	0	0	<b>810</b>	<b>920</b>	<b>1030</b>	<b>1130</b>	1310		
575 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	5900	9410																	
	3/4	0.55	4270	6810																	
	1	0.75	3630	5800	9120																
	1.5	1.1	2620	4180	6580																
	2	1.5	2030	3250	5110	8060															
	3	2.2	1580	2530	3980	6270															
	5	3.7	920	1480	2330	3680	5750														
	7.5	5.5	660	1060	1680	2650	4150														
	10	7.5	490	780	1240	1950	3060	4770	5940												
	15	11	<b>330</b>	530	850	1340	2090	3260	4060												
	20	15	0	<b>410</b>	650	1030	1610	2520	3140	3860	4760	5830									
	25	18.5	0	0	<b>520</b>	830	1300	2030	2530	3110	3840	4710									
	30	22	0	0	<b>430</b>	680	1070	1670	2080	2560	3160	3880	4770	5780	7030	8000					
	40	30	0	0	0	<b>500</b>	790	1240	1540	1900	2330	2860	3510	4230	5140	5830					
	50	37	0	0	0	0	<b>640</b>	1000	1250	1540	1890	2310	2840	3420	4140	4700	5340	5990	6530	7580	
	60	45	0	0	0	0	0	<b>850</b>	1060	1300	1600	1960	2400	2890	3500	3970	4520	5070	5530	6410	
	75	55	0	0	0	0	0	<b>690</b>	<b>860</b>	<b>1060</b>	1310	1600	1970	2380	2890	3290	3750	5220	4610	5370	
	100	75	0	0	0	0	0	0	0	<b>790</b>	<b>970</b>	<b>1190</b>	1460	1770	2150	2440	2790	3140	3430	3990	
	125	93	0	0	0	0	0	0	0	0	<b>770</b>	<b>950</b>	<b>1160</b>	1400	1690	1920	2180	2440	2650	3070	
	150	110	0	0	0	0	0	0	0	0	0	<b>800</b>	<b>990</b>	<b>1190</b>	1440	1630	1860	2080	2270	2640	
175	130	0	0	0	0	0	0	0	0	0	0	<b>870</b>	<b>1050</b>	<b>1270</b>	<b>1450</b>	1650	1860	2030	2360		
200	150	0	0	0	0	0	0	0	0	0	0	0	<b>920</b>	<b>1110</b>	<b>1260</b>	<b>1440</b>	1620	1760	2050		

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors in free air or water. Lengths NOT in bold meet NEC ampacity requirements for either individual conductors or jacketed cable. See 11 for additional details.



# APPLICATION Three-Phase Motors

Table 18 Three-Phase 60 °C Cable (Continued)

**60 °C**

MOTOR RATING			60 °C INSULATION - AWG COPPER WIRE SIZE												MCM COPPER WIRE SIZE						
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500	
200 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	160	250	420	660	1030	1620	2020	2490	3060	3730	4570	5500	6660	7540					
	7.5	5.5	110	180	300	460	730	1150	1440	1770	2170	2650	3250	3900	4720	5340					
	10	7.5	<b>80</b>	130	210	340	550	850	1080	1320	1630	1990	2460	2950	3580	4080	4650	5220	5700	6630	
	15	11	0	0	<b>140</b>	240	370	580	730	900	1110	1360	1660	2010	2440	2770	3150	3520	3850	4470	
	20	15	0	0	0	<b>170</b>	280	450	570	690	850	1050	1290	1570	1900	2160	2470	2770	3030	3540	
	25	18.5	0	0	0	<b>140</b>	<b>220</b>	360	450	550	690	850	1050	1260	1540	1750	1990	2250	2460	2850	
30	22	0	0	0	0	<b>180</b>	294	370	460	570	700	870	1050	1270	1450	1660	1870	2040	2380		
230 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	210	340	550	880	1380	2140	2680	3280	4030	4930	6040	7270	8800	9970					
	7.5	5.5	150	240	390	630	970	1530	1900	2340	2880	3510	4300	5160	6240	7060	8010	8950	9750		
	10	7.5	<b>110</b>	180	280	460	730	1140	1420	1750	2160	2640	3240	3910	4740	5380	6150	6900	7530	8760	
	15	11	0	0	<b>190</b>	310	490	780	970	1200	1470	1800	2200	2670	3220	3660	4170	4660	5100	5910	
	20	15	0	0	<b>140</b>	230	370	600	750	910	1140	1390	1710	2070	2520	2860	3270	3670	4020	4680	
	25	18.5	0	0	0	<b>190</b>	300	480	600	750	910	1120	1380	1680	2040	2310	2640	2970	3240	3780	
30	22	0	0	0	<b>150</b>	<b>240</b>	390	490	610	760	930	1140	1390	1690	1920	2200	2470	2700	3160		
380 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	600	960	1510	2380	3730	5800	7170	8800											
	7.5	5.5	400	660	1030	1630	2560	3960	4890	6000	7390	9010									
	10	7.5	300	480	760	1200	1870	2890	3570	4360	5350	6490	7840	9390							
	15	11	210	340	550	880	1380	2140	2650	3250	4030	4930	6000	7260	8650	9780					
	20	15	<b>160</b>	260	410	660	1050	1630	2020	2500	3090	3790	4630	5640	6750	7660	4260	9760			
	25	18.5	0	<b>210</b>	330	540	850	1320	1650	2020	2500	3070	3760	4560	5460	6190	7080	7870	8610	9880	
	30	22	0	0	<b>270</b>	430	700	1090	1360	1680	2070	2550	3120	3780	4530	5140	5880	6540	7150	8230	
	40	30	0	0	0	<b>320</b>	510	790	990	1230	1510	1860	2280	2760	3300	3750	4270	4750	5200	5980	
	50	37	0	0	0	<b>250</b>	<b>400</b>	630	810	990	1230	1500	1830	2220	2650	3010	3430	3820	4170	4780	
	60	45	0	0	0	0	<b>340</b>	540	660	840	1030	1270	1540	1870	2250	2550	2910	3220	3520	4050	
	75	55	0	0	0	0	0	<b>450</b>	550	690	855	1050	1290	1570	1900	2160	2490	2770	3040	3520	
	100	75	0	0	0	0	0	0	<b>420</b>	<b>520</b>	640	760	940	1140	1360	1540	1770	1960	2140	2470	
	125	93	0	0	0	0	0	0	0	<b>400</b>	<b>490</b>	<b>600</b>	730	930	1110	1260	1420	1590	1740	1990	
	150	110	0	0	0	0	0	0	0	0	<b>420</b>	<b>510</b>	<b>620</b>	750	930	1050	1180	1320	1440	1630	
175	130	0	0	0	0	0	0	0	0	<b>360</b>	<b>440</b>	<b>540</b>	660	780	970	1120	1260	1380	1600		
200	150	0	0	0	0	0	0	0	0	0	0	<b>480</b>	<b>580</b>	<b>690</b>	790	940	1050	1140	1320		
460 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	880	1420	2250	3540	5550	8620													
	7.5	5.5	630	1020	1600	2530	3960	6150	7650	9390											
	10	7.5	460	750	1180	1870	2940	4570	5700	7020	8620										
	15	11	310	510	810	1270	2010	3130	3900	4800	5890	7210	8850								
	20	15	<b>230</b>	380	610	970	1540	2410	3000	3700	4560	5590	6870	8290							
	25	18.5	<b>190</b>	310	490	790	1240	1950	2430	2980	3670	4510	5550	6700	8140						
	30	22	0	<b>250</b>	410	640	1020	1600	1990	2460	3040	3730	4590	5550	6750	7690	8790				
	40	30	0	0	<b>300</b>	480	750	1180	1470	1810	2230	2740	3370	4060	4930	5590	6370				
	50	37	0	0	0	<b>370</b>	590	960	1200	1470	1810	2220	2710	3280	3970	4510	5130	5740	6270	7270	
	60	45	0	0	0	<b>320</b>	<b>500</b>	810	1000	1240	1530	1870	2310	2770	3360	3810	4330	4860	5310	6150	
	75	55	0	0	0	0	<b>420</b>	660	810	1020	1260	1540	1890	2280	2770	3150	3600	4050	4420	5160	
	100	75	0	0	0	0	0	<b>500</b>	<b>610</b>	760	930	1140	1410	1690	2070	2340	2680	3010	3280	3820	
	125	93	0	0	0	0	0	0	0	<b>470</b>	<b>590</b>	<b>730</b>	880	1110	1330	1500	1830	2080	2340	2550	2940
	150	110	0	0	0	0	0	0	0	0	<b>510</b>	<b>630</b>	<b>770</b>	950	1140	1380	1570	1790	2000	2180	2530
175	130	0	0	0	0	0	0	0	0	<b>550</b>	<b>680</b>	<b>830</b>	1000	1220	1390	1580	1780	1950	2180	2270	
200	150	0	0	0	0	0	0	0	0	0	<b>590</b>	<b>730</b>	<b>880</b>	1070	1210	1380	1550	1690	1970		
575 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	1380	2220	3490	5520	8620														
	7.5	5.5	990	1590	2520	3970	6220														
	10	7.5	730	1170	1860	2920	4590	7150	8910												
	15	11	490	790	1270	2010	3130	4890	6090												
	20	15	370	610	970	1540	2410	3780	4710	5790	7140	8740									
	25	18.5	<b>300</b>	490	780	1240	1950	3040	3790	4660	5760	7060									
	30	22	<b>240</b>	400	645	1020	1600	2500	3120	3840	4740	5820	7150	8670							
	40	30	0	<b>300</b>	480	750	1180	1860	2310	2850	3490	4290	5260	6340	7710	8740					
	50	37	0	0	<b>380</b>	590	960	1500	1870	2310	2830	3460	4260	5130	6210	7050	8010	8980	9790		
	60	45	0	0	0	<b>500</b>	<b>790</b>	1270	1590	1950	2400	2940	3600	4330	5250	5950	6780	7600	8290	9610	
	75	55	0	0	0	<b>420</b>	<b>660</b>	1030	1290	1590	1960	2400	2950	3570	4330	4930	5620	6330	6910	8050	
	100	75	0	0	0	0	<b>400</b>	<b>780</b>	960	1180	1450	1780	2190	2650	3220	3660	4180	4710	5140	5980	
	125	93	0	0	0	0	0	<b>600</b>	<b>740</b>	920	1150	1420	1740	2100	2530	2880	3270	3660	3970	4600	
	150	110	0	0	0	0	0	0	<b>650</b>	<b>800</b>	<b>990</b>	1210	1480	1780	2160	2450	2790	3120	3410	3950	
175	130	0	0	0	0	0	0	0	<b>700</b>	<b>860</b>	1060	1300	1570	1910	2170	2480	2780	3040	3540		
200	150	0	0	0	0	0	0	0	0	<b>760</b>	<b>930</b>	1140	1370	1670	1890	2160	2420	2640	3070		

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors in free air or water. Lengths NOT in bold meet NEC ampacity requirements for either individual conductors or jacketed cable. See page 11 for additional details.



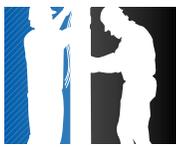
# APPLICATION Three-Phase Motors

Table 19 Three-Phase 75 °C Cable, 60 Hz (Service Entrance to Motor) Maximum Length in Feet

**75 °C**

MOTOR RATING			75 °C INSULATION - AWG COPPER WIRE SIZE													MCM COPPER WIRE SIZE					
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500	
200 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	710	1140	1800	2840	4420														
	3/4	0.55	510	810	1280	2030	3160														
	1	0.75	430	690	1080	1710	2670	4140	5140												
	1.5	1.1	310	500	790	1260	1960	3050	3780												
	2	1.5	240	390	610	970	1520	2360	2940	3610	4430	5420									
	3	2.2	180	290	470	740	1160	1810	2250	2760	3390	4130									
	5	3.7	<b>110</b>	170	280	440	690	1080	1350	1660	2040	2490	3050	3670	4440	5030					
	7.5	5.5	0	0	<b>150</b>	230	370	570	720	880	1090	1330	1640	1970	2390	2720	3100	3480	3800	4420	
	15	11	0	0	0	<b>160</b>	250	390	490	600	740	910	1110	1340	1630	1850	2100	2350	2570	2980	
	20	15	0	0	0	0	<b>190</b>	300	380	460	570	700	860	1050	1270	1440	1650	1850	2020	2360	
	25	18.5	0	0	0	0	0	<b>240</b>	300	370	460	570	700	840	1030	1170	1330	1500	1640	1900	
	30	22	0	0	0	0	0	<b>200</b>	<b>250</b>	310	380	470	580	700	850	970	1110	1250	1360	1590	
230 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	930	1490	2350	3700	5760	8910													
	3/4	0.55	670	1080	1700	2580	4190	6490	8060	9860											
	1	0.75	560	910	1430	2260	3520	5460	6780	8290											
	1.5	1.1	420	670	1060	1670	2610	4050	5030	6160	7530	9170									
	2	1.5	320	510	810	1280	2010	3130	3890	4770	5860	7170	8780								
	3	2.2	240	390	620	990	1540	2400	2980	3660	4480	5470	6690	8020	9680						
	5	3.7	<b>140</b>	230	370	590	920	1430	1790	2190	2690	3290	4030	4850	5870	6650	7560	8460	9220		
	7.5	5.5	0	<b>160</b>	260	420	650	1020	1270	1560	1920	2340	2870	3440	4160	4710	5340	5970	6500	7510	
	10	7.5	0	0	<b>190</b>	310	490	760	950	1170	1440	1760	2160	2610	3160	3590	4100	4600	5020	5840	
	15	11	0	0	0	<b>210</b>	330	520	650	800	980	1200	1470	1780	2150	2440	2780	3110	3400	3940	
	20	15	0	0	0	<b>160</b>	<b>250</b>	400	500	610	760	930	1140	1380	1680	1910	2180	2450	2680	3120	
	25	18.5	0	0	0	0	<b>200</b>	320	400	500	610	750	920	1120	1360	1540	1760	1980	2160	2520	
30	22	0	0	0	0	0	<b>260</b>	330	410	510	620	760	930	1130	1280	1470	1650	1800	2110		
380 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	2690	4290	6730																
	3/4	0.55	2000	3190	5010	7860															
	1	0.75	1620	2580	4060	6390	9980														
	1.5	1.1	1230	1970	3100	4890	7630														
	2	1.5	870	1390	2180	3450	5400	8380													
	3	2.2	680	1090	1710	2690	4200	6500	8020	9830											
	5	3.7	400	640	1010	1590	2490	3870	4780	5870	7230	8830									
	7.5	5.5	270	440	690	1090	1710	2640	3260	4000	4930	6010	7290	8780							
	10	7.5	<b>200</b>	320	510	800	1250	1930	2380	2910	3570	4330	5230	6260	7390	8280	9340				
	15	11	0	0	370	590	920	1430	1770	2170	2690	3290	4000	4840	5770	6520	7430	8250	8990		
	20	15	0	0	<b>280</b>	440	700	1090	1350	1670	2060	2530	3090	3760	4500	5110	2840	6510	7120	8190	
	25	18.5	0	0	0	<b>360</b>	570	880	1100	1350	1670	2050	2510	3040	3640	4130	4720	5250	5740	6590	
	30	22	0	0	0	<b>290</b>	470	730	910	1120	1380	1700	2080	2520	3020	3430	3920	4360	4770	5490	
	40	30	0	0	0	0	0	<b>530</b>	660	820	1010	1240	1520	1840	2200	2500	2850	3170	3470	3990	
	50	37	0	0	0	0	0	<b>440</b>	<b>540</b>	660	820	1000	1220	1480	1770	2010	2290	2550	2780	3190	
	60	45	0	0	0	0	0	<b>370</b>	<b>460</b>	<b>560</b>	690	850	1030	1250	1500	1700	1940	2150	2350	2700	
	75	55	0	0	0	0	0	0	0	<b>460</b>	<b>570</b>	700	860	1050	1270	1440	1660	1850	2030	2350	
100	75	0	0	0	0	0	0	0	0	<b>420</b>	<b>510</b>	<b>630</b>	760	910	1030	1180	1310	1430	1650		
125	93	0	0	0	0	0	0	0	0	0	0	0	<b>510</b>	<b>620</b>	<b>740</b>	840	950	1060	1160	1330	
150	110	0	0	0	0	0	0	0	0	0	0	0	0	<b>520</b>	<b>620</b>	<b>700</b>	<b>790</b>	880	960	1090	
175	130	0	0	0	0	0	0	0	0	0	0	0	0	<b>560</b>	<b>650</b>	<b>750</b>	<b>840</b>	920	1070		
200	150	0	0	0	0	0	0	0	0	0	0	0	0	0	<b>550</b>	<b>630</b>	<b>700</b>	<b>760</b>	880		

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors in free air or water. Lengths NOT in bold meet NEC ampacity requirements for either individual conductors or jacketed cable. See page 11 for additional details.



# APPLICATION Three-Phase Motors

Table 20 Three-Phase 75 °C Cable (Continued)

**75 °C**

MOTOR RATING			75 °C INSULATION - AWG COPPER WIRE SIZE													MCM COPPER WIRE SIZE					
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500	
460 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	3770	6020	9460																
	3/4	0.55	2730	4350	6850																
	1	0.75	2300	3670	5770	9070															
	1.5	1.1	1700	2710	4270	6730															
	2	1.5	1300	2070	3270	5150	8050														
	3	2.2	1000	1600	2520	3970	6200														
	5	3.7	590	950	1500	2360	3700	5750													
	7.5	5.5	420	680	1070	1690	2640	4100	5100	6260	7680										
	10	7.5	310	500	790	1250	1960	3050	3800	4680	5750	7050									
	15	11	0	<b>340</b>	540	850	1340	2090	2600	3200	3930	4810	5900	7110							
	20	15	0	0	410	650	1030	1610	2000	2470	3040	3730	4580	5530							
	25	18.5	0	0	<b>330</b>	530	830	1300	1620	1990	2450	3010	3700	4470	5430						
	30	22	0	0	<b>270</b>	430	680	1070	1330	1640	2030	2490	3060	3700	4500	5130	5860				
	40	30	0	0	0	<b>320</b>	<b>500</b>	790	980	1210	1490	1830	2250	2710	3290	3730	4250				
	50	37	0	0	0	0	<b>410</b>	640	800	980	1210	1480	1810	2190	2650	3010	3420	3830	4180	4850	
	60	45	0	0	0	0	0	<b>540</b>	<b>670</b>	830	1020	1250	1540	1850	2240	2540	2890	3240	3540	4100	
	75	55	0	0	0	0	0	<b>440</b>	<b>550</b>	<b>680</b>	840	1030	1260	1520	1850	2100	2400	2700	2950	3440	
	100	75	0	0	0	0	0	0	0	<b>500</b>	<b>620</b>	<b>760</b>	940	1130	1380	1560	1790	2010	2190	2550	
	125	93	0	0	0	0	0	0	0	0	0	<b>600</b>	<b>740</b>	<b>890</b>	1000	1220	1390	1560	1700	1960	
	150	110	0	0	0	0	0	0	0	0	0	0	<b>630</b>	<b>760</b>	<b>920</b>	1050	1190	1340	1460	1690	
175	130	0	0	0	0	0	0	0	0	0	0	0	<b>670</b>	<b>810</b>	<b>930</b>	1060	1190	1300	1510		
200	150	0	0	0	0	0	0	0	0	0	0	0	<b>590</b>	<b>710</b>	<b>810</b>	<b>920</b>	1030	1130	1310		
575 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	5900	9410																	
	3/4	0.55	4270	6810																	
	1	0.75	3630	5800	9120																
	1.5	1.1	2620	4180	6580																
	2	1.5	2030	3250	5110	8060															
	3	2.2	1580	2530	3980	6270															
	5	3.7	920	1480	2330	3680	5750														
	7.5	5.5	660	1060	1680	2650	4150														
	10	7.5	490	780	1240	1950	3060	4770	5940												
	15	11	<b>330</b>	530	850	1340	2090	3260	4060												
	20	15	0	<b>410</b>	650	1030	1610	2520	3140	3860	4760	5830									
	25	18.5	0	0	520	830	1300	2030	2530	3110	3840	4710									
	30	22	0	0	<b>430</b>	680	1070	1670	2080	2560	3160	3880	4770	5780	7030	8000					
	40	30	0	0	0	<b>500</b>	790	1240	1540	1900	2330	2860	3510	4230	5140	5830					
	50	37	0	0	0	<b>410</b>	<b>640</b>	1000	1250	1540	1890	2310	2840	3420	4140	4700	5340	5990	6530	7580	
	60	45	0	0	0	0	<b>540</b>	850	1060	1300	1600	1960	2400	2890	3500	3970	4520	5070	5530	6410	
	75	55	0	0	0	0	0	<b>690</b>	860	1060	1310	1600	1970	2380	2890	3290	3750	5220	4610	5370	
	100	75	0	0	0	0	0	0	<b>640</b>	<b>790</b>	970	1190	1460	1770	2150	2440	2790	3140	3430	3990	
	125	93	0	0	0	0	0	0	0	<b>630</b>	<b>770</b>	<b>950</b>	1160	1400	1690	1920	2180	2440	2650	3070	
	150	110	0	0	0	0	0	0	0	0	<b>660</b>	<b>800</b>	<b>990</b>	1190	1440	1630	1860	2080	2270	2640	
175	130	0	0	0	0	0	0	0	0	0	<b>700</b>	<b>870</b>	<b>1050</b>	1270	1450	1650	1860	2030	2360		
200	150	0	0	0	0	0	0	0	0	0	0	<b>760</b>	<b>920</b>	<b>1110</b>	1260	1440	1620	1760	2050		

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors in free air or water. Lengths NOT in bold meet NEC ampacity requirements for either individual conductors or jacketed cable. See page 11 for additional details.



# APPLICATION Three-Phase Motors

**75 °C**

**Table 21 Three-Phase 75 °C Cable (Continued)**

MOTOR RATING			75 °C INSULATION - AWG COPPER WIRE SIZE												MCM COPPER WIRE SIZE						
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500	
200 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	160	250	420	660	1030	1620	2020	2490	3060	3730	4570	5500	6660	7540					
	7.5	5.5	110	180	300	460	730	1150	1440	1770	2170	2650	3250	3900	4720	5340					
	10	7.5	<b>80</b>	130	210	340	550	850	1080	1320	1630	1990	2460	2950	3580	4080	4650	5220	5700	6630	
	15	11	0	0	140	240	370	580	730	900	1110	1360	1660	2010	2440	2770	3150	3520	3850	4470	
	20	15	0	0	<b>120</b>	170	280	450	570	690	850	1050	1290	1570	1900	2160	2470	2770	3030	3540	
	25	18.5	0	0	0	<b>140</b>	220	360	450	550	690	850	1050	1260	1540	1750	1990	2250	2460	2850	
30	22	0	0	0	<b>120</b>	<b>180</b>	294	370	460	570	700	870	1050	1270	1450	1660	1870	2040	2380		
230 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	210	340	550	880	1380	2140	2680	3280	4030	4930	6040	7270	8800	9970					
	7.5	5.5	150	240	390	630	970	1530	1900	2340	2880	3510	4300	5160	6240	7060	8010	8950	9750		
	10	7.5	<b>110</b>	180	280	460	730	1140	1420	1750	2160	2640	3240	3910	4740	5380	6150	6900	7530	8760	
	15	11	0	<b>130</b>	190	310	490	780	970	1200	1470	1800	2200	2670	3220	3660	4170	4660	5100	5910	
	20	15	0	0	<b>140</b>	230	370	600	750	910	1140	1390	1710	2070	2520	2860	3270	3670	4020	4680	
	25	18.5	0	0	<b>120</b>	190	300	480	600	750	910	1120	1380	1680	2040	2310	2640	2970	3240	3780	
30	22	0	0	0	<b>150</b>	240	390	490	610	760	930	1140	1390	1690	1920	2200	2470	2700	3160		
380 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	600	960	1510	2380	3730	5800	7170	8800											
	7.5	5.5	400	660	1030	1630	2560	3960	4890	6000	7390	9010									
	10	7.5	300	480	760	1200	1870	2890	3570	4360	5350	6490	7840	9390							
	15	11	210	340	550	880	1380	2140	2650	3250	4030	4930	6000	7260	8650	9780					
	20	15	<b>160</b>	260	410	660	1050	1630	2020	2500	3090	3790	4630	5640	6750	7660	4260	9760			
	25	18.5	0	<b>210</b>	330	540	850	1320	1650	2020	2500	3070	3760	4560	5460	6190	7080	7870	8610	9880	
	30	22	0	0	<b>270</b>	430	700	1090	1360	1680	2070	2550	3120	3780	4530	5140	5880	6540	7150	8230	
	40	30	0	0	<b>210</b>	320	510	790	990	1230	1510	1860	2280	2760	3300	3750	4270	4750	5200	5980	
	50	37	0	0	0	<b>250</b>	400	630	810	990	1230	1500	1830	2220	2650	3010	3430	3820	4170	4780	
	60	45	0	0	0	0	<b>340</b>	540	660	840	1030	1270	1540	1870	2250	2550	2910	3220	3520	4050	
	75	55	0	0	0	0	<b>290</b>	450	550	690	855	1050	1290	1570	1900	2160	2490	2770	3040	3520	
	100	75	0	0	0	0	0	<b>340</b>	<b>420</b>	520	640	760	940	1140	1360	1540	1770	1960	2140	2470	
	125	93	0	0	0	0	0	0	<b>340</b>	<b>400</b>	<b>490</b>	600	730	930	1110	1260	1420	1590	1740	1990	
	150	110	0	0	0	0	0	0	0	<b>350</b>	<b>420</b>	<b>510</b>	620	750	930	1050	1180	1320	1440	1630	
175	130	0	0	0	0	0	0	0	0	<b>360</b>	<b>440</b>	<b>540</b>	660	780	970	1120	1260	1380	1600		
200	150	0	0	0	0	0	0	0	0	0	<b>410</b>	<b>480</b>	<b>580</b>	690	790	940	1050	1140	1320		
460 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	880	1420	2250	3540	5550	8620													
	7.5	5.5	630	1020	1600	2530	3960	6150	7650	9390											
	10	7.5	460	750	1180	1870	2940	4570	5700	7020	8620										
	15	11	310	510	810	1270	2010	3130	3900	4800	5890	7210	8850								
	20	15	230	380	610	970	1540	2410	3000	3700	4560	5590	6870	8290							
	25	18.5	<b>190</b>	310	490	790	1240	1950	2430	2980	3670	4510	5550	6700	8140						
	30	22	0	<b>250</b>	410	640	1020	1600	1990	2460	3040	3730	4590	5550	6750	7690	8790				
	40	30	0	0	<b>300</b>	480	750	1180	1470	1810	2230	2740	3370	4060	4930	5590	6370				
	50	37	0	0	<b>250</b>	370	590	960	1200	1470	1810	2220	2710	3280	3970	4510	5130	5740	6270	7270	
	60	45	0	0	0	<b>320</b>	500	810	1000	1240	1530	1870	2310	2770	3360	3810	4330	4860	5310	6150	
	75	55	0	0	0	0	<b>420</b>	660	810	1020	1260	1540	1890	2280	2770	3150	3600	4050	4420	5160	
	100	75	0	0	0	0	<b>310</b>	<b>500</b>	610	760	930	1140	1410	1690	2070	2340	2680	3010	3280	3820	
	125	93	0	0	0	0	0	<b>390</b>	<b>470</b>	<b>590</b>	730	880	1110	1330	1500	1830	2080	2340	2550	2940	
	150	110	0	0	0	0	0	0	<b>420</b>	<b>510</b>	<b>630</b>	770	950	1140	1380	1570	1790	2000	2180	2530	
175	130	0	0	0	0	0	0	0	<b>450</b>	<b>550</b>	<b>680</b>	830	1000	1220	1390	1580	1780	1950	2270		
200	150	0	0	0	0	0	0	0	0	<b>480</b>	<b>590</b>	<b>730</b>	880	1070	1210	1380	1550	1690	1970		
575 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	1380	2220	3490	5520	8620														
	7.5	5.5	990	1590	2520	3970	6220														
	10	7.5	730	1170	1860	2920	4590	7150	8910												
	15	11	490	790	1270	2010	3130	4890	6090												
	20	15	370	610	970	1540	2410	3780	4710	5790	7140	8740									
	25	18.5	<b>300</b>	490	780	1240	1950	3040	3790	4660	5760	7060									
	30	22	<b>240</b>	400	645	1020	1600	2500	3120	3840	4740	5820	7150	8670							
	40	30	0	<b>300</b>	480	750	1180	1860	2310	2850	3490	4290	5260	6340	7710	8740					
	50	37	0	0	<b>380</b>	590	960	1500	1870	2310	2830	3460	4260	5130	6210	7050	8010	8980	9790		
	60	45	0	0	<b>330</b>	500	790	1270	1590	1950	2400	2940	3600	4330	5250	5950	6780	7600	8290	9610	
	75	55	0	0	0	<b>420</b>	660	1030	1290	1590	1960	2400	2950	3570	4330	4930	5620	6330	6910	8050	
	100	75	0	0	0	0	<b>400</b>	780	960	1180	1450	1780	2190	2650	3220	3660	4180	4710	5140	5980	
	125	93	0	0	0	0	0	<b>600</b>	740	920	1150	1420	1740	2100	2530	2880	3270	3660	3970	4600	
	150	110	0	0	0	0	0	<b>520</b>	<b>650</b>	800	990	1210	1480	1780	2160	2450	2790	3120	3410	3950	
175	130	0	0	0	0	0	0	<b>570</b>	<b>700</b>	860	1060	1300	1570	1910	2170	2480	2780	3040	3540		
200	150	0	0	0	0	0	0	<b>500</b>	<b>610</b>	<b>760</b>	930	1140	1370	1670	1890	2160	2420	2640	3070		

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors in free air or water. Lengths NOT in bold meet NEC ampacity requirements for either individual conductors or jacketed cable.

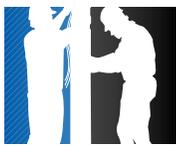


# APPLICATION

## Three-Phase Motors

**Table 22 Three-Phase Motor Specifications (60 Hz) 3450 rpm**

TYPE	MOTOR MODEL PREFIX	RATING					FULL LOAD		MAXIMUM LOAD		LINE TO LINE RESISTANCE OHMS	EFFICIENCY %		LOCKED ROTOR AMPS	KVA CODE
		HP	KW	VOLTS	HZ	S.F.	AMPS	WATTS	AMPS	WATTS		S.F.	FL.		
4"	234501	1/2	0.37	200	60	1.6	2.8	585	3.4	860	6.6-8.4	70	64	17.5	N
	234511			230	60	1.6	2.4	585	2.9	860	9.5-10.9	70	64	15.2	N
	234541			380	60	1.6	1.4	585	2.1	860	23.2-28.6	70	64	9.2	N
	234521			460	60	1.6	1.2	585	1.5	860	38.4-44.1	70	64	7.6	N
	234531			575	60	1.6	1.0	585	1.2	860	58.0-71.0	70	64	6.1	N
	234502	3/4	0.55	200	60	1.5	3.6	810	4.4	1150	4.6-5.9	73	69	24.6	N
	234512			230	60	1.5	3.1	810	3.8	1150	6.8-7.8	73	69	21.4	N
	234542			380	60	1.5	1.9	810	2.5	1150	16.6-20.3	73	69	13	N
	234522			460	60	1.5	1.6	810	1.9	1150	27.2-30.9	73	69	10.7	N
	234532			575	60	1.5	1.3	810	1.6	1150	41.5-50.7	73	69	8.6	N
	234503	1	0.75	200	60	1.4	4.5	1070	5.4	1440	3.8-4.5	72	70	30.9	M
	234513			230	60	1.4	3.9	1070	4.7	1440	4.9-5.6	72	70	26.9	M
	234543			380	60	1.4	2.3	1070	2.8	1440	12.2-14.9	72	70	16.3	M
	234523			460	60	1.4	2	1070	2.4	1440	19.9-23.0	72	70	13.5	M
	234533			575	60	1.4	1.6	1070	1.9	1440	30.1-36.7	72	70	10.8	M
	234504	1.5	1.1	200	60	1.3	5.8	1460	6.8	1890	2.5-3.0	76	76	38.2	K
	234514			230	60	1.3	5	1460	5.9	1890	3.2-4.0	76	76	33.2	K
	234544			380	60	1.3	3	1460	3.6	1890	8.5-10.4	76	76	20.1	K
	234524			460	60	1.3	2.5	1460	3.1	1890	13.0-16.0	76	76	16.6	K
	234534			575	60	1.3	2	1460	2.4	1890	20.3-25.0	76	76	13.3	K
	234305	2	1.5	200	60	1.25	7.7	1960	9.3	2430	1.8-2.4	76	76	50.3	K
	234315			230	60	1.25	6.7	1960	8.1	2430	2.3-3.0	76	76	45.0	K
	234345			380	60	1.25	4.1	1960	4.9	2430	6.6-8.2	76	76	26.6	K
	234325			460	60	1.25	3.4	1960	4.1	2430	9.2-12.0	76	76	22.5	K
	234335			575	60	1.25	2.7	1960	3.2	2430	14.6-18.7	76	76	17.8	K
	234306	3	2.2	200	60	1.15	10.9	2920	12.5	3360	1.3-1.7	77	77	69.5	K
	234316			230	60	1.15	9.5	2920	10.9	3360	1.8-2.2	77	77	60.3	K
	234346			380	60	1.15	5.8	2920	6.6	3360	4.7-6.0	77	77	37.5	K
	234326			460	60	1.15	4.8	2920	5.5	3360	7.2-8.8	77	77	31.0	K
	234336			575	60	1.15	3.8	2920	4.4	3360	11.4-13.9	77	77	25.1	K
	234307	5	3.7	200	60	1.15	18.3	4800	20.5	5500	.68-.83	78	78	116	K
	234317			230	60	1.15	15.9	4800	17.8	5500	.91-1.1	78	78	102	K
234347	380			60	1.15	9.6	4800	10.8	5500	2.6-3.2	78	78	60.2	K	
234327	460			60	1.15	8.0	4800	8.9	5500	3.6-4.4	78	78	53.7	K	
234337	575			60	1.15	6.4	4800	7.1	5500	5.6-6.9	78	78	41.8	K	
234308	7.5	5.5	200	60	1.15	26.5	7150	30.5	8200	.43-.53	78	78	177	K	
234318			230	60	1.15	23.0	7150	26.4	8200	.60-.73	78	78	152	K	
234348			380	60	1.15	13.9	7150	16.0	8200	1.6-2.0	78	78	92.7	K	
234328			460	60	1.15	11.5	7150	13.2	8200	2.3-2.8	78	78	83.8	K	
234338			575	60	1.15	9.2	7150	10.6	8200	3.6-4.5	78	78	64.6	K	
234549	10	7.5	380	60	1.15	19.3	10000	21.0	11400	1.2-1.6	75	75	140	L	
234595			460	60	1.15	15.9	10000	17.3	11400	1.8-2.3	75	75	116.0	L	
234598			575	60	1.15	12.5	10000	13.6	11400	2.8-3.5	75	75	92.8	L	



# APPLICATION

## Three-Phase Motors

**Table 23 Three-Phase Motor Fuse Sizing**

TYPE	MOTOR MODEL PREFIX	RATING			CIRCUIT BREAKERS OR FUSE AMPS			CIRCUIT BREAKERS OR FUSE AMPS		
					(MAXIMUM PER NEC)			(TYPICAL SUBMERSIBLE)		
		HP	KW	VOLTS	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER
4"	234501	1/2	0.37	200	10	5	8	10	4	15
	234511			230	8	4.5	6	8	4	15
	234541			380	5	2.5	4	5	2	15
	234521			460	4	2.25	3	4	2	15
	234531			575	3	1.8	3	3	1.4	15
	234502	3/4	0.55	200	15	7	10	12	5	15
	234512			230	10	5.6	8	10	5	15
	234542			380	6	3.5	5	6	3	15
	234522			460	5	2.8	4	5	3	15
	234532			575	4	2.5	4	4	1.8	15
	234503	1	0.75	200	15	8	15	15	6	15
	234513			230	15	7	10	12	6	15
	234543			380	8	4.5	8	8	4	15
	234523			460	6	3.5	5	6	3	15
	234533			575	5	2.8	4	5	2.5	15
	234504	1.5	1.1	200	20	12	15	20	8	15
	234514			230	15	9	15	15	8	15
	234544			380	10	5.6	8	10	4	15
	234524			460	8	4.5	8	8	4	15
	234534			575	6	3.5	5	6	3	15
	234305	2	1.5	200	25	15	20	25	11	20
	234315			230	25	12	20	25	10	20
	234345			380	15	8	15	15	6	15
	234325			460	15	6	10	11	5	15
	234335			575	10	5	8	10	4	15
	234306	3	2.2	200	35	20	30	35	15	30
	234316			230	30	17.5	25	30	12	25
	234346			380	20	12	15	20	8	15
	234326			460	15	9	15	15	6	15
	234336			575	15	7	10	11	5	15
	234307	5	3.7	200	60	35	50	60	25	50
	234317			230	50	30	40	45	20	40
234347	380			30	17.5	25	30	12	25	
234327	460			25	15	20	25	10	20	
234337	575			20	12	20	20	8	20	
234308	7.5	5.5	200	90	50	70	80	35	70	
234318			230	80	45	60	70	30	60	
234348			380	45	25	40	40	20	40	
234328			460	40	25	30	35	15	30	
234338			575	30	17.5	25	30	12	25	
234349	10	7.5	380	70	40	60	60	25	60	
234329			460	60	30	45	50	25	45	
234339			575	45	25	35	40	20	35	
234549			380	70	35	60	60	25	60	
234595			460	60	30	45	50	25	45	
234598			575	45	25	35	40	20	35	

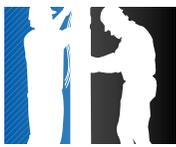


# APPLICATION Three-Phase Motors

**Table 24 Three-Phase Motor Specifications (60 Hz) 3450 rpm**

TYPE	MOTOR MODEL PREFIX	RATING					FULL LOAD		MAXIMUM LOAD		LINE TO LINE RESISTANCE	EFFICIENCY %		LOCKED ROTOR AMPS	KVA CODE
		HP	KW	VOLTS	HZ	S.F.	AMPS	WATTS	AMPS	WATTS	OHMS	S.F.	F.L.		
<b>6" STD.</b>	236650	5	3.7	200	60	1.15	17.5	4700	20.0	5400	.77-.93	79	79	99	H
	236600			230	60	1.15	15	4700	17.6	5400	1.0-1.2	79	79	86	H
	236660			380	60	1.15	9.1	4700	10.7	5400	2.6-3.2	79	79	52	H
	236610			460	60	1.15	7.5	4700	8.8	5400	3.9-4.8	79	79	43	H
	236620			575	60	1.15	6	4700	7.1	5400	6.3-7.7	79	79	34	H
	236651	7.5	5.5	200	60	1.15	25.1	7000	28.3	8000	.43-.53	80	80	150	H
	236601			230	60	1.15	21.8	7000	24.6	8000	.64-.78	80	80	130	H
	236661			380	60	1.15	13.4	7000	15	8000	1.6-2.1	80	80	79	H
	236611			460	60	1.15	10.9	7000	12.3	8000	2.4-2.9	80	80	65	H
	236621			575	60	1.15	8.7	7000	9.8	8000	3.7-4.6	80	80	52	H
	236652	10	7.5	200	60	1.15	32.7	9400	37	10800	.37-.45	79	79	198	H
	236602			230	60	1.15	28.4	9400	32.2	10800	.47-.57	79	79	172	H
	236662			380	60	1.15	17.6	9400	19.6	10800	1.2-1.5	79	79	104	H
	236612			460	60	1.15	14.2	9400	16.1	10800	1.9-2.4	79	79	86	H
	236622			575	60	1.15	11.4	9400	12.9	10800	3.0-3.7	79	79	69	H
	236653	15	11	200	60	1.15	47.8	13700	54.4	15800	.24-.29	81	81	306	H
	236603			230	60	1.15	41.6	13700	47.4	15800	.28-.35	81	81	266	H
	236663			380	60	1.15	25.8	13700	28.9	15800	.77-.95	81	81	161	H
	236613			460	60	1.15	20.8	13700	23.7	15800	1.1-1.4	81	81	133	H
	236623			575	60	1.15	16.6	13700	19	15800	1.8-2.3	81	81	106	H
	236654	20	15	200	60	1.15	61.9	18100	69.7	20900	.16-.20	82	82	416	J
	236604			230	60	1.15	53.8	18100	60.6	20900	.22-.26	82	82	362	J
	236664			380	60	1.15	33	18100	37.3	20900	.55-.68	82	82	219	J
	236614			460	60	1.15	26.9	18100	30.3	20900	.8-1.0	82	82	181	J
	236624			575	60	1.15	21.5	18100	24.2	20900	1.3-1.6	82	82	145	J
	236655	25	18.5	200	60	1.15	77.1	22500	86.3	25700	.12-.15	83	83	552	J
	236605			230	60	1.15	67	22500	75	25700	.15-.19	83	83	480	J
	236665			380	60	1.15	41	22500	46	25700	.46-.56	83	83	291	J
	236615			460	60	1.15	33.5	22500	37.5	25700	.63-.77	83	83	240	J
	236625			575	60	1.15	26.8	22500	30	25700	1.0-1.3	83	83	192	J
	236656	30	22	200	60	1.15	90.9	26900	104	31100	.09-.11	83	83	653	J
	236606			230	60	1.15	79	26900	90.4	31100	.14-.17	83	83	568	J
236666	380			60	1.15	48.8	26900	55.4	31100	.35-.43	83	83	317	J	
236616	460			60	1.15	39.5	26900	45.2	31100	.52-.64	83	83	284	J	
236626	575			60	1.15	31.6	26900	36.2	31100	.78-.95	83	83	227	J	
236667	40	30	380	60	1.15	66.5	35600	74.6	42400	.26-.33	83	83	481	J	
236617			460	60	1.15	54.9	35600	61.6	42400	.34-.42	83	83	397	J	
236627			575	60	1.15	42.8	35600	49.6	42400	.52-.64	83	83	318	H	
236668	50	37	380	60	1.15	83.5	45100	95	52200	.21-.25	82	83	501	H	
236618			460	60	1.15	67.7	45100	77	52200	.25-.32	82	83	414	H	
236628			575	60	1.15	54.2	45100	61.6	52200	.40-.49	82	83	331	H	
276668			380	60	1.15	82.4	45100	94.5	52200	.21-.25	82	83	501	H	
276618			460	60	1.15	68.1	45100	78.1	52200	.25-.32	82	83	414	H	
276628	575	60	1.15	54.5	45100	62.5	52200	.40-.49	82	83	331	H			
236669	60	45	380	60	1.15	98.7	53500	111	61700	.15-.18	84	84	627	H	
236619			460	60	1.15	80.5	53500	91	61700	.22-.27	84	84	518	H	
236629			575	60	1.15	64.4	53500	72.8	61700	.35-.39	84	84	414	H	
276669			380	60	1.15	98.1	53500	111.8	61700	.15-.18	84	84	627	H	
276619			460	60	1.15	81.0	53500	92.3	61700	.22-.27	84	84	518	H	
276629	575	60	1.15	64.8	53500	73.9	61700	.35-.39	84	84	414	H			

Model numbers above are for three-lead motors. Six-lead motors with different model numbers have the same running performance, but when Wye connected for starting have locked rotor amps 33% of the values shown. Six-lead individual phase resistance = table X 1.5.

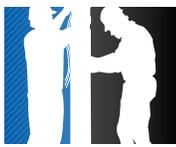


# APPLICATION Three-Phase Motors

**Table 25 6" Three-Phase Motor Specifications (60 Hz) 3450 rpm**

TYPE	MOTOR MODEL PREFIX	RATING					FULL LOAD		MAXIMUM LOAD		LINE TO LINE RESISTANCE OHMS	EFFICIENCY %		LOCKED ROTOR AMPS	KVA CODE
		HP	KW	VOLTS	HZ	S.F.	AMPS	WATTS	AMPS	WATTS		S.F.	F.L.		
<b>6" HI-TEMP 90 °C</b>	276650	5	3.7	200	60	1.15	17.2	5200	19.8	5800	.53 - .65	73	72	124	K
	276600			230	60	1.15	15.0	5200	17.2	5800	.68 - .84	73	72	108	K
	276660			380	60	1.15	9.1	5200	10.4	5800	2.0 - 2.4	73	72	66.0	K
	276610			460	60	1.15	7.5	5200	8.6	5800	2.8 - 3.4	73	72	54.0	K
	276620			575	60	1.15	6.0	5200	6.9	5800	4.7 - 5.7	73	72	43.0	K
	276651	7.5	5.5	200	60	1.15	24.8	7400	28.3	8400	.30 - .37	77	76	193	K
	276601			230	60	1.15	21.6	7400	24.6	8400	.41 - .50	77	76	168	K
	276661			380	60	1.15	13.1	7400	14.9	8400	1.1 - 1.4	77	76	102	K
	276611			460	60	1.15	10.8	7400	12.3	8400	1.7 - 2.0	77	76	84.0	K
	276621			575	60	1.15	8.6	7400	9.9	8400	2.6 - 3.2	77	76	67.0	K
	276652	10	7.5	200	60	1.15	32.0	9400	36.3	10700	.21 - .26	80	79	274	L
	276602			230	60	1.15	27.8	9400	31.6	10700	.28 - .35	80	79	238	L
	276662			380	60	1.15	16.8	9400	19.2	10700	.80 - .98	80	79	144	L
	276612			460	60	1.15	13.9	9400	15.8	10700	1.2 - 1.4	80	79	119	L
	276622	575	60	1.15	11.1	9400	12.7	10700	1.8 - 2.2	80	79	95.0	L		
	276653	15	11	200	60	1.15	48.5	14000	54.5	15900	.15 - .19	81	80	407	L
	276603			230	60	1.15	42.2	14000	47.4	15900	.19 - .24	81	80	354	L
	276663			380	60	1.15	25.5	14000	28.7	15900	.52 - .65	81	80	214	L
	276613			460	60	1.15	21.1	14000	23.7	15900	.78 - .96	81	80	177	L
	276623	575	60	1.15	16.9	14000	19.0	15900	1.2 - 1.4	81	80	142	L		
	276654	20	15	200	60	1.15	64.9	18600	73.6	21300	.10 - .12	80	80	481	K
	276604			230	60	1.15	56.4	18600	64.0	21300	.14 - .18	80	80	418	K
	276664			380	60	1.15	34.1	18600	38.8	21300	.41 - .51	80	80	253	K
	276614			460	60	1.15	28.2	18600	32.0	21300	.58 - .72	80	80	209	K
	276624			575	60	1.15	22.6	18600	25.6	21300	.93 - 1.15	80	80	167	K
	276655	25	18.5	200	60	1.15	80.0	22600	90.6	25800	.09 - .11	83	82	665	L
	276605			230	60	1.15	69.6	22600	78.8	25800	.11 - .14	83	82	578	L
	276665			380	60	1.15	42.1	22600	47.7	25800	.27 - .34	83	82	350	L
	276615			460	60	1.15	34.8	22600	39.4	25800	.41 - .51	83	82	289	L
	276625	575	60	1.15	27.8	22600	31.6	25800	.70 - .86	83	82	231	L		
276656	30	22	200	60	1.15	95.0	28000	108.6	31900	.07 - .09	81	80	736	K	
276606			230	60	1.15	82.6	28000	94.4	31900	.09 - .12	81	80	640	K	
276666			380	60	1.15	50.0	28000	57.2	31900	.23 - .29	81	80	387	K	
276616			460	60	1.15	41.3	28000	47.2	31900	.34 - .42	81	80	320	K	
276626			575	60	1.15	33.0	28000	37.8	31900	.52 - .65	81	80	256	K	
276667	40	30	380	60	1.15	67.2	35900	76.0	42400	.18 - .23	84	83	545	L	
276617			460	60	1.15	55.4	35900	62.8	42400	.23 - .29	84	83	450	L	
276627			575	60	1.15	45.2	35900	50.2	42400	.34 - .43	84	83	360	L	

Model numbers above are for three-lead motors. Six-lead motors with different model numbers have the same running performance, but when Wye connected for starting have locked rotor amps 33% of the values shown. Six-lead individual phase resistance = table X 1.5.



# APPLICATION

## Three-Phase Motors

**Table 26 Three-Phase Motor Fuse Sizing**

TYPE	MOTOR MODEL PREFIX		RATING			CIRCUIT BREAKERS OR FUSE AMPS			CIRCUIT BREAKERS OR FUSE AMPS		
						(MAXIMUM PER NEC)			(TYPICAL SUBMERSIBLE)		
			HP	KW	VOLTS	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER
<b>6" STD. &amp; HI-TEMP</b>	236650	276650	5	3.7	200	60	35	45	50	25	45
	236600	276600			230	45	30	40	45	20	40
	236660	276660			380	30	17.5	25	30	12	25
	236610	276610			460	25	15	20	25	10	20
	236620	276620			575	20	12	15	20	8	15
	236651	276651	7.5	5.5	200	80	45	70	80	35	70
	236601	276601			230	70	40	60	70	30	60
	236661	276661			380	45	25	35	40	20	35
	236611	276611			460	35	20	30	35	15	30
	236621	276621			575	30	17.5	25	25	11	25
	236652	276652	10	7.5	200	100	60	90	100	45	90
	236602	276602			230	90	50	80	90	40	80
	236662	276662			380	60	35	45	50	25	45
	236612	276612			460	45	25	40	45	20	40
	236622	276622			575	35	20	30	35	15	30
	236653	276653	15	11	200	150	90	125	150	60	125
	236603	276603			230	150	80	110	125	60	110
	236663	276663			380	80	50	70	80	35	70
	236613	276613			460	70	40	60	60	30	60
	236623	276623			575	60	30	45	50	25	45
	236654	276654	20	15	200	200	110	175	175	80	175
	236604	276604			230	175	100	150	175	70	150
	236664	276664			380	100	60	90	100	45	90
	236614	276614			460	90	50	70	80	35	70
	236624	276624			575	70	40	60	70	30	60
	236655	276655	25	18.5	200	250	150	200	225	100	200
	236605	276605			230	225	125	175	200	90	175
	236665	276665			380	125	80	110	125	50	110
	236615	276615			460	110	60	90	100	45	90
	236625	276625			575	90	50	70	80	35	70
236656	276656	30	22	200	300	175	250	300	125	250	
236606	276606			230	250	150	225	250	100	200	
236666	276666			380	150	90	125	150	60	125	
236616	276616			460	125	70	110	125	50	100	
236626	276626			575	100	60	90	100	40	80	
236667	276667	40	30	380	200	125	175	200	90	175	
236617	276617			460	175	100	150	175	70	150	
236627	276627			575	150	80	110	125	60	110	
236668	276668	50	37	380	250	150	225	250	110	225	
236618	276618			460	225	125	175	200	90	175	
236628	276628			575	175	100	150	175	70	150	
236669	276669	60	45	380	300	175	250	300	125	250	
236619	276619			460	250	150	225	250	100	225	
236629	276629			575	200	125	175	200	80	175	



# APPLICATION Three-Phase Motors

**Table 27 Three-Phase Motor Specifications (60 Hz) 3525 rpm**

TYPE	MOTOR MODEL PREFIX	RATING					FULL LOAD		MAXIMUM LOAD		LINE TO LINE RESISTANCE OHMS	EFFICIENCY %		LOCKED ROTOR AMPS	KVA CODE
		HP	KW	VOLTS	HZ	S.F.	AMPS	KILOWATTS	AMPS	KILOWATTS		S.F.	F.L.		
<b>8" STD.</b>	239660	40	30	380	60	1.15	64	35	72	40	.16-.20	86	86	479	J
	239600			460	60	1.15	53	35	60	40	.24-.30	86	86	396	J
	239610			575	60	1.15	42	35	48	40	.39-.49	86	86	317	J
	239661	50	37	380	60	1.15	79	43	88	49	.12-.16	87	87	656	K
	239601			460	60	1.15	64	43	73	49	.18-.22	87	87	542	K
	239611			575	60	1.15	51	43	59	49	.28-.34	87	87	434	K
	239662	60	45	380	60	1.15	92	52	104	60	.09-.11	88	87	797	K
	239602			460	60	1.15	76	52	86	60	.14-.17	88	87	658	K
	239612			575	60	1.15	61	52	69	60	.22-.28	88	87	526	K
	239663	75	55	380	60	1.15	114	64	130	73.5	.06-.09	88	88	1046	L
	239603			460	60	1.15	94	64	107	73.5	.10-.13	88	88	864	L
	239613			575	60	1.15	76	64	86	73.5	.16-.21	88	88	691	L
	239664	100	75	380	60	1.15	153	85	172	97.5	.05-.06	89	89	1466	L
	239604			460	60	1.15	126	85	142	97.5	.07-.09	89	89	1211	L
	239614			575	60	1.15	101	85	114	97.5	.11-.13	89	89	969	L
	239165	125	93	380	60	1.15	202	109	228	125	.03-.04	87	86	1596	K
	239105			460	60	1.15	167	109	188	125	.05-.07	87	86	1318	K
	239115			575	60	1.15	134	109	151	125	.08-.11	87	86	1054	K
	239166	150	110	380	60	1.15	235	128	266	146	.02-.03	88	87	1961	K
	239106			460	60	1.15	194	128	219	146	.04-.05	88	87	1620	K
239116	575			60	1.15	155	128	176	146	.06-.08	88	87	1296	K	
239167	175	130	380	60	1.15	265	150	302	173	.02-.04	88	88	1991	J	
239107			460	60	1.15	219	150	249	173	.04-.05	88	88	1645	J	
239117			575	60	1.15	175	150	200	173	.06-.08	88	88	1316	J	
239168	200	150	380	60	1.15	298	169	342	194	.02-.03	88	88	2270	J	
239108			460	60	1.15	246	169	282	194	.03-.05	88	88	1875	J	
239118			575	60	1.15	197	169	226	194	.05-.07	88	88	1500	J	

**Table 27A 8" Three-Phase Motor Specifications (60 Hz) 3525 rpm**

TYPE	MOTOR MODEL PREFIX	RATING					FULL LOAD		MAXIMUM LOAD		LINE TO LINE RESISTANCE OHMS	EFFICIENCY %		LOCKED ROTOR AMPS	KVA CODE
		HP	KW	VOLTS	HZ	S.F.	AMPS	KILOWATTS	AMPS	KILOWATTS		S.F.	F.L.		
<b>8" HI-TEMP</b>	279160	40	30	380	60	1.15	69.6	38	78.7	43	.11 - .14	79	78	616	M
	279100			460	60	1.15	57.5	38	65.0	43	.16 - .19	79	78	509	M
	279110			575	60	1.15	46.0	38	52.0	43	.25 - .31	79	78	407	M
	279161	50	37	380	60	1.15	84.3	47	95.4	53	.07 - .09	81	80	832	M
	279101			460	60	1.15	69.6	47	78.8	53	.11 - .14	81	80	687	M
	279111			575	60	1.15	55.7	47	63.0	53	.18 - .22	81	80	550	M
	279162	60	45	380	60	1.15	98.4	55	112	62	.06 - .07	83	82	1081	N
	279102			460	60	1.15	81.3	55	92.1	62	.09 - .11	83	82	893	N
	279112			575	60	1.15	65.0	55	73.7	62	.13 - .16	83	82	715	N
	279163	75	56	380	60	1.15	125	68	141	77	.05 - .06	83	82	1175	L
	279103			460	60	1.15	100	68	114	77	.07 - .09	83	82	922	L
	279113			575	60	1.15	80	68	92	77	.11 - .14	83	82	738	L
	279164	100	75	380	60	1.15	159	88	181	100	.04 - .05	86	85	1508	M
	279104			460	60	1.15	131	88	149	100	.05 - .07	86	85	1246	M
	279114			575	60	1.15	105	88	119	100	.08 - .10	86	85	997	M
	279165	125	93	380	60	1.15	195	109	223	125	.03 - .04	86	85	1793	L
	279105			460	60	1.15	161	109	184	125	.04 - .06	86	85	1481	L
	279115			575	60	1.15	129	109	148	125	.07 - .09	86	85	1185	L
	279166	150	110	380	60	1.15	235	133	269	151	.02 - .03	85	84	2012	K
	279106			460	60	1.15	194	133	222	151	.03 - .05	85	84	1662	K
279116	575			60	1.15	155	133	178	151	.05 - .07	85	84	1330	K	

Model numbers above are for three-lead motors. Six-lead motors with different model numbers have the same running performance, but when Wye connected for starting have locked rotor amps 33% of the values shown. Six-lead individual phase resistance = table X 1.5.



# APPLICATION Three-Phase Motors

**Table 28 Three-Phase Motor Fuse Sizing**

TYPE	MOTOR MODEL PREFIX	RATING			CIRCUIT BREAKERS OR FUSE AMPS			CIRCUIT BREAKERS OR FUSE AMPS		
					(MAXIMUM PER NEC)			(TYPICAL SUBMERSIBLE)		
		HP	KW	VOLTS	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER
<b>8" STD.</b>	239660	40	30	380	200	125	175	200	80	175
	239600			460	175	100	150	175	70	150
	239610			575	150	80	110	125	60	110
	239661	50	37	380	250	150	200	225	100	200
	239601			460	200	125	175	200	80	175
	239611			575	175	90	150	150	70	150
	239662	60	45	380	300	175	250	300	125	250
	239602			460	250	150	200	225	100	200
	239612			575	200	110	175	175	80	175
	239663	75	55	380	350	200	300	350	150	300
	239603			460	300	175	250	300	125	250
	239613			575	250	150	200	225	100	200
	239664	100	75	380	500	275	400	450	200	400
	239604			460	400	225	350	400	175	350
	239614			575	350	200	300	300	125	300
	239165	125	93	380	700	400	600	600	250	600
	239105			460	500	300	450	500	225	450
	239115			575	450	250	350	400	175	350
	239166	150	110	380	800	450	600	700	300	600
	239106			460	600	350	500	600	250	500
239116	575			500	300	400	450	200	400	
239167	175	130	380	800	500	700	800	350	700	
239107			460	700	400	600	700	300	600	
239117			575	600	350	450	600	225	450	
239168	200	150	380	1000	600	800	1000	400	800	
239108			460	800	450	700	800	350	700	
239118			575	600	350	500	600	250	500	

**Table 28A 8" Three-Phase Motor Fuse Sizing**

TYPE	MOTOR MODEL PREFIX	RATING			CIRCUIT BREAKERS OR FUSE AMPS			CIRCUIT BREAKERS OR FUSE AMPS		
					(MAXIMUM PER NEC)			(TYPICAL SUBMERSIBLE)		
		HP	KW	VOLTS	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER
<b>8" HI-TEMP</b>	279160	40	30	380	225	125	175	200	90	175
	279100			460	175	110	150	175	70	150
	279110			575	150	90	125	125	60	125
	279161	50	37	380	250	150	225	225	110	225
	279101			460	200	125	175	200	90	175
	279111			575	175	100	150	150	70	150
	279162	60	45	380	300	175	250	300	125	250
	279102			460	275	150	225	250	100	225
	279112			575	200	125	175	175	80	175
	279163	75	56	380	400	200	350	350	150	350
	279103			460	300	175	275	300	125	275
	279113			575	275	150	225	225	100	225
	279164	100	75	380	500	300	450	450	200	450
	279104			460	400	250	350	400	175	350
	279114			575	350	200	300	300	125	300
	279165	125	93	380	700	400	600	600	250	600
	279105			460	500	300	450	500	225	450
	279115			575	450	250	350	400	175	350
	279166	150	110	380	800	450	600	700	300	600
	279106			460	600	350	500	600	250	500
279116	575			500	300	400	450	200	400	



# APPLICATION

## Three-Phase Motors

### Overload Protection of Three-Phase Submersible Motors **Class 10 Protection Required**

The characteristics of submersible motors are different than standard motors and special overload protection is required.

If the motor is locked, the overload protection must trip within 10 seconds to protect the motor windings. Subtrol/ SubMonitor, a Franklin-approved adjustable overload relay, or a Franklin-approved fixed heater must be used.

Fixed heater overloads must be the ambient-compensated quick-trip type to maintain protection at high and low air temperatures.

All heaters and amp settings shown are based on total line amps. When determining amperage settings or making heater selections for a six-lead motor with a Wye-Delta starter, divide motor amps by 1.732.

Pages 29, 30 and 31 list the correct selection and settings for some manufacturers. Approval for other manufacturers' types not listed may be requested by calling Franklin's Submersible Service Hotline at 800-348-2420.

Refer to notes on page 30.

**Table 29 - 60 Hz 4" Motors**

HP	KW	VOLTS	NEMA STARTER SIZE	HEATERS FOR OVERLOAD RELAYS		ADJUSTABLE RELAYS (NOTE 3)	
				FURNAS (NOTE 1)	G.E. (NOTE 2)	SET	MAX.
1/2	0.37	200	00	K31	L380A	3.2	3.4
		230	00	K28	L343A	2.7	2.9
		380	00	K22	L211A	1.7	1.8
		460	00	-	L174A	1.4	1.5
		575	00	-	-	1.2	1.3
3/4	0.55	200	00	K34	L510A	4.1	4.4
		230	00	K32	L420A	3.5	3.8
		380	00	K27	L282A	2.3	2.5
		460	00	K23	L211A	1.8	1.9
		575	00	K21	L193A	1.5	1.6
1	0.75	200	00	K37	L618A	5.0	5.4
		230	00	K36	L561A	4.4	4.7
		380	00	K28	L310A	2.6	2.8
		460	00	K26	L282A	2.2	2.4
		575	00	K23	L211A	1.8	1.9
1.5	1.1	200	00	K42	L750A	6.3	6.8
		230	00	K39	L680A	5.5	5.9
		380	00	K32	L420A	3.3	3.6
		460	00	K29	L343A	2.8	3.0
		575	00	K26	L282A	2.2	2.4
2	1.5	200	0	K50	L111B	8.6	9.3
		230	0	K49	L910A	7.5	8.1
		380	0	K36	L561A	4.6	4.9
		460	00	K33	L463A	3.8	4.1
		575	00	K29	L380A	3.0	3.2
3	2.2	200	0	K55	L147B	11.6	12.5
		230	0	K52	L122B	10.1	10.9
		380	0	K41	L750A	6.1	6.6
		460	0	K37	L618A	5.1	5.5
		575	0	K34	L510A	4.1	4.4
5	3.7	200	1	K62	L241B	19.1	20.5
		230	1	K61	L199B	16.6	17.8
		380	0	K52	L122B	10.0	10.8
		460	0	K49	L100B	8.3	8.9
		575	0	K42	L825A	6.6	7.1
7.5	5.5	200	1	K68	L332B	28.4	30.5
		230	1	K67	L293B	24.6	26.4
		380	1	K58	L181B	14.9	16.0
		460	1	K55	L147B	12.3	13.2
		575	1	K52	L122B	9.9	10.6
10	7.5	380	1	K62	L241B	19.5	21.0
		460	1	K60	L199B	16.1	17.3
		575	1	K56	L165B	12.9	13.6



# APPLICATION

## Three-Phase Motors

**Table 30 - 60 Hz 6" Standard & Hi-Temp Motors**

HP	KW	VOLTS	NEMA STARTER SIZE	HEATERS FOR OVERLOAD RELAYS		ADJUSTABLE RELAYS (NOTE 3)	
				FURNAS (NOTE 1)	G.E. (NOTE 2)	SET	MAX.
5	3.7	200	1	K61	L220B	17.6	19.1
		230	1	K61	L199B	15.4	16.6
		380	0	K52	L122B	9.4	10.1
		460	0	K49	L100B	7.7	8.3
		575	0	K42	L825A	6.1	6.6
7.5	5.5	200	1	K67	L322B	26.3	28.3
		230	1	K64	L293B	22.9	24.6
		380	1	K57	L165B	13.9	14.9
		460	1	K54	L147B	11.4	12.3
		575	1	K52	L111B	9.1	9.8
10	7.5	200	2(1)	K72	L426B	34.4	37.0
		230	2(1)	K70	L390B	29.9	32.2
		380	1	K61	L220B	18.1	19.5
		460	1	K58	L181B	15.0	16.1
		575	1	K55	L147B	12.0	12.9
15	11	200	3(1)	K76	L650B	50.7	54.5
		230	2	K75	L520B	44.1	47.4
		380	2(1)	K68	L322B	26.7	28.7
		460	2(1)	K64	L265B	22.0	23.7
		575	2(1)	K61	L220B	17.7	19.0
20	15	200	3	K78	L787B	64.8	69.7
		230	3(1)	K77	L710B	56.4	60.6
		380	2	K72	L426B	34.1	36.7
		460	2	K69	L352B	28.2	30.3
		575	2	K64	L393B	22.7	24.4
25	18.5	200	3	K86	L107C	80.3	86.3
		230	3	K83	L866B	69.8	75.0
		380	2	K74	L520B	42.2	45.4
		460	2	K72	L426B	34.9	37.5
		575	2	K69	L352B	27.9	30.0
30	22	200	4(1)	K88	L126C	96.7	104.0
		230	3	K87	L107C	84.1	90.4
		380	3(1)	K76	L650B	50.9	54.7
		460	3(1)	K74	L520B	42.0	45.2
		575	3(1)	K72	L390B	33.7	36.2
40	30	380	3	K83	L866B	69.8	75.0
		460	3	K77	L710B	57.7	62.0
		575	3	K74	L593B	46.1	49.6
50	37	380	3	K87	L107C	86.7	93.2
		460	3	K83	L950B	71.6	77.0
		575	3	K77	L710B	57.3	61.6
60	45	380	4(1)	K89	L126C	102.5	110.2
		460	4(1)	K87	L107C	84.6	91.0
		575	4(1)	K78	L866B	67.7	72.8

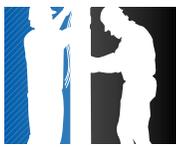
### Footnotes for Tables 29, 30, and 31

**NOTE 1:** Furnas intermediate sizes between NEMA starter sizes apply where (1) is shown in tables, size 1.75 replacing 2, 2.5 replacing 3, 3.5 replacing 4, and 4.5 replacing 5. Heaters were selected from Catalog 294, table 332 and table 632 (starter size 00, size B). Size 4 starters are heater type 4 (JG). Starters using these heater tables include classes 14, 17 and 18 (inNOVA), classes 36 and 37 (reduced voltage), and classes 87, 88 and 89 (pump and motor control centers). Overload relay adjustments should be set no higher than 100% unless necessary to stop nuisance tripping with measured amps in all lines below nameplate maximum. Heater selections for class 16 starters (Magnetic Definite Purpose) will be furnished upon request.

**NOTE 2:** General Electric heaters are type CR123 usable only on type CR124 overload relays and were selected from Catalog GEP-126OJ, page 184. Adjustment should be set no higher than 100%, unless necessary to stop nuisance tripping with measured amps in all lines below nameplate maximum.

**NOTE 3:** Adjustable overload relay amp settings apply to approved types listed. Relay adjustment should be set at the specified SET amps. Only if tripping occurs with amps in all lines measured to be within nameplate maximum amps should the setting be increased, not to exceed the MAX value shown.

**NOTE 4:** Heaters shown for ratings requiring NEMA size 5 or 6 starters are all used with current transformers per manufacturer standards. Adjustable relays may or may not use current transformers depending on design.



# APPLICATION Three-Phase Motors

**Table 31 - 60 Hz 8" Motors**

MOTOR MODEL PREFIX	HP	KW	VOLTS	NEMA STARTER SIZE	HEATERS FOR OVERLOAD RELAYS		ADJUSTABLE RELAYS (NOTE 3)	
					FURNAS (NOTE 1)	G.E. (NOTE 2)	SET	MAX.
239600	460	3	K77	L710B	56	60		
239610	575	3	K73	L520B	45	48		
239661	50	37	380	3	K86	L107C	81	87
239601			460	3	K78	L866B	68	73
239611			575	3	K77	L710B	56	60
239662	60	45	380	4(1)	K89	L126C	101	108
239602			460	4(1)	K86	L107C	83	89
239612			575	4(1)	K78	L787B	64	69
239663	75	55	380	4	K92	L142C	121	130
239603			460	4(1)	K89	L126C	100	107
239613			575	4(1)	K85	L950C	79	85
239664	100	75	380	5(1)	K28	L100B	168	181
239604			460	4	K92	L155C	134	144
239614			575	4	K90	L142C	108	116
239165	125	93	380	5	K32	L135B	207	223
239105			460	5(1)	K29	L111B	176	189
239115			575	5(1)	K26	L825A	140	150
239166	150	110	380	5	-	L147B	248	267
239106			460	5(1)	K32	L122B	206	221
239116			575	5(1)	K28	L100B	165	177
239167	175	130	380	6	K26	-	270	290
239107			460	5	K33	L147B	233	250
239117			575	5	K31	L111B	186	200
239168	200	150	380	6	K27	-	316	340
239108			460	5	K33	L165B	266	286
239118			575	5	K32	L135B	213	229

**Table 31A - 60 Hz 8" Hi-Temp 75°C Motors**

MOTOR MODEL PREFIX	HP	KW	VOLTS	NEMA STARTER SIZE	HEATERS FOR OVERLOAD RELAYS		ADJUSTABLE RELAYS (NOTE 3)	
					FURNAS (NOTE 1)	G.E. (NOTE 2)	SET	MAX.
279100	460	3	K77	L710B	60	65		
279110	575	3	K74	L593B	48	52		
279161	50	37	380	3	K87	L107C	89	95
279101			460	3	K83	L866B	73	79
279111			575	3	K77	L710B	59	63
279162	60	45	380	4(1)	K89	L126C	104	112
279102			460	4(1)	K87	L107C	86	92
279112			575	4(1)	K78	L866B	69	74
279163	75	56	380	4	K92	L155C	131	141
279103			460	4(1)	K89	L126C	106	114
279113			575	4(1)	K87	L950C	86	92
279164	100	75	380	5(1)	K28	L100B	168	181
279104			460	5(1)	K26	L825A	139	149
279114			575	4	K90	L142C	111	119
279165	125	93	380	5	K32	L135B	207	223
279105			460	5(1)	K29	L111B	171	184
279115			575	5(1)	K26	L825A	138	148
279166	150	110	380	5	-	L147B	250	269
279106			460	5(1)	K32	L122B	206	222
279116			575	5(1)	K28	L100B	166	178

**Note:** Other relay types from these and other manufacturers may or may not provide acceptable protection, and they should not be used without approval of Franklin Electric.

Some approved types may only be available for part of the listed motor ratings. When relays are used with current transformers, relay setting is the specified amps divided by the transformer ratio.

## Recommended Adjustable Overload Relays

**Advance Controls:** MDR3 Overload

**AEG Series:** B17S, B27S, B27-2

**ABB Type:** RVH 40, RVH65, RVP160, T25DU, T25CT, TA25DU

**AGUT:** MT03, R1K1, R1L0, R1L3, TE set Class 5

**Allen Bradley:** Bulletin 193, SMP-Class 10 only

**Automatic Switch Types:** DQ, LR1-D, LR1-F, LR2 Class 10

**Benshaw:** RSD6 (Class 10) Soft Start

**Bharita C-H:** MC 305 ANA 3

**Clipsal:** 6CTR, 6MTR

**Cutler-Hammer:** C316F, C316P, C316S, C310-set at 6 sec max, Advantage Class10

**Fanal Types:** K7 or K7D through K400

**Franklin Electric:** Subtrol-Plus, SubMonitor

**Fuji Types:** TR-OQ, TR-OQH, TR-2NQ, TR- 3NQ, TR-4NQ, TR-6NQ, RCa 3737-ICQ & ICQH

**Furnas Types:** US15 48AG & 48BG, 958L, ESP100-Class 10 only, 3RB10-Class 10

**General Electric:** CR4G, CR7G, RT\*1, RT\*2, RTF3, RT\*4, CR324X-Class 10 only

**Kasuga:** RU Set Operating Time Code = 10 & time setting 6 sec max

**Klockner-Moeller Types:** ZOO, Z1, Z4, PKZM1, PKZM3 & PKZ2

**Lovato:** RC9, RC22, RC80, RF9, RF25 & RF95

**Matsushita:** FKT-15N, 15GN, 15E, 15GE, FT-15N, FHT-15N

**Mitsubishi:** ET, TH-K12ABKP, TH-K20KF, TH-K20KP, TH-K20TAKF, TH-K60KF, TH-K60TAKF

**Omron:** K2CM Set Operating Timing Code = 10 & time setting 6 sec max, SE-KP24E time setting 6 sec max

**Riken:** PM1, PM3

**Samwha:** EOCSR Set for Class 5, EOCSR-ST, EOCSR-SE, EOCSR-AT time setting 6 sec max

**Siemens Types:** 3UA50, -52, -54, -55, -58, -59, -60, -61, -62, -66, -68, -70, 3VUI3, 3VE, 3UB (Class 5)

**Sprecher and Schuh Types:** CT, CT1, CTA 1, CT3K, CT3-12 thru CT3-42, KTA3, CEF1 & CET3 set at 6 sec max, CEP 7 Class 10, CT4, 6, & 7, CT3, KT7

**Square D/Telemecanique:** Class 9065 Types: TD, TE, TF, TG, TJ, TK, TR, TJE & TJF (Class 10), LR1-D, LR1-F, LR2 Class 10, Types 18A, 32A, SS-Class 10, SR-Class 10 and 63-A-LB Series. Integral 18,32,63, GV2-L, GV2-M, GV2-P, GV3-M (1.6-10 amp only) LR9D, SF Class 10, ST Class 10, LT6 (Class 5 or 10), LRD (Class 10), Motor Logic (Class10)

**Toshiba Type:** 2E RC820, set at 8 sec max.

**WEG:** RW2

**Westinghouse Types:** FT13, FT23, FT33, FT43, K7D, K27D, K67D, Advantage (Class 10), MOR, IQ500 (Class 5)

**Westmaster:** OLWROO and OLWTOO suffix D thru P



# SUBMERSIBLE PUMP Installation Check List

## 1. Motor Inspection

- A. Verify that the model, hp or kW, voltage, phase and hertz on the motor nameplate match the installation requirements.
- B. Check that the motor lead assembly is not damaged.
- C. Measure insulation resistance using a 500 or 1000 volt DC megohmmeter from each lead wire to the motor frame. Resistance should be at least 200 megohms without drop cable.
- D. Keep a record of motor model number, hp or kW, voltage, and serial number (S/N). (S/N is stamped in shell above the nameplate. A typical example, S/N 07A18 01-0123)

## 2. Pump Inspection

- A. Check that the pump rating matches the motor.
- B. Check for pump damage and verify that the pump shaft turns freely.

## 3. Pump/Motor Assembly

- A. If not yet assembled, check that pump and motor mounting faces are free from dirt, debris and uneven paint thickness.
- B. Pumps and motors over 5 hp should be assembled in the vertical position to prevent stress on pump brackets and shafts. Assemble the pump and motor together so their mounting faces are in contact and then tighten assembly bolts or nuts evenly to manufacturer specifications.
- C. If accessible, check that the pump shaft turns freely.
- D. Assemble the pump lead guard over the motor leads. Do not cut or pinch lead wires during assembly or installation.

## 4. Power Supply and Controls

- A. Verify that the power supply voltage, Hertz, and kVA capacity match motor requirements.
- B. Verify control box hp and voltage matches motor (3-wire only).
- C. Check that the electrical installation and controls meet all safety regulations and match the motor requirements, including fuse or circuit breaker size and motor overload protection. Connect all metal plumbing and electrical enclosures to the power supply ground to prevent shock hazard. Comply with national and local codes.

## 5. Lightning and Surge Protection

- A. Use properly rated surge (lightning) arrestors on all submersible pump installations. Motors 5 hp and smaller, which are marked "Equipped with Lightning Arrestors", contain internal arrestors.
- B. Ground all above ground arrestors with copper wire directly to the motor frame, or to metal drop pipe or casing which reaches below the well pumping level. Connecting to a ground rod does not provide good surge protection.

## 6. Electrical Drop Cable

- A. Use submersible cable sized in accordance with local regulations and the cable charts. See pages 11 and 16-21. Ground motor per national and local codes.
- B. Include a ground wire to the motor and surge protection, connected to the power supply ground if required by codes. Always ground any pump operated outside a drilled well.

## 7. Motor Cooling

- A. Ensure at all times that the installation provides adequate motor cooling; see page 6 for details.



# SUBMERSIBLE PUMP Installation Check List

## 8. Pump/Motor Installation

- A. Splice motor leads to supply cable using electrical grade solder or compression connectors, and carefully insulate each splice with watertight tape or adhesive-lined shrink tubing, as shown in motor or pump installation data.
- B. Support the cable to the delivery pipe every 10 feet (3 meters) with straps or tape strong enough to prevent sagging. Use padding between cable and any metal straps.
- C. A check valve in the delivery pipe is recommended. More than one check valve may be required, depending on valve rating and pump setting; see page 5 for details.
- D. Assemble all pipe joints as tightly as practical, to prevent unscrewing from motor torque. Torque should be at least 10 pound feet per hp (2 meter-KG per kW).
- E. Set the pump far enough below the lowest pumping level to assure the pump inlet will always have at least the Net Positive Suction Head (NPSH) specified by the pump manufacturer. Pump should be at least 10 feet (3 meters) from the bottom of the well to allow for sediment build up.
- F. Check insulation resistance as pump/motor assembly is lowered into the well. Resistance may drop gradually as more cable enters the water, but any sudden drop indicates possible cable, splice or motor lead damage; see page 45.

## 9. After Installation

- A. Check all electrical and water line connections and parts before starting the pump.
- B. Start the pump and check motor amps and pump delivery. If normal, continue to run the pump until delivery is clear. If three-phase pump delivery is low, it may be running backward. Rotation may be reversed (with power off) by interchanging any two motor lead connections to the power supply.
- C. Check three-phase motors for current balance within 5% of average, using motor manufacturer instructions. Imbalance over 5% will cause higher motor temperatures and may cause overload trip, vibration, and reduced life.
- D. Verify that starting, running and stopping cause no significant vibration or hydraulic shocks.
- E. After at least 15 minutes running time, verify that pump output, electrical input, pumping level, and other characteristics are stable and as specified.

Date \_\_\_\_\_ Filled In By \_\_\_\_\_

Notes \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



# SUBMERSIBLE MOTOR INSTALLATION RECORD

## Form 2207 - Page 1

**RMA Number**  
 \_\_\_\_\_

**KEY DEALER #** \_\_\_\_\_

DISTRIBUTOR	INSTALLER	END USER
Name: _____	Name: _____	Name: _____
City: _____	City: _____	City: _____
State: _____ Zip: _____	State: _____ Zip: _____	State: _____ Zip: _____

Well ID or GPS: \_\_\_\_\_ Water Temperature: \_\_\_\_\_  °F  °C

Application/Water Use (e.g. potable water, irrigation, municipal, fountain, etc.): \_\_\_\_\_

Date Installed (mm/yy): \_\_\_\_\_ Date Failed (mm/yy): \_\_\_\_\_ Motor Position Shaft-Up:  Yes  No

Operating Cycle: ON Time Per Start \_\_\_\_\_  Hrs.  Mins. Time OFF Between Stop & Restart \_\_\_\_\_  Hrs.  Mins.

**MOTOR**

Model: \_\_\_\_\_ Serial Number: \_\_\_\_\_ Date Code (if updated): \_\_\_\_\_

**MOTOR OVERLOAD**

System Typical Operating Current: \_\_\_\_\_ Amps @ \_\_\_\_\_ Volts

Overload:  FE SubMonitor Input Amps \_\_\_\_\_ D3 Attached  Yes  No Fault Settings Attached  Yes  No

Other Manufacturer Model: \_\_\_\_\_ Dial Set at: \_\_\_\_\_ or Heater# \_\_\_\_\_

NEMA Class:  10  20  30 Ambient Compensated:  Yes  No

Power to Motor by:  Full Volt Starter  VFD  Soft Starter VFD or Soft Starter Mfr. & Model: \_\_\_\_\_

**PUMP**

Manufacturer: \_\_\_\_\_

Model: \_\_\_\_\_

Stages: \_\_\_\_\_

Design Rating: \_\_\_\_\_ gpm @ \_\_\_\_\_ ft TDH

Horsepower Required by Pump End: \_\_\_\_\_

Actual Pump Delivery: \_\_\_\_\_ gpm @ \_\_\_\_\_ psi

What Controls When System Runs & Stops:  
 \_\_\_\_\_  
 (e.g. pressure, level, flow, manual on/off, timer, time clock etc.)

**WELL DATA** (All measurements from well head down.)

Casing Diameter \_\_\_\_\_ in

Drop Pipe Diameter \_\_\_\_\_ in

Number of Sticks of Drop Pipe \_\_\_\_\_

Static Water Level \_\_\_\_\_ ft

Drawdown (pumping) Water Level \_\_\_\_\_ ft

Spring Assist Check Valves:  
 (Measured from Well Head Down)

#1 \_\_\_\_\_ #2 \_\_\_\_\_ #3 \_\_\_\_\_ #4 \_\_\_\_\_ ft

Solid  Drilled Poppet  Break-Off Plug

Pump Inlet Setting \_\_\_\_\_ ft

Flow Sleeve  No  Yes, Dia. \_\_\_\_\_ in

Case Ends \_\_\_\_\_ ft

Well Screen  Perforated Casing

#1 from \_\_\_\_\_ to \_\_\_\_\_ ft & #2 from \_\_\_\_\_ to \_\_\_\_\_ ft

Well Depth \_\_\_\_\_ ft

**YOUR NAME / DATE**

\_\_\_\_\_ / \_\_\_\_\_



# SUBMERSIBLE MOTOR INSTALLATION RECORD

## Form 2207 - Page 2

**RMA Number**

### TRANSFORMERS

Number of Transformers:  Two  Three      Transformers Supply Motor Only:  Yes  No  Unsure  
 Transformer #1: \_\_\_\_\_ kVA    Transformer #2: \_\_\_\_\_ kVA    Transformer #3: \_\_\_\_\_ kVA

### POWER CABLES & GROUND WIRE

**1 Service Entrance to Pump Control Panel:**  
 Length: \_\_\_\_\_ ft. & Gauge: \_\_\_\_\_ AWG/MCM  
 Material:  Copper  Aluminum      Construction:  Jacketed  Individual Conductors  Web  Twisted  
 Temperature Rating of Cable:  60C  75C  90C  125C or Insulation Type: \_\_\_\_\_ (e.g. THHN)

**2 Pump Control Panel to Motor:**  
 Length: \_\_\_\_\_ ft. & Gauge: \_\_\_\_\_ AWG/MCM  
 Material:  Copper  Aluminum      Construction:  Jacketed  Individual Conductors  Web  Twisted  
 Temperature Rating of Cable:  60C  75C  90C  125C or Insulation Type: \_\_\_\_\_ (e.g. THHN)

**3 Ground Wire Size:** From Control Panel to Motor: \_\_\_\_\_ AWG/MCM  
 Control Grounded to (mark all that apply):  
 Well Head  Metal Casing  Motor  Driven Rod  Power Supply

### INCOMING VOLTAGE

No Load    L1-L2 \_\_\_\_\_ L2-L3 \_\_\_\_\_ L1-L3 \_\_\_\_\_  
 Full Load    L1-L2 \_\_\_\_\_ L2-L3 \_\_\_\_\_ L1-L3 \_\_\_\_\_

### RUNNING AMPS & CURRENT BALANCE

Full Load    L1 \_\_\_\_\_ L2 \_\_\_\_\_ L3 \_\_\_\_\_  
 % Unbalance: \_\_\_\_\_

### CONTROL PANEL

**1 Pump Panel Manufacturer/Fabricator:** \_\_\_\_\_

**2 Short Circuit Protection - Fuses or Circuit Breaker**  
**Option #1 - Fuse**  
 Manufacturer: \_\_\_\_\_ Model: \_\_\_\_\_ Rating: \_\_\_\_\_ Amps  
 Type:  Time-Delay  Standard  
**Option #2 - Circuit Breaker**  
 Manufacturer: \_\_\_\_\_ Model: \_\_\_\_\_ Rating: \_\_\_\_\_ Amps Setting: \_\_\_\_\_

**3 Starter - Full Voltage, Reduced Voltage, Soft-Starter or VFD (Variable Frequency Drive)**  
**Option #1 - Full Voltage**  
 Manufacturer: \_\_\_\_\_ Model: \_\_\_\_\_ Size: \_\_\_\_\_ Contacts:  NEMA  IEC  
**Option #2 - Reduced Voltage**  
 Manufacturer: \_\_\_\_\_ Model: \_\_\_\_\_ Ramp Time to Full Voltage: \_\_\_\_\_ sec.  
**Option #3 - Soft-Starter or VFD**  
 Manufacturer: \_\_\_\_\_ Model: \_\_\_\_\_ Max. Continuous Amp Output Rating: \_\_\_\_\_  
 Min. Setting: \_\_\_\_\_ Hz & GPM: \_\_\_\_\_ Max. Setting: \_\_\_\_\_ Hz & GPM: \_\_\_\_\_  
 Start Ramp Time to 30 Hz: \_\_\_\_\_ sec.      Stop Mode:  Power Off Coast  30-0 Hz Ramp \_\_\_\_\_ sec.  
 Special Output Filter Purchased:  Yes  No  
 Output Filter Manufacturer: \_\_\_\_\_ Model: \_\_\_\_\_ % Reactance: \_\_\_\_\_

**4 Surge Arrestor:**  No  Yes, Manufacturer: \_\_\_\_\_ Model: \_\_\_\_\_





# SUBMERSIBLE MOTOR

# Booster Installation Record

**RMA Number**

Date \_\_\_\_/\_\_\_\_/\_\_\_\_ Filled In By \_\_\_\_\_

### INSTALLATION

Owner/User \_\_\_\_\_ Telephone (\_\_\_\_) \_\_\_\_\_

Address \_\_\_\_\_ City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Installation Site, If Different \_\_\_\_\_

Contact \_\_\_\_\_ Telephone (\_\_\_\_) \_\_\_\_\_

System Application \_\_\_\_\_

System Manufactured By \_\_\_\_\_ Model \_\_\_\_\_ Serial No. \_\_\_\_\_

System Supplied By \_\_\_\_\_ City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Is this a "HERO" system (10.0 - 10.5 PH)?  Yes  No

### MOTOR

Model No. \_\_\_\_\_ Serial No. \_\_\_\_\_ Date Code \_\_\_\_\_

Horsepower \_\_\_\_\_ Voltage \_\_\_\_\_  Single-Phase  Three-Phase Diameter \_\_\_\_\_ in.

Slinger Removed?  Yes  No Check Valve Plug Removed?  Yes  No

Motor Fill Solution  Standard  DI Water Model No. \_\_\_\_\_ Serial No. \_\_\_\_\_ Date Code \_\_\_\_\_

### PUMP

Manufacturer \_\_\_\_\_ Model \_\_\_\_\_ Serial No. \_\_\_\_\_

Stages \_\_\_\_\_ Diameter \_\_\_\_\_ Flow Rate Of \_\_\_\_\_ gpm At \_\_\_\_\_ TDH

Booster Case Internal Diameter \_\_\_\_\_ Material \_\_\_\_\_

### CONTROLS AND PROTECTIVE DEVICES

SubMonitor?  Yes  No If Yes, Warranty Registration No. \_\_\_\_\_

If Yes, Overload Set?  Yes  No \_\_\_\_\_ Set At \_\_\_\_\_

Underload Sets?  Yes  No \_\_\_\_\_ Set At \_\_\_\_\_

VFD or Reduced Voltage Starter?  Yes  No If Yes, Type \_\_\_\_\_

Mfr. \_\_\_\_\_ Setting \_\_\_\_\_ % Full Voltage In \_\_\_\_\_ sec

Pump Panel?  Yes  No If Yes, Mfr. \_\_\_\_\_ Size \_\_\_\_\_

Magnetic Starter/Contactor Mfr. \_\_\_\_\_ Model \_\_\_\_\_ Size \_\_\_\_\_

Heaters Mfr. \_\_\_\_\_ No. \_\_\_\_\_ If Adjustable Set At \_\_\_\_\_

Fuses Mfr. \_\_\_\_\_ Size \_\_\_\_\_ Type \_\_\_\_\_

Lightning/Surge Arrestor Mfr. \_\_\_\_\_ Model \_\_\_\_\_

Controls Are Grounded to \_\_\_\_\_ with No. \_\_\_\_\_ Wire

Inlet Pressure Control  Yes  No If Yes, Mfr. \_\_\_\_\_ Model \_\_\_\_\_ Setting \_\_\_\_\_ psi Delay \_\_\_\_\_ sec

Inlet Flow Control  Yes  No If Yes, Mfr. \_\_\_\_\_ Model \_\_\_\_\_ Setting \_\_\_\_\_ gpm Delay \_\_\_\_\_ sec

Outlet Pressure Control  Yes  No If Yes, Mfr. \_\_\_\_\_ Model \_\_\_\_\_ Setting \_\_\_\_\_ psi Delay \_\_\_\_\_ sec

Outlet Flow Control  Yes  No If Yes, Mfr. \_\_\_\_\_ Model \_\_\_\_\_ Setting \_\_\_\_\_ gpm Delay \_\_\_\_\_ sec

Water Temperature Control  Yes  No If Yes, Mfr. \_\_\_\_\_ Model \_\_\_\_\_ Delay \_\_\_\_\_ sec

Set At \_\_\_\_\_ °F or \_\_\_\_\_ °C Located \_\_\_\_\_



# SUBMERSIBLE MOTOR Booster Installation Record

## INSULATION CHECK

Initial Megs: Motor & Lead Only      Black (T1/U1) \_\_\_\_\_ Yellow (T2/V1) \_\_\_\_\_ Red (T3/W1) \_\_\_\_\_

Installed Megs: Motor, Lead, & Cable      Black (T1/U1) \_\_\_\_\_ Yellow (T2/V1) \_\_\_\_\_ Red (T3/W1) \_\_\_\_\_

## VOLTAGE TO MOTOR

Non-Operating:      B-Y (T1/U1 - T2/V1) \_\_\_\_\_ Y-R (T2/V1 - T3/W1) \_\_\_\_\_ R-B (T3/W1 - T1/U1) \_\_\_\_\_

At Rated Flow of \_\_\_\_\_ gpm      B-Y (T1/U1 - T2/V1) \_\_\_\_\_ Y-R (T2/V1 - T3/W1) \_\_\_\_\_ R-B (T3/W1 - T1/U1) \_\_\_\_\_

At Open Flow \_\_\_\_\_ gpm      B-Y (T1/U1 - T2/V1) \_\_\_\_\_ Y-R (T2/V1 - T3/W1) \_\_\_\_\_ R-B (T3/W1 - T1/U1) \_\_\_\_\_

## AMPS TO MOTOR

At Rated Flow of \_\_\_\_\_ gpm      Black (T1/U1) \_\_\_\_\_ Yellow (T2/V1) \_\_\_\_\_ Red (T3/W1) \_\_\_\_\_

At Open Flow \_\_\_\_\_ gpm      Black (T1/U1) \_\_\_\_\_ Yellow (T2/V1) \_\_\_\_\_ Red (T3/W1) \_\_\_\_\_

At Shut Off\*      Black (T1/U1) \_\_\_\_\_ Yellow (T2/V1) \_\_\_\_\_ Red (T3/W1) \_\_\_\_\_

\*Do **NOT** run at Shut Off more than two (2) minutes.

Inlet Pressure \_\_\_\_\_ psi      Outlet Pressure \_\_\_\_\_ psi      Water Temperature \_\_\_\_\_ °F or \_\_\_\_\_ °C

**If you have any questions or problems, call the Franklin Electric Toll-Free Hot Line: 1-800-348-2420**

Comments: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

## PLEASE SKETCH THE SYSTEM



# APPLICATION Three-Phase Motors

## SubMonitor Three-Phase Protection

### Applications

SubMonitor is designed to protect 3-phase pumps/ motors with service factor amp ratings (SFA) from 5 to 350 A (approx. 3 to 200 hp). Current, voltage, and motor temperature are monitored using all three legs and allows the user to set up the SubMonitor quickly and easily.

### Protects Against

- Under/Overload
- Under/Overvoltage
- Current Unbalance
- Overheated Motor  
(if equipped with Subtrol Heat Sensor)
- False Start (Chattering)
- Phase Reversal



## Power Factor Correction

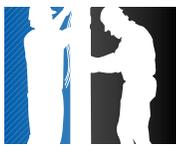
In some installations, power supply limitations make it necessary or desirable to increase the power factor of a submersible motor. The table lists the capacitive kVAR required to increase the power factor of large Franklin three-phase submersible motors to the approximate values shown at maximum input loading.

Capacitors must be connected on the line side of the overload relay, or overload protection will be lost.

**Table 32 kVAR Required 60 Hz**

MOTOR		KVAR REQUIRED FOR PF OF:		
HP	KW	0.90	0.95	1.00
5	3.7	1.2	2.1	4.0
7.5	5.5	1.7	3.1	6.0
10	7.5	1.5	3.3	7.0
15	11	2.2	4.7	10.0
20	15	1.7	5.0	12.0
25	18.5	2.1	6.2	15.0
30	22	2.5	7.4	18.0
40	30	4.5	11.0	24.0
50	37	7.1	15.0	32.0
60	45	8.4	18.0	38.0
75	55	6.3	18.0	43.0
100	75	11.0	27.0	60.0
125	93	17.0	36.0	77.0
150	110	20.0	42.0	90.0
175	130	9.6	36.0	93.0
200	150	16.0	46.0	110.0

Values listed are total required (not per phase).



# APPLICATION Three-Phase Motors

## Three-Phase Starter Diagrams

Three-phase combination magnetic starters have two distinct circuits: a power circuit and a control circuit.

The power circuit consists of a circuit breaker or fused line switch, contacts, and overload heaters connecting incoming power lines L1, L2, L3 and the three-phase motor.

The control circuit consists of the magnetic coil, overload contacts and a control device such as a pressure switch. When the control device contacts are closed, current flows through the magnetic contactor coil, the contacts close, and power is applied to the motor. Hand-Off-Auto switches, start timers, level controls and other control devices may also be in series in the control circuit.

### Line Voltage Control

This is the most common type of control encountered. Since the coil is connected directly across the power lines L1 and L2, the coil must match the line voltage.

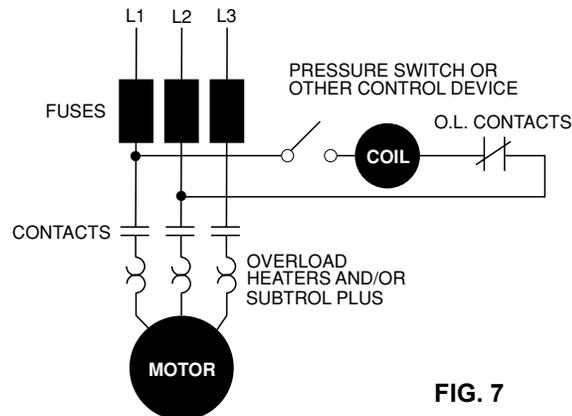


FIG. 7

### Low Voltage Transformer Control

This control is used when it is desirable to operate push buttons or other control devices at some voltage lower than the motor voltage. The transformer primary must match the line voltage and the coil voltage must match the secondary voltage of the transformer.

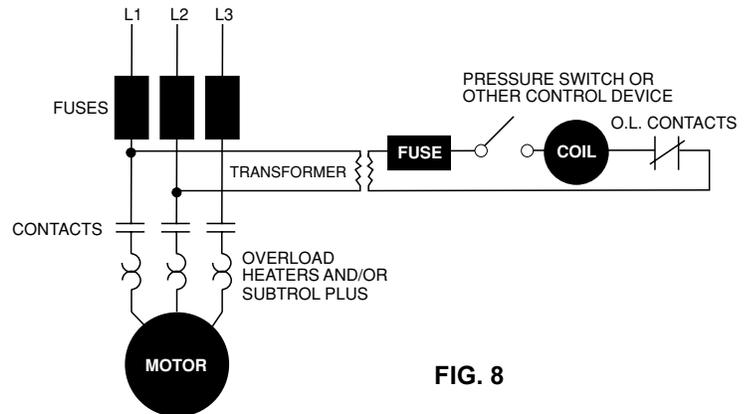


FIG. 8

### External Voltage Controls

Control of a power circuit by a lower circuit voltage can also be obtained by connecting to a separate control voltage source. The coil rating must match the control voltage source, such as 115 or 24 volts.

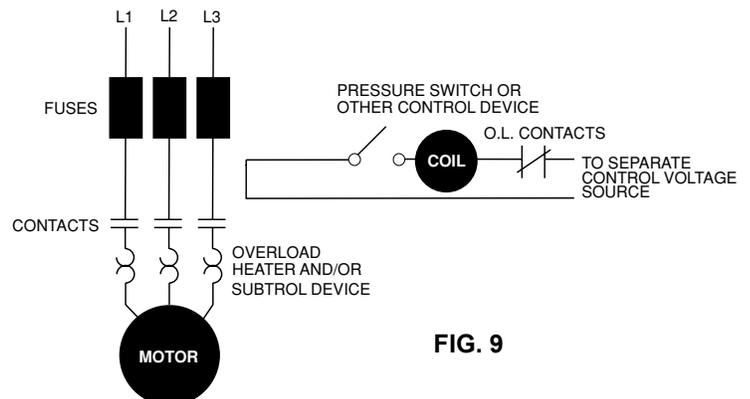
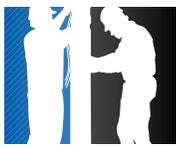


FIG. 9

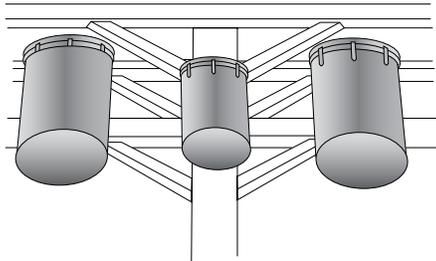


### Three-Phase Power Unbalance

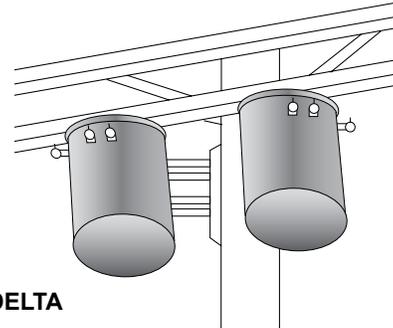
A full three-phase supply is recommended for all three-phase motors, consisting of three individual transformers or one three-phase transformer. So-called “open” delta or Wye connections using only two transformers can be used, but are more likely to cause problems, such as

poor performance, overload tripping or early motor failure due to current unbalance.

Transformer rating should be no smaller than listed in table 4 for supply power to the motor alone.



**FIG. 10**  
**FULL THREE-PHASE**



**FIG. 11**  
**OPEN DELTA**

### Checking and Correcting Rotation and Current Unbalance

1. Establish correct motor rotation by running the motor in both directions. Normal rotation is CCW viewing the shaft end. Rotation can be changed by interchanging any two of the three motor leads. The rotation that gives the most water flow is typically the correct rotation.
2. After correct rotation has been established, check the current in each of the three motor leads and calculate the current unbalance as explained in 3 below.  
If the current unbalance is 2% or less, leave the leads as connected.  
If the current unbalance is more than 2%, current readings should be checked on each leg using each of three possible hook-ups. Roll the motor leads across the starter in the same direction to prevent motor reversal.
3. To calculate percent of current unbalance:
  - A. Add the three line amps values together.
  - B. Divide the sum by three, yielding average current.
  - C. Pick the amp value which is furthest from the average current (either high or low).

- D. Determine the difference between this amp value (furthest from average) and the average.
- E. Divide the difference by the average. Multiply the result by 100 to determine percent of unbalance.
4. Current unbalance should not exceed 5% at max amp load or 10% at rated input load. If the unbalance cannot be corrected by rolling leads, the source of the unbalance must be located and corrected. If, on the three possible hookups, the leg farthest from the average stays on the same power lead, most of the unbalance is coming from the “power side” of the system. If the reading farthest from average moves with the same motor lead, the primary source of unbalance is on the “motor side” of the starter. In this instance, consider a damaged cable, leaking splice, poor connection, or faulty motor winding.

#### Phase designation of leads for CCW rotation viewing shaft end.

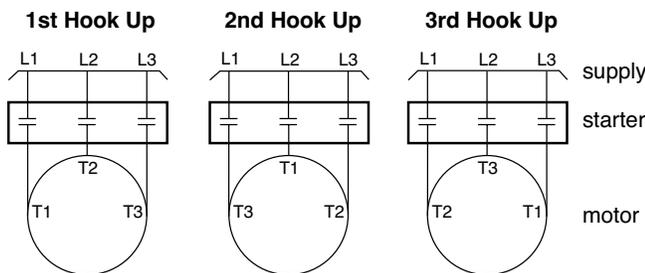
To reverse rotation, interchange any two leads.

Phase 1 or “A” - Black, T1, or U1

Phase 2 or “B” - Yellow, T2, or V1

Phase 3 or “C” - Red, T3, or W1

**NOTICE:** Phase 1, 2 and 3 may not be L1, L2 and L3.



#### EXAMPLE:

T1 = 51 amps	T3 = 50 amps	T2 = 50 amps
T2 = 46 amps	T1 = 49 amps	T3 = 48 amps
<u>+ T3 = 53 amps</u>	<u>+ T2 = 51 amps</u>	<u>+ T1 = 52 amps</u>
Total = 150 amps	Total = 150 amps	Total = 150 amps
$\frac{150}{3} = 50$ amps	$\frac{150}{3} = 50$ amps	$\frac{150}{3} = 50$ amps
50 - 46 = 4 amps	50 - 49 = 1 amp	50 - 48 = 2 amps
$\frac{4}{50} = 0.08$ or 8%	$\frac{1}{50} = 0.02$ or 2%	$\frac{2}{50} = 0.04$ or 4%

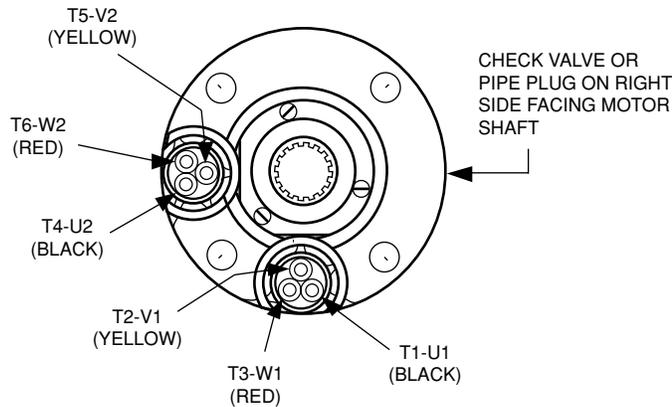


# APPLICATION Three-Phase Motors

## Three-Phase Motor Lead Identification

### Line Connections — Six-Lead Motors

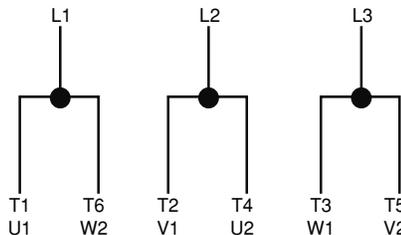
**WARNING:** When installing 6-lead motors extra care must be used to ensure lead identification at the surface. Leads must be marked and connected per diagram. Motor leads are not connected red to red, yellow to yellow, etc.



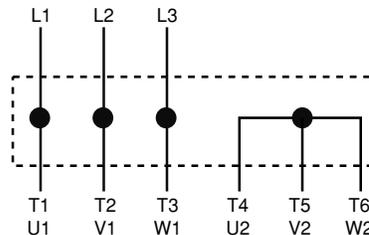
LEADS LOCATED HERE ONLY  
FOR 3 LEAD (DOL) MOTORS

### 90° Lead Spacing

Connections for across-the-line starting, running, and any reduced voltage starting except WYE-DELTA type starters.



WYE-DELTA starters connect the motor as shown below during starting, then change to the running connection shown at the left.



Each motor lead is numbered with two markers, one near each end. To reverse rotation, interchange any two line connections.

## Phase Converters

There are a number of different types of phase converters available. Each generates three-phase power from a single-phase power line.

In all phase converters, the voltage balance is critical to current balance. Although some phase converters may be well balanced at one point on the system-operating curve, submersible pumping systems often operate at differing points on the curve as water levels and operating pressures fluctuate. Other converters may be well balanced at varying loads, but their output may vary widely with fluctuations in the input voltage.

The following guidelines have been established for submersible installations to be warrantable when used with a phase converter.

1. Limit pump loading to rated horsepower. Do not load into motor service factor.
2. Maintain at least 3 ft/s flow past the motor. Use a flow sleeve when necessary.
3. Use time delay fuses or circuit breakers in pump panel. Standard fuses or circuit breakers do not provide secondary motor protection.
4. SubMonitor may be used with electro mechanical type phase converters, however special connections are required. Consult SubMonitor Manual for connections of receiver and lightning arrestor.
5. SubMonitor will not work with electronic solid state phase converters.
6. Current unbalance must not exceed 10%.



## Reduced Voltage Starters

All Franklin three-phase submersible motors are suitable for full-voltage starting. Under this condition the motor speed goes from zero to full speed within a half second or less. The motor current goes from zero to locked rotor amps, then drops to running amps at full speed. This may dim lights, cause momentary voltage dips to other electrical equipment, and shock power distribution transformers.

In some cases the power companies may require reduced-voltage starters to limit this voltage dip. There are also times when reduced-voltage starters may be desirable to reduce motor starting torque thus reducing the stress on shafts, couplings, and discharge piping. Reduced-voltage starters also slow the rapid acceleration of the water on start-up to help control upthrust and water hammer.

Reduced-voltage starters may not be required if the maximum recommended cable length is used. With maximum recommended cable length there is a 5% voltage drop in the cable at running amps, resulting in about 20% reduction in starting current and about 36% reduction in starting torque compared to having rated voltage at the motor. This may be enough reduction in starting current so that reduced-voltage starters are not required.

**Three-Lead Motors:** Autotransformer or solid-state reduced-voltage starters may be used for soft-starting standard three-phase motors.

When autotransformer starters are used, the motor should be supplied with at least 55% of rated voltage to ensure adequate starting torque. Most autotransformer starters have 65% and 80% taps. Setting the taps on these starters depends on the percentage of the

maximum allowable cable length used in the system. If the cable length is less than 50% of the maximum allowable, either the 65% or the 80% taps may be used. When the cable length is more than 50% of allowable, the 80% tap should be used.

**Six-Lead Motors:** Wye-Delta starters are used with six-lead Wye-Delta motors. All Franklin 6" and 8" three-phase motors are available in six-lead Wye-Delta construction. Consult the factory for details and availability. Part winding starters are not compatible with Franklin Electric submersible motors and should not be used.

Wye-Delta starters of the open-transition type, which momentarily interrupt power during the starting cycle, are not recommended. Closed-transition starters have no interruption of power during the start cycle and can be used with satisfactory results.

**Reduced-voltage starters have adjustable settings for acceleration ramp time, typically preset at 30 seconds. They must be adjusted so the motor is at full voltage within THREE SECONDS MAXIMUM to prevent excessive radial and thrust bearing wear.**

**If Subtrol-Plus or SubMonitor is used the acceleration time must be set to TWO SECONDS MAXIMUM due to the 3 second reaction time of the Subtrol-Plus or SubMonitor.**

**Solid-state starters AKA soft starts may not be compatible with Subtrol-Plus/SubMonitor. However, in some cases a bypass contactor has been used. Consult the factory for details.**

**During shutdown, Franklin Electric's recommendation is for the power to be removed, allowing the pump/motor to coast down. Stopping the motor by ramping down the voltage is possible, but should be limited to three (3) seconds maximum.**

## Inline Booster Pump Systems

Franklin Electric offers three different types of motors for non-vertical applications.

1. The **Booster** motors are specifically designed for booster applications. They are the "**Best Choice**" for sealed Reverse Osmosis applications. These motors are the result of two years of focused development and bring additional value and durability to booster module systems. These motors are only available to OEMs or Distributors who have demonstrated capability in Booster Module systems design and operation and adhere to Franklin's Application Manual requirements.
2. The **Hi-Temp** motors have many of the internal design features of the Booster motor. It's additional length allows for higher temperature handling and the Sand Fighter sealing system provides greater abrasion resistance. One or both of these conditions

are often experienced in open atmosphere applications such as lakes, ponds, etc.

3. The **Standard Vertical Water Well** (40-125 hp) motors can be adapted to non-vertical applications when applied per the below guidelines. However, they will be more sensitive to application variances than the other two designs.

All of the above motors must be applied per the guidelines listed below. In addition, for all applications where the motor is applied in a sealed system, a Submersible Motor Booster Installation Record (Form 3655) or its equivalent must be completed at startup and received by Franklin Electric within 60 days. A sealed system is one where the motor and pump intake are mounted in a sleeve and the water feeding the pump intake is not open to the atmosphere.



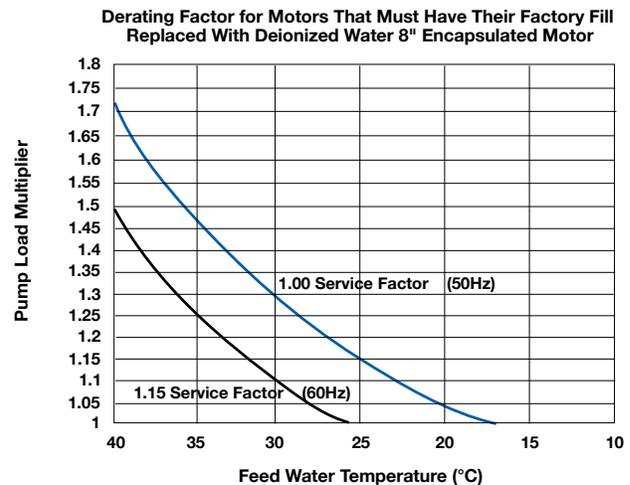
**Inline Booster Pump Systems (continued)**

Design And Operational Requirements

- 1. Non-Vertical Operation:** Vertical Shaft-up (0°) to Horizontal (90°) operation is acceptable as long as the pump transmits “down-thrust” to the motor within 3 seconds after start-up and continuously during operation. However, it is best practice to provide a positive slope whenever it is possible, even if it is only a few degrees.
- 2. Motor, Sleeve, and Pump Support System:** The booster sleeve ID must be sized according to the motor cooling and pump NPSHR requirements. The support system must support the motor’s weight, prevent motor rotation and keep the motor and pump aligned. The support system must also allow for thermal axial expansion of the motor without creating binding forces.
- 3. Motor Support Points:** A minimum of two support points are required on the motor. One in the motor/pump flange connection area and one in the bottom end of the motor area. The motor castings, not the shell area, are recommended as support points. If the support is a full length support and/or has bands in the shell area, they must not restrict heat transfer or deform the shell.
- 4. Motor Support Material and Design:** The support system shall not create any areas of cavitation or other areas of reduced flow less than the minimum rate required by this manual. They should also be designed to minimize turbulence and vibration and provide stable alignment. The support materials and locations must not inhibit the heat transfer away from the motor.
- 5. Motor and Pump Alignment:** The maximum allowable misalignment between the motor, pump, and pump discharge is 0.025 inch per 12 inches of length (2 mm per 1000 mm of length). This must be measured in both directions along the assembly using the motor/pump flange connection as the starting point. The booster sleeve and support system must be rigid enough to maintain this alignment during assembly, shipping, operation and maintenance.
- The best motor lubrication and heat resistance is obtained with the factory based propylene glycol fill solution. Only when an application **MUST HAVE** deionized (DI) water should the factory fill solution be replaced. When a deionized water fill is required, the motor must be derated as indicated on the below chart. The exchange of the motor fill solution to DI

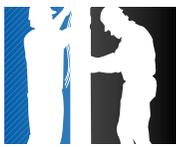
water must be done by an approved Franklin service shop or representative using a vacuum fill system per Franklin’s Motor Service Manual instruction. The motor shell then must be permanently stamped with a D closely behind the Serial Number.

The maximum pressure that can be applied to the motor internal components during the removal of the factory fill solution is 7 psi (0.5 bar.)



**FIG. 12**

- First:** Determine maximum Feed Water Temperature that will be experienced in this application. If the feed water exceeds the maximum ambient of the motor, both the DI water derating and a hot water application derating must be applied.
  - Second:** Determine the Pump Load Multiplier from the appropriate Service Factor curve. (Typical 1.15 Service Factor is for 60 Hz ratings & 1.00 Service Factor for 50 Hz ratings).
  - Third:** Multiply the Pump Load Requirement times the pump load multiplier number indicated on the vertical axis to determine the Minimum Motor Nameplate Rating.
  - Fourth:** Select a motor with a nameplate equal or higher than the above calculated value.
- 7. Motor Alterations - Sand Slinger & Check Valve Plug:** On 6” and 8” motors, the rubber sand slinger located on the shaft must be removed. If a pipe plug is covering the check valve, it must be removed. The special Booster motor already has these modifications.
  - 8. Frequency of Starts:** Fewer than 10 starts per 24-hour period are recommended. Allow at least 20 minutes between shutdown and start-up of the motor.



**Inline Booster Pump Systems (continued)**

9. **Controls-Soft Starters and VFDs:** Reduced voltage starters and variable speed drives (inverter drives) may be used with Franklin three-phase submersible motors to reduce starting current, upthrust, and mechanical stress during start-up. The guidelines for their use with submersible motors are different than with normal air cooled motor applications. Refer to the Franklin Electric Application, Installation and Maintenance (AIM) Manual Reduced Voltage Starters section or Variable Speed Submersible Pump Operation, Inverter Drives sections for specific details including required filtering.
10. **Motor Overload Protection:** Submersible motors require properly sized ambient compensated Class 10 quick-trip overloads per Franklin's AIM Manual guidelines to protect the motor. Class 20 or higher overloads are NOT acceptable. Franklin's SubMonitor is strongly recommended for all large submersibles since it is capable of sensing motor heat without any additional wiring to the motor. Applications using Soft Starters with a SubMonitor require a start-up bypass - consult the factory for details. SubMonitor can not be used in applications using a VFD control.
11. **Motor Surge Protection:** Properly sized, grounded and dedicated motor surge arrestors must be installed in the supply line of the booster module as close to the motor as possible. This is required on all systems including those using soft-starters and variable speed drives (inverter drives).
12. **Wiring:** Franklin's lead assemblies are only sized for submerged operation in water to the motor nameplate maximum ambient temperature and may overheat and cause failure or serious injury if operated in air. Any wiring not submerged must meet applicable national and local wiring codes and Franklin Cable Chart tables 16-21. (Notice: wire size, wire rating and insulation temperature rating must be known when determining its suitability to operate in air or conduit. Typically, for a given size and rating, as the insulation temperature rating increases its ability to operate in air or conduit also increases.)
13. **Check Valves:** Spring-loaded check valves must be used on start-up to minimize motor upthrusting, water hammer, or in multiple booster (parallel) applications to prevent reverse flow.
14. **Pressure Relief Valves:** A pressure relief valve is required and must be selected to ensure that, as the pump approaches shut-off, it never reaches the point that the motor will not have adequate cooling flow past it.
15. **System Purge (Can Flooding):** An air bleeder valve must be installed on the booster sleeve so that flooding may be accomplished prior to booster start-up. Once flooding is complete, the booster should be started and brought up to operating pressure as quickly as possible to minimize the duration of an upthrust condition. At no time should air be allowed to gather in the booster sleeve because this will prevent proper cooling of the motor and permanently damage it.
16. **System Flush – Must Not Spin Pump:** Applications may utilize a low flow flushing operation. Flow through the booster sleeve must not spin the pump impellers and the motor shaft. If spinning takes place, the bearing system will be permanently damaged and the motor life shortened. Consult the booster pump manufacturer for maximum flow rate through the pump when the motor is not energized.

**Table 38 Franklin Cable chart (See 12. Wiring)**

CABLE TEMP. RATING (°C)	MOTOR NAMEPLATE RATED AMPS FULL LOAD	#10 AWG		#8 AWG		#6 AWG		#4 AWG		#2 AWG	
		IN AIR	IN CONDUIT	IN AIR	IN CONDUIT	IN AIR	IN CONDUIT	IN AIR	IN CONDUIT	IN AIR	IN CONDUIT
75	3-LEAD (DOL)	40A	28A	56A	40A	76A	52A	100A	68A	136A	92A
	6-LEAD (Y-Δ)	69A	48A	97A	69A	132A	90A	173A	118A	236A	159A
90	3-LEAD (DOL)	44A	32A	64A	44A	84A	60A	112A	76A	152A	104A
	6-LEAD (Y-Δ)	76A	55A	111A	76A	145A	104A	194A	132A	263A	180A
125	3-LEAD (DOL)	66A	46A	77A	53A	109A	75A	153A	105A	195A	134A
	6-LEAD (Y-Δ)	114A	80A	133A	91A	188A	130A	265A	181A	337A	232A

Based on 30 °C maximum ambient with cable length of 100 feet or less.



**Inline Booster Pump Systems (continued)**

17. **Open Atmosphere Booster Pump Systems:** When an open booster is placed in a lake, tank, etc. that is open to atmospheric pressure, the water level must provide sufficient head pressure to allow the pump to operate above its NPSHR requirement at all times and all seasons. Adequate inlet pressure must be provided prior to booster start-up.

**Four Continuous Monitoring System Requirements for Sealed Booster Systems.**

1. **Water Temperature:** Feed water on each booster must be continuously monitored and not allowed to exceed the motor nameplate maximum ambient temperature at any time. IF THE INLET TEMPERATURE EXCEEDS THE MOTOR NAMEPLATE MAXIMUM AMBIENT TEMPERATURE, THE SYSTEM MUST SHUTDOWN IMMEDIATELY TO PREVENT PERMANENT MOTOR DAMAGE. If feed water temperatures are expected to be above the allowable temperature, the motor must be derated. See Franklin's AIM Manual Hot Water Applications section for derating guidelines. (The high temperature feed water derating is in addition to the exchange to DI water derating if the motor factory fill solution was exchanged to DI water.)
2. **Inlet Pressure:** The inlet pressure on each booster module must be continuously monitored. It must always be positive and higher than the NPSHR (Net Positive Suction Head Requirement) of the pump. A minimum of 20 PSIG (1.38 Bar) is required at all times, except for 10 seconds or less when the motor is starting and the system is coming up to pressure.

Even during these 10 seconds the pressure must remain positive and be higher than the NPSHR (Net Positive Suction Head Requirement) of the pump.

PSIG is the actual value displayed on a pressure gauge in the system piping. PSIG is the pressure above the atmospheric conditions. If at any time these pressure requirements are not being met, the motor must be de-energized immediately to prevent permanent damage to the motor. Once the motor is damaged, it is usually not immediately noticeable, but progresses and results in a premature motor failure weeks or months after the damage occurred.

Motors that will be exposed to pressure in excess of 500 psi (34.47 Bar) must undergo special high pressure testing. Consult factory for details and availability.

3. **Discharge Flow:** The flow rate for each pump must not be allowed to drop below the motor minimum cooling flow requirement. IF THE MOTOR MINIMUM COOLING FLOW REQUIREMENT IS NOT BEING MET FOR MORE THAN 10 SECONDS, THE SYSTEM MUST BE SHUT DOWN IMMEDIATELY TO PREVENT PERMANENT MOTOR DAMAGE.
4. **Discharge Pressure:** The discharge pressure must be monitored to ensure that a downthrust load toward the motor is present within 3 seconds after start-up and continuously during operation. IF THE MOTOR DISCHARGE PRESSURE IS NOT ADEQUATE TO MEET THIS REQUIREMENT, THE SYSTEM MUST BE SHUT DOWN IMMEDIATELY TO PREVENT PERMANENT MOTOR DAMAGE.



## Variable Frequency Drive Submersible Motor Requirements

Franklin Electric's three-phase, encapsulated submersible motors can be used with variable frequency drives (VFD) when applied within the guidelines below.

All three-phase, encapsulated submersible motors must have the VFD sized based on the motor's nameplate maximum amps, not horsepower. The continuous rated amps of the VFD must be equal to or greater than the motor's nameplate maximum amps or warranty will be void.

Franklin Electric's single-phase, 2- and 3-wire, encapsulated submersible motors can only be used with the appropriate Franklin constant pressure controller.

Franklin Electric's submersible motor Application Installation Maintenance (AIM) manual should be checked for the latest guidelines and can be found online at [www.franklin-electric.com](http://www.franklin-electric.com).

**WARNING:** There is a potential shock hazard from contact with and/or touching the insulated cables connected to the variable frequency drive output anytime the motor has energy applied.

### Output Filter Requirement Test:

**NOTICE:** An incoming power supply or line-side filter for the drive does not replace the need for additional output filters.

**An output filter is required if the answer is yes to one or both of the items below:**

#1 - Is the VFD's pulse width modulation (PWM) voltage rise-time (dV/dt) more than 500 Volts per micro-second (500 V/ $\mu$ -second)?

#2 - Is the motor nameplate voltage more than 379 Volts and is the cable from drive-to-motor more than 50 ft (15.2 m)?

**NOTICE:**

More than 99% of the drives applied on water well submersible motors will require the purchase of additional output filtering based on question #1.

Output filters can be expensive. However, when needed, it is required for the motor to be considered for warranty. Make sure this item is not overlooked when quoting a job.

PWM dV/dt value can be defined as: the rate at which voltage is changing with time or how fast the voltage is accelerating. This information can be supplied by the drive manufacturer or the manufacturer's drive specification sheet. The dV/dt value cannot be measured with typical field equipment, even when using a true-RMS voltage/ampere multi-meter.

Franklin Electric has a line of VFDs that are specifically designed for Franklin application systems. These VFDs are used in the MonoDrive and SubDrive constant pressure systems. Franklin drive systems have the required additional output filtering installed; however, the SubDrive HPX does not.

### Types of Output Filters:

A resistor-inductor-capacitor (RLC) filter has both a high pass filter & a low pass filter section and are considered the best practice, but a high pass reactor filter is also acceptable.

Filters should be recommended by the drive manufacturer; for the correct recommendations provide them with answers to all five of the items below.

### REQUIRED ITEMS FOR PROPER VFD FILTER SIZING:

(1) VFD model (2) Carrier frequency setting (3) Motor nameplate voltage (4) Motor nameplate max amps (5) Cable length from the drive output terminals to the motor

### Input Current & Motor Overload Protection:

- Motor input current should be set at the system's typical operating current when running at nameplate rated voltage and frequency (Hz).
- Motor overload protection should be set to trip at 115% of the system's typical operating current.
- Motor overload protection must trip equal to or faster than NEMA Class 10 motor overload curve requirements.

### Motor Maximum Load Limits:

- The system must never operate in excess of the motor nameplate maximum amps.
- On 50 Hz motors, nameplate amps are maximum amps as these motors have a 1.0 service factor.



## **Variable Frequency Drive Submersible Motor Requirements**

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### **Motor Operating Hertz, Cooling Requirements & Underload Settings:**

- Standard practice for large VFD installations is to limit the operation to 60 Hz max. Operating at greater than 60 Hz requires special system design considerations.
- The motor must never operate below 30 Hz. This is the minimum speed required to provide correct bearing lubrication.
- The motor's operating speed must always operate so the minimum water flow requirements of 0.5 ft/sec for 6-inch & 8-inch motors and 0.25 ft/sec for 4-inch motors is supplied.
- The motor underload protection is normally set to trip at 80% of the system's typical operating current. However, the underload trip point must be selected so that minimum flow requirements are always met.

### **Starting & Stopping Ramp Settings:**

- The motor must reach or pass the 30 Hz operating speed within 1 second of the motor being energized. If this does not occur, the motor bearings will be damaged and the motor life reduced.
- The best stopping method is to turn power off followed by a natural coast to stop.
- A controlled stop from 30 Hz to 0 Hz is allowed if the time does not exceed 1 second.

### **Drive Carrier Frequency:**

- The carrier frequency is set in the field. The drive typically has a selectable range between 2k and 12k Hz. The higher the carrier wave frequency setting, the greater the voltage spikes; the lower the carrier wave frequency setting, the rougher/poorer the shape of the power curve.
- The carrier frequency should be set within the range of 4k to 5k Hz for encapsulated submersible motors.

### **Application Function Setting:**

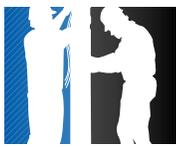
- If the VFD has a setting of centrifugal pump or propeller fan it should be used.
- Centrifugal pumps and fans have similar load characteristics.

### **VFD Frequency of Starts:**

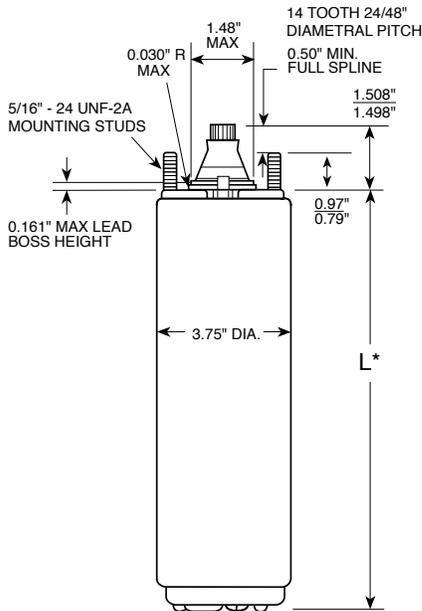
- Keeping the starts per day within the recommended numbers shown in the frequency of starts section of the AIM manual provides the best system life. However, since in-rush current is typically reduced when used with a properly configured VFD, large 3-phase submersible motors can be started more frequently. In all cases a minimum of 7 minutes must be allowed between a power off and the next restart attempt or consecutive restart attempts.

### **NEMA MG1 Above Ground Motor Standard Comments:**

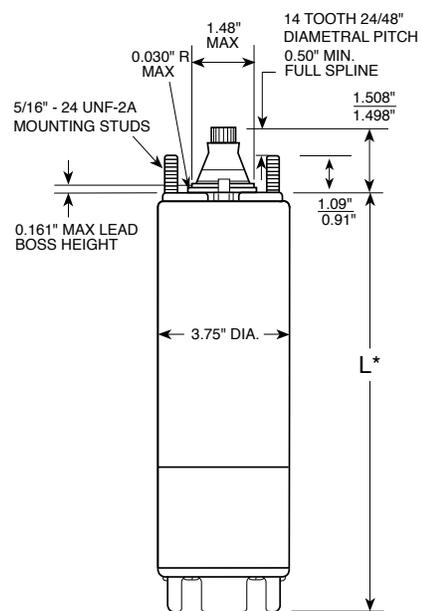
- Franklin Electric encapsulated submersible motors are not declared inverter duty motors by NEMA MG1 standards. The reason is NEMA MG1 standard part 31 does not include a section covering encapsulated winding designs.
- Franklin submersible motors can be used with VFDs without problems or warranty concerns providing Franklin's Application Installation Maintenance (AIM) manual guidelines are followed. See Franklin's on-line AIM manual for the latest guidelines.



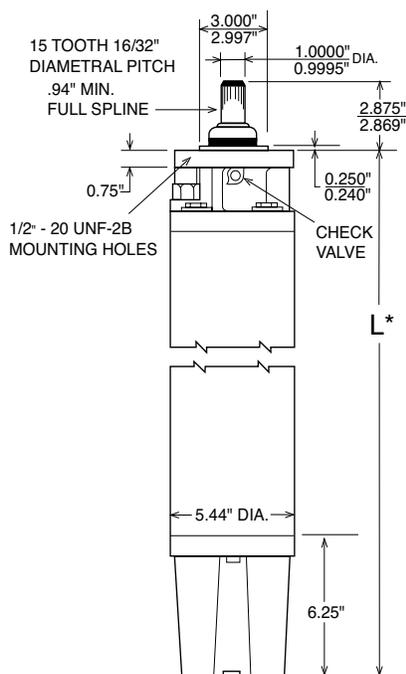
**4" Super Stainless — Dimensions**  
**(Standard Water Well)**



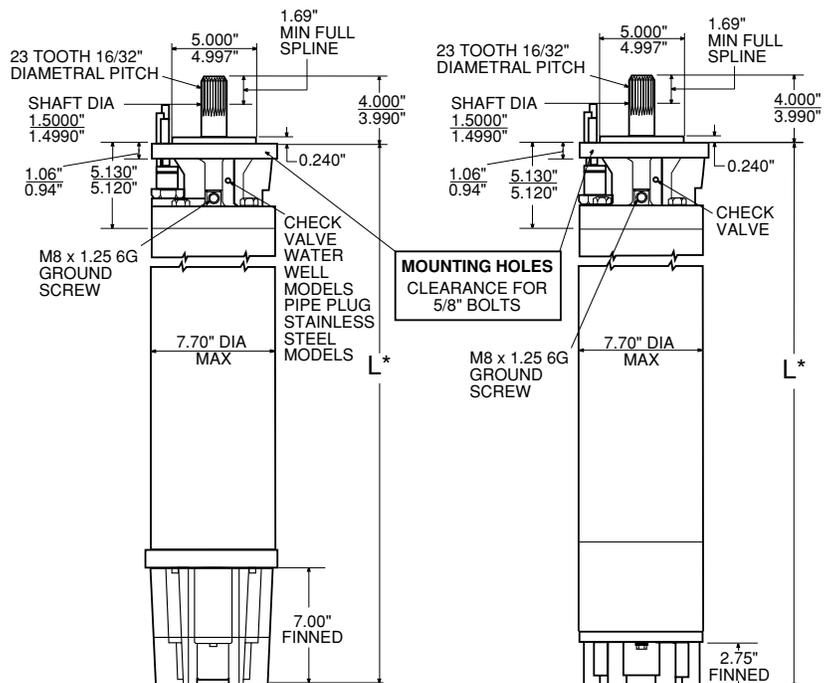
**4" High Thrust — Dimensions**  
**(Standard Water Well)**



**6" — Dimensions**  
**(Standard Water Well)**



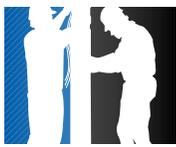
**8" — Dimensions**  
**(Standard Water Well)**



40 to 100 hp

125 to 200 hp

\* Motor lengths and shipping weights are available on Franklin Electric's web site ([www.franklin-electric.com](http://www.franklin-electric.com)) or by calling Franklin's submersible hotline (800-348-2420).



## Tightening Motor Lead Connector Jam Nut

### 4" Motors with Jam Nut:

15 to 20 ft-lb (20 to 27 Nm)

### 4" Motors with 2 Screw Clamp Plate:

35 to 45 in-lb (4.0 to 5.1 Nm)

### 6" Motors:

40 to 50 ft-lb (54 to 68 Nm)

### 8" Motors with 1-3/16" to 1-5/8" Jam Nut:

50 to 60 ft-lb (68 to 81 Nm)

### 8" Motors with 4 Screw Clamp Plate:

Apply increasing torque to the screws equally in a criss-cross pattern until 80 to 90 in-lb (9.0 to 10.2 Nm) is reached.

Jam nut tightening torques recommended for field assembly are shown. Rubber compression set within the first few hours after assembly may reduce the jam nut torque. This is a normal condition which does not indicate reduced seal effectiveness. Retightening is not required, but is permissible and recommended if original torque was questionable.

A motor lead assembly should not be reused. A new lead assembly should be used whenever one is removed from the motor, because rubber set and possible damage from removal may prevent proper resealing of the old lead.

**All motors returned for warranty consideration must have the lead returned with the motor.**

## Pump to Motor Coupling

Assemble coupling with non-toxic FDA approved waterproof grease such as Mobile FM102, Texaco CYGNUS2661, or approved equivalent. This prevents abrasives from entering the spline area and prolongs spline life.

## Pump to Motor Assembly

After assembling the motor to the pump, torque mounting fasteners to the following:

**4" Pump and Motor:** 10 lb-ft (14 Nm)

**6" Pump and Motor:** 50 lb-ft (68 Nm)

**8" Pump and Motor:** 120 lb-ft (163 Nm)

## Shaft Height and Free End Play

Table 42

MOTOR	NORMAL SHAFT HEIGHT		DIMENSION SHAFT HEIGHT		FREE END PLAY	
					MIN.	MAX.
4"	1 1/2"	38.1 mm	$\frac{1.508"}{1.498"}$	$\frac{38.30}{38.05}$ mm	0.010" 0.25 mm	0.045" 1.14 mm
6"	2 7/8"	73.0 mm	$\frac{2.875"}{2.869"}$	$\frac{73.02}{72.88}$ mm	0.030" 0.76 mm	0.050" 1.27 mm
8" TYPE 1	4"	101.6 mm	$\frac{4.000"}{3.990"}$	$\frac{101.60}{101.35}$ mm	0.008" 0.20 mm	0.032" 0.81 mm
8" TYPE 2.1	4"	101.6 mm	$\frac{4.000"}{3.990"}$	$\frac{101.60}{101.35}$ mm	0.030" 0.76 mm	0.080" 2.03 mm

If the height, measured from the pump-mounting surface of the motor, is low and/or end play exceeds the limit, the motor thrust bearing is possibly damaged, and should be replaced.

## Submersible Leads and Cables

A common question is why motor leads are smaller than specified in Franklin's cable charts.

The leads are considered a part of the motor and actually are a connection between the large supply wire and the motor winding. The motor leads are short and there is virtually no voltage drop across the lead.

In addition, the lead assemblies **operate under water**, while at least part of the supply cable must **operate in air**. Lead assemblies running under water operate cooler.

**CAUTION:** Lead assemblies on submersible motors are suitable only for use in water and may overheat and cause failure if operated in air.



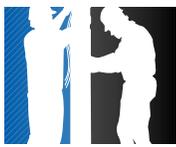
## System Troubleshooting

### Motor Does Not Start

POSSIBLE CAUSE	CHECKING PROCEDURES	CORRECTIVE ACTION
A. No power or incorrect voltage.	Check voltage at line terminals. The voltage must be $\pm 10\%$ of rated voltage.	Contact power company if voltage is incorrect.
B. Fuses blown or circuit breakers tripped.	Check fuses for recommended size and check for loose, dirty or corroded connections in fuse receptacle. Check for tripped circuit breakers.	Replace with proper fuse or reset circuit breakers.
C. Defective pressure switch.	Check voltage at contact points. Improper contact of switch points can cause voltage less than line voltage.	Replace pressure switch or clean points.
D. Control box malfunction.	For detailed procedure, see pages 48-56.	Repair or replace.
E. Defective wiring.	Check for loose or corroded connections or defective wiring	Correct faulty wiring or connections.
F. Bound pump.	Check for misalignment between pump and motor or a sand bound pump. Amp readings will be 3 to 6 times higher than normal until the overload trips	Pull pump and correct problem. Run new installation until the water clears
G. Defective cable or motor.	For detailed procedure, see pages 46 & 47.	Repair or replace.

### Motor Starts Too Often

A. Pressure switch.	Check setting on pressure switch and examine for defects.	Reset limit or replace switch.
B. Check valve - stuck open.	Damaged or defective check valve will not hold pressure.	Replace if defective.
C. Waterlogged tank.	Check air charge	Clean or replace.
D. Leak in system.	Check system for leaks.	Replace damaged pipes or repair leaks.



## System Troubleshooting

### Motor Runs Continuously

POSSIBLE CAUSE	CHECKING PROCEDURES	CORRECTIVE ACTION
A. Pressure switch.	Check switch for welded contacts. Check switch adjustments.	Clean contacts, replace switch, or adjust setting.
B. Low water level in well.	Pump may exceed well capacity. Shut off pump, wait for well to recover. Check static and drawdown level from well head.	Throttle pump output or reset pump to lower level. Do not lower if sand may clog pump.
C. Leak in system.	Check system for leaks.	Replace damaged pipes or repair leaks.
D. Worn pump.	Symptoms of worn pump are similar to those of drop pipe leak or low water level in well. Reduce pressure switch setting, if pump shuts off worn parts may be the fault.	Pull pump and replace worn parts.
E. Loose coupling or broken motor shaft.	Check for loose coupling or damaged shaft.	Replace worn or damaged parts.
F. Pump screen blocked.	Check for clogged intake screen.	Clean screen and reset pump depth.
G. Check valve stuck closed.	Check operation of check valve.	Replace if defective.
H. Control box malfunction.	See pages 47-55 for single-phase.	Repair or replace.

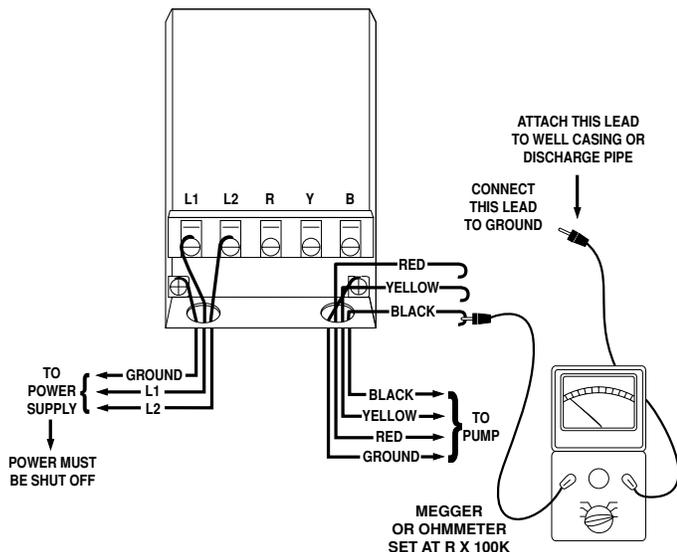
### Motor Runs But Overload Protector Trips

A. Incorrect voltage.	Using voltmeter, check the line terminals. Voltage must be within $\pm 10\%$ of rated voltage.	Contact power company if voltage is incorrect.
B. Overheated protectors.	Direct sunlight or other heat source can raise control box temperature causing protectors to trip. The box must not be hot to touch.	Shade box, provide ventilation or move box away from source.
C. Defective control box.	For detailed procedures, see pages 47-55.	Repair or replace.
D. Defective motor or cable.	For detailed procedures, see pages 45 & 46.	Repair or replace.
E. Worn pump or motor.	Check running current, see tables 13, 22, 24 & 27.	Replace pump and/or motor.

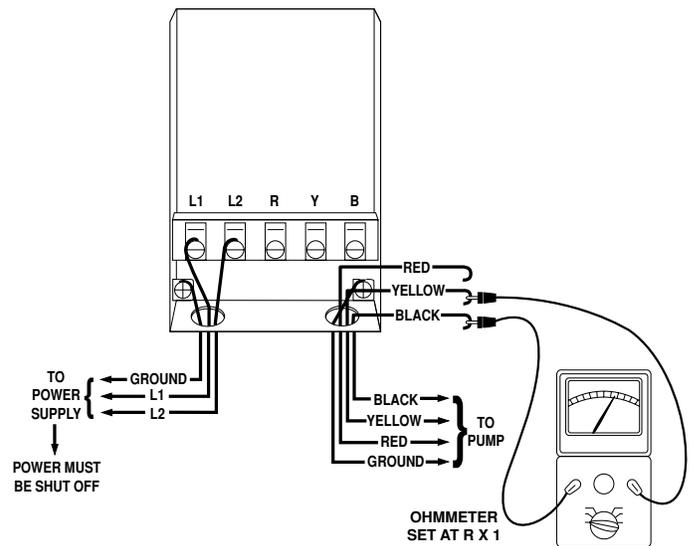


**Table 45 Preliminary Tests - All Sizes Single- and Three-Phase**

TEST	PROCEDURE	WHAT IT MEANS
<b>Insulation Resistance</b>	<ol style="list-style-type: none"> <li>1. Open master breaker and disconnect all leads from control box or pressure switch (QD type control, remove lid) to avoid electric shock hazard and damage to the meter.</li> <li>2. Use a megohmmeter or set the scale lever to R X 100K on an ohmmeter. Zero the meter.</li> <li>3. Connect one meter lead to any one of the motor leads and the other lead to the metal drop pipe. If the drop pipe is plastic, connect the meter lead to ground.</li> </ol>	<ol style="list-style-type: none"> <li>1. If the ohms value is normal (table 46), the motor is not grounded and the cable insulation is not damaged.</li> <li>2. If the ohms value is below normal, either the windings are grounded or the cable insulation is damaged. Check the cable at the well seal as the insulation is sometimes damaged by being pinched.</li> </ol>
<b>Winding Resistance</b>	<ol style="list-style-type: none"> <li>1. Open master breaker and disconnect all leads from control box or pressure switch (QD type control, remove lid) to avoid electric shock hazard and damage to the meter.</li> <li>2. Set the scale lever to R X 1 for values under 10 ohms. For values over 10 ohms, set the scale lever to R X 10. "zero" the ohmmeter.</li> <li>3. On 3-wire motors measure the resistance of yellow to black (main winding) and yellow to red (start winding).</li> </ol> <p>On 2-wire motors: measure the resistance from line-to-line.</p> <p>Three-phase motors: measure the resistance line-to-line for all three combinations.</p>	<ol style="list-style-type: none"> <li>1. If all ohms values are normal (tables 13, 22, 24 &amp; 27), the motor windings are neither shorted nor open, and the cable colors are correct</li> <li>2. If any one value is less than normal, the motor is shorted.</li> <li>3. If any one ohm value is greater than normal, the winding or the cable is open, or there is a poor cable joint or connection.</li> <li>4. If some ohms values are greater than normal and some less on single-phase motors, the leads are mixed. See page 46 to verify cable colors.</li> </ol>



**FIG. 13**



**FIG. 14**



## Insulation Resistance Readings

**Table 46 Normal ohm and Megohm Values Between All Leads and Ground**

CONDITION OF MOTOR AND LEADS	OHMS VALUE	MEGOHM VALUE
A new motor (without drop cable).	200,000,000 (or more)	200.0 (or more)
A used motor which can be reinstalled in well.	10,000,000 (or more)	10.0 (or more)
MOTOR IN WELL. READINGS ARE FOR DROP CABLE PLUS MOTOR.		
New motor.	2,000,000 (or more)	2.0 (or more)
Motor in good condition.	500,000 - 2,000,000	0.50 - 2.0
Insulation damage, locate and repair.	Less than 500,000	Less than .50

Insulation resistance varies very little with rating. Motors of all hp, voltage, and phase rating have similar values of insulation resistance.

The table above is based on readings taken with a megohm meter with a 500 VDC output. Readings may vary using a lower voltage ohmmeter, consult Franklin Electric if readings are in question.

## Resistance of Drop Cable (ohms)

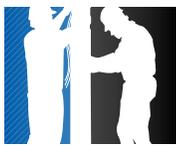
The values below are for copper conductors. If aluminum conductor drop cable is used, the resistance will be higher. To determine the actual resistance of the aluminum drop cable, divide the ohm readings from this chart by 0.61. This chart shows total resistance of cable from control to motor and back.

## Winding Resistance Measuring

The winding resistance measured at the motor should fall within the values in tables 13, 22, 24 & 27. When measured through the drop cable, the resistance of the drop cable must be subtracted from the ohmmeter readings to get the winding resistance of the motor. See table below.

**Table 46A DC Resistance in ohms per 100 ft of Wire (Two conductors) @ 50 °F**

AWG OR MCM WIRE SIZE (COPPER)		14	12	10	8	6	4	3	2		
OHMS		0.544	0.338	0.214	0.135	0.082	0.052	0.041	0.032		
1	1/0	2/0	3/0	4/0	250	300	350	400	500	600	700
0.026	0.021	0.017	0.013	0.010	0.0088	0.0073	0.0063	0.0056	0.0044	0.0037	0.0032

**Identification Of Cables When Color Code Is Unknown (Single-Phase 3-Wire Units)**

If the colors on the individual drop cables cannot be found with an ohmmeter, measure:

- Cable 1 to Cable 2
- Cable 2 to Cable 3
- Cable 3 to Cable 1

Find the highest resistance reading.

The lead not used in the highest reading is the yellow lead.

Use the yellow lead and each of the other two leads to get two readings:

- Highest is the red lead.
- Lowest is the black lead.

**EXAMPLE:**

The ohmmeter readings were:

- Cable 1 to Cable 2 - 6 ohms
- Cable 2 to Cable 3 - 2 ohms
- Cable 3 to Cable 1 - 4 ohms

The lead not used in the highest reading (6 ohms) was Cable 3—Yellow

From the yellow lead, the highest reading (4 ohms) was To Cable 1—Red

From the yellow lead, the lowest reading (2 ohms) was To Cable 2—Black

**Single-Phase Control Boxes****Checking and Repairing Procedures (Power On)**

**WARNING:** Power must be on for these tests. Do not touch any live parts.

**A. VOLTAGE MEASUREMENTS****Step 1. Motor Off**

1. Measure voltage at L1 and L2 of pressure switch or line contactor.
2. Voltage Reading: Should be  $\pm 10\%$  of motor rating.

**Step 2. Motor Running**

1. Measure voltage at load side of pressure switch or line contactor with pump running.
2. Voltage Reading: Should remain the same except for slight dip on starting. Excessive voltage drop can be caused by loose connections, bad contacts, ground faults, or inadequate power supply.
3. Relay chatter is caused by low voltage or ground faults.

**B. CURRENT (AMP) MEASUREMENTS**

1. Measure current on all motor leads.
2. Amp Reading: Current in red lead should momentarily be high, then drop within one second to values in table 13. This verifies relay or solid state relay operation. Current in black and yellow leads should not exceed values in table 13.
3. Relay or switch failures will cause red lead current to remain high and overload tripping.
4. Open run capacitor(s) will cause amps to be higher than normal in the black and yellow motor leads and lower than normal in the red motor lead.
5. A bound pump will cause locked rotor amps and overloading tripping.
6. Low amps may be caused by pump running at shutoff, worn pump, or stripped splines.
7. Failed start capacitor or open switch/relay are indicated if the red lead current is not momentarily high at starting.

**CAUTION:** The tests in this manual for components such as capacitors, relays, and QD switches should be regarded as indicative and not as conclusive. For example, a capacitor may test good (not open, not shorted) but may have lost some of its capacitance and may no longer be able to perform its function.



## Ohmmeter Tests

### QD, Solid State Control Box (Power Off)

#### A. START CAPACITOR AND RUN CAPACITOR IF APPLICABLE (CRC)

1. Meter Setting: R x 1,000.
2. Connections: Capacitor terminals.
3. Correct meter reading: Pointer should swing toward zero, then back to infinity.

#### B. Q.D. (BLUE) RELAY

##### Step 1. Triac Test

1. Meter setting: R x 1,000.
2. Connections: Cap and B terminal.
3. Correct meter reading: Infinity for all models.

##### Step 2. Coil Test

1. Meter Setting: R x 1.
2. Connections: L1 and B.
3. Correct meter reading: Zero ohms for all models.

#### C. POTENTIAL (VOLTAGE) RELAY

##### Step 1. Coil Test

1. Meter setting: R x 1,000.
2. Connections: #2 & #5.
3. Correct meter readings:  
For 115 Volt Boxes:  
0.7-1.8 (700 to 1,800 ohms).  
For 230 Volt Boxes:  
4.5-7.0 (4,500 to 7,000 ohms).

##### Step 2. Contact Test

1. Meter setting: R x 1.
2. Connections: #1 & #2.
3. Correct meter reading: Zero for all models.

## Ohmmeter Tests

### Integral Horsepower Control Box (Power Off)

#### A. OVERLOADS (Push Reset Buttons to make sure contacts are closed.)

1. Meter Setting: R x 1.
2. Connections: Overload terminals.
3. Correct meter reading: Less than 0.5 ohms.

#### B. CAPACITOR (Disconnect leads from one side of each capacitor before checking.)

1. Meter Setting: R x 1,000.
2. Connections: Capacitor terminals.
3. Correct meter reading: Pointer should swing toward zero, then drift back to infinity, except for capacitors with resistors which will drift back to 15,000 ohms.

#### C. POTENTIAL (VOLTAGE) RELAY

##### Step 1. Coil Test

1. Meter setting: R x 1,000.
2. Connections: #2 & #5.
3. Correct meter readings: 4.5-7.0 (4,500 to 7,000 ohms) for all models.

##### Step 2. Contact Test

1. Meter Setting: R x 1.
2. Connections: #1 & #2.
3. Correct meter reading: Zero ohms for all models.

#### D. CONTACTOR

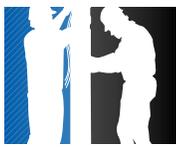
##### Step 1. Coil

1. Meter setting: R x 100
2. Connections: Coil terminals
3. Correct meter reading:  
1.8-14.0 (180 to 1,400 ohms)

##### Step 2. Contacts

1. Meter Setting: R X 1
2. Connections: L1 & T1 or L2 & T2
3. Manually close contacts
4. Correct meter reading: Zero ohms

**CAUTION:** The tests in this manual for components such as capacitors, relays, and QD switches should be regarded as indicative and not as conclusive. For example, a capacitor may test good (not open, not shorted) but may have lost some of its capacitance and may no longer be able to perform its function.



**Table 49 QD Control Box Parts 60 Hz**

HP	VOLTS	CONTROL BOX MODEL NUMBER	QD (BLUE) RELAY	START CAPACITOR	MFD	VOLTS	RUN CAPACITOR	MFD	VOLTS
1/3	115	280 102 4915	223 415 905	275 464 125	159-191	110			
	230	280 103 4915	223 415 901	275 464 126	43-53	220			
1/2	115	280 104 4915	223 415 906	275 464 201	250-300	125			
	230	280 105 4915	223 415 902	275 464 105	59-71	220			
	230	282 405 5015 (CRC)	223 415 912	275 464 126	43-53	220	156 362 101	15	370
3/4	230	280 107 4915	223 415 903	275 464 118	86-103	220			
	230	282 407 5015 (CRC)	223 415 913	275 464 105	59-71	220	156 362 102	23	370
1	230	280 108 4915	223 415 904	275 464 113	105-126	220			
	230	282 408 5015 (CRC)	223 415 914	275 464 118	86-103	220	156 362 102	23	370

**Table 49A QD Capacitor Replacement Kits**

CAPACITOR NUMBER	KIT
275 464 105	305 207 905
275 464 113	305 207 913
275 464 118	305 207 918
275 464 125	305 207 925
275 464 126	305 207 926
275 464 201	305 207 951
156 362 101	305 203 907
156 362 102	305 203 908

**Table 49B Overload Kits 60 Hz**

HP	VOLTS	KIT (1)
1/3	115	305 100 901
1/3	230	305 100 902
1/2	115	305 100 903
1/2	230	305 100 904
3/4	230	305 100 905
1	230	305 100 906

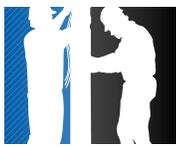
(1) For Control Boxes with model numbers that end with 4915.

**Table 49C QD Relay Replacement Kits**

QD RELAY NUMBER	KIT
223 415 901	305 101 901
223 415 902	305 101 902
223 415 903	305 101 903
223 415 904	305 101 904
223 415 905	305 101 905
223 415 906	305 101 906
223 415 912 (CRC)	305 105 901
223 415 913 (CRC)	305 105 902
223 415 914 (CRC)	305 105 903

**FOOTNOTES:**

- (1) Control boxes supplied with QD Relays (1) are designed to operate on 230-volt systems. For 208-volt systems or where line voltage is between 200 volts and 210 volts use the next larger cable size, or use a boost transformer to raise the voltage.
- (2) Voltage relays kits for 115-volts (305 102 901) and 230-volts (305 102 902) will replace current, voltage or QD Relays, and solid state switches.

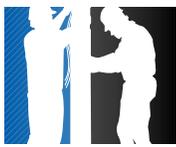


**Table 50 Integral Horsepower Control Box Parts 60 Hz**

MOTOR SIZE	MOTOR RATING HP	CONTROL BOX (1) MODEL NO.	CAPACITORS				OVERLOAD (2) PART NO.	RELAY (3) PART NO.	CONTACTOR (2) PART NO.
			PART NO. (2)	MFD.	VOLTS	QTY.			
4"	1 - 1.5 STANDARD	282 300 8110 (See Note 5)	275 464 113 S 155 328 102 R	105-126 10	220 370	1 1	275 411 107	155 031 102	
		282 300 8110 (See Note 5)	275 464 113 S 155 328 101 R	105-126 15	220 370	1 1	275 411 114 S 275 411 113 M	155 031 102	
		282 300 8610	275 464 113 S 155 328 101 R	105-126 15	220 370	1 1	None (See Note 4)	155 031 102	
4"	2 STANDARD	282 301 8110	275 464 113 S 155 328 103 R	105-126 20	220 370	1 1	275 411 117 S 275 411 113 M	155 031 102	
4"	2 DELUXE	282 301 8310	275 464 113 S 155 328 103 R	105-126 20	220 370	1 1	275 411 117 S 275 411 113 M	155 031 102	155 325 102 L
4"	3 STANDARD	282 302 8110	275 463 123 S 155 327 109 R	208-250 45	220 370	1 1	275 411 118 S 275 411 115 M	155 031 102	
4"	3 DELUXE	282 302 8310	275 463 123 S 155 327 109 R	208-250 45	220 370	1 1	275 411 118 S 275 411 115 M	155 031 102	155 325 102 L
4" & 6"	5 STANDARD	282 113 8110	275 468 119 S 155 327 114 R	270-324 40	330 370	1 2	275 411 119 S 275 406 102 M	155 031 601	
4" & 6"	5 DELUXE	282 113 9310	275 468 119 S 155 327 114 R	270-324 40	330 370	1 2	275 411 119 S 275 406 102 M	155 031 601	155 326 101 L
6"	7.5 STANDARD	282 201 9210	275 468 119 S	270-324	330	1	275 411 102 S 275 406 122 M	155 031 601	
			275 468 118 S	216-259	330	1			
			155 327 109 R	45	370	1			
6"	7.5 DELUXE	282 201 9310	275 468 119 S	270-324	330	1	275 411 102 S 275 406 121 M	155 031 601	155 326 102 L
			275 468 118 S	216-259	330	1			
			155 327 109 R	45	370	1			
6"	10 STANDARD	282 202 9210	275 468 119 S	270-324	330	1	275 406 103 S 155 409 101 M	155 031 601	
			275468 120 S	350-420	330	1			
			155 327 102 R	35	370	2			
6"	10 STANDARD	282 202 9230	275 463 120 S	130-154	330	1	275 406 103 S 155 409 101 M	155 031 601	
			275 468 118 S	216-259	330	1			
			275 468 119 S	270-324	330	1			
			155 327 102 R	35	370	2			
6"	10 DELUXE	282 202 9310	275 468 119 S	270-324	330	1	275 406 103 S 155 409 101 M	155 031 601	155 326 102 L
			275468 120 S	350-420	330	1			
			155 327 102 R	35	370	2			
6"	10 DELUXE	282 202 9330	275 463 120 S	130-154	330	1	275 406 103 S 155 409 101 M	155 031 601	155 326 102 L
			275 468 118 S	216-259	330	1			
			275 468 119 S	270-324	330	1			
			155 327 102 R	35	370	2			
6"	15 DELUXE	282 203 9310	275 468 120 S	350-420	330	2	275 406 103 S 155 409 102 M	155 031 601	155 429 101 L
			155 327 109 R	45	370	3			
6"	15 DELUXE	282 203 9330	275 463 122 S	161-193	330	1	275 406 103 S 155 409 102 M	155 031 601	155 429 101 L
			275 468 119 S	270-324	330	2			
			155 327 109 R	45	370	3			
6"	15 X-LARGE	282 203 9621	275 468 120 S 155 327 109 R	350-420 45	330 370	2 3	275 406 103 S 155 409 102 M	155 031 601 2 required	155 429 101 L

**FOOTNOTES:**

- (1) Lightning arrestors 150 814 902 are suitable for all control boxes.
- (2) S = Start, M = Main, L = Line, R = Run  
Deluxe = Control box with line contactor.
- (3) For 208-volt systems or where line voltage is between 200 volts and 210 volts, a low voltage relay is required. On 3 hp and smaller control boxes use relay part 155 031 103 in place of 155 031 102 and use the next larger cable size than specified in the 230-volt table. On 5 hp and larger use relay 155 031 602 in place of 155 031 601 and next larger wire. Boost transformers per page 15 are an alternative to special relays and cable.
- (4) Control box model 282 300 8610 is designed for use with motors having internal overload protectors. If used with a 1.5 hp motor manufactured prior to date code 06H18, Overload/Capacitor Kit 305 388 901 is required.
- (5) Control box model 282 300 8110 with date code 11C19 (March 2011) and newer contain 15 MFD run capacitor and both start and run overloads. This box is designed for use with any Franklin 1.5 hp motor.



**Table 51 Integral hp Capacitor Replacement Kits**

CAPACITOR NUMBER	KIT
275 463 120	305 206 920
275 463 122	305 206 922
275 463 123	305 206 923
275 464 113	305 207 913
275 468 118	305 208 918
275 468 119	305 208 919
275 468 120	305 208 920
155 327 101	305 203 901
155 327 102	305 203 902
155 327 109	305 203 909
155 327 114	305 203 914
155 328 101	305 204 901
155 328 102	305 204 902
155 328 103	305 204 903

**Table 51A Integral hp Overload Replacement Kits**

OVERLOAD NUMBER	KIT
275 406 102	305 214 902
275 406 103	305 214 903
275 406 121	305 214 921
275 406 122	305 214 922
275 411 102	305 215 902
275 411 107	305 215 907
275 411 108	305 215 908
275 411 113	305 215 913
275 411 114	305 215 914
275 411 115	305 215 915
275 411 117	305 215 917
275 411 118	305 215 918
275 411 119	305 215 919

**Table 51B Integral hp Voltage Relay Replacement Kits**

RELAY NUMBER	KIT
155 031 102	305 213 902
155 031 103	305 213 903
155 031 601	305 213 961
155 031 602	305 213 962

**Table 51C Integral hp Contactor Replacement Kits**

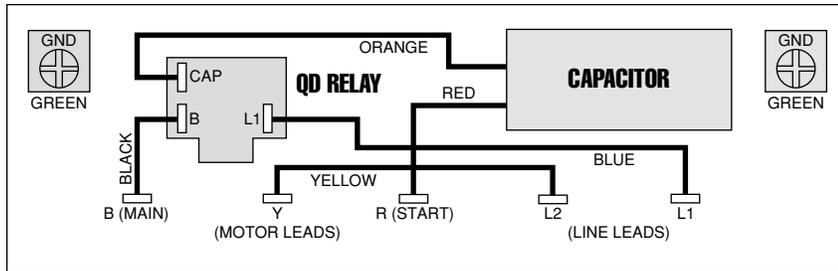
CONTACTOR	KIT
155 325 102	305 226 902
155 326 101	305 347 903
155 326 102	305 347 902
155 429 101	305 347 901

**FOOTNOTES:**

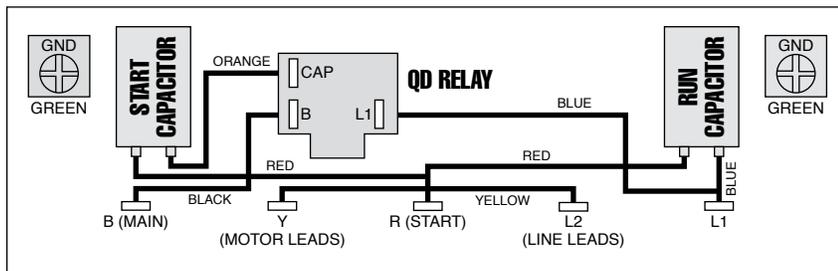
- (1) The following kit number changes were made for number consistency purposes only. Parts in the kit did not change.
  - 305 206 922 was 305 206 912
  - 305 206 923 was 305 206 911
  - 305 213 962 was 305 213 904
  - 305 226 902 was 305 226 901



**Control Box Wiring Diagrams**



**1/3 - 1 hp QD RELAY**  
280 10\_ 4915  
Sixth digit depends on hp

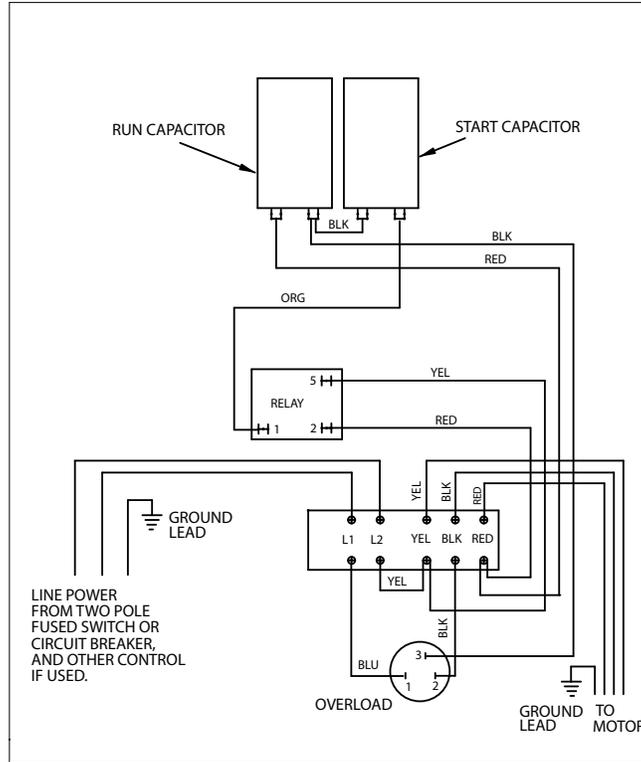


**1/2 - 1 hp CRC QD RELAY**  
282 40\_ 5015  
Sixth digit depends on hp

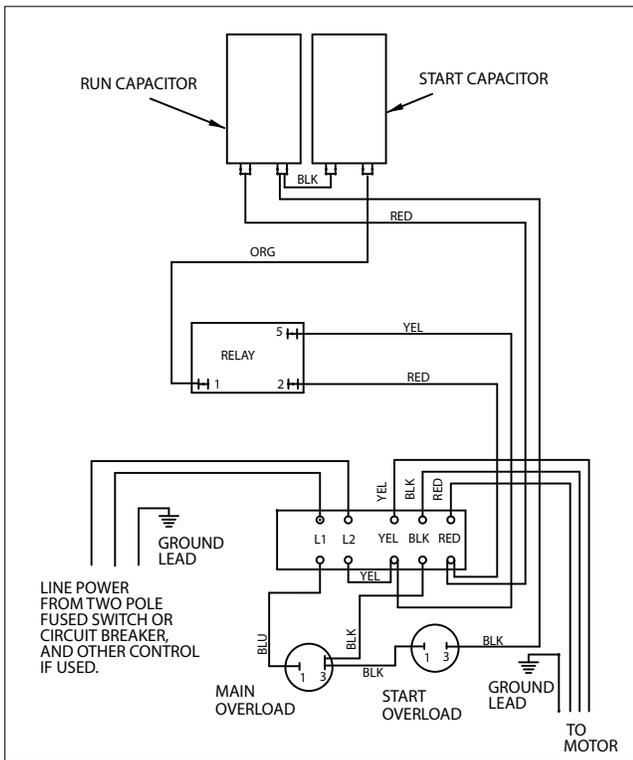


# MAINTENANCE

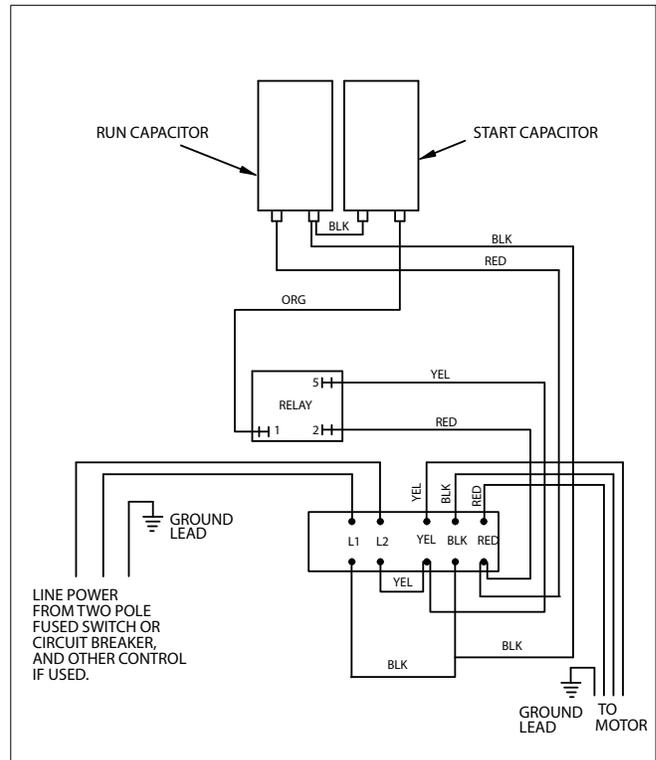
# Single-Phase Motors & Controls



**1 - 1.5 hp**  
**282 300 8110**  
(Date Codes 11C19 & Older)



**1 - 1.5 hp**  
**282 300 8110**  
(Date Codes 11C19 & Newer)

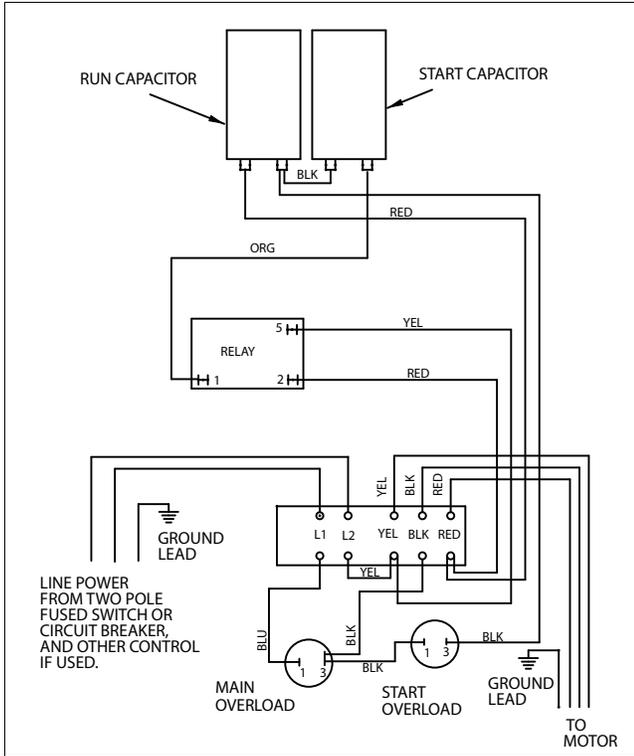


**1 - 1.5 hp**  
**282 300 8610**

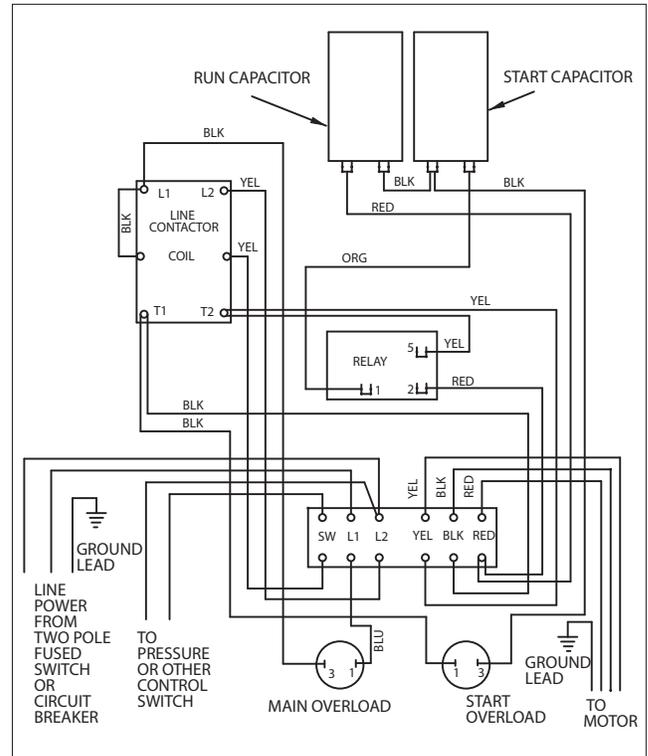


# MAINTENANCE

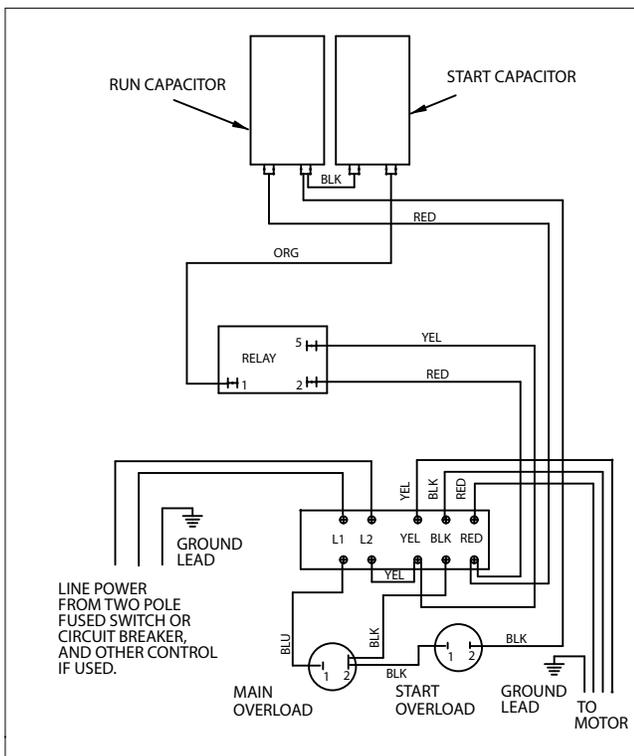
# Single-Phase Motors & Controls



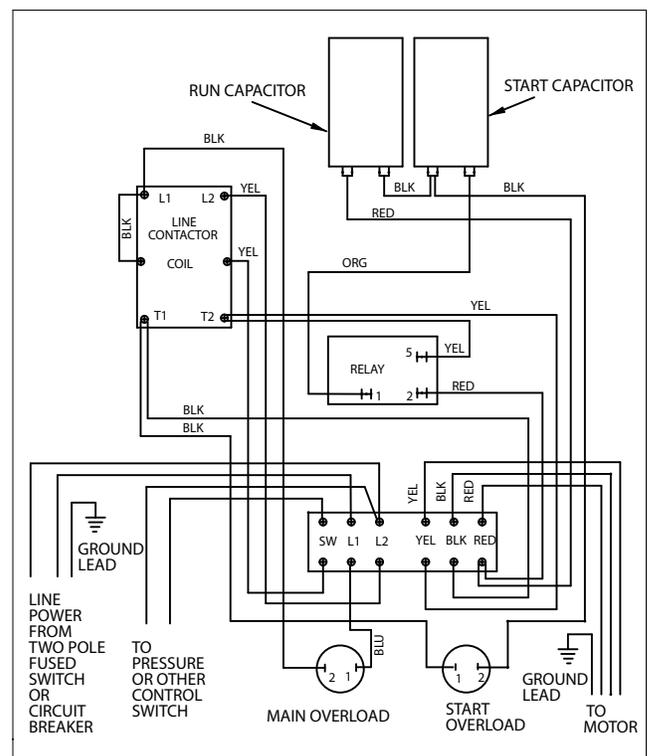
**2 hp STANDARD**  
282 301 8110



**2 hp DELUXE**  
282 301 8310



**3 hp STANDARD**  
282 302 8110

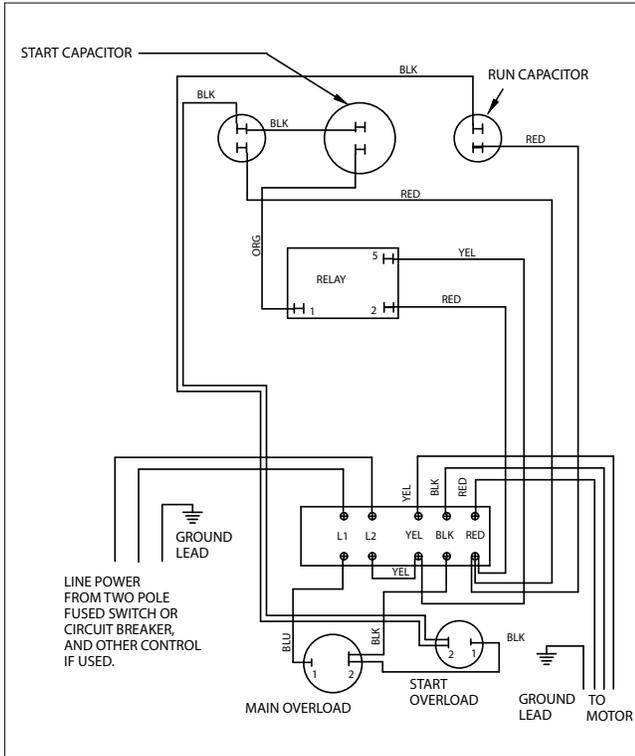


**3 hp DELUXE**  
282 302 8310



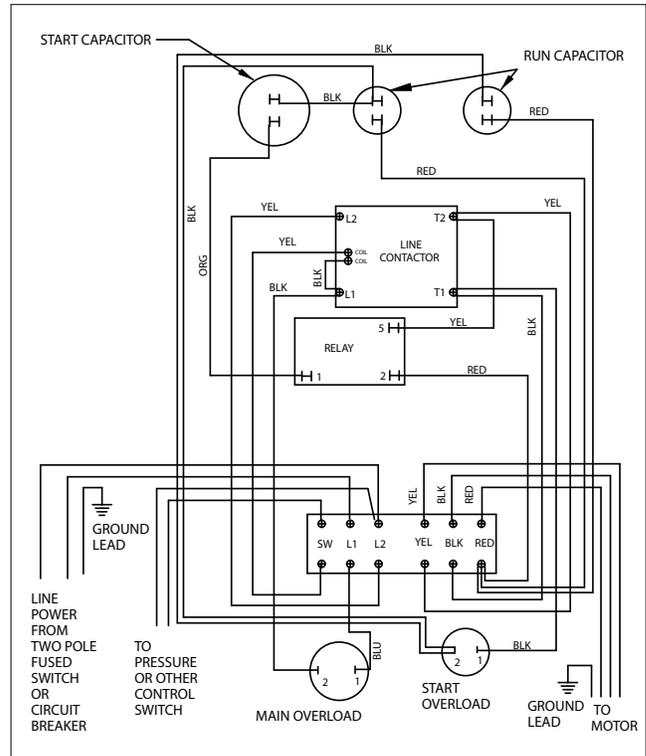
# MAINTENANCE

# Single-Phase Motors & Controls



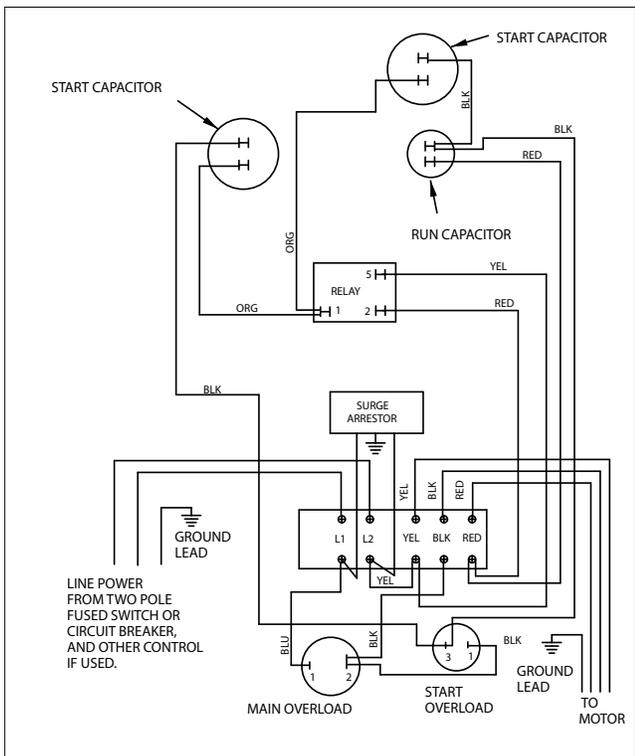
### 5 hp STANDARD

282 113 8110



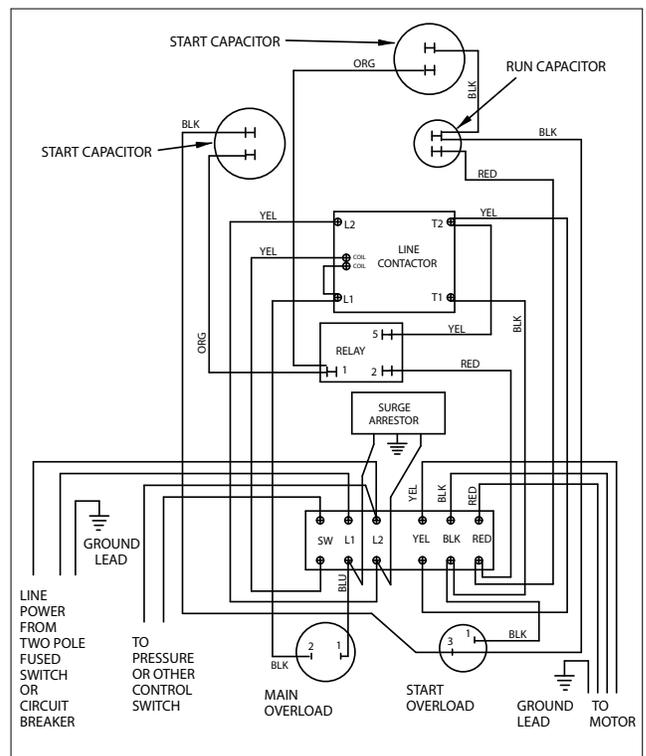
### 5 hp DELUXE

282 113 8310 or 282 113 9310



### 7.5 hp STANDARD

282 201 9210



### 7.5 hp DELUXE

282 201 9310





## Pumpteck-Plus

Pumpteck-Plus is a pump/motor protection device designed to work on any 230 V single-phase induction motor (PSC, CSCR, CSIR, and split phase) ranging in size from 1/2 to 5 horsepower. Pumpteck-Plus uses a micro-computer to continuously monitor motor power and line voltage to provide protection against dry well, water logged tank, high and low voltage and mud or sand clogging.

### Pumpteck-Plus – Troubleshooting During Installation

SYMPTOM	POSSIBLE CAUSE	SOLUTION
Unit Appears Dead (No Lights)	No Power to Unit	Check wiring. Power supply voltage should be applied to L1 and L2 terminals of the Pumpteck-Plus. In some installations the pressure switch or other control devices is wired to the input of the Pumpteck-Plus. Make sure this switch is closed.
Flashing Yellow Light	Unit Needs to Be Calibrated	Pumpteck-Plus is calibrated at the factory so that it will overload on most pump systems when the unit is first installed. This overload condition is a reminder that the Pumpteck-Plus unit requires calibration before use. See step 7 of the installation instructions.
	Miscalibrated	Pumpteck-Plus should be calibrated on a full recovery well with the maximum water flow. Flow restrictors are not recommended.
Flashing Yellow Light During Calibration	2-Wire Motor	Step C of the calibration instructions indicate that a flashing green light condition will occur 2 to 3 seconds after taking the SNAPSHOT of the motor load. On some two-wire motors the yellow light will flash instead of the green light. Press and release the reset button. The green should start flashing.
Flashing Red and Yellow Lights	Power Interruption	During the installation of Pumpteck-Plus power may be switched on and off several times. If power is cycled more than four times within a minute Pumpteck-Plus will trip on rapid cycle. Press and release the reset button to restart the unit.
	Float Switch	A bobbing float switch may cause the unit to detect a rapid cycle condition on any motor or an overload condition on two-wire motors. Try to reduce water splashing or use a different switch.
Flashing Red Light	High Line Voltage	The line voltage is over 253 volts. Check line voltage. Report high line voltage to the power company.
	Unloaded Generator	If you are using a generator the line voltage may become too high when the generator unloads. Pumpteck-Plus will not allow the motor to turn on again until the line voltage returns to normal. Overvoltage trips will also occur if line frequency drops too far below 60 Hz.
Solid Red Light	Low Line Voltage	The line voltage is below 207 volts. Check line voltage.
	Loose Connections	Check for loose connections which may cause voltage drops.
	Loaded Generator	If you are using a generator the line voltage may become too low when the generator loads. Pumpteck-Plus will trip on undervoltage if the generator voltage drops below 207 volts for more than 2.5 seconds. Undervoltage trips will also occur if the line frequency rises too far above 60 Hz.



## Pumptec-Plus

### Pumptec-Plus - Troubleshooting **After Installation**

SYMPTOM	POSSIBLE CAUSE	SOLUTION
<b>Solid Yellow Light</b>	Dry Well	Wait for the automatic restart timer to time out. During the time out period the well should recover and fill with water. If the automatic reset timer is set to the manual position, then the reset button must be pressed to reactivate the unit.
	Blocked Intake	Clear or replace pump intake screen.
	Blocked Discharge	Remove blockage in plumbing.
	Check Valve Stuck	Replace check valve.
	Broken Shaft	Replace broken parts.
	Severe Rapid Cycling	Machine gun rapid cycling can cause an underload condition. See flashing red and yellow lights section below.
	Worn Pump	Replace worn pump parts and recalibrate.
<b>Yellow Flashing Light</b>	Stalled Motor	Repair or replace motor. Pump may be sand or mud locked.
	Float Switch	A bobbing float switch can cause two-wire motors to stall. Arrange plumbing to avoid splashing water. Replace float switch.
	Ground Fault	Check insulation resistance on motor and control box cable.
<b>Solid Red Light</b>	Low Line Voltage	The line voltage is below 207 volts. Pumptec-Plus will try to restart the motor every two minutes until line voltage is normal.
	Loose Connections	Check for excessive voltage drops in the system electrical connections (i.e. circuit breakers, fuse clips, pressure switch, and Pumptec-Plus L1 and L2 terminals). Repair connections.
<b>Flashing Red Light</b>	High Line Voltage	The line voltage is over 253 volts. Check line voltage. Report high line voltage to the power company.
<b>Flashing Red and Yellow Lights</b>	Rapid Cycle	The most common cause for the rapid cycle condition is a waterlogged tank. Check for a ruptured bladder in the water tank. Check the air volume control or snifter valve for proper operation. Check setting on the pressure switch and examine for defects.
	Leaky Well System	Replace damaged pipes or repair leaks.
	Stuck Check Valve	Failed valve will not hold pressure. Replace valve.
	Float Switch	Press and release the reset button to restart the unit. A bobbing float switch may cause the unit to detect a rapid cycle condition on any motor or an overload condition on 2-wire motors. Try to reduce water splashing or use a different switch.



## QD Pumptec and Pumptec

QD Pumptec and Pumptec are load sensing devices that monitor the load on submersible pumps/motors. If the load drops below a preset level for a minimum of 4 seconds the QD Pumptec or the Pumptec will shut off the motor.

The QD Pumptec is designed and calibrated expressly for use on Franklin Electric 230 V 3-wire motors (1/3 to 1 hp.) The QD Pumptec must be installed in QD relay boxes.

The Pumptec is designed for use on Franklin Electric 2- and 3-wire motors (1/3 to 1.5 hp) 115 and 230 V. The Pumptec is not designed for jet pumps.

### QD Pumptec & Pumptec – Troubleshooting

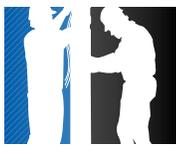
SYMPTOM	CHECKS OR SOLUTION
<p>If the QD Pumptec or Pumptec trips in about 4 seconds with some water delivery.</p>	<ul style="list-style-type: none"> <li>A. Is the voltage less than 90% of nameplate rating?</li> <li>B. Are the pump and motor correctly matched?</li> <li>C. Is the <b>QD Pumptec</b> or <b>Pumptec</b> wired correctly? For the <b>Pumptec</b> check the wiring diagram and pay special attention to the positioning of the power lead (230 V or 115 V).</li> <li>D. For <b>QD Pumptec</b> is your system 230 V 60 Hz or 220 V 50 Hz?</li> </ul>
<p>If the QD Pumptec or Pumptec trips in about 4 seconds with no water delivery.</p>	<ul style="list-style-type: none"> <li>A. The pump may be airlocked. If there is a check valve on top of the pump, put another section of pipe between the pump and the check valve.</li> <li>B. The pump may be out of water.</li> <li>C. Check the valve settings. The pump may be dead-heading.</li> <li>D. Pump or motor shaft may be broken.</li> <li>E. Motor overload may be tripped. Check the motor current (amperage).</li> </ul>
<p>If the QD Pumptec or Pumptec will not timeout and reset.</p>	<ul style="list-style-type: none"> <li>A. Check switch position on side of circuit board on <b>Pumptec</b>. <b>QD Pumptec</b> check timer position on top/front of unit. Make sure the switch is not between settings.</li> <li>B. If the reset time switch is set to manual reset (position 0), <b>QD Pumptec</b> and <b>Pumptec</b> will not reset (turn power off for 5 sec. then back on to reset).</li> </ul>
<p>If your pump/motor will not run at all.</p>	<ul style="list-style-type: none"> <li>A. Check voltage.</li> <li>B. Check wiring.</li> <li>C. Remove the <b>QD Pumptec</b> from the control box. Reconnect wires in box to original state. If motor does not run the problem is not <b>QD Pumptec</b>. Bypass <b>Pumptec</b> by connecting L2 and motor lead with jumper. Motor should run. If not, the problem is not <b>Pumptec</b>.</li> <li>D. On <b>Pumptec</b> only check that <b>Pumptec</b> is installed between the control switch and the motor.</li> </ul>
<p>If your QD Pumptec or Pumptec will not trip when the pump breaks suction.</p>	<ul style="list-style-type: none"> <li>A. Be sure you have a Franklin motor.</li> <li>B. Check wiring connections. On <b>Pumptec</b> is lead power (230 V or 115 V) connected to correct terminal? Is motor lead connected to correct terminal?</li> <li>C. Check for ground fault in the motor and excessive friction in the pump.</li> <li>D. The well may be “gulping” enough water to keep <b>QD Pumptec</b> or <b>Pumptec</b> from tripping. It may be necessary to adjust the <b>QD Pumptec</b> or the <b>Pumptec</b> for these extreme applications. Call the Franklin Electric Service Hotline at 800-348-2420 for information.</li> <li>E. On <b>Pumptec</b> applications does the control box have a run capacitor? If so, <b>Pumptec</b> will not trip. (Except for Franklin 1.5 hp motors).</li> </ul>
<p>If your QD Pumptec or Pumptec chatters when running.</p>	<ul style="list-style-type: none"> <li>A. Check for low voltage.</li> <li>B. Check for waterlogged tank. Rapid cycling for any reason can cause the <b>QD Pumptec</b> or the <b>Pumptec</b> relay to chatter.</li> <li>C. On <b>Pumptec</b> make sure the L2 and motor wires are installed correctly. If they are reversed, the unit can chatter.</li> </ul>



**SubDrive2W, 75, 100, 150, 300, MonoDrive, & MonoDrive XT**

The Franklin Electric SubDrive/MonoDrive Constant Pressure controller is a variable-speed drive that delivers water at a constant pressure.

**WARNING:** Serious or fatal electrical shock may result from failure to connect the motor, SubDrive/MonoDrive Controller, metal plumbing and all other metal near the motor or cable to the power supply ground terminal using wire no smaller than motor cable wires. To reduce the risk of electrical shock, disconnect power before working on or around the water system. Capacitors inside the SubDrive/MonoDrive Controller can still hold a lethal voltage even after power has been removed. Allow 10 minutes for dangerous internal voltage to discharge. Do not use motor in swimming areas.



**SubDrive2W, 75, 100, 150, 300, MonoDrive, & MonoDrive XT**

**SubDrive/MonoDrive Troubleshooting**

Should an application or system problem occur, built-in diagnostics will protect the system. The “FAULT” light or digital display on the front of the SubDrive/MonoDrive Controller will flash a given number of times or display a number indicating the nature of the fault. In some cases, the system will shut itself off until corrective action is taken. Fault codes and their corrective actions are listed below. See SubDrive/MonoDrive Installation Manual for installation data.

NUMBER OF FLASHES OR DIGITAL DISPLAY	FAULT	POSSIBLE CAUSE	CORRECTIVE ACTION
<b>1</b>	MOTOR UNDERLOAD	<ul style="list-style-type: none"> <li>- Overpumped well</li> <li>- Broken shaft or coupling</li> <li>- Blocked screen, worn pump</li> <li>- Air/gas locked pump</li> <li>- SubDrive not set properly for pump end</li> </ul>	<ul style="list-style-type: none"> <li>- Frequency near maximum with less than 65% of expected load, 42% if DIP #3 is “on”</li> <li>- System is drawing down to pump inlet (out of water)</li> <li>- High static, light loading pump - reset DIP switch #3 to “on” for less sensitivity if not out of water</li> <li>- Check pump rotation (SubDrive only) reconnect if necessary for proper rotation</li> <li>- Air/gas locked pump - if possible, set deeper in well to reduce</li> <li>- Verify DIP switches are set properly</li> </ul>
<b>2</b>	UNDERVOLTAGE	<ul style="list-style-type: none"> <li>- Low line voltage</li> <li>- Misconnected input leads</li> </ul>	<ul style="list-style-type: none"> <li>- Line voltage low, less than approximately 150 VAC (normal operating range = 190 to 260 VAC)</li> <li>- Check incoming power connections and correct or tighten if necessary</li> <li>- Correct incoming voltage - check circuit breaker or fuses, contact power company</li> </ul>
<b>3</b>	LOCKED PUMP	<ul style="list-style-type: none"> <li>- Motor and/or pump misalignment</li> <li>- Dragging motor and/or pump</li> <li>- Abrasives in pump</li> </ul>	<ul style="list-style-type: none"> <li>- Amperage above SFL at 10 Hz</li> <li>- Remove and repair or replace as required</li> </ul>
<b>4</b> (MonoDrive & MonoDriveXT only)	INCORRECTLY WIRED	<ul style="list-style-type: none"> <li>- MonoDrive only</li> <li>- Wrong resistance values on main and start</li> </ul>	<ul style="list-style-type: none"> <li>- Wrong resistance on DC test at start</li> <li>- Check wiring, check motor size and DIP switch setting, adjust or repair as needed</li> </ul>
<b>5</b>	OPEN CIRCUIT	<ul style="list-style-type: none"> <li>- Loose connection</li> <li>- Defective motor or drop cable</li> <li>- Wrong motor</li> </ul>	<ul style="list-style-type: none"> <li>- Open reading on DC test at start.</li> <li>- Check drop cable and motor resistance, tighten output connections, repair or replace as necessary, use “dry” motor to check drive functions, if drive will not run and exhibits underload fault replace drive</li> </ul>
<b>6</b>	SHORT CIRCUIT	<ul style="list-style-type: none"> <li>- When fault is indicated immediately after power-up, short circuit due to loose connection, defective cable, splice or motor</li> </ul>	<ul style="list-style-type: none"> <li>- Amperage exceeded 50 amps on DC test at start or max amps during running</li> <li>- Incorrect output wiring, phase to phase short, phase to ground short in wiring or motor</li> <li>- If fault is present after resetting and removing motor leads, replace drive</li> </ul>
	OVER CURRENT	<ul style="list-style-type: none"> <li>- When fault is indicated while motor is running, over current due to loose debris trapped in pump</li> </ul>	<ul style="list-style-type: none"> <li>- Check pump</li> </ul>
<b>7</b>	OVERHEATED DRIVE	<ul style="list-style-type: none"> <li>- High ambient temperature</li> <li>- Direct sunlight</li> <li>- Obstruction of airflow</li> </ul>	<ul style="list-style-type: none"> <li>- Drive heat sink has exceeded max rated temperature, needs to drop below 85 °C to restart</li> <li>- Fan blocked or inoperable, ambient above 125 °F, direct sunlight, air flow blocked</li> <li>- Replace fan or relocate drive as necessary</li> </ul>
<b>8</b> (SubDrive300 only)	OVER PRESSURE	<ul style="list-style-type: none"> <li>- Improper pre-charge</li> <li>- Valve closing too fast</li> <li>- Pressure setting too close to relief valve rating</li> </ul>	<ul style="list-style-type: none"> <li>- Reset the pre-charge pressure to 70% of sensor setting. Reduce pressure setting well below relief valve rating. Use next size larger pressure tank.</li> <li>- Verify valve operation is within manufacturer’s specifications.</li> <li>- Reduce system pressure setting to a value less than pressure relief rating.</li> </ul>
<b>RAPID</b>	INTERNAL FAULT	<ul style="list-style-type: none"> <li>- A fault was found internal to drive</li> </ul>	<ul style="list-style-type: none"> <li>- Unit may require replacement. Contact your supplier.</li> </ul>
<b>9</b> (SubDrive2W only)	OVER RANGE (Values outside normal operating range)	<ul style="list-style-type: none"> <li>- Wrong hp/voltage</li> <li>- Internal fault</li> </ul>	<ul style="list-style-type: none"> <li>- Verify motor hp and voltage</li> <li>- Unit may require replacement. Contact your supplier.</li> </ul>



## SubMonitor

### SubMonitor Troubleshooting

FAULT MESSAGE	PROBLEM/CONDITION	POSSIBLE CAUSE
SF Amps Set Too High	SF Amps setting above 359 Amps.	Motor SF Amps not entered.
Phase Reversal	Reversed incoming voltage phase sequence.	Incoming power problem.
Underload	Normal line current.	Wrong SF Max Amps setting.
	Low line current.	Over pumping well. Clogged pump intake. Closed valve. Loose pump impeller. Broken shaft or coupling. Phase loss.
Overload	Normal line current.	Wrong SF Max Amps setting.
	High line current.	High or low line voltage. Ground fault. Pump or motor dragging. Motor stalled or bound pump.
Overheat	Motor temperature sensor has detected excess motor temperature.	High or low line voltage. Motor is overloaded. Excessive current unbalance. Poor motor cooling. High water temperature. Excessive electrical noise (VFD in close proximity).
Unbalance	Current difference between any two legs exceeds programmed setting.	Phase loss. Unbalanced power supply. Open Delta transformer.
Overvoltage	Line voltage exceeds programmed setting.	Unstable power supply.
Undervoltage	Line voltage below programmed setting.	Poor connection in motor power circuit. Unstable or weak power supply.
False Starts	Power has been interrupted too many times in a 10 second period.	Chattering contacts. Loose connections in motor power circuit. Arcing contacts.



## Subtrol-Plus (Obsolete - See SubMonitor)

### Subtrol-Plus - Troubleshooting After Installation

SYMPTOM	POSSIBLE CAUSE OR SOLUTION
<b>Subtrol-Plus Dead</b>	When the Subtrol-Plus reset button is depressed and released, all indicator lights should flash. If line voltage is correct at the Subtrol-Plus L1, L2, L3 terminals and the reset button does not cause lights to flash, Subtrol-Plus receiver is malfunctioning.
<b>Green Off Time Light Flashes</b>	The green light will flash and not allow operation unless both sensor coils are plugged into the receiver. If both are properly connected and it still flashes, the sensor coil or the receiver is faulty. An ohmmeter check between the two center terminals of each sensor coil connected should read less than 1 ohm, or coil is faulty. If both coils check good, receiver is faulty.
<b>Green Off Time Light On</b>	The green light is on and the Subtrol-Plus requires the specified off time before the pump can be restarted after having been turned off. If the green light is on except as described, the receiver is faulty. Note that a power interruption when the motor is running will initiate the delay function.
<b>Overheat Light On</b>	This is a normal protective function which turns off the pump when the motor reaches maximum safe temperatures. Check that amps are within the nameplate maximum on all three lines, and that the motor has proper water flow past it. If overheat trip occurs without apparent motor overheating, it may be the result of an arcing connection somewhere in the circuit or extreme noise interference on the power lines. Check with the power company or Franklin Electric. A true motor overheat trip will require at least five minutes for a motor started cold. If trips do not conform to this characteristic, suspect arcing connections, power line noise, ground fault, or SCR variable speed control equipment.
<b>Overload Light On</b>	This is a normal protective function, protecting against an overload or locked pump. Check the amps in all lines through a complete pumping cycle, and monitor whether low or unbalanced voltage may be causing high amps at particular times. If overload trip occurs without high amps, it may be caused by a faulty rating insert, receiver, or sensor coil. Recheck that the insert rating matches the motor. If it is correct, carefully remove it from the receiver by alternately lifting sides with a knife blade or thin screwdriver, and make sure it has no pins bent over. If the insert is correct and its pins are okay, replace receiver and/or sensor coils.
<b>Underload Light On</b>	This is a normal protective function. A. Make sure the rating insert is correct for the motor. B. Adjusting the underload setting as described to allow the desired range of operating conditions. Note that a DECREASE in underload setting is required to allow loading without trip. C. Check for drop in amps and delivery just before trip, indicating pump breaking suction, and for unbalanced line current. D. With the power turned off, recheck motor lead resistance to ground. A grounded lead can cause underload trip.



**Subtrol-Plus (Obsolete - See SubMonitor)**

**Subtrol-Plus - Troubleshooting After Installation (Continued)**

SYMPTOM	POSSIBLE CAUSE OR SOLUTION
<p><b>Tripped Light On</b></p>	<p>Whenever the pump is off as a result of Subtrol-Plus protective function, the red tripped light is on. A steady light indicates the Subtrol-Plus will automatically allow the pump to restart as described, and a flashing light indicates repeated trips, requiring manual reset before the pump can be restarted. Any other red light operation indicates a faulty receiver. One-half voltage on 460 V will cause tripped light on.</p>
<p><b>Control Circuit Fuse Blows</b></p>	<p>With power turned off, check for a shorted contactor coil or a grounded control circuit lead. The coil resistance should be at least 10 ohms and the circuit resistance to panel frame over 1 megohm. A standard or delay-type 2 amp fuse should be used.</p>
<p><b>Contactor Will Not Close</b></p>	<p>If proper voltage is at the control coil terminals when controls are operated to turn the pump on, but the contactor does not close, turn off power and replace the coil. If there is no voltage at the coil, trace the control circuit to determine if the fault is in the Subtrol-Plus receiver, fuse, wiring, or panel operating switches. This tracing can be done by first connecting a voltmeter at the coil terminals, and then moving the meter connections step by step along each circuit to the power source, to determine at which component the voltage is lost.</p> <p>With the Subtrol-Plus receiver powered up, with all leads disconnected from the control terminals and with an ohmmeter set at RX10, measure the resistance between the control terminals. It should measure 100 to 400 ohms. Depress and hold in the reset button. The resistance between the control terminals should measure close to infinity.</p>
<p><b>Contactor Hums or Chatters</b></p>	<p>Check that coil voltage is within 10% of rated voltage. If voltage is correct and matches line voltage, turn off power and remove the contactor magnetic assembly and check for wear, corrosion, and dirt. If voltage is erratic or lower than line voltage, trace the control circuit for faults similar to the previous item, but looking for a major drop in voltage rather than its complete loss.</p>
<p><b>Contactor Opens When Start Switch is Released</b></p>	<p>Check that the small interlocks switch on the side of the contactor closes when the contactor closes. If the switch or circuit is open, the contactor will not stay closed when the selector switch is in HAND position.</p>
<p><b>Contactor Closes But Motor Doesn't Run</b></p>	<p>Turn off power. Check the contactor contacts for dirt, corrosion, and proper closing when the contactor is closed by hand.</p>
<p><b>Signal Circuit Terminals Do Not Energize</b></p>	<p>With the Subtrol-Plus receiver powered up and all leads disconnected from the signal terminals, with an Ohmmeter set at RX10, measure the resistance between the signal terminals. Resistance should measure close to infinite. Depress and hold in the reset button. The resistance between the signal terminals should measure 100 to 400 ohms.</p>



# AIM MANUAL

## Abbreviations

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A	Amp or amperage	MCM	Thousand Circular Mils
AWG	American Wire Gauge	mm	Millimeter
BJT	Bipolar Junction Transistor	MOV	Metal Oxide Varister
°C	Degree Celsius	NEC	National Electrical Code
CB	Control Box	NEMA	National Electrical Manufacturer Association
CRC	Capacitor Run Control	Nm	Newton Meter
DI	Deionized	NPSH	Net Positive Suction Head
Dv/dt	Rise Time of the Voltage	OD	Outside Diameter
EFF	Efficiency	OL	Overload
°F	Degree Fahrenheit	PF	Power Factor
FDA	Federal Drug Administration	psi	Pounds per Square Inch
FL	Full Load	PWM	Pulse Width Modulation
ft	Foot	QD	Quick Disconnect
ft-lb	Foot Pound	R	Resistance
ft/s	Feet per Second	RMA	Return Material Authorization
GFCI	Ground Fault Circuit Interrupter	RMS	Root Mean Squared
gpm	Gallon per Minute	rpm	Revolutions per Minute
HERO	High Efficiency Reverse Osmosis	SF	Service Factor
hp	Horsepower	SFhp	Service Factor Horsepower
Hz	Hertz	S/N	Serial Number
ID	Inside Diameter	TDH	Total Dynamic Head
IGBT	Insulated Gate Bipolar Transistor	UNF	Fine Thread
in	Inch	V	Voltage
kVA	Kilovolt Amp	VAC	Voltage Alternating Current
kVAR	Kilovolt Amp Rating	VDC	Voltage Direct Current
kW	Kilowatt (1000 watts)	VFD	Variable Frequency Drive
L1, L2, L3	Line One, Line Two, Line Three	W	Watts
lb-ft	Pound Feet	XFMR	Transformer
L/min	Liter per Minute	Y-D	Wye-Delta
mA	Milliamp	Ω	ohms
max	Maximum		



**AIM MANUAL**  
**Notes**

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**AIM MANUAL**  
**Notes**

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**AIM MANUAL**  
**Notes**

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**AIM MANUAL**  
**Notes**

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**TOLL FREE HELP FROM A FRIEND**  
**800-348-2420 • 260-827-5102 (fax)**

Phone Franklin's toll free SERVICE HOTLINE for answers to your pump and motor installation questions. When you call, a Franklin expert will offer assistance in troubleshooting and provide immediate answers to your system application questions. Technical support is also available online. Visit our website at:

**[www.franklin-electric.com](http://www.franklin-electric.com)**



**Franklin Electric**

The Company You Trust Deep Down



**10E**

**Redi-Flo4 Environmental Submersible Pumps**

**Submittal Data**

**3450 RPM**

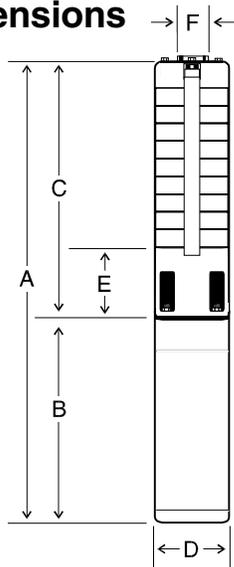
**60 Hertz**



JOB or CUSTOMER:	
ENGINEER:	
CONTRACTOR:	
SUBMITTED BY:	DATE:
APPROVED BY:	DATE:
ORDER NO:	DATE:
SPECIFICATION REF:	

QUANTITY	TAG NO.	MODEL NO.	GPM	FEET	VOLT	PHASE	COMMENTS

**Dimensions**



**Technical Data**

**FLOW RANGE:** 5 to 14 U.S. GPM

**MOTORS:** Grundfos MS402E Environmental Submersible Motor (Standard)  
 Maximum Operating Temperature: 104°F (40°C)  
 Maximum Submergence Pressure: 220 PSI  
 Maximum Number of Starts Per Hour: 100  
 Minimum Recommended Flow Past Motor: 0.25 ft./sec.

(NOTE: Franklin Pollution Recovery motor is optional.)

**DISCHARGE SIZE:** 1 1/4" NPT

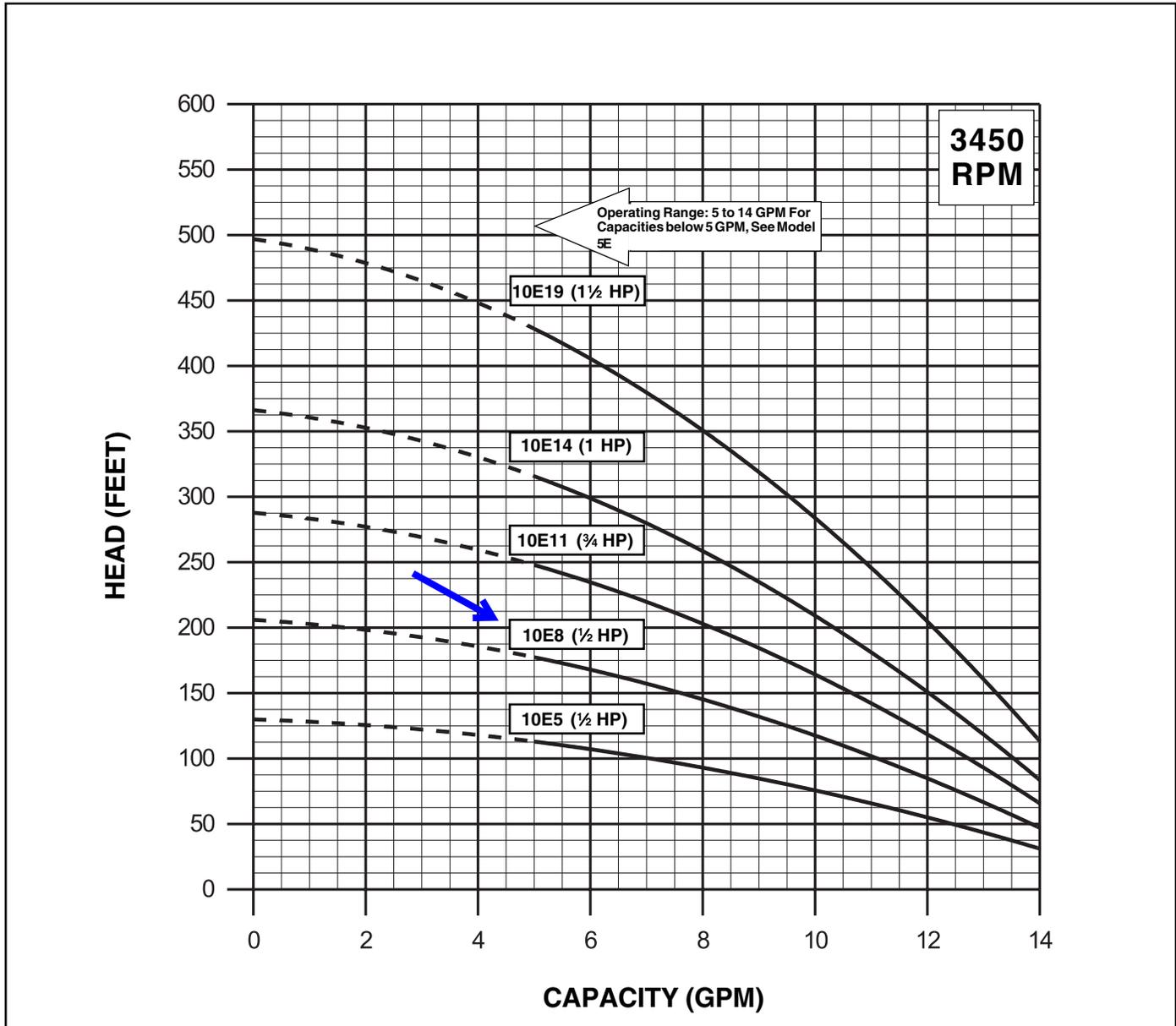
**MATERIALS OF CONSTRUCTION:** See reverse side.

**INSTALLATION:** Unit to be installed vertically for submerged operation.

**Electrical Data, Dimensions, and Weights †**

Pump Type	Motors				DIMENSIONS IN INCHES							
	HP	SF	PH	Volts	Overall Length A	Motor Length B	Pump End Length C	Max. Dia. D	Inlet E	Disch. Pipe Size (NPT) F	Net Weight (Lbs.)†	Ship. Weight (Lbs.)†
10E5	1/2	1.60	3	230	21 1/8	10 13/16	10 5/16	3 31/32	3 1/4	1 1/4	25	26
10E8	1/2	1.60	1	230	23 9/16	10 13/16	12 3/4	3 31/32	3 1/4	1 1/4	26	28
10E11	3/4	1.50	1	230	26 9/16	11 3/8	15 3/16	3 31/32	3 1/4	1 1/4	28	30
10E14	1	1.40	1	230	29 11/16	12	17 11/16	3 31/32	3 1/4	1 1/4	31	32
10E19	1 1/2	1.30	1	230	35 3/8	13 9/16	21 13/16	3 31/32	3 1/4	1 1/4	35	37

† Data for Grundfos MS402E motors. † Does not include motor leads.



## Materials of Construction

### REDI-FLO4 PUMP END

Description	Material
Check Valve Housing, Check Valve, Diffuser Chamber, Impeller, Suction Interconnector, Inlet Screen, Pump Shaft, Straps, Cable Guard, Priming Inducer	304 SS
Check Valve Seat	304 SS & Teflon®
Impeller Seal Ring	Teflon®
Coupling	316/431 SS
Intermediate Bearings	Teflon®

### GRUNDFOS ENVIRONMENTAL MOTOR LEADS

Description	Material
Connector Sleeve	304 SS
Connector Potting	Scotch Cast #4® Epoxy w/FPM Cap
Connector Plug	FPM
Lead Insulation	Teflon®
Conductor	Stranded Copper, 12 AWG

**NOTES:** Specifications are subject to change without notice.  
 Teflon® is a registered trademark of DuPont.  
 Scotch Cast #4® is a registered trademark of 3M Company.

### GRUNDFOS ENVIRONMENTAL MOTOR

Description	Material
NEMA Top, Studs & Fasteners, Stator Housing, Fill Plug Screw	304 SS
Nuts	316 SS
Sand Slinger	FPM
Shaft Extension	431 SS
Diaphragm	FPM
Fill Plug Washer	Teflon®



**GRUNDFOS Pumps Corporation** • 3131 N. Business Park Ave. Fresno, CA 93727  
 Customer Service Centers: Allentown, PA • Fresno, CA  
 Phone: (800)333-1366 • Fax: (800)333-1363  
 Canada: Oakville, Ontario • Mexico: Apodaca, N.L.



**NES Project: 12-133**  
**GWT – Cargo Box**  
**AECOM – Textron Providence, RI**

***Section 8 - Groundwater Treatment Components***

Manifold Magmeters - GF Signet Model 3-2551-P0-42

Magmeter Installation Tees, 1" - GF Signet Model MPV8T010

High Pressure Switch - Dwyer Model CS-150

Bag Filter Housings - Pentek Model 156112-75

Air Stripper, SS, 6-Tray (Refurbished) - QED Model EZ Tray 8.6SS

AS Sump Level Transmitter - Gems Model XT800-3-BR-BN-13-11.5-7.1300-J-H-COLLARS

AS Sump E-High Level Switch - Gems Model MYEL40T

AS Regenerative Blower - FPZ Model SCL K10-MS-10-3

Blower Inlet Filter, 4" - Solberg Model FS-235P-400

Bleed Filter/Silencer, 2" - Solberg Model FS-31P-200

Blower High Pressure Switch - Dwyer Model 1950P-2-2F

Blower Low Pressure Switch - Dwyer Model 1950-20-2F

AS Tray Differential Pressure Indicator - Dwyer Model 2050

Blower Flowmeter Pitot Tube, 6in - Dwyer Model DS-300-6

Pitot Tube Mag Gauge - Dwyer Model 2001

Vapor Phase Carbon Vessels, 1000lb (Refurbished) - Calgon Model V-1M

AS Centrifugal Transfer Pump - Goulds Model 1ST1G5B4

High Pressure Switch - Dwyer Model CS-150

Bag Filter Housings - Pentek Model 156112-75

Mechanical Flowmeter / Totalizer, 1" - Neptune Model T10-1

Modified Zeolite Vessel - Tetrasolv Model AF-500

8x14 Modified Zeolite - Hydrosil Model HS-200

LGAC Vessel - Tetrasolv Model AF-500

Discharge Magmeter - GF Signet Model 3-2551-P0-42

Magmeter Installation Tee, 1" - GF Signet Model MPV8T010



# Georg Fischer Signet LLC

## Signet 2551 Magmeter

### Certificate of Calibration and Conformance

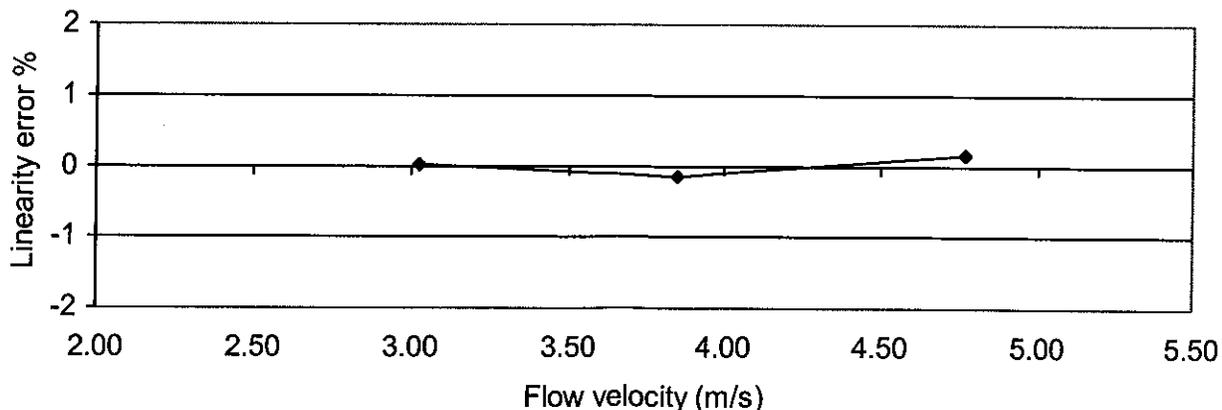
#### Part information

Part number: 3-2551-P0-42  
Type: PP/316L SS; mA output  
Serial number: 61211290477  
Calibration date: November 29, 2012

#### Test conditions

Test media: Water  
Pipe type: SYGEF PVDF d50  
Pipe fitting: PVDF Tee d50, SFMT015  
Output jumper: S<sup>3</sup>L (applies to 3-2551-XX-X1 only)  
Pipe size jumper: Off

Flow Velocity ft/s (m/s)	Reynolds Number	Linearity (% of reading)
9.92 (3.02)	124431.79	0.01
12.63 (3.85)	158555.71	-0.15
15.64 (4.77)	196475.61	0.15



Refer to Signet 2551 Magmeter manual (PN 3-2551.090 or 3-2551.090-1) for technical specification. Reference flowmeter calibration is traceable to NIST and certified at preset intervals.

Georg Fischer Signet LLC  
3401 Aerojet Avenue  
El Monte, CA 91731-2882  
www.gfsignet.com

# Georg Fischer Signet LLC

## Signet 2551 Magmeter

### Certificate of Calibration and Conformance

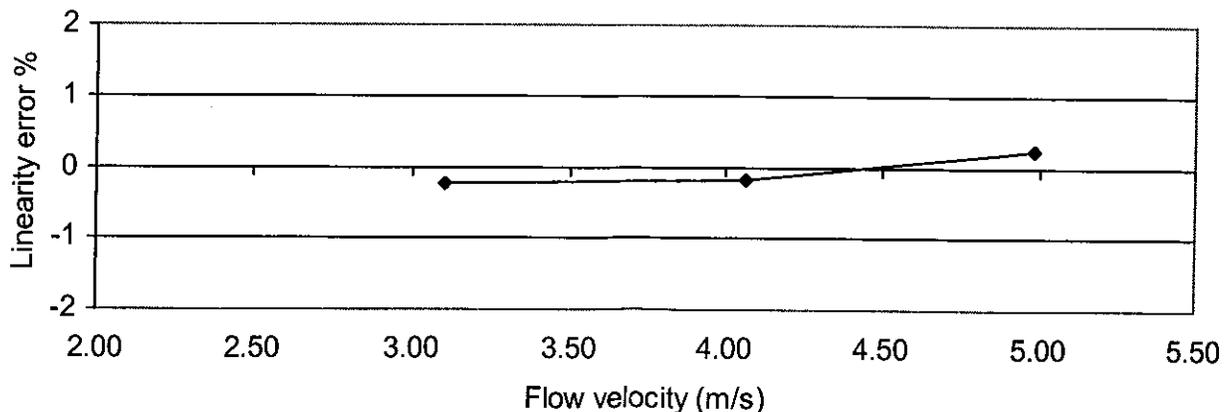
#### Part information

Part number: 3-2551-P0-42  
Type: PP/316L SS; mA output  
Serial number: 61303210070  
Calibration date: March 21, 2013

#### Test conditions

Test media: Water  
Pipe type: SYGEF PVDF d50  
Pipe fitting: PVDF Tee d50, SFMT015  
Output jumper: S<sup>3</sup>L (applies to 3-2551-XX-X1 only)  
Pipe size jumper: Off

Flow Velocity ft/s (m/s)	Reynolds Number	Linearity (% of reading)
10.17 (3.10)	133464.54	-0.25
13.33 (4.06)	175357.09	-0.17
16.34 (4.98)	215171.54	0.25



Refer to Signet 2551 Magmeter manual (PN 3-2551.090 or 3-2551.090-1) for technical specification. Reference flowmeter calibration is traceable to NIST and certified at preset intervals.

# Georg Fischer Signet LLC Signet 2551 Magmeter



## Certificate of Calibration and Conformance

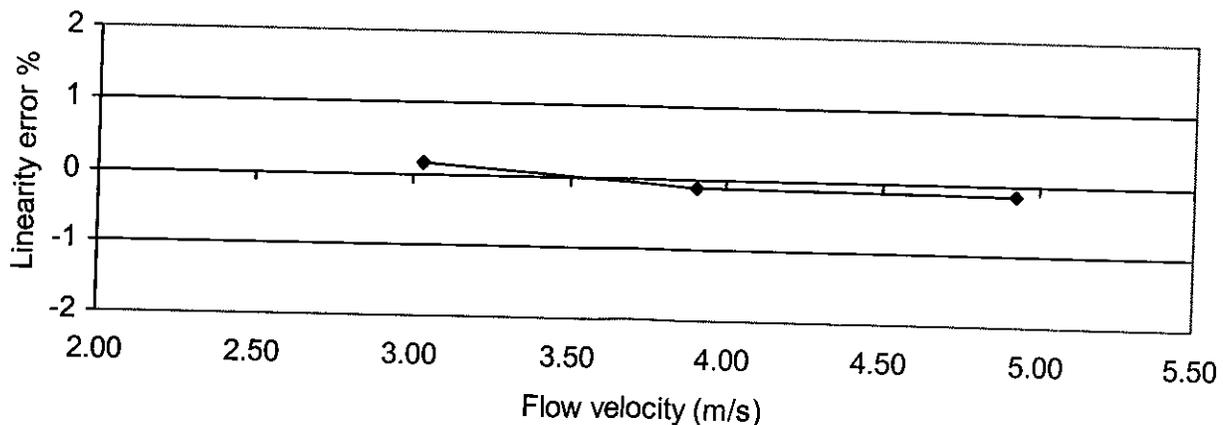
### Part information

Part number: 3-2551-P0-42  
Type: PP/316L SS; mA output  
Serial number: 61212120425  
Calibration date: December 12, 2012

### Test conditions

Test media: Water  
Pipe type: SYGEF PVDF d50  
Pipe fitting: PVDF Tee d50, SFMT015  
Output jumper: S<sup>3</sup>L (applies to 3-2551-XX-X1 only)  
Pipe size jumper: Off

Flow Velocity ft/s (m/s)	Reynolds Number	Linearity (% of reading)
9.94 (3.03)	126476.01	0.16
12.82 (3.91)	163348.82	-0.13
16.16 (4.92)	206137.29	-0.16



Refer to Signet 2551 Magmeter manual (PN 3-2551.090 or 3-2551.090-1) for technical specification.  
Reference flowmeter calibration is traceable to NIST and certified at preset intervals.

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3401 Aerojet Avenue  
El Monte, CA 91731-2882  
www.gfsignet.com



## SAFETY INSTRUCTIONS

1. Depressurize and vent system prior to installation or removal.
2. Confirm chemical compatibility before use.
3. Do not exceed maximum temperature/pressure specifications.
4. Wear safety goggles or faceshield during installation/service.
5. Do not alter product construction.



## 1. Description

The 2551 Magmeter measures the flow rate in a full pipe by monitoring the voltage produced when the (conductive) fluid moves through a magnetic field. Output options include a traditional frequency signal, a serial data (Digital (S<sup>3</sup>L)) output, and a 4 to 20 mA output.

The 2551 Magmeter is available in three sizes that will accommodate pipes from ½-inch through 36-inch diameters.

Select from three different material combinations to match the Magmeter to the application requirements.

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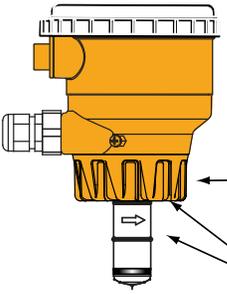


**WARNING!**

FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN THE SENSOR BEING EJECTED FROM THE PIPE!

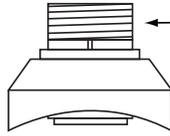
- DO NOT USE ANY TOOLS ON THE RETAINING CAP. HAND TIGHTEN ONLY.
- LUBRICATE O-RINGS WITH A NON-PETROLEUM BASED, VISCOUS LUBRICANT (GREASE) COMPATIBLE WITH THE SYSTEM.
- DO NOT USE THREAD SEALANT OR LUBRICANTS ON THE RETAINING CAP OR ON THE PLASTIC FITTING THREADS.
- IF LEAKING IS OBSERVED FROM THE RETAINING CAP, IT INDICATES DEFECTIVE OR WORN O-RINGS ON THE SENSOR. DO NOT ATTEMPT TO CORRECT BY FURTHER TIGHTENING.





Do not use any tools to tighten the yellow retaining cap. DO NOT USE thread sealant or lubricants on retaining cap!

Lubricate O-rings with a non-petroleum based, viscous lubricant (grease) compatible with the system.



DO NOT USE thread sealant or lubricants on the fitting threads!

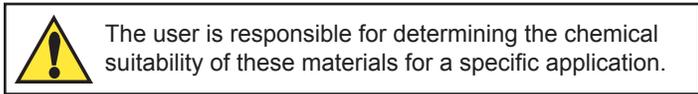
## 2. Specifications

### General

- Pipe size range: DN15 to DN900 (½ to 36 in.)
- Flow Range: Minimum: 0.05 ms (0.15 ft/s) Maximum: 10 ms (33 ft/s)
- (Bi-directional)
- Linearity: ±1% of reading +0.01 ms (0.033 ft/s)
- Repeatability: ±0.5% of reading @ 25 °C (77 °F)
- Minimum Conductivity: 20 µS/cm

### Wetted Materials:

- Sensor body and Electrodes and Grounding ring:
  - -P0, -P1, -P2: Polypropylene and 316L SS
  - -T0, -T1, -T2: PVDF and Titanium
  - -V0, -V1, -V2: PVDF and Hastelloy-C
  - O-rings: FPM (standard) EPDM, FFFPM (optional)



### Power Requirements

- 4 to 20 mA: 21.6 to 26.4 VDC, 22.1 mA max. 400 mV p-p maximum ripple voltage
- Frequency: 5 to 26.4 VDC, 15 mA max.
- Digital: 5 to 6.5 VDC, 15 mA max.
- Auxiliary (only required for units with relays): 9 to 24 VDC, 0.4A max
- Reverse polarity and short circuit protected

### Output Specifications

#### Current output (4 to 20 mA)

- Max Loop Resistance: 300 Ω
- Loop Accuracy: 32 µA max. error (25 °C @ 24 VDC) ± 1 µA per °C max.
- Temp. drift: ± 1 µA per °C max.
- Power supply rejection: ± 1 µA per V
- Isolation: Low voltage < 48 VAC/DC from electrodes and aux power
- Maximum cable: 300 m (1000 ft.)
- Error condition: 22.1 mA

#### Frequency output:

- Output modes: Freq, Freq+10, or Mirror Relay 1
- Max. Pullup Voltage: 30 VDC
- Max. Current Sink: 50 mA, current limited
- Maximum cable: 300 m (1000 ft.)
- Reverse Polarity Protected to -40 V

#### Digital (S<sup>3</sup>L) Output:

- Serial ASCII, TTL level 9600 bps
- Compatible with Signet 8900 and 9900

### Relay Specifications

- Relay 1 and 2 Type: Mechanical SPDT
  - Rating: 5 A @ 30 VDC max., 5 A @ 250 VAC max.
- Relay 3 Type: Solid State
  - Rating: 50 mA @ 30 VDC, 50 mA @ 42 VAC
- Hysteresis: Adjustable, plus timer delay
- Trigger Delay: Adjustable (0 to 9999.9 sec.)
- Relay Modes: Off, Low, High, Window, and Proportional Pulse
- Relay Source: Flow Rate, Resettable Totalizer
- Error Condition: Selectable; Fail Open or Fail Closed

### Display

- Characters: 2 x 16
- Contrast: User-set in four levels
- Backlighting (only on relay versions): Requires external 9-24 VDC, 0.4 mA max.

### Environmental Requirements

- Case: PBT
- Display window: Polyamide
- Storage Temperature: -20 to 70 °C (-4 to 158 °F)
- Relative Humidity: 0 to 95% (non-condensing)
- Operating Temperature
  - Ambient: -10 to 70 °C (14 to 158 °F)
  - Media: 0 to 85 °C (32 to 185 °F)
- Max. operating pressure:
  - 10.3 bar @ 25 °C (150 psi @ 77 °F)
  - 1.4 bar @ 85 °C (20 psi @ 185 °F)

### Standards and Approvals

- CE
- UL, CUL (for display versions with relays)
- NEMA 4X / IP65 Enclosure (with cap installed)



China RoHS

For more information go to [www.gfsignet.com](http://www.gfsignet.com)



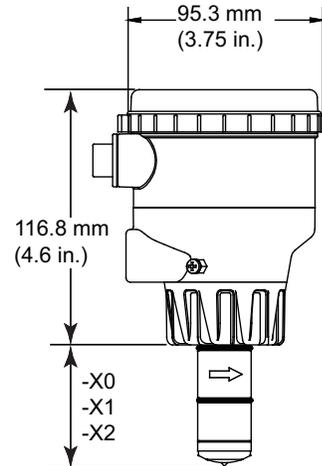
### Declaration of Conformity according to FCC Part 15

This device complies with Part 15 of the FCC rules.

Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and,
- (2) This device must accept any interference received, including interference that may cause undesired operation.

### Dimensions

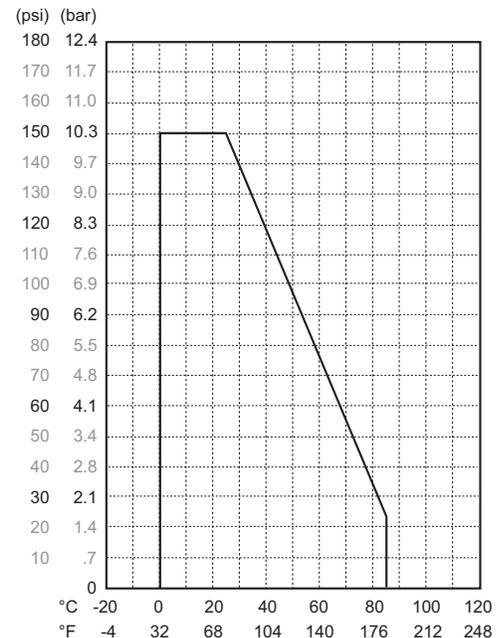


#### Pipe Range

- 1/2 to 4 in. -X0 = 58 mm (2.3 in.)
- 5 to 8 in. -X1 = 91 mm (3.6 in.)
- 10 to 36 in. -X2 = 167 mm (6.6 in.)

X = Sensor Body P, T, or V

### Operating Temperature/Pressure



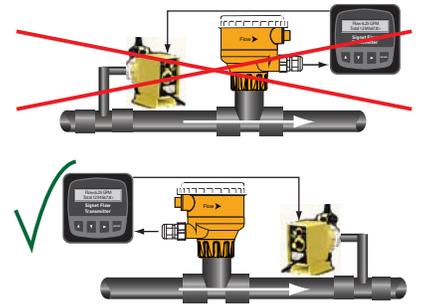
### 3. Installation: Pipe Fittings

Georg Fischer offers a wide selection of installation fittings that control the position of the Magmeter electrodes in relation to the dimensions of the pipe. You will find a complete list of order numbers for installation fittings in the Calibration Tables on pages 12-13.

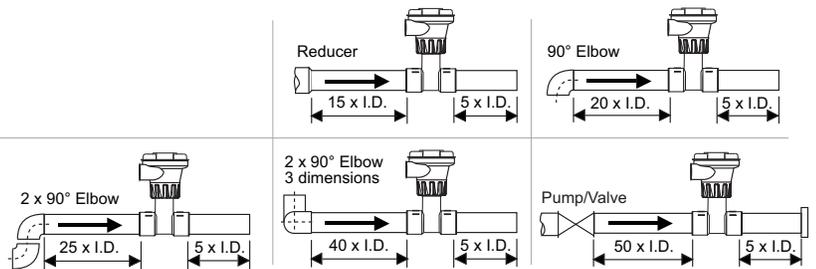
Type	Description	Type	Description
Plastic tees 	<ul style="list-style-type: none"> <li>• 0.5 to 2 inch versions</li> <li>• MPVC or CPVC</li> </ul>	Iron, Carbon Steel, 316 SS Threaded tees 	<ul style="list-style-type: none"> <li>• 0.5 to 2 in. versions</li> <li>• Mounts on threaded pipe ends</li> </ul>
PVC Glue-on Saddles 	<ul style="list-style-type: none"> <li>• Available in 10 and 12 inch sizes only</li> <li>• Cut 2-1/2 inch hole in pipe</li> <li>• Weld in place using solvent cement</li> </ul>	Carbon steel & stainless steel Weld-on Weldolets 	<ul style="list-style-type: none"> <li>• 2 to 4 inch, cut 1-7/16 inch hole in pipe</li> <li>• Over 4 inch, cut 2-1/8 inch hole in pipe</li> </ul>
PVC Clamp-on Saddles 	<ul style="list-style-type: none"> <li>• 2 to 4 inch, cut 1-7/16 inch hole in pipe</li> <li>• 6 to 8 inch, cut 2-1/8 inch hole in pipe</li> </ul>	Fiberglass tees 	<ul style="list-style-type: none"> <li>• 1.5 in. to 2 in. PVDF insert</li> </ul>
Iron Strap-on saddles 	<ul style="list-style-type: none"> <li>• 2 to 4 inch, cut 1-7/16 inch hole in pipe</li> <li>• Over 4 inch, cut 2-1/8 inch hole in pipe</li> <li>• Special order 14 in. to 36 in.</li> </ul>	Union Fittings and Wafers 	<ul style="list-style-type: none"> <li>• For pipes from DN 15 to 50 mm</li> <li>• PP or PVDF</li> </ul>

#### 3.1 Installation: Selecting a Location

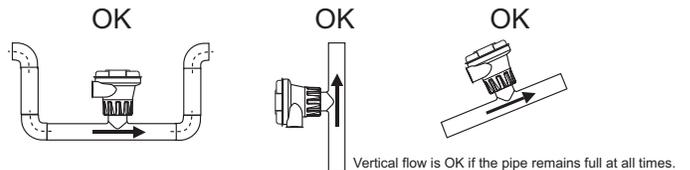
- The 2551 requires a full pipe and a fully developed turbulent flow profile for accurate measurement.
- If the piping system harbors air pockets or bubbles, take steps to locate the sensor so the air pockets will not contact the electrodes.
- In vertical installations, assemble the 2551 so the conduit ports are facing downward. This prevents condensation inside the conduit from being directed into the 2551 electronics housing.
- Chemical injection systems can temporarily alter the fluid conductivity and cause anomalies in the magmeter measurement. To avoid this problem, install the magmeter UPSTREAM of the injection point.



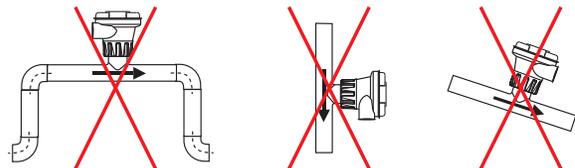
Select a location with sufficient distance of straight pipe immediately upstream of the sensor.



Locating the sensor in a trap or where the flow is upward helps to protect the sensor from exposure to air bubbles when the system is in operation.

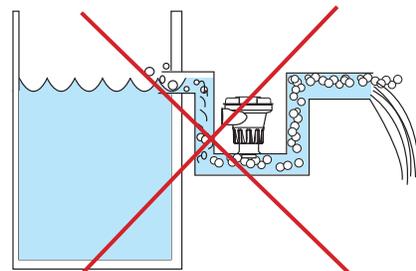


These configurations are not recommended because it is difficult to keep the pipe full.



In a gravity-flow system, the tank must be designed so the level does not drop below the outlet.

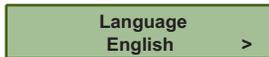
This causes the pipe to draw air in from the tank. If air bubbles pass across the Magmeter electrodes, the output will become erratic.



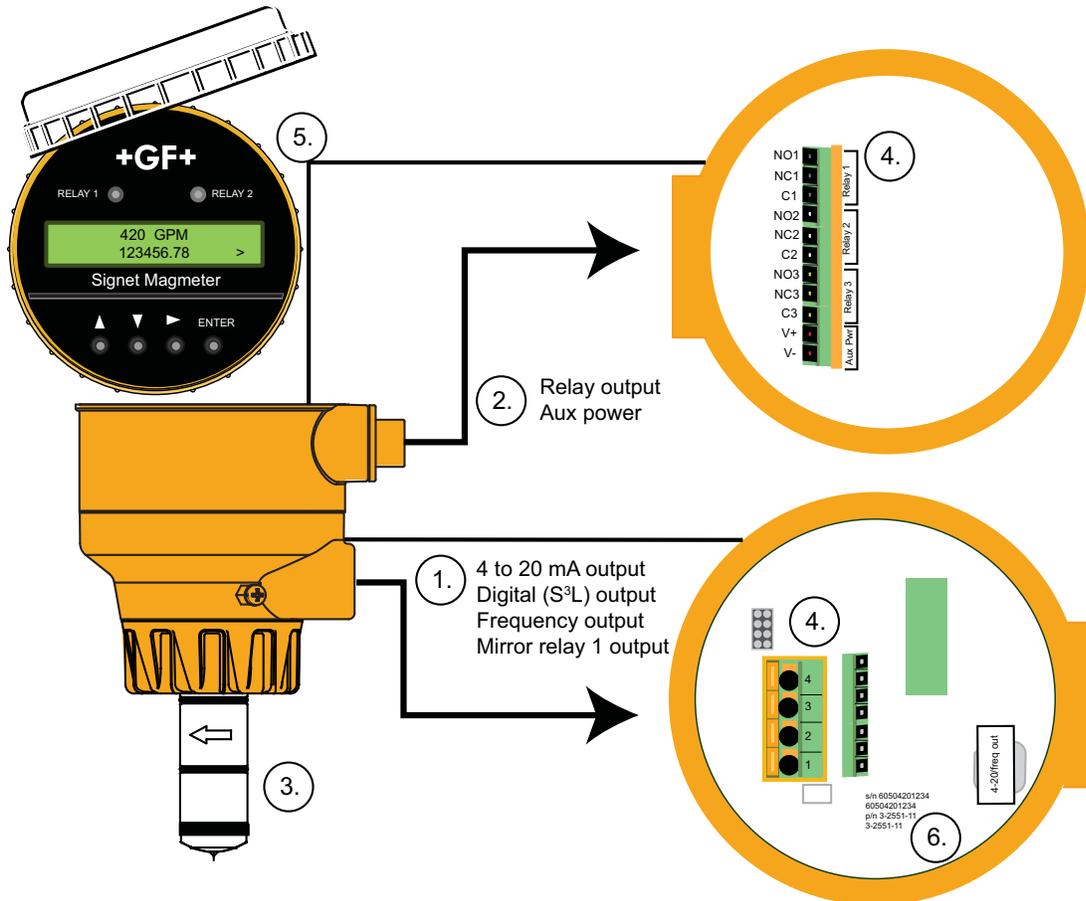
## 4. Overview of 2551 Display Magmeter

2551 Display Magmeters use a dual-sided electronics module and dual conduit ports. Unused ports must be sealed to protect the electronics from water damage.

- ① The lower set of conduit ports provide access to the wiring terminals for:
  - Loop Power
  - Flow Output Signal (current loop, Digital (S<sup>3</sup>L), frequency or Mirror Relay 1 output).
- ② The upper set of conduit ports provide access to the wiring terminals for:
  - Relay output wiring
  - Auxiliary power for relay coils and display backlight
- ③ The sensor is marked with a directional arrow to indicate the direction identified as forward flow.
  - An adhesive decal is also provided that can be affixed to the pipe to indicate the direction of forward flow.
  - Flow in the opposite direction from the arrow will be identified as reverse flow on the display by a "-" symbol.
- ④ The terminals in the magmeter are designed to accommodate 16 to 22 AWG conductors.
- ⑤ The display includes two LEDs that light when Relay 1 or Relay 2 are activated.
  - All three relays can be monitored by scrolling to the Relay Status display located in the View menu.
  - If the Language option has not been made, new magmeters will always open with the Select Language display.



- ⑥ The part number, serial number and output type are identified on the electronics module.



### Chemical Compatibility Warning

The retaining nuts of Magmeters are not designed for prolonged contact with aggressive substances. Strong acids, caustic substances and solvents or their vapor may lead to failure of the retaining nut, ejection of the sensor and loss of the process fluid with possibly serious consequences, such as damage to equipment and serious personal injury. Retaining nuts that may have been in contact with such substances e.g. due to leakage or spilling, must be replaced.

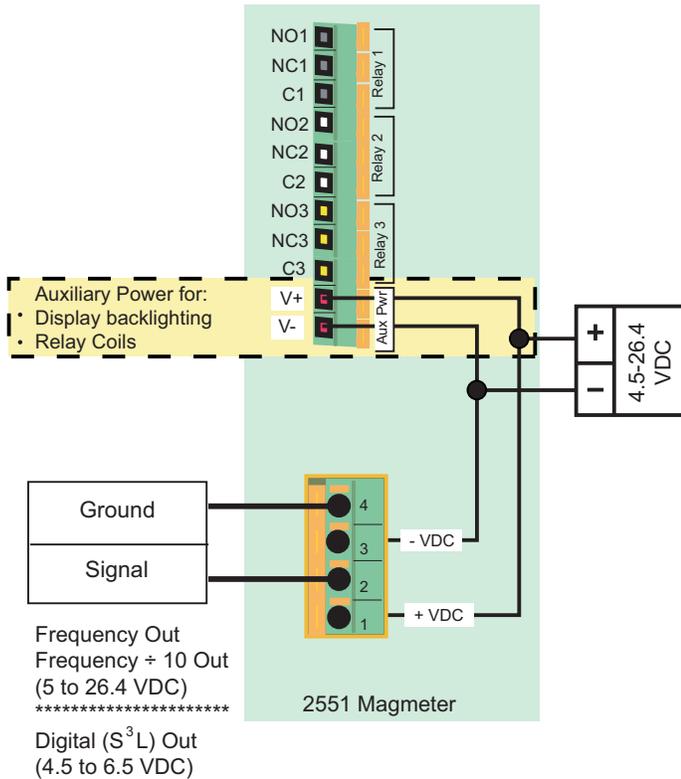
## 5. Wiring

### 5.1 Basic Wiring

#### Frequency output

3-2551-21 and -41 Magmeters may be programmed in the OPTIONS menu to provide an open collector FREQUENCY output.

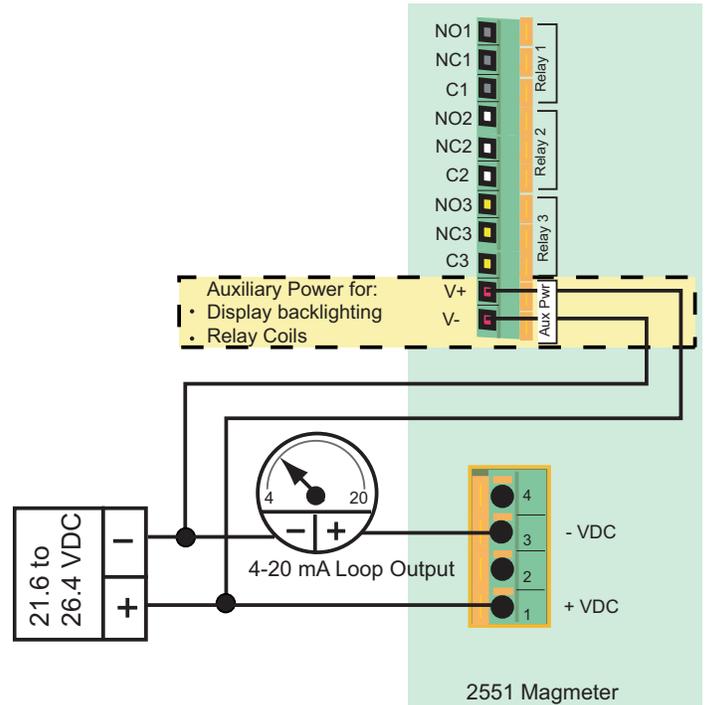
- The maximum frequency output is 1000 Hz (@ 10 meters per second)
- If the Frequency ÷ 10 output is selected, the maximum frequency is 100 Hz (@ 10 meters per second).
- AUX PWR must be connected to power the display backlighting and to power the relay coils if included.



#### 4 to 20 mA output

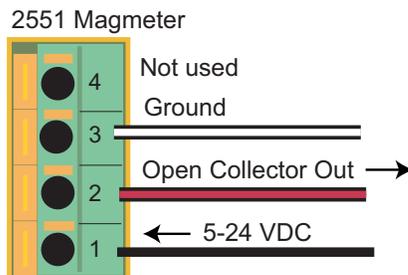
The 3-2551-22 and -42 Magmeters provide a passive 4 to 20 mA loop output.

- External loop power (24 VDC) is required.
- Factory standard calibration is 4 - 20 mA = 0 - 5 m/s.
- The 4 to 20 mA output can be spanned to any range, from -10 m/s to +10 m/s.
- AUX PWR must be connected to power the display backlighting and to power to the relay coils if included.



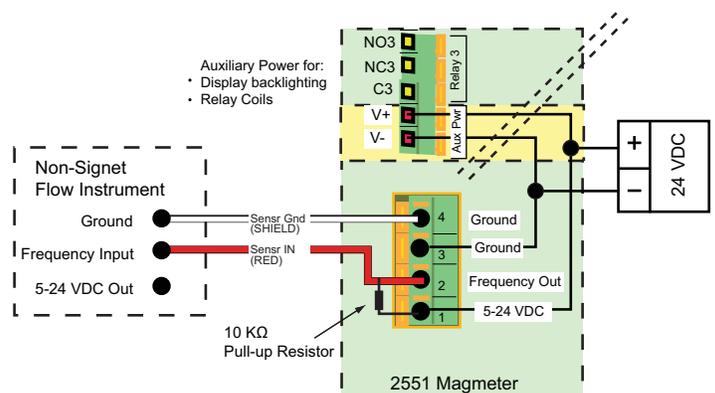
### 5.2 Wiring: Mirror Relay 1 output

The 3-2551-21 and -41 Magmeter can be configured in the OPTIONS menu to provide an Open Collector output in lieu of the sensor signal provided by Frequency or Digital (S<sup>3</sup>L) output selections. The Open Collector output can be programmed via the Relay 1 menu.



### 5.3 2551 and other manufacturer's instruments

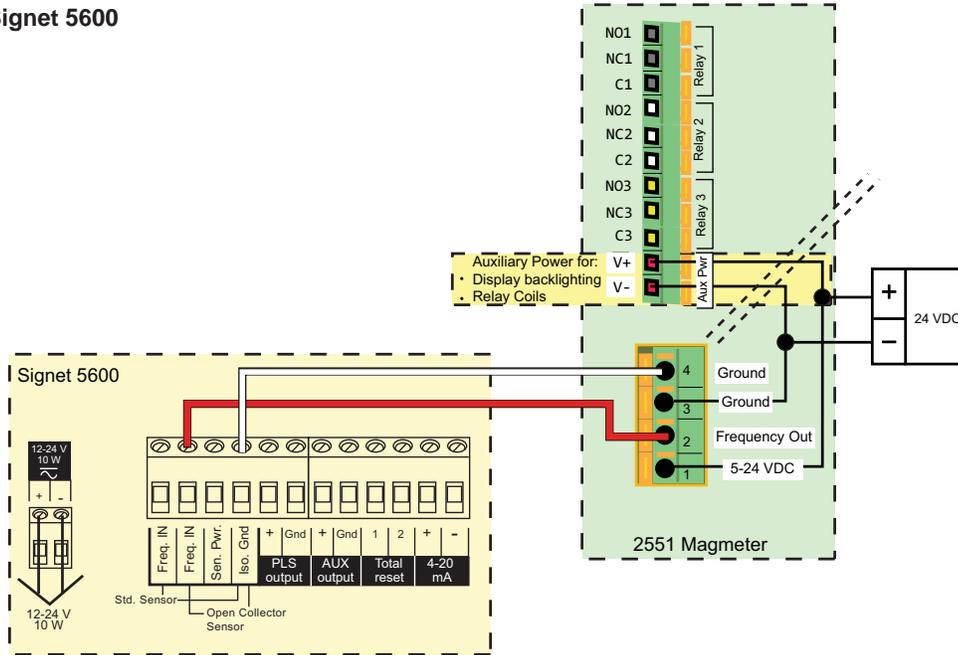
When using the 2551 in a system with other manufacturer's equipment, a 10 KΩ pull-up resistor (not supplied) may be required to power the open collector output.



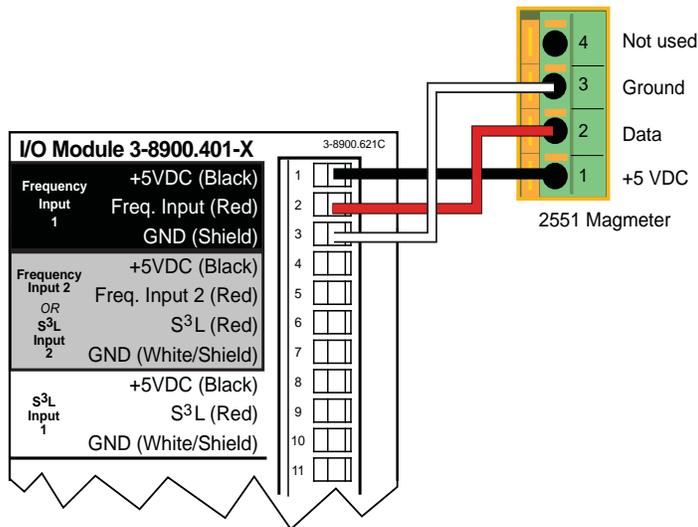
## 5.4 Wiring to Signet Flow Instruments

The 2551-21 and -41 Magmeter can be configured in the OPTIONS menu to provide a Frequency or Digital (S<sup>3</sup>L) output. Frequency output can be used by Signet 5600 Flow Transmitter, and by Signet 8900 Multi-Parameter Controller and 9900 Transmitter. The Digital (S<sup>3</sup>L) output can be used by the 8900 and 9900.

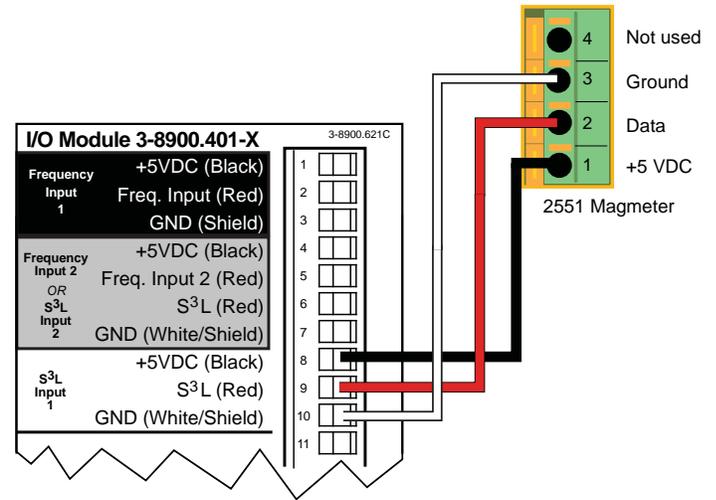
### 2551 Frequency Out to Signet 5600



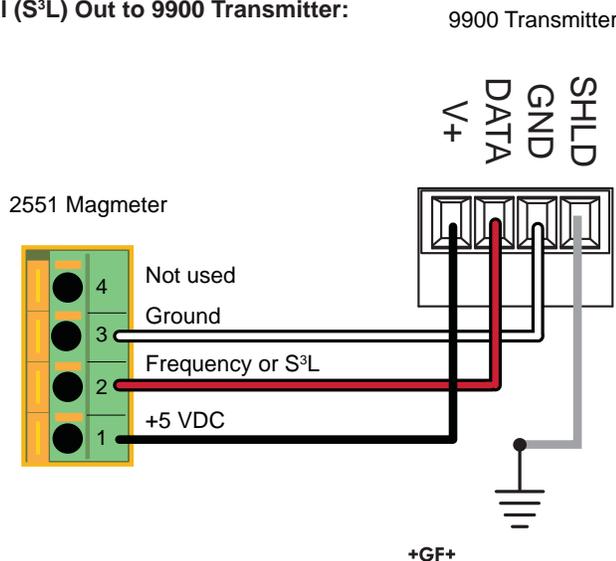
### 2551 Frequency Out to 8900 Controller:



### 2551 Digital (S<sup>3</sup>L) Out to 8900 Controller:



### 2551 Frequency or Digital (S<sup>3</sup>L) Out to 9900 Transmitter:



## 5.5 Wiring Relays

Relay 1, Relay 2 Type: Mechanical SPDT  
 Rating: 5A @ 30 VDC max., 5 A @ 250 VAC max

Relays 1 and 2 are dry contact relays rated for 5 A maximum current. They are best suited for switching high voltage loads, such as AC powered pumps and valves.

When used to switch inductive loads, dry contact relays may be damaged by arcing. Signet recommends the installation of a filter device to prevent such damage.

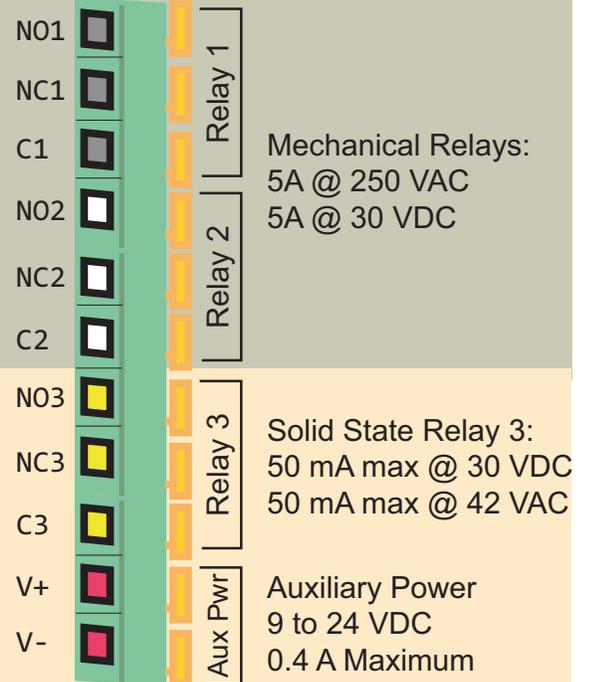
3-8050.396      159 000 617      RC Filter kit (for relay use)

Relay 3 Type: Solid State  
 Rating: 50 mA @ 30 VDC, 50 mA @ 42 VAC

Relay 3 is a solid state relay. It can be applied exactly the same as a dry contact relay, but the current rating is 0.2 A (200 mA) maximum. Relay 3 is best suited to pulse applications and low voltage loads.



Auxiliary power must be connected to operate the relays and to power the display backlighting. Auxiliary power is fully isolated. The Loop Power supply may be used for Aux power if the power source provides a sufficient current rating.



**Relay Terminal Legend:**  
**NO:** Normally Open  
**NC:** Normally Closed  
**C:** Common

### Application Notes: Relay Wiring

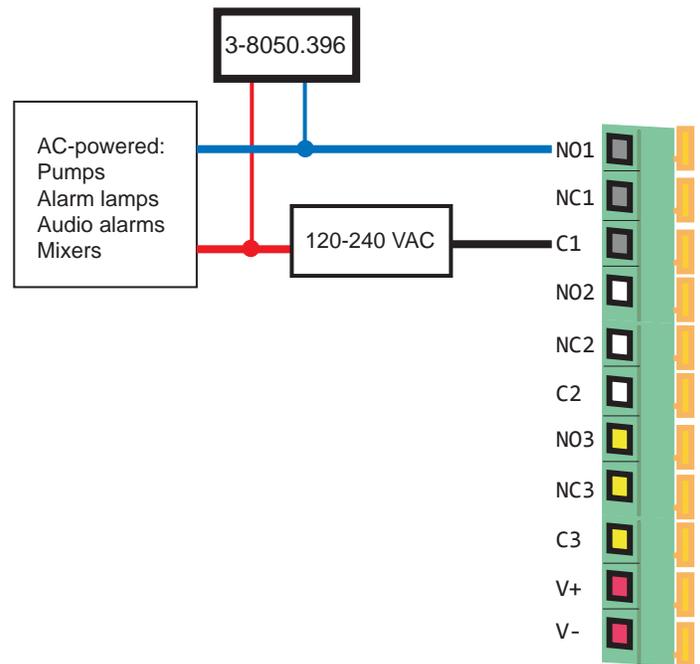
- Inductive relay loads may generate transient voltage spikes well in excess of the relay contact ratings. This will cause arcing across the contacts and consequently rapid relay wear. Signet recommends an RC-style filter ("snubber"), installed as illustrated here.
- The filter kit (3-8050.396) is available as an accessory item. See ordering information on back cover.
- Signet product warranty does not cover damage to relays due to contact burnout.

#### Definition:

An **inductive load** is an electrical device generally made of wire that is coiled to create a magnetic field to produce mechanical work when energized.

Examples of inductive loads include motors, solenoids, and relays.

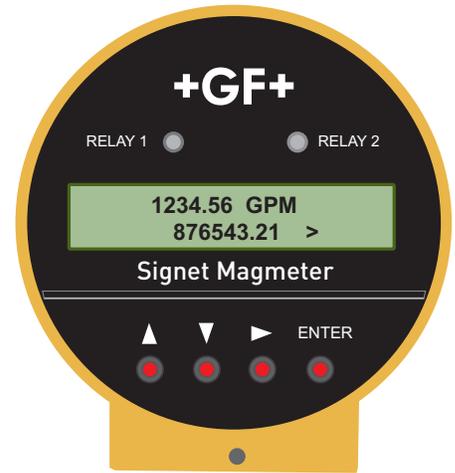
High voltage transients from these types of loads can cause arcing across mechanical switching contacts or can cause damage to solid-state contacts.



## 6. View Menu

The VIEW menu contains all of the basic information available from the Magmeter.

- The normal operating display shows the FLOW RATE on the top line of the display and the Resettable Totalizer on the lower line of the display.
- The Right Prompt symbol (>) always indicates a sub-menu associated with the current display. In this display it points the way to the TOTALIZER RESET function. See section 6.1 for detailed instructions.
- With AUXILIARY power connected to the magmeters with Relays, the display will be backlit. There is no switch to turn the backlight off.
-  A flashing character or text on the display indicates that the item is being edited. This manual uses a (red) star to illustrate a flashing display.
- The following information is viewed by scrolling ▲ or ▼. These displays will remain in the display for 10 minutes, then the normal operating display will return.



Show the permanent total. This totalizer cannot be reset.



Shows the current output. For 4 to 20 mA Output models only.



Relay States shown for units with a relay board.



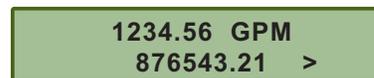
This display is a reminder to visit the Signet website for updates and information about Signet products.



Enter menus from this display. See section 6.2.



### 6.1 Resetting the Resettable Totalizer



1. From the normal operating display, press the ► key.
2. The resettable totalizer can be configured to require the security code before allowing the reset. If the Total Reset is set to "RESET OFF" this display will not appear. See section 11, Options Menu for instructions.
3. Press any arrow key to toggle the flashing selection from NO to YES.
4. Press the ENTER key. The totalizer will reset to all zeroes and the display will immediately return to the normal operating display.

## 6.2 Navigating the Menus

### Normal Operation Display

The normal operating display shows the Flow Rate on the top line and the Resettable Totalizer on the bottom line.

- All menu instructions in this manual assume that the instrument is showing this display.

### 2551 Menu Directory

The 2551 Magmeter uses seven main menus to provide access to the calibration and programming features. Each menu serves a specific function.

Starting from the normal operating display, there are two ways to access the menus:

- Press the ▲ key to scroll to the Enter Menu display, then press the ► key.
- Press the ENTER key and hold it for about three seconds.

### Setup Menu

This menu contains all of the settings and information that the magmeter requires to operate, including the K-Factor, the totalizer settings, low flow cutoff, and several display characteristics. See section 7.0 for details related to this menu.

### Calibration Menu

This menu provides two different methods for adjusting the calibration. See section 8.0 for details related to this menu.

### Relay Menus

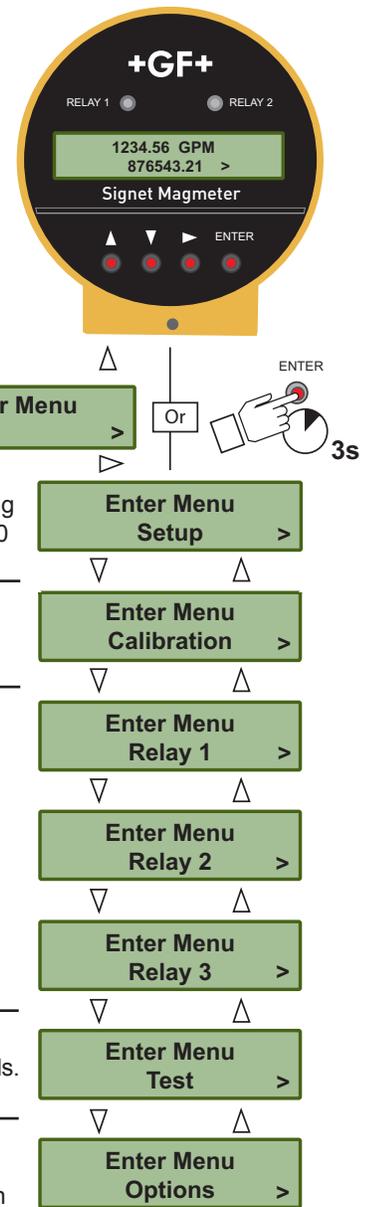
Each of the available relays in the 2551-21 and -22 are programmed from their own dedicated menu. See section 9 for details related to these menus. **NOTE:** Menu items associated with Relays 2 and 3 are suppressed in models without relays. See section 9.0 for details related to this menu.

### Test Menu

This menu is used to manually toggle relays or to induce a known value out of the 4 to 20 mA terminals. See section 10.0 for details related to this menu.

### Options Menu

This menu contains those settings and values that are usually programmed during the initial installation, and then seldom modified, including the SECURITY CODE (see section 6.4). See section 11.0 for details related to the Options menu.



## 6.3 Keypad Functions



Scrolls UP through any menu.  
If the display shows any flashing character or selection, scrolls UP to the previous value or selection.



Scrolls DOWN through any menu.  
If the display shows any flashing character or selection, scrolls DOWN to the next value or selection.



Press the ▲ and ▼ keys together to abandon any unsaved edits and return to the previous display.



Opens the menu currently being displayed.  
In Edit modes, advances the flashing character.  
In menus with only two options (Yes or No, On or Off) toggles between selections.

ENTER Saves a new selection in any menu.  
From Normal Operation display, jumps to first selection in Menu directory (when held for three seconds)

## 6.4 Security Code

The 2551 has a security code that can be programmed to any four-digit numerical value.

- The factory setting is 0-0-0-0.
- To program the security code go to the Options menu.
- The security code will be required to edit any of the items in the menus. It is required only once for each editing session.
- Record the custom security code here or in a safe location.
- If the security code is lost, contact your Signet service center for instructions.



Security Code \_\_\_\_\_

**WRITE IT DOWN!**

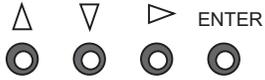
## 7. Setup Menu

The Setup menu contains all of the parameters necessary for the 2551 Magmeter to begin measuring flow.

**NOTE:** The Security Code must be entered before any changes can be made to the Setup menu. See the Options menu in section 11 for details.



Use the keypad to navigate through each setting.

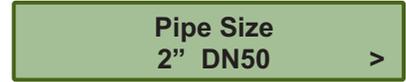


The values shown for each menu item represent the factory standard setting. All 2551 magmeters are packaged with these settings.

**K-Factor:** See the charts in section 7.3 for values in pulses per U.S. gallon or in pulses per liter. To use other units, convert the published values as appropriate.



**Pipe Size:** Select the pipe size that is nearest to the nominal pipe size.



**Flow Units:** Set the units for the application. Four characters are available. The first three characters can be set to any symbol or alpha character, upper or lower case. The following special symbols are located between the upper case and lower case menus:

- (centered dot)      μ (micro)      \_ (blank)
- (dash)              / (slash)        3 (for cubic units)



The last character selects the timebase for the flow rate measurement. Select S/s (seconds) M/m (minutes), H/h (hours) or D/d (days)

**Set 4 mA:** (2551-22 and -42 versions only) Set the flow rate where the current output will be 4 mA.



**Set 20 mA:** (2551-22 and -42 versions only) Set the flow rate where the current output will be 20 mA.

The 4 to 20 mA output may be spanned to monitor forward and reverse flow rates.



**Total Factor:** Set the factor by which the totalizer will count. This setting is made in the application units (i.e., gallons, liters, etc.)



**Totalizer Units:** Set the Totalizer Units. This setting serves as a label for the totalizer displays only. It has no effect on the measurement. The special characters listed in the Total Factor settings are available here also.



**Low Flow Cutoff:** Set a flow rate that the 2551 Magmeter will use as a minimum threshold. If the flow rate falls below this value, the 2551 will respond as if the flow were zero.



**Averaging:** Set the averaging period based on the installation and flow conditions. Smaller values allow the 2551 to respond to changes in flow rate quickly, while larger values smooth the fluctuations caused by installation and flow conditions. See section 7.1 for details.



**Sensitivity:** Set a percentage of maximum range by which the flow must change to override the averaging feature and "jump" quickly to the new flow rate. See detailed explanation in section 7.1.



## 7.1 Averaging and Sensitivity

Even the most carefully engineered flow systems may experience erratic and unstable conditions. If the instability is communicated to the output functions, the results may create problems for control devices.

To alleviate these issues, the 2551 provides two adjustments that operate in tandem. The information here will help in determining the appropriate settings for any specific application.

### Averaging

- The AVERAGING setting dictates the time over which the magmeter will average the flow signal.

The LCD display is updated every second. With averaging at 14 seconds, the flow rate on the display is an average of the previous 14 seconds input.

Short averaging times provide the fastest display and output response to changes in the flow rate.

Higher averaging times help to smooth the display and current output where the flow in the pipe is erratic or unstable due to installation limitations.

### Sensitivity

- The SENSITIVITY setting determines how the 2551 responds to sudden surges in the flow rate. It "overrides" the Averaging function just long enough to allow an actual change in flow rate to be displayed, then resumes the averaging. The result is a smooth flow display and a quick response to large shifts in the flow rate.

The settings for Sensitivity represent a percentage of the magmeter's maximum range, or 10 milliseconds (ms).

Example: A sensitivity setting of 25% means that the flow rate must change instantly and by more than 2.5 ms before the function is enabled.

**NOTE:** The SENSITIVITY function is ineffective if the AVERAGING function is set to zero.

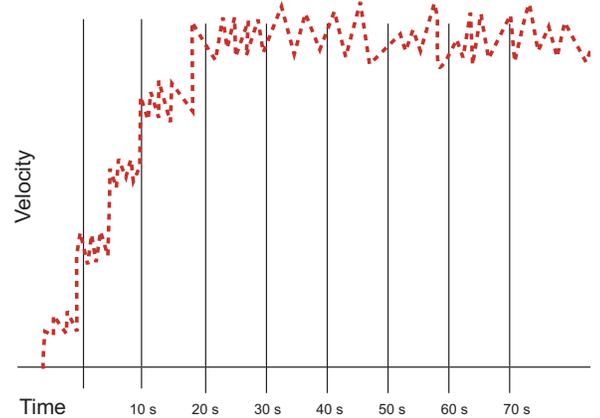


#### CAUTION

The SENSITIVITY function changes the response characteristics of the magmeter. If used as part of a tuned closed loop control system, such a change may be undesirable.

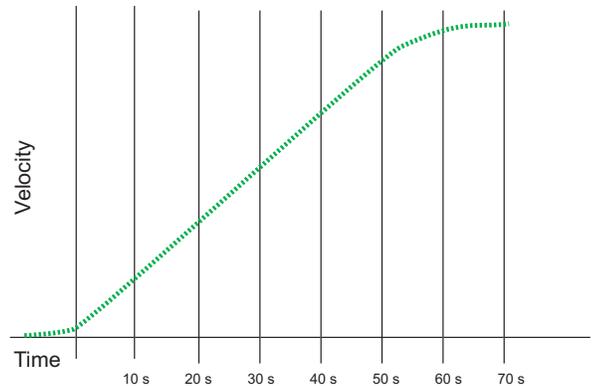
### No Averaging

With AVERAGING set to zero, the flow rate will be displayed immediately and with no filtering. This line represents the actual output of the flow sensor as it responds to unstable flow conditions in the pipe.



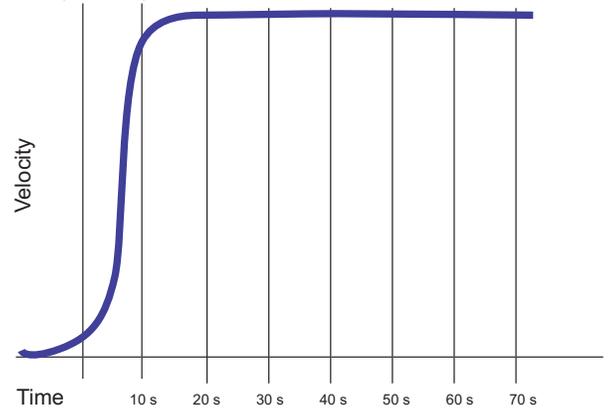
### Averaging Only

With AVERAGING set to 50 seconds and SENSITIVITY still set to zero the flow rate is stabilized, but a sharp change in flow rate is not represented on the display or at the output for 50 seconds or longer.



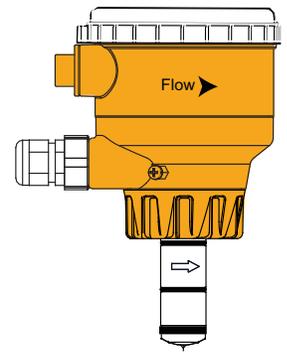
### Averaging and Sensitivity

With AVERAGING at 50 seconds and SENSITIVITY set to 25%, the flow rate is stabilized, while the sudden shift in flow is reflected very quickly.



## 7.2 Bi-Directional Flow

- The 2551 magmeter is designed to measure bi-directional flow.
- The forward flow direction is indicated by the directional arrow molded into the side of the 2551 sensor.
- The conduit ports are assembled at the factory to point UPSTREAM. They may be reversed by disassembling the components of the magmeter and reassembling.



**Flow Rate Display:** The "+" sign is suppressed during forward flow.  
"-123.45 GPM" during reverse flow.

**Totalizer Display:** The totalizer will count during forward flow conditions only.  
During reverse flow the totalizer will not increment.

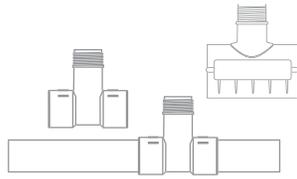
**Relay Outputs:** May be set to detect reverse flow: "Low Setpoint at -25 GPM."

**4 to 20 mA output:** May be scaled to span any flow range:  
For example: "4 to 20 mA = -100 GPM to +100 GPM"

**Frequency output, Frequency ÷ 10 output:** Reverse flow is processed same as forward flow in the frequency output magmeters.

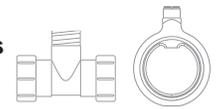
**Digital (S<sup>3</sup>L) output:** Reverse flow results in 0 flow rate output.

## 7.3 Calibration Data: K-Factors



### PVC Tees and Clamp-on Saddles

### Polypropylene True Union Tees and Wafers PVDF True Union Tees PVC True Union Tees



Pipe Size (In.)	Fitting Type	K-Factor Gallons	K-Factor Liters
-----------------	--------------	------------------	-----------------

#### SCH 80 PVC-U TEES FOR SCH 80 PIPE

½	MPV8T005	2277.0	601.58
¾	MPV8T007	1407.6	371.90
1	MPV8T010	861.17	227.52
1¼	MPV8T012	464.91	122.83
1½	MPV8T015	331.43	87.56
2	MPV8T020	192.89	50.96

#### SCH 80 PVC TEES FOR SCH 80 PIPE

2½	PV8T025	131.46	34.73
3	PV8T030	82.52	21.80
4	PV8T040	44.78	11.83

#### SCH 80 CPVC TEES FOR SCH 80 PIPE

½	MCPV8T005	2277.0	601.58
¾	MCPV8T007	1407.6	371.90
1	MCPV8T010	861.17	227.52
1¼	MCPV8T012	464.91	122.83
1½	MCPV8T015	331.43	87.56
2	MCPV8T020	192.89	50.96

#### SCH 80 PVC CLAMP-ON SADDLES FOR SCH 80 PIPE

2	PV8S020	193.83	51.21
2½	PV8S025	138.01	36.46
3	PV8S030	83.89	22.16
4	PV8S040	40.88	10.80
6	PV8S060	22.53	5.95
8	PV8S080	12.52	3.31
10	PV8S100	7.94	2.10
12	PV8S120	5.71	1.51

#### SCH 80 PVC CLAMP-ON SADDLES FOR SCH 40 PIPE

2	PV8S020	180.01	47.56
2½	PV8S025	123.72	32.69
3	PV8S030	75.81	20.03
4	PV8S040	41.87	11.06
6	PV8S060	19.71	5.21
8	PV8S080	11.73	3.10
10	PV8S100	7.43	1.96
12	PV8S120	5.23	1.38

Pipe Size (Metric)	Fitting Type	K-Factor Gallons	K-Factor Liters
--------------------	--------------	------------------	-----------------

#### POLYPROPYLENE FITTINGS (DIN/ISO, BS, ANSI)

DN15	PPMT005	2192.73	579.32
DN20	PPMT007	1327.81	350.81
DN25	PPMT010	737.16	194.76
DN32	PPMT012	453.46	119.81
DN40	PPMT015	275.03	72.66
DN50	PPMT020	164.17	43.35

#### PVDF FITTINGS (DIN/ISO, BS, ANSI)

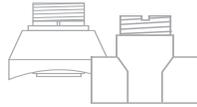
DN15	SFMT005	1946.49	514.26
DN20	SFMT007	1158.05	305.96
DN25	SFMT010	749.09	197.91
DN32	SFMT012	439.51	116.12
DN40	SFMT015	248.93	65.77
DN50	SFMT020	146.85	38.80

#### PVC FITTINGS (DIN/ISO, BS, ANSI)

DN15	PVMT005	2067.76	546.30
DN20	PVMT007	1136.61	300.29
DN25	PVMT010	716.52	189.31
DN32	PVMT012	446.07	117.85
DN40	PVMT015	278.83	73.67
DN50	PVMT020	159.36	42.10

7.3 Calibration Data: K-Factors

Carbon Steel Tees and Weld-o-Lets  
Stainless Steel Tees and Weld-o-Lets  
Galvanized Iron Tees



Pipe Size (In.)	Fitting Type	K-Factor Gallons	K-Factor Liters
-----------------	--------------	------------------	-----------------

**CARBON STEEL TEES ON SCH 40 PIPE**

1/2	CS4T005	1572.66	415.50
3/4	CS4T007	1086.73	287.11
1	CS4T010	582.34	153.86
1 1/4	CS4T012	377.48	99.73
1 1/2	CS4T015	267.79	70.75
2	CS4T020	167.85	44.35

**STAINLESS STEEL TEES ON SCH 40 PIPE**

1/2	CR4T005	1601.26	423.05
3/4	CR4T007	937.78	247.76
1	CR4T010	606.18	160.15
1 1/4	CR4T012	279.68	73.89
1 1/2	CR4T015	147.65	39.01
2	CR4T020	111.90	29.56

**STAINLESS STEEL WELDOLETS ON SCH 40 PIPE**

2 1/2	CR4W025	106.31	28.09
3	CR4W030	72.27	19.09
4	CR4W040	36.84	9.73
5	CR4W050	29.28	7.73
6	CR4W060	20.29	5.36
8	CR4W080	11.73	3.10
10	CR4W100	7.45	1.97
12	CR4W120	5.24	1.39

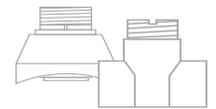
**CARBON STEEL WELDOLETS ON SCH 40 PIPE**

2 1/2	CS4W025	105.70	27.93
3	CS4W030	70.68	18.67
4	CS4W040	36.38	9.61
5	CS4W050	29.28	7.73
6	CS4W060	20.29	5.36
8	CS4W080	11.73	3.10
10	CS4W100	7.45	1.97
12	CS4W120	5.24	1.39

**GALVANIZED IRON TEES ON SCH 40 PIPE**

1	IR4T010	558.50	147.56
1 1/4	IR4T012	334.45	88.36
1 1/2	IR4T015	248.97	65.78
2	IR4T020	146.00	38.57

Bronze and Copper Tees and Brazolets



Pipe Size (In.)	Fitting Type	K-Factor Gallons	K-Factor Liters
-----------------	--------------	------------------	-----------------

**BRONZE TEES ON SCH 40 PIPE**

1	BR4T010	582.34	153.86
1 1/4	BR4T012	330.54	87.33
1 1/2	BR4T015	254.76	67.31
2	BR4T020	157.36	41.58

**COPPER TEES FITTING ON COPPER PIPE SCH K**

1/2	CUKT005	2459.19	649.72
3/4	CUKT007	1108.02	292.74
1	CUKT010	649.87	171.70
1 1/4	CUKT012	422.03	111.50
1 1/2	CUKT015	281.43	74.35
2	CUKT020	136.02	35.94

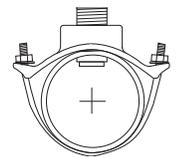
**COPPER TEES FITTING ON COPPER PIPE SCH L**

1/2	CUKT005	2406.30	635.75
3/4	CUKT007	1174.77	310.37
1	CUKT010	672.28	177.62
1 1/4	CUKT012	402.84	106.43
1 1/2	CUKT015	294.99	77.94
2	CUKT020	149.63	39.53

**COPPER/BRONZE BRAZOLET ON SCH 40 PIPE**

2 1/2	BR4B025	117.31	30.99
3	BR4B030	78.62	20.77
4	BR4B040	45.13	11.92
5	BR4B050	32.79	8.66
6	BR4B060	22.73	6.01
8	BR4B080	13.14	3.47
10	BR4B100	8.34	2.20
12	BR4B120	5.87	1.55

Iron Saddles



Pipe Size (In.)	Fitting Type	K-Factor Gallons	K-Factor Liters
-----------------	--------------	------------------	-----------------

**SCH 80 IRON SADDLE ON SCH 80 PIPE**

2	IR8S020	194.85	51.48
2 1/2	IR8S025	142.28	37.59
3	IR8S030	87.53	23.13
4	IR8S040	40.62	10.73
5	IR8S050	29.28	7.74
6	IR8S060	22.30	5.89
8	IR8S080	12.52	3.31
10	IR8S100	7.94	2.10
12	IR8S120	5.65	1.49

**SCH 80 IRON SADDLE ON SCH 40 PIPE**

2	IR8S020	185.35	48.97
2 1/2	IR8S025	127.47	33.68
3	IR8S030	76.62	20.24
4	IR8S040	40.23	10.63
5	IR8S050	27.32	7.22
6	IR8S060	19.71	5.21
8	IR8S080	11.61	3.07
10	IR8S100	7.36	1.94
12	IR8S120	5.18	1.37

## 8. Calibration Menu

The K-Factors published in this manual assume that the flow conditions in the pipe are ideal.

Many factors that affect the flow rate are beyond the control of the magmeter; variations in actual pipe dimensions, pipe smoothness, and other flow conditions will contribute to the total system error.

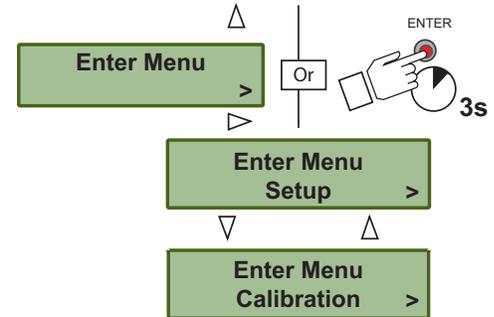
Performing a custom calibration with the magmeter in place will adjust the K-Factor and can serve to compensate for installation conditions that may be less than ideal.

Select one of the calibration methods in this menu to achieve the most accurate measurement possible in a specific application.



**NOTE:** The Security Code must be entered before selecting the calibration method.

Enter Code  
0000



### 8.1 Volume Method of Calibration

Use the volume method of calibration if the fluid passing the magmeter can be measured by a volumetric method (as in a vessel of known volume, or by weight). It requires the ability to pump a known volume of water past the magmeter, and then input the volume into the 2551 program. It is most useful for small pipes and lower flow rates.

When performed properly, volumetric calibration is the most accurate method. For best results a five minute test period is recommended, and the test period should be no less than two minutes.

Press Enter To Start	At START, the 2551 begins counting the flow past the sensor.
Press Enter To Stop	At STOP, the 2551 stores the total flow accumulated since the START.
Enter Volume 000000. GPM	Enter the VOLUME that has been pumped past the sensor.
Value must be more than 0.0	This error message appears if volume entered or the accumulated flow is zero. Repeat the test after checking the system.
K-Factor Out of Range	This message appears if the new K-Factor is less than 0.0001 or greater than 999999. To correct the problem, perform the volumetric flow again, and be certain that the volume entered is accurate.
K-Factor 45.6789	Using the information from the VOLUME method, the 2551 will recalculate a new K-Factor. Press ENTER to accept the new value, or use the keypad to adjust the value.

### 8.2 Rate Method of Calibration

Use this method if the 2551 Magmeter must be calibrated to match a reference flow meter. This is the method most commonly used by monitoring agencies, and for large pipes where volumetric calibration is impractical. The accuracy of this calibration method is largely dependent on the accuracy of the reference meter and the proximity of the reference to the Signet 2551 Magmeter.

Set New Flowrate 45.6789	The flow rate shown is based on the existing calibration of the 2551. Use the keypad to modify the flow rate to match the reference meter. The 2551 will automatically calculate a new K-Factor based on the new flow rate.
K-Factor Out of Range	This message appears if the new K-Factor is less than 0.0001 or greater than 999999. To correct the problem, reexamine the flow rate and make certain it is accurate.
K-Factor 56.7890	Using the information from the RATE MATCHING method, the 2551 will recalculate a new K-Factor. Press ENTER to accept the new value, or use the keypad to adjust the value.

## 9. Relay Menus

Magmeter models 3-2551-21 and -22 have two dry contact relays (Relays 1 and 2) and one Solid State relay (Relay 3).

Any of these relays can be set to any of the operating modes listed below.

The setpoint values for HIGH, LOW and WINDOW modes can be set to negative values if required. For example, a LOW alarm might be set to activate if the flow rate falls below -10 GPM.

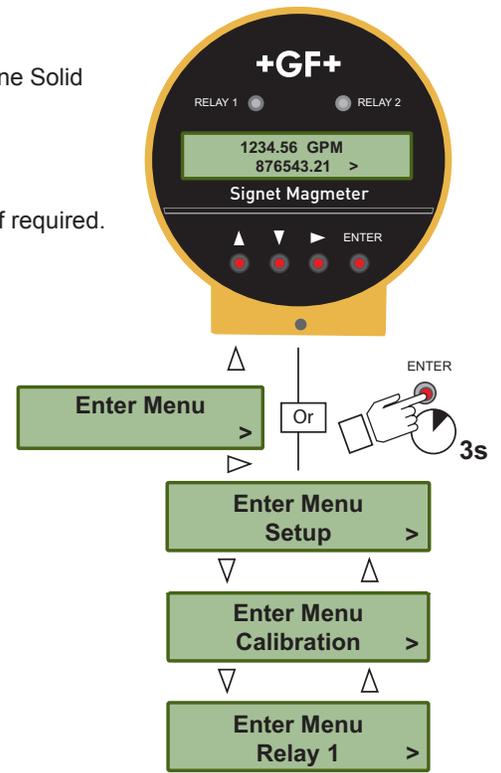
Negative values are not available for relays in PULSE or TOTAL modes.

**Off:** If a relay is not used, it can be turned Off to prevent contact wear.



**NOTE:** The Security Code must be entered before modifying the relay menu.

Enter Code  
0000



### 9.1 Pulse Relay mode

Program a relay to activate for a fixed period, for each volume of fluid that passes the sensor.

For example, program the relay to pulse once for 100 ms for every 3 gallons that pass by the sensor.

Relay 1 Mode  
Pulse >

Relay 1 Volume  
0.0000 Gal >

Relay 1 Width  
0.1 secs >

**Relay Volume:** Set the volume of fluid that the 2551 must measure before activating the relay for one pulse.

**Pulse Width:** Adjust the length of time the relay will remain activated. The pulse width setting is dependent on the type of external equipment being connected to the relay.

### 9.2 Total Relay mode

Program a relay to activate when the Resettable totalizer reaches a specific value. The maximum setting is 999999.

Application example: A filter must be replaced in an R.O. system every 10000 gallons. The service representative that installs a new filter sets relay 3 to Total mode, sets the setpoint at 10000 and resets the totalizer to 000000.00. Every time the Totalizer reaches 10000, the relay activates and lights a message indicator to remind the service representative to replace the filter.

When the totalizer is reset, the relay will be deactivated and the process begins anew.

Relay 1 Mode  
Total >

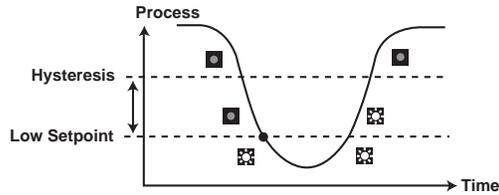
Relay 1 Set High  
000000 >

### 9.3 High, Low, or Window Relay modes

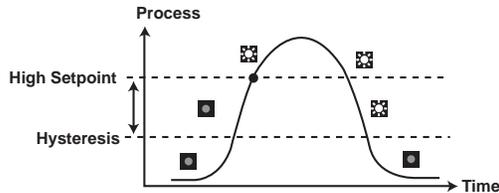
Program the relay to activate when the flow rate reaches a setpoint (High or Low) or when the flow rate moves outside of a prescribed range (Window).

#### Reverse Flow

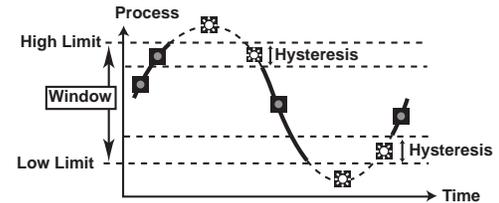
The setpoint values for HIGH, LOW and WINDOW modes can be set to negative values if required. For example, a LOW alarm might be set to activate if the flow rate falls to -10 GPM.



Relay behavior with LOW Setpoint

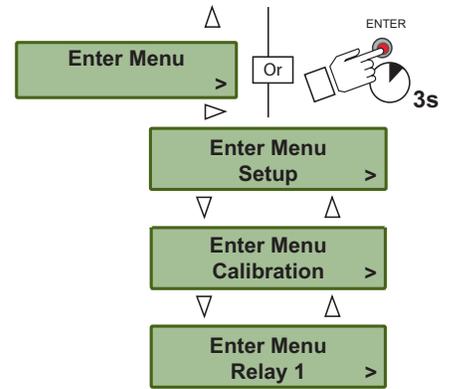


Relay behavior with HIGH Setpoint



Relay behavior with WINDOW Setpoints

Relay activated   
Relay deactivated 



**NOTE:** The Security Code must be entered before modifying the relay menu.

 Enter Code 0000

The values shown for each menu item represent the factory standard setting. All 2551 magmeters are packaged with these settings.

**Set Low:** Set the flow rate where a Low relay will be activated.

**Hysteresis:** Set a flow rate increment where the relay will be deactivated. The hysteresis setting serves to prevent relay "chatter" when the flow rate recovers from an alarm condition by requiring the low rate to move substantially within the setpoint.

**Set High:** Set the flow rate where a High relay will be activated.

**Delay:** Set a time period for the relay to wait after reaching the setpoint. This delay serves to prevent the relay "chatter" by allowing the flow rate time to move back within the setpoint.

Relay 1 Mode Low >	Relay 1 Set Low 00.000 GPM >
	Relay 1 Hys 00.000 GPM >
	Relay 1 Delay 0.1 secs >
Relay 1 Mode High >	Relay 1 Set High 00.000 GPM >
	Relay 1 Hys 00.000 GPM >
	Relay 1 Delay 0.1 secs >
Relay 1 Mode Window >	Relay 1 Set Low 00.000 GPM >
	Relay 1 Set High 00.000 GPM >
	Relay 1 Hys 00.000 GPM >
	Relay 1 Delay 0.1 secs >

The menu repeats for Relay 2 and Relay 3.

## 10. Test Menu

The Test menu provides a simple method to verify that the system is operating properly. Auxiliary power **MUST** be connected to the 2551 to activate the relays



Test Output 4.20 mA >
Test Relay 1 Open Closed >
Test Relay 2 Open Closed >
Test Relay 3 Open Closed >

Shown for 4 to 20 mA models only (3-2551-XX-22, -42).  
Use the keypad to enter any current output from 4.0 mA minimum to 22.1 mA maximum.

Shown for Relay models Only  
Toggle any of these relays ON and OFF to verify that the system is operating properly.

Auxiliary power **MUST** be connected to the 2551 to test the relays.



## 11. Options Menu

The Options Menu contains those features and settings that will normally be set one time and then seldom changed. These include language preference, decimal placement, Security Code assignment, etc.



Language English >
Security Code **** >
Contrast 2 >
Total Reset Lock On >
Noise Rejection 60 Hz >
Flow Decimal ****. ** >
Total Decimal *****. ** >
Separator ddd.d >
Output Mode Frequency >

Select from English, French, German, Italian, Portuguese or Spanish. This selection will be displayed at first power-up of a new magmeter.

Security Code can be set to any four digit number. Factory standard setting is 0000.

Set for best view after the magmeter is installed. Larger number means display appears darker.

Lock ON requires the Security Code before resetting the Resettable Totalizer. Lock OFF reset with no security code.

Filters out common 50 or 60 Hz electrical noise.

Set the maximum resolution for the FLOW RATE display by limiting the decimal to this point. The Flow Rate display will auto-scale from this resolution up to whole units.

Set the maximum resolution for the TOTALIZER display by limiting the decimal to this point. The Totalizer display will always show this resolution.

Select decimal point or comma for use in numeric displays.

For Frequency/Digital models only: Select Freq output, Freq ÷ 10 output, Mirror Relay 1 output or S<sup>3</sup>L Digital output.

The values shown for each menu item represent the factory standard setting. All 2551 magmeters are packaged with these settings.

### 11.1 Output Modes

In **FREQUENCY** output mode, the 2551 serves as a traditional flow sensor and provides an output pulse that is compatible with all Signet POWERED flow instruments. It is not compatible with the 5090 Self-Powered Flow Meter or the 8150-1 Battery-Powered Flow Totalizer. The frequency output range is from 0 Hz to 1000 Hz.

The **FREQUENCY ÷ 10** output mode reduces the output frequency of the 2551 to a range that is useful for some programmable logic controllers (PLC). The frequency output range is from 0 Hz to 100 Hz. This shift does not affect the stated accuracy of the 2551 Magmeter's frequency output.

The **MIRROR RELAY 1** output mode allows 2551 Frequency/Digital models to use the Open Collector Output like a relay that can be programmed via the Relay 1 menu.

If the magmeter is equipped with relays, this mode will mirror the settings of Relay 1.

If the magmeter is not equipped with relays, this mode can still be selected and programmed via the Relay 1 menu.

The **S<sup>3</sup>L Digital** output mode switches the 2551 to the Signet serial data output called S<sup>3</sup>L (Signet Serial Sensor Link). In this mode the 2551 can be added to the serial bus of the Signet 8900 Multi-Parameter Controller or 9900 Transmitter.

## 12. Technical Information

### 12.1 Grounding

Precalibration conditioning: The magmeter may appear to be unstable immediately after installation. Allow the sensor to sit in a full pipe for **24 hours** before beginning calibration and operation.

- Use a cable gland or a liquid tight connector to seal the cable ports from water intrusion.
- Use PTFE tape or a suitable sealant on cable ports.
- The 2551 magmeter must be carefully grounded to eliminate electrical noise that may interfere with the measurement.
- Grounding requirements will vary with each installation.
- The following recommendations should be applied in sequence until the interference is eliminated.

- ① The ground terminal on the outside of the yellow housing is connected internally to the grounding ring at the tip of the sensor. Connect a conductor (14 AWG/1.5 mm<sup>2</sup> wire recommended) from this terminal directly to Earth ground to prevent electrical noise from interfering with the magmeter signal.

If the interference persists, apply step #2:

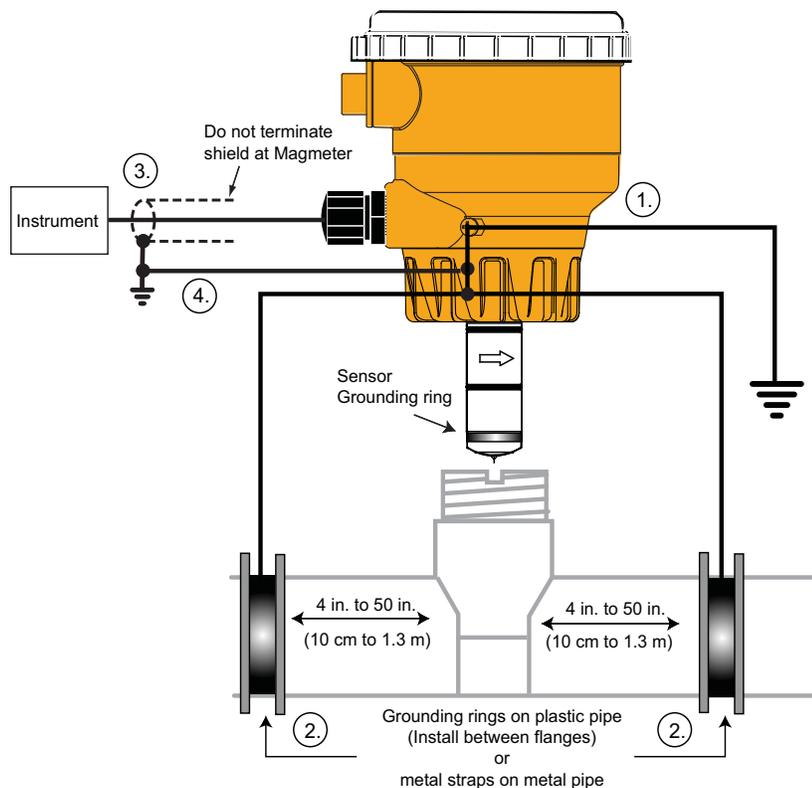
- ② Connect grounding rings, metal clamps or grounding electrodes to the pipe immediately upstream and downstream of the magmeter sensor location. These devices must be in contact with the fluid.

If the interference persists, apply step #3:

- ③ The shield from the output cable must be terminated at the remote instrument ONLY. This shield must not be connected at both ends!

If the interference persists, apply step #4:

- ④ Connect an additional wire (minimum AWG 14/1.5 mm<sup>2</sup>) from the remote instrument ground to the magmeter ground terminal.



### 12.2 Maintenance

The 2551 Magmeter requires very little maintenance. There are no user-serviceable components in the magmeter.

- If the fluid contains deposits and solids that may coat the electrodes, a regular cleaning regimen is recommended.
- Do not use abrasive materials on the metal electrodes. Clean with soft cloth and mild detergent only.
- Use a cotton swab and mild detergent to remove deposits on the metal electrodes.

#### Environmental Recommendations:

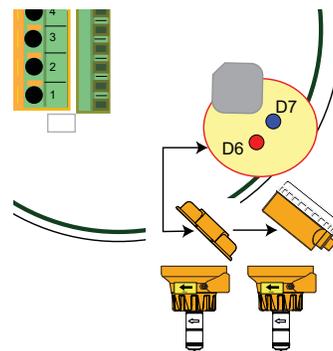
- When used properly, this product presents no inherent danger to the environment.
- Please follow local ordinance when disposing of this or any product with electronic components.

## 12.3 Troubleshooting

Symptom	Possible Cause	Solution
Output is erratic and unstable.	Magmeter installed too close to upstream obstruction.	Relocate the magmeter to have straight uninterrupted pipe upstream of the sensor for at least 10 x the pipe diameter.
	Magmeter located in area exposed to air bubbles/pockets.	Eliminate air bubbles in the pipe.
	Magmeter is installed in pipe backwards.	Remove the magmeter and reinstall with the flow direction arrow on the sensor body pointed DOWNSTREAM.
	Electrical noise is interfering with the measurement.	Review the grounding of the magmeter and the pipe. Install adequate Earth ground to allow the Magmeter to operate properly.
	Electrodes are coated with deposits or chemical oxide layers.	Carefully clean the electrodes. Refer to sensor manual for details.
Output is not 0 when flow is stopped.	Electrodes not adequately conditioned in fluid.	Allow the sensor to sit in full pipe for 24 hours then restart.
	Fluid is moving inside the pipe.	Increase the Low Flow Cutoff. (section 7.0)
No 4 to 20 mA output.	Loop power not connected correctly.	Connect 24 VDC $\pm$ 10% connected to loop terminals 1 and 3.
4 to 20 mA current output is incorrect.	4-20 mA is not scaled properly.	Check and reset in the Setup Menu.
No Frequency output. No S <sup>3</sup> L output.	2551 is wrong model.	Frequency/S <sup>3</sup> L model: 3-2551-21 (w/rlys) or -41 (w/o rlys).
	Incorrect setting in Options Menu.	Select Frequency in the Options menu.
	Wiring is not correct.	Check wiring, make corrections.
	Frequency input to other manufacturer's flow instrument does not have pull-up resistor.	Install 10 k $\Omega$ resistor. (section 5.1)
No flow rate, current output is 22 mA.	The fluid is too clean for Magmeter.	Unsuitable application for Magmeter.
	Electronic component failure.	Return 2551 to factory.
Blank display, no backlighting, no relay LEDs, but external equipment using output signal is still working.	2551 AUX power is not connected.	Connect AUX power (section 5.5) (9 to 24 VDC, 0.4 A max.)
Error Message: "Error Not Saved"	Main power is below specification.	Correct the main power deficiency.

### Troubleshooting with the RED and BLUE LEDs

- No Lights:** The power is off or the sensor is not connected
- Solid Blue:** The power is on but there is no flow in the pipe.
- Blinking Blue:** Normal operation, blink rate is proportional to the flow rate.
- Alternating Red-Blue:** Empty pipe indication (electrodes are not wet.)
- Blinking Red:** System errors (Electrical noise interference)
- Solid Red:** Instrument error (defective electronic component)



### Reverse flow:

- Frequency out cannot distinguish reverse flow from forward flow. The output will be the absolute value.
- Digital (S<sup>3</sup>L) output: Reverse flow results in 0 flow rate displayed on 8900, or with negative numbers on the 9900.
- 4 to 20 mA output can be spanned into negative flow range using the custom setup tool. (example: 4-20 mA = -100 to +100 GPM)

### Empty Pipe Detection

- Frequency output will be locked to 0 Hz if electrodes are not wet.
- Digital (S<sup>3</sup>L) output will be locked to 0 if electrodes are not wet.
- 4-20 mA will be locked to 4 mA if electrodes are not wet.
- Blue and Red LED indicators on the magmeter circuit will blink alternately if the electrodes are not wet.

## 13. Ordering Information

Sensor Part No.	
3-2551	
Sensor Body (Transducer) and electrodes/grounding ring materials - Choose one	
-P	Polypropylene and 316L SS
-T	PVDF and Titanium
-V	PVDF and Hastelloy-C
Pipe size - Choose one	
0	DN15 to DN100 (1/2 to 4 in.)
1	DN125 to DN200 (5 to 8 in.)
2	DN250 to DN900 (10 to 36 in.)
Display Options - Choose One	
-2	With Display, two SPDT relays, one solid state relay
-4	With Display, no relays
Output options - Choose One	
1	Open Collector Frequency out or Digital (S <sup>3</sup> L) out
2	4 to 20 mA output
3-2551	-P 0 -2 2 Example Part Number

Mfr. Part Number	Code	Mfr. Part Number	Code
3-2551-P0-21	159 001 267	3-2551-T2-21	159 001 454
3-2551-P0-22	159 001 273	3-2551-T2-22	159 001 455
3-2551-P0-41	159 001 261	3-2551-T2-41	159 001 460
3-2551-P0-42	159 001 279	3-2551-T2-42	159 001 461
3-2551-P1-21	159 001 268	3-2551-V0-21	159 001 269
3-2551-P1-22	159 001 274	3-2551-V0-22	159 001 275
3-2551-P1-41	159 001 262	3-2551-V0-41	159 001 263
3-2551-P1-42	159 001 280	3-2551-V0-42	159 001 281
3-2551-P2-21	159 001 435	3-2551-V1-21	159 001 270
3-2551-P2-22	159 001 438	3-2551-V1-22	159 001 276
3-2551-P2-41	159 001 432	3-2551-V1-41	159 001 264
3-2551-P2-42	159 001 441	3-2551-V1-42	159 001 282
3-2551-T0-21	159 001 436	3-2551-V2-21	159 001 456
3-2551-T0-22	159 001 439	3-2551-V2-22	159 001 457
3-2551-T0-41	159 001 433	3-2551-V2-41	159 001 462
3-2551-T0-42	159 001 442	3-2551-V2-42	159 001 463
3-2551-T1-21	159 001 437		
3-2551-T1-22	159 001 440		
3-2551-T1-41	159 001 434		
3-2551-T1-42	159 001 443		

### Replacement Parts and Accessories

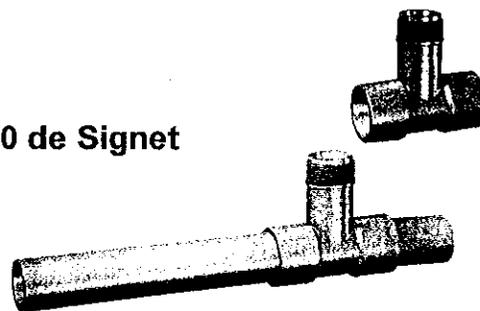
Mfr. Part No.	Code	Description
1220-0021	198 801 186	O-ring, FPM
1224-0021	198 820 006	O-ring, EPDM
1228-0021	198 820 007	O-ring, FFPDM
3-8050.390-1	159 001 702	Retaining Nut Replacement Kit, NPT, Valox <sup>®</sup>
3-8050.390-3	159 310 116	Retaining Nut Replacement Kit, NPT, PP
3-8050.390-4	159 310 117	Retaining Nut Replacement Kit, NPT, PVDF
3-8050.391	159 001 703	Retaining Nut Replacement Kit, NPT, Stainless Steel
3-8050.396	159 000 617	RC Filter kit (for relay protection)
3-8551.521	159 001 378	Clear plastic cap for display



Georg Fischer Signet LLC, 3401 Aero Jet Avenue, El Monte, CA 91731-2882 U.S.A. • Tel. (626) 571-2770 • Fax (626) 573-2057  
 For Worldwide Sales and Service, visit our website: [www.gfsignet.com](http://www.gfsignet.com) • Or call (in the U.S.): (800) 854-4090  
 For the most up-to-date information, please refer to our website at [www.gfsignet.com](http://www.gfsignet.com)

**Signet Schedule 80 PVC and CPVC Installation Fittings**  
**Raccords d'installation Signet PVC et CPVC norme 80**  
**Signet Schedule 80 PVC- und CPVC-Installationsfittings**  
**Accesorios de instalación de PVC y CPVC de catálogo 80 de Signet**

3-MXPV8.090 Rev B 03/10 (English, French, German, Spanish)



**English**



**SAFETY INSTRUCTIONS**

1. Confirm chemical compatibility before use.
2. Do not exceed maximum temperature or pressure specifications of fittings or sensors.
3. Do not use this product for any purpose other than for which it was designed.
4. Use schedule 80 pipe.
5. Use with liquids only.
6. Improper pipe fitting installation may result in pressure failure, personal injury, and/or property damage.
7. Always match fitting and piping materials.
8. Always use piping cement designed for your specific fitting and piping material.

**Compatibility**

These schedule 80 fittings are designed to be used with the Signet flow and pH sensors listed below.

**Français**



**CONSIGNES DE SÉCURITÉ**

1. Vérifier la compatibilité chimique avant l'utilisation.
2. Ne pas dépasser les spécifications maximales de température et de pression pour les raccords ou les capteurs.
3. Ne pas utiliser ce produit à d'autres fins que celle pour laquelle il a été conçu.
4. Utiliser un tuyau norme 80.
5. Utiliser uniquement avec des liquides.
6. Un raccord mal installé peut entraîner des chutes de pression et des dommages corporels ou matériels.
7. Utilisez toujours un raccord de même matériau que le tuyau sur lequel il doit être posé.
8. Utilisez toujours du mastic conçu spécialement pour le matériau de votre tuyau et de votre raccord.

**Compatibilité**

Ces raccords norme 80 sont conçus pour être utilisés avec les capteurs de pH et d'écoulement Signet répertoriés ci-dessous.

**Deutsch**



**SICHERHEITSVORSCHRIFTEN**

1. Vor dem Einsatz die Chemikalienverträglichkeit bestätigen.
2. Die angegebenen maximalen Temperatur- oder Druckwerte von Fittings oder Sensoren nicht überschreiten.
3. Das Produkt ausschließlich für den beabsichtigten Zweck verwenden.
4. Schedule 80 Rohr verwenden.
5. Nur mit Flüssigkeiten verwenden.
6. Unsachgemäße Installation des Fittings kann zu Druck-, Personen- oder Sachschäden führen.
7. Fitting- und Rohrleitungsmaterial muß stets aufeinander abgestimmt sein.
8. Stets einen für das spezielle Material von Fitting und Rohrleitungen geeigneten Klebstoff verwenden.

**Kompatibilität**

Diese Schedule 80 Fittings sind zur Verwendung mit den nachstehend aufgeführten Durchfluss- und pH-Sensoren von Signet konzipiert.

**Español**



**INSTRUCCIONES DE SEGURIDAD**

1. Confirme la compatibilidad química antes de utilizar este producto.
2. No exceda las especificaciones de temperatura o presión máximas de los accesorios o sensores.
3. No use este producto para ningún fin que no sea para el que se ha diseñado.
4. Use tuberías de catálogo 80.
5. Use con líquidos solamente.
6. La instalación indebida del conector de tubería puede producir fallas de presión, lesión personal y/o daños a la propiedad.
7. Siempre haga coincidir los materiales del conector y de la tubería.
8. Siempre use el cemento de tubería diseñado para su conector y material de tubería específicos.

**Compatibilidad**

Estos accesorios de catálogo 80 están diseñados para ser usados con los sensores de caudal y pH de Signet indicados abajo.

Flow Sensors Captéurs d'écoulement Durchflusssensoren Sensores de caudal	pH/ORP Electrodes Électrodes indicatrices de pH/ORP pH/ORP-Elektroden Electrodos de pH/ORP (pH/potencial redox)
P51530-X0	3-2714 - 2717
3-8510-X0	3-2724 - 2726
3-8512-X0	
3-2536-X0	
3-2537-XC-X0	
3-2551-X0-XX	

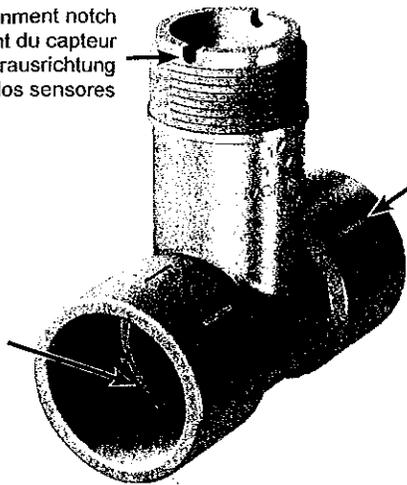
**Identification**

**Identification**

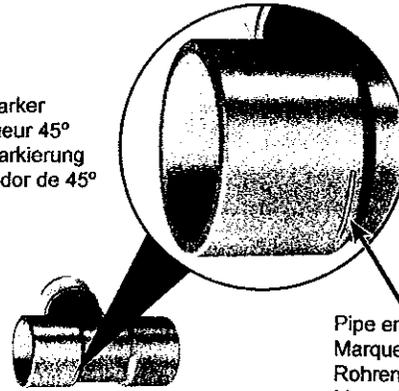
**Identifizierung**

**Identificación**

Sensor alignment notch  
Encoche d'alignement du capteur  
Kerbe zur Sensorausrichtung  
Muesca de alineación de los sensores



45° marker  
Marqueur 45°  
45°-Markierung  
Marcador de 45°



Pipe end marker  
Marqueur d'extrémité de tuyau  
Rohrendenmarkierung  
Marcador de extremo de tubería

Glue trap  
Collecteur de colle  
Kleberfalle  
Interceptor de pegamento

**Fitting only**

**Raccord uniquement**

**Nur Fitting**

**Accesorio solamente**

SCH 80 PVC		SCH 80 CPVC		Size (inches) Dim. (pouces) Größe (Zoll) Tamaño (pulgadas)	L (inches) (pouces) (Zoll) (pulgadas)	H (inches) (pouces) (Zoll) (pulgadas)	i.d. (inches) (pouces) (Zoll) (pulgadas)
Part No. Référence Teile-Nr. N° de pieza	Code Code Code Código	Part No. Référence Teile-Nr. N° de pieza	Code Code Code Código				
MPV8T005F	159.001.614	MCPV8T005F	159.001.632	1/2"	3.75	3.50	0.85
MPV8T007F	159.001.615	MCPV8T007F	159.001.633	3/4"	3.75	3.70	1.06
MPV8T010F	159.001.616	MCPV8T010F	159.001.634	1"	4.30	4.00	1.33
MPV8T012F	159.001.617	MCPV8T012F	159.001.635	1-1/4"	4.40	4.30	1.67
MPV8T015F	159.001.618	MCPV8T015F	159.001.636	1-1/2"	5.00	4.60	1.91
MPV8T020F	159.001.619	MCPV8T020F	159.001.637	2"	5.50	5.00	2.40

**Fitting with pipe**

**Raccord avec tuyau**

**Fitting mit Rohr**

**Accesorio con tubería**

SCH 80 PVC		SCH 80 CPVC		Size (inches) Dim. (pouces) Größe (Zoll) Tamaño (pulgadas)	L (inches) (pouces) (Zoll) (pulgadas)	H (inches) (pouces) (Zoll) (pulgadas)	o.d. (inches) (pouces) (Zoll) (pulgadas)
Part No. Référence Teile-Nr. N° de pieza	Code Code Code Código	Part No. Référence Teile-Nr. N° de pieza	Code Code Code Código				
MPV8T005	159.001.623	MCPV8T005	159.001.641	1/2"	14	3.50	0.84
MPV8T007	159.001.624	MCPV8T007	159.001.642	3/4"	14	3.70	1.05
MPV8T010	159.001.625	MCPV8T010	159.001.643	1"	17	4.00	1.32
MPV8T012	159.001.626	MCPV8T012	159.001.644	1-1/4"	20	4.30	1.66
MPV8T015	159.001.627	MCPV8T015	159.001.645	1-1/2"	24	4.60	1.90
MPV8T020	159.001.628	MCPV8T020	159.001.646	2"	26.5	5.02	2.38

### K-Factors

A **K-Factor** is the number of pulses (P) a sensor will generate for each engineering unit of fluid that passes the sensor. K-factors for water are listed below in U.S. gallons and liters. For example, in a 1 inch SCH 80 PVC pipe, the 515 paddlewheel generates 172.07 pulses per gallon of water passing the rotor.

**K-Factors are for schedule 80 pipe.**

### Facteurs K

Un **Facteur K** est le nombre d'impulsions (P) qu'un capteur produit pour chaque unité d'ingénierie de fluide qui y passe. Les facteurs K pour l'eau sont indiqués ci-dessous en gallons U.S. et en litres. Par exemple, dans un tuyau en PVC de 25,4 mm (1 pouce), la roue à palettes 515 produit 172.07 impulsions par gallon (3,78 litres) d'eau qui passe dans le rotor.

**Les facteurs K sont pour les tuyaux de norme 80.**

### K-Faktoren

Der **K-Faktor** repräsentiert die Anzahl der Impulse (P), die vom Sensor für jede physikalische Einheit durchfließender Flüssigkeit erzeugt wird. K-Faktoren für Wasser sind nachstehend in US-Gallonen und Liter aufgeführt. Beispielsweise erzeugt das 515 Schaufelrad in einem 1-Zoll-PVC-Rohr 172.07 Impulse pro Gallone Wasser, das durch den Rotor fließt.

**K-Faktoren sind für Schedule 80 Rohre.**

### Factores K

El **Factor K** es el número de impulsos (P) que genera un sensor por cada unidad de líquido que pasa por el sensor. En las tablas de abajo se muestran los factores K para agua (en unidades de galones norteamericanos [EE. UU.] y litros). Por ejemplo, en una tubería de PVC de 1 pulg., la 515 rueda de paletas genera 172.07 impulsos por galón de agua que pasa por el rotor.

**Los factores K son para tuberías del catálogo 80**

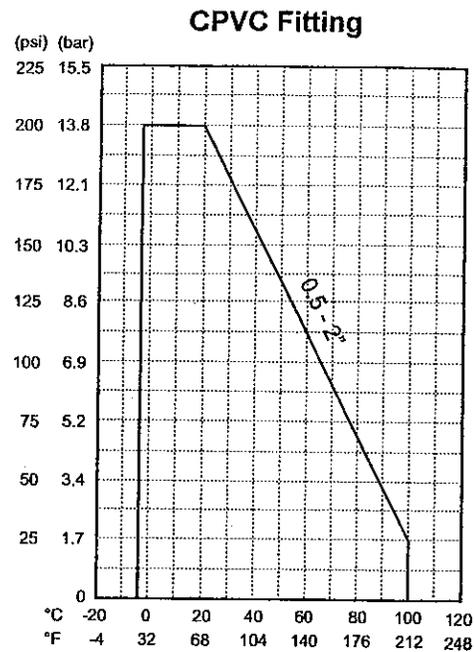
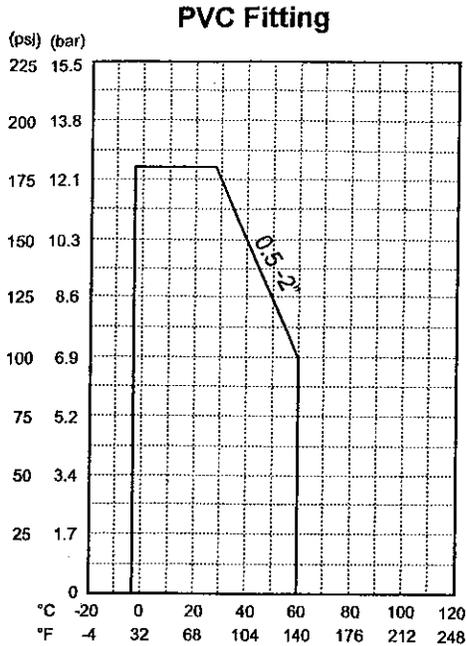
PIPE SIZE TAILLE DE TUYAU ROHRGRÖSSE TAMAÑO DE LA TUBERÍA	SCH. 80 FITTING RACCORD DE NORME 80 SCHEDULE 80 FITTING ACCESORIO DE CATÁLOGO 80	515/8510		2536/2537/8512		2551	
		P/LITERS P/LITRES P/LITROS	P/U.S. GAL	P/LITERS P/LITRES P/LITROS	P/U.S. GAL	P/LITERS P/LITRES P/LITROS	P/U.S. GAL
1/2"	MPV8T005F MCPV8T005F MPV8T005 MCPV8T005	137.42	520.12	271.37	1027.1	601.58	2277.0
3/4"	MPV8T007F MCPV8T007F MPV8T007 MCPV8T007	78.61	297.52	154.08	583.19	371.90	1407.6
1"	MPV8T010F MCPV8T010F MPV8T010 MCPV8T010	45.46	172.07	88.65	335.53	227.52	861.17
1-1/4"	MPV8T012F MCPV8T012F MPV8T012 MCPV8T012	24.19	91.54	47.24	178.79	122.83	464.91
1-1/2"	MPV8T015F MCPV8T015F MPV8T015 MCPV8T015	16.44	62.22	32.08	121.42	87.56	331.43
2"	MPV8T020F MCPV8T020F MPV8T020 MCPV8T020	9.60	36.32	18.87	71.44	50.96	192.89

**Specifications**

**Spécifications**

**Spezifikationen**

**Especificaciones**



The pressure ratings are for the fitting only. NEVER EXCEED the pressure rating of the installed sensor.

Follow plastic piping cement manufacturer's recommended preparation and gluing instructions. Avoid excess cement in fitting joints to prevent any port obstruction.

Les niveaux de pression ne concernent que le raccord. NE JAMAIS DÉPASSER le niveau de pression du capteur installé.

Suivez les instructions de préparation et d'application du mastic données par le fournisseur de celui-ci. Evitez d'appliquer le mastic en trop grande quantité pour ne risquer aucune obstruction.

Die Drucknennwerte beziehen sich nur auf die Fittinge. Den Drucknennwert des installierten Sensors NIEMALS ÜBERSCHREITEN.

Anweisungen des Klebstoff-Herstellers befolgen. Nicht zuviel Klebstoff an den Verbindungsstellen auftragen, um Verstopfungen der Öffnungen zu vermeiden.

Las presiones nominales son para el accesorio solamente. NO EXCEDA NUNCA la presión nominal del sensor instalado.

Siga las instrucciones recomendadas por el fabricante para la preparación y el engomado del cemento para tuberías plásticas. Evite el exceso de cemento en las juntas de los conectores para prevenir obstrucciones en los orificios.

Rigid PVC and CPVC Material Compounds Specification: ASTM D 1784

Dimensional and Compound Plastic Pipe Fittings Specifications: ASTM D 2467 ASTM F 439

Standard Test Methods Specification: ASTM F 1970

Matériau PVC et CPVC rigide Spécifications des composés : ASTM D 1784

Dimensions et composé Raccords pour tuyau en plastique Spécifications : ASTM D 2467 ASTM F 439

Méthodes standard de test Spécifications : ASTM F 1970

Verbundstoffspezifikation für unbiegsames PVC- und CPVC-Material: ASTM D 1784

Abmessungs- und Verbundstoffspezifikationen für Rohrfittinge aus Kunststoff: ASTM D 2467 ASTM F 439

Spezifikation für Standardtestmethoden: ASTM F 1970

PVC y CPVC rígidos Especificación de los compuestos: ASTM D 1784

Dimensiones y composición Accesorios de tuberías de plástico Especificaciones: ASTM D 2467 ASTM F 439

Métodos de prueba estándar Especificación: ASTM F 1970

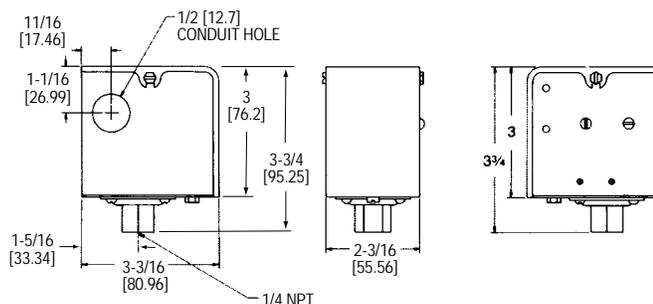
**+GF+**

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## Series CS Low Cost Diaphragm Pressure Switches

### Specifications – Installation and Operating Instructions



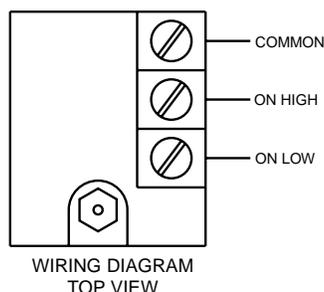
The Series CS Low Cost Diaphragm Pressure Switch is ideal for instrument panels, small compressors and general industrial applications. Visible set point and easy-to-wire SPDT snap switch reduce installation time. This switch operates in any position and is vibration resistant.

#### INSTALLATION/MOUNTING

The control can be pipe mounted. Do not twist the case when installing. Use wrench on the pressure connection flats.

#### WIRING

All wiring must conform to the National Electrical code and local regulations. Do not install control to handle loads in excess of electrical rating shown in specifications or as indicated on instructions inside control cover. Connect wiring to screw terminals depending on the action required. Common and High contacts will close and Common and Low contacts will open when increasing pressure (or vacuum) reaches set point. The reverse will occur when pressure (or vacuum) drops below the set point less the deadband.



**CAUTIONS:** Do not oil any parts. Mount control securely. Never exceed electrical rating for switch. Use only with compatible.

#### WARNING

A failure resulting in injury or damage can be caused by over-pressure, excessive vibration or pressure pulsation, excessive temperature, corrosion of pressure containing parts and movement assembly, electrical overload or other misuse.

#### PHYSICAL DATA

**Temperature Limits:** -30 to 150°F (-34.4 to 65.6°C)

**Pressure Connections:** 1/4" NPT(F)

**Electrical Ratings:** 12 A @ 120 VAC; 8 A @ 240 VAC; 7A @ 277 VAC; 1/8 HP @ 120 VAC; 1/4 HP @ 240 VAC

**Switch Type:** SPDT snap acting

**Conduit Opening:** 1/2"

**Wiring Connections:** Three screw type, common, N.O., N.C.

**Set Point Adjustment:** Screw type, inside cover

**Housing:** Galvanized steel, NEMA 1

**Diaphragm:** Buna-N/Nylon

**Calibration Spring:** Plated steel

**Installation:** Any position

**Weight:** 1/2 lb. (0.23 kg)

Model No.	Adjustable Operating Range	Fixed Deadband		Max. Pressure
		Maximum	Minimum	
CS-1	1-30" Hg. Vac. 2.5-75 cm Hg. Vac	1.5" Hg. 3.8 cm Hg. Vac	1" Hg. VAC 2.5 cm Hg. Vac	30 psig
CS-3	10-100" w.c. 2.5-250 cm w.c.	7" w.c. 17.8 cm w.c.	5" w.c. 12.7 cm w.c.	30 psig
CS-10	1-10 psig 0.07-0.7 kg/cm <sup>2</sup>	0.4 psig 0.03 kg/cm <sup>2</sup>	0.25 psig 0.02 kg/cm <sup>2</sup>	30 psig
CS-30	1-30 psig 0.07-2.1 kg/cm <sup>2</sup>	1.0 psig 0.07 kg/cm <sup>2</sup>	0.5 psig 0.035 kg/cm <sup>2</sup>	50 psig
CS-150	10-150 psig 0.07-10.5 kg/cm <sup>2</sup>	5 psig 0.35 kg/cm <sup>2</sup>	1.5 psig 0.1 kg/cm <sup>2</sup>	175 psig



### Bag Filter Housing, Alum, 2 In FNPT

Bag Filter Housing, Bottom Outlet, Overall Height 37.41 In. Aluminum Housing Material, Stainless Steel Basket, Max. Flow GPM 200, Size 2 In, Connection FNPT, 8.0 Dia. (In.), Max. Pressure (PSI) 150, Max. Water Temp. (F) 300, Filter Bag Size 2, Leg Type Eye Bolt

Grainger Item #	4BB26
Your Price (ea.)	
Brand	PENTEK
Mfr. Model #	156112-75
Ship Qty.	1
Sell Qty. (Will-Call)	1
Ship Weight (lbs.)	41.0
Availability	Ready to Ship
Catalog Page No.	4161

#### Additional Info

##### Single Eyebolt Bag Filter Housings

Feature a standard O-ring Viton® seal between the basket and housing to assure a positive seal and prevent bypass, while removing dirt, pipe scale, and other contaminants from process liquids. FNPT connections. Carbon steel housings have a 2-part epoxy paint finish.

- Max. pressure: 150 psi Max. temp.: 300°F, except No. 1YBN7 is 200°F

#### Tech Specs

**Item:** Bag Filter Housing

**Outlet:** Bottom

**Housing Material:** Aluminum

**Basket:** Stainless Steel

**Max. Flow GPM:** 200

**Size:** 2"

**Connection:** FNPT

**Dia. (In.):** 8

**Max. Pressure (PSI):** 150

**Max. Water Temp. (F):** 300

**Filter Bag Size:** 2

**Leg Type:** Eye Bolt

**Overall Height (In.):** 37.41

**Height:** 22"

#### Notes & Restrictions

There are currently no notes or restrictions for this item.

#### MSDS

This item does not require a **Material Safety Data Sheet (MSDS)**.

#### Required Accessories

There are currently no required accessories for this item.

# OPERATING INSTRUCTIONS

## LIQUID BAG MODELS 44, 66, 88

READ THE WARNING/SAFETY INFORMATION ON  
BACK BEFORE PROCEEDING

The housing you have purchased is manufactured with the highest quality materials and with the greatest pride to offer you a superior in-line housing for industrial applications.

If there is any damage to the housing or element, a **CLAIM MUST BE FILED WITH THE FREIGHT CARRIER. SHIPPER WILL NOT ACCEPT RETURNS WITHOUT PRIOR AUTHORIZATION, UNAUTHORIZED SHIPMENTS WILL BE REFUSED.**

### A. RECEIVING INSTRUCTIONS

1. Unpack the housing(s) and discard any shipping materials.
2. Place housing in the desired location on a flat surface. Secure support legs to the base if applicable.

### B. INSTALLATION INSTRUCTIONS

**\*\*flow to the housing should be turned off\*\***

1. Place housing on pipe connections:
  - a. **N.P.T. / Coupling style** - Krystil Klear does not recommend using any type of liquid sealant due to contamination of the pipe that may occur.
  - b. **Flange style** - put a small amount of clean, heavy oil on one side of the gaskets, place oiled side down onto existing flanges to hold gaskets.
2. Please note the labeling of the inlet and outlet connections for proper installation. Tighten housing with proper tension to seal housing on existing pipe or flange. Note: housing has been factory pressure tested to assure a leak proof vessel. If leaking occurs, check for improper connections.
3. Remove lid from housing by turning eye nuts until loosened and swing them down. Using the Lid Lift Handle, swing the lid until full view of the inner housing area is gained.
4. Check inner housing and pipe connections for foreign material and discard any items that have entered during shipping or unpacking.
5. Make sure that the strainer baskets are pushed fully into housing grooves. If using a filter bag, seat bag fully into strainer basket to assure a leak-proof seal between bag and basket. For best results, bag should be fully extended into the basket.
6. Close lid and alternately tighten the eye nuts until lid is fully seated onto the

O-Ring gasket.

7. Housing is now ready for start-up.

### C. START-UP OF HOUSING

1. Loosen vent plug to allow air to escape from housing  
Slowly open the inlet to gradually fill the housing body.
2. When housing body is full (liquid escapes from top vent), close the vent.
3. Open the outlet connection and fully open the inlet connection.  
Housing is now operating properly

### D. REMOVAL OF SPENT ELEMENT:

1. When the housing reaches your pre-determined differential pressure, stop flow to the housing and relieve housing pressure through housing drain.  
Remove enough liquid to show top of basket flange.
2. Loosen eye nuts on housing and, using the Lid Lift Handle, swing the lid to gain full access to the inside of housing.
3. If using a liquid bag, pull the element out of basket and discard the element in accordance with any required local and federal laws.
4. Remove filter baskets and clean thoroughly.
5. Housing debris and sludge should be removed to prolong filter efficiencies.
6. Replace filter baskets and bags into housing as noted in B-5 thru C-3 above.

### C. RECOMMENDED MAINTENANCE

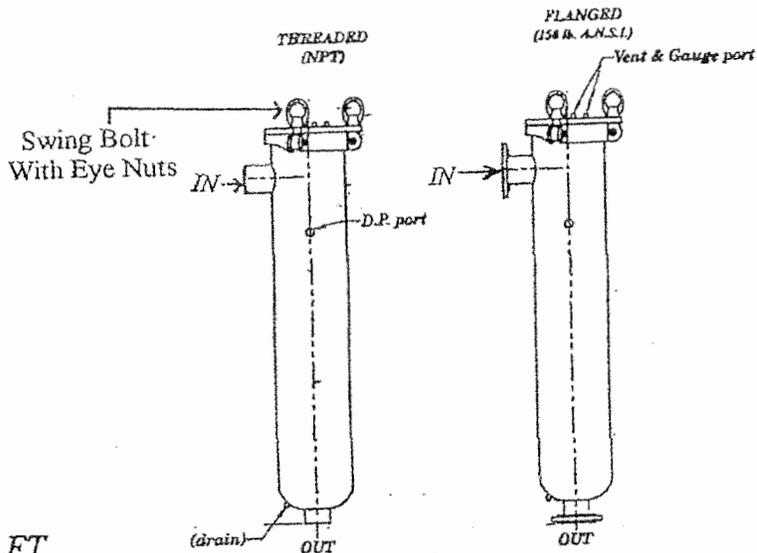
Periodic checks should be made on all housing lid and basket o-rings to ensure no cuts or damage has incurred that would cause the housing not to seal. If housing parts become damaged or worn, replace immediately.

<b>PART NUMBER</b>	<b>DESCRIPTION</b>
* LV	Viton Lid O-ring
88BV	Viton Basket O-ring
*LGCA	18" Tri-Pod Leg Assembly Carbon Steel
*LGSS	18" Tri-Pod Leg Assembly Stainless
EN	Eye Nut
RE	Rod End
CBA	Clevis Bolt Assembly
*LDCA	Lid Cover Carbon Steel
*LDSS304	Lid Cover Stainless Steel
PER APPLICATION **	Filter Bags
PER APPLICATION **	Filter Basket

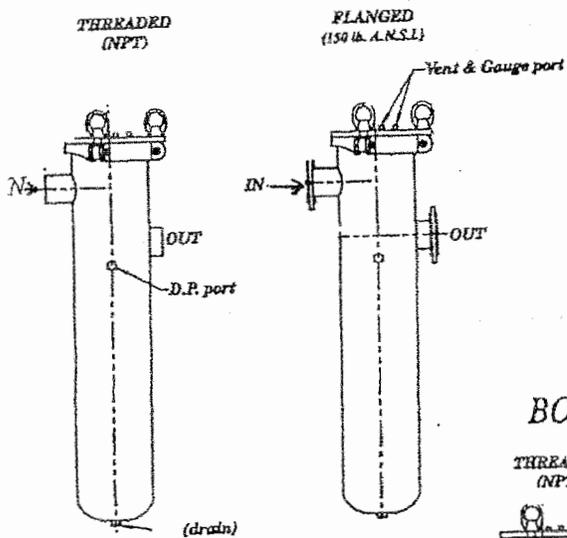
\* insert first two digits of housing model # (44,66, or 88)

\*\* Full line of replacement bags and baskets available

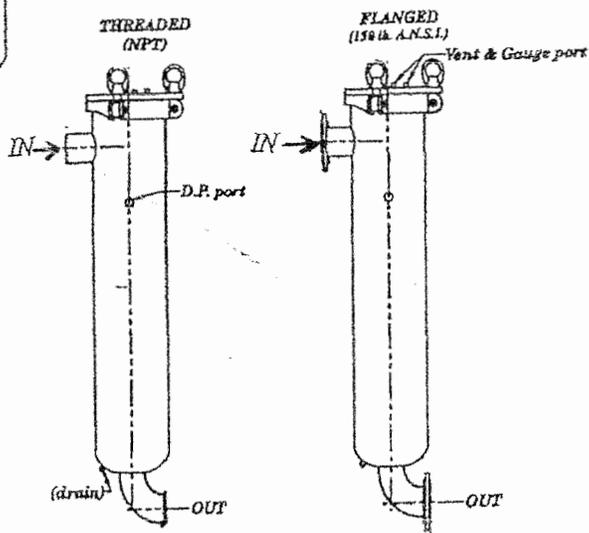
BOTTOM OUTLET



SIDE OUTLET



BOTTOM OUTLET 90°



## \*\*WARNING-SAFETY INFORMATION\*\*

- 1.) The housings in this catalog, if improperly used, can cause serious injury or death.
- 2.) Always wear proper protective clothing for the liquid being filtered. Check your M.S.D.S. for any instructions or suggestions.
- 3.) Do not run housing in excess of the rated pressure or temperature found on the housing tank label. (See warning #1)
- 4.) Check chemical compatibility of selected o-ring and housing material before housing installation.
- 5.) Do not open a housing when the system is under pressure; always relieve all pressure through housing before opening of housing lid.
- 6.) Stop all flow of liquid *before opening of lid.*
- 7.) Bolt housing to floor, as tipping may occur when lid is opened.

# E-Z Tray™ *Easy to Clean Removable Tray Air Strippers*

## THE MOST PRACTICAL, ECONOMICAL STRIPPERS

E-Z Tray™ air strippers (patent pending) are the only high-performance strippers with lightweight, front-slideout trays. They provide many advantages.

- Forced-draft air bubble technology delivers rapid, efficient VOC removal (to 99.999%) and generates a self-cleaning action that fights fouling
- One-person cleaning can save thousands of dollars per year on cleaning costs.
- Front serviceability - with just 4" clearance required at back and sides - allows positioning in corners, tight access or low-clearance locations - saving thousands more by cutting building space needs 10-40%.

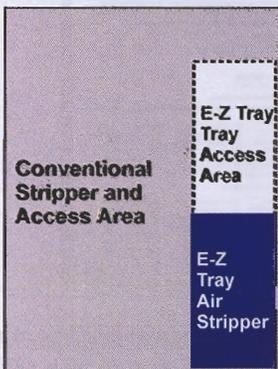
## HOW E-Z TRAY AIR STRIPPERS WORK

As influent enters through the top of the unit, millions of air bubbles are forced through the perforated trays, vigorously aerating the water to a froth and removing volatile contaminants as gravity pulls the water down through each tray. This simple, revolutionary technology delivers up to 99.999% removal, while the low maintenance and easy access cut O&M costs dramatically.



## QED Treatment Advantages

- Unique front access design provides long-term O&M savings
- Single-person cleaning
- Easy access stainless steel design, needs less floor space
- Provides up to 80% lower O&M
- High-efficiency VOC removal



SEVERN  
TRENT  
SERVICES

## QED ENVIRONMENTAL SYSTEMS

P.O. Box 3726, Ann Arbor, MI 48106-3726 USA [www.qedenv.com](http://www.qedenv.com)  
(800) 624-2026 734-995-2547 Fax: 734-995-1170 [info@qedenv.com](mailto:info@qedenv.com)

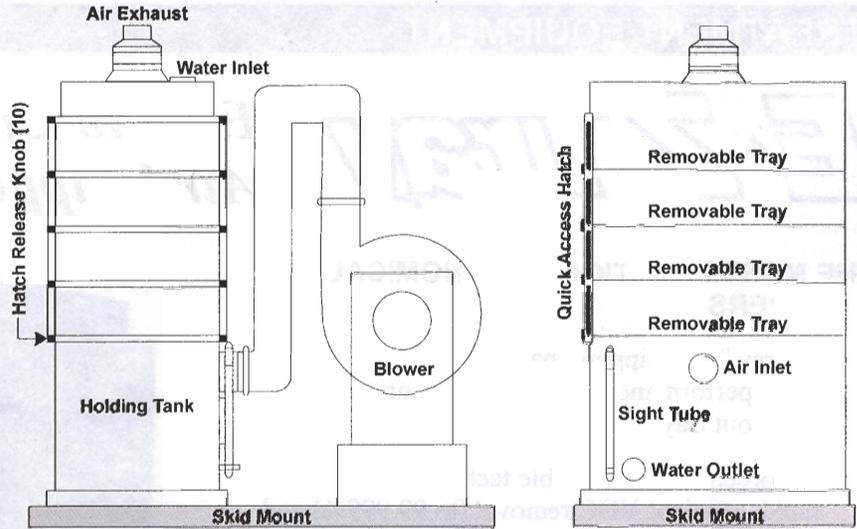
# E-Z Tray™

## STANDARD ITEMS

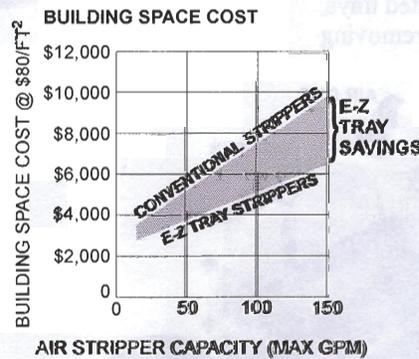
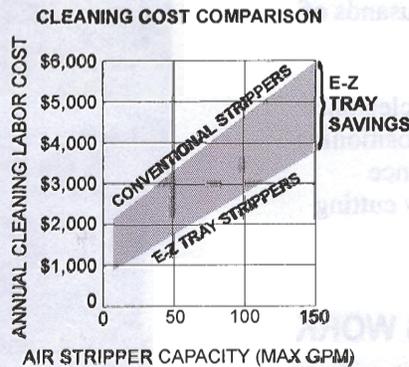
- One piece shell with integral sump
- Stainless Steel shell and trays
- Quick-access front hatch assembly
- Clear-PVC liquid level sight gauge
- Poly mesh demister
- Pre-piping

## E-Z TRAY OPTIONS

- EXP or TEFC blower & pump motors
- Spare trays
- Control panel
- Effluent pump
- Pump Controls
- Additional fittings
- Temperature & pressure gauges
- Water flow meter
- Pre-wiring
- Intrinsically safe sensors
- Base unit pre-plumbed to blower
- Skid mounting
- Stainless steel shell construction
- 4 and 6 tray units



## COST COMPARISON GRAPHS



**Note:** These are average cleaning costs, based on moderate levels of fouling requiring 12 cleanings per year at a labor cost of \$40.00/hour. Actual cost will vary depending on changes in these factors. This graph assumes every other Latch-Tray cleaning will require full disassembly, with internal spray-wand cleaning only in alternate months. Each E-Z Tray cleaning includes tray removal.

## MODELS TO FIT YOUR NEEDS, SPACE, AND BUDGET

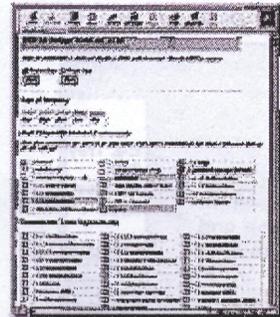
E-Z Tray air strippers are available in four or six-tray combinations, with maximum flow ratings from 1-25 GPM (4-100 LPM) through 1-200 GPM (4-760 LPM).

## E-Z Modeler

*Specifying air strippers can be easy - even for MTBE!*

Now there's a fast, simple way to choose the **right** air stripper for your remediation project, on-line!

With a few keystrokes and a couple of mouse clicks, QED's web-based *E-Z Modeler* tells you which air stripper is the best match for your flow rate and contaminant removal requirements - even for MTBE and other hard-to-remove substances.



Check it out at [www.qedenv.com/ezmodeler](http://www.qedenv.com/ezmodeler) or call to talk to a QED Applications Specialist about which E-Z Tray Stripper is right for your project - and find out how much you'll save.

## E-Z TRAY AIR STRIPPER SPECIFICATIONS:

Model Number	Max. Flow (GPM)	Dry Weight (lbs.)	Oper. Weight (lbs.)	Shell Dimension (LxWxH)
4.4 SS	1-25	630	985	29x27x82
4.6 SS	1-25	780	1,219	29x27x102
6.4 SS	1-60	790	1,285	37x27x82
6.6 SS	1-60	978	1,591	37x27x102
8.4 SS	1-60	955	1,590	49x27x82
8.6 SS	1-60	1,182	1,956	49x27x102
12.4 SS	1-100	1,163	2,163	73x27x82
12.6 SS	1-100	1,442	2,606	73x27x102
16.4 SS	1-120	1,625	2,870	49x52x84
16.6 SS	1-120	2,011	3,553	49x52x104
24.4 SS	1-200	2,100	3,980	73x52x84
24.6 SS	1-200	2,599	4,926	73x52x104

## INSTALLATION DATA

Model No.	Water Inlet	Water Outlet	Blower Inlet	Exhaust Outlet	Water Drain	Blower HP (Std)
4.XSS	2" FNPT	3" FNPT	4" PIPE	4" PIPE	1" FNPT	5.0
6.XSS	2" FNPT	3" FNPT	4" PIPE	6" PIPE	1" FNPT	5.0
8.XSS	3" FNPT	4" FNPT	4" PIPE	6" PIPE	1" FNPT	5.0
12.XSS	4" FNPT	4" FNPT	6" PIPE	8" PIPE	1" FNPT	7.5
16.XSS	4" FNPT	4" FNPT	6" PIPE	8" PIPE	1" FNPT	7.5
24.XSS	4" FNPT	4" FNPT	8" PIPE	8" PIPE	1" FNPT	15

QED SAMPLE ENGINEERING SPECIFICATION

**ENGINEERING DATA SHEET 1  
AIR STRIPPER (REMOVABLE TRAY)**

GENERAL PRODUCT DATA

Model No.	Max. Flow (GPM)	Dry Weight (lbs)	Oper. Weight (lbs)	Shell Dimension ("LxWxH)	Trays per tier (no x lbs)	Active Area (sq ft)	Nom. air flow (cfm)	*Required Clearance (inches)
4.4	1-25	630	985	29 x 27 x 82	4 x 29	2.8	210	4 x <27
4.6	1-25	780	1,219	29 x 27 x 102	6 x 29	2.8	210	4 x <27
6.4	1-60	790	1,285	37 x 27 x 82	4 x 40	3.8	320	4 x <35
6.6	1-60	978	1,591	37 x 27 x 102	6 x 40	3.8	320	4 x <35
8.4	1-60	855	1,588	49 x 27 x 82	4 x 50	5.6	420	4 x <47
8.6	1-60	1,182	1,956	49 x 27 x 102	6 x 50	5.6	420	4 x <47
12.4	1-100	1,165	2,105	73 x 27 x 82	4 x 74	8.8	600	4 x <71
12.6	1-100	1,442	2,606	73 x 27 x 102	6 x 74	8.8	600	4 x <71
16.4	1-120	1,625	2,870	49 x 52 x 84	8 x 50	11.1	850	4 x <47
16.6	1-120	2,011	3,553	49 x 52 x 104	12 x 50	11.1	850	4 x <47
24.4	1-200	2,100	3,980	73 x 52 x 84	8 x 74	17.5	1300	4 x <72
24.6	1-200	2,599	4,926	73 x 52 x 104	12 x 74	17.5	1300	4 x <72

\*Required clearances (back/sides by front, installed on standard skid)

INSTALLATION DATA

Model No.	Water Inlet (" FNPT)	Water Outlet (" FNPT)	Blower Inlet (" flange)	Exhaust Outlet (" O.D. pipe)	Water drain (" FNPT)	+Exhaust Stack size (inches)	*Max. back pressure ("H <sub>2</sub> O)
4.4	2	3	4.5	4.5	1	4	10
4.6	2	3	4.5	4.5	1	4	5
6.4	3	3	4.5	6.63	1	6	10
6.6	3	3	4.5	6.63	1	6	5
8.4	3	4	4.5	6.63	1	6	10
8.6	3	4	4.5	6.63	1	6	5
12.4	4	4	6.63	6.56	1	6	10
12.6	4	4	6.63	6.56	1	6	5
16.4	4	4	6.63	8.62	1	8	10
16.6	4	4	6.63	8.62	1	8	5
24.4	4	4	8.63	8.63	1	8	10
24.6	4	4	8.63	8.63	1	8	5

+ Minimum recommended nominal diameter of exhaust stack, if added

\* Maximum clean-tray exhaust back-pressure allowed without auxiliary blower

# QED Environmental Systems

6155 Jackson Ave. Ann Arbor, MI 48103 Phone: 800-624-2026 Fax:734-995-1170

## QED EZ-Tray™ Air Stripper System Operations and Maintenance Manual

**QED Treatment Equipment, P.O.Box 3726, Ann Arbor, MI 48106**  
**Phone: (800)-624-2026, Fax: (734)-995-1170**  
**p/n 95167 Rev 3/18/04**

***EZ-TRAY™ AIR STRIPPER  
OPERATION AND MAINTENANCE MANUAL***

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Thank you for relying on QED Treatment Systems to handle your treatment needs. After reading your Operation and Maintenance Manual, if you have any questions regarding the startup or operation of your system, please contact the **QED Service and Repair Department at 1-800-624-2026.**

***PLEASE NOTE!***

**Read your QED Operation and Maintenance Manual First!**

The manual will assist you in the proper procedure for equipment hookups, installation, startup, maintenance, and troubleshooting.

**It is Important That a Qualified, Licensed Electrician Perform All Electrical/Wiring Installation Work.**

Please see Equipment Set-Up in the Operating Instructions section of this manual.

**Follow the Manufacturers Instructions**

All the mechanical equipment that was supplied with your air stripper system should include the respective manufacturer's instruction manual for each piece of equipment. The documentation will either be found with the actual piece of equipment (if shipped loose) or found within a QED Operation and Maintenance manual that includes all relevant manufacturers' instruction sheets.

**Follow Safe Work Practices**

Be sure to follow all associated safety practices.

## ***BASIC SYSTEM DESCRIPTION***

EZ-Tray™ systems are fabricated from rugged stainless steel, or treated carbon steel. Each system is pre-assembled and factory tested before shipment to your site. EZ-Tray™ low profile air strippers are built to meet site and project specifications, which can include a number of standard or optional pieces of equipment. Depending upon the specifics of your order, the equipment described in this manual may or may not be included with your system configuration. Please refer to your sales order for the equipment that should be included with your system. Equipment information will be found either within this O&M manual or in separate documentation provided in addition to this manual.

### **Air Pressure Gauge (Standard)**

The standard pressure gauge reads the differential pressure between the sump pressure and atmospheric pressure, in inches of water column. The gauge is connected to the system via tubing that is attached to a pressure port on the air stripper sump. The air hose connected to the sump leads to the "high" pressure port on the gauge. The "low" pressure port is left open to the atmosphere.

### **Demister (Standard)**

A demister pad is installed beneath the air discharge stack located on the top cover of the unit. The purpose of the demisting pad is to remove entrained water droplets that would have blown through the discharge stack. It is possible, though unlikely, that the demisting pad may become plugged or fouled. If this occurs the demisting pad is easily removed. Disconnect the vent line, take off the demister cap, and remove the demister. The demisting pad can be cleaned with a pressure washer or replaced with a new one.

### **Gaskets (Standard)**

Three gaskets are used in the EZ-Tray™ air stripper units. One gasket is installed in the air discharge stack flange, one gasket is used to form an airtight seal between the front hatch and aeration trays, and a felt gasket is located on the underside of each aeration tray. Through the course of regular maintenance, these gaskets will eventually wear and will not seal effectively. When the gaskets are ripped, worn, or do not seal properly, these gaskets should be replaced. Contact QED for replacement gaskets and adhesive. Please contact QED prior to making any gasket repairs or adjustments.

### **Sight Tube (Standard)**

The sight tube provides a means of easily viewing the water level in the sump tank.

### **Blower**

The blowers on the EZ-Tray™ low profile air stripper units are typically cast aluminum type B spark resistant, direct drive @ 3450 rpm, with motor options of TEFC or EXP. Each blower is selected to meet the proper air flow requirements (cfm) at the anticipated working pressures (inches of water column) of each system.

It is critical that the blower damper be opened wide enough to provide the unit with the designated minimum flow. If the damper is opened too wide, however, high airflow can cause water entrainment, with water droplets caught up in the airstream and sent out of the air stripper discharge stack.

It is also critical that water does not enter the blower housing while the blower is in operation; this will damage your blower and void the warranty. The high water level alarm switch prevents this from happening. Make sure it is installed correctly. If not installed by QED, it is recommended that the blower piping be of an inverted-U design, capable of collecting water within the blower piping and minimizing the potential for blower flooding. Please refer to Figure 3 for a typical blower piping configuration.

If water does accumulate in the blower, it must be removed from the blower housing before continuing operation. A small drain hole may be drilled and plugged on the bottom side of the blower housing to provide a means of discharging any water that may accumulate. Remove the plug temporarily to drain any water. Else, take off the front panel of the fan housing and remove the water.

When starting the unit for the first time, *check that the blower wheel is rotating in the direction of the arrow on the blower housing*. If you hear the blower wheel rubbing or any odd sounds shut down the system immediately and call QED.

### **Damper**

The standard QED blowers normally have a damper on the discharge side of the blower. The damper is used to make adjustments to the air flow rate (cubic feet per minute) of your system. The air flow rate is increased (higher cfm's) by opening the damper, and decreased by closing the damper.

Use the damper to adjust the sump pressure to its proper operating value. By adjusting the sump pressure, the proper operating airflow through the air stripper will be achieved. Follow the instructions given in the earlier "Air Pressure Gauge" section to obtain the correct sump operating pressure. Using an air flow meter and an air pressure gauge together is desirable for confirming airflow and sump pressure, especially when attempting to troubleshoot any problems encountered with the air stripper operation. It is also recommended that you keep a log book of pressure readings so you can determine when and the frequency of system fouling.

### **Air Blower Silencer**

The air blower silencer reduces the dynamic noise level of the blower. The size of the silencer and the type of connection used to mount it is dictated by the size of the blower and the choice of options. If a silencer is purchased through QED, they are typically shipped loose, for customer installation. The silencer can be mounted either horizontally or vertically (through the use of an elbow) but should be properly supported to avoid over-stressing the blower housing. Silencers exposed to high wind velocities should also be properly secured.

### **Air Flow Meter**

The air flow meter measures the amount of air flowing through the system. If it is a pitot tube-type, two air tubes lead from the air piping to a meter/gauge. To operate effectively, the pitot tube must be located a minimum required distance upstream and downstream from elbows, valves, etc. Refer to manufacturer's installation instructions for proper installation procedures.

The air flow meter typically gives readings in feet per minute, which is then multiplied by the cross sectional area, square feet, of the vent line to give cubic feet per minute (CFM). As stated in the damper section, the air flow meter is needed to make damper adjustments, especially after initial start-up.

## **Control Panel**

The control panel serves two basic functions required for the safe operation of the system. The first is to provide the required electrical safety components for each motor (blowers and pumps) per NEC standards. These components consist of fuses, motor starters, and overload relays.

The second function is to provide the required process safety alarm components. The alarm circuit monitors the low air pressure switch and the high water level alarm switch. If either of these alarms occur then the alarm contacts will shut off the incoming water source (feed or well pumps) if the appropriate connections have been made. A qualified, licensed electrician should perform any and all electrical connections.

## **Control Panel Intrinsically Safe Components**

EZ-Tray™ low profile air stripper systems that process potentially explosive concentrations of vapors require intrinsically safe (IS) signals to all electrical components housed in non-explosion proof enclosures. The IS signal does not have enough energy to ignite the concentration of any NEC classified explosive vapor. Typical components that need IS signals are the float switches and well probes. Determination of when IS signals are required is generally the responsibility of the groundwater remediation engineer who has placed the order for a system. A qualified, licensed electrician should perform any and all electrical connections.

## **Water Flow Indicators and Totalizers**

The digital water flow indicator, typically installed in the incoming process water line or shipped loose, reads the rate of flow (GPM) and the totalized flow (gallons). The flow meters are selected to exceed the maximum flow of your system while providing a wide working range. The digital face plate is battery operated and intrinsically safe. The mechanical components of the meter is the turbine styled rotor which spins around a shaft that is axial to the flow of water.

The standard nutating disc meters have a totalizing function only. They operate upon the positive-displacement principle, where the flow of water through the meter moves a disc which in turn rotates a magnet. Every magnet rotation corresponds to a fixed volume of fluid which is then added to the summed total of flow.

## **Feed and Discharge Pumps**

Any transfer pumps included in the air stripper order have been selected by our engineering staff to meet all known flow and pressure requirements. The standard pumps are typically stainless steel centrifugal-type with motor options of EXP or TEFC. The standard pumps are not self-priming; they must be primed *before starting* by filling either the discharge port or the priming port with clean water until the entire pump chamber is full. The pipe/hose leading into the pump should also be full of water, too. Install throttle valves on the discharge lines for adjusting water flowrate. The valve should be throttled back until the motor draws the nameplate current rating. Warning: If the pump is running wide open and it is not pumping against the required head, the pump will cavitate and adversely affect pump performance and pump life.

Centrifugal transfer pumps used by QED typically must be throttled back if they are not pumping against the required head. Before initial system startup, double check the pump rotation. A pump shaft rotating in the wrong direction could spin off the pump impeller and cause serious damage to the pump. Pumps operating in the wrong

rotation will show poor performance. Systems using pumps should have the flow rates tuned so that the discharge is keeping up with the feed pump.

### **High Water Level Alarm Switch**

The high water level alarm switch is one of the two alarm interlocks that must be properly connected by a licensed electrician prior to the system's initial start-up. Please see the Special Cautions at the beginning of the Operating Instructions section for more information. The purpose of the high water level alarm switch is to prevent water from flooding the blower by shutting off the incoming contaminated water once it has reached a designated level. The high water level switch will send an alarm signal when it is approximately 3½ inches above the coupling its cord emerges from.

### **Line Sampling Ports**

The line sampling ports provide a quick and easy means to take a water sample of both incoming contaminated water and outgoing clean water. The sampling ports are the ball valves located on both of the inlet and outlet piping. When starting the unit for the first time double check that the valves on the sample ports are closed.

When taking a water sample, open the valve and let the water flow for at least 1 minute prior to taking the sample. This purges the sample port of any stagnant water. When purging the sample port on the contaminated water line, make the contaminated water is collected in some sort of storage container and then properly dispose of the water after sampling.

### **Low Air Pressure Alarm Switch**

The low air pressure alarm switch is one of the two alarm interlocks that must be properly connected by a licensed electrician prior to the system's initial start up. Please see the Special Cautions at the beginning of Operating Instructions section for more information. The low air pressure alarm switch monitors the blower for continuous water treatment.

Should the blower fail, the low air pressure switch should be wired to shut off all incoming water. It, like the air pressure gauge, is connected to the system via an air hose which is attached to a pressure port on the sump tank. The air hose is connected to the "high" pressure port on the switch. The "low" pressure port is open to the atmosphere. Periodically inspect and remove any water which may have accumulated in the tubing. The presence of water can affect proper switch operation.

Test the switch, at initial start up, by removing the air hose from the pressure port on the sump tank once the system is in full operation. This should set the system into an alarm condition and shut off the incoming contaminated water.

### **Main Disconnect Switch**

The main disconnect switch removes power from the EZ-Tray™ low profile air stripper. A disconnect is required by the National Electric Code (NEC) and must be installed. Some control panels, not supplied by QED, contain an internal disconnect or circuit breaker to remove power. Disconnects supplied by QED are external to the control panel, providing flexibility in situations where a site already contains a disconnect for the air stripped system. A qualified, licensed electrician should perform any and all electrical connections.

### **Intermittent Operation**

Some systems are ordered with the intermittent operation option. EZ-Tray™ low profile air stripper systems can be designed to run intermittently when continuous blower

operation is a concern. When the feed water is flowing into the system, the blower will be in operation and the outlet pump (if provided) will maintain proper sump tank levels. When the feed water is shut down, the blower will run for an additional period of time to treat the water that had previously entered the air stripper before shutting down. When the feed water is restored, the blower will start up to treat the new incoming water. The benefits of intermittent operation are lower operating costs, better control of noise, and longer motor life.

### **Water Temperature Gauge**

The temperature gauges can be installed on both the inlet and outlet piping. The water temperature represents an important factor when estimating the system's performance since it directly effects removal efficiency. Temperature gauges provided by QED typically have read outs of 0-140 degrees F.

### **Water Pressure Gauge**

Water pressure gauges can be installed on both the inlet and outlet water lines. The gauges can be used to determine the water pressures entering and exiting the system. Excessively high readings could signal that something in your system is plugged. Large fluctuations in the pressure readings could be a sign that the water flow rate is varying.

## ***EQUIPMENT SET UP***

### **Special Cautions!**

**Use a Licensed, Qualified Electrician for Any and All Electrical/Wiring Work, and Always Use Proper Work Safety Practices!**

#### **Follow All Applicable Codes**

The plumbing and electrical installations must be performed by qualified personnel. All installations must be done in accordance with local, state and national codes.

#### **Install Adequate Supports on Piping and Ductwork**

The external process piping that will connect into and from the QED equipment should be properly supported to minimize stresses and vibration from non-QED equipment. The QED equipment is not designed to support the process water and air lines without proper structural support.

#### **Do Not Run Free Product, Oil or Grease Through the Air Stripper**

Free product will contaminate the unit by coating the sidewalls with a film of free-product. Air strippers are not designed to treat free product, oil, grease, or any other type of immiscible phase.

**Equipment Setup Steps** Depending upon how the system was ordered, some of the following instructions may not apply.

#### **Setup Step 1. Secure/Mount the Equipment**

For shipping purposes, the EZ-Tray™ unit may come either already skid-mounted or the equipment shipped loose. If shipped loose, locate the equipment as required and firmly secure to the floor, base, etc.

#### **Setup Step 2. Install the Blower Piping**

If the blower is not already pre-piped on a QED skid, install the blower piping to connect the blower outlet to the air inlet nozzle on the air stripper sump. Refer to Figure 3 for an example of a blower piping configuration.

#### **Setup Step 3. Level the EZ-Tray™ Unit**

Level the EZ-Tray™ unit. This is a critical step in the proper assembly of the equipment. The aeration trays must be as close to level as possible.

#### **Setup Step 4. Install Discharge Piping, either gravity-discharge or pump-discharge.**

#### **Install the Gravity Discharge Pipe (For Gravity Discharge Units Only)**

Refer to the outlet piping drawing in Figure 4 to assemble the piping kit and vacuum breaker. Customers providing their own gravity discharge piping must ensure that proper water sump levels are maintained during operation.

**It is essential that the piping be mounted vertically and that it be properly supported.** Install outlet piping from the pump's discharge port. Use proper pipe sealant, PVC cement, and proper plumbing techniques as necessary.

**Caution: The vertical height of the piping should not be changed from that provided in the kit unless air stripper conditions have changed dramatically from the originally-specified flows. The piping kit includes flexible couplings to allow easy vertical height adjustment, should it be necessary.**

**Install the Pump Discharge Pipe (For Pump Discharge Units Only)**

For a unit with a discharge pump that has not come mounted to a QED skid, install the water line from the air stripper sump to the pump inlet. If customer has purchased a QED pump kit, the components will be found in a separate box. Install outlet piping from the pump's discharge port. Use proper pipe sealant, PVC cement, and proper plumbing techniques as necessary.

Prime the pump. Allow the inlet line and pump chamber to fill completely.

**Setup Step 5. Install the Sump Drain Valve and the Sight Tube** (if not already installed at the factory)

**Setup Step 6. Connect the Water Lines**

Connect the process water lines to the inlet and discharge piping. **Firmly support the process water lines to prevent excessive stress on the piping. The piping is not designed to support the weight of the customer's process water lines.**

Use proper pipe sealant, PVC cement, and proper plumbing techniques as necessary.

**Setup Step 7. Connect the Tubing Between Pressure Gauges, Pressure Switch(es), and Air Stripper Sump**

Connect the air line tubing from the hose barb located on the top of the sight tube to the high pressure ports on both the air pressure gauge and the air pressure switch(es). Keep the low pressure ports open to the atmosphere (remove plugs or caps).

**Setup Step 8. Install Air Discharge Stack**

Install any necessary extension to the air stripper air discharge stack as necessary. **Caution: Any added extension should have an inner diameter at least as large as the air stripper stack.** Connect the stack extension to the exhaust stack using a flexible rubber coupling or other suitable means. Support the extension independently of the air stripper so that it can be easily disconnected if the demister element must be removed for maintenance purposes.

**Setup Step 9. Wire the Electrical Components**

Have a qualified, licensed electrician wire up the electrical components in compliance with local, state, and national codes.

**IMPORTANT! Make sure the safety interlocks are connected properly!** To avoid damage to the blower and flooding of the equipment with contaminated feed water, install the high water level and low air pressure interlock switches. If the water level in the sump tank rises beyond the maximum level water could

flood the blower. This will destroy the blower and void the warranty. The high water level interlock switch will shut off the feed water pump in an emergency situation. The low air pressure interlock switch will shut off the feed water pump in the event of a blower failure. This reduces the risk of having untreated water passing through the air stripper.

If QED is supplying the control panel, refer to the appropriate wiring diagrams.

**Setup Step 10. Install Optional Items**

Refer to manufacturers' installation instructions for all equipment and properly support all equipment in an appropriate manner. This also applies to the optional air stripper blower silencer which requires support to avoid overstressing the air stripper blower housing.

## **START UP**

Please refer to Figures 1 and 2 at the end of this manual for a general drawing of an E-Z Tray air stripper and its aeration tray. Upon completion of the equipment set-up procedure (above), mechanical and electrical installation (including float switches, air pressure switches, etc.), proceed as follows:

**Startup Step 1. Turn Off Electrical Components Using the Site's Appropriate "Lock-Out" Procedure. Close Drain and Sample Valves.**

Check that all electrical components associated with the unit are turned off, and all drain and sample valves are closed.

**Startup Step 2. IMPORTANT! Fill the Inlet Chambers with Clean Water.**

Each downcomer (see Figures 1 and 2) must be sealed by having its end immersed in the seal pot water of the tray below it. Remove the air stripper front hatch and fill the seal pots to their proper levels (to the height of the weir). Failure to do so may create a situation where not enough back pressure is provided upon blower startup, causing the blower motor overload to trip.

**Startup Step 3. IMPORTANT! Fill the Sump Tank with One Foot of Clean Water.**

On initial start-up, the sump tank must be filled with clean water to a height of about one foot. The sump tank can be filled by taking off the front hatch and filling the sump directly or by disconnecting the water inlet piping and using a hose applied through the water inlet connection. The water level should be seen in the sight tube.

**Startup Step 4. Power May Now Be Supplied to the System.**

**Startup Step 5. IMPORTANT! Check the Blower Rotation (IMPORTANT for proper air stripper operation)**

Check the blower rotation by momentarily turning the Hand-Off-Auto (HOA) Switch to the "Hand" position ("bumping" the motor). Verify that the fan turns in the direction of the arrow on the blower casing. If rotation is incorrect 1) have a licensed electrician correct the wiring per manufacturer's instructions, and 2) check and correct the rotation of the other motor(s) in the system.

**(This is a common oversight and very often is the reason for inadequate blower operation. If the blower is not providing the expected airflow or backpressure, please double-check this step).**

**Startup Step 6. Connect a Clean Water Line to the Air Stripper Inlet. Trial-run Air Stripper System Using Clean Feed Water at the Expected Flowrate.**

Start the QED Air Stripper System by closing the Blower Damper and Placing the Appropriate HOA Switches in the "Auto" Position. Carefully open the damper to achieve the desired tray pressure or air flowrate at the anticipated water flowrate for the system.

**Startup Step 7. Monitor the Trial Run and Adjust the System Accordingly.**

The following items should be monitored as water builds up on each tray:

1. Proper sump pressure. This may require 15-30 minutes for the water to reach the proper depth on each tray. Once the blower has reached its operational speed and water flow is steady, the blower can be throttled to adjust airflow to optimal conditions. QED wet-tests every EZ-Tray unit for proper sump pressures at the customer’s expected water flow rates for “clean tray” and “fouled tray” conditions. The wet-test values are normally printed on a label and affixed to the side of the air stripper. Adjustments should be made first by referring to these wet-test pressure values. If no values are given, refer to the table below. The values are estimates, and vary depending upon the influent water flowrates. The table assumes there is no additional pressure from equipment downstream of the air stack. If downstream equipment adds backpressure, these values may not be accurate.

<b><u># of Trays</u></b>	<b><u>Typical Sump Operating Pressures, (approximate*)</u></b>
1 tray system	4-6" wc
2 tray system	8-12" wc
3 tray system	12-18" wc
4 tray system	16-24" wc
etc.	etc.

IT IS RECOMMENDED THAT A BOOSTER BLOWER BE USED IF IT IS EXPECTED THAT THE COMBINED PRESSURE LOSS OF THE QED AIR STRIPPER AND ANY DOWNSTREAM EQUIPMENT EXCEEDS 40" WC.

Be careful when making damper adjustments—fouling of the system over time will affect the air flow rate. A “fouled” system will have lower air flow at the same sump pressure reading than a clean system. A severely fouled air stripper will not produce the minimum air flow the system requires for proper performance. The blower damper should therefore be adjusted to the proper sump pressure after the trays have been properly cleaned. Refer to the “Equipment Maintenance Instructions” for proper cleaning procedures.

2. Check for any leaks and correct.

Note: If the blower overload trips, the system will shut down. This overload may indicate that the damper needs to be partially closed. Reset the overload and try to start the system again.

Once Step 7 is successfully completed, turn HOA switches to “Off” and proceed to Step 8.

**Startup Step 8. Replace the Clean Water Feed Line with the Contaminated Feed Line.**

Install the inlet piping according to proper plumbing practices. Use proper pipe sealant and PVC cement where necessary.

**Startup Step 9. Initiate Full Operation.**

Switch all air stripper system HOA switches to “Auto”.

**PLEASE NOTE:** The blower damper should now already be in its proper position to provide the desired airflow for the system's anticipated influent water flowrate; however, the airflow through the air stripper upon initiating "full operation" will be greater until water builds up on the trays. If this increased airflow is a concern, it is advised to close the damper slightly to throttle the airflow until the water has built up to its final height on each tray.

**Startup Step 10. Inspect and Record Unit's Operation Data**

Inspect the unit's operation at regular intervals and take pertinent instrument readings. Record readings and performance data in an operations log book.

**Startup Step 11. Set the Throttle Valve on Discharge Pump**

Units with a discharge pump are supplied with a throttle valve. The valve should be set so that the pump matches the influent flow rate without cavitation and draws no more than the rated full load amps stamped on the pump motor.

## ***SYSTEM SHUT DOWN PROCEDURE***

### **Shut Down Step 1. Shut Water Off**

Shut off the water feed to the system.

### **Shut Down Step 2. Wait 5 Minutes Before Blower Shutoff**

Wait 5 minutes to allow the water in the aeration trays to be completely treated, then shut off the blower.

### **Shut Down Step 3. Shut Power Off**

Shut off power at the main disconnected switch if more than a temporary shut down is anticipated.

### **Caution:**

**If proper shut down procedures are not followed contaminated water will drain into the sump and contaminate the water that has collected in the sump. Allow the blower to run the additional 5 minutes after the feed water is shut off.**

## ***EQUIPMENT MAINTENANCE INSTRUCTIONS***

This information describes how to clean the QED EZ-Tray™ Air Stripper unit. Please refer to the manufacturer's instructions for maintenance on the non-air stripper equipment.

### **Tray Fouling**

With normal operation of the air stripper, the sump pressure will typically increase over time. This typically indicates that the air stripper trays are becoming fouled. If this occurs, shut down the system. Remove the door and visually inspect for signs of fouling and clean the air stripper as outlined in the "Maintenance" section of this manual. Occasionally inspect the pressure gauge tubing for water build up. Water trapped in the air tubing could produce an erroneous reading. A pinch clamp is provided on the tubing and should be closed when no one is at the site in order to prevent potential condensate accumulation. Condensation buildup will ruin the pressure gauge.

### **Dealing with High Mineral Concentrations**

Minerals, dissolved in high concentrations, tend to precipitate out of groundwater during aeration processes. These minerals form insoluble deposits commonly referred to as "fouling". Deposits from iron-rich or mineral-rich feed water can be reduced by pre-treating it with sequestering agents or possibly other types of technologies. There are a number of sequestering suppliers that should be able to offer recommendations or suggestions. The recommended cleaning procedure is pressure washing. Follow the instructions detailed below.

### **Cleaning the Air Stripper**

#### **Recommended cleaning equipment:**

##### **Pressure Washer with Washer Wand**

2 GPM minimum flow at 900 PSI maximum. Equipment rental companies can usually supply such a unit on a daily rental basis.

##### **Clean Water Supply**

Clean water supply with a capacity of at least 2 GPM at 20 PSI, connected to the pressure washer by means of an ordinary garden hose.

**Cleaning the Unit.** The QED air stripper is designed for easy cleaning. Trays can either be removed for cleaning or left in the unit and cleaned. Another option would be for the customer to purchase a spare set of trays which would allow maintenance personnel to replace the fouled trays with clean trays and reduce air stripper downtime and allow the maintenance personnel to clean the trays at a more convenient time.

#### **Cleaning Step 1. Turn Off Equipment, Perform Electrical "Lockout" Procedure**

Turn off the feed water supply and all associated electrical equipment.

#### **Cleaning Step 2. Provide for Waste Disposal**

Make provisions for disposing of the sludge and waste generated during cleaning.

**Cleaning Step 3. Remove Front Cover(s). Either remove the trays from the air stripper unit or leave them in for cleaning.**

**Cleaning Step 4. Turn On Water and Pressure Washer**

Turn on the water supply to the pressure washer. Then, turn on the pressure washer itself. Wear protective goggles while spraying.

**Cleaning Step 5. Insert Wand into Air Stripper** (This step is for cleaning trays while they remain in the air stripper unit. If trays have been removed for cleaning, skip step 5 and proceed to step 6.)

Insert the wand all the way into the door opening. Point the spray nozzle up towards the bottom of the lowest tray.

**Cleaning Step 6. Clean Bottom Side of Tray**

Holding the wand tightly, pull the trigger to start the pressurized water flow. Expect the wand to kick back as flow starts. Move the wand side to side at a rate of about 1" per second. Be sure to cover the entire tray bottom area. The tray holes must be cleaned of all deposits. Periodically stop the cleaning operation and inspect the cleaned area. The area is clean when there are no deposits around the aeration holes.

**Cleaning Step 7. Clean Top Side of Tray**

Move the wand to the top side of the tray. Continue spraying with the nozzle pointed down onto the top surface of the tray. Also clean the downcomer and sealpot areas. Remove all visible deposits from the tray baffles and the walls of the unit. Inspect the cleaned area for deposits.

**Cleaning Step 8. Repeat for all Trays**

Repeat the procedure for all trays, working up to the top-most tray.

**Cleaning Step 9. Spray the Ceiling and Walls of the Air Stripper.**

If the air stripper is a mild-steel unit with coal tar epoxy coating, extra care must be taken not to remove the epoxy with the high pressure water. Cleaning the walls and ceiling are not necessarily required for proper air stripper operation.

**Cleaning Step 10. Rinse**

After the cleaning operation is finished, rinse the ceiling, trays, baffles, and walls with the pressure sprayer. Work down from the top down to the sump tank. Make sure the surfaces are clean and the holes are not blocked by loosened debris.

**Cleaning Step 11. Check the Demister Pad and Replace as Necessary**

Inspect the demister pad and clean as needed.

Use the pressure sprayer to remove debris, deposits and gummy residues sometimes found on the demister pad.

Demister pads that are excessively plugged should be replaced.

**Cleaning Step 12. Inspect the Air Stripper**

Visually inspect the air stripper box for the following:

1. Gasket integrity
2. a. If this is a mild steel unit, the internal and external epoxy-coatings must be inspected for exposed areas. Scratches, chips, burns, etc. will expose the mild steel to water, contaminants, and the elements, creating potential for corrosion. These exposed areas must be cleaned, dried, and re-epoxyed before commencing air stripper operation. Contact QED for touchup epoxy.  
b. If this is a steel unit, inspect the air stripper for any damage and repair as necessary.
3. Aeration tray integrity. Inspect trays for structural damage, felt gasket integrity, and acceptable silicone sealant in the sealpot area. Check the downcomer of each tray for holes, rips, etc. Replace as necessary. Contact QED for replacement items.
4. Inspect the internal piping (typically PVC piping) and replace as necessary.

**Cleaning Step 13. Follow Manufacturer's Instructions for Maintenance on Non-Air Stripper Equipment**

## **TROUBLESHOOTING**

### **Problem 1. Blower Won't Start or Run**

#### **No Power to Blower**

Check that all switches are in "ON" or "AUTO" position.

Position main disconnect switch to "ON" position. Turn control switches to "ON" or "AUTO".

#### **Blown Fuse**

Check to see if fuses are okay. Check fuses in main disconnect switch and in control panel.

If blown, replace with fuse of same size and rating.

#### **Overload Relay Trips**

Locate reset button on blower overload relay.

Rush reset button in. Reasons for tripping: incorrect line voltage, motor wired incorrectly, inadequate ventilation, bearings are bad.

#### **tubing to Pressure Switch Plugged with Water or Debris**

Remove tubing from pressure switch and blow into it towards tank.

Clean or replace tubing if plugged or kinked.

#### **Blower Wheel Jammed Against Side of Housing**

TURN OFF ALL power to the system. Try to spin wheel by hand. Wheel should rotate freely. Call QED.

### **Problem 2. Outlet Pump Won't Shut Off**

#### **Suction or Discharge Piping for Pump is Clogged**

Check water flow from discharge pipe. Piping should be clean inside. Look for narrowing caused by scale or iron accumulation.

Remove piping, inspect and clean or replace as necessary.

#### **Float Switch in Tank is Stuck in Down Position**

Look into sump and check that all floats are floating on the water.

Clean all deposits from float. Replace float is necessary.

#### **Normal Operation - Water Level in Sump is Okay**

Pump will stop when water level reaches pre-determined height in tank.

#### **Allow water level to decrease until pump turns off.**

Let water level reach pre-determined lower level, which will cause outlet pump to turn off.

### **Problem 3. Outlet Pump Won't Start or Run**

#### **No Power to Pump**

Check that all switches are in "ON" or "AUTO" position.

Position main disconnect switch to "ON" position. Turn control switches to "ON" or "AUTO".

#### **Blown fuse**

Check to see if fuses are okay. Check fuses in main disconnect switch and in control panel.

If blown, replace with fuse of same size and rating.

#### **Overload Relay Trips**

Locate reset button on pump overload relay.

Push reset button in. Reasons for tripping: incorrect line voltage, motor wires incorrectly, inadequate ventilation, bearings are bad.

#### **Normal Operation - Water Level in Sump is Okay**

Pump will start when water level reaches pre-determined height in tank.

Allow water level to increase until pump turns on. be sure pump switch is in "Auto" position.

Let water level reach pre-determined upper level, which will cause outlet pump to turn on.

#### **Level Switch in Tank is Wired Incorrectly in Control Panel**

Check wiring circuit against diagram. See that all connections are tight and no short circuits exist because of worn insulation, crossed wires, etc.

Rewire any incorrect circuits. Tighten connections, replace defective wires.

#### **Impeller, Seal or Bearing Damaged**

TURN OFF POWER. Try to turn impeller by hand.

If impeller won't turn, remove housing and locate source of binding.

### **Problem 4. Low Air Pressure in Stripper Tank**

#### **Blower Damper Closed**

Visually check position of damper on inlet of blower.

Open damper to get proper reading on pressure gauge. Firmly tighten screws.

#### **Motor Rotation Backwards**

Watch rotation of blower wheel at slow speed.

Reconnect for proper rotation as per motor diagram.

**Gravity Discharge Trap Installed Incorrectly**

Tray should be positioned vertically.

Install discharge trap per outlet plumbing drawings provided in Figure 4.

**Inlet Chamber (Sealpot) in each Tray is Not Full of Water**

Slide tray aside and look at water level in chamber.

Remove front cover. Fill up inlet chambers with a hose. Or, follow inlet chambers fill up procedures above in Initial Start Up.

**Front Cover not in Place**

Front cover must be secured during operation.

**Tubing to Pressure Gauge Plugged with Water or Debris**

Remove tubing from pressure gauge and blow into it towards tank.

Clean or replace tubing if plugged or kinked.

**Debris Blocking Blower Intake**

Look at blower intake. Remove any accumulated debris.

**Normal Operation for Automatic Unit**

When inlet pump starts, blowers will start, air pressure will rise to operational level.

No action necessary.

**Problem 5. High Pressure in Stripper**

**Air Exhaust Piping is Restricted**

Check vent piping for obstructions. Check that vent pipe diameter does not decrease.

Vent piping diameter must be the same as the outlet vent diameter on the cover.

**Air Holes in Bottom of Trays are Plugged**

Remove inspection and cleanout caps and visually inspect holes.

For iron fouling, clean out unit with a 1000 PSI pressure washer. For scaling, scrape or bang scale from all surfaces, then use a pressure washer to open holes. Consider using sequestering agent or other technology to reduce scaling.

**Demister Pad is Plugged**

Inspect the bottom of the demister pad in the cover. Clean and/or replace as necessary.

**Problem 6. Water Won't Flow into Unit**

**Inlet/Well Pump Functioning Properly**

Allow water level to rise in well pump, which will turn on inlet pump to system.

No action necessary.

**Tank Air Pressure is Low. System is in Alarm Condition**

Read tank air pressure from pressure gauge. System should be in alarm condition if pressure is below about 2 inches w.c.

Check that blower is operating properly. Check that all rubber caps are in place on end of trays.

**Inlet Piping is Plugged**

Remove inlet piping and inspect for debris and buildup.

Clean or replace clogged parts.

**Problem 7. Iron Fouling is a Problem**

**Iron Precipitates Out of Water When Treated with an Air Stripper Causing Iron Build Up in Unit**

Remove the front door(s) and inspect inside of tray for buildup/fouling.

Clean out unit with 1000 PSI pressure washer on routine basis.

Pretreat incoming water using sequestering agents or other appropriate technology.

## **QED TREATMENT EQUIPMENT WARRANTY**

QED Environmental Systems Inc. (QED) warrants to the original purchaser of its products that, subject to the limitations and conditions provided below, the products, materials and/or workmanship shall reasonably conform to descriptions of the products and shall be free of defects in materials and workmanship. Any failure of the products to conform to this warranty will be remedied by QED in the manner provided herein.

QED warrants the equipment components of its manufacture for a period of one (1) year from date of delivery. Our sole obligation during this warranty will be to repair or replace (at our option) the defective components. We are not responsible for consequential damages. Labor costs are not included.

Purchaser's exclusive remedy for breach of said warranty shall be as follows: if, and only if, QED is notified in writing within the applicable warranty period of the existence of any such defects in the said products, and QED upon examination of any such defects, shall find the same to be within the term of and covered by the warranty running from QED to Purchaser, QED will, at its option, as soon as reasonably possible, replace or repair any such product, without charge to Purchaser. If QED for any reason, cannot repair a product covered hereby within four (4) weeks after receipt of the original Purchaser's notification of a warranty claim, then QED's sole responsibility shall be, at its option, either to replace the defective product with a comparable new unit at no charge to the Purchaser, or to refund the full purchase price. In no event shall such allegedly defective products be returned to QED without its consent, and QED's obligations of repair, replacement or refund are conditioned upon the Purchaser's return of the defective product to QED.

### **IN NO EVENT SHALL QED ENVIRONMENTAL SYSTEMS INC. BE LIABLE FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES FOR BREACH OF SAID WARRANTY.**

The foregoing warranty does not apply to major subassemblies and other equipment, accessories, and other parts manufactured by others, and such other parts, accessories, and equipment are subject only to the warranties supplied by their respective manufacturers. In the event of failure of any such product or accessory, QED will give assistance to Purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in light of the manufacturer's own warranty.

**THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY (INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE), WHICH OTHER WARRANTIES ARE EXPRESSLY EXCLUDED HEREBY,** and of any other obligations or liabilities on the part of QED, and QED neither assumes nor authorizes any person to assume for it any other obligation or liability in connection with said products, materials and/or workmanship.

It is understood and agreed that QED shall in no event be liable for incidental or consequential damages resulting from its breach of any of the terms of this agreement, nor for special damages, nor for improper selection of any product described or referred to for a particular application.

This warranty will be void in the event of unauthorized disassembly of component assemblies. Defects in any equipment that result from abuse, operation in any manner outside the recommended procedures, use and applications other than for intended use, or exposure to chemical or physical environment beyond the designated limits of materials and construction will also void this warranty.

The equipment is warranted to perform as specified under the conditions specified here and within the air stripper model or QED will make the necessary changes at no cost to the owner. Some restrictions apply. Requirements for warranty consideration include, (but are not limited to):

1. Current operating conditions do not differ from the previously-modeled conditions.
2. The system should be cleaned regularly to maintain system performance.
3. The equipment is installed, operated and maintained according to QED's instruction or non-QED manufactured subassembly manufacturer's instructions.
4. Air stripper influent air is not "dirty" (does not contain VOC's, etc.).
5. No surfactants, oils, greases, or other immiscible phases are present in the water.
6. Each influent contaminant does not exceed 25% of its maximum solubility under modeled conditions.

QED shall be released from all obligations under all warranties if any product covered hereby is repaired or modified by persons other than QED's service personnel unless such repair by others is made with the consent of QED. If any product covered hereby is actually defective within the terms of this warranty, Purchaser must contact QED for determination of warranty coverage. If the return of a component is determined to be necessary, QED will authorize the return of the component, at owner's expense. If the product proves not to be defective within the terms of this warranty, then all costs and expenses in connection with the processing of the Purchaser's claim and all costs for repair, parts and labor as authorized by owner hereunder shall be borne by the Purchaser.

In the event of air stripper performance issues, QED may require customer to conduct a variety of troubleshooting steps. These include, but are not limited to, modifying operational parameters, cleaning air stripper system, modifying (temporarily or permanently) process piping, and obtaining reasonable and necessary influent/effluent samples. These steps are the responsibility of the customer and will be conducted by customer prior to consideration by QED for a site visit. These steps and the associated costs incurred are the responsibility of the customer, regardless of future action. Should customer request a site visit by QED or accept a site visit offer by a QED-trained technician, the visit and associated costs: a) will be the responsibility of the customer at \$500/day, plus travel, lodging, and meals, if the visit finds improper sampling, process piping installation, or equipment operation inconsistent with QED's Operation and Maintenance Manual; or b) will be the responsibility of QED if the visit finds QED responsible for the performance issue(s) raised.

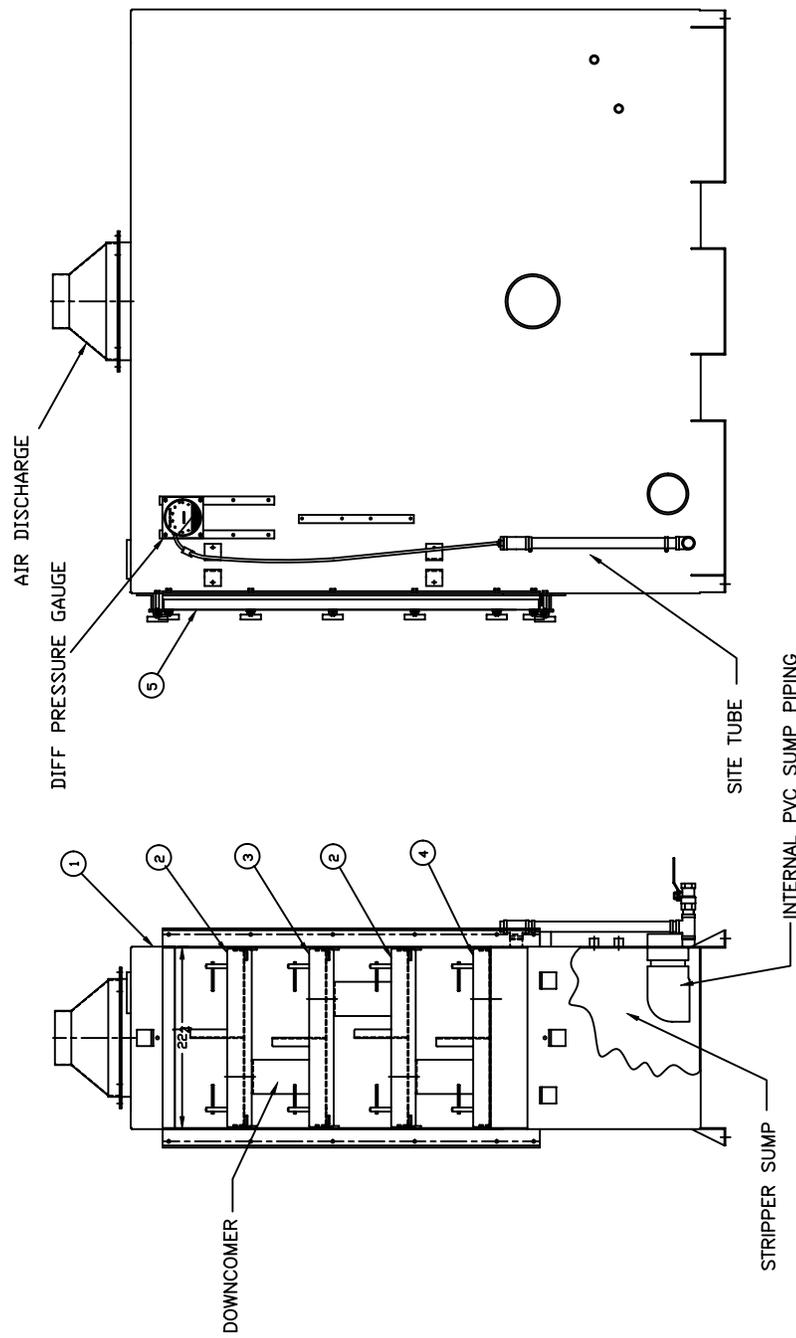
The original Purchaser's sole responsibility in the instance of a warranty claim shall be to notify QED of the defect, malfunction, or other manner in which the terms of this warranty are believed to be violated. You may secure performance of obligations hereunder by contacting the Customer Service Department of QED and:

1. Identify the product or system involved by job number or QED order number.
2. Specifying where, when, and from whom the product was purchased.
3. Describing the nature of the defect or malfunction covered by this warranty.
4. If applicable, send the malfunctioning component, *after receiving a Return Authorization Code (RAC) Number by the QED Service Department, to:*

**QED Environmental Systems Inc.  
6241 Jackson Road  
Ann Arbor, MI 48103**

**Attn: R.A.C. No.** (Return Authorization Code Number provided by QED Service Dept.)

FIGURE 1. GENERAL DWG OF E-Z TRAY AIR STRIPPER



ITEM	QTY	DESCRIPTION	REMARKS
6	1	WELDMENT, DEMISTER	QED #807048
5	1	STANDARD HATCH	QED #807019
4	1	SIEVE TRAY ASSEMBLY, BOTTOM RH	QED #807062
3	1	SIEVE TRAY ASSEMBLY, INTERMEDIATE RH	QED #807056
2	2	SIEVE TRAY ASSEMBLY, INTERMEDIATE LH	QED #807059
1	1	BOX ASSEMBLY 12.4 R.H. AIR STRIPPER	QED #807044

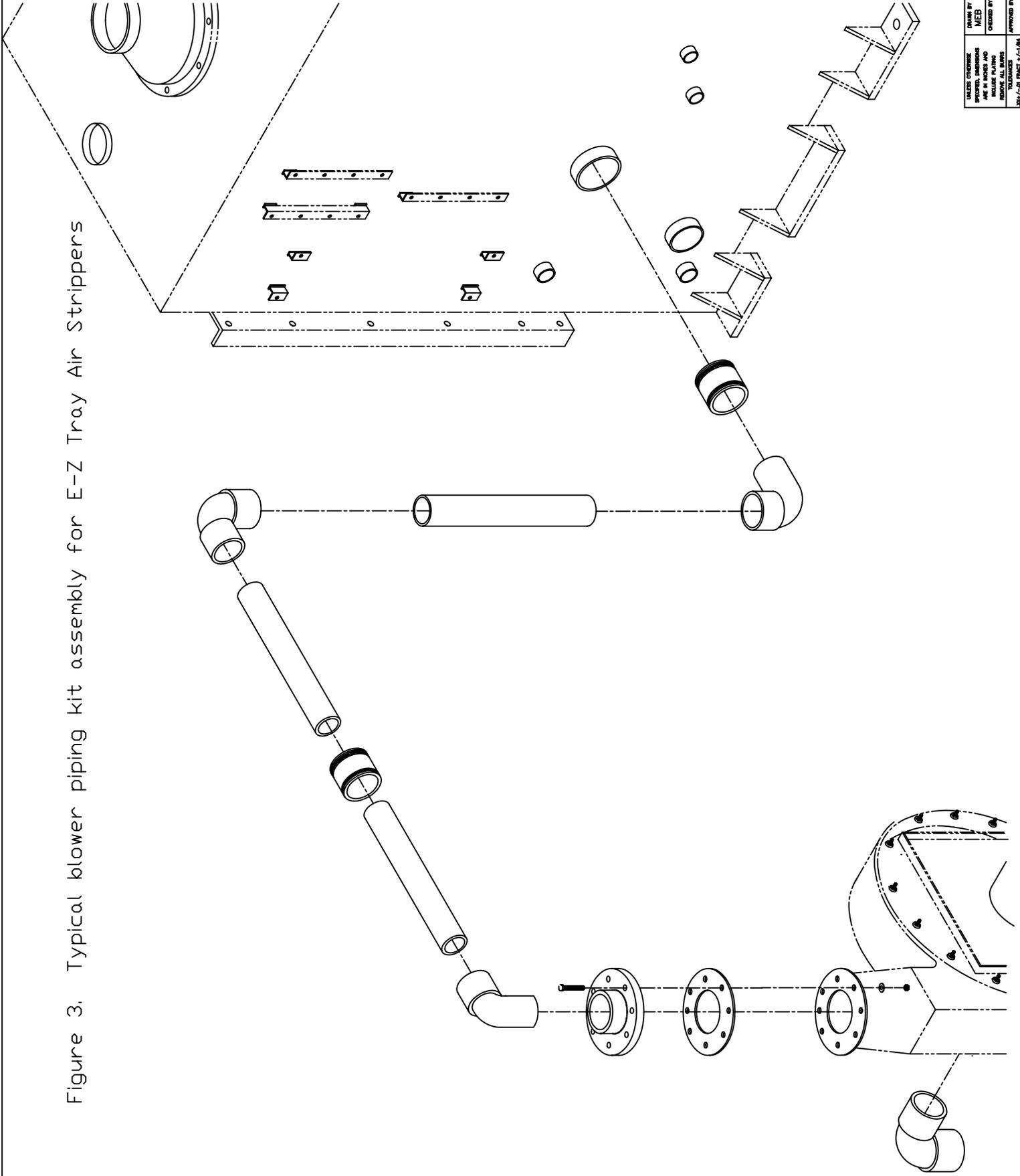
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES AND INCLUDE PLATING REMOVE ALL BURRS TOLERANCES .00X+/-01 FRACT +/-1/64 .00X+/-005 ANGLES +/-1/2 OTHER TOLERANCES AS SPECIFIED	DRAWN BY	DATE
	MEB	01/20/97
	CHECKED BY	
	APPROVED BY	
	MFG. APPROVAL	
	MATERIAL	

Q.E.D. ENVIRONMENTAL SYSTEMS, INC. 6155 JACKSON ROAD, ANN ARBOR, MI.	TITLE EZ-TRAY AIR STRIPPER DWG
DRAWING NUMBER ez1dwg.dwg	REV
SCALE	SHEET 1 OF 1

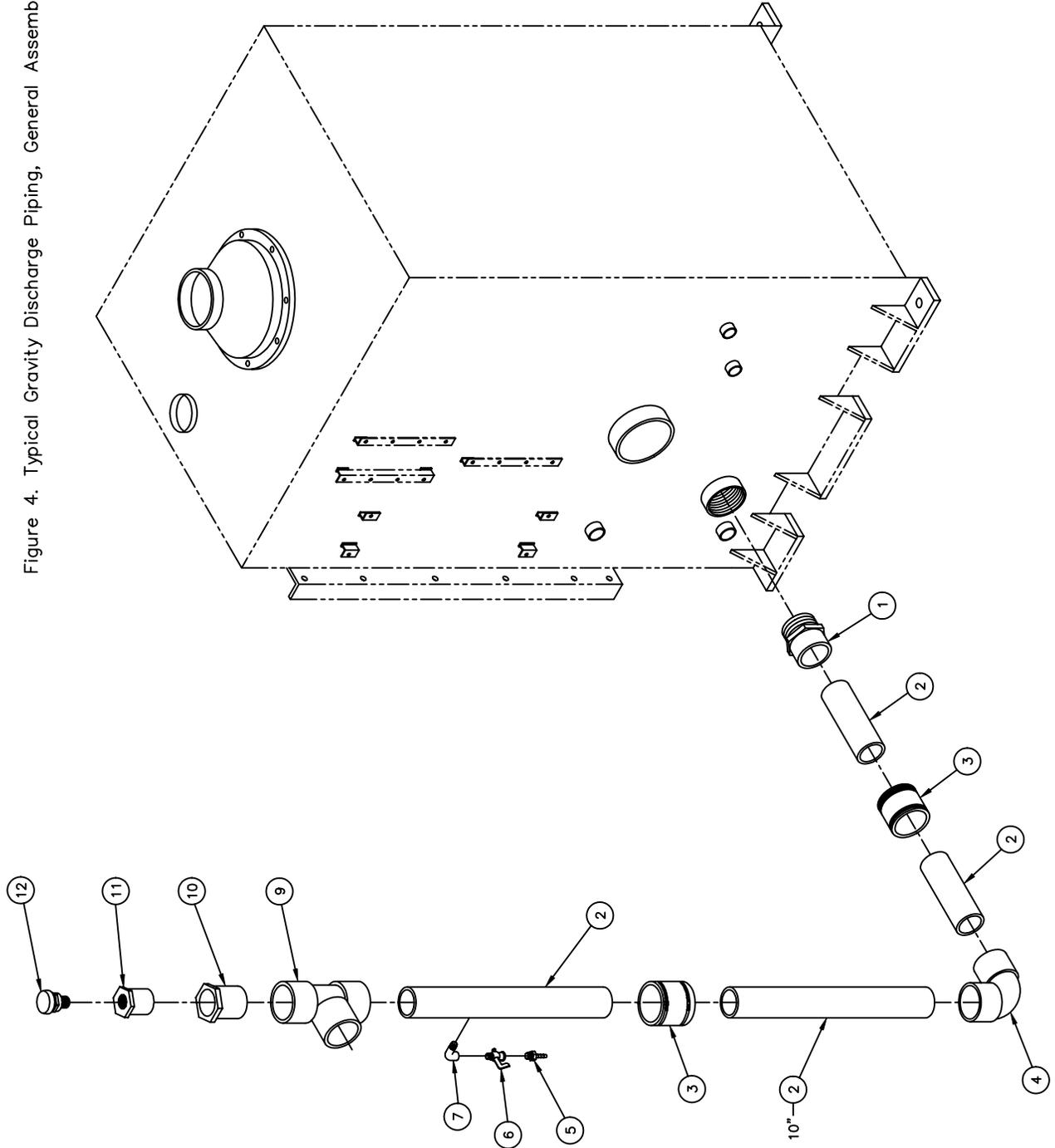


Figure 3. Typical blower piping kit assembly for E-Z Tray Air Strippers



UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES AND INCLUDE PLATING TOLERANCES	DESIGNED BY MEB	DATE 9/16/97	Q.E.D. ENVIRONMENTAL SYSTEMS INC. 6165 JACKSON ROAD, JAY, ARIZONA, AZ
200 +/- .01 INCHES +/- .01 INCHES OTHER TOLERANCES AS SPECIFIED	CHECKED BY	APPROVED BY DATE	TITLE BLOWER KIT W/O BLOWER ASSEMBLY/BOM/KIT
NEXT SIZE	USED ON	FIGURE	DRAWING NUMBER 02101KIT.CHG   REV A
			SCALE N.T.S.   SHEET 1 OF 1

Figure 4. Typical Gravity Discharge Piping, General Assembly



**NOTE:**  
 1. CENTER LINE OF WATER OUT (ITEM 1)  
 TO CENTER LINE OF DRAIN CONNECTOR  
 (ITEM 9) TO BE 27" - 6 TRAY  
 18" - 4 TRAY  
 (DIMENSIONS ARE APPROXIMATE--REQUIRES SOME ADJUSTMENT  
 AS NECESSARY BASED UPON PUMP PRESSURES AND WATER FLOWS.  
 ASSUMES STANDARD OPERATING CONDITIONS.)

12	1	BREAKER, VACUUM RELIEF 1/2"
11	1	BUSHING, SPI X THD PVC SCH 80
10	1	BUSHING, REDUCER SPI. X SOC.
9	1	TEE, SOCKET PVC SCH 80
8		
7	1	ELBOW, STREET 1/8" FPT BRASS
6	1	COCK, SHUTOFF 1/8"MPT X 1/8"FPT BRASS
5	1	BARB, 1/8"MPT X 3/16" BARB
4	1	ELBOW, 90 DEGREE PVC SCH 80 SOCKET
3	2	FERNCO, FLEXIBLE PVC
2	TBD	PIPE, PVC SCH 80
1	1	ADAPTER, PVC SCH 80
ITEM QTY		DESCRIPTION
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES AND INCLUDE PLAYING REMOVE ALL BURRS		DATE
TOLERANCES		10/29/99
.XX+/-01 FRACT +/0-1/64		MEB
.XXX+/-005 ANGLES+/-1/2		CHECKED BY
OTHER TOLERANCES AS SPECIFIED		APPROVED BY
EZ-TRAY (24-X)		MFG. APPROVAL
NEXT ASSY		MATERIAL
USED ON		FINISH
		SCALE N.T.S.
		SHEET 1 OF 1
		PART #
		QED
		ENVIRONMENTAL SYSTEMS INC.
		6155 JACKSON ROAD, ANN ARBOR, MI.
		TITLE
		GRAVITY DRAIN
		ASSEMBLY/BOM/KIT
		DRAWING NUMBER eztraydrain
		REV
		1

## Small Size – Alloys

### XM/XT-800 Series – Compact Analog Sensors

- ▶ Stainless or Brass Construction
- ▶ 1/4" Resolution
- ▶ Lengths to 144 inches (366 cm)
- ▶ OEM Configurations Available

These compact transmitters feature the rugged durability of stainless steel or brass construction. The XM-800 series provides analog output, and can be combined with GEMS Digital Meter Receiver Stations and compact Level Cubes described in this catalog. Our versatile XT-800 Series adds a choice of signal conditioning for use with GEMS digital bargraph receivers or other digital display and control equipment.

#### Approvals

XM-800 and XT-800 Series transmitters may carry the following commercial approvals:

- ◊ FM ◊ FM Approved, Explosion-Proof (J-Box and Stainless Steel Float required).
- UL Recognized.

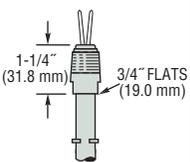
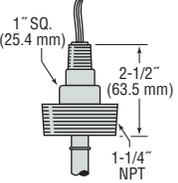
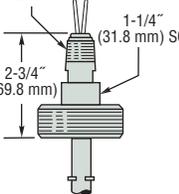
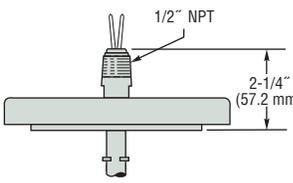
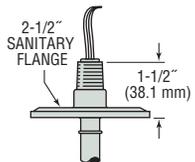
XM-800 Series transmitters only:

- CSA Certified

XT-800 Series transmitters only:

- ◊ FM ◊ FM Approved, Intrinsic Safety (J-Box and Stainless Steel Float required).

#### 1. Mounting Types

Type 1 1/2" NPT	Type 2 1-1/4" NPT	Type 3 2" NPT	Type 4 3" 150# Flange	Type 6 2-1/2" Sanitary Flange
				

<b>Stem Material</b>	Brass or 316 Stainless Steel	316 Stainless Steel	
<b>Mounting Material</b>	Brass or 316 Stainless Steel	Carbon Steel or 316 Stainless Steel	316 Stainless Steel
<b>Float Stop Material</b>	Brass Units: Beryllium Copper Grip Rings; Stainless Steel Units: S.S. ARMCO PH-15-7MO Grip Rings		
<b>Operating Temperature*</b> With J. Box Mounted or XM Signal Conditioners	Oil: -40°F to +230°F (-40°C to 110°C), Water to +180°F (82.2°C)—Buna N Float -40°F to +230°F (-40°C to 110°C)—Stainless Steel Float		
<b>With Stem Mounted Signal Conditioners</b>	+5°F to +160°F (-15°C to +70°C)		
<b>Operating Pressure</b>	Dependent on Float Type; See Next Page		
<b>Overall Length, Max.</b>	72" (183 cm) Tubing; 144" (366 cm) Pipe (Types 3 & 4 only)		

\* Consult factory for higher temperature ranges.

**ORDER IT!**

Ordering is Easy! See Page C-5.  
Easy online ordering too!

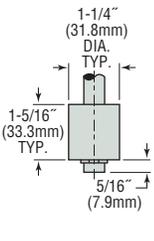
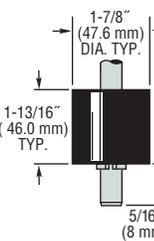
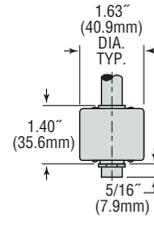
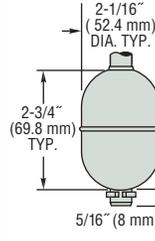
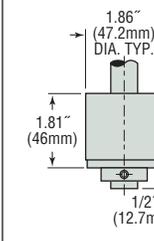
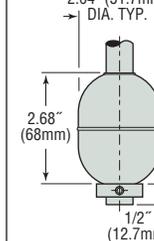
Lengths  
to 12 ft!



**3-Day**  
Qwik Configured  
Available for up to 5 units  
**Built & Shipped  
in 3 Days!**

## 2. Float Types

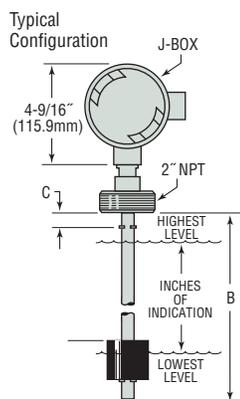
Based on the overall length required by your tank, select from two main subsets of floats below; further refine selection based on material and performance parameters.

Float Material	For Overall Lengths To 72"				For Lengths Greater Than 72" (144" Max.)	
	Buna N		Stainless Steel		Buna N	Stainless Steel
<b>Float Dimensions</b>						
<b>Compatible Mountings</b>	1, 2, 3, 4, 6	1, 3, 4	1, 3, 4, 6	1, 3, 4	3, 4	3, 4
<b>Part Number</b>	<b>164255<sup>2</sup></b>	<b>43359</b>	<b>156490</b>	<b>43590</b>	<b>69654</b>	<b>52084</b>
<b>Min. Liquid Spec. Gravity</b>	.55	.55	.70	.75	.55	.75
<b>Operating Pressure, Max.<sup>1</sup></b>	150 psi (10 bar)	150 psi (10 bar)	80 psi (6 bar)	300 psi (21 bar)	150 psi (10 bar)	300 psi (21 bar)
<b>Operating Temp., Max.</b>	Water: 180°F (82°C) Oil: 230°F (110°C)		230°F (110°C) <sup>3</sup>		Water: 180°F (82°C) Oil: 230°F (110°C)	230°F (110°C)*

Notes:

- @ Ambient Temperature
- Recommended for Type 2 mounting only.
- Consult factory for higher temperature range.

## 3. To Determine Dimensions



- B: Overall Length = Inches of Indication + C + X (See Table at Right)  
 C: Distance From Bottom of Mounting to Float Stop (Customer Specified):
- 1/4" (6.4mm) Minimum
  - 1-1/4" (31.8mm) Minimum on Type 1, XT Series only.

### Calculating Length

- To find Overall Length when Inches or Indication is known:
- Inches of Indication + C\* + X = Overall Length
- To find Maximum Inches of Indication when Overall Length is known:
- Overall Length - C\* - X = Maximum Inches of Indication

\*C dimension is determined by customer.

### Float Factor – X

Float Part Number	X
<b>164255</b>	2.0" (50.8)
<b>43359</b>	2.5" (63.5)
<b>156490</b>	2.062" (52.4)
<b>43590</b>	3.437" (87.3)
<b>69654</b>	2.687" (68.3)
<b>52084</b>	3.625" (92.1)

Inch (mm)

## 4. Input/Output

For XM-800 Series, no special output designation is necessary.  
 For XT-800 Series, specify the desired signal conditioning by Part Number.  
 Additional information about GEMS signal conditioning modules is found on Page C-16.

Series	Input Voltage	Output Signal	Part Number	Electrical Termination	Compatible Mountings		
					Type 1	Type 3	Type 4
XM-800	10 to 30 VDC	Proportional Voltage	—	Lead Wires (3), #22 AWG, 24" (60.9 cm), PTFE Jacket	•	•	•
					•	•	•
XT-800	8 to 24 VDC*	0-5 VDC	<b>51965</b>	Lead Wires, #22 AWG, 24" (60.9 cm), PTFE Jacket	•	•	•
	14 to 30 VDC*	0-12 VDC	<b>51970</b>		•	•	•
	8 to 24 VDC*	0-5 VDC	<b>52536</b>	Junction Box		•	•
	15 to 30 VDC*	0-12 VDC	<b>52537</b>			•	•
	10 to 40 VDC	4-20 mA	<b>52555</b>	Panel Mount with Plug-in Base		•	•
		4-20 mA	<b>112300</b>		•	•	•

\* Stem mounted.

### Important Points!

- Product must be maintained and installed in strict accordance with the National Electrical Codes, Gems technical brochure, instruction bulletin, and any applicable electrical code in the country in which the product is installed. Failure to observe this warning could result in serious injuries or damages.
- For hazardous area applications involving such things as (but not limited to) ignitable mixtures, combustible dust and flammable materials, use an appropriate intrinsically safe interface device.
- Warning: To prevent ignition of flammable or combustible atmospheres, disconnect power before servicing.
- The pressure and temperature limitations shown on the individual catalog pages and drawings for the specified level sensors must not be exceeded. These pressures and temperatures take into consideration possible system surge pressures/temperatures and their frequencies.
- Selection of materials for compatibility with the media is critical to the life and operation of GEMS level sensors. Take care in the proper selection of materials of construction, particularly wetted materials.
- Electrical entries and mounting points in an enclosed tank may require liquid/vapor sealing.
- Physical damage sustained by the product may render it unserviceable.

### Return Policy

Cancellations and returns are accepted up to 30 days from date of order. You must contact our Returns Department for a Return Authorization (RA) number. Then return goods, freight prepaid, in the original container and include original packing slip. C.O.D. returns are not accepted. Gems Sensors reserves the right to apply restocking or cancellation charges.

### Warranty

Gems Sensors, the seller, warrants its products to be free from defects in material and workmanship in normal use and service for a period of one year from date of shipment. Gems Sensors reserves the right and option to refund the purchase price in lieu of repair or replacement upon evaluation of the returned original part. Modification, misuse, attempted repair by others, improper installation or operation shall render this guarantee null and void. Imo Industries Inc., Gems Sensors, makes no warranty of merchantability or fitness for a part or purpose.

**Limits of Liability:** In no circumstances shall Gems Sensors be liable for special, consequential or exemplary damages of any kind or character, including contract, tort, and strict liability in tort and contract. Equipment sold by Gems Sensors is not intended for use in a nuclear installation, nor shall it be used as a "Basic Component" as same is defined under Part 21, Title 10 of the Code of Federal Regulations. In the event of such use, you agree to indemnify and hold us harmless from any and all subsequent liabilities and responsibilities which might arise in connection with such use.



**Gems Sensors Inc.**  
One Cowles Road  
Plainville, CT  
06062.1198

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fax 860.747.4244

(Inside the U.S., call 1-800-847-5691 TOLL-FREE)



## Continuous Level Transmitters

XM-800/XMP-800 Analog Output (Proportional Voltage)

XT-800/XTP-800 Signal Conditioned Output (4-20mA, 0-5 VDC, 0-12 VDC)

### Instruction Bulletin No. 179685

#### Note

XM-800 Series includes models XM-800, XMP-800, XM-850, XM-820

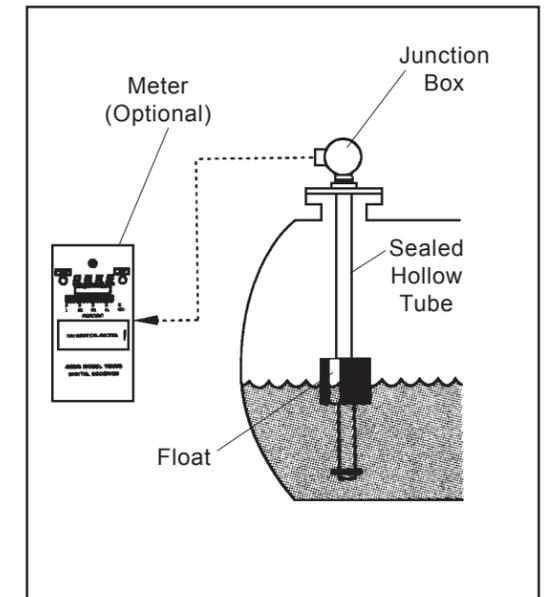
XT-800 Series includes models XT-800, XTP-800, XT-850, XT-820

**Designed for continuous liquid level sensing, GEMS transmitters are considered "components".**

### Operating Principle

The XM/XT-800 utilizes reed switch/magnet technology. A magnet-equipped float rises or lowers with corresponding liquid level. The magnetic field generated from the float actuates a series of reed switches mounted within a sealed hollow tube. The series of reed switches is combined with resistors to form a voltage divider.

When a regulated DC voltage is applied to an XM-800, the resulting voltage output is directly proportional to liquid level. An XT-800 is an XM-800 with a signal conditioned output, for use in applications that require unregulated input voltage or current output.



### Installation / Mounting

Units operate normally in any attitude, from vertical to a 30° inclination, up or down.

#### Thread Treatment

**Sealing:** When threading metal threads into a metal coupling, pipe sealant or Teflon tape is recommended. Due to potential compatibility problems, when sealing plastic threaded units, a compatible pipe sealant such as "No More Leaks" from Permatex is recommended.

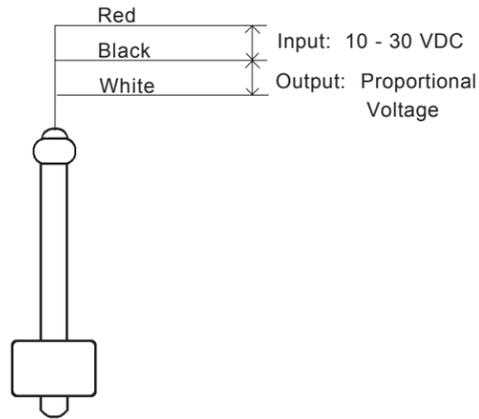
**Tightening (Plastic to Metal):** When threading a plastic sensor into a metal coupling, the installer should use a suitable wrench and tighten the threads 1 to 1-1/2 additional turns past hand-tight. Over-torquing of the threads will result in damage to the plastic mounting plug.

**Tightening (Metal to Metal):** When threading a metal sensor into a metal coupling, the installer should use a suitable wrench and tighten the threads 1-1/2 turns past hand-tight.

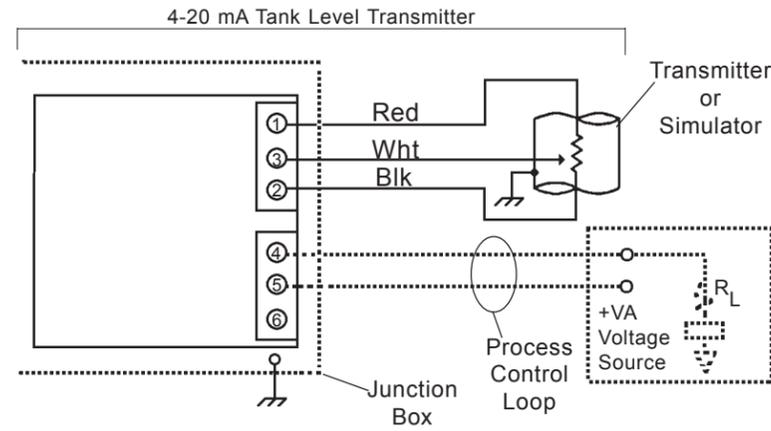
## Wiring Diagrams

**Note:** For hazardous area applications, use an appropriate intrinsically safe interface device.

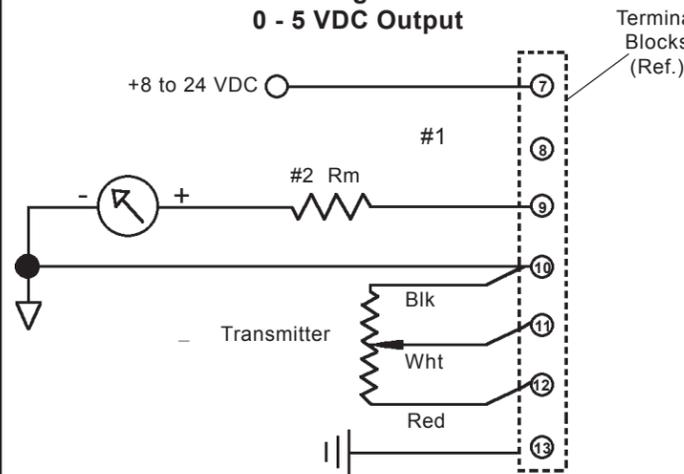
### XM-800 Wiring Diagram Analog Output (Proportional Voltage)



### XT-800 Wiring Diagram (4-20mA Output)



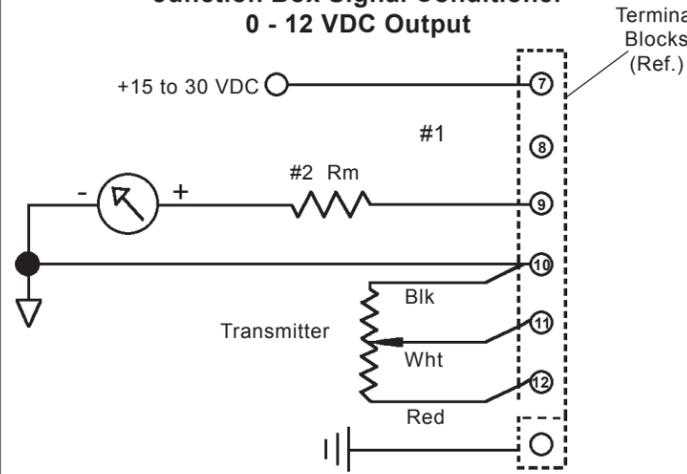
### Junction Box Signal Conditioner 0 - 5 VDC Output



#1: Remove wire from terminal 9 and connect it to terminal 8 to provide "full" reference of the system.

#2: Output signal loading (Rm): 4K Ohms/V Max (.25 mA)

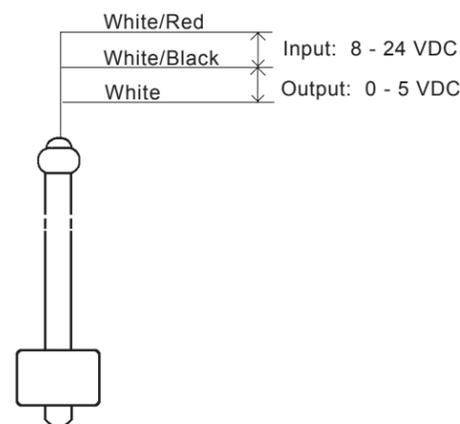
### Junction Box Signal Conditioner 0 - 12 VDC Output



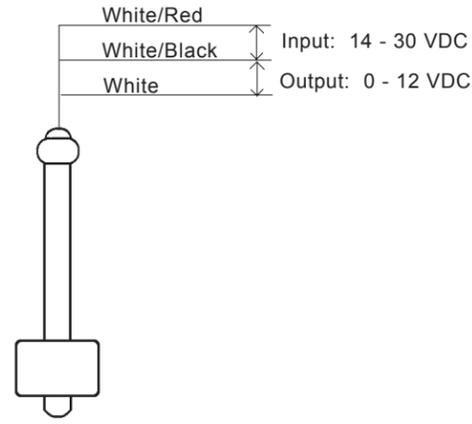
#1: Remove wire from terminal 9 and connect to terminal 8 to provide "full" reference of the system.

#2: Output signal loading (Rm): 2K Ohms/V Max (.5 mA)

### Stem-Mounted Signal Conditioner 0 - 5 VDC Output



### Stem-Mounted Signal Conditioner 0 - 12 VDC Output



## Calibration

The signal conditioner on your XT-800 has been Factory-set. You do not need to calibrate.

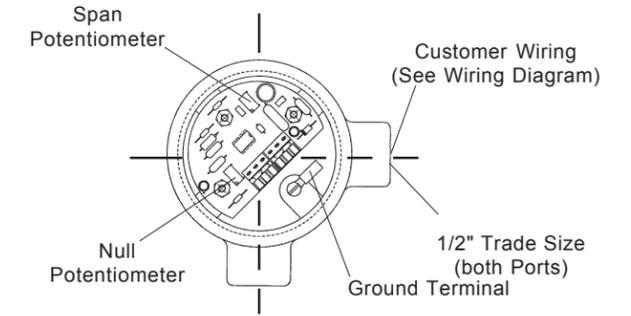
### Steps:

- Calibration should be performed with the probe disconnected from the signal conditioner. Turn off power to loop. Disconnect the red, black and white wires from terminals 1, 2, and 3.
- Adjust both the null and span potentiometers at approximately mid-range. (**Figure 1**)
- Wire as shown per **Figure 2**, connecting a jumper wire in place of the black and white probe wires. Connect an ammeter in series to monitor loop current. Apply power to loop. Adjust null pot for 4mA.
- Remove power from loop. Reposition the jumper wire in place of red and white probe wires. Reapply power and with the span pot, set the output current to 20mA.
- Repeat Steps C and D for final adjustment.
- If power is maintained during jumper connections, current level may increase to 36mA. This is normal. Current will return to regular readings when connections are made.

## Troubleshooting

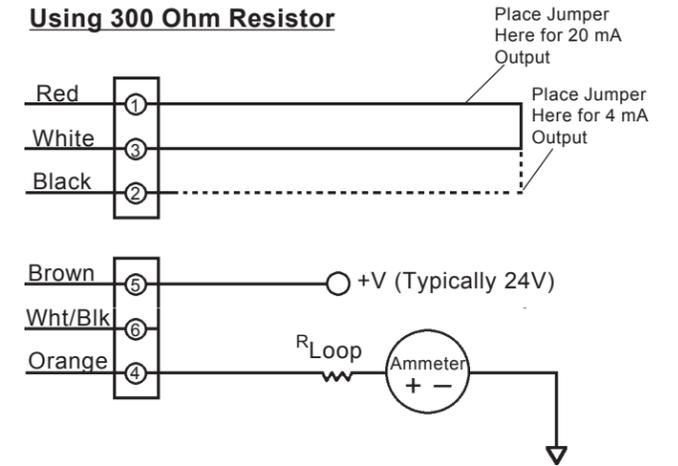
Verify proper wiring, power supply, and loop resistance. If transmitter is not functioning properly, isolate the transmitter from the system and wire per **Figure 3**. Meter should read 4mA with float at bottom and 20mA with float on top of transmitter. If unit is still not operating properly, please consult Factory for further troubleshooting details.

**Figure 1**

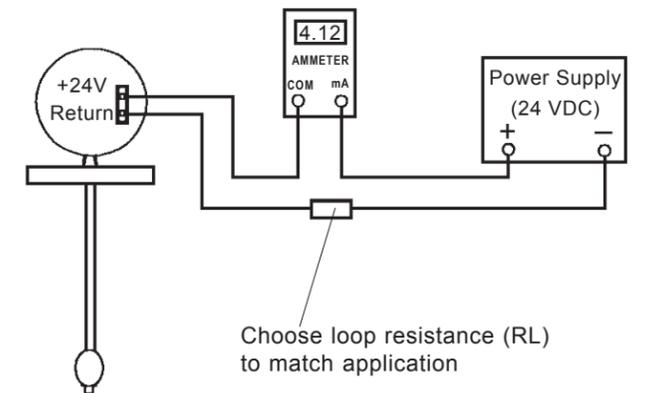


**Figure 2**

### Using 300 Ohm Resistor



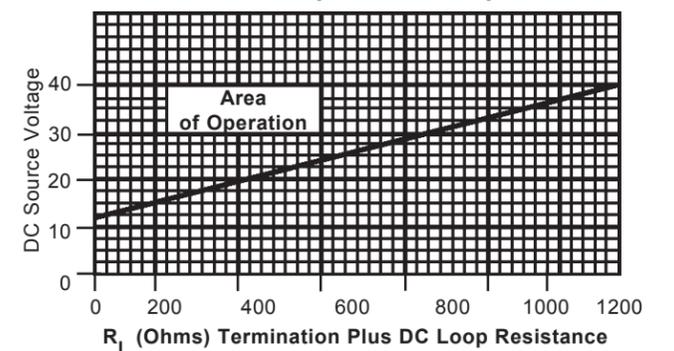
**Figure 3**



### Excitation Required for Transmitters Using 4-20 mA Signal Conditioners

The minimum excitation required for operation of transmitters with 4-20 mA, DC signal converters (**See Chart**) can be determined for a given total loop resistance from the graph shown. (Total loop resistance = the sum of the DC termination resistance plus loop resistance.) For optimum operation, which is a function of source voltage (+V<sub>A</sub>) and total loop resistance, the source voltage value used should be above the minimum load line for the related loop resistance.

### Minimum Excitation Required For Loop Resistance



## Series M Mechanical Tilt Float Level Switch

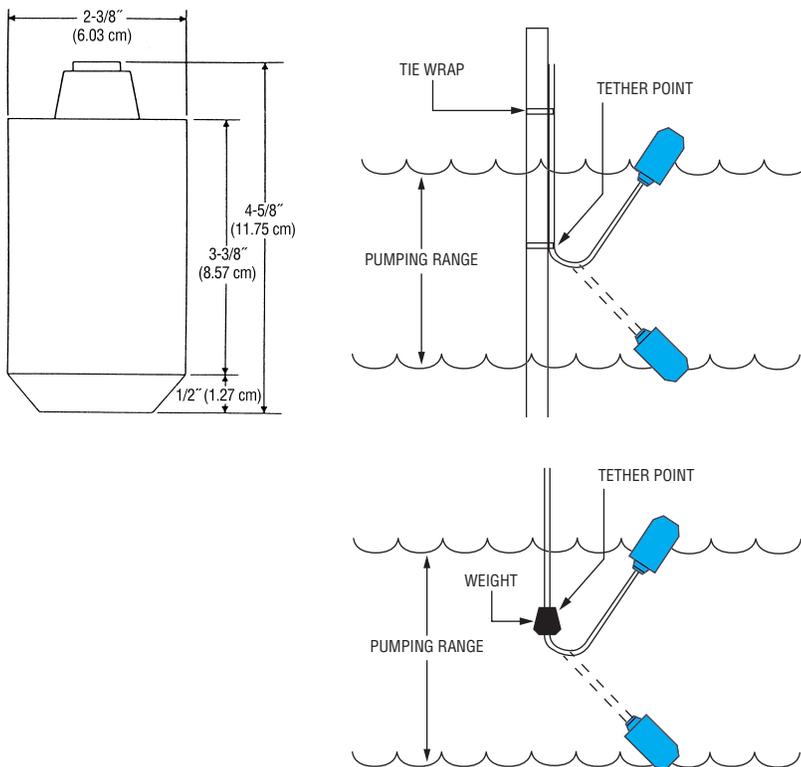
- ▶ Non-Mercury Switch
- ▶ Sealed Cable
- ▶ Impact & Corrosion Resistant ABS Shell
- ▶ N.O., N.C., SPDT Contacts
- ▶ Various Cable Lengths
- ▶ Color Coded Body

Designed for level control and alarm applications in difficult liquids such as sewage and waste water. Series M mechanical tilt floats are ideal for applications where the presence of mercury is a concern. Series M Switches have impact resistant ABS shell and neoprene jacketed cable.

### Specifications

<b>Cord</b>	2 or 3 conductor 16 AWG wire SJOW Oil Resistant CPE
<b>Contact Rating</b>	13 amp @ 120/240 VAC 1/2 hp
<b>Contact Design</b>	SPST, Normally Open or Normally Closed Common with N.O. & N.C. (form C)
<b>Temperature Rating</b>	
<b>Dry</b>	32°F to 194°F (0°C to 90°C)
<b>Water Resistant</b>	32°F to 140°F (0°C to 60°C)
<b>Overall Weight</b>	1.0 lbs. (not including weight)
<b>Tether Method</b>	Tie-wrap nylon, weight: 2.5 lbs.
<b>Approvals</b>	U.L. Recognized, CSA Cert.

### Dimensions



### Applications

- Level Control
- Alarms
- Sewage Lift Systems
- Slurries
- Drainage Sumps
- Wastewater Treatment
- Holding Tanks

### How to Order

Use the **Bold** characters from the chart below to construct a product code.

Series	<b>M</b>	XXX	XX	X
Contact Configuration	<b>YEL</b>			
Length	<b>40</b>			
Tether Method	<b>T</b>			

**W** – Weight  
**T** – Tie

Tether Method	Part Number
Tie Wrap	<b>7762360</b>
Weight	<b>7762381</b>

#### Notes:

1. Narrow angle pumping range approximately 2 in. to 8 in.
2. Wide angle pumping range approximately 5 in. to 18 in.

# Warrick®

## Series M Mechanical Tilt Float Switch

### Installation and Operation Bulletin

#### Specifications

Cord	16 gauge, 2 or 3 conductor SJOW, Oil Resistant CPE
Contact Rating	13 amp @ 120/240 VAC, 1/2hp
Contact Design	SPST, Normally Open or Normally Closed, Common with N.O. & N.C. (Form C)
Temperature Rating	32°F (0°C) to 194°F (90°C) Dry and 140°F (60°C) Water Resistant
Overall Weight	1.0 lbs. (not including weight)
Tether Method	Tie-wrap nylon, weight: 2.5 lbs.
Approvals	U.L. Recognized, CSA Certified

#### Installation

##### Tether Tie-Wrap (Fig 1)

Attach cord, using a tie-wrap, to a stationary structure. This is known as the tether point, it will determine the pumping range. The farther the float is placed from the tether point, the greater the pumping range. The minimum distance that the float should be placed from the tether point is 3 inches.

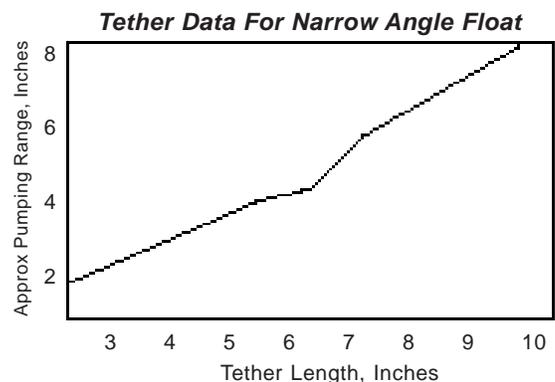
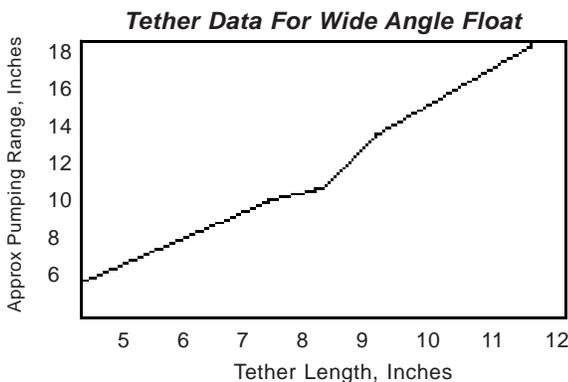
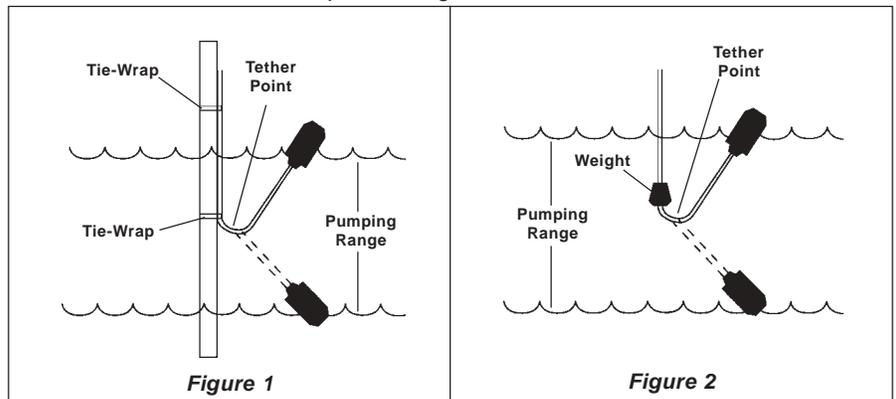
##### Tether-Weight (Fig 2)

Place tension-brand over the cord before installation. Place the weight at the desired position and secure with the tension-band. This position will determine the pumping range. The farther the float is placed from the tether point, the greater the pumping range. The minimum distance that the float should be placed from the tether point is 3 inches.

#### Notes:

- To Prevent Motor Burnout - In a pumpdown application make sure the turn-off level is at least 2 inches above the intake of the submersible pump.
- Securing Tether Points - Make sure levels are correct and that floats are free from any obstructions before securing tether points.

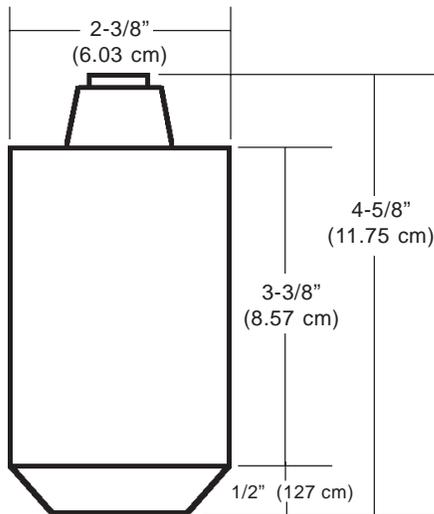
Determine tether point using charts below as a reference



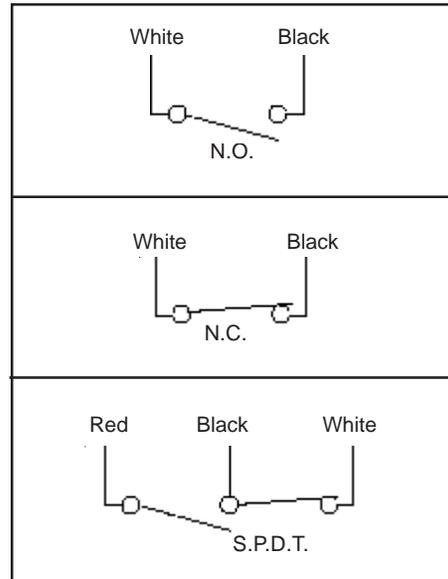
#### Notes:

- Narrow angle pumping range is approximately 2 In. to 8 In.
- Wide angle pumping range is approximately 5 In. to 18 In.

## Dimensions



## Contact Configurations



### Important Points:

- Gems products must be maintained and installed in strict accordance with the National Electrical Code and the applicable Gems Product Instruction Bulletin that covers installation, operation and proper maintenance. Failure to observe this information may result in serious injury or damages.
- For hazardous area applications involving such things as, but not limited to, ignitable mixtures, combustible dust and flammable materials, use an appropriate explosionproof enclosure or intrinsically safe interface device.
- Please adhere to the pressure and temperature limitations shown throughout this catalog for our level and flow sensors. These limitations must not be exceeded. These pressures and temperatures take into consideration possible system surge pressures/temperatures and their frequencies.
- Selection of materials for compatibility with the media is critical to the life and operation of Gems products. Take care in the proper selection of materials of construction, testing is required.
- NSF-approved sensors are made of materials approved for potable water applications according to Standard 61.
- Stainless steel is generally regarded as safe by NSF and FDA.
- Life expectancy of switch contacts varies with application. Contact Gems if life cycle testing is required.
- Ambient temperature changes do affect switch set points, since the gravity of a liquid can vary with temperature.
- Our sensors have been designed to resist shock and vibration. However, shock and vibration should be minimized.
- Filter liquid media containing particulate and/or debris to ensure the proper operation of our products.
- Electrical entries and mounting points in an enclosed tank may require liquid/vapor sealing.
- Our sensors must not be field-repaired.
- Physical damage sustained by product may render it unserviceable.

### Return Policy

Returns are accepted on stock items up to 30 days from date of order. You must contact our Returns Department for a Return Authorization (RA) number. Return the goods - freight prepaid - in the original container and include original packing slip. C. O. D. returns are not accepted. Gems reserves the right to apply restocking charges.

**Tel: 860-793-4357**  
**Fax: 860-793-4563**



Gems Sensors Inc.  
One Cowles Road  
Plainville, CT 06062-1198  
Tel: 860-793-4579  
Fax: 860-793-4580



**FPZ, Inc**  
 150 N. Progress Drive  
 Saukville, WI 53080 - U.S.A.  
 Tel. (262) 268-0180  
 Fax (262) 268-0415  
 E-mail usa@fpz.com

REGENERATIVE BLOWERS - PRESSURE  
**SCL K07 / K08 / K09 / K10 / K11 / K12**

**MS SERIES - MOR RANGE**

SN 1805-13 1/2

**TECHNICAL CHARACTERISTICS**

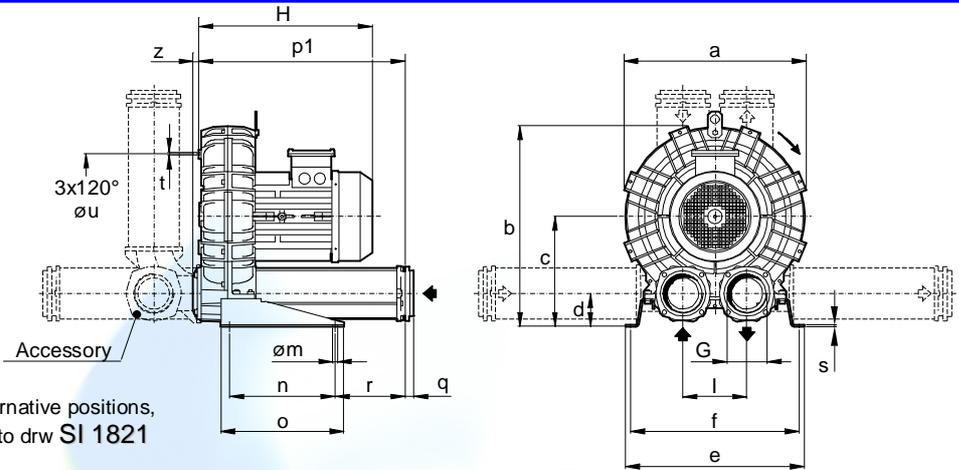
- Aluminium alloy construction
- Smooth operation
- High efficiency impeller
- Maintenance free
- Mountable in any position
- Recognized TEFC - cURus motor

**OPTIONS**

- Special voltages (IEC 38)
- Surface treatments

**ACCESSORIES**

- Inlet and/or inline filters
- Additional inlet/outlet silencers
- Safety valves
- Flow converting device
- Optional connectors



Possible alternative positions,  
 please refer to drw SI 1821

Dimensions in inches.  
 Dimension for reference only.

Model	a	b	c	d	e	f	G	l	m	n	o	p1	q	r	s	t	u	z
K07-MS	16.69	18.84	10.59	3.23	18.43	17.24	3" NPT	6.10	0.51	11.81	13.78	20.16	0.98	5.39	0.20	M8	11.61	0.63
K08-MS	17.99	19.61	10.59	3.23	18.82	17.64	3" NPT	6.10	0.51	11.81	13.78	20.16	0.98	5.39	0.20	M8	12.2	0.63
<del>K09-MS</del>	<del>19.37</del>	<del>22.00</del>	<del>12.40</del>	<del>3.78</del>	<del>20.00</del>	<del>18.82</del>	<del>4" NPT</del>	<del>7.17</del>	<del>0.51</del>	<del>11.81</del>	<del>13.78</del>	<del>23.07</del>	<del>0.98</del>	<del>7.83</del>	<del>0.20</del>	<del>M8</del>	<del>14.17</del>	<del>0.63</del>
K10-MS	20.31	22.56	12.40	3.78	20.00	18.82	4" NPT	7.17	0.51	11.81	13.78	23.07	0.98	7.83	0.20	M8	14.17	0.63
K11-MS	21.34	23.74	13.07	3.58	21.26	20.00	4" NPT	7.87	0.51	11.81	13.78	23.46	0.98	8.03	0.20	M8	15.35	0.63
K12-MS	21.57	23.82	13.07	3.58	21.26	20.00	4" NPT	7.87	0.51	11.81	13.78	23.58	0.98	8.03	0.20	M8	15.35	0.51

Model	Maximum flow Scfm		Installed power Hp		Maximum differential pressure Dp (In WG)		Noise level Lp dB (A) <sup>(1)</sup>		Overall dimensions H Inches	Weight Lbs
	60 Hz 3500 rpm	50 Hz 2900 rpm	60 Hz 3500 rpm	50 Hz 2900 rpm	60 Hz 3500 rpm	50 Hz 2900 rpm	60 Hz 3500 rpm	50 Hz 2900 rpm		
K07-MS	294	243	4	4	50	63	78.7	76.7	15.45	103.00
			5 1/2	5 1/2	75	86	79.0	77.0	15.45	107.10
			7 1/2	7 1/2	130	138	79.3	77.3	18.37	145.70
			10	10	181	161	79.6	77.6	18.37	154.50
K08-MS	381	316	5 1/2	5 1/2	40	52	79.7	77.7	15.45	115.70
			7 1/2	7 1/2	68	90	80.0	78.0	18.37	154.30
			10	10	115	125	80.3	78.3	18.37	163.10
			15	15	181	181	80.6	78.6	19.15	184.00
K09-MS	471	390	7 1/2	7 1/2	50	63	80.2	78.2	18.84	166.50
			10	10	80	95	80.5	78.5	18.84	175.10
			15	15	140	155	81.0	79.0	19.63	196.20
			20	20	181	181	81.3	79.3	23.74	269.00
K10-MS	556	460	7 1/2	7 1/2	36	51	80.1	78.1	18.84	170.00
			10	10	64	80	80.5	78.5	18.84	179.50
			15	15	120	133	81.0	79.0	19.63	200.00
			20	20	167	191	81.4	79.4	23.74	273.40
			25	25	211	201	81.6	79.6	24.61	298.70
K11-MS	650	539	10	10	40	53	82.0	80.0	19.04	194.90
			15	15	82	97	82.4	80.4	19.83	216.00
			20	20	125	141	82.7	80.7	23.94	288.80
			25	25	162	201	85.6	83.6	24.81	313.10
K12-MS	726	602	15	15	52	90	82.9	80.9	19.95	223.70
			20	20	85	130	83.2	81.2	24.06	296.50
			25	25	120	160	86.1	84.1	24.92	320.80

(1) Noise measured at 1 m distance with inlet and outlet ports piped, in accordance to ISO 3744.

- For proper use, the blower should be equipped with inlet filter and safety valve; other accessories available on request.
- Ambient temperature from +5° to +104°F.
- Specifications subject to change without notice.

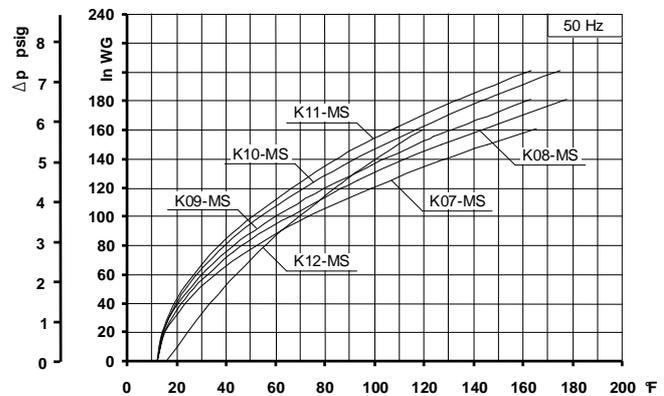
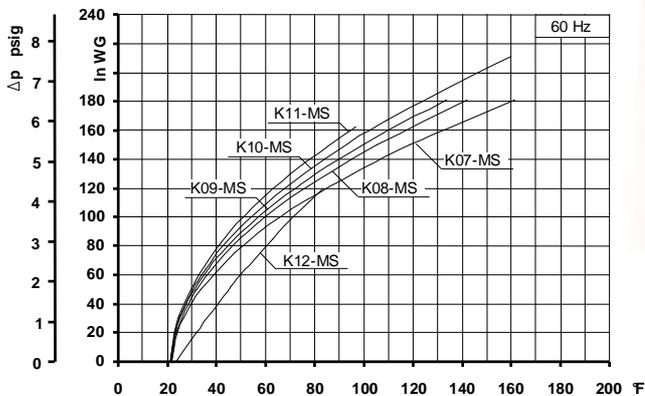
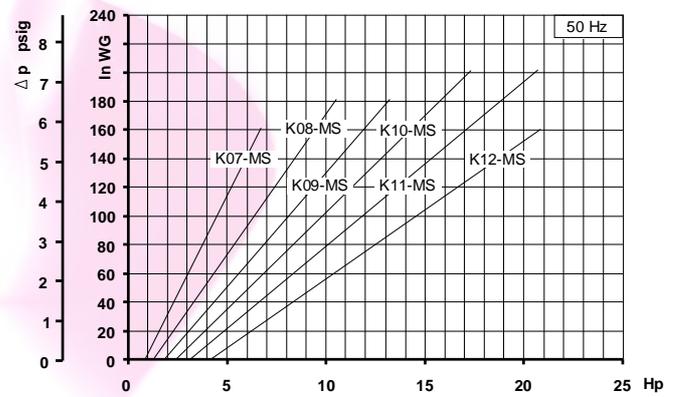
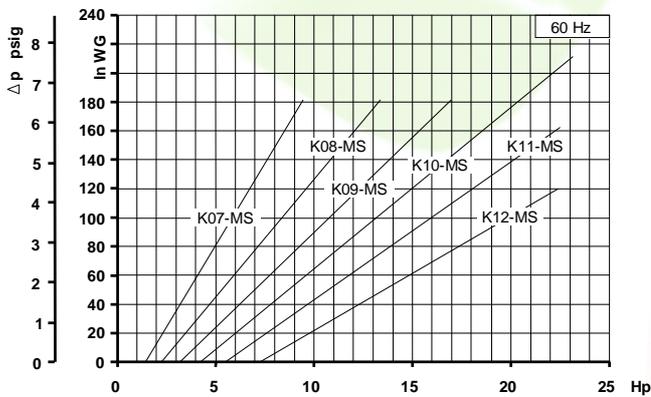
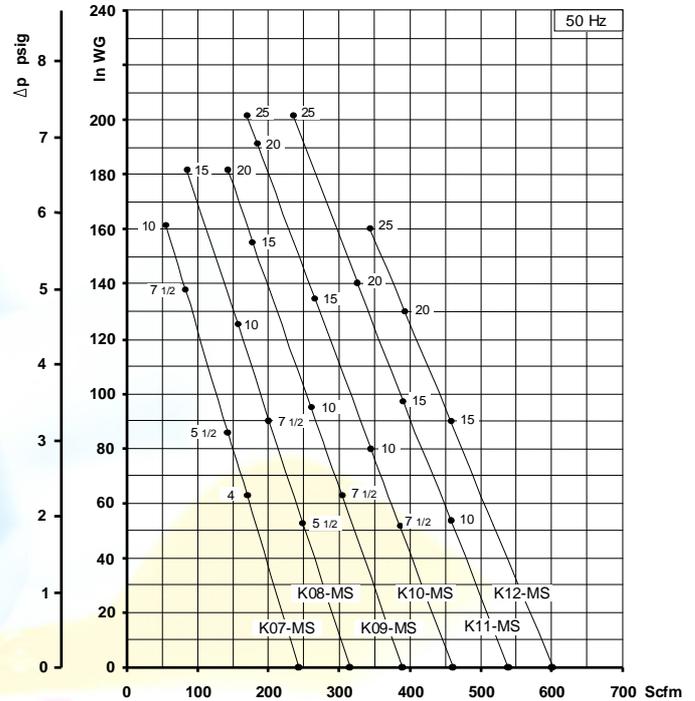
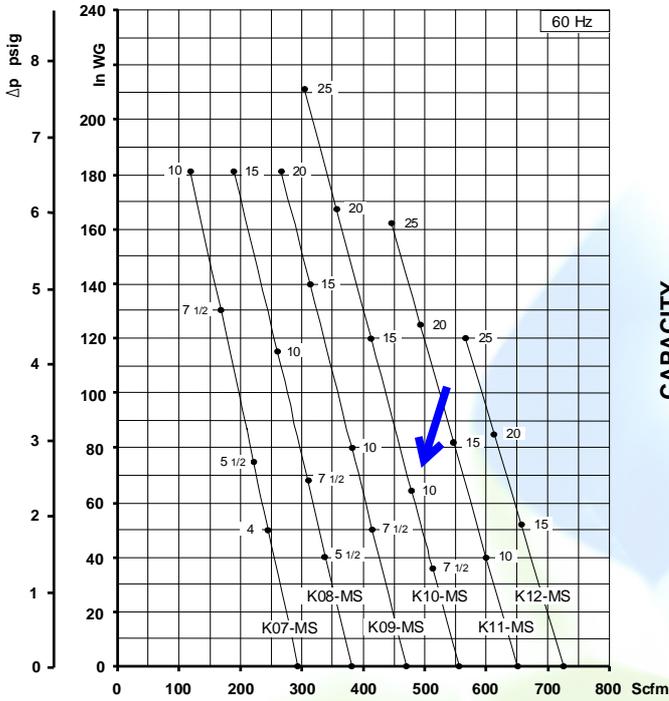


# REGENERATIVE BLOWERS - PRESSURE

## SCL K07 / K08 / K09 / K10 / K11 / K12

### MS SERIES - MOR RANGE

SN 1805-13 2/2



Curves refer to air at 68°F temperature and 29.92 In Hg atmospheric pressure (abs) measured at inlet port.  
 Values for flow, power consumption and temperature rise: +/-10% tolerance.  
 Data subject to change without notice.



® **FPZ S.p.A.**

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**COMPRESSORI - ASPIRATORI A CANALE LATERALE**

**LATERAL CHANNEL BLOWERS - EXHAUSTERS**

**COMPRESSEURS - ASPIRATEURS A CANAL LATERAL**

**SEITENKANALVERDICHTER - VAKUUMPUMPEN BAUREIHE**

**COMPRESORES - ASPIRADORES DE CANAL LATERAL**

**ISTRUZIONI I**

**INSTRUCTIONS GB**

**INSTRUCTIONS F**

**BETRIEBSANLEITUNG D**

**INSTRUCCIONES E**



*LEGGERE ATTENTAMENTE TUTTE LE ISTRUZIONI E CONSERVARLE I*

*PLEASE READ CAREFULLY ALL INSTRUCTIONS AND KEEP THEM FOR FUTURE REFERENCE GB*

*LIRE ATTENTIVEMENT TOUTES LES INSTRUCTIONS ET LES CONSERVER F*

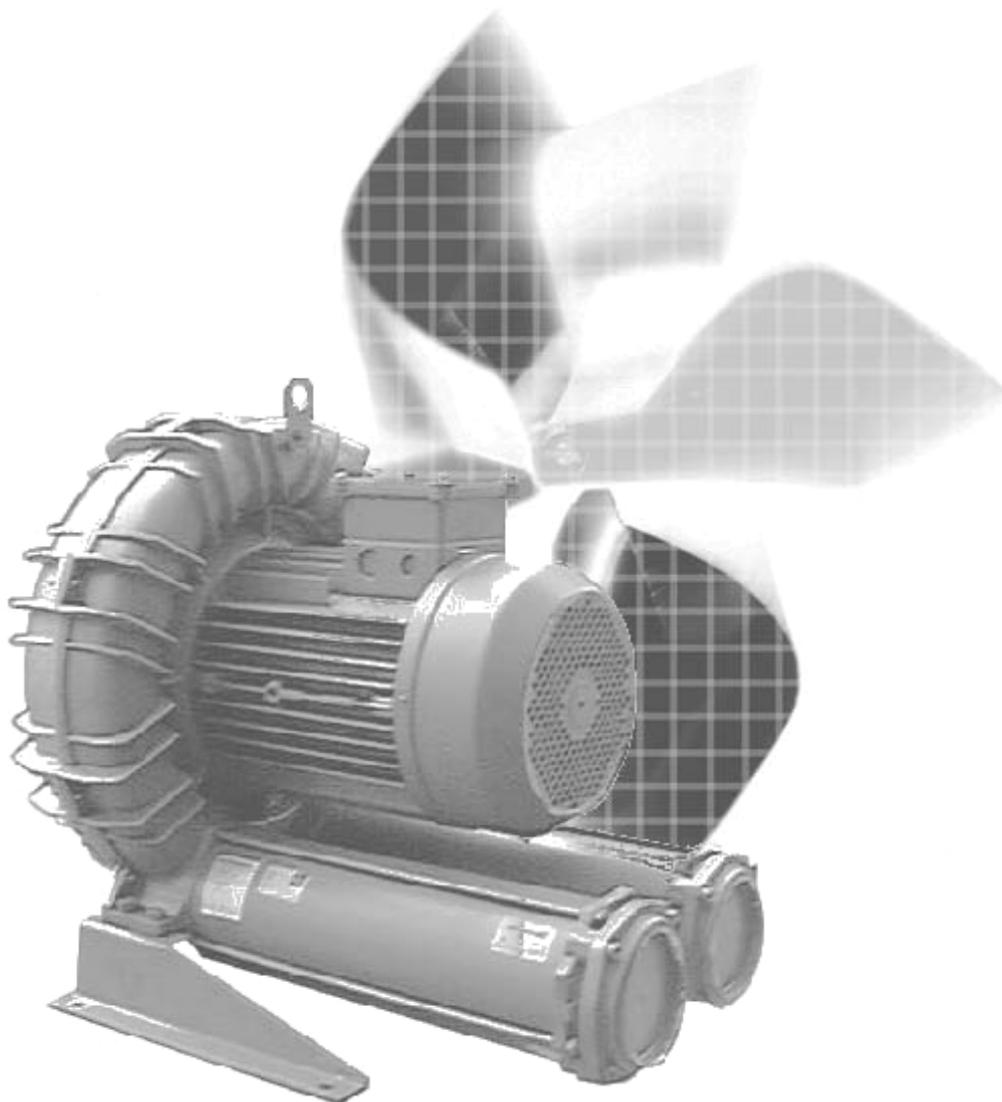
*ALLE ANLEITUNGEN SIND SORGFÄLTIG ZU LESEN UND AUFZUBEWAHREN! D*

*SIRVASE LEER CUIDADOSAMENTE TODAS LAS INSTRUCCIONES Y CONSERVARLAS PARA FUTURA REFERENCIA E*

**SN 1968-6**

**SCL K07 / K75 / K08 / K09 / K10 / K11 / K12**

**MS - MOR**





**DICHIARAZIONE DI CONFORMITÀ ALLA DIRETTIVA MACCHINE  
DECLARATION OF CONFORMITY TO THE MACHINERY DIRECTIVE**

Unità tipo - *Unit type*

**SCL K07-MS MOR  
SCL K75-MS MOR  
SCL K08-MS MOR**

**SCL K09-MS MOR  
SCL K10-MS MOR**

**SCL K11-MS MOR  
SCL K12-MS MOR**

1. L'unità è in conformità con:
  - DIRETTIVA MACCHINE CE 2006/42;
  - DIRETTIVA COMPATIBILITÀ ELETTROMAGNETICA (EMC) 2004/108;
  - DIRETTIVA BASSA TENSIONE 2006/95/CE.È tuttavia vietata la messa in servizio prima che la macchina in cui sarà incorporata sia dichiarata conforme con le citate Direttive.
2. Sottoposta a collaudo funzionale è risultata conforme alle caratteristiche richieste.
3. Il Fascicolo tecnico elaborato secondo Allegato VII della direttiva CE 2006/42 viene conservato presso la sede della società FPZ SpA a Concorezzo (MB), via F.lli Cervi 16.

1. *The unit conforms to the:*
  - *MACHINERY DIRECTIVE CE 2006/42;*
  - *ELECTROMAGNETIC COMPATIBILITY (EMC) CE 2004/108;*
  - *LOW VOLTAGE DIRECTIVE (LVD) 2006/95/CE;**Nevertheless it is forbidden to put the unit in service before the machine in which will be incorporated is declared in conformity with the above Directives.*
2. *The unit has been tested and meets its operating performances.*
3. *FPZ SpA in Concorezzo (ITALY), Via F.lli Cervi 16, store the Technical Files developed according Annex VII of Machinery Directive CE 2006/42*

Concorezzo (MB), data 16.04.2010

Amministratore Delegato  
Managing Director

Sergio Ferigo

Direttore Tecnico  
Technical Manager

Luis Sagastegui

**DATI CARATTERISTICI I**  
**PERFORMANCE TABLE GB**  
**CARACTÉRISTIQUES TECHNIQUES F**  
**LEISTUNGSDATEN D**  
**DATOS CARACTERISTICOS E**

SI - Unità / Units / Einheiten / Unidades	Modello Model Modèle Modell Modelo	Potenza installata Installed power Puissance installé Installierte Motorleistung Potencia instalada		Pressione massima differenziale Maximum differential pressure Pression différentielle maxi Druckdifferenz Presión diferencial máxima		Rumorosità massima Max noise level Max niveau sonore Max Schalldruckpegel Rumorosidad máxima		Pressione massima assoluta Maximum absolute pressure Pression absolue maxi Maximal absoluter druck Presión absoluta máxima		Massa Weight Masse Gewicht Peso
		kW		hPa ( mbar )		Lp / Lw (1) dB (A)		Ps max A	M	
		50 Hz 2900 min <sup>-1</sup>	60 Hz 3500 min <sup>-1</sup>	50 Hz 2900 min <sup>-1</sup>	60 Hz 3500 min <sup>-1</sup>	50 Hz 2900 min <sup>-1</sup>	60 Hz 3500 min <sup>-1</sup>	MPa (bar)	kg	
SCL K07-MS		2.2	2.55	- 130 / + 130	- 100 / + 100	76.4	78.4	0.28 (2.8)	46.5	
		3.0	3.45	- 200 / + 200	- 175 / + 175	76.7	78.7	0.28 (2.8)	47.5	
		4.0	4.6	- 280 / + 280	- 250 / + 250	77.0	79.0	0.28 (2.8)	51.0	
		5.5	6.3	- 325 / + 400	- 375 / + 375	77.3	79.3	0.28 (2.8)	61.5	
SCL K75-MS		4.0	4.6	- 150 / + 150	- 100 / + 100	77.4	79.4	0.28 (2.8)	51.5	
		5.5	6.3	- 250 / + 250	- 200 / + 200	77.7	79.7	0.28 (2.8)	62.0	
		7.5	8.7	- / + 325	- 300 / + 300	78.0	80.0	0.28 (2.8)	67.0	
SCL K08-MS		3.0	3.45	- 125 / + 125	- 100 / + 100	77.4	79.4	0.28 (2.8)	49.0	
		4.0	4.6	- 180 / + 180	- 150 / + 150	77.7	79.7	0.28 (2.8)	52.5	
		5.5	6.3	- 275 / + 275	- 250 / + 250	78.0	80.0	0.28 (2.8)	63.0	
		7.5	8.7	- 350 / + 400	- 375 / + 375	78.3	80.3	0.28 (2.8)	68.0	
		9.2	10.6	- / + 450	- / + 450	78.6	80.6	0.28 (2.8)	77.5	
SCL K09-MS		4.0	4.6	- 130 / + 130	- 85 / + 85	78.0	80.0	0.28 (2.8)	62.0	
		5.5	6.3	- 210 / + 210	- 150 / + 150	78.2	80.2	0.28 (2.8)	72.5	
		7.5	8.7	- 290 / + 290	- 250 / + 250	78.5	80.5	0.28 (2.8)	77.5	
		9.2	10.6	- 350 / + 350	- 325 / + 325	78.7	80.7	0.28 (2.8)	87.0	
		11	12.7	- / + 450	- 375 / + 400	79.0	81.0	0.28 (2.8)	87.5	
SCL K10-MS		5.5	6.3	- 160 / + 160	- 115 / + 115	78.1	80.1	0.28 (2.8)	75.0	
		7.5	8.7	- 250 / + 250	- 200 / + 200	78.5	80.5	0.28 (2.8)	80.0	
		9.2	10.6	- 300 / + 300	- 270 / + 270	79.0	81.0	0.28 (2.8)	89.5	
		11	12.7	- 350 / + 400	- 375 / + 375	79.4	81.4	0.28 (2.8)	90.0	
		15	17.4	- / + 500	- / + 500	79.6	81.6	0.28 (2.8)	95.0	
SCL K11-MS		7.5	8.7	- 175 / + 175	- 130 / + 130	80.0	82.0	0.28 (2.8)	83.5	
		9.2	10.6	- 230 / + 230	- 175 / + 175	80.5	82.5	0.28 (2.8)	93.0	
		11	12.7	- 300 / + 300	- 250 / + 250	81.0	83.0	0.28 (2.8)	93.5	
		15	17.4	- 350 / + 400	- 350 / + 350	81.8	83.8	0.28 (2.8)	98.5	
		18.5	21.5	- / + 500	- / + 500	83.6	85.6	0.28 (2.8)	128.5	
SCL K12-MS		9.2	10.6	- 150 / + 150	- 100 / + 100	81.0	83.0	0.28 (2.8)	96.5	
		11.0	12.7	- 200 / + 200	- 150 / + 150	81.5	83.5	0.28 (2.8)	97.0	
		15.0	17.4	- 300 / + 300	- 275 / + 275	82.3	84.3	0.28 (2.8)	102.0	
		18.5	21.5	- 325 / + 425	- 350 / + 375	85.2	87.2	0.28 (2.8)	132.0	

- (1) Rumorosità misurata alla distanza di 1 m con aspirazione e mandata canalizzate, secondo la Normativa ISO 3744.  
(1) Noise measured at 1 m distance with inlet and outlet ports piped, in accordance to ISO 3744.  
(1) Niveau de bruit mesuré a 1 m de distance, conduits d'aspiration et refoulement raccordés selon la norme ISO 3744.  
(1) Schalldruckpegel, mit angeschlossener Schlauchleitung am Ein- und Auslass, im Abstand von 1 m gemäß ISO 3744 gemessen.  
(1) Rumorosidad medida a la distancia de 1 m con vías de acceso de aspiración e impulsión canalizadas, según la Normativa ISO 3744.

**DATI CARATTERISTICI I**  
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US - Unità / Units / Unités / Einheiten / Unidades	Modello Model Modèle Modell Modelo	Potenza installata Installed power Puissance installé Installierte Motorleistung Potencia instalada	Pressione massima differenziale Maximum differential pressure Pression différentielle maxi Druckdifferenz Presión diferencial máxima		Rumorosità massima Max noise level Max niveau sonore Max Schalldruckpegel Rumorosidad máxima		Pressione massima assoluta Maximum absolute pressure Pression absolue maxi Maximal absoluter druck Presión absoluta máxima	Massa Weight Masse Gewicht Peso	
		Hp		In Hg / In WG		Lp / Lw (1) dB (A)		Ps max	M
		60 Hz 3500 rpm	50 Hz 2900 rpm	60 Hz 3500 rpm	50 Hz 2900 rpm	60 Hz 3500 rpm	50 Hz 2900 rpm	In Hg	lbs
SCL K07-MS	4	4	- 3.7 / + 50	- 4.6 / + 63	78.7	76.7	82.7	103.00	
	5 ½	5 ½	- 5.6 / + 75	- 6.3 / + 86	79.0	77.0	82.7	107.10	
	7 ½	7 ½	- 9.6 / + 130	- 8.9 / + 138	79.3	77.3	82.7	145.70	
	10	10	- 11.1 / + 181	- / + 161	79.6	77.6	82.7	154.50	
SCL K08-MS	5 ½	5 ½	- 2.9 / + 40	- 3.8 / + 52	79.7	77.7	82.7	115.70	
	7 ½	7 ½	- 5.9 / + 80	- 6.6 / + 90	80.0	78.0	82.7	154.30	
	10	10	- 8.5 / + 115	- 9.2 / + 125	80.3	78.3	82.7	163.10	
	15	15	- 11.1 / + 181	- / + 181	80.6	78.6	82.7	184.10	
SCL K09-MS	7 ½	7 ½	- 3.7 / + 50	- 4.6 / + 63	80.2	78.2	82.7	166.50	
	10	10	- 5.9 / + 80	- 7.0 / + 95	80.5	78.5	82.7	175.10	
	15	15	- 10.3 / + 140	- 10.4 / + 155	81.0	79.0	82.7	196.20	
	20	20	- 11.1 / + 181	- / + 181	81.3	79.3	82.7	269.00	
SCL K10-MS	7 ½	7 ½	- 2.7 / + 36	- 3.8 / + 51	80.1	78.1	82.7	170.90	
	10	10	- 4.7 / + 64	- 5.9 / + 80	80.5	78.5	82.7	179.50	
	15	15	- 8.8 / + 120	- 9.9 / + 135	81.0	79.0	82.7	200.60	
	20	20	- 11.1 / + 167	- / + 191	81.4	79.4	82.7	273.40	
	25	25	- / + 211	- / + 201	81.6	79.6	82.7	298.70	
SCL K11-MS	10	10	- 2.9 / + 40	- 3.9 / + 53	82.0	80.0	82.7	194.90	
	15	15	- 6.0 / + 82	- 7.1 / + 97	82.5	80.5	82.7	216.00	
	20	20	- 9.2 / + 125	- 10.4 / + 141	83.0	81.0	82.7	288.80	
	25	25	- 11.1 / + 162	- / + 201	85.6	83.6	82.7	313.10	
SCL K12-MS	15	15	- 3.8 / + 52	- 6.6 / + 90	83.5	81.5	82.7	223.70	
	20	20	- 6.3 / + 85	- 9.6 / + 130	84.3	82.3	82.7	296.50	
	25	25	- 8.8 / + 120	- / + 160	87.2	84.1	82.7	320.80	

- (1) Rumorosità misurata alla distanza di 1 m con aspirazione e mandata canalizzate, secondo la Normativa ISO 3744.  
(1) Noise measured at 1 m distance with inlet and outlet ports piped, in accordance to ISO 3744.  
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(1) Rumorosidad medida a la distancia de 1 m con vías de acceso de aspiración e impulsión canalizadas, según la Normativa ISO 3744.

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## 1 SAFETY STANDARDS

This operating manual:

- Applies to “K” series side channel compressors-vacuum pumps in an “MOR” single block version.
- Contains instructions for transporting, installation, commissioning, operating, storing, and maintenance of “K” series side channel compressors-vacuum pumps in an “MOR” format.
- Must be read carefully and understood fully before doing any work using the unit.
- Must be complied with fully.
- Must be to hand at all times at the workstation at which the unit is used.

Failure to comply with the safety standards may result in serious injury to people – even with fatal consequences – as well as damage to materials and the environment.

### 1.1 NOTES FOR THE USER’S SAFETY

The safety standards referred to in this operating manual are marked by a danger symbol. Next to this symbol there is wording indicating the seriousness of the danger. You are kindly requested to fully comply with the procedures described in order to avoid any danger to people or property!



This **Danger** symbol indicates dangers that may result in **injury to people** with consequences including **death or serious injury** if the necessary precautions are not taken.

The term **“WARNING”** indicates dangers that may result in **damage to property**.

**“USER’S NOTES”** are intended to allow the unit to be used in the best way to achieve best performance, in safety and respecting the environment.

### 1.2 GENERAL SAFETY WARNINGS

#### **WARNING!**

The “K” series of side channel compressors-vacuum pumps in an “MOR” format are designed and built for use in industrial plants are fitted with three-phase or single-phase electric motors of an asynchronous bipolar type, in compliance with IEC 34-1.



**Any use other than the intended use of the unit may cause serious injury and even death!**

- The unit may only be started:  
In conformity with the use, transport, and handling purposes indicated in “INTENDED USE”.  
According to the values indicated in the “CHARACTERISTIC DATA” table on page 3/4.
- All transportation, assembly, installation, starting up, and maintenance operations are only to be carried out by qualified personnel, that is, personnel whose training, instruction, experience, knowledge of standards, regulations, accident prevention procedures, and operating and service conditions, makes them capable of carrying out all the works necessary, while being aware of and avoiding any possible danger and/or damage.



**When the unit is working there is a danger of injury due to shearing, crushing, entanglement, and burns!**

Transportation, assembly, installation, starting up, and maintenance operations are to be carried out wearing adequate **personal protective clothing** (protective gloves and safety glasses, safety shoes, and a hardhat).

Do not wear loose-fitting garments, long laces, or other items that may get entangled in the machine.

Long hair must be gathered up.



**Electrical danger!**

Inappropriate behaviour may result in serious injury and even death!

Work on electrical equipment (installation and maintenance) is only to be done by qualified, authorised electricians!

Before starting to work on the unit or plant, the following precautions must be taken:

Switch off the mains power supply.

Adopt measures to prevent it being switched on again.

Only open the terminal box after checking that the power is off altogether!



**Danger due to rotating components (cooling fan for the electric motor, impeller, and shaft): Cutting or shearing of limbs, entanglement or trapping of hair or clothing.**

**Danger due to excess pressure and vacuum: Sudden ejection of process gases (injury to the skin and eyes), and sudden sucking in of hair and clothing!**

**Danger due to process gases that come out and cause burns!**

- The unit may only be started and operated under the following conditions:

The unit must be fully assembled and whole (not damaged).

Piping must be connected to the silencers using fixings, connections, pipes, pipe fittings, and tanks that are watertight and sufficiently strong to withstand the pressures that develop.

Connections to the suction and delivery silencers must not be closed, clogged, or dirty.

Regularly check that the seatings for fixings, connections, piping, pipe fittings, and tanks are firmly secured!

- Before starting maintenance work on the unit, the following safety precautions must be taken:

Put the unit out of order and ensure that it cannot be switched on again.

Put a sign on the plant’s controls and on the control units that reads: “DANGER! Maintenance work on the compressor-vacuum pump in progress! Do not switch on!”

Wait until the unit has stopped completely, that is, until the impeller has stopped rotating.

Allow the unit to cool down!

Make sure that there is no pressure or vacuum in the unit or in the piping to be disconnected.

Make sure that no fluid can flow out of the unit and/or plant!



**Danger due to rotating impeller: Cutting or shearing of limbs!**

The impeller can be accessed while it is rotating by opening the suction and delivery silencers!

Never put your hands or any item into these openings.

Fit the suction and/or delivery silencers with additional silencers or additional pipes sufficiently long to prevent access to the impeller.



**Danger due to burns caused by contact with hot surfaces on the unit!**

When operating in compliance with the values indicated in the "CHARACTERISTIC DATA" table on page 3/4 the compressors-vacuum pumps can reach high surface temperatures of up to 160°C (+320°F).

Fit the unit with adequate protection against the risks of involuntary contact with hot surfaces.

Do not touch the unit's surfaces on purpose when it is running!

Before doing any work after having switched off the unit, allow it to cool!



**Danger due to hot surfaces – up to 160°C (+320°F)!**

Under operating conditions there is a possibility of burns due to contact with the unit's surfaces.

**Protective steps to be taken:**

Fit the unit with adequate protection against the risks of involuntary contact with hot surfaces.

Do not touch the unit's surfaces on purpose when it is running!

Before starting with any work, wait for the unit to cool down after switching it off!



**Danger resulting from the impeller seizing due to the performance values being exceeded: Vacuum and/or pressure exceeding the declared values!**

Do not allow the unit to operate with the suction and/or delivery openings obscured for any reason.

Install a safety valve that can prevent excessive vacuum and/or pressure, and that makes it possible to comply with the values indicated among the "CHARACTERISTIC DATA" given on page 3/4 of this manual.

In order to limit the formation of layers of dust on the surfaces, which may compromise natural exchanging of heat between the unit and the environment, regularly clean and remove all dust using suitable equipment.

Suction and/or delivery piping must not be dirty or clogged!

**If any anomalous noises are heard, which may be a warning that the impeller is about to seize, switch off the unit and move away from it immediately.**



**Danger due to noise emitted by the unit!**

When the compressors-vacuum pumps are running they emit noise that may exceed 80 dB(A)!

**Protective steps to be taken:**

Mark the area around the unit using warning signs.

Wear personal protective equipment for hearing.

If necessary, fit additional silencers on the suction and/or delivery silencers.

From time to time use noise tests to check the efficiency of the soundproofing panels in the suction and delivery silencers. The reference values are indicated in the "CHARACTERISTIC DATA" table on page 3/4 of this manual.



**Danger due to the impeller seizing due to use in an unsuitable place and/or due to conveying fluids that are not suitable: Unsuitable ambient and suction temperatures!**

Check that the ambient and suction temperatures for the gas conveyed are between: -15°C (+5°F) and +40°C (+104 °F).

Check that good ventilation is provided for the unit.

Use a filter on the suction side to filter particles 25 µm or larger, which will make it possible to limit the entry of any solids into the unit, thereby avoiding possible breakage of the impeller blades, making the fragments projected out of the delivery opening dangerous!

During installation and when the unit is running, check for load losses due to the use of this filter: The maximum load loss allowed is 30 mbar. This value must be subtracted from the maximum admissible pressure indicated in the "CHARACTERISTIC DATA" table on page 3/4 of this manual.

**If any anomalous noises are heard, which may be a warning that the impeller is about to seize, switch off the unit and move away from it immediately.**



**Any use other than the intended use of the unit may cause serious injury and even death!**

Failure to comply with the prohibitions / obligations indicated may result in technical faults, damage to the plant, or injury!

**Danger of very serious injury!**

**1.3 OTHER HAZARDS**



**Danger due to rotating components: Cooling fan for the electric motor!**

There is an immediate danger of hair and clothing becoming entangled in the cooling fan in the electric motor's cowling via the cowling itself!

**Protective steps to be taken:**

Do not wear loose-fitting garments, long laces, or other items that may get entangled in the machine.

Long hair must be gathered up.

**2 INTENDED USE**

The "K" series of side channel compressors-vacuum pumps in an "MOR" format are made to generate vacuums and pressures, and for conveying air and gas that is not explosive, not inflammable, not poisonous, and not aggressive, for continuous operation in a non-explosive environment.

The "K" series of side channel compressors-vacuum pumps in an "MOR" format are designed and built for use in industrial plants are fitted with three-phase or single-phase electric motors of an asynchronous bipolar type, in compliance with IEC 34-1.

**2.1 TYPICAL EXAMPLES OF IMPROPER USE**

THE FOLLOWING ARE STRICTLY FORBIDDEN:

- Using the unit in non-industrial installations, unless all the necessary precautions or protective measures have been taken (e.g. protection against contact to safeguard children).
- Using the unit in places in which there are explosive dust and/or gas or where these may form.
- Sucking up and conveying explosive, inflammable, aggressive, corrosive, and/or harmful fluids.
- Using the unit under conditions that differ from those indicated in the "CHARACTERISTIC DATA" table on page 3/4.
- Using the unit without having installed a suction filter.
- Operating with the suction and/or delivery openings closed.

- Making modifications to the unit or transforming it, or making repairs or doing maintenance based on your own initiative. Maintenance works are only to be carried out as described in this operating manual by qualified personnel, that is, personnel whose training, instruction, experience, knowledge of standards, regulations, accident prevention procedures, and operating and service conditions, makes them capable of carrying out all the works necessary, while being aware of and avoiding any possible danger and/or damage.
- Starting the unit up again after a fault, unless it has been repaired by qualified personnel.

**THE FOLLOWING ARE OBLIGATORY:**

- Doing maintenance work as indicated in chapter 6.
- Carrying out preliminary and periodic checks as indicated in the "STARTING UP" chapter.

**3 STORAGE AND TRANSPORT**



**Danger due to loads that fall over or fall down!**

Heavy loads that fall over or down may cause crushing, resulting in injuries to people and even death!  
Do not put loads on top of the packing.



**Danger due to lifting heavy loads!**

Heavy loads that fall over or down may cause crushing, resulting in injuries to people and even death!

Before undertaking handling operations (lifting, moving, transporting, and putting down) look at the unit's mass (M) shown in the "CHARACTERISTIC DATA" table on page 3/4 and determine the best way to work in maximum safety.

In this regard all the prevention measures must be applied, including any local and/or specific regulations that make it possible to carry out the handling operations:

Using qualified personnel that have specific skills and adequate training, using suitable equipment.

Organising the work in such a way that it poses the least risk possible and is done under safe, healthy, conditions.

Using safe, stable support surfaces.

Use of suitable working clothes and adequate personal protective equipment (protective gloves and safety glasses, safety shoes and a hardhat).

Working in an area with sufficient space, level floors, no obstructions.

Avoiding impacts, jolting, and shaking.

Units with a mass that exceeds 25 kg (55 lbs) are fitted with lugs to be used for handling.

**WARNING!**

Lifting the unit is any way other than that indicated is strictly forbidden. Use the lug provided on the blower unit or motor.

Store in a dry place, keeping the packing if possible. Do not remove the covers over the openings.

**4 INSTALLATION**

**4.1 SCL K COMPRESSOR – VACUUM PUMP**



**Any use other than the intended use of the unit may cause serious injury and even death!**

- This operating manual:  
MUST be read carefully and understood fully before doing any work using the unit.  
MUST be complied with fully.  
MUST be to hand at all times at the workstation at which the unit is used.
- Remember that installation operations are only to be carried out by qualified personnel, that is, personnel whose training, instruction, experience, knowledge of standards, regulations, accident prevention procedures, and operating and service conditions, makes them capable of carrying out all the works necessary, while being aware of and avoiding any possible danger and/or damage.



**Danger due to a lack of a clear view of the place in which the unit is installed!**

Make sure that the unit installed is always under control when doing anything in the installation area.

The controls must be positioned in such a way as to be able to see the unit installed.

Danger of very serious injury!

**WARNING!**

If the flow rate has to be reduced, use a draw-off valve rather than throttling back the suction or delivery lines.

**4.1.1 WORKING CONDITIONS**

The "K" series of side channel compressors-vacuum pumps in an "MOR" format are made to generate vacuums and pressures, and for conveying air and gas that is not explosive, not inflammable, not poisonous, and not aggressive, for continuous operation in a non-explosive environment.

If installed outdoors, protect the unit against exposure to sunlight.

The maximum pressure differentials allowed are indicated in the "CHARACTERISTIC DATA" table on page 3 of this manual and must never be exceeded. Only the following conditions are valid:

As a compressor:

Gas intake temperature 20°C (+68°F) and atmospheric pressure 1013 mbar (abs) (29,92 in Hg) measured at the suction opening.

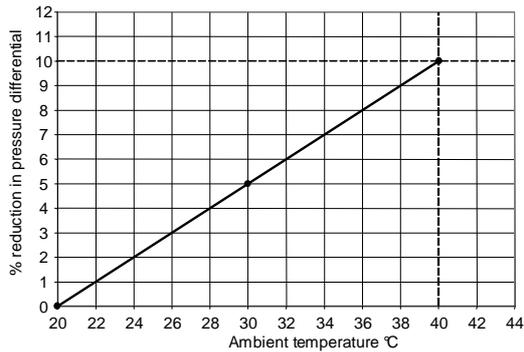
As a vacuum pump:

Gas intake temperature 20°C (+68°F) measured at the suction opening and atmospheric back pressure 1013 mbar (abs) (29,92 in Hg).

The ambient temperature and the intake temperature of the gas conveyed is allowed within the -15°C (+5°F) to + 40 °C (+104°F) range, with the following provisions:

- If the ambient temperature is +30°C (+86°F) **reduce** the maximum pressure differentials indicated in the "CHARACTERISTIC DATA" table on page 3/4 by 5%.
- If the ambient temperature is +40°C (+104°F) **reduce** the maximum pressure differentials indicated in the "CHARACTERISTIC DATA" table on page 3/4 by 10%.

The graph to be used to reduce the maximum pressure differentials when the ambient temperature is between +21°C (+70°F) and +40°C (+104°F) is given below.



#### 4.1.2 INSTALLATION CONDITIONS

For installation exceeding 1000 m (3300 ft) contact FPZ for assistance as installations at higher altitudes will affect blower performance.

The support surfaces for the unit must be flat, strong, stable, and as level as possible.

It is important that the unit be installed on a structure that does not transmit significant vibrations back to the blower.

Under all conditions, do not install units on structures that can transmit or amplify noise (tanks, steel plating, etc.).

The unit must always be installed using anti-vibration supports.



#### **Danger due to vibrations!**

Regularly check that the points at which the unit is fixed to the support structure are tight.

Excess vibration of the unit can cause damage to balance, resulting in injury to people and even death!

The unit must be installed in such a way that the motor's ventilation is not impeded by obstacles put in the immediate vicinity.

To this end a minimum gap must be kept between the motor's fan guard and any other structure of at least 50 mm (2 in.).

#### **WARNING!**

To guarantee that the unit is well ventilated after installation, proceed as follows:

The air intake on the motor's fan guard must be kept free.

Intake fresh air only. Avoid recirculation and / or ingestion of contaminated / hot air from other sources.

If the unit is installed in a closed space, guarantee a good flow of cooling air by using an extractor / fan and correct air intake for cooling the motor.



#### **Any use other than the intended use of the unit may cause serious injury and even death!**

To avoid overloading due to pressure fluctuations, fit a safety valve on the suction pipe if used as a vacuum pump and on the delivery pipe if used as a compressor.



#### **Danger due to foreign bodies and dirt getting into the unit!**

Any foreign bodies, even very small in size, getting into the unit causes serious damage and probable breakage of the impeller, and a danger that broken bits may be projected outwards!

Foreign bodies include: Dust, sand, lime scale, impurities in the pipes, cutting or threading burrs, welding drops or slag, metal burrs or residue of sealing products used when connecting up the pipework.

Protect the suction pipe using a suitable filter with a maximum degree of filtration of 25µm and a maximum load loss of  $\Delta P=20\text{mbar}$  (8" wg).

Replace filters regularly!

#### **WARNING!**

Size piping and choose accessories that cause the minimum load losses, and so:

Do not fit pipes of a diameter smaller than that of the machine's openings.

When installing a number of machines in parallel, size the manifold and main line accordingly.

Do not use elbows, but large radius bends.

Do not fit valves with a passage smaller than the nominal size and non-return valves with a spring-loaded shutter (the non-return valve that causes the smallest load loss is one with a lightened shutter).

When using for aeration, choose diffusers with a low passage resistance (low load loss) and do not forget that the diffusers and porous sieves can clog over time and increases load.

#### **WARNING!**

Avoid the possibility of standing water, especially when installing the unit with its axis vertical.

See the **INSTALLATION DIAGRAMS** in chapter 8.

#### 4.1.3 HORIZONTAL INSTALLATION

The unit is ready for installation in a horizontal position, suitably fixed to the bracket / brackets.

The bracket has fixing holes. Use all the holes and suitable bolt types.

See point 4.1.2 for the **INSTALLATION CONDITIONS**.

Remove the covers over the openings before checking the direction of rotation and before final connection.

#### **WARNING!**

Check the direction of rotation in the motor.

(See point 4.2.3 **ROTATION DIRECTION**)

When connecting the unit cabin to the ducting, do so using the flanges on the silencer housings and form suitable connections using flexible hoses. Avoid rigid connections that may impose loads and give rise to harmful vibrations.

Fit the flanges on the silencer housings complete with gaskets again, and tighten.

#### 4.1.4 INSTRUCTIONS FOR REPOSITIONING THE SILENCER HOUSINGS



**Danger due to rotating components: Impeller!**

There may be a danger of shearing due to the impeller rotating even when the machine is switched off, if it is started manually.

Suitable working clothes and personal protective equipment must therefore be used.

The SCL K-MS series is designed to provide maximum flexibility in positioning the silencer housings, to allow for various installation configurations.

The blower comes with the silencers positioned as shown in fig 1.

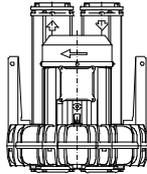


fig.1

If this layout has to be modified, proceed to identify the layout of the silencer housings required.

The possible solutions are shown in fig 2, fig 3, and fig 4 below.

fig 2

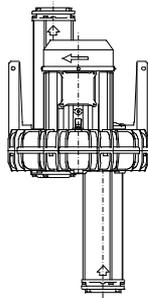


fig 2 with 90° manifold

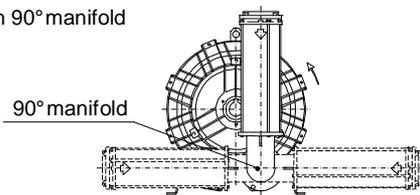


fig 3

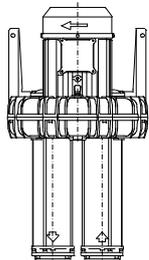


fig 3 with 90° manifolds

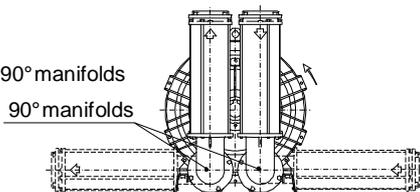


fig 4

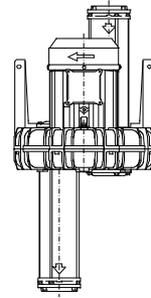
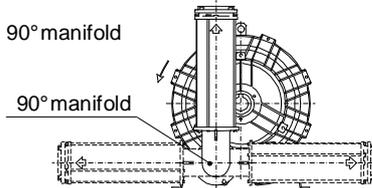


fig 4 with 90° manifold



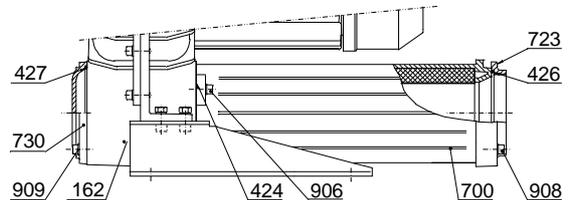
Position the unit in a horizontal position with the brackets on a flat, stable surface.

#### Disassembling the silencer housing:

- Remove the bolts (908) and remove the flange (723) with the O-Ring (426).
- Remove the bolts (906).
- Remove the silencer (700) with its gasket (424).

#### Fitting the blank flange (730):

- Remove the bolts (909) and the flange (730) with the O-Ring (427).



Fit everything again in reverse order, not forgetting gaskets 424, 426, and 427.

#### USING THE (accessory) CK TYPE 90° MANIFOLD KIT

The 90° manifold can only be fitted for 162 cover openings and as shown in fig 2, fig 3, and fig 4 above there are a number of installation configurations that are possible.

The CK type 90° manifold kit comprises:

- N°1 manifold
- N°1 gasket and
- N°4 M8x25 UNI 5739 bolts

#### To assemble the 90° manifold proceed as follows:

- Remove the silencer housing as described before.
- Put the gasket between the cover (162) and the 90° manifold, and tighten the M8x25 UNI 5739 bolts.
- Assemble the silencer housing, following the instructions in reverse order and not forgetting gasket 424 and 426.

#### 4.1.5 VERTICAL INSTALLATION ON THE COVER

For installing in a vertical position, fit the anti-vibration supports supplied with the unit on the cover, and then fix the whole structure to the support.

See point 4.1.2 for the INSTALLATION CONDITIONS.



**Any use other than the intended use of the unit may cause serious injury and even death!**

When installing vertically DO NOT use the bracket supplied with the unit as this is only suitable for horizontal installations.

Remove the covers over the openings before checking the direction of rotation and before final connection.

#### NOTE FOR THE USER

A bracket for fitting the unit in a vertical position on the cover is available as an accessory.

The bracket has fixing holes. Use all the holes and suitable bolt types.

#### WARNING!

Check the direction of rotation in the motor.

(See point 4.2.1 ROTATION DIRECTION)

When connecting the unit to the ducting, do so using the flanges on the silencer housings and form suitable connections using flexible hoses. Avoid rigid connections that may impose loads and give rise to harmful vibrations.

Fit the flanges on the silencer housings complete with gaskets again, and tighten.

#### 4.2 ELECTRIC MOTOR



**Electrical danger!**

- Improper installation may result in serious injury and even death!
- Work on electrical equipment (installation and maintenance) is only to be done by qualified, authorised electricians!
- Before starting to work on the unit or plant, the following precautions must be taken:
  - Make sure that the line is NOT switched on.
  - Adopt measures to prevent it being switched on again.
  - Only open the terminal box after checking that the power is off altogether!
- The terminal box must not contain:
  - Foreign bodies
  - Impurities
  - Moisture.

Close the cover on the terminal box and seal the openings in the cable glands in order to prevent dust, water, and moisture to penetrate.

Check the seals periodically.

- Should you touch a defective unit there may be a danger of electric shock!
  - Fit a motor trip-switch.
  - Have the unit's electrical system checked by an electrician on a regular basis.

The electric motor is sized to work at an ambient temperature between -15°C (+5°F) and +40°C (+104°F), and a maximum altitude of 1000 m (3300 ft) above sea level.

Under other conditions the motor cannot be used at full load and so difficulties may arise for starting, particularly with a single-phase power supply for the motors.

#### WARNING!

A maximum of n° 6 evenly distributed starts per hour, is allowed.

Failure to comply with this may seriously damage the unit.

#### 4.2.1 CONNECTION

#### WARNING!

Connecting the motor incorrectly may seriously damage the unit.

The power supply for the motor and any auxiliary equipment must be provided using cables of suitable section to avoid abnormal overheating and great voltage drops.

Check that the details on the nameplate are compatible with the line voltage and frequency.

A voltage tolerance of  $\pm 10\%$  compared to the nominal value is admissible.

Connect the motor's earth cable to the relevant terminal marked with this symbol  $\oplus$  always before connecting to the mains supply and check the dispersion capacity.

The earth cable can be recognised by its colour (yellow/green).

This connection to the main supply must be formed as shown in the wiring diagram contained in the terminal box.

Use the cable gland openings to allow power supply cables to pass into the terminal box.

Proceed to tighten the power supply cables, taking the section of the electrical cables into account each time.

The terminal block connections must be tightened properly to avoid high contact resistances and resulting overheating.

Check that the insulation gaps between the various conductors are not in contact with other surfaces, as indicated in the standards.

All the screws used to close the terminal board must be tightened properly. Damaged screws must be replaced immediately, using screws of the same or better quality.

The connection must guarantee:

- that it will maintain integrity over time.
- that no wire ends are sticking out.

Fuses do not constitute protection for the motor, but merely protect against short-circuits.

Size the fuses according to the peak currents, especially when using direct starting.

Protection with a (thermal or amperometric) trip switches is essential to deal with risks of overloading, a loss of one phase in the mains supply, excessive voltage fluctuations, or the rotor getting stuck.

Set the motor trip switch using the current value shown on the nameplate as a maximum.

#### 4.2.2 INVERTER POWERED ELECTRIC MOTOR

#### WARNING!

A maximum of n° 6 evenly distributed starts per hour, is allowed.

Failure to comply with this may seriously damage the unit.

#### WARNING!

The unit's nominal pressure or vacuum characteristics for service at mains frequency cannot be maintained if the unit is powered via an inverter.

If an inverter is used for the power supply the installer is responsible for the checks and any steps necessary to comply with the immunity and emission limits laid down by the standards.

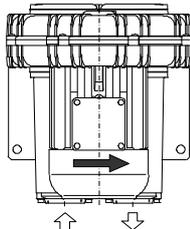
When using the unit with a motor powered via an inverter, follow the wiring instructions supplied by the inverter manufacturer carefully.

### WARNING!

The performance of the unit powered via an inverter is shown in the relevant tables that can be requested from FPZ's assistance service.

#### 4.2.3 ROTATION DIRECTION

The SCL K compressors–vacuum pumps must be used with the rotation direction shown by the arrow on the fan guard for the electric motor (see figure below).



To check the direction of rotation, switch on the motor very briefly. If the rotation direction is incorrect, switch the position of two of the three power supply conductors on the terminals.

## 5 STARTING UP



**Any use other than the intended use of the unit may cause serious injury and even death!**

The unit may only be started:

After having carefully read, fully understood, and complied with this operating manual ("SAFETY STANDARDS" and "INSTALLATION").

In conformity with the purposes laid down under "INTENDED USE".

According to the values indicated in the "CHARACTERISTIC DATA" table on page 3/4.



**Danger due to rotating components (electric motor fan, impeller, and shaft): Cutting or shearing of limbs, entanglement or trapping of hair or clothing!**

**Danger due to excess pressure or vacuum: Sudden ejection of process gases (injury to the skin and eyes), and sudden sucking in of hair and clothing!**

**Danger due to process gases that come out and cause burns!**

**Danger due to burns caused by contact with hot surfaces on the unit!**

**Electrical danger!**

**Danger due to the impeller seizing due to use in an unsuitable place and/or due to conveying fluids that are not suitable: Unsuitable ambient and suction temperatures!**

**Danger resulting from the impeller seizing due to the performance values being exceeded: Vacuum and/or pressure exceeding the declared values and/or openings closed!**

**Danger due to noise emitted by the unit!**

- CHECK THAT ALL THE SAFETY GUARDS HAVE BEEN FITTED CORRECTLY.

### WARNING!

A maximum of n° 6 evenly distributed starts per hour, is allowed.

Failure to comply with this may seriously damage the unit.

#### 5.1 PRELIMINARY CHECKS

Before finally starting up, carry out the following preliminary checks:

- If a lot of time has passed since the unit was last started up, check its condition and check for and if necessary remove dust deposited on the external surfaces.
- Deactivate/open any closing elements on the piping (closing valves, solenoid valves, etc.) before starting the unit.

**Do not allow the unit to be started and operate with the suction and/or delivery openings obscured for any reason!**

- Check that the ambient and suction temperatures for the gas conveyed are between: -15°C (+5°F) and +40°C (+104°F).
- Check the rotation direction as indicated previously in the "INSTALLATION" chapter.
- Check that the setting for the motor trip switch corresponds to the motor's nominal current shown on the nameplate.
- Check that the safety valve is working correctly.

#### 5.2 OPERATION

Having carried out all the preliminary checks, you can start with final starting of the unit.

Start the unit by switching on the power supply to the electric motor.

Check the operating pressure or vacuum and compare them to the values indicated in the "CHARACTERISTIC DATA" table on page 3/4. Load losses on the pipes are often underestimated but are determining factors for the operating pressure differential.

Measure the motor's absorption and check against the nameplate value.



**Any use other than the intended use of the unit may cause serious injury and even death!**

The unit may only be used:

- After having carefully read, fully understood, and complied with this operating manual ("SAFETY STANDARDS" and "INSTALLATION").
- In conformity with the purposes laid down under "INTENDED USE".
- According to the values indicated in the "CHARACTERISTIC DATA" table on page 3/4.

#### 5.2.1 ROUTINE CHECKS

It is important that the units be checked routinely while running by qualified personnel, using inspections to avoid faults that may cause damage directly or indirectly.

**When the unit is running, routinely carry out the following checks:**

- Delivery temperature
- Operating pressure and/or vacuum
- Electric motor current absorption
- Vibrations
- State of the filter and related load loss.

Variations in normal working conditions (increases in power absorbed, anomalous noise, vibrations, excess overheating of the service fluid) indicate that the unit is not working correctly.

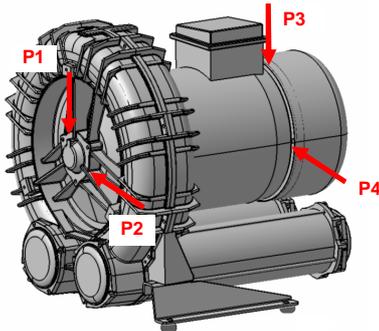
Also compare the values measured with those indicated in the "CHARACTERISTIC DATA" table on page 3/4.

See chapter 9 "TROUBLESHOOTING" for preventing possible breakage or faults.

### Measuring vibrations

Measurements to determine vibration speed [mm/s] must be carried out using an electronic vibration meter at the points indicated below (see the figure below).

- **Points P1 and P2 (front bearing):** The vibration meter must be put on the cover near the bearing seating, and the highest value must be recorded.
- **Points P3 and P4 (back bearing):** The vibration meter must be put on the electric motor casing near the bearing seating (not on the fan guard), and the highest value must be recorded.



The results must be evaluated by comparing the maximum speed value measured with the limits laid down for the zones (A, B) shown in the table below, in compliance with ISO 14694.

Effective vibration speed value [mm/s]	<b>Class I</b> (≤ 15kW)	Effective vibration speed value [mm/s]	<b>Class II</b> (> 15kW)
1.8	<b>A</b>	2.8	<b>A</b>
4.5	<b>B</b>	7.1	<b>B</b>

### Legend:

Machine classification:

**Class I** = SCL with electric motor power ≤ 15 kW

**Class II** = SCL with electric motor power > 15 kW

Evaluation zones:

**Zone A** = SCL with vibrations within this zone are considered acceptable for long-term service.

**Zone B** = SCL with vibrations within this zone are considered unsuitable for continuous long-term service. Under these conditions the machine can be operated for a limited period, until the opportunity arises for suitable corrective work to be done.



### Danger resulting from the impeller seizing due to excessive vibrations!

Vibration values exceeding zone B (table of effective vibration speed values) are considered NOT admissible and may cause damage to the machine and resulting serious injury and even death!

- If any anomalous noises and/or vibrations are detected, these may be a warning that the impeller is about to seize, switch off the unit and move away from it immediately.

### When the unit is stopped, routinely carry out the following checks:

- **Dust deposits:** Check and, if necessary, use suitable equipment to remove deposits on the external surfaces of the unit that may impede correct heat exchanging.
- **Suction filter:** Every 8-10 days check and if necessary clean or replace the filter cartridge. In very dusty environments, change the filter more frequently. A dirty cartridge creates extensive resistance at the suction, resulting in an increase in: the pressure differential, the power absorbed, and the operating temperature. The load loss must not exceed 30 mbar.



### Electrical danger!

- Before doing anything else, make sure that the power supply is NOT switched on.



### Danger due to burns caused by contact with hot surfaces on the unit!

When operating the compressors-vacuum pumps can reach high surface temperatures of up to 160°C (+320°F).

- Before starting with any work, wait for the unit to cool down after switching it off!

## 6 MAINTENANCE



### Any use other than the intended use of the unit may cause serious injury and even death!

Maintenance may only be carried out on the unit:

If the maintenance instructions, parts list, and section/exploded view of the relevant unit are available.

After having carefully read, fully understood, and complied with this operating manual ("SAFETY STANDARDS" "STORAGE AND TRANSPORT" and "INSTALLATION").

In conformity with the purposes laid down under "INTENDED USE".

By qualified personnel, that is, personnel whose training, instruction, experience, knowledge of standards, regulations, accident prevention procedures, and operating and service conditions, makes them capable of carrying out all the works necessary, while being aware of and avoiding any possible danger and/or damage.



### Danger due to burns caused by contact with hot surfaces on the unit!

When operating the compressors-vacuum pumps can reach high surface temperatures of up to 160°C (+320°F).

- Before starting with any work, wait for the unit to cool down after switching it off!



### Electrical danger!

- Before doing anything else, make sure that the power supply is NOT switched on.



**Any use other than the intended use of the unit may cause serious injury and even death!**

The user is not authorised to make repairs or do maintenance work that involves restoring seized surfaces.

In these cases contact FPZ's assistance service or an authorised dealer.

After seizing the components involved may undergo deformation that makes the components unsuitable for being used again. Seized components must be analysed by FPZ before being reused or replaced.

- **Using unsuitable components may cause the impeller blades to break, giving rise to dangerous ejected fragments.**



**Danger due to rotating components: Impeller!**

There may be a danger of shearing due to the impeller rotating even when the machine is switched off, if it is started manually.

- **Suitable working clothes and personal protective equipment must therefore be used.**

## 6.1 INSTRUCTIONS FOR INTERNAL CLEANING

Should it be necessary to clean the inside of the unit, proceed as follows:

See fig. 1

1. Position the unit in a vertical position with the fan guard cowl on a flat, stable surface.
2. Remove screws (915) and (902) in order from the cover (162).
3. Remove the cover (162) by using the two threaded holes placed on cover itself
4. Remove the screws (900) and washer (365).
5. Remove the bearing (321) and bearing cover (360) working through the extractor.

N.B.: The shims washers (935) are included when necessary to accommodate the axial clearance. Be careful not to misplace.

6. Remove the impeller (230) through the extractor if necessary.

Clean and reassemble following the instructions in reverse order, and forming the seal (423) using Loctite 5970 or a similar product after having carefully cleaned the surfaces previously sealed.

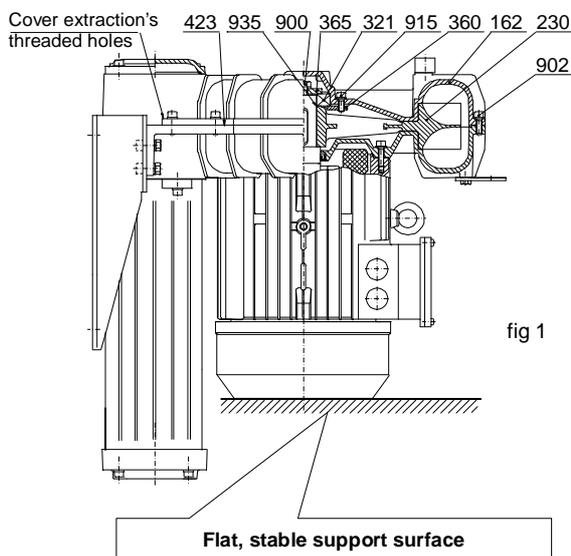


fig 1

**If it becomes necessary to replace the soundproofing in the silencers, proceed as follows:**

See fig. 2

1. Position the unit in a horizontal position with its bracket on a flat, stable surface.
2. Remove the bolts (906).
3. Remove the silencers (700) from the unit, being careful not to lose the gaskets (424).
4. Remove the soundproofing (720) from the silencer housings.
5. Retrieve the support mesh (710).

Replace the soundproofing (720) and reassemble the unit following the instructions in reverse order and not forgetting the gaskets (424).

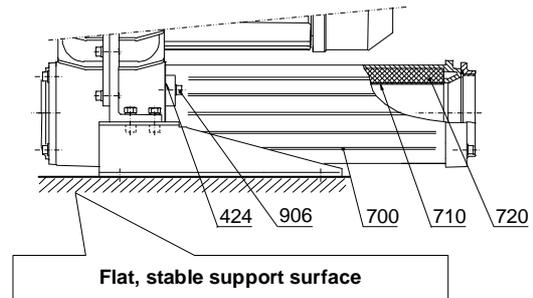


fig 2

## 6.2 LIFESPAN OF BEARINGS

Under normal operating conditions (values shown in CHARACTERISTIC DATA – page 3/4) the machine's bearings have to be replaced after a maximum of 25,000 working hours or not more than 4 years.



**Any use other than the intended use of the unit may cause serious injury and even death!**

The bearings may only be replaced:

If the instructions, parts list, and section/exploded view of the relevant unit are available.

After having carefully read, fully understood, and complied with this operating manual ("SAFETY STANDARDS" "STORAGE AND TRANSPORT" and "INSTALLATION").

In conformity with the purposes laid down under "INTENDED USE".

By qualified personnel, that is, personnel whose training, instruction, experience, knowledge of standards, regulations, accident prevention procedures, and operating and service conditions, makes them capable of carrying out all the works necessary, while being aware of and avoiding any possible danger and/or damage.

## 7 COMMERCIAL CONDITIONS

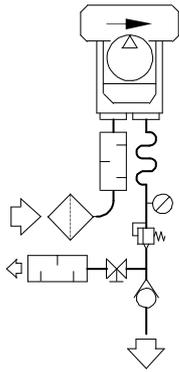
All undertakings, agreements, or legal relations are governed by the relevant sales contract. These are in no way limited by the contents of this manual.

The quality of the materials and workmanship is guaranteed, as indicated in the general sales conditions.

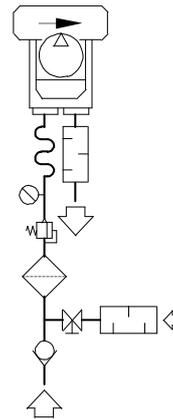
Guarantees are regulated by the general conditions of sale.

## 8. INSTALLATION DIAGRAMS

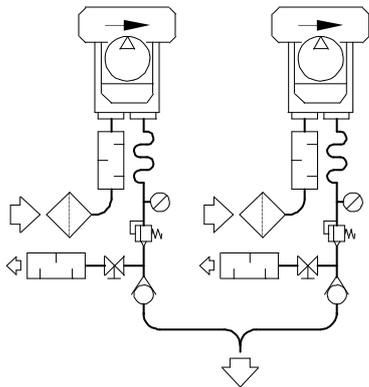
### 8.1 PRESSURE SERVICE



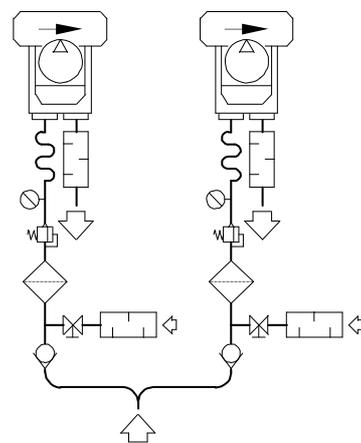
### 8.4 VACUUM SERVICE



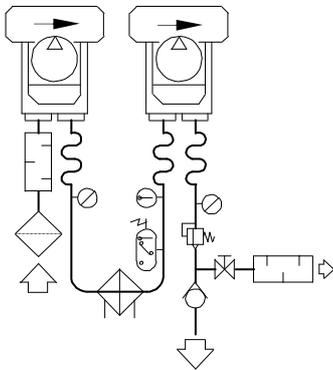
### 8.2 PARALLEL PRESSURE SERVICE



### 8.5 PARALLEL VACUUM SERVICE



### 8.3 SERIES PRESSURE SERVICE



### 8.6 LIST ACCESSORIES

Item		Denomination	Item		Denomination
1		Filter – Inline filter	7		Non return valve
(2)		Silencer	8		Valve
3		Flexible coupling	(9)		Cooler
4		Pressure – Vacuum gauge	(10)		Thermometer
5		Pressure – Vacuum switch	(11)		Temperature switch
6		Safety valve	(x) IF NECESSARY		

9 TROUBLESHOOTING

Problem	Cause	Solution
<b>The unit does not start</b>	Electrical wiring incorrect	Get the operator to check the electrical connection against the wiring diagram contained in the terminal board box.
	Power supply voltage unsuitable	Check that the power supply voltage, measured at the motor's terminals, is within +/- 10% of the nominal voltage.
	The impeller is stuck	Get the operator to repair the unit
<b>No or insufficient air flow</b>	The suction filter is clogged	Get the operator to clean or replace the cartridge
	Frequency wrong (for units powered via an inverter)	Correct the frequency
	Profile of the impeller blades modified (due to deposits on the profile)	Get the operator to clean the impeller, check if it is worn and, if necessary, replace it.
<b>No or insufficient pressure differential</b>	Incorrect rotation direction	Get the operator to invert the rotation direction by switching two of the electrical power supply conductors.
	Leaks in the plant	Identify the leak and seal
<b>Current absorption exceeding the admissible value</b>	Electrical wiring incorrect	Get the operator to check the electrical connection against the wiring diagram contained in the terminal board box.
	Drop in mains supply voltage	Get the operator to reinstate the power supply voltage at the terminals at the admissible values
	The suction filter is clogged	Get the operator to clean or replace the cartridge
	The unit has accumulated deposits inside	Get the operator to clean the inside of the unit
	The unit is operating at a pressure and/or vacuum that exceeds the admissible value	Adjust the system and/or the regulating valve to lower pressure differentials.
<b>High delivery air temperature</b>	The unit is operating at a pressure and/or vacuum that exceeds the admissible value	Adjust the system and/or the regulating valve to lower pressure differentials.
	The suction filter is clogged	Get the operator to clean or replace the cartridge
	The unit has accumulated deposits inside	Get the operator to clean the inside of the unit
	Suction and/or delivery piping obstructed.	Get the operator to remove any obstructions
	Suction air temperature exceeds 40°C (+104°F)	Use heat exchangers to reduce the suction air temperature
<b>Anomalous noise</b>	The soundproofing is damaged	Get the operator to replace the soundproofing
	The impeller scrapes against the casing. - The unit is operating at a pressure and/or vacuum that exceeds the admissible value - Reduction of assembly play due to internal deposits (dust, impurities in the pipes, process residues, etc.)	Reduce the pressure differentials in the plant  Get the operator to clean the inside of the plant
	Bearing worn	Get the operator to replace the bearing
	Unit's installation position unsuitable	Do not fit structures (tanks, steel plating, etc.) on the unit that can transmit or amplify noise
<b>Abnormal vibrations</b>	The impeller is damaged	Get the operator to replace the impeller
	The impeller has accumulated deposits	Get the operator to clean the inside of the unit
	Unit fixing without anti-vibration supports	Get the operator to fix the unit with anti-vibration supports
	Rigid connection to the plant	Get the operator to fit flexible hoses between the unit and the piping
	Bearing on the blower or motor side defective	Get the operator to replace the bearing
<b>Leaks in the unit</b>	Defective silencer gaskets	Get the operator to clean or replace the gaskets
	Defective cover gaskets	Get the operator to clean or replace the gaskets

The term "operator" means: A qualified person appointed to install, operate, set, clean, repair or move a unit or to carry out maintenance work on it.



# Compact Filter Silencers

"FS" Series 3" - 6" MPT

## APPLICATIONS & EQUIPMENT

- ♦ Industrial & Severe Duty
- ♦ Blowers - Side Channel & P.D.
- ♦ Piston Compressors
- ♦ Screw Compressors
- ♦ Hydraulic Breathers – fine filtration
- ♦ Engines
- ♦ Fans
- ♦ Construction\Contractor Industry
- ♦ Medical
- ♦ Pneumatic Conveying
- ♦ Waste Water Aeration
- ♦ Sparging
- ♦ Factory Air
- ♦ Vacuum Vent Breathers

## FEATURES & SPECIFICATIONS

- ♦ Polyester: 99%+ removal efficiency standard to 5 micron
- ♦ Paper: 99%+ removal efficiency standard to 2 micron
- ♦ Fully drawn weatherhood - no welds to rust or vibrate apart
- ♦ Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- ♦ Durable carbon steel construction with gray baked enamel finish and powder coated weatherhood
- ♦ Interchangeable media: Polyester, Paper, HEPA
- ♦ Several element sizes available per given connection (safety factor)
- ♦ Low pressure drop center bracket and outlet pipe design
- ♦ Temp (continuous): min -15°F (-26°C) max 220°F (104°C)
- ♦ Filter change out differential: 10"-15" H<sub>2</sub>O over initial delta P
- ♦ Pressure drop graphs available upon request

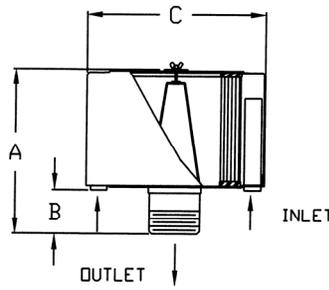
## OPTIONS (Inquiries Encouraged)

- ♦ Various media available
- ♦ 1/8" tap holes
- ♦ Pressure Drop Indicator
- ♦ Available in **Stainless Steel**
- ♦ Epoxy coated housings
- ♦ Special connections, NPT
- ♦ Side Access Silencers Filters for space restricted enclosures (Selected models)

## CONFIGURATION

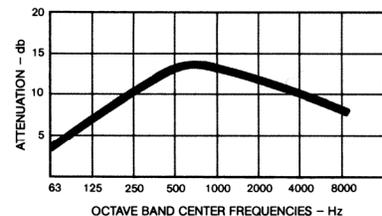


## DRAWING



Dimension tolerance  $\pm 1/4"$

TYPICAL NOISE ATTENUATION – FS SERIES



♦ Noise attenuation may vary due to the wide range of applications and machines

**I = Industrial Duty S = Severe Duty E = Extreme Duty**

	with Polyester Element	with Paper Element	MPT Outlet	DIMENSIONS - inches			Rated Flow SCFM			No. of Silencing Tubes	Approx. Wt. lbs
				A	B	C	Piston	Screw, Blower, Fan	Element Rating		
S	FS-235P-300	FS-234P-300	3"	13	3	16	200	300	570	9	29
S	FS-245P-300	FS-244P-300	3"	13	3	16	200	300	880	9	30
E	FS-275P-300	FS-274P-300	3"	13	3	16	200	300	1100	9	33
I	FS-235P-400	FS-234P-400	4"	14	4	16	300	520	570	9	30
S	FS-245P-400	FS-244P-400	4"	14	4	16	450	520	880	9	31
E	FS-275P-400	FS-274P-400	4"	14	4	16	450	520	1100	9	34
I	FS-245P-500	FS-244P-500	5"	14	4	16	500	800	880	14	33
S	FS-275P-500	FS-274P-500	5"	14	4	16	650	800	1100	14	36
I	FS-275P-600	FS-274P-600	6"	15	5	16	650	1100	1100	18	38

Note: Model offerings and design parameters may change without notice.

Solberg – Discover the Possibilities

FS35-306

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E-mail: sales@solbergmfg.com • Web Site: www.solbergmfg.com



# Small Compact Filter Silencers w/ Standard Filter Design

"FS" Series 1/2" - 3" MPT

FILTER SILENCERS  
FS, 2G, LQB, BBF, SLCR Series

## APPLICATIONS & EQUIPMENT

- ♦ Industrial & Severe Duty
- ♦ Piston Compressors
- ♦ Screw Compressors
- ♦ Blowers - Side Channel & P.D.
- ♦ Hydraulic Breathers – fine filtration
- ♦ Engines
- ♦ Construction\Contractor Industry
- ♦ Workshop
- ♦ Medical\Dental Industry
- ♦ Pneumatic Conveying
- ♦ Waste Water Aeration
- ♦ Nailers and Staplers
- ♦ Vacuum Vent Breathers

## FEATURES & SPECIFICATIONS

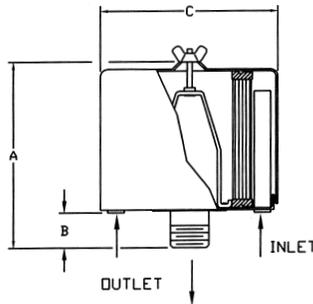
- ♦ Polyester: 99%+ removal efficiency standard to 5 micron
- ♦ Paper: 99%+ removal efficiency standard to 2 micron
- ♦ Fully drawn weatherhood - no welds to rust or vibrate apart
- ♦ Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- ♦ Durable carbon steel construction with baked enamel finish and powder coated weatherhood
- ♦ Interchangeable media: Polyester, Paper, HEPA
- ♦ Several element sizes available per given connection (safety factor)
- ♦ Temp (continuous): min -15°F (-26°C) max 220°F (104°C)
- ♦ Filter change out differential: 10"-15" H<sub>2</sub>O over initial delta P
- ♦ Pressure drop graphs available upon request

## OPTIONS (Inquiries Encouraged)

- ♦ 1/8" tap holes
- ♦ Pressure Drop Indicator
- ♦ Available in **Stainless Steel**
- ♦ Epoxy coated housings
- ♦ Various media available
- ♦ Special connections, BSPT

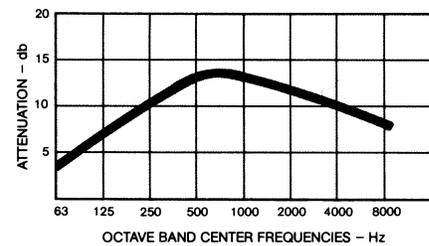
## CONFIGURATION

## DRAWING



Dimension tolerance  $\pm 1/4"$

TYPICAL NOISE ATTENUATION – FS SERIES



♦ Noise attenuation may vary due to the wide range of applications and machines

**I = Industrial Duty S = Severe Duty**

	with Polyester Element	with Paper Element	MPT Outlet	DIMENSIONS - inches			Rated Flow SCFM			No. of Silencing Tubes	Approx. Wt. lbs
				A	B	C	Piston	Screw, Blower, Fan	Element Rating		
I	FS-15-050	FS-14-050	1/2"	4	1 1/2	6	10	10	35	1	2
I	FS-15-075	FS-14-075	3/4"	4	1 1/2	6	20	25	35	2	2
I	FS-15-100	FS-14-100	1"	4	1 1/2	6	25	35	35	3	2
S	FS-19P-100	FS-18P-100	1"	6 5/8	1 5/8	6	35	55	100	3	3
I	FS-19P-125	FS-18P-125	1 1/4"	6 5/8	1 5/8	6	55	70	100	5	3
I	FS-19P-150	FS-18P-150	1 1/2"	6 5/8	1 5/8	6	70	95	100	5	4
I	FS-31P-200	FS-30P-200	2"	7 1/4	2 1/4	10	85	135	195	5	8
S	FS-231P-200	FS-230P-200	2"	12 1/4	2 1/4	10	135	135	300	5	14
S	FS-231P-250	FS-230P-250	2 1/2"	12 1/2	2 1/2	10	195	195	300	9	15
I	FS-231P-300	FS-230P-300	3"	13	3	10	200	300	300	9	15

Note: Model offerings and design parameters may change without notice.

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E-mail: sales@solbergmfg.com • Web Site: www.solbergmfg.com



SOLBERG



## Filter Silencers and Inlet Filters Maintenance Manual

[www.solbergmfg.com](http://www.solbergmfg.com)

Note: Please read the maintenance instructions given by the OEM for the machinery first. The OEM's manual should be adhered to in order to protect the equipment. Solberg Manufacturing, Inc has made every effort to make sure that these instructions are accurate but is not responsible for any typos, slight variations or for human errors that may occur.

Solberg Manufacturing, Inc., 1151 Ardmore Itasca, IL 60143 USA  
Ph: 630.773.1363 Fax: 630.773.0727 Email: [sales@solbergmfg.com](mailto:sales@solbergmfg.com) Web: [www.solbergmfg.com](http://www.solbergmfg.com)  
Rev: MMIFS-407

# Maintenance Manual

## ***Solberg Air Inlet Filters and Filter Silencers***

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*\*For Further Information Please Call: 630-773-1363*



## Section A

### **INTRODUCTION**

The purpose of this manual is instruction on the proper assembly and care of Solberg inlet air filters.

## **\*WARNING\***

**This manual must be read and thoroughly understood before using and caring for this air filter. Failure to comply could result in explosion, product/system contamination or personal injury.**

This manual should be used as a supplement to the user's understanding of the proper care needed to maintain a safe and dependable air filter. It is the responsibility of the user to interpret and explain all instructions to persons who do not read or understand English BEFORE they are allowed to maintain and use this filter.

This manual should be readily available to all operators responsible for operation and maintenance of the inlet air filters.

We thank you for selecting products from Solberg Manufacturing, Inc. We are confident that our superior filter designs will meet your application requirements.

## Section B

### **GENERAL INFORMATION**

#### **1. Identification of Solberg Inlet Air Filters.**

All Solberg inlet air filters should have an identification label/nameplate that gives the following information:

**Assembly Model #  
Replacement Element #**

(The exception is OEM supplied units. In this case, please enter the OEM part numbers below.)

**Page 3**

*Solberg Manufacturing, Inc., 1151 Ardmore Itasca, IL 60143 USA  
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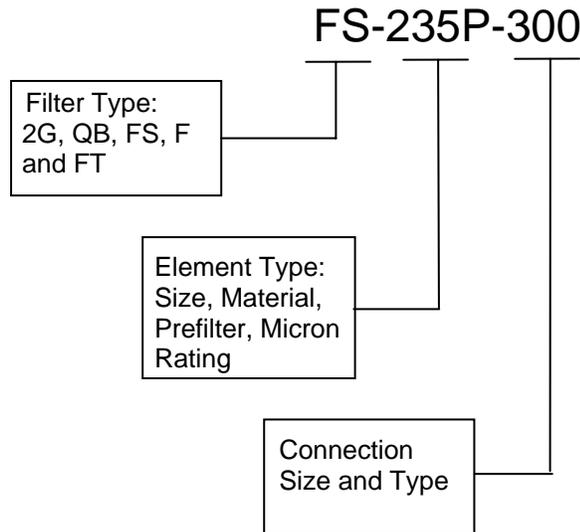
**SOLBERG**

Fill in the actual nameplate data from your new Solberg inlet filter(s):

No.	Filter Model Number	Replacement Element	Initial Delta P Readings
1			
2			
3			
4			
5			

Table 1

The model number designates the filter type, the original element configuration and housing connection size. For example, the following part number identifies the filter as being a 'FS' design filter with a 235 element with prefilter and 3" MPT connection size:



## 2. Filtration Rules of Thumb

**General:** For peak output performance from a compressor, blower, vacuum pump, engine, or any other machine that consumes air, one must have clean, unrestricted air. Proper filtration can help stabilize the working environment within rotating equipment even when the external conditions may be quite severe. A critical component in creating the right working conditions is filter sizing. With the properly sized filter, equipment will run smoothly over its entire expected operating life.

A major factor in filtration and filter sizing is air velocity through the filter media. Generally, the slower the velocity of air through a media the higher the filter



efficiency and, conversely, the lower the pressure drop. Therefore, the primary goal in filter sizing is to optimize the velocity of air through the media (sometimes called face velocity).

**Rule of Thumb #1:** Always begin with the filter cartridge requirements when sizing a filter. Once the appropriate element has been selected then move on to the housing requirements.

**Rule of Thumb #2:** Always ask or specify a filter based on a micron rating **with filtration efficiencies**. As an example, stating a requirement for a 1-micron filter is misleading because no efficiency rating has been specified. A 1-micron filter at 95% efficiency may be less efficient than a 5-micron filter at 99% efficiency. For proper air system performance in light and industrial duty environments, a filter with a minimum of 99% filtration efficiency at 5 microns is required.

**Rule of Thumb #3:** Size your filter correctly by understanding the impact air velocity through a media has on efficiency and pressure drop. Maintain the suggested Air-to-Media ratios listed below based on the external environment listings and Filtration efficiency needs.

Filtration Efficiency Requirements (99%+ efficiency)	Environmental Conditions	Air to Media Ratio	
		CFM/ft <sup>2</sup>	(m <sup>3</sup> /h)/cm <sup>2</sup>
<i>Industrial Grade</i> 2-micron Paper	Industrial Duty (clean, office/warehouse-like)	30 CFM/ft <sup>2</sup>	(51m <sup>3</sup> /h)/cm <sup>2</sup>
	Severe Duty (workshop, factory-like)	15 CFM/ft <sup>2</sup>	(25.5m <sup>3</sup> /h)/cm <sup>2</sup>
	Extreme Duty (Foundry, Construction-like)	10 CFM/ft <sup>2</sup>	(17m <sup>3</sup> /h)/cm <sup>2</sup>
<i>Industrial Grade</i> 5-micron Polyester	Industrial Duty (clean, office/warehouse-like)	50 CFM/ft <sup>2</sup>	(85m <sup>3</sup> /h)/cm <sup>2</sup>
	Severe Duty (workshop, factory-like)	40 CFM/ft <sup>2</sup>	(68m <sup>3</sup> /h)/cm <sup>2</sup>
	Extreme Duty (Foundry, Construction-like)	25 CFM/ft <sup>2</sup>	(42.5m <sup>3</sup> /h)/cm <sup>2</sup>
<i>Industrial Grade</i> 1-micron Polyester	Severe Duty (Foundry, Construction-like)	10 CFM/ft <sup>2</sup>	(17m <sup>3</sup> /h)/cm <sup>2</sup>
<i>Industrial Grade</i> 0.3-micron HEPA Glass @ 99.97% Efficiency	Industrial Duty (Pre-filtered Applications)	10 CFM/ft <sup>2</sup>	(17m <sup>3</sup> /h)/cm <sup>2</sup>
	Severe Duty (workshop, factory-like)	7 CFM/ft <sup>2</sup>	(12m <sup>3</sup> /h)/cm <sup>2</sup>
	Extreme Duty (Foundry, Construction-like)	5 CFM/ft <sup>2</sup>	(8.5m <sup>3</sup> /h)/cm <sup>2</sup>

Table 2



**Rule of Thumb #4:** Pressure drop is also caused by the dirt holding capacity of the element. As the element fills up with dirt, the pressure drop increases. It is important to document the pressure drop across a given filter when it is new and then clean or replace it when the pressure drop increases by 10" to 15" / 250-280mm H<sub>2</sub>O over the original reading.

**Rule of Thumb #5:** The inlet connection greatly influences the overall pressure drop of the filter system. To minimize the restriction contributed by an inlet filter, a velocity of 6,000 ft/min (10200m<sup>3</sup>/h) or less is suggested through the outlet pipe. The table below lists the suggested flows based on pipe size:

Pipe Size (inches)	Max Airflow		Pipe Size (inches)	Max Airflow		Pipe Size (inches)	Airflow	
1/4"	6 CFM	10m <sup>3</sup> /h	1 ¼"	60 CFM	102m <sup>3</sup> /h	6"	1,100 CFM	1870m <sup>3</sup> /h
3/8"	8 CFM	14m <sup>3</sup> /h	1 ½"	80 CFM	136m <sup>3</sup> /h	8"	1,800 CFM	3060m <sup>3</sup> /h
1/2"	10 CFM	17m <sup>3</sup> /h	2"	135 CFM	230m <sup>3</sup> /h	10"	3,300 CFM	5610m <sup>3</sup> /h
3/4"	20 CFM	34m <sup>3</sup> /h	2 ½"	195 CFM	332m <sup>3</sup> /h	12"	4,700 CFM	7990m <sup>3</sup> /h
1"	35 CFM	60m <sup>3</sup> /h	3"	300 CFM	510m <sup>3</sup> /h	14"	6,000 CFM	10200m <sup>3</sup> /h
			4"	520 CFM	884m <sup>3</sup> /h			
			5"	800 CFM	1360m <sup>3</sup> /h			

Table 3 *\*Note: This information is for general use only. A qualified engineer must properly design each system.*

### 3. Element Specifications

Temperature Range: -15° to 220°F / -26° to 105°C

Filter Change-Out Differential: 10" to 15" / 250-380mm H<sub>2</sub>O Over Initial Delta P

Media	Micron Rating
Standard Paper	99+% @ 2 micron
Standard Polyester	99+% @ 5 micron
"S" Series Wire Mesh	Epoxy Coated Wire Mesh
"Z" Series Polyester	99+% @ 1 micron
"HE" Series HEPA	99.97% @ 0.3 microns
"U" Series Polyester	99+% @ 25 micron
"W" Series Polyester	99+% @ 100 micron
"S2" Series	Stainless Steel Wire Mesh
"AC" & "ACP" Series	N/A
"Y" Series Polypropylene	99+% @ 5 micron

Table 4



Temperature Range: -15° to 385°F / -26° to 196°C

Filter Change-Out Differential: 10" to 15"/ 250-380mm H<sub>2</sub>O Over Initial Delta P

Media	Micron Rating
"MX" & "MXD" Series – Nomex Cloth	99+% @ 5 micron

Table 5

#### 4. Element Cleaning

Some types of Solberg inlet filter elements can be cleaned and reused. However, damage can occur to an element during cleaning so it is imperative that care is taken during disassembly, cleaning and re-assembly. Damaged elements can allow particulate bypass which will damage rotating equipment.

- A. **Polyester Element.** The polyester element may be washed in warm soapy water, vacuumed, gently blown out or replaced. The element should be dry before reinstallation.
- B. **Paper Element.** The paper element may be lightly blown with low pressure air. It is disposable and in most cases should be replaced with a new element.
- C. **Polyurethane Prefilter.** The prefilter may be washed as a sponge or replaced to give the element a longer service life.
- D. **Epoxy Coated Wire Mesh and Stainless Steel Wire Mesh Element.** Cleaning instructions similar to polyester, except mild solvents may be used.
- E. **Activated Carbon Element.** Not cleanable
- F. **Polypropylene Element.** Cleaning instructions similar to polyester
- G. **Nomex Cloth Element.** Cleaning instructions similar to polyester

If you are not confident that the integrity of the element was maintained during cleaning, it is recommended that a new element be installed. Also, spare parts such as gaskets, wingnuts and washers can be supplied upon request.

## Section C

### **PROCEDURES**

#### **1. Installation.**

- A. Maximum operating temperature for most Solberg inlet air filter products is 220°F / 105°C. Temperatures in excess of this could cause damage to elements, media and elastomers. High temperature products are available.

Page 7

Solberg Manufacturing, Inc., 1151 Ardmore Itasca, IL 60143 USA

Ph: 630.773.1363 Fax: 630.773.0727 Email: sales@solbergmfg.com Web: www.solbergmfg.com

Rev: MMIFS-407



SOLBERG

- B. Direction of flow is typically from the outside of the element to the inside of the element. Most products have arrows indicating direction of flow on the inlet and outlet ports.
- C. Ensure that pipe/flange connections are adequately sealed so the potential for leaks is reduced to a minimum.

## 2. Disconnecting canister top from canister base.

- A. FS-04-06-10 (or 05-07-11): Twist top housing to open. Use care to support bottom housing while removing top housing. Fitting damage can occur if fitting is torqued in the wrong direction.
- B. Small QB/FS/F/FT: Remove weather hood or top plate by loosening hex nut or wing nut and lifting off.
- C. Large 2Q/QB/FS/F/FT: Remove cover by loosening hex nut or wing nut and lifting off.

## 3. Removing element for service/maintenance.

- A. Carefully remove retaining hex head/wing-nut and washer over top plate, and then remove element. Note: Model "04-06-10" elements should be free when housing tops are removed.
- B. Clean sealing surfaces of housing, top plates and element endcaps so that they are free of dirt or any other particulate.

# \*WARNING\*

**Failure to comply with these instructions may result in system or equipment contamination.**

## 4. Securing Element.

- A. Place new or cleaned element evenly on base plate. Be sure element seats properly on base and there is no dirt or particulate present on sealing surfaces. With multiple element stacks place elements in line with base element and ensure elements seat properly.



- B. Place top plate (if necessary) on element by centering on tap bolt.
- C. Secure washer and wing nut to end cap (or top plate) and tap bolt. Element must be tightly secured. Note: Do NOT over tighten!

## **\*WARNING\***

**Defective installation may cause system or pump contamination. Use only genuine Solberg replacement parts.**

### **5. Securing canister top to canister base.**

- A. Make sure all surfaces are free from dust and other particulate.
- B. Small QB/FS/F/FT: Replace top plate and/or weather hood if necessary. Feed threaded rod into corresponding bolthole and tighten. Note: Do NOT over tighten!
- C. Large 2G/QB/FS/F/FT: Replace cover. Feed threaded rod into corresponding bolt hole(s) and tighten. Note: Do NOT over tighten!
- D. FS-04-06-10 (or 05-07-11): Reassemble top housing to bottom housing by aligning tabs and turning into place.

## Section D

### **MAINTENANCE RECOMMENDATIONS**

1. Pressure drop readings are recommended to have an effective air filter. Always document initial pressure drop during start-up when element is clean. Replacement cartridge is needed when system experiences 10" to 15" / 250-380mm H<sup>2</sup>O above drop above the initial reading. Refer to page 4 for initial values.
2. Always check replacement cartridge gaskets to insure they are adhered uniformly along the end caps during handling. If not, contact Solberg Manufacturing, Inc. immediately. Do not modify or change!



3. Always check inlets/outlets, element base and its components when replacing element to insure cleanliness. Wipe clean if necessary.

4. Operate only when a proper seal exists.

**SPARE PARTS LIST:**

**2G/QB/FS Series**

Parent Model 2G/QB-Element-Connection	Prefilter Model	Housing Weatherhood/Top		Element Top Plate Model No.	Wingnut(s)/ Lock Hex Nut(s) Model No.	Washer(s) Model No.
		for FS Series Model No.	for 2G/QB Series Model No.			
Model-15/14-xxx	PF14	WH6X2	N/A	N/A	WN25X20	WR25X20
Model-19/18-xxx	PF18	WH6X5	QB6X5	N/A	WN25X20	WR25X20
Model-31/30-xxx	PF30	WH10X5	QB10X5	N/A	WN25X20	WR25X20
Model-231/230-xxx	PF230	WH10X10	QB10X10	N/A	WN38X16	WR38X16
Model-235/234-xxx	PF234	WH16X10	QB16X10	N/A	WN38X16	WR38X16
Model-245/244-xxx	PF244	WH16X10	QB16X10	N/A	WN38X16	WR38X16
Model-275/274-xxx	PF274	WH16X10	QB16X10	N/A	WN38X16	WR38X16
Model-375/374-xxx	PF374	T16000625	T16000625	T12000625	LHN50X13	WR50X13
Model-377/376-xxx	PF376	T22000625	T22000625	T14750625	LHN50X13	WR50X13
Model-385/384-xxx	PF384	T28000625	T28000625	T19750625	LHN50X13	WR50X13
Model-384(2)-xxx	PF384(2)	T28000625	T28000625	T19750625	LHN50X13	WR50X13
Model-485/484-xxx	PF484	T28000625	T28000625	T19750625	LHN50X13	WR50X13
Model-485(2)/484(2)-xxx	PF484(2)	T28000625	T28000625	T19750625	LHN50X13	WR50X13
Model-685-xxx	PF684	T28000625	T28000625	T19750625	LHN50X13	WR50X13

**F/FT Series**

Parent Model F/FT-Element-Connection	Prefilter Model	Weatherhood/Top for F Series Model No.	Element Top for F Series Model No.	Top for FT Series Model No.	Wingnut(s)/ Lock Hex Nut(s) Model No.	Washer(s) Model No.
Model-15/14-xxx	PF14	WH6X2	N/A	T4500312	WN25X20	WR25X20
Model-19/18-xxx	PF18	WH6X5	N/A	T4500312	WN25X20	WR25X20
Model-31/30-xxx	PF30	WH7.625X5	N/A	T6000312	WN25X20	WR25X20
Model-231/230-xxx	PF230	WH10X10	N/A	T6000312	WN38X16	WR38X16
Model-235/234-xxx	PF234	WH10X10	N/A	T8000437	WN38X16	WR38X16
Model-245/244-xxx	PF244	WH16X10	N/A	T1000437	WN38X16	WR38X16
Model-275/274-xxx	PF274	WH16X10	N/A	T12000437	WN38X16	WR38X16
Model-375/374-xxx	PF374	WH16X16	N/A	T12000625	LHN50X13	WR50X13
Model-377/376-xxx	PF376	WH22.5X15	N/A	T14750625	LHN50X13	WR50X13
Model-385/384-xxx	PF384	WH28X15	N/A	T19750625	LHN50X13	WR50X13
Model-384(2)-xxx	PF384(2)	T28000625	T19750625	T19750625	LHN50X13	WR50X13
Model-485/484-xxx	PF484	WH28X24	N/A	T19750625	LHN50X13	WR50X13
Model-485(2)/484(2)-xxx	PF484(2)	T28000625	T19750625	T19750625	LHN50X13	WR50X13
Model-685-xxx	PF684	T28000625	T19750625	T19750625	LHN50X13	WR50X13

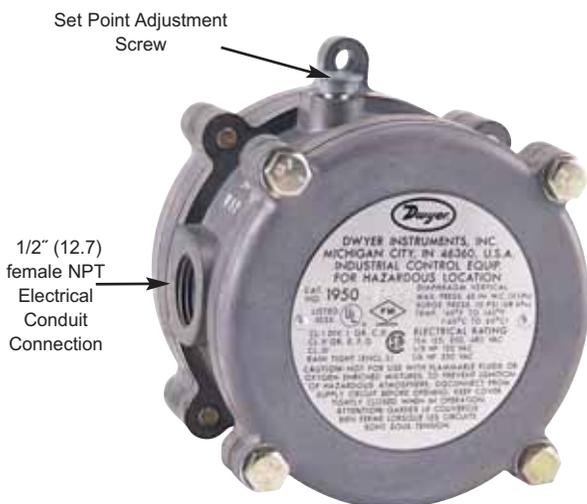
\*Note: Spare parts are for standard products. See page 4 for replacement element.





## Series 1950 Explosion-Proof Differential Pressure Switches

### Specifications - Installation and Operating Instructions



UL and CSA Listed, FM Approved For  
CL. I GR. C, D - CL. II GR. E, F, G - CL. III

#### Series 1950 Switches

Operating ranges and deadbands

To order specify Model Number	Operating Range: Inches, W.C.	Approximate Dead Band	
		At Min. Set Point	At Max. Set Point
1950-02-2S	0.03 to 0.10	0.025	0.05
1950-00-2F	0.07 to 0.15	0.04	0.05
1950-0-2F	0.15 to 0.5	0.10	0.15
1950-1-2F	0.4 to 1.6	0.15	0.20
1950-5-2F	1.4 to 5.5	0.3	0.4
1950-10-2F	3.0 to 11.0	0.4	0.5
1950-20-2F	4.0 to 20.0	0.4	0.6
Model Number	Operating Range: PSI	Approximate Dead Band	
		Min. Set Point	Max. Set Point
1950P-2-2F	0.5 to 2.0	0.3 psi	0.3 psi
1950P-6-2F	1.5 to 6.0	1.0 psi	1.0 psi
1950P-15-2F	3.0 to 15.0	0.9 psi	0.9 psi
1950P-25-2F	4.0 to 25.0	0.7 psi	0.7 psi
1950P-50-2F	15.0 to 50	1.0 psi	1.5 psi

**Series 1950 Explosion-Proof Differential Pressure Switches** combine the best features of the Series 1900 Pressure Switch with an integral explosion-proof and weather-proof housing. Each unit is UL & CSA listed; FM approved for use in Class I, Groups C & D; Class II, Groups E, F, & G; and Class III atmospheres (NEMA 7 & 9). They are totally rain-tight for outdoor installations. Twelve models allow set-points from .03 to 20 inches w.c. and from .5 to 50 psi (3.4 to 345 kPa).

Easy access to the SPDT switch for electrical hook-up is provided by removing the top plate of the three-part aluminum housing. Adjustment to the set point of the switch can be made without disassembling the housing. The unit is very compact, about half the weight and bulk of equivalent conventional explosion-proof switches.

#### CAUTION

For use only with air or compatible gases. Use of the Model 1950 switch with explosive media connected to the Low pressure port (including differential pressure applications in such media) is not recommended. Switch contact arcing can cause an explosion inside the switch housing which, while contained, may render the switch inoperative. If switch is being used to sense a single positive pressure relative to atmosphere, run a line from the low pressure port to a non-hazardous area free of combustible gases. This may increase response time on -0 and -00 models.

**Note:** The last number-letter combination in the model number identifies the switch's electrical rating (number) and diaphragm material (letter). The 2F combination is standard as described in the physical data above. In case of special models, a number 1 rating is the same as 2; a number 3 or 4 rating is 10A 125, 250, 480 VAC; 1/8 H.P. 125 VAC; 1/4 H.P. 250 VAC; a number 5 or 6 rating is 1A 125 VAC. Letter B indicates a Buna-N diaphragm; N = Neoprene; S = Silicone; and V = Viton®.

#### SPECIFICATIONS

**Service:** Air and non-combustible, compatible gases.

**Wetted Materials:** Consult factory.

**Temperature Limits:** -40 to 140°F (-40 to 60°C); 0 to 140°F (-17.8 to 60°C) for 1950P-8, 15, 25, and 50. -30 to 130°F (-34.4 to 54.4°C) for 1950-02.

#### Pressure Limits:

Continuous: 1950's - 45" w.c. (0.11 bar);

1950P's - 35 psi (2.41 bar); 1950P-50 only - 70 psi (4.83 bar).

Surge: 1950's - 10 psi (0.69 bar), 1950P's - 50 psi (3.45 bar), 1950P-50 only - 90 psi (6.21 bar).

**Enclosure Rating:** IP54, NEMA 3, 7 and 9.

**Switch Type:** Single-pole double-throw (SPDT).

**Electrical Rating:** 15 A @, 125, 250, 480 VAC, 60 Hz. Resistive 1/8 HP @ 125 VAC, 1/4 HP @ 250 VAC, 60 Hz.

**Electrical Connections:** 3 screw type, common, normally open and normally closed.

**Process Connections:** 1/8" female NPT.

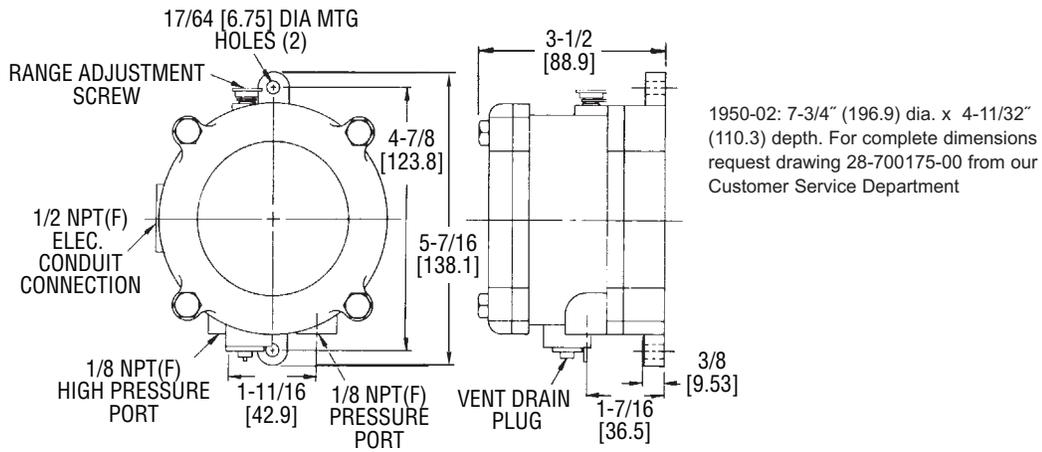
**Mounting Orientation:** Diaphragm in vertical position. Consult factory for other position orientations.

**Set Point Adjustment:** Screw type on top of housing.

**Weight:** 3.25 lb (1.5 kg); 1950-02 model, 4.4 lb (2 kg).

**Agency Approvals:** CE, UL, CSA, FM.

**RESPONSE TIME:** Because of restrictive effect of flame arrestors, switch response time may be as much as 10-25 seconds where applied pressures are near set point.



1950 Switch Outline Dimensions

## INSTALLATION

1. Select a location free from excess vibration and corrosive atmospheres where temperatures will be within the limits noted under Specifications on reverse. Switch may be installed outdoors or in areas where the hazard of explosion exists. See reverse for specific types of hazardous service.

2. Mount standard switches with the diaphragm in a vertical plane and with switch lettering and nameplate in an upright position. Some switches are position sensitive and may not reset properly unless they are mounted with the diaphragm vertical.

3. Connect switch to source of pressure, vacuum or differential pressure. Metal tubing with 1/4" O.D. is recommended, but any tubing which will not restrict the air flow can be used. Connect to the two 1/8" female NPT pressure ports as noted below:

A. Differential pressures - connect pipes or tubes from source of greater pressure to high pressure port marked HIGH PRESS, and from source of lower pressure to low pressure port marked LOW PRESS.

B. Pressure only (above atmospheric pressure) - connect tube from source of pressure to high pressure port. The low pressure port is left open to atmosphere.

C. Vacuum only (below atmospheric pressure) - connect tube from source of vacuum to low pressure port. The high pressure port is left open to atmosphere.

4. To make electrical connections, remove the three hex head screws from the cover and after loosening the fourth captive screw, swing the cover aside. Electrical connections to the standard single pole, double throw snap switch are provided by means of terminals marked "COM" (common), "NO" (norm open), "NC" (norm closed). The normally open contacts close and the normally closed contacts open when pressure increases beyond the set point. Switch loads for standard models should not exceed the maximum specified current rating of 15 amps resistive. Switch capabilities decrease with an increase in ambient temperature, load inductance, or cycling rate. Whenever an application involves one or more of these factors, the user may find it desirable to limit the switched current to 10 amps or less in the interest of prolonging switch life.

## ADJUSTMENT: To Change the Set point

1. Remove the plastic cap and turn the slotted Adjust-ment Screw at the top of the housing clockwise to raise the set point pressure and counter-clockwise to lower the set point. After calibration, replace the plastic cap and re-check the set point.

2. The recommended procedure for calibrating or checking calibration is to use a "T" assembly with three rubber tubing leads, all as short as possible and the entire assembly offering minimum flow restriction. Run one lead to the pressure switch, another to a manometer of known accuracy and appropriate range, and apply pressure through the third tube. Make final approach to the set point very slowly. Note that manometer and pressure switch will have different response times due to different internal volumes, lengths of tubing, fluid drainage, etc. Be certain the switch is checked in the position it will assume in use, i.e. with diaphragm in a vertical plane and switch lettering and Dwyer nameplate in an upright position.

3. For highly critical applications check the set point adjustment and if necessary, reset it as noted in step A.

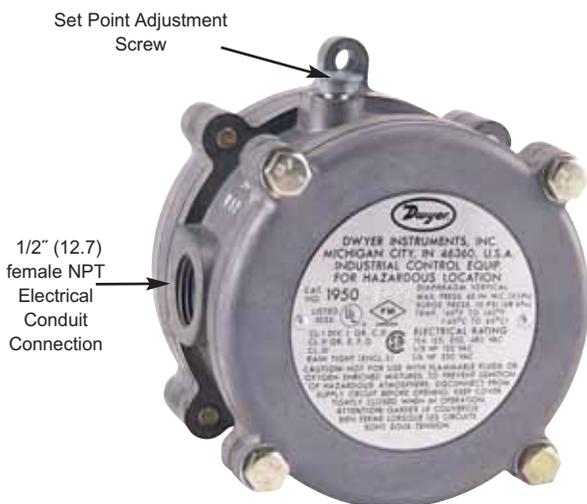
## MAINTENANCE

The moving parts of these switches need no maintenance or lubrication. The only adjustment is that of the set point. Care should be taken to keep the switch reasonably clean. Periodically the vent drain plug should be rotated, then returned to its original position. This will dislodge deposits which could accumulate in applications where there is excessive condensation within the switch. The Series 1950 Explosion-Proof Differential Pressure Switch is not field serviceable and should be returned if repair is needed (field repair should not be attempted and may void warranty). Be sure to include a brief description of the problem plus any relevant application notes. Contact customer service to receive a return goods authorization number before shipping.



## Series 1950 Explosion-Proof Differential Pressure Switches

### Specifications - Installation and Operating Instructions



**Series 1950 Explosion-Proof Differential Pressure Switches** combine the best features of the Series 1900 Pressure Switch with an integral explosion-proof and weather-proof housing. Each unit is UL & CSA listed; FM approved for use in Class I, Groups C & D; Class II, Groups E, F, & G; and Class III atmospheres (NEMA 7 & 9). They are totally rain-tight for outdoor installations. Twelve models allow set-points from .03 to 20 inches w.c. and from .5 to 50 psi (3.4 to 345 kPa).

Easy access to the SPDT switch for electrical hook-up is provided by removing the top plate of the three-part aluminum housing. Adjustment to the set point of the switch can be made without disassembling the housing. The unit is very compact, about half the weight and bulk of equivalent conventional explosion-proof switches.

#### CAUTION

For use only with air or compatible gases. Use of the Model 1950 switch with explosive media connected to the Low pressure port (including differential pressure applications in such media) is not recommended. Switch contact arcing can cause an explosion inside the switch housing which, while contained, may render the switch inoperative. If switch is being used to sense a single positive pressure relative to atmosphere, run a line from the low pressure port to a non-hazardous area free of combustible gases. This may increase response time on -0 and -00 models.

**Note:** The last number-letter combination in the model number identifies the switch's electrical rating (number) and diaphragm material (letter). The 2F combination is standard as described in the physical data above. In case of special models, a number 1 rating is the same as 2; a number 3 or 4 rating is 10A 125, 250, 480 VAC; 1/8 H.P. 125 VAC; 1/4 H.P. 250 VAC; a number 5 or 6 rating is 1A 125 VAC. Letter B indicates a Buna-N diaphragm; N = Neoprene; S = Silicone; and V = Viton®.

**UL and CSA Listed, FM Approved For**  
CL. I GR. C, D - CL. II GR. E, F, G - CL. III

#### Series 1950 Switches

Operating ranges and deadbands

To order specify Model Number	Operating Range: Inches, W.C.	Approximate Dead Band	
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1950-00-2F	0.07 to 0.15	0.04	0.05
1950-0-2F	0.15 to 0.5	0.10	0.15
1950-1-2F	0.4 to 1.6	0.15	0.20
1950-5-2F	1.4 to 5.5	0.3	0.4
1950-10-2F	3.0 to 11.0	0.4	0.5
1950-20-2F	4.0 to 20.0	0.4	0.6

Model Number	Operating Range: PSI	Approximate Dead Band	
		Min. Set Point	Max. Set Point
1950P-2-2F	0.5 to 2.0	0.3 psi	0.3 psi
1950P-8-2F	1.5 to 8.0	1.0 psi	1.0 psi
1950P-15-2F	3.0 to 15.0	0.9 psi	0.9 psi
1950P-25-2F	4.0 to 25.0	0.7 psi	0.7 psi
1950P-50-2F	15.0 to 50	1.0 psi	1.5 psi

#### SPECIFICATIONS

**Service:** Air and non-combustible, compatible gases.

**Wetted Materials:** Consult factory.

**Temperature Limits:** -40 to 140°F (-40 to 60°C); 0 to 140°F (-17.8 to 60°C) for 1950P-8, 15, 25, and 50. -30 to 130°F (-34.4 to 54.4°C) for 1950-02.

#### Pressure Limits:

Continuous: 1950's - 45" w.c. (0.11 bar);

1950P's - 35 psi (2.41 bar); 1950P-50 only - 70 psi (4.83 bar).

Surge: 1950's - 10 psi (0.69 bar), 1950P's - 50 psi (3.45 bar), 1950P-50 only - 90 psi (6.21 bar).

**Enclosure Rating:** IP54, NEMA 3, 7 and 9.

**Switch Type:** Single-pole double-throw (SPDT).

**Electrical Rating:** 15 A @, 125, 250, 480 VAC, 60 Hz. Resistive 1/8 HP @ 125 VAC, 1/4 HP @ 250 VAC, 60 Hz.

**Electrical Connections:** 3 screw type, common, normally open and normally closed.

**Process Connections:** 1/8" female NPT.

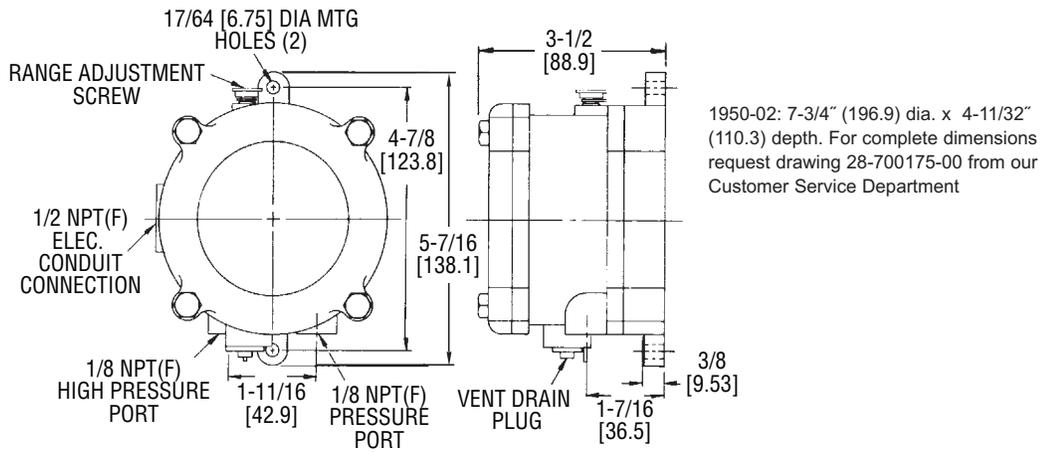
**Mounting Orientation:** Diaphragm in vertical position. Consult factory for other position orientations.

**Set Point Adjustment:** Screw type on top of housing.

**Weight:** 3.25 lb (1.5 kg); 1950-02 model, 4.4 lb (2 kg).

**Agency Approvals:** CE, UL, CSA, FM.

**RESPONSE TIME:** Because of restrictive effect of flame arrestors, switch response time may be as much as 10-25 seconds where applied pressures are near set point.



1950 Switch Outline Dimensions

## INSTALLATION

1. Select a location free from excess vibration and corrosive atmospheres where temperatures will be within the limits noted under Specifications on reverse. Switch may be installed outdoors or in areas where the hazard of explosion exists. See reverse for specific types of hazardous service.

2. Mount standard switches with the diaphragm in a vertical plane and with switch lettering and nameplate in an upright position. Some switches are position sensitive and may not reset properly unless they are mounted with the diaphragm vertical.

3. Connect switch to source of pressure, vacuum or differential pressure. Metal tubing with 1/4" O.D. is recommended, but any tubing which will not restrict the air flow can be used. Connect to the two 1/8" female NPT pressure ports as noted below:

A. Differential pressures - connect pipes or tubes from source of greater pressure to high pressure port marked HIGH PRESS, and from source of lower pressure to low pressure port marked LOW PRESS.

B. Pressure only (above atmospheric pressure) - connect tube from source of pressure to high pressure port. The low pressure port is left open to atmosphere.

C. Vacuum only (below atmospheric pressure) - connect tube from source of vacuum to low pressure port. The high pressure port is left open to atmosphere.

4. To make electrical connections, remove the three hex head screws from the cover and after loosening the fourth captive screw, swing the cover aside. Electrical connections to the standard single pole, double throw snap switch are provided by means of terminals marked "COM" (common), "NO" (norm open), "NC" (norm closed). The normally open contacts close and the normally closed contacts open when pressure increases beyond the set point. Switch loads for standard models should not exceed the maximum specified current rating of 15 amps resistive. Switch capabilities decrease with an increase in ambient temperature, load inductance, or cycling rate. Whenever an application involves one or more of these factors, the user may find it desirable to limit the switched current to 10 amps or less in the interest of prolonging switch life.

## ADJUSTMENT: To Change the Set point

1. Remove the plastic cap and turn the slotted Adjust-ment Screw at the top of the housing clockwise to raise the set point pressure and counter-clockwise to lower the set point. After calibration, replace the plastic cap and re-check the set point.

2. The recommended procedure for calibrating or checking calibration is to use a "T" assembly with three rubber tubing leads, all as short as possible and the entire assembly offering minimum flow restriction. Run one lead to the pressure switch, another to a manometer of known accuracy and appropriate range, and apply pressure through the third tube. Make final approach to the set point very slowly. Note that manometer and pressure switch will have different response times due to different internal volumes, lengths of tubing, fluid drainage, etc. Be certain the switch is checked in the position it will assume in use, i.e. with diaphragm in a vertical plane and switch lettering and Dwyer nameplate in an upright position.

3. For highly critical applications check the set point adjustment and if necessary, reset it as noted in step A.

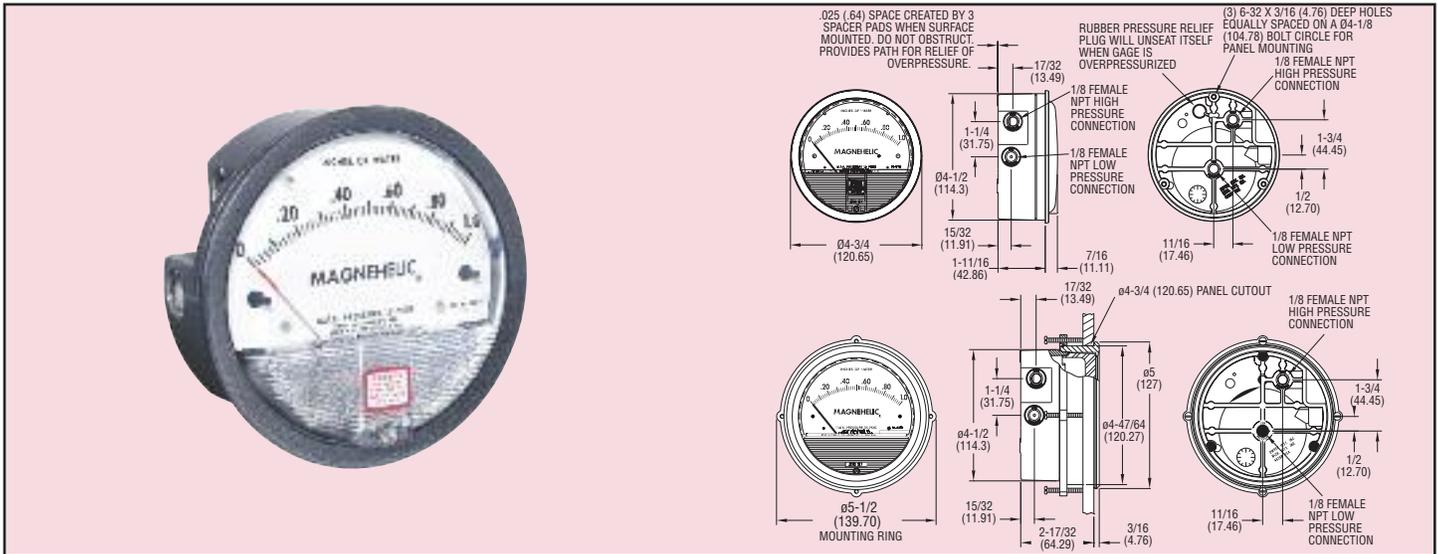
## MAINTENANCE

The moving parts of these switches need no maintenance or lubrication. The only adjustment is that of the set point. Care should be taken to keep the switch reasonably clean. Periodically the vent drain plug should be rotated, then returned to its original position. This will dislodge deposits which could accumulate in applications where there is excessive condensation within the switch. The Series 1950 Explosion-Proof Differential Pressure Switch is not field serviceable and should be returned if repair is needed (field repair should not be attempted and may void warranty). Be sure to include a brief description of the problem plus any relevant application notes. Contact customer service to receive a return goods authorization number before shipping.

Series  
2000

# Magnehelic® Differential Pressure Gages

Indicate Positive, Negative or Differential, Accurate within 2%



Select the Dwyer® Magnehelic® gage for high accuracy – guaranteed within 2% of full scale – and for the wide choice of 81 models available to suit your needs precisely. Using Dwyer's simple, frictionless Magnehelic® gage movement, it quickly indicates low air or non-corrosive gas pressures – either positive, negative (vacuum) or differential. The design resists shock, vibration and over-pressures. No manometer fluid to evaporate, freeze or cause toxic or leveling problems. It's inexpensive, too.

The Magnehelic® gage is the industry standard to measure fan and blower pressures, filter resistance, air velocity, furnace draft, pressure drop across orifice plates, liquid levels with bubbler systems and pressures in fluid amplifier or fluidic systems. It also checks gas-air ratio controls and automatic valves, and monitors blood and respiratory pressures in medical care equipment.

**Note:** May be used with hydrogen. Order a Buna-N diaphragm. Pressures must be less than 35 psi.



Flush, Surface or Pipe Mounted

### Mounting

A single case size is used for most models of Magnehelic® gages. They can be flush or surface mounted with standard hardware supplied. With the optional **A-610** Pipe Mounting Kit they may be conveniently installed on horizontal or vertical 1-1/4" - 2" pipe. Although calibrated for vertical position, many ranges above 1" may be used at any angle by simply re-zeroing. However, for maximum accuracy, they must be calibrated in the same position in which they are used. These characteristics make Magnehelic® gages ideal for both stationary and portable applications. A 4-9/16" hole is required for flush panel mounting. Complete mounting and connection fittings plus instructions are furnished with each instrument.

### Vent Valves

In applications where pressure is continuous and the Magnehelic® gage is connected by metal or plastic tubing which cannot be easily removed, we suggest using Dwyer A-310A vent valves to connect gage. Pressure can then be removed to check or re-zero the gage.

### High and Medium Pressure Models

Installation is similar to standard gages except that a 4-13/16" hole is needed for flush mounting. The medium pressure construction is rated for internal pressures up to 35 psig and the high pressure up to 80 psig. Available for all models. Because of larger case, the medium pressure and high pressure models will not fit in a portable case size. Installation of the A-321 safety relief valve on standard Magnehelic® gages often provides adequate protection against infrequent overpressure.

### SPECIFICATIONS

**Service:** Air and non-combustible, compatible gases (natural gas option available).

**Wetted Materials:** Consult factory.

**Housing:** Die cast aluminum case and bezel, with acrylic cover. Exterior finish is coated gray to withstand 168 hour salt spray corrosion test.

**Accuracy:** ±2% of FS (±3% on -0, -100 Pa, -125 Pa, 10MM and ±4% on -00, -60 Pa, -6MM ranges), throughout range at 70°F (21.1°C).

**Pressure Limits:** -20 in Hg to 15 psig (-0.677 to 1.034 bar); MP option: 35 psig (2.41 bar); HP option: 80 psig (5.52 bar).

**Overpressure:** Relief plug opens at approximately 25 psig (1.72 bar), standard gages only. See Overpressure Protection Note on next page.

**Temperature Limits:** 20 to 140°F\* (-6.67 to 60°C).

**Size:** 4" (101.6 mm) diameter dial face.

**Mounting Orientation:** Diaphragm in vertical position. Consult factory for other position orientations.

**Process Connections:** 1/8" female NPT duplicate high and low pressure taps - one pair side and one pair back.

**Weight:** 1 lb 2 oz (510 g), MP & HP 2 lb 2 oz (963 g).

**Standard Accessories:** Two 1/8" NPT plugs for duplicate pressure taps, two 1/8" pipe thread to rubber tubing adapter and three flush mounting adapters with screws. (Mounting and snap ring retainer substituted for three adapters in MP & HP gage accessories.)

**Agency Approval:** RoHS.

\*Low temperature models available as special option.

†For applications with high cycle rate within gage total pressure rating, next higher rating is recommended. See Medium and High pressure options at lower left.

### OPTIONS AND ACCESSORIES



#### Transparent Overlays

Furnished in red and green to highlight and emphasize critical pressures.



#### Adjustable Signal Flag

Integral with plastic gage cover. Available for most models except those with medium or high pressure construction. Can be ordered with gage or separate.

Add suffix **-ASF** to end of gage model number



#### LED Setpoint Indicator

Bright red LED on right of scale shows when setpoint is reached. Field adjustable from gage face, unit operates on 12-24 VDC. Requires MP or HP style cover and bezel.

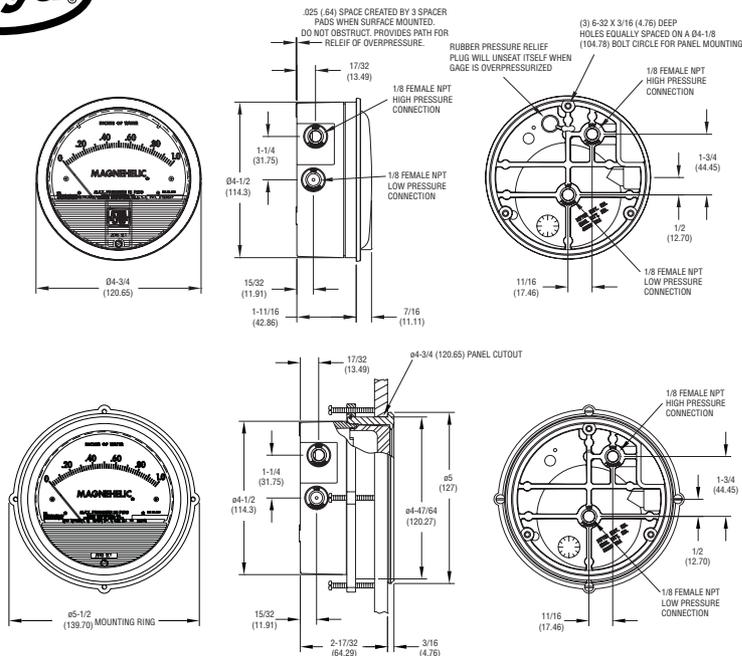
Add suffix **-SP** to end of gage model number

**Note:** -SP option models not RoHS approved.





# Magnehelic® Differential Pressure Gage



\*The blowout plug is not used on models above 180 inches of water pressure, medium or high pressure models, or on gages which require an elastomer other than silicone for the diaphragm.

**STANDARD GAGE ACCESSORIES:** Two 1/8" NPT plugs for duplicate pressure taps, two 1/8" pipe thread to rubber tubing adapters and three flush mounting adapters with screws.

**MP AND HP GAGE ACCESSORIES:** Mounting ring and snap ring retainer substituted for 3 adaptors, 1/4" compression fittings replace 1/8" pipe thread to rubber tubing adaptors.

**OVERPRESSURE PROTECTION:** Standard Magnehelic® Differential Pressure Gages are rated for a maximum pressure of 15 psig and should not be used where that limit could be exceeded. Models employ a rubber plug on the rear which functions as a relief valve by unseating and venting the gage interior when over pressure reaches approximately 25 psig (excludes MP and HP models). To provide a free path for pressure relief, there are four spacer pads which maintain .023" clearance when gage is surface mounted. Do not obstruct the gap created by these pads.

## SPECIFICATIONS

**Service:** Air and non-combustible, compatible gases. (Natural Gas option available.)

**Wetted Materials:** Consult factory.

**Housing:** Die cast aluminum case and bezel, with acrylic cover. (MP model has polycarbonate cover).  
**Accuracy:** ±2% of full scale (±3% on -0, -100 Pa, -125 Pa, 10MM and ±4% on -00, -00N, -60 Pa, -6MM ranges), throughout range at 70°F (21.1°C).

**Pressure Limits:** -20" Hg to 15 psig.† (-0.677 bar to 1.034 bar); MP option: 35 psig (2.41 bar), HP option: 80 psig (5.52 bar).

**Overpressure:** Relief plug opens at approximately 25 psig (1.72 bar), standard gages only. The blowout plug is not used on models above 180 inches of water pressure, medium or high pressure models, or on gages which require an elastomer other than silicone for the diaphragm.

**Temperature Limits:** 20 to 140°F (-6.67 to 60°C).

†Low temperature models available as special option.

**Size:** 4" (101.6 mm) diameter dial face.

**Mounting Orientation:** Diaphragm in vertical position. Consult factory for other position orientations.

**Process Connections:** 1/8" female NPT duplicate high and low pressure taps - one pair side and one pair back.

**Weight:** 1 lb 2 oz (610 g), MP & HP 2 lb 2 oz (963 g).

†For applications with high cycle rate within gage total pressure rating, next higher rating is recommended. See Medium and High pressure options.

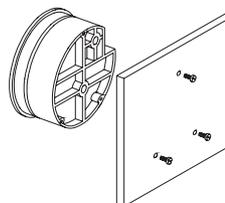
**Note:** May be used with hydrogen when ordering Buna-N diaphragm. Pressure must be less than 35 psi.

## INSTALLATION

Select a location free from excessive vibration and where the ambient temperature will not exceed 140°F (60°C). Also, avoid direct sunlight which accelerates discoloration of the clear plastic cover. Sensing lines may be run any necessary distance. Long tubing lengths will not affect accuracy but will increase response time slightly. Do not restrict lines. If pulsating pressures or vibration cause excessive pointer oscillation, consult the factory for ways to provide additional damping.

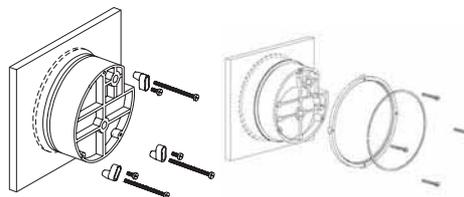
All standard Magnehelic® Differential Pressure Gages are calibrated with the diaphragm vertical and should be used in that position for maximum accuracy. If gages are to be used in other than vertical position, this should be specified on the order. Many higher range gages will perform within tolerance in other positions with only rezeroing. Low range models of 0.5" w.c. plus 0.25" w.c. and metric equivalents must be used in the vertical position only.

## SURFACE MOUNTING



Locate mounting holes, 120° apart on a 4-1/8" dia. circle. Use No. 6-32 machine screws of appropriate length.

## FLUSH MOUNTING



Provide a 4-9/16" dia. (116 mm) opening in panel. Provide a 4-3/4" dia. (120 mm) opening for MP and HP models. Insert gage and secure in place with No. 6-32 machine screws of appropriate length, with adapters, firmly secured in place.

## PIPE MOUNTING

To mount gage on 1-1/4" - 2" pipe, order optional A-610 pipe mounting kit.

## TO ZERO GAGE AFTER INSTALLATION

Set the indicating pointer exactly on the zero mark, using the external zero adjust screw on the

cover at the bottom. Note that the zero check or adjustment can only be made with the high and low pressure taps both open to atmosphere.

## OPERATION

**Positive Pressure:** Connect tubing from source of pressure to either of the two high pressure ports. Plug the port not used. Vent one or both low pressure ports to atmosphere.

**Negative Pressure:** Connect tubing from source of vacuum or negative pressure to either of the two low pressure ports. Plug the port not used. Vent one or both high pressure ports to atmosphere.

**Differential Pressure:** Connect tubing from the greater of two pressure sources to either high pressure port and the lower to either low pressure port. Plug both unused ports.

When one side of the gage is vented in dirty, dusty atmosphere, we suggest an A-331 Filter Vent Plug be installed in the open port to keep inside of gage clean.

**A.** For portable use of temporary installation use 1/8" pipe thread to rubber tubing adapter and connect to source of pressure with flexible rubber or vinyl tubing.

**B.** For permanent installation, 1/4" O.D., or larger, copper or aluminum tubing is recommended.

## MAINTENANCE

No lubrication or periodic servicing is required. Keep case exterior and cover clean. Occasionally disconnect pressure lines to vent both sides of gage to atmosphere and re-zero. Optional vent valves should be used in permanent installations. The Series 2000 is not field serviceable and should be returned if repair is needed (field repair should not be attempted and may void warranty). Be sure to include a brief description of the problem plus any relevant application notes. Contact customer service to receive a return goods authorization number before shipping.

## WARNING

Attempted field repair may void your warranty. Recalibration or repair by the user is not recommended.

## TROUBLE SHOOTING TIPS

**Gage won't indicate or is sluggish.**

1. Duplicate pressure port not plugged.
2. Diaphragm ruptured due to overpressure.
3. Fittings or sensing lines blocked, pinched, or leaking.
4. Cover loose or "O"ring damaged, missing.
5. Pressure sensor, (static tips, Pitot tube, etc.) improperly located.
6. Ambient temperature too low. For operation below 20°F (-7°C), order gage with low temperature, (LT) option.

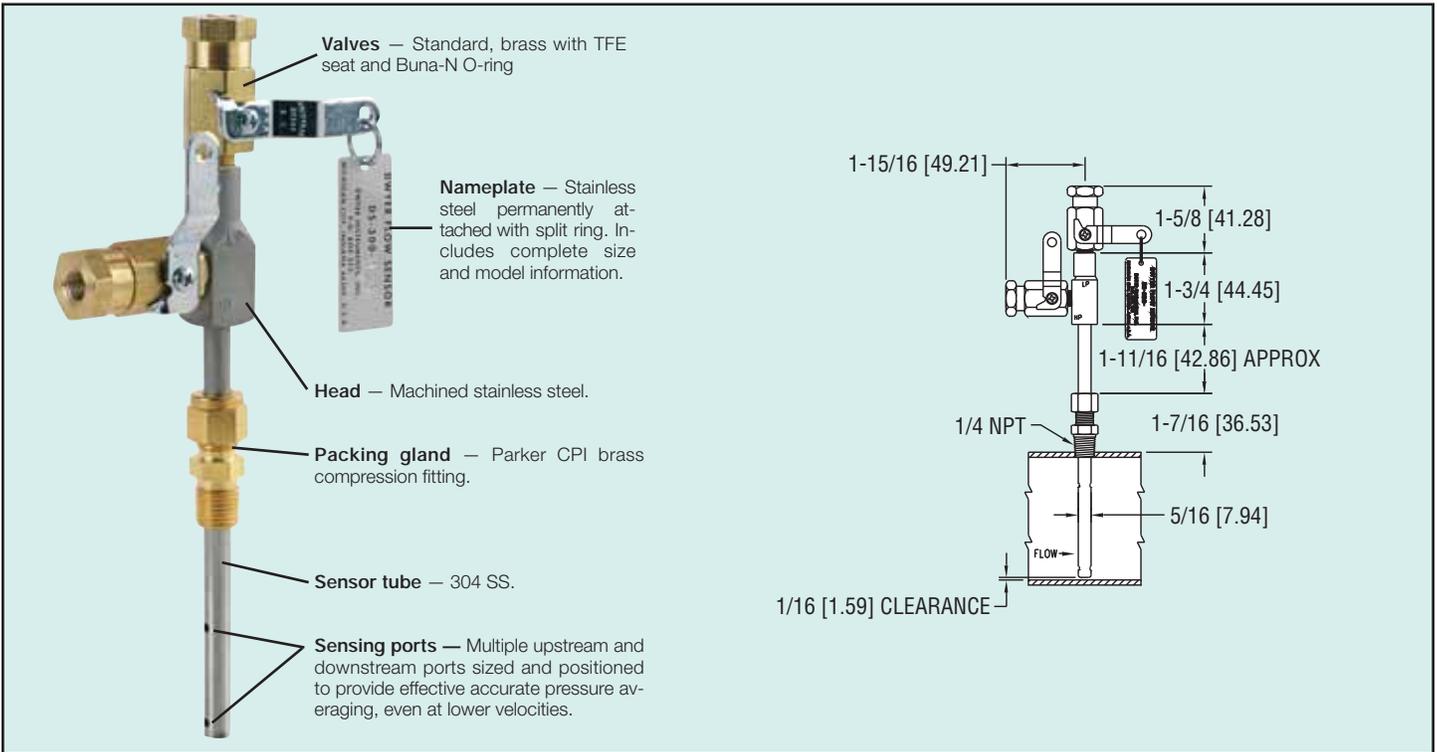


Series  
DS

# In-Line Flow Sensors

Use with the Dwyer® Differential Pressure Gages or Transmitters

Flow



**In-Line Flow Sensors** are averaging Pitot tubes that provide accurate and convenient flow rate sensing for schedule 40 pipe. When purchased with a Dwyer® Capsuhelic® differential pressure gage of appropriate range, the result is a flow indicating system delivered off the shelf at an economical price.

Pitot tubes have been used in flow measurement for years. Conventional pitot tubes sense velocity pressure at only one point in the flowing stream. Therefore, a series of measurements must be taken across the stream to obtain a meaningful average flow rate. The Dwyer® flow sensor eliminates the need for “traversing” the flowing stream because of its multiple sensing points and built-in averaging capability.

**The Series DS-300** flow sensors are designed to be inserted in the pipeline through a compression fitting. They are furnished with instrument shut-off valves on both pressure connections. Valves are fitted with 1/8” female NPT connections. Accessories include adapters with 1/4” SAE 45° flared ends compatible with hoses supplied with the Model A-471 Portable Capsuhelic® gage kit. Standard valves are rated at 200 psig (13.7 bar) and 200°F (93.3°C). Where valves are not required, they can be omitted at reduced cost. Series DS-300 flow sensors are available for pipe sizes from 1” to 10”.

**DS-400 Averaging Flow Sensors** are quality constructed from extra strong 3/4” dia. stainless steel to resist increased forces encountered at higher flow rates with both air and water. This extra strength also allows them to be made in longer insertion lengths up to 24 inches (61 cm). All models include convenient and quick-acting quarter-turn ball valves to isolate the sensor for zeroing. Process connections to the valve assembly are 1/8” female NPT. A pair of 1/8” NPT X 1/4” SAE 45° flared adapters are included, compatible with hoses used in the Model A-471 Portable Capsuhelic® Gage Kit. Supplied solid brass mounting adapter has a 3/4” dia. compression fitting to lock in required insertion length and a 3/4” male NPT thread for mounting in a Threaded Branch Connection.

Select model with suffix which matches pipe size

- DS-300-1”
- DS-300-1-1/4”
- DS-300-1-1/2”
- DS-300-2”
- DS-300-2-1/2”
- DS-300-3”
- DS-300-4”
- DS-300-6”
- DS-300-8”
- DS-300-10”

- DS-400-6”
- DS-400-8”
- DS-400-10”
- DS-400-12”
- DS-400-14”
- DS-400-16”
- DS-400-18”
- DS-400-20”
- DS-400-24”

#### Options and Accessories

- A-160 Threaded Branch Connection, 3/8” NPT, forged steel, 3000 psi
- A-161 Brass Bushing, 1/4” x 3/8”
- DS-300 Less Valves. To order, add suffix -LV

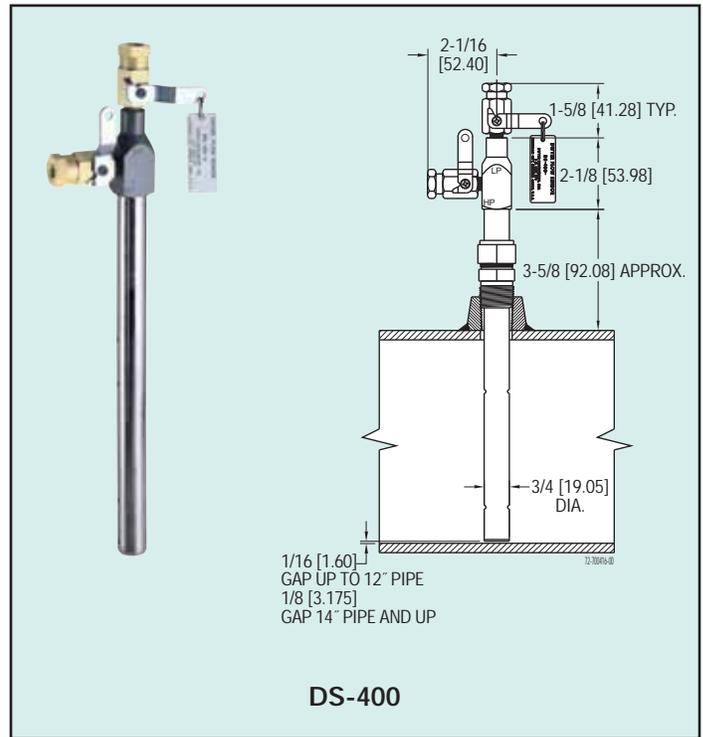
# How To Order

Merely determine the pipe size into which the flow sensor will be mounted and designate the size as a suffix to Model DS-300. For example, a flow sensor to be mounted in a 2" pipe would be a Model No. DS-300-2".

For non-critical water and air flow monitoring applications, the chart below can be utilized for ordering a stock Capsuhelic® differential pressure gage for use with the DS-300 flow sensor. Simply locate the maximum flow rate for the media being measured under the appropriate pipe size and read the Capsuhelic® gage range in inches of water column to the left. The DS-300 sensor is supplied with installation and operating instructions, Bulletin F-50. It also includes complete flow conversion information for the three media conditions shown in the chart below. This information enables the user to create a complete differential pressure to flow rate conversion table for the sensor and differential pressure gage employed. Both the Dwyer® Capsuhelic® gage and flow sensor feature excellent repeatability so, once the desired flow rate is determined, deviation from that flow in quantitative measure can be easily determined. You may wish to order the adjustable signal flag option for the Capsuhelic® gage to provide an easily identified reference point for the proper flow.

Capsuhelic® gages with special ranges and/or direct reading scales in appropriate flow units are available on special order for more critical applications. Customer supplied data for the full scale flow (quantity and units) is required along with the differential pressure reading at that full flow figure. Prior to ordering a special Capsuhelic® differential pressure gage for flow read-out, we recommend you request Bulletin F-50 to obtain complete data on converting flow rates of various media to the sensor differential pressure output. With this bulletin and after making a few simple calculations, the exact range gage required can easily be determined.

## Large 3/4 Inch Diameter for Extra Strength in Lengths to 24 Inches



FLOW

GAGE RANGE (IN. W.C.)	MEDIA @ 70°F	FULL RANGE FLOWS BY PIPE SIZE (APPROXIMATE)									
		1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"	6"	8"	10"
2	Water (GPM)	4.8	8.3	11.5	20.5	30	49	86	205	350	560
	Air @ 14.7 PSIA (SCFM)	19.0	33.0	42.0	65.0	113	183	330	760	1340	2130
	Air @ 100 PSIG (SCFM)	50.0	90.5	120.0	210.0	325	510	920	2050	3600	6000
5	Water (GPM)	7.7	14.0	18.0	34.0	47	78	138	320	560	890
	Air @ 14.7 PSIA (SCFM)	30.0	51.0	66.0	118.0	178	289	510	1200	2150	3400
	Air @ 100 PSIG (SCFM)	83.0	142.0	190.0	340.0	610	820	1600	3300	5700	10000
10	Water (GPM)	11.0	19.0	25.5	45.5	67	110	195	450	800	1260
	Air @ 14.7 PSIA (SCFM)	41.0	72.0	93.0	163.0	250	410	725	1690	3040	4860
	Air @ 100 PSIG (SCFM)	120.0	205.0	275.0	470.0	740	1100	2000	4600	8100	15000
25	Water (GPM)	18.0	32.0	40.5	72.0	108	173	310	720	1250	2000
	Air @ 14.7 PSIA (SCFM)	63.0	112.0	155.0	255.0	390	640	1130	2630	4860	7700
	Air @ 100 PSIG (SCFM)	185.0	325.0	430.0	760.0	1200	1800	3300	7200	13000	22000
50	Water (GPM)	25.0	44.0	57.5	100.0	152	247	435	1000	1800	
	Air @ 14.7 PSIA (SCFM)	90.0	161.0	205.0	360.0	560	900	1600	3700	6400	
	Air @ 100 PSIG (SCFM)	260.0	460.0	620.0	1050.0	1700	2600	4600	10000	18500	
100	Water (GPM)	36.5	62.0	82.0	142.0	220	350	620	1500		
	Air @ 14.7 PSIA (SCFM)	135.0	230.0	300.0	505.0	800	1290	2290	5000		
	Air @ 100 PSIG (SCFM)	370.0	660.0	870.0	1500.0	2300	3600	6500	15000		

## Model A-471 Portable Kit

The Dwyer® Series 4000 Capsuhelic® differential pressure gage is ideally suited for use as a read-out device with the DS-300 Flow Sensors. The gage may be used on system pressures of up to 500 psig even when the flow sensor differential pressure to be read is less than 0.5" w.c. With accuracy of ±3% of full scale, the Capsuhelic® gage can be used in ambient temperatures from 32 to 200°F (0 to 93.3°C). Zero and range adjustments are made from outside the gage. The standard gage with a die cast aluminum housing can be used with the flow sensor for air or oil applications. For water flow measurements, the optional forged brass housing should be specified. The Capsuhelic® gage may be panel or surface mounted and permanently plumbed to the flow sensor if desired. The optional A-610 pipe mounting bracket allows the gage to be easily attached to any 1-1/4" - 2" horizontal or vertical pipe.

For portable operation, the A-471 Capsuhelic® Portable Gage Kit is available complete with tough polypropylene carrying case, mounting bracket, 3-way manifold valve, two 10' high pressure hoses, and all necessary fittings. See pages 8 and 9 for complete information on the Capsuhelic® gage.

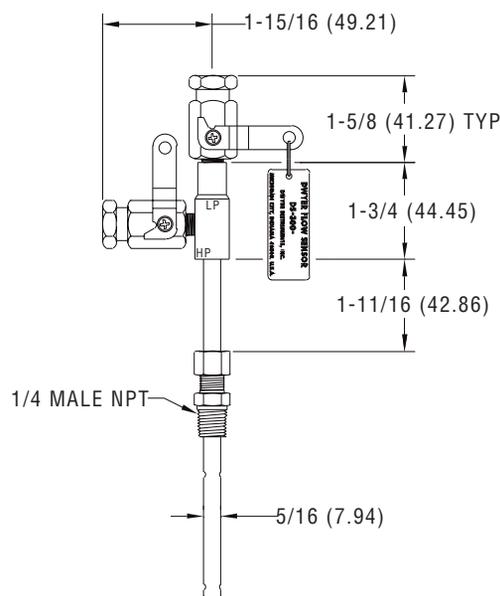


CAPSUHELIC® GAGE SHOWN INSTALLED IN A-471 PORTABLE KIT



# Series DS-300 Flow Sensors

## Installation and Operating Instructions Flow Calculations



**Series DS-300 Flow Sensors** are averaging pitot tubes that provide accurate, convenient flow rate sensing. When purchased with a Dwyer Capsuhelic® for liquid flow or Magnehelic® for air flow, differential pressure gage of appropriate range, the result is a flow-indicating system delivered off the shelf at an economical price. Series DS-300 Flow Sensors are designed to be inserted in the pipeline through a compression fitting and are furnished with instrument shut-off valves on both pressure connections. Valves are fitted with 1/8" female NPT connections. Accessories include adapters with 1/4" SAE 45° flared ends compatible with hoses supplied with the Model A-471 Portable Capsuhelic® kit. Standard valves are rated at 200°F (93.3°C). Where valves are not required, they can be omitted at reduced cost. Series DS-300 Flow Sensors are available for pipe sizes from 1" to 10".

### INSPECTION

Inspect sensor upon receipt of shipment to be certain it is as ordered and not damaged. If damaged, contact carrier.

### INSTALLATION

**General** - The sensing ports of the flow sensor must be correctly positioned for measurement accuracy. The instrument connections on the sensor indicate correct positioning. The side connection is for total or high pressure and should be pointed upstream. The top connection is for static or low pressure.

**Location** - The sensor should be installed in the flowing line with as much straight run of pipe upstream as possible. A rule of thumb is to allow 10 - 15 pipe diameters upstream and 5 downstream. The table below lists recommended up and down piping.

### PRESSURE AND TEMPERATURE

Maximum: 200 psig (13.78 bar) at 200°F (93.3°C).

Upstream and Downstream Dimensions in Terms of Internal Diameter of Pipe *			
Upstream Condition	Minimum Diameter of Straight Pipe		
	Upstream		Downstream
	In-Plane	Out of Plane	
One Elbow or Tee	7	9	5
Two 90° Bends in Same Plane	8	12	5
Two 90° Bends in Different Plane	18	24	5
Reducers or Expanders	8	8	5
All Valves**	24	24	5

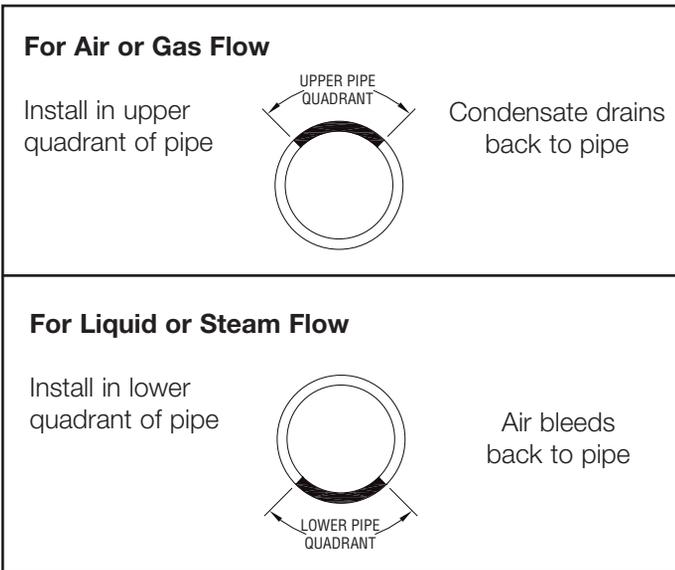
\* Values shown are recommended spacing, in terms of internal diameter for normal industrial metering requirements. For laboratory or high accuracy work, add 25% to values.

\*\* Includes gate, globe, plug and other throttling valves that are only partially opened. If valve is to be fully open, use values for pipe size change. **CONTROL VALVES SHOULD BE LOCATED AFTER THE FLOW SENSOR.**

## POSITION

Be certain there is sufficient clearance between the mounting position and other pipes, walls, structures, etc, so that the sensor can be inserted through the mounting unit once the mounting unit has been installed onto the pipe.

Flow sensors should be positioned to keep air out of the instrument connecting lines on liquid flows and condensate out of the lines on gas flows. The easiest way to assure this is to install the sensor into the pipe so that air will bleed into, or condensate will drain back to, the pipe.



## INSTALLATION

1. When using an A-160 thred-o-let, weld it to the pipe wall. If replacing a DS-200 unit, an A-161 bushing (1/4" x 3/8") will be needed.
2. Drill through center of the thred-o-let into the pipe with a drill that is slightly larger than the flow sensor diameter.
3. Install the packing gland using proper pipe sealant. If the packing gland is disassembled, note that the tapered end of the ferrule goes into the fitting body.
4. Insert sensor until it bottoms against opposite wall of the pipe, then withdraw 1/16" to allow for thermal expansion.
5. Tighten packing gland nut finger tight. Then tighten nut with a wrench an additional 1-1/4 turns. Be sure to hold the sensor body with a second wrench to prevent the sensor from turning.

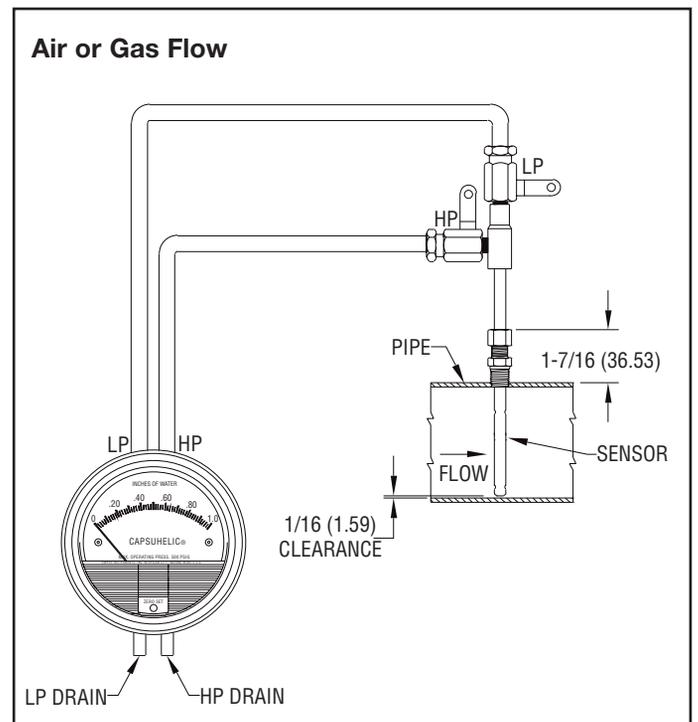
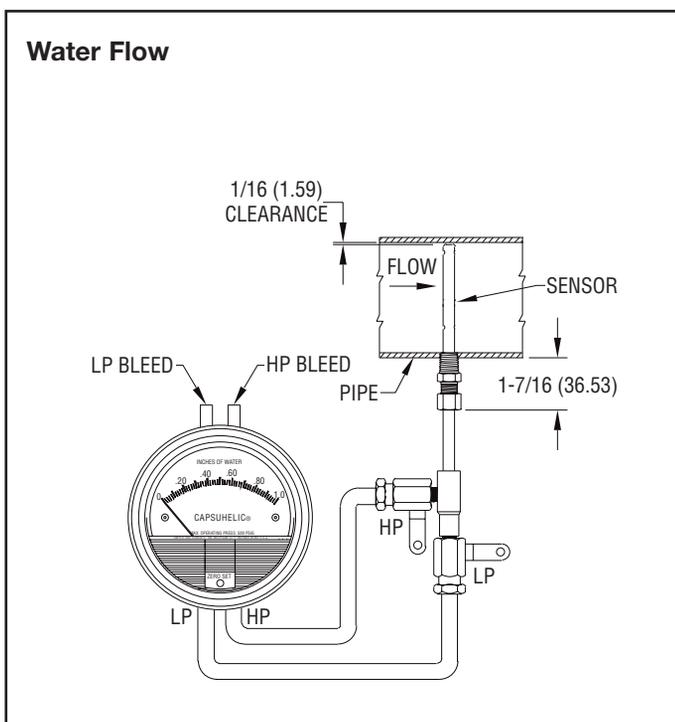
## INSTRUMENT CONNECTION

Connect the slide pressure tap to the high pressure port of the Magnehelic® (air only) or Capsuhelic® gage or transmitting instrument and the top connection to the low pressure port.

See the connection schematics below.

Bleed air from instrument piping on liquid flows. Drain any condensate from the instrument piping on air and gas flows.

Open valves to instrument to place flow meter into service. For permanent installations, a 3-valve manifold is recommended to allow the gage to be zero checked without interrupting the flow. The Dwyer A-471 Portable Test Kit includes such a device.

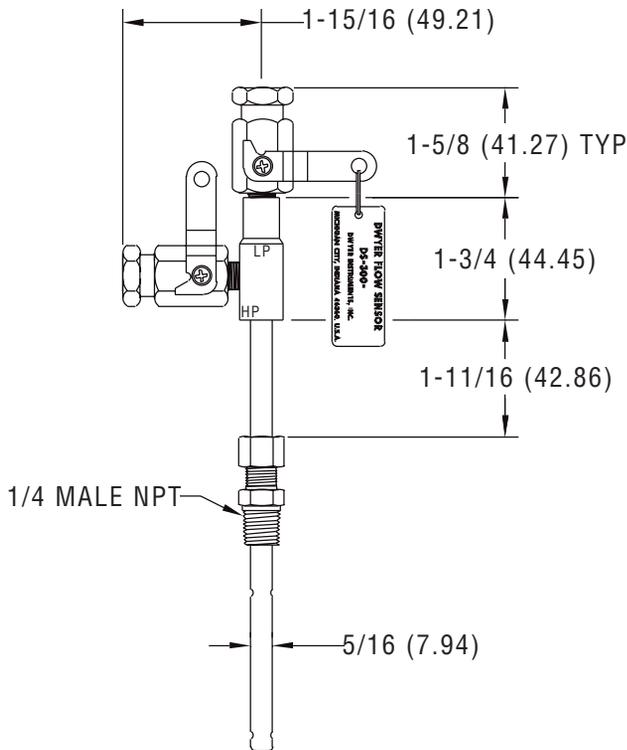


### Flow Calculations and Charts

The following information contains tables and equations for determining the differential pressure developed by the DS-300 Flow Sensor for various flow rates of water, steam, air or other gases in different pipe sizes.

This information can be used to prepare conversion charts to translate the differential pressure readings being sensed into the equivalent flow rate. When direct readout of flow is required, use this information to calculate the full flow differential pressure in order to specify the exact range of Dwyer Magnehelic® or Capsuhelic® gage required. Special ranges and calculations are available for these gages at minimal extra cost. See bulletins A-30 and F-41 for additional information on Magnehelic® and Capsuhelic® gages and DS-300 flow sensors.

For additional useful information on making flow calculations, the following service is recommended: Crane Valve Co. Technical Paper No. 410 "Flow of Fluids Through Valves, Fittings and Pipe." It is available from Crane Valve Company, [www.cranvalve.com](http://www.cranvalve.com).



Using the appropriate differential pressure equation from Page 4 of this bulletin, calculate the differential pressure generated by the sensor under normal operating conditions of the system. Check the chart below to determine if this value is within the recommended operating range for the sensor. Note that the data in this chart is limited to standard conditions of air at 60°F (15.6°C) and 14.7 psia static line pressure or water at 70°F (21.1°C). To determine recommended operating ranges of other gases, liquids an/or operating conditions, consult factory.

**Note:** the column on the right side of the chart which defines velocity ranges to avoid. Continuous operation within these ranges can result in damage to the flow sensor caused by excess vibration.

Pipe Size (Schedule 40)	Flow Coefficient "K"	Operating Ranges Air @ 60°F & 14.7 psia (D/P in. W.C.)	Operating Ranges Water @ 70°F (D/P in. W.C.)	Velocity Ranges Not Recommended (Feet per Second)
1	0.52	1.10 to 186	4.00 to 675	146 to 220
1-1/4	0.58	1.15 to 157	4.18 to 568	113 to 170
1-1/2	0.58	0.38 to 115	1.36 to 417	96 to 144
2	0.64	0.75 to 75	2.72 to 271	71 to 108
2-1/2	0.62	1.72 to 53	6.22 to 193	56 to 85
3	0.67	0.39 to 35	1.43 to 127	42 to 64
4	0.67	0.28 to 34	1.02 to 123	28 to 43
6	0.71	0.64 to 11	2.31 to 40	15 to 23
8	0.67	0.10 to 10	0.37 to 37	9.5 to 15
10	0.70	0.17 to 22	0.60 to 79	6.4 to 10

## FLOW EQUATIONS

1. Any Liquid

$$Q \text{ (GPM)} = 5.668 \times K \times D^2 \times \sqrt{\Delta P / S_f}$$

2. Steam or Any Gas

$$Q \text{ (lb/Hr)} = 359.1 \times K \times D^2 \times \sqrt{p \times \Delta P}$$

3. Any Gas

$$Q \text{ (SCFM)} = 128.8 \times K \times D^2 \times \sqrt{\frac{P \times \Delta P}{(T + 460) \times S_s}}$$

## DIFFERENTIAL PRESSURE EQUATIONS

1. Any Liquid

$$\Delta P \text{ (in. WC)} = \frac{Q^2 \times S_f}{K^2 \times D^4 \times 32.14}$$

2. Steam or Any Gas

$$\Delta P \text{ (in. WC)} = \frac{Q^2}{K^2 \times D^4 \times p \times 128,900}$$

3. Any Gas

$$\Delta P \text{ (in. WC)} = \frac{Q^2 \times S_s \times (T + 460)}{K^2 \times D^4 \times P \times 16,590}$$

## Technical Notations

The following notations apply:

$\Delta P$  = Differential pressure expressed in inches of water column

Q = Flow expressed in GPM, SCFM, or PPH as shown in equation

K = Flow coefficient— See values tabulated on Pg. 3.

D = Inside diameter of line size expressed in inches.

$$\text{For square or rectangular ducts, use: } D = \frac{\sqrt{4 \times \text{Height} \times \text{Width}}}{\pi}$$

P = Static Line pressure (psia)

T = Temperature in degrees Fahrenheit (plus 460 = °Rankine)

p = Density of medium in pounds per square foot

S<sub>f</sub> = Sp Gr at flowing conditions

S<sub>s</sub> = Sp Gr at 60°F (15.6°C)

---

## SCFM TO ACFM EQUATION

$$\text{SCFM} = \text{ACFM} \times \left( \frac{14.7 + \text{PSIG}}{14.7} \right) \left( \frac{520^*}{460 + ^\circ\text{F}} \right)$$

$$\text{ACFM} = \text{SCFM} \times \left( \frac{14.7}{14.7 + \text{PSIG}} \right) \left( \frac{460 + ^\circ\text{F}}{520} \right)$$

$$\frac{\text{POUNDS PER CUBIC FOOT}}{\text{STD.}} = \frac{\text{POUNDS PER CUBIC FOOT}}{\text{ACT.}} \times \left( \frac{14.7}{14.7 + \text{PSIG}} \right) \left( \frac{460 + ^\circ\text{F}}{520^*} \right)$$

$$\frac{\text{POUNDS PER CUBIC FOOT}}{\text{ACT.}} = \frac{\text{POUNDS PER CUBIC FOOT}}{\text{STD.}} \times \left( \frac{14.7 + \text{PSIG}}{14.7} \right) \left( \frac{520^*}{460 + ^\circ\text{F}} \right)$$

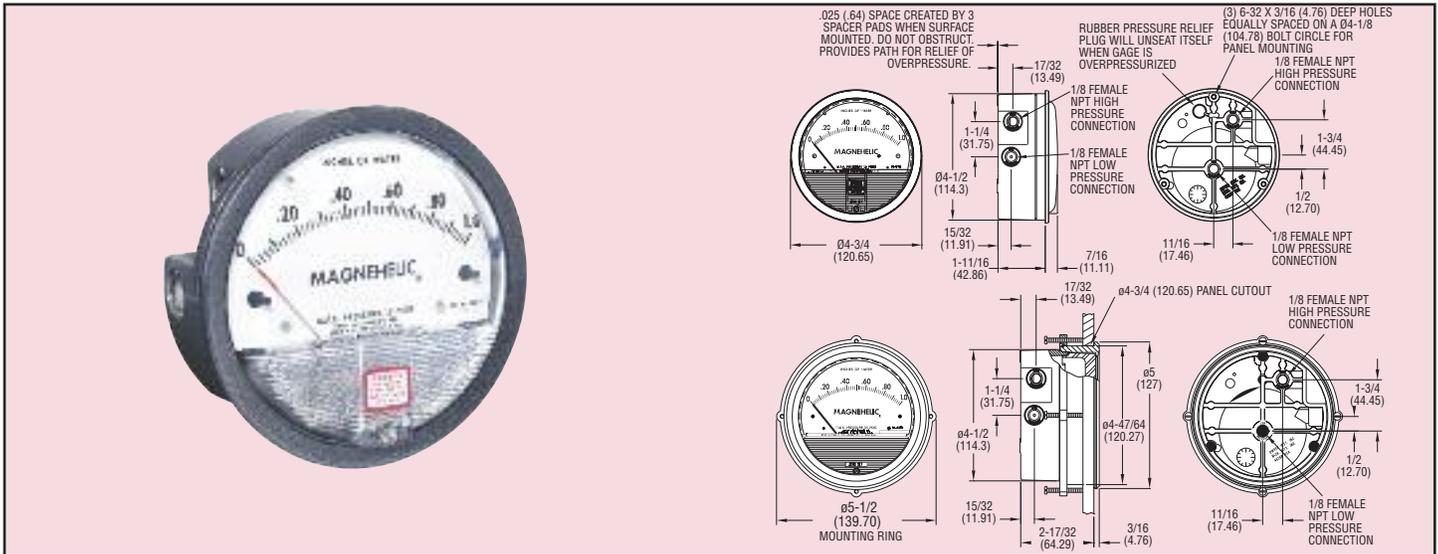
1 Cubic foot of air = 0.076 pounds per cubic foot at 60° F (15.6°C) and 14.7 psia.

\* (520° = 460 + 60°) Std. Temp. Rankine

Series  
2000

# Magnehelic® Differential Pressure Gages

Indicate Positive, Negative or Differential, Accurate within 2%



Select the Dwyer® Magnehelic® gage for high accuracy – guaranteed within 2% of full scale – and for the wide choice of 81 models available to suit your needs precisely. Using Dwyer's simple, frictionless Magnehelic® gage movement, it quickly indicates low air or non-corrosive gas pressures – either positive, negative (vacuum) or differential. The design resists shock, vibration and over-pressures. No manometer fluid to evaporate, freeze or cause toxic or leveling problems. It's inexpensive, too.

The Magnehelic® gage is the industry standard to measure fan and blower pressures, filter resistance, air velocity, furnace draft, pressure drop across orifice plates, liquid levels with bubbler systems and pressures in fluid amplifier or fluidic systems. It also checks gas-air ratio controls and automatic valves, and monitors blood and respiratory pressures in medical care equipment.

**Note:** May be used with hydrogen. Order a Buna-N diaphragm. Pressures must be less than 35 psi.



Flush, Surface or Pipe Mounted

### Mounting

A single case size is used for most models of Magnehelic® gages. They can be flush or surface mounted with standard hardware supplied. With the optional **A-610** Pipe Mounting Kit they may be conveniently installed on horizontal or vertical 1-1/4" - 2" pipe. Although calibrated for vertical position, many ranges above 1" may be used at any angle by simply re-zeroing. However, for maximum accuracy, they must be calibrated in the same position in which they are used. These characteristics make Magnehelic® gages ideal for both stationary and portable applications. A 4-9/16" hole is required for flush panel mounting. Complete mounting and connection fittings plus instructions are furnished with each instrument.

### Vent Valves

In applications where pressure is continuous and the Magnehelic® gage is connected by metal or plastic tubing which cannot be easily removed, we suggest using Dwyer A-310A vent valves to connect gage. Pressure can then be removed to check or re-zero the gage.

### High and Medium Pressure Models

Installation is similar to standard gages except that a 4-13/16" hole is needed for flush mounting. The medium pressure construction is rated for internal pressures up to 35 psig and the high pressure up to 80 psig. Available for all models. Because of larger case, the medium pressure and high pressure models will not fit in a portable case size. Installation of the A-321 safety relief valve on standard Magnehelic® gages often provides adequate protection against infrequent overpressure.

### SPECIFICATIONS

**Service:** Air and non-combustible, compatible gases (natural gas option available).

**Wetted Materials:** Consult factory.

**Housing:** Die cast aluminum case and bezel, with acrylic cover. Exterior finish is coated gray to withstand 168 hour salt spray corrosion test.

**Accuracy:** ±2% of FS (±3% on -0, -100 Pa, -125 Pa, 10MM and ±4% on -00, -60 Pa, -6MM ranges), throughout range at 70°F (21.1°C).

**Pressure Limits:** -20 in Hg to 15 psig (-0.677 to 1.034 bar); MP option: 35 psig (2.41 bar); HP option: 80 psig (5.52 bar).

**Overpressure:** Relief plug opens at approximately 25 psig (1.72 bar), standard gages only. See Overpressure Protection Note on next page.

**Temperature Limits:** 20 to 140°F\* (-6.67 to 60°C).

**Size:** 4" (101.6 mm) diameter dial face.

**Mounting Orientation:** Diaphragm in vertical position. Consult factory for other position orientations.

**Process Connections:** 1/8" female NPT duplicate high and low pressure taps - one pair side and one pair back.

**Weight:** 1 lb 2 oz (510 g), MP & HP 2 lb 2 oz (963 g).

**Standard Accessories:** Two 1/8" NPT plugs for duplicate pressure taps, two 1/8" pipe thread to rubber tubing adapter and three flush mounting adapters with screws. (Mounting and snap ring retainer substituted for three adapters in MP & HP gage accessories.)

**Agency Approval:** RoHS.

\*Low temperature models available as special option.

†For applications with high cycle rate within gage total pressure rating, next higher rating is recommended. See Medium and High pressure options at lower left.

### OPTIONS AND ACCESSORIES



#### Transparent Overlays

Furnished in red and green to highlight and emphasize critical pressures.



#### Adjustable Signal Flag

Integral with plastic gage cover. Available for most models except those with medium or high pressure construction. Can be ordered with gage or separate.

Add suffix **-ASF** to end of gage model number



#### LED Setpoint Indicator

Bright red LED on right of scale shows when setpoint is reached. Field adjustable from gage face, unit operates on 12-24 VDC. Requires MP or HP style cover and bezel.

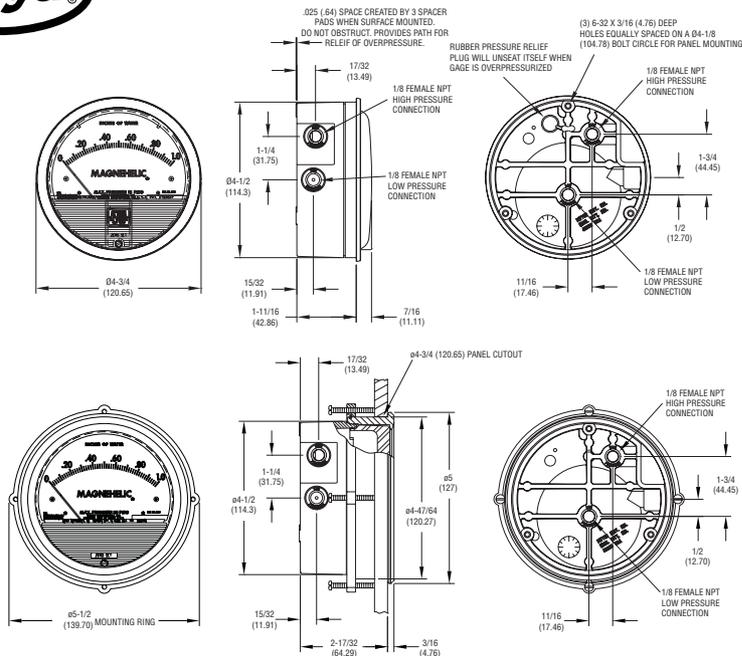
Add suffix **-SP** to end of gage model number

**Note:** -SP option models not RoHS approved.





# Magnehelic® Differential Pressure Gage



\*The blowout plug is not used on models above 180 inches of water pressure, medium or high pressure models, or on gages which require an elastomer other than silicone for the diaphragm.

**STANDARD GAGE ACCESSORIES:** Two 1/8" NPT plugs for duplicate pressure taps, two 1/8" pipe thread to rubber tubing adapters and three flush mounting adapters with screws.

**MP AND HP GAGE ACCESSORIES:** Mounting ring and snap ring retainer substituted for 3 adaptors, 1/4" compression fittings replace 1/8" pipe thread to rubber tubing adaptors.

**OVERPRESSURE PROTECTION:** Standard Magnehelic® Differential Pressure Gages are rated for a maximum pressure of 15 psig and should not be used where that limit could be exceeded. Models employ a rubber plug on the rear which functions as a relief valve by unseating and venting the gage interior when over pressure reaches approximately 25 psig (excludes MP and HP models). To provide a free path for pressure relief, there are four spacer pads which maintain .023" clearance when gage is surface mounted. Do not obstruct the gap created by these pads.

## SPECIFICATIONS

**Service:** Air and non-combustible, compatible gases. (Natural Gas option available.)

**Wetted Materials:** Consult factory.

**Housing:** Die cast aluminum case and bezel, with acrylic cover. (MP model has polycarbonate cover).

**Accuracy:** ±2% of full scale (±3% on -0, -100 Pa, -125 Pa, 10MM and ±4% on -00, -00N, -60 Pa, -6MM ranges), throughout range at 70°F (21.1°C).

**Pressure Limits:** -20" Hg to 15 psig † (-0.677 bar to 1.034 bar); MP option: 35 psig (2.41 bar), HP option: 80 psig (5.52 bar).

**Overpressure:** Relief plug opens at approximately 25 psig (1.72 bar), standard gages only. The blowout plug is not used on models above 180 inches of water pressure, medium or high pressure models, or on gages which require an elastomer other than silicone for the diaphragm.

**Temperature Limits:** 20 to 140°F (-6.67 to 60°C).

†Low temperature models available as special option.

**Size:** 4" (101.6 mm) diameter dial face.

**Mounting Orientation:** Diaphragm in vertical position. Consult factory for other position orientations.

**Process Connections:** 1/8" female NPT duplicate high and low pressure taps - one pair side and one pair back.

**Weight:** 1 lb 2 oz (510 g), MP & HP 2 lb 2 oz (963 g).

†For applications with high cycle rate within gage total pressure rating, next higher rating is recommended. See Medium and High pressure options.

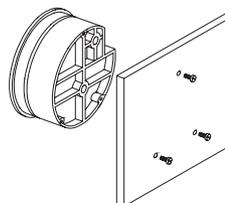
**Note:** May be used with hydrogen when ordering Buna-N diaphragm. Pressure must be less than 35 psi.

## INSTALLATION

Select a location free from excessive vibration and where the ambient temperature will not exceed 140°F (60°C). Also, avoid direct sunlight which accelerates discoloration of the clear plastic cover. Sensing lines may be run any necessary distance. Long tubing lengths will not affect accuracy but will increase response time slightly. Do not restrict lines. If pulsating pressures or vibration cause excessive pointer oscillation, consult the factory for ways to provide additional damping.

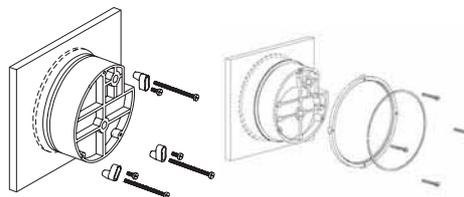
All standard Magnehelic® Differential Pressure Gages are calibrated with the diaphragm vertical and should be used in that position for maximum accuracy. If gages are to be used in other than vertical position, this should be specified on the order. Many higher range gages will perform within tolerance in other positions with only rezeroing. Low range models of 0.5" w.c. plus 0.25" w.c. and metric equivalents must be used in the vertical position only.

## SURFACE MOUNTING



Locate mounting holes, 120° apart on a 4-1/8" dia. circle. Use No. 6-32 machine screws of appropriate length.

## FLUSH MOUNTING



Provide a 4-9/16" dia. (116 mm) opening in panel. Provide a 4-3/4" dia. (120 mm) opening for MP and HP models. Insert gage and secure in place with No. 6-32 machine screws of appropriate length, with adapters, firmly secured in place.

## PIPE MOUNTING

To mount gage on 1-1/4" - 2" pipe, order optional A-610 pipe mounting kit.

## TO ZERO GAGE AFTER INSTALLATION

Set the indicating pointer exactly on the zero mark, using the external zero adjust screw on the

cover at the bottom. Note that the zero check or adjustment can only be made with the high and low pressure taps both open to atmosphere.

## OPERATION

**Positive Pressure:** Connect tubing from source of pressure to either of the two high pressure ports. Plug the port not used. Vent one or both low pressure ports to atmosphere.

**Negative Pressure:** Connect tubing from source of vacuum or negative pressure to either of the two low pressure ports. Plug the port not used. Vent one or both high pressure ports to atmosphere.

**Differential Pressure:** Connect tubing from the greater of two pressure sources to either high pressure port and the lower to either low pressure port. Plug both unused ports.

When one side of the gage is vented in dirty, dusty atmosphere, we suggest an A-331 Filter Vent Plug be installed in the open port to keep inside of gage clean.

**A.** For portable use of temporary installation use 1/8" pipe thread to rubber tubing adapter and connect to source of pressure with flexible rubber or vinyl tubing.

**B.** For permanent installation, 1/4" O.D., or larger, copper or aluminum tubing is recommended.

## MAINTENANCE

No lubrication or periodic servicing is required. Keep case exterior and cover clean. Occasionally disconnect pressure lines to vent both sides of gage to atmosphere and re-zero. Optional vent valves should be used in permanent installations. The Series 2000 is not field serviceable and should be returned if repair is needed (field repair should not be attempted and may void warranty). Be sure to include a brief description of the problem plus any relevant application notes. Contact customer service to receive a return goods authorization number before shipping.

## WARNING

Attempted field repair may void your warranty. Recalibration or repair by the user is not recommended.

## TROUBLE SHOOTING TIPS

**Gage won't indicate or is sluggish.**

1. Duplicate pressure port not plugged.
2. Diaphragm ruptured due to overpressure.
3. Fittings or sensing lines blocked, pinched, or leaking.
4. Cover loose or "O"ring damaged, missing.
5. Pressure sensor, (static tips, Pitot tube, etc.) improperly located.
6. Ambient temperature too low. For operation below 20°F (-7°C), order gage with low temperature, (LT) option.

# PROTECT V

## Carbon Adsorber Canisters



### Description

The PROTECT V vapor phase carbon adsorber canisters are air or vapor treatment units for use in applications requiring higher pressures or slight vacuum conditions. PROTECT V canisters contain all of the operating elements required for utilization of granular activated carbon in air or vapor treatment, including a flat carbon bed support across the entire bed cross sectional area and plenum area below this support for effective air introduction and distribution across the bed. The canisters are constructed of unlined carbon steel with a stainless steel screen bed support for use with activated carbon in air treatment.

The PROTECT V vapor phase carbon adsorber canisters are available in 2 convenient sizes that will contain 1000 or 2000 pounds of granular activated carbon for treating air or vapor sources typically up to 750 cfm at pressures up to 15 psig and up to 15 inches of Mercury of vacuum.

The PROTECT V vapor phase adsorbers can be provided with any of Calgon Carbon's wide variety of vapor phase activated carbon products that can be selected for a specific air or vapor treatment application. Most commonly used are Type AP4-60 grade virgin activated carbon, which is a 4mm pelletized activated carbon with a carbon Tetrachloride Number of 60 for higher purity air or vapor, or optimal usage for low levels of organic contamination, or Type VPR quality controlled reactivated grade vapor phase carbon for a more economical carbon product for general air treatment.

### Features

The PROTECT V vapor phase carbon adsorber canisters offer several important features that make it an effective value driven option for higher pressure air or vapor phase treatment applications:

- Sturdy carbon steel construction
- Capable of operating up to 15 psig which will manage most vent or higher pressure exhaust fan situations.
- Capable of operating up to 5 inches of Mercury vacuum.
- Exterior painted with a durable urethane finish
- Operating temperature up to 200°F
- Top 16 inch diameter access port for activated carbon media fill and removal
- Carbon bed support across the full canister cross sectional area, consisting of 20 mesh type 316 stainless steel screen placed on slotted steel plate for vapor distribution across the entire bed for maximum activated carbon utilization and low pressure drop.
- Top lifting lugs and bottom fork guides for portability



### Specifications

Canister	Sturdy $\frac{3}{16}$ " thick carbon steel canister with $\frac{3}{16}$ " thick steel concave bottom head (inside flat bottom) and top dished head
Pressure	Recommended 15 psig maximum operating pressure (shop hydrotested in excess of recommended pressure)
Vacuum	Recommended maximum 15" Hg vacuum operation
Temperature	Recommended 200°F maximum
Internal coating	None – unfinished steel
External Coating	Direct-to-Metal polyurethane
Inlet (bottom side)	6" FPT coupling (shipped with plug)
Inlet distributor	Stainless steel screen bed support on slotted steel plate
Vent / sample port	$\frac{3}{4}$ " FPT coupling
Outlet (top side)	6" FPT coupling (shipped with plug)
Drain	$\frac{3}{4}$ " FPT coupling with $\frac{3}{4}$ " threaded plug
Access Port	16" diameter access port with threaded clamp ring and BUNA-N gasket.
Dimensions	Refer to Model chart

# PROTECT V

## Carbon Adsorber Canisters



### Installation

PROTECT V canisters are shipped ready for installation with the dry activated carbon fill installed in the unit. The canisters are self supporting and should be set on a level accessible area as near as possible to the emission source. Standard installation does not utilize any anchoring devices. Installation is simple, requiring a flexible hose, duct or pipe to connect the vent or emission source to the 6 inch FPT bottom inlet of the canister.

The PROTECT V canister's treated air discharge is a 6 inch FPT connection on the upper side of the vessel and can be left open or equipped with flexible hose, duct or pipe to direct the treated air to a desired discharge point. If the canister is located outside and to be vented directly, then a U-shaped outlet pipe or rain hat (such as a pipe tee) is recommended to be installed to prevent precipitation from entering the unit.

The recommended air flow for the PROTECT V canisters are listed in the table. If higher flows are anticipated, then either a larger canister should be utilized or two or more PROTECT V canisters can be placed in parallel operation.

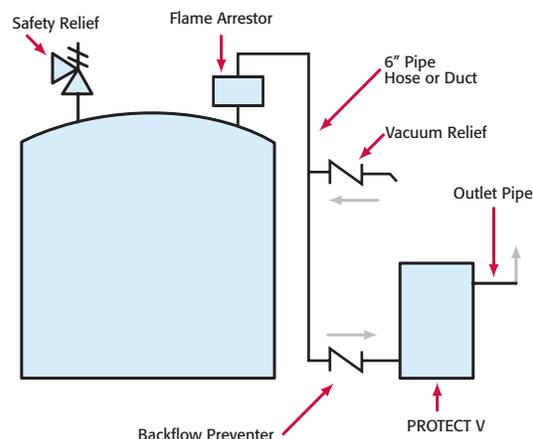
The recommended maximum static pressure and vacuum capabilities are also listed. These ratings should not be exceeded, as the canister could be irreparably damaged.

PROTECT V canisters can be used to treat vents directly from storage tank or other process vessels. The motive force for the air or vapor can be produced by either a blower or by using the positive pressure inside the tank or process vessel. In many cases, the pressure or surge of pressure within the tank or vessel is sufficient to overcome the pressure drop across the canister, thus eliminating the need for a blower. Please consult the pressure drop data in this bulletin for more information.

When PROTECT V canisters are used to control vapors from organic solvent storage tanks, refer to the typical installation drawing in the bulletin and the following recommended precautions:

- A safety relief valve must be provided on the storage tank. This protects the storage tank should the canister become plugged or blocked in any fashion. Such a vent would open in an emergency situation, thereby relieving pressure within the storage tank.
- Under appropriate conditions, a flame arrestor and/or backflow preventer must be installed as shown in the typical installation drawing. This prevents backflow of air through the canister when the storage tank is being emptied.
- High organic compound concentration in the vented air or vapor – defined as being greater than 0.5 to 1.0 volume % - may cause an elevated heat of adsorption in the carbon bed. This effect can be dissipated by pre-wetting the carbon to provide a heat sink, adding dilution air to the vented air or vapor to reduce the concentration, or by adding water spray to the vented air or vapor to provide an ongoing heat sink.

### Typical PROTECT V Installation at Storage Tank



If PROTECT V canisters are used to control organic compound emissions from air-strippers, soil venting or other high moisture content air or vapor streams, then it is recommended that the humidity in the air stream be reduced to under 50%. High humidity may cause water vapor to condense within the carbon pores, filling the pores with water and preventing the air or vapor with organic contamination from accessing the internal surface of the activated carbon where adsorption takes place. Therefore, lower humidity will optimize the adsorptive capacity of the activated carbon. Also, for applications that may carry condensed water, it is recommended to install a drain or condensate trap on the inlet duct or piping.

### Carbon Exchange or Replacement

When the treated air or vapor exceeds the desired contaminant concentration, the granular activated carbon in the PROTECT V canister should be replaced with fresh activated carbon. The canister is to be isolated from the process by either closing and locking the inlet and outlet valves, or physically disconnecting the canister from the inlet and outlet pipe or hose. The carbon exchange procedure can either take place where the canister is installed, or the disconnected canister can be moved to another location for this activity.

The spent granular activated carbon can be removed by using a vacuum media removal procedure through the top access port. Fresh granular activated carbon can be filled using bags or "supersacks" by loading into the canister through the top access port. Once the fresh carbon is installed, the access port securely closed, and the inlet and outlet connections are reestablished, follow the procedures under the Installation section.

Contact Calgon Carbon Corporation for resupply of the carbon products for effective air or vapor treatment. Calgon Carbon Corporation can also provide complete turnkey services, including removal and management of the spent carbon and refilling the canister with the fresh carbon.

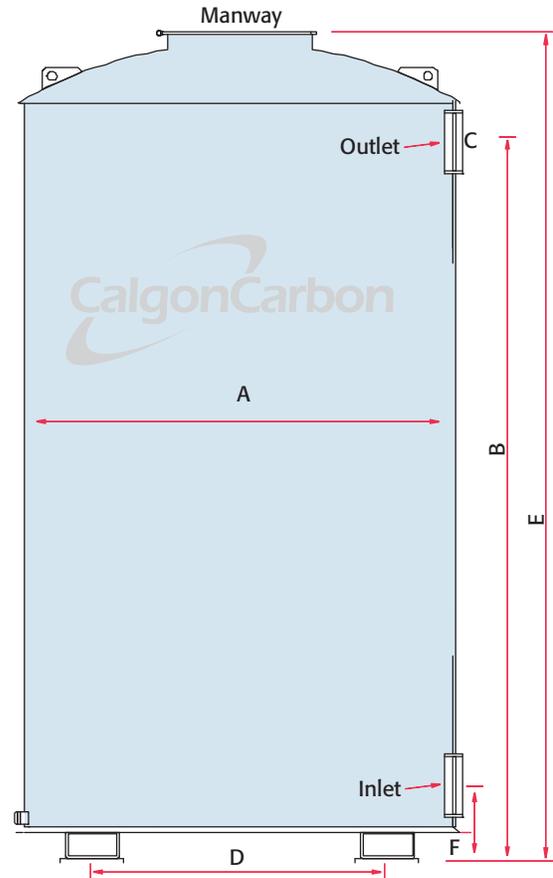
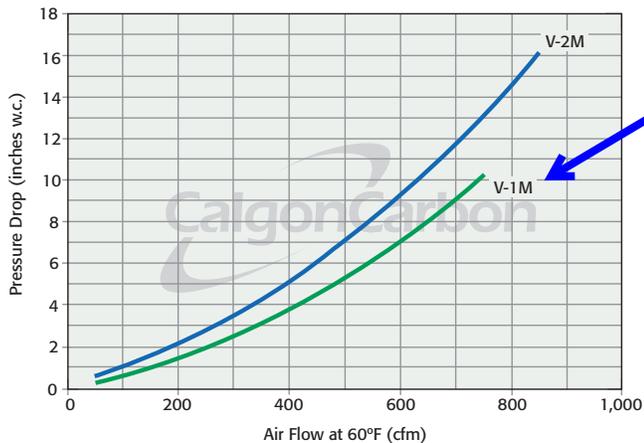
# PROTECT V Carbon Adsorber Canisters



## Pressure Drop Curve

Pressure drop through a PROTECT V canister is a function of the process air flow as shown in the graph. If higher flows or lower pressure drop is needed, multiple canisters can be installed in parallel operation. The maximum pressure in the canister should not exceed 15 psig, regardless of the pressure drop across the unit.

## Pressure Drop Curve



Drawing not to scale.

## Calgon Carbon Air Purification Systems

The PROTECT V canisters are designed for a variety of higher pressure air or vapor applications at low to moderate air flows. Calgon Carbon Corporation offers a wide range of carbon adsorption systems and services for a range of air or vapor flow rates and carbon usages to meet specific applications.

## Model Information

Model Number	V-1M	V-2M
GAC or media volume (cu ft)	36	72
GAC amount (pounds)	1000	2000
Recommended max flow rate (cfm)	675	750
Weight, empty (pounds)	1000	1150
Approximate operating weight (pounds)	2000	3150
Diameter (A) in.	45.5	48
Height to outlet (B) in. (approx)	70.5	82.5
Inlet /Outlet ( C ) fpt, in.	6	6
Forkguides (D) in.	33	33
Overall Height (E) in. (approx)	84	96
Height to inlet (F) in. (approx)	8	8
Overall width; in. (approx)	45.5	48

# PROTECT V

## Carbon Adsorber Canisters



### Safety Considerations

While complying with the recommended installation instructions, plant operators should also be aware of these additional heat-related safety considerations:

- When in contact with activated carbon, some types of organic chemical compounds, such as those from the ketone and aldehyde families and some organic acids or organic sulfur compounds, may react on the carbon surface causing severe exotherms or temperature excursions. **If you are unaware or unsure of the reaction of an organic compound on activated carbon, appropriate tests should be performed before placing a PROTECT V canister in service.**
- Heat of adsorption can lead to severe temperature excursions at high concentrations of organic compounds in the inlet air or vapor. Heating may be controlled by diluting the inlet air or adding water vapor as a heat sink, by time weighting the inlet concentration to allow heat to dissipate, or by pre-wetting the carbon.
- **Do not use PROTECT V canisters with ST1-X carbon in petrochemical or chemical industry applications.**
- ST1-X carbon can liberate heat by reacting chemically with oxygen. To prevent heat buildup within a canister, the carbon must not be confined without adequate air flow to dissipate the heat. In situations where there is insufficient or disrupted air flow through the vessel, the chemical reaction can be prevented by sealing the inlet and outlet connections to the canister.
- For temperatures greater than 140°F, Calgon Carbon recommends that personnel protection be provided. The form of protection is determined per the end users specific plant practices and standards. Also note that at elevated temperatures, the paint may discolor.

### Safety Message

Activated carbon will preferentially remove oxygen from air. In closed or partially closed containers or vessels, oxygen depletion may reach hazardous levels. If workers are to enter a container or vessel containing activated carbon, appropriate air sampling and work procedures for potentially low oxygen content spaces should be followed, including all applicable Federal and State requirements.

### Warranty

Calgon Carbon Corporation warrants that the PROTECT V canister will be free from defects in materials and workmanship for a period of 90 days following the date of purchase. In the event of a breach of this warranty, Calgon Carbon Corporation will, in its discretion, repair or replace any defective parts or the complete unit during the warranty period. This warranty does not apply to defects caused by (i) normal wear and tear, (ii) accident, disaster or event of force majeure, (iii) misuse, fault or negligence of or by Buyer, (iv) use of the PROTECT V canister in a manner for which it is not designed, (v) external causes such as, but not limited to, power failure or electrical power surges, or (vi) improper storage and handling of the PROTECT V canister. **Except as expressly provided in this warranty statement, Calgon Carbon Corporation disclaims all other warranties, whether express or implied, oral or written, including without limitations all implied warranties or merchantability or fitness for particular purpose. Calgon Carbon Corporation does not warrant that the PROTECT V canisters are error-free or will accomplish any particular result. Any advice or assistance furnished by Calgon Carbon Corporation in relation to the PROTECT V canister provided for hereunder shall not give rise to any warranty or guarantee of any kind. This warranty will take precedence over any and all other warranties unless specifically disclaimed and referenced by Calgon Carbon Corporation.**

### Limitations of Liability

Calgon Carbon Corporation's liability and the Buyer's exclusive remedy for any cause of action arising out of this transaction, including, but not limited to, breach of warranty, negligence and/or indemnification, is expressly limited to a maximum of the purchase price of the canister sold hereunder. All claims of whatsoever nature shall be deemed waived unless made in writing within forty-five (45) days of the occurrence giving rise to the claim. Under no circumstance shall Calgon Carbon Corporation be liable for any incidental, consequential, punitive, exemplary, or special damages of any kind arising as a result of or in connection with the PROTECT V canisters regardless of the cause giving rise to any claim. Nor shall Calgon Carbon Corporation be liable for loss of profits or fines imposed by governmental agencies. In no event shall Calgon Carbon Corporation's liability exceed the purchase price paid by purchaser, for any reason, whether by reason of breach of contract, tort, indemnification, warranty or otherwise. This limitation of liability statement will take precedence over any and all other liability provisions unless specifically disclaimed and referenced by Calgon Carbon Corporation.



Making Water and Air Safer and Cleaner

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### Your local representative



# NPE

316L SS

NPE SERIES END SUCTION CENTRIFUGAL PUMPS

*BOMBAS CENTRÍFUGAS DE SUCCIÓN FINAL SERIE NPE*

### A FULL RANGE OF PRODUCT FEATURES UNA GAMA TOTAL DE CARACTERÍSTICAS DEL PRODUCTO

#### Superior Materials of Construction:

Complete AISI 316L stainless steel liquid handling components and mounting bracket for corrosion resistance, quality appearance, and improved strength and ductility.

#### High Efficiency Impeller:

Enclosed impeller with unique floating seal ring design maintains maximum efficiencies over the life of the pump without adjustment.

#### Casing and Adapter Features:

Stainless steel construction with NPT threaded, centerline connections, easily accessible vent, prime and drain connections with stainless steel plugs. Optional seal face vent/flush available.

#### Mechanical Seal:

Standard John Crane Type 21 with carbon versus silicon-carbide faces, Viton elastomers, and 316 stainless metal parts. Optional high temperature and chemical duty seals available.

#### Motors:

NEMA standard open drip-proof, totally enclosed fan cooled or explosion proof enclosures. Rugged ball bearing design for continuous duty under all operating conditions.

The various versions of the NPE are identified by a product code number on the pump label. This number is also the catalog number for the pump. The meaning of each digit in the product code number is shown at left.

#### Materiales Superiores de Construcción:

Componentes completos para manejo de líquidos en acero inoxidable AISI 316L y consola para el montaje para resistencia a la corrosión, apariencia de calidad, y fuerza y ductilidad mejoradas.

#### Impulsor de Eficiencia Superior:

El impulsor encerrado con un diseño único de anillo del sello flotante, mantiene sin ajustes, la eficiencia máxima sobre la vida de la bomba.

#### Características de la Carcasa y del Adaptador:

Construcción en acero inoxidable con NPT roscado, conexiones centrales, válvulas de fácil acceso, conexiones de cebado y drenaje con enchufes de acero inoxidable. Cara del sello válvula/chorro opcional disponible.

#### Sello Mecánico:

Estándar John Crane Tipo 21 con carbón en contraste con caras de silicón-carbide, elastómeros de Viton, y partes metálicas de acero inoxidable 316. Sellos de alta temperatura y productos químicos están disponibles.

#### Motores:

Estándar NEMA a prueba de goteo, ventilador totalmente encerrado o recintos a prueba de explosión. Diseño robusto de balineras de bolas para trabajo continuo en todas las condiciones de funcionamiento.

Las diferentes versiones de la NPE se identifican con un número de código del producto en la etiqueta de la bomba. Este número es también el número del catálogo para la bomba. El significado de cada dígito en el número de código del producto se muestra a la izquierda.

### NPE PRODUCT LINE NUMBERING SYSTEM LÍNEA DE PRODUCTO NPE SISTEMA DE NUMERACIÓN

#### Example Product Code, Ejemplo Código del Producto

1 ST 2 C 1 A 4 F

Seal Vent/Flush Option,  
Opción de Sello Válvula/Chorro Seal Ven

Mechanical Seal and O-ring

4 = Pre-engineered standard  
For optional mechanical seal modify catalog order no. with seal code listed below.

Sello Mecánico y Anillo 'O'

4 = Estándar aprobado  
Para sello mecánico opcional modificar el número de orden del catálogo con el código del sello anotado abajo.

John Crane Type 21 Mechanical Seal (3/8" seal), Sello Mecánico John Crane Tipo 21 (sello de 3/8")					
Seal Code, Código del Sello	Rotary, Rotativo	Stationary, Estacionario	Elastomers, Elastómeros	Metal Parts, Partes Metálicas	Part No., Pieza Número
2			EPR	316 SS	10K18
4	Carbon		Viton		10K55
5	Silicon Carbide	Silicon Carbide	EPR		10K81
6	Carbon		Viton		10K62

#### Impeller Option . . . No Adder Required

For optional impeller diameters modify catalog order no. with impeller code listed. Select optional impeller diameter from pump performance curve.

#### Código del Impulsor Opcional

Para impulsores con diámetros opcionales modificar el número de orden del catálogo con el código del impulsor anotado. Escoger el impul con diámetro opcional de la curva de funcionamiento de la bomba.

Impeller Code, Código del Impulsor	Pump Size, Tamaño de la Bomba		
	1 x 1 1/4 - 6 Diameter	1 1/4 x 1 1/2 - 6 Diameter	1 1/2 x 2 - 6 Diameter
K	-	6 1/8	-
G	-	5 1/16	5 3/8
H	-	5 1/2	5
A	6 3/8	5 1/4	4 3/4
B	5 3/4	5 1/16	4 3/8
C	5 3/16	4 7/8	4 3/8
D	4 3/4	4 3/8	4 1/16
E	4 7/16	4 1/4	3 3/8
F	4 1/16	3 7/8	-

#### Driver, Conductor

1 = 1 PH, ODP    7 = 3 PH, XP  
2 = 3 PH, ODP    8 = 575 V, XP  
3 = 575 V, ODP    9 = 3 PH, TEFC  
4 = 1 PH, TEFC    Premium Eff.  
5 = 3 PH, TEFC    0 = 1 PH, XP  
6 = 575 V, TEFC

#### HP Rating, HP Potencia

C = 1/2 HP    E = 1 HP    G = 2 HP    J = 5 HP  
D = 3/4 HP    F = 1 1/2 HP    H = 3 HP

#### Driver: Hertz/Pole/RPM,

#### Conductor: Hercios/Polos/RPM

1 = 60 Hz, 2 pole, 3500 RPM  
2 = 60 Hz, 4 pole, 1750 RPM  
3 = 60 Hz, 6 pole, 1150 RPM  
4 = 50 Hz, 2 pole, 2900 RPM  
5 = 50 Hz, 4 pole, 1450 RPM

#### Material

ST = Stainless steel, Acero inoxidable

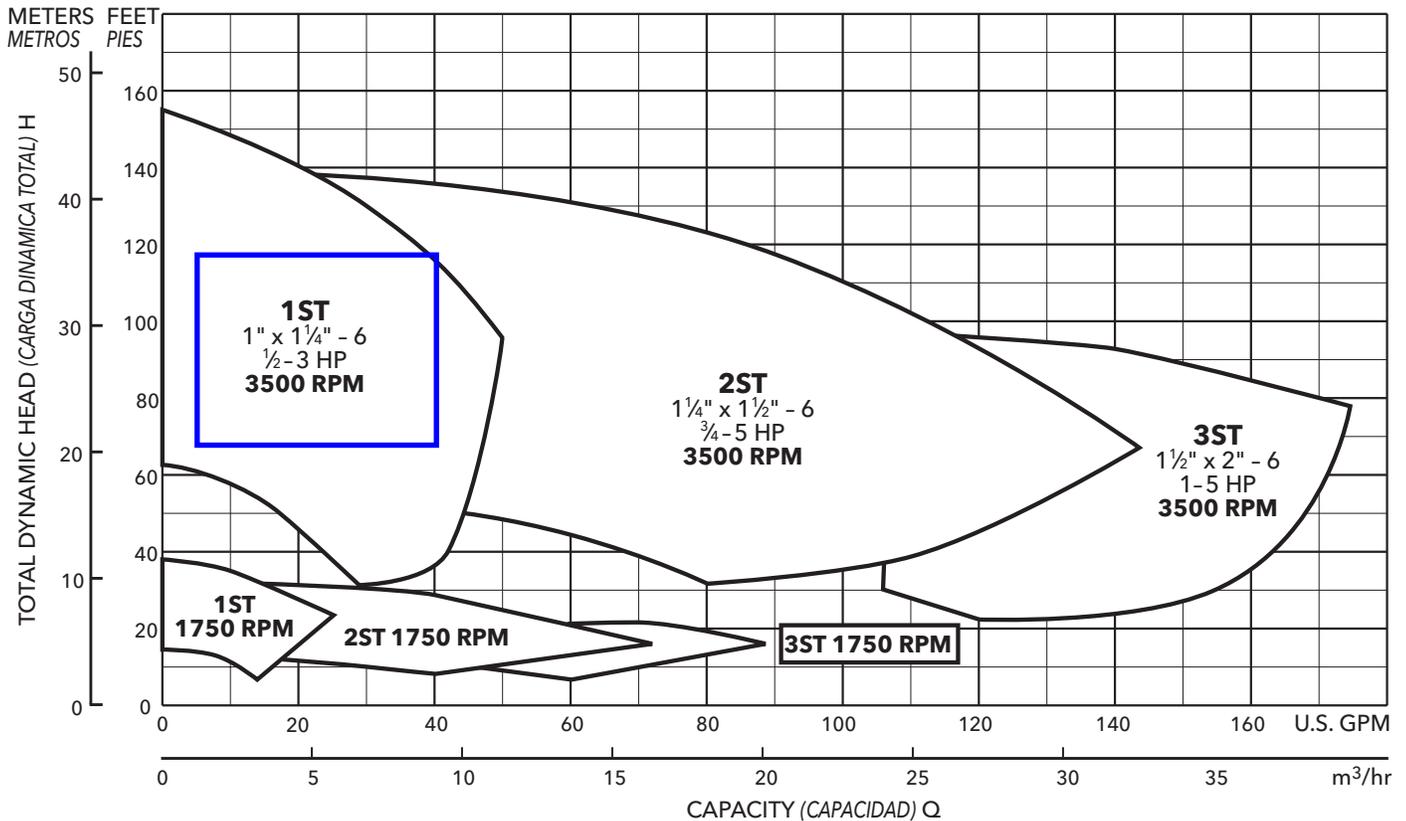
#### Pump Size, Tamaño de la Bomba

1 = 1 x 1 1/4 - 6    2 = 1 1/4 x 1 1/2 - 6    3 = 1 1/2 x 2 - 6

For frame mounted version, substitute the letters "FRM" in these positions.

Para la versión con el armazón montado, sustituya las letras "FRM" en estas posiciones.

### PERFORMANCE COVERAGE (60 HZ) ALCANCE DE FUNCIONAMIENTO (60 HZ)



#### NOTES:

Not recommended for operation beyond printed H-Q curve.

For critical application conditions consult factory.

Not all combinations of motor, impeller and seal options are available for every pump model. Please check with G&L on non-cataloged numbers.

All standard 3500 RPM ODP and TEFC motors supplied by Goulds Pumps, have minimum of 1.15 service factor. Standard catalog units may utilize available service factor. Any motors supplied other than Goulds Pumps check available service factor.

#### NOTAS:

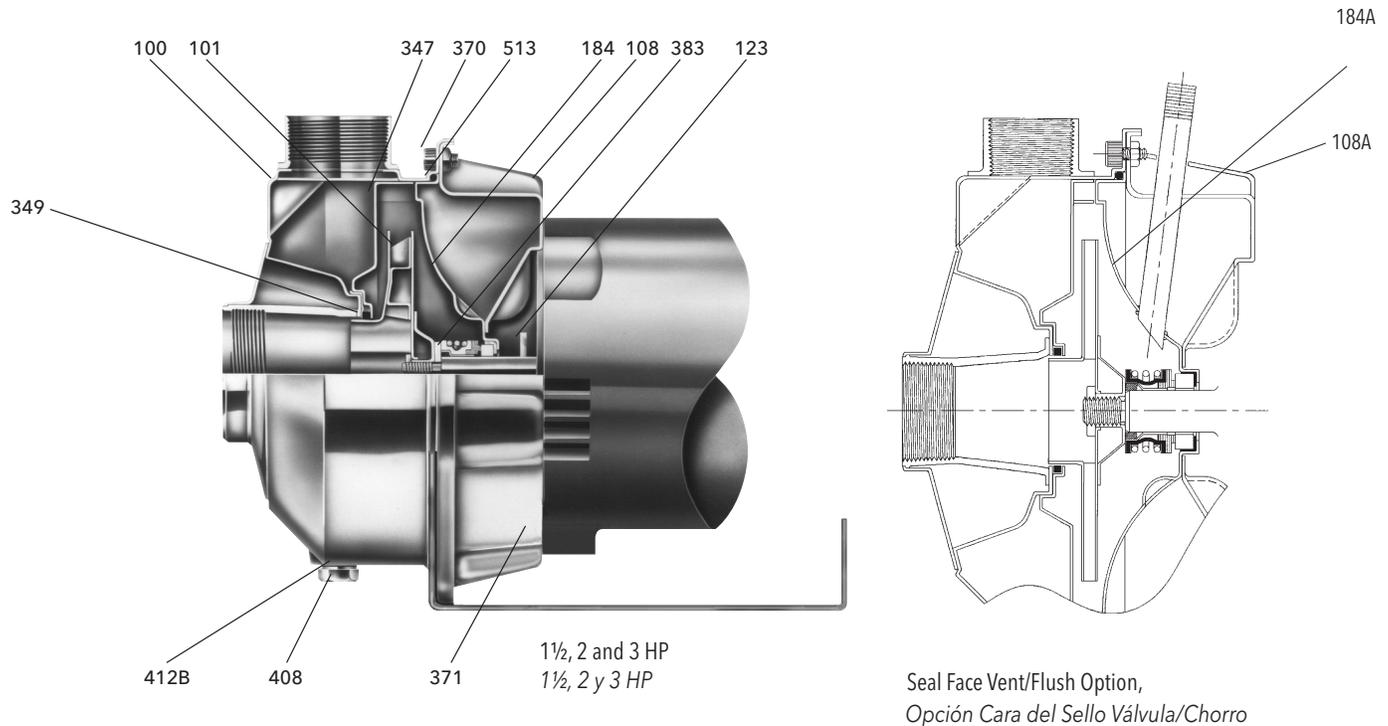
No se recomienda para funcionamiento superior al impreso en la curva H-Q.

Para condiciones de aplicaciones críticas consultar con la fábrica.

No todas las combinaciones de las opciones de motor, impulsor y sello están disponibles para cada modelo de bombas. Por favor verifique con G&L en los números no catalogados.

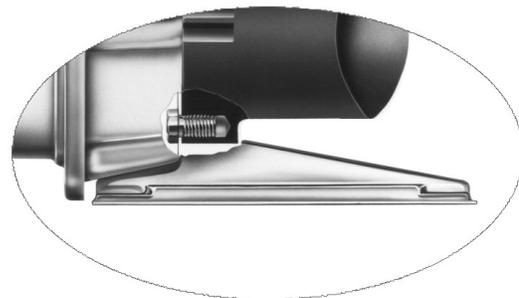
Todos los motores estándar de 3500 RPM, ODP (abiertos resguardados) y TEFC (totalmente encerrados con enfriamiento forzado) provistos por Goulds Pumps tienen un factor mínimo de servicio de 1,15. Las unidades estándar de catálogo pueden utilizar el factor de servicio disponible. Verificar el factor de servicio disponible de todo motor no provisto por Goulds Pumps.

### NPE CLOSE COUPLED PUMP MAJOR COMPONENTS: MATERIALS OF CONSTRUCTION BOMBA CERRADA ACOPLADA NPE COMPONENTES PRINCIPALES: MATERIALES DE CONSTRUCCIÓN



Seal Face Vent/Flush Option,  
Opción Cara del Sello Válvula/Chorro

Item No., Parte No.	Description, Descripción	Materials, Materiales
100	Casing; Carcasa	
101	Impeller; Impulsor	AISI 316L SS;
108	Motor adapter; Adaptador del motor	AISI 316L Acero inoxidable
108A	Motor adapter seal vent/flush; Sello válvula/chorro del adaptador del motor	
123	Deflector; Deflector	BUNA-N
184	Seal housing; Alojamiento del sello	AISI 316L SS;
184A	Seal housing seal vent/flush; Sello válvula/chorro del alojamiento del sello	AISI 316L Acero inoxidable
347	Guidevane; Difusor	
349	Seal ring, guidevane; Anillo del sello, difusor	Viton
370	Socket head screws, casing; Encajes cabezas de tornillos, carcasa	AISI 410 SS; AISI 410 Acero inoxidable
371	Bolts, motor; Tornillos, motor	Plated steel; Acero chapeado
383	Mechanical seal; Sello mecánico	**see chart, ver tabla
408	Drain and vent plug, casing; Enchufes de drenaje y válvula, carcasa	AISI 316L SS; AISI 316L Acero inoxidable
412B	O-ring, drain and vent plug; Anillo 'O', enchufe de drenaje y válvula	Viton (Standard, estándar) EPR (Optional, Opcional)
513	O-ring, casing; Anillo 'O', carcasa	
Motor	NEMA standard, 56J flange; Motor NEMA estándar, brida 56J	

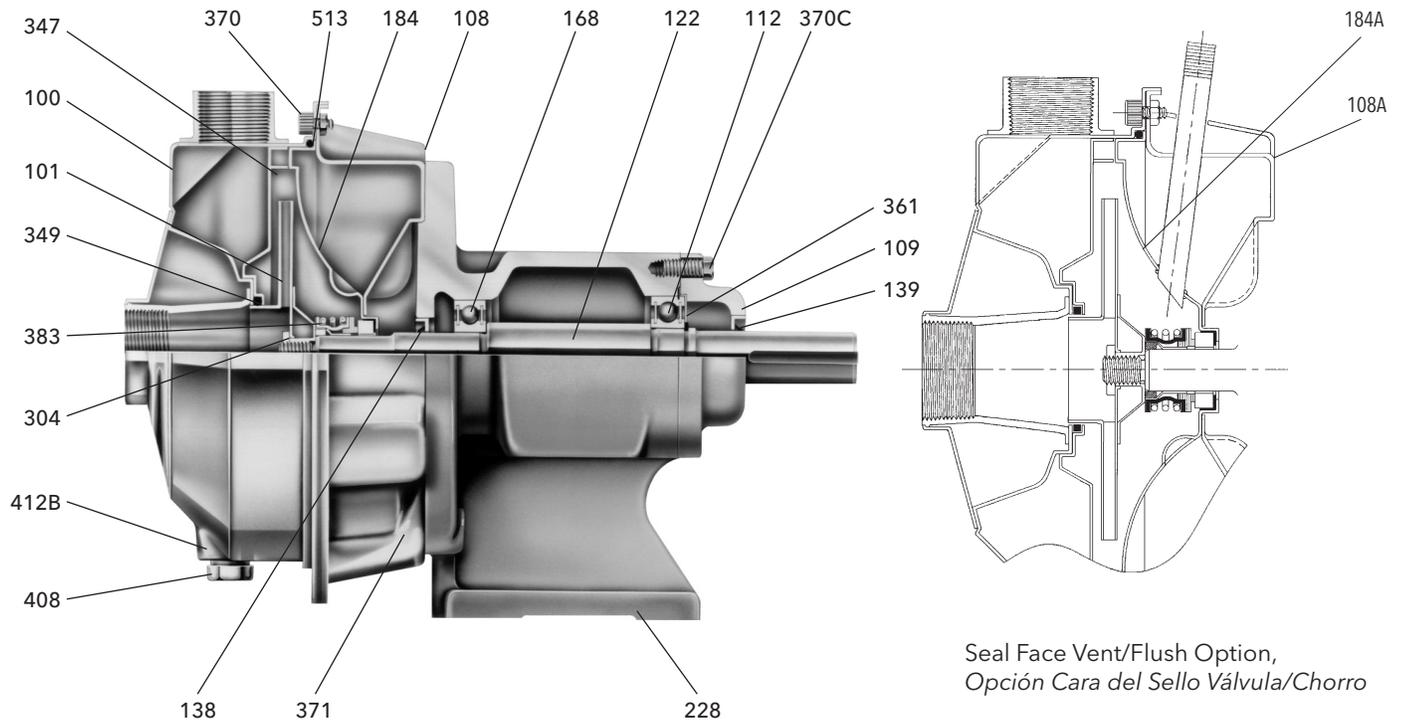


1/2, 3/4 and 1 HP  
1/2, 3/4 y 1 HP

Footed motor for 5 HP ODP and TEFC, all explosion proof motors, see page 13.

Motor con pie para 5 HP ODP y TEFC, a prueba de explosiones motores, en la página 13.

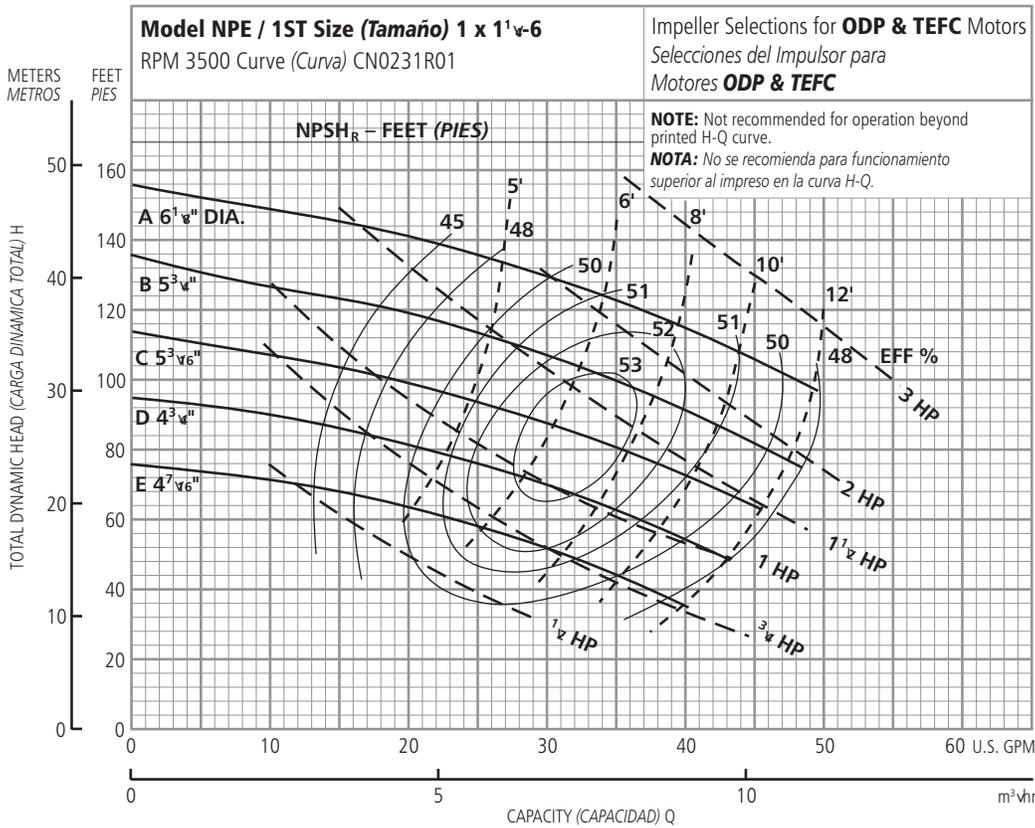
### NPE FRAME MOUNTED PUMP MAJOR COMPONENTS: MATERIALS OF CONSTRUCTION BOMBA NPE DE ARMAZÓN MONTADO COMPONENTES PRINCIPALES: MATERIALES DE CONSTRUCCIÓN



Item No., Parte No.	Description, Descripción	Materials, Materiales
100	Casing; <i>Carcasa</i>	
101	Impeller; <i>Impulsor</i>	AISI 316L SS;
108	Adapter; <i>Adaptador</i>	AISI 316L Acero inoxidable
108A	Motor adapter seal vent/flush; <i>Sello válvula/chorro del adaptador del motor</i>	
109	Bearing cover; <i>Cubierta de balineras</i>	Cast iron; <i>Hierro fundido</i>
112	Ball bearing (outboard); <i>Balineras de bolas (exterior)</i>	Steel; Acero
122	Shaft; <i>Eje</i>	AISI 316 SS; AISI 316 Acero inoxidable
138	Lip-seal (inboard); <i>Sello cubierto (interior)</i>	BUNA/steel; <i>BUNA/acero</i>
139	Lip-seal (outboard); <i>Sello cubierto (exterior)</i>	BUNA/steel; <i>BUNA/acero</i>
168	Ball bearing (inboard); <i>Balineras de bolas (interior)</i>	Steel; Acero
184	Seal housing; <i>Alojamiento del sello</i>	AISI 316L SS;
184 A	Seal housing seal vent/flush; <i>Sello válvula/chorro del alojamiento del sello</i>	AISI 316L Acero inoxidable
228	Bearing frame; <i>Armazón de balineras</i>	Cast iron, <i>Hierro fundido</i>

Item No., Parte No.	Description, Descripción	Materials, Materiales
304	Impeller locknut; <i>Contratuercas del impulsor</i>	AISI 316 SS;
347	Guidevane; <i>Difusor</i>	AISI 316 Acero inoxidable
349	Seal ring, guidevane; <i>Anillo del sello, difusor</i>	Viton
361	Retaining ring; <i>Anillo de retención</i>	Steel; Acero
370	Socket head screws, casing; <i>Encaje cabeza del tornillo, carcasa</i>	AISI 410 SS; AISI 410 Acero inoxidable
370C	Hex head screw, bearing cover; <i>Tornillo de cabeza hexagonal, cubierta de balineras</i>	Plated steel; Acero chapado
371	Hex head screw, bearing frame; <i>Tornillo de cabeza hexagonal, armazón de balineras</i>	Plated steel; Acero chapado
383	Mechanical seal; <i>Sello mecánico</i>	**see chart; ver tabla
400	Shaft key; <i>Llave del eje</i>	Steel; Acero
408	Drain and vent plug, casing; <i>Enchufes de drenaje y válvula, carcasa</i>	AISI 316 SS; AISI 316 Acero inoxidable
412B	O-ring, drain and vent plug; <i>Anillo 'O', enchufe de drenaje y válvula</i>	Viton (Standard, estándar) EPR (Optional, Opcional)
513	O-ring, casing; <i>Anillo 'O', carcasa</i>	

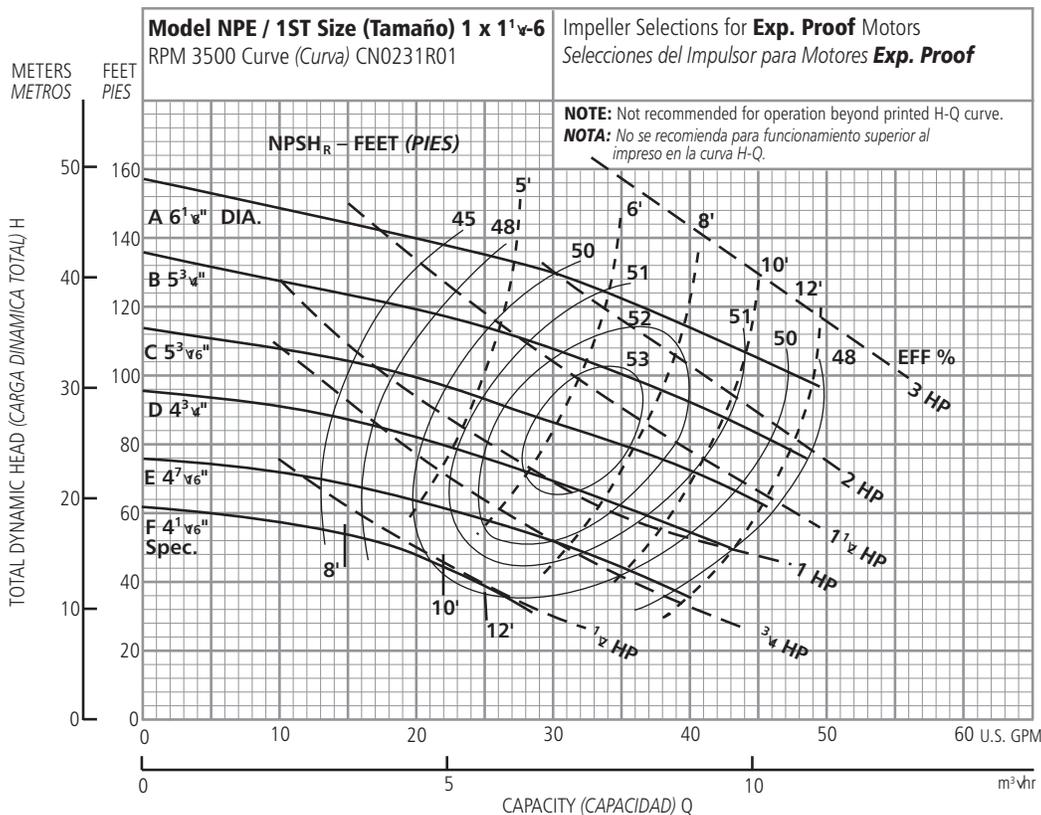
### PERFORMANCE CURVES - 60 HZ, 3500 RPM CURVAS DE FUNCIONAMIENTO - 60 HZ, 3500 RPM



Ordering Code, Código de Pedido	Standard HP Rating, Estándar HP Potencia	Imp. Dia.
E	1/2	4 <sup>7</sup> / <sub>16</sub> "
D	3/4	4 <sup>3</sup> / <sub>4</sub> "
C	1	5 <sup>3</sup> / <sub>16</sub> "
B	1 1/2	5 <sup>3</sup> / <sub>4</sub> "
A	2	6 <sup>1</sup> / <sub>8</sub> "

**NOTE:** Although not recommended, the pump may pass a 1/16" sphere.

**NOTA:** Si bien no se recomienda, la bomba puede pasar una esfera de 1/16".

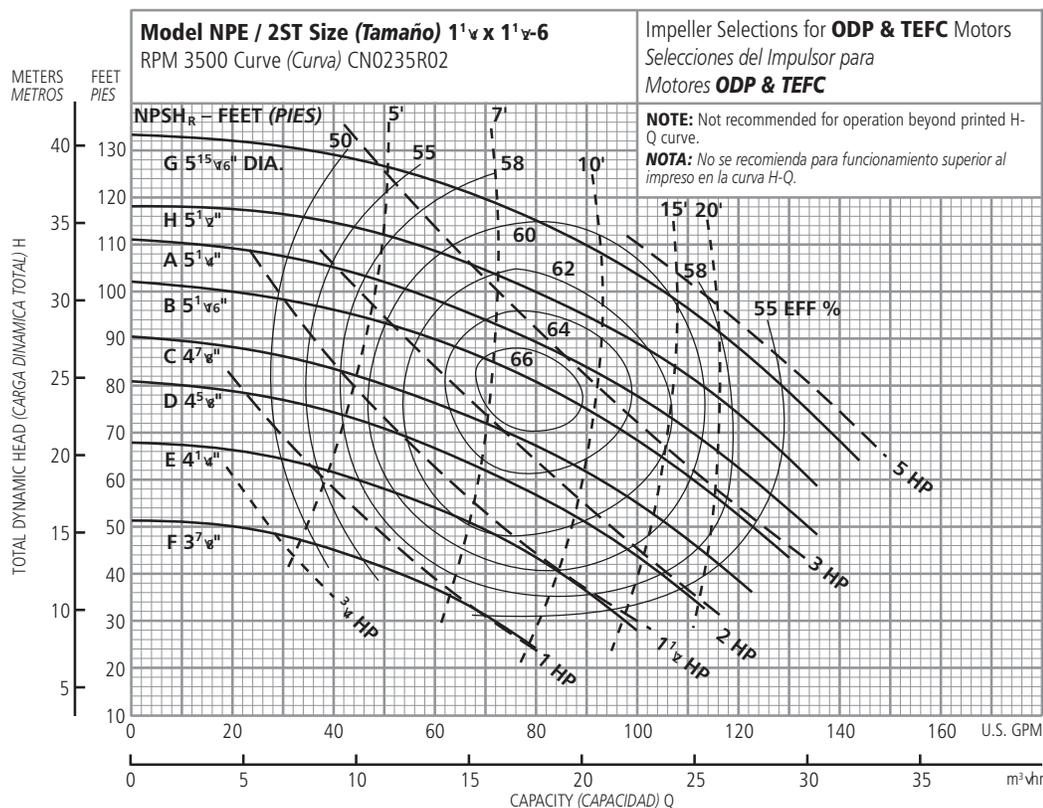


Ordering Code, Código de Pedido	Standard HP Rating, Estándar HP Potencia	Imp. Dia.
F	1/2	4 <sup>1</sup> / <sub>16</sub> " spec.
E	3/4	4 <sup>7</sup> / <sub>16</sub> "
D	1	4 <sup>3</sup> / <sub>4</sub> "
C	1 1/2	5 <sup>3</sup> / <sub>16</sub> "
B	2	5 <sup>3</sup> / <sub>4</sub> "
A	3	6 <sup>1</sup> / <sub>8</sub> "

**NOTE:** Although not recommended, the pump may pass a 1/16" sphere.

**NOTA:** Si bien no se recomienda, la bomba puede pasar una esfera de 1/16".

### PERFORMANCE CURVES - 60 HZ, 3500 RPM CURVAS DE FUNCIONAMIENTO - 60 HZ, 3500 RPM

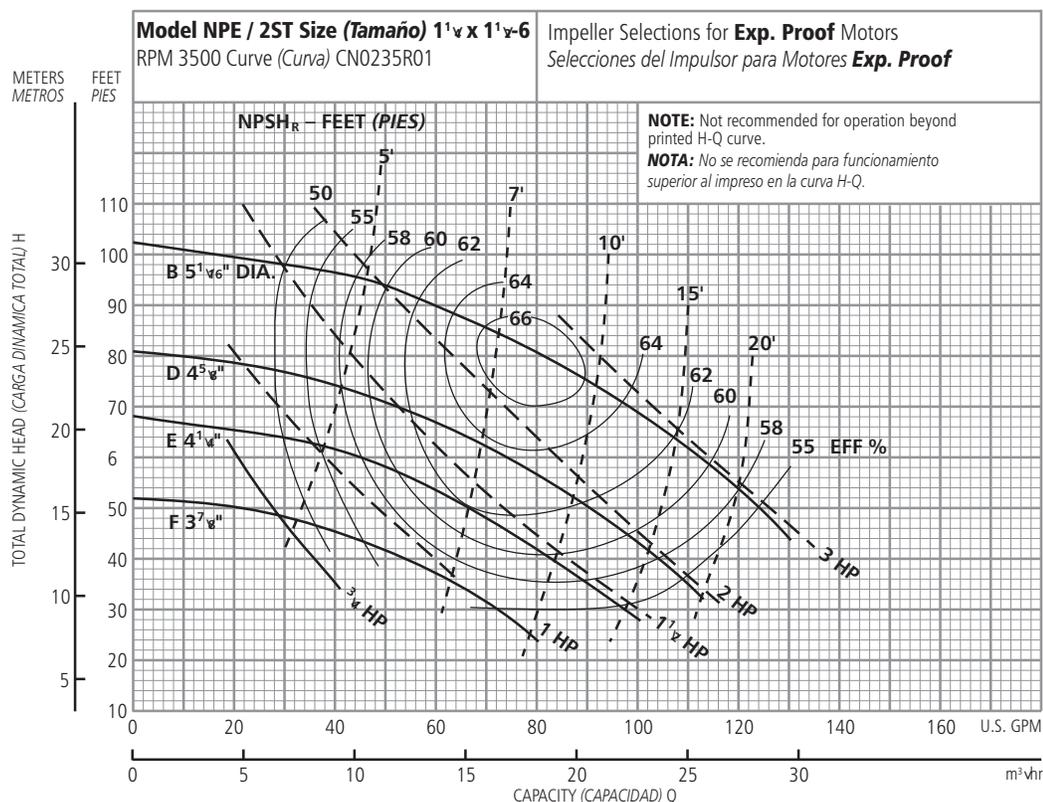


**Ordering Code, Código de Pedido**

Ordering Code, Código de Pedido	Standard HP Rating, Estándar HP Potencia	Imp. Dia.
F	3/4	3 7/8"
E	1	4 1/4"
D	1 1/2	4 5/8"
C	2	4 7/8"
B	3	5 1/16"
A	3	5 1/4"
H	5	5 1/2"
G	5	5 15/16"

**NOTE:** Although not recommended, the pump may pass a 3/16" sphere.

**NOTA:** Si bien no se recomienda, la bomba puede pasar una esfera de 3/16".



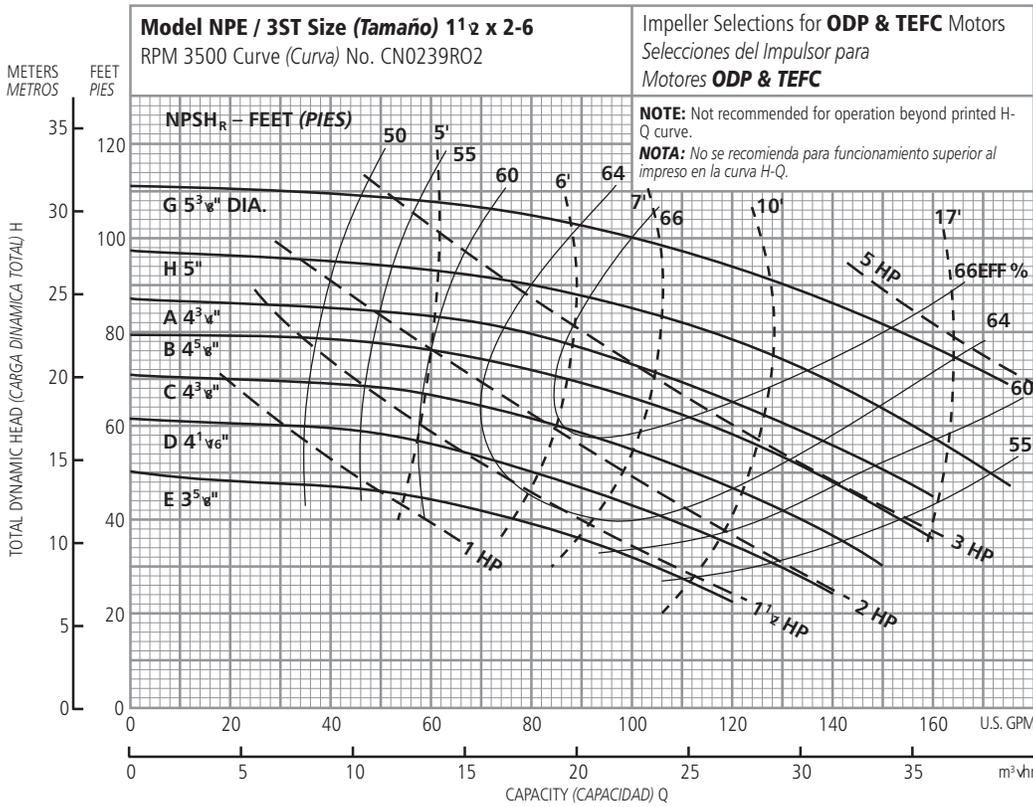
**Ordering Code, Código de Pedido**

Ordering Code, Código de Pedido	Standard HP Rating, Estándar HP Potencia	Imp. Dia.
F	1	3 7/8"
E	1 1/2	4 1/4"
D	2	4 5/8"
B	3	5 1/16"

**NOTE:** Although not recommended, the pump may pass a 3/16" sphere.

**NOTA:** Si bien no se recomienda, la bomba puede pasar una esfera de 3/16".

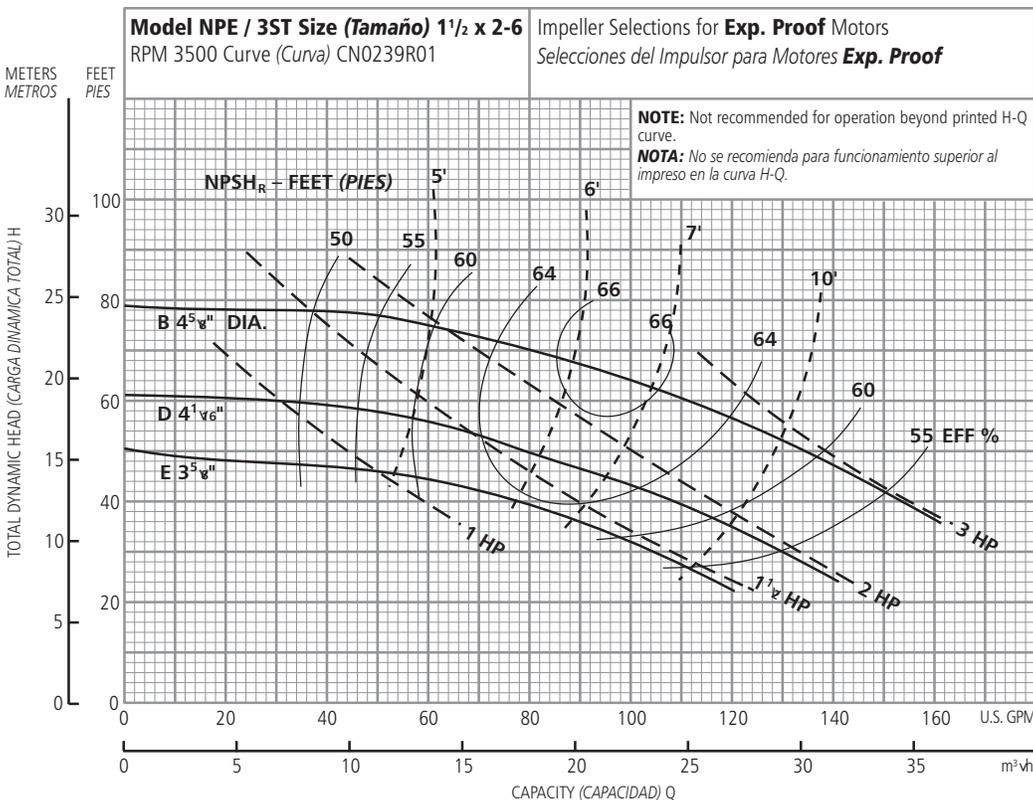
### PERFORMANCE CURVES - 60 HZ, 3500 RPM CURVAS DE FUNCIONAMIENTO - 60 HZ, 3500 RPM



Ordering Code, Código de Pedido	Standard HP Rating, Estándar HP Potencia	Imp. Dia.
E	1	3 5/8"
D	1 1/2	4 1/16
C	2	4 3/8
B	3	4 5/8
A	3	4 3/4
H	5	5
G	5	5 3/8

**NOTE:** Although not recommended, the pump may pass a 1 1/32" sphere.

**NOTA:** Si bien no se recomienda, la bomba puede pasar una esfera de 1/32".



Ordering Code, Código de Pedido	Standard HP Rating, Estándar HP Potencia	Imp. Dia.
E	1 1/2	3 5/8"
D	2	4 1/16
B	3	4 5/8

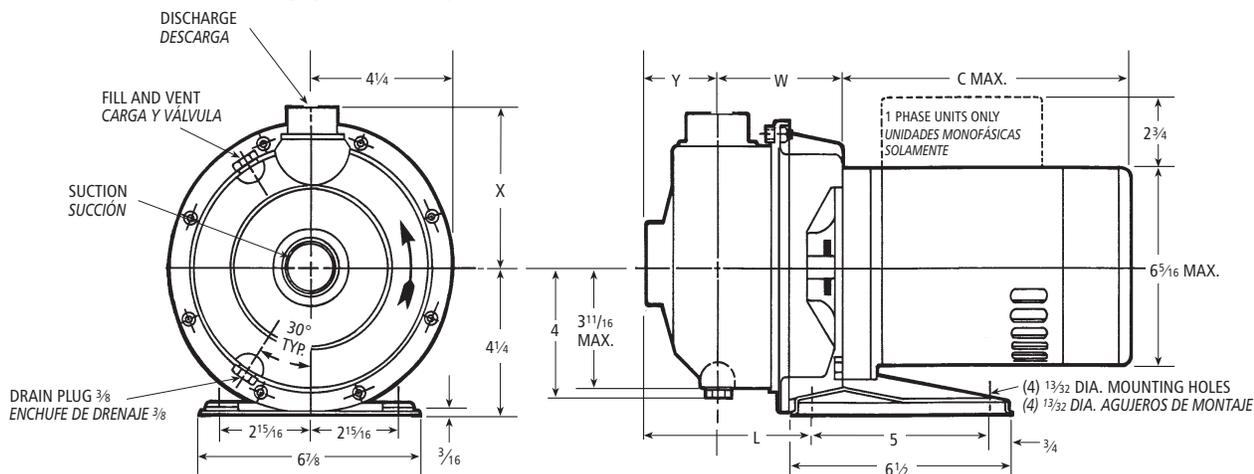
**NOTE:** Although not recommended, the pump may pass a 1 1/32" sphere.

**NOTA:** Si bien no se recomienda, la bomba puede pasar una esfera de 1/32".

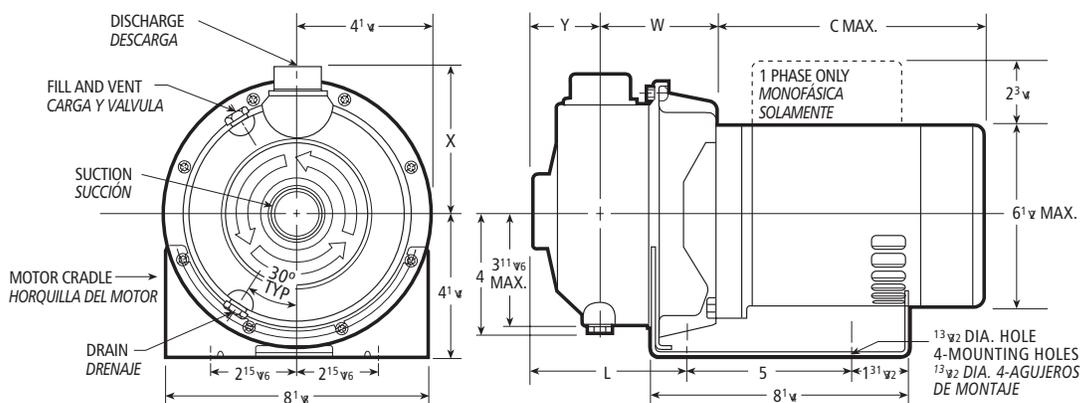
### NPE CLOSE COUPLED - DIMENSIONS, WEIGHTS AND SPECIFICATIONS NPE ACOPLE CERRADO - DIMENSIONES, PESOS Y ESPECIFICACIONES

#### Clockwise Rotation Viewed from Drive End

#### Rotación en Dirección de las Agujas del Reloj Visto desde el Extremo del Motor



ODP and TEFC 1/2, 3/4 and 1 HP (standard), ODP y TEFC 1/2, 3/4 y 1 HP (estándar)



ODP and TEFC 1 1/2, 2 and 3 HP (standard), ODP y TEFC 1 1/2, 2 y 3 HP (estándar)

### SPECIFICATIONS - ESPECIFICACIONES

#### Capacities to:

85 GPM (322L/min) at 1750 RPM  
170 GPM (643L/min) at 3500 RPM

#### Heads to:

39 feet (12 m) at 1750 RPM  
150 feet (46 m) at 3500 RPM

#### Working pressures to:

125 PSIG (9 bars)

#### Maximum temperatures to:

250° F (121° C)

#### Direction of rotation:

Clockwise when viewed from motor end.

#### Motor specifications:

NEMA 56J frame, 1750 RPM, 1/2 HP. 3500 RPM 1/2 through 5 HP. Open drip-proof, totally enclosed fan-cooled or explosion proof enclosures. Stainless steel shaft with ball bearings.

**Single phase:** Voltage 115/230 ODP and TEFC. (3 and 5 HP model - 230 V only) Built-in overload with auto-reset provided.

**Three phase:** Voltage 208-230/460 ODP, TEFC and EX PROOF.

**NOTE:** For three phase motors, overload protection must be provided in starter unit. Starter and heaters must be ordered separately.

#### Capacidades:

85 GPM (322L/min) a 1750 RPM  
170 GPM (643L/min) a 3500 RPM

#### Cargas:

39 pies (12 m) a 1750 RPM  
150 pies (46 m) a 3500 RPM

#### Presión de trabajo:

125 PSIG (9 bars)

#### Temperatura máxima:

250° F (121° C)

#### Dirección de rotación:

En dirección de las agujas del reloj visto desde el extremo final del motor.

#### Motores:

Armazón 56J NEMA, 1750 RPM 1/2 HP. 3500 RPM 1/2 a 5 HP. Cubiertas abiertas resguardadas, totalmente encerradas enfrías por ventilador o a prueba de explosiones. Eje de acero inoxidable con balineras de bolas.

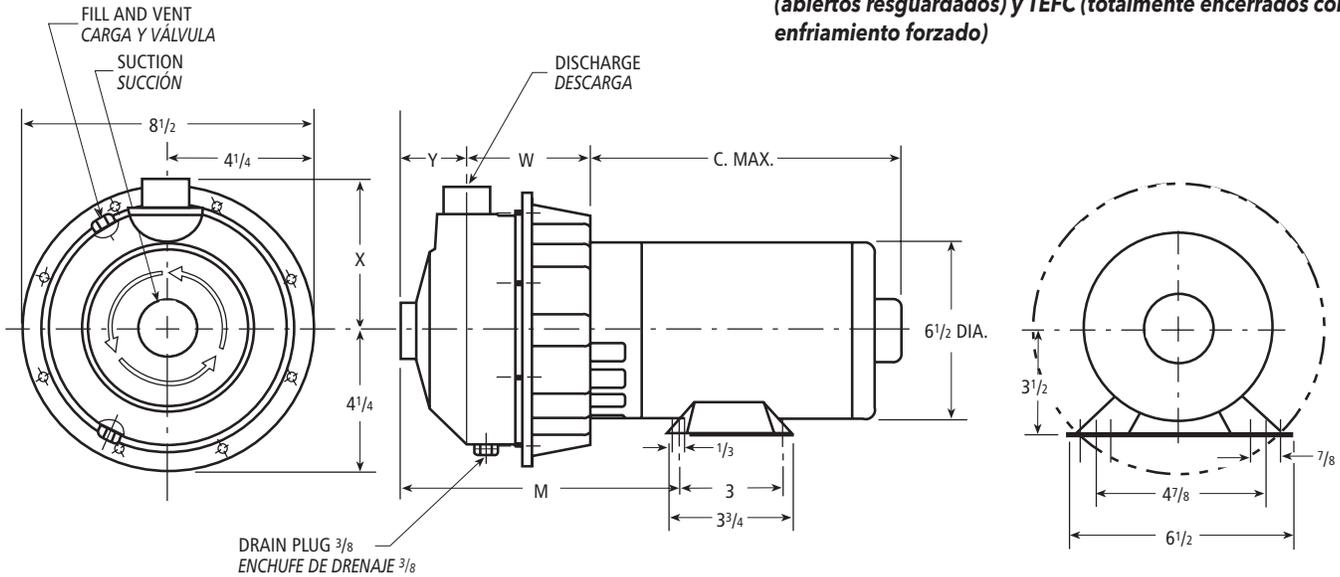
**Monofásicos:** Voltaje 115/230 ODP y TEFC. (modelo 3 y 5 HP - 230 voltios solamente) Se proporciona protección térmica contra sobrecarga construida con reseteo automático.

**Trifásicos:** Voltaje 208-230/460 ODP, TEFC y EX PROOF.

**NOTA:** Para motores trifásicos se debe proporcionar la protección térmica contra sobrecarga en la unidad de arranque. El arrancador y los calentadores se deben pedir por separado.

### NPE CLOSE COUPLED WITH FOOTED MOTOR, EXPLOSION-PROOF AND 5 HP MOTORS NPE ACOPLA CERRADO CON MOTOR CON PATAS, MOTORES A PRUEBA DE EXPLOSIÓN Y 5 HP

**All Explosion Proof Motors and 5 HP ODP and TEFC**  
**Todos los motores son a prueba de explosiones, 5 HP, ODP (abiertos resguardados) y TEFC (totalmente encerrados con enfriamiento forzado)**



#### Dimensions - Determined by Pump, Dimensiones - Determinadas por la Bomba

Pump, Bomba	Suction, Succión	Discharge, Descarga	HP	W	X	Y	L	M
1ST	1 1/4	1	1/2 - 3	3 5/16	4 3/8	2	4 9/16	7 5/16
2ST	1 1/2	1 1/4	3/4 - 5	3 3/4	4 1/2	2 1/8	5 1/8	7 7/8
3ST	2	1 1/2	1 - 5	3 3/4	4 5/8	2 1/8	5 1/8	7 7/8

#### Available Motor Weights and Dimensions Pesos y Dimensiones Disponibles del Motor

HP	Motor Weights, Pesos del Motor						C Max. Length, (Longitud)
	1 Phase, Monofásicos			3 Phase, Trifásicos			
	ODP	TEFC	EXP	ODP	TEFC	EXP	
1/2	16	21	47	19	18	27	10 3/16
3/4	19	24	41	21	21	30	10 7/16
1	22	26	49	23	21	30	11 1/16
1 1/2	28	35	56	27	27	37	11 15/16
2	33	39	60	32	33	44	12 11/16
3	40	43	-	41	37	-	13 3/16
5	42	-	-	42	45	-	13 3/16

Dimensions in inches, weights in pounds.  
Dimensiones en pulgadas, pesos en libras.

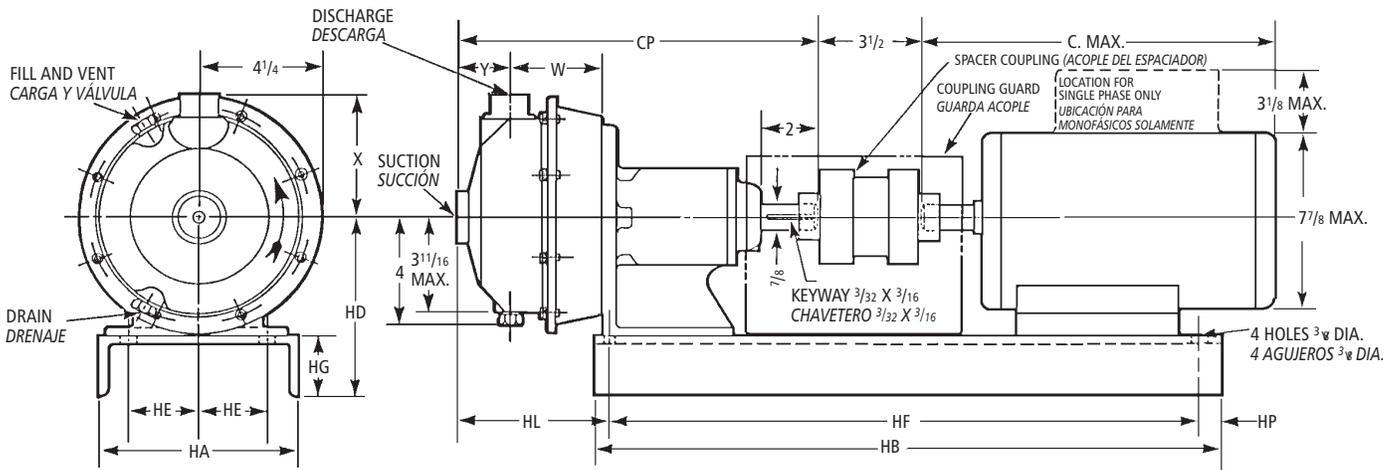
#### NOTES:

- Pump will be shipped with top vertical discharge position as standard. For other orientations, remove casing bolts, rotate discharge to desired position, replace and tighten 6mm bolts to 5 - 6 lbs.-ft.
- Motor dimensions may vary with motor manufacturers.
- Dimensions in inches, weights in pounds.
- For explosion proof motor dimensions consult factory for information.
- Not to be used for construction purposes unless certified.

#### NOTAS:

- Las bombas se transportarán con la descarga vertical superior como estándar. Para otras orientaciones, retirar los tornillos de la carcasa, rotar la descarga a la posición deseada, y reemplazar y apretar los tornillos de 6mm a 5 - 6 libras-pies.
- Las dimensiones del motor puede que varíen con los fabricantes.
- Dimensiones en pulgadas, pesos en libras.
- Para las dimensiones de los motores a prueba de explosión consultar con la fábrica para información.
- No usar para propósitos de construcción sin certificar.

### NPE FRAME MOUNTED - DIMENSIONS, WEIGHTS AND SPECIFICATIONS NPE ARMAZÓN MONTADO - DIMENSIONES, PESOS Y ESPECIFICACIONES



### SPECIFICATIONS ESPECIFICACIONES

#### Capacities to:

85 GPM (322L/min) at 1750 RPM  
170 GPM (643L/min) at 3500 RPM

#### Heads to:

39 feet (12 m) at 1750 RPM  
150 feet (47 m) at 3500 RPM

#### Working pressures to:

125 PSIG (9 bars)

#### Maximum temperatures to:

250°F (121°C)

#### Direction of rotation:

Clockwise when viewed from motor end.

#### Motor specifications:

T-frame single and three phase. Open drip-proof, TEFC or explosion proof enclosures are available for 60 Hz, 3500 and 1750 RPM operation.

For three phase motors, overload protection must be provided in starter unit. Starter and heaters must be ordered separately.

#### Capacidades:

85 GPM (322L/min) a 1750 RPM  
170 GPM (643L/min) a 3500 RPM

#### Cargas:

39 pies (12 m) a 1750 RPM  
150 pies (47 m) a 3500 RPM

#### Presión de trabajo:

125 PSIG (9 bars)

#### Temperatura máxima:

250°F (121°C)

#### Dirección de rotación:

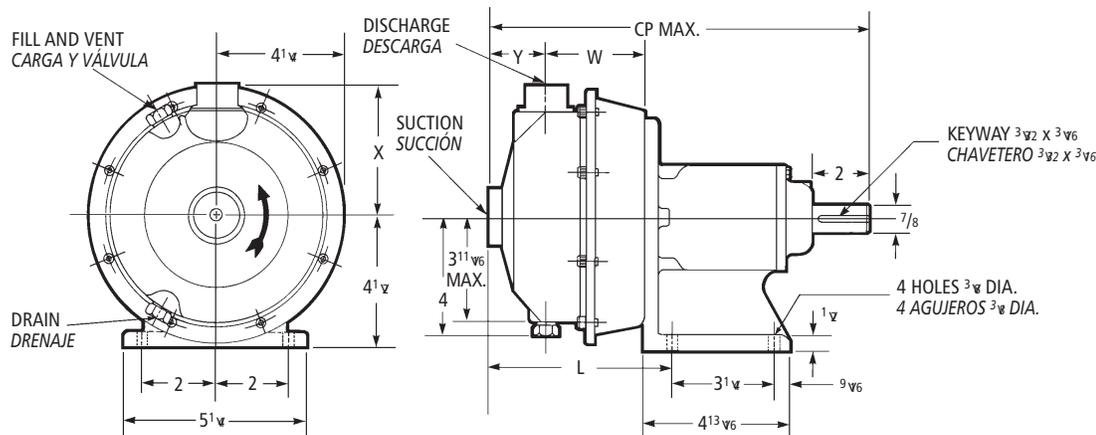
En dirección de las agujas del reloj visto desde el extremo final del motor.

#### Motores:

Armazón T- monofásico y trifásico. A prueba de goteo, TEFC o recintos a prueba de explosión están disponibles para funcionamiento de 60 Hz, 3500 y 1750 RPM.

Para motores trifásicos se debe de proporcionar la protección térmica contra sobrecarga en la unidad de arranque. El arrancador y los calentadores se deben pedir por separado.

### NPE-F



### Dimensions and Weights Dimensiones y Pesos

#### Dimensions and Weights - Determined by Pump, Dimensiones y Pesos - Determinados por la Bomba

Dim. "HL" Determined by Pump and Motor,  
Dim. "HL" Determinadas por la Bomba y el Motor

Pump, Bomba	Suct. NPT, Succión NPT	Disch. NPT, Descarga NPT	CP	L	W	X	Y	Wt., Peso	Frame, Armazón		
									56	140	180
1ST	1¼	1	12 <sup>15</sup> / <sub>16</sub>	6 <sup>7</sup> / <sub>16</sub>	3 <sup>5</sup> / <sub>16</sub>	4 <sup>3</sup> / <sub>8</sub>	2	22½	4 <sup>9</sup> / <sub>16</sub>	6 <sup>7</sup> / <sub>16</sub>	
2ST	1½	1¼	13½	7	3¾	4½	2 <sup>1</sup> / <sub>8</sub>	23	5½	7	
3ST	2	1½				4 <sup>5</sup> / <sub>8</sub>					

#### Available Motor and Bedplate Dimensions and Weights, Pesos y Dimensiones Disponibles de la Fundación y del Motor

Motor Frame, Armazón del Motor	HA	HB	HD	HE	HF	HG	HP	Wt. Max., Peso Máx	Shims, Deflector
56 143T 145T	8	26	6 <sup>7</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>8</sub>	22 <sup>3</sup> / <sub>8</sub>	2 <sup>3</sup> / <sub>8</sub>	1	30	1"
182T 184T	10	26	7¼	3¾	24	2¼	¾	43	-

Frame Size, Tamaño del Armazón	Horsepower, Fuerza				C Max.	Wt. Max., Peso Máx.
	3500 RPM					
	Single Phase, Monofásicos		Three Phase, Trifásicos			
	ODP	TEFC	ODP	TEFC		
56	½ - 1½	½ - 1½	½ - 1	½ - 1	13	45
143T	-	-	1½	1½	13 <sup>3</sup> / <sub>8</sub>	45
145T	2	2	1½ - 3	1½ - 2	14¼	52
182T	3	3	5	3	16 <sup>5</sup> / <sub>8</sub>	63
184T	5	5	-	5	18½	112

#### NOTES:

- Pump will be shipped with top vertical discharge position as standard. For other orientations, remove casing bolts, rotate discharge to desired position, replace and tighten 6mm bolts to 5 - 6 lbs.-ft.
- Motor dimensions may vary with motor manufacturers.
- Dimensions in inches, weights in pounds.
- For explosion proof motor dimensions consult factory for information.
- Not to be used for construction purposes unless certified.

#### NOTAS:

- Las bombas se transportarán con la descarga vertical superior como estándar. Para otras orientaciones, retirar los tornillos de la carcasa, rotar la descarga a la posición deseada, y reemplazar y apretar los tornillos de 6mm a 5 - 6 libras-pies.
- Las dimensiones del motor puede que varíen con los fabricantes.
- Dimensiones en pulgadas, pesos en libras.
- Para las dimensiones de los motores a prueba de explosión consultar con la fábrica para información.
- No usar para propósitos de construcción sin certificar.



# Model NPE/NPE-F

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS

## Table of Contents

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### Owner's Information

Pump Model Number: \_\_\_\_\_

Pump Serial Number: \_\_\_\_\_

Dealer: \_\_\_\_\_

Dealer Phone No.: \_\_\_\_\_

Date of Purchase: \_\_\_\_\_

Date of Installation: \_\_\_\_\_

Current Readings at Startup:

1 Ø	3 Ø	L1-2	L2-3	L3-1
Amps: _____	Amps: _____	_____	_____	_____
Volts: _____	Volts: _____	_____	_____	_____

## SAFETY INSTRUCTIONS

**TO AVOID SERIOUS OR FATAL PERSONAL INJURY OR MAJOR PROPERTY DAMAGE, READ AND FOLLOW ALL SAFETY INSTRUCTIONS IN MANUAL AND ON PUMP.**

**THIS MANUAL IS INTENDED TO ASSIST IN THE INSTALLATION AND OPERATION OF THIS UNIT AND MUST BE KEPT WITH THE PUMP.**



This is a **SAFETY ALERT SYMBOL**. When you see this symbol on the pump or in the manual, look for one of the following signal words and be alert to the potential for personal injury or property damage.

**⚠ DANGER** Warns of hazards that **WILL** cause serious personal injury, death or major property damage.

**⚠ WARNING** Warns of hazards that **CAN** cause serious personal injury, death or major property damage.

**⚠ CAUTION** Warns of hazards that **CAN** cause personal injury or property damage.

**NOTICE: INDICATES SPECIAL INSTRUCTIONS WHICH ARE VERY IMPORTANT AND MUST BE FOLLOWED.**

**THOROUGHLY REVIEW ALL INSTRUCTIONS AND WARNINGS PRIOR TO PERFORMING ANY WORK ON THIS PUMP.**

**MAINTAIN ALL SAFETY DECALS.**

### **⚠ WARNING**



Hazardous fluids can cause fire, burns or death.

**UNIT NOT DESIGNED FOR USE WITH HAZARDOUS LIQUIDS OR FLAMMABLE GASES. THESE FLUIDS MAY BE PRESENT IN CONTAINMENT AREAS.**

## DESCRIPTION & SPECIFICATIONS:

The Models NPE (close-coupled) and NPE-F (frame-mounted) are end suction, single stage centrifugal pumps for general liquid transfer service, booster applications, etc. Liquid-end construction is all AISI Type 316 stainless steel, stamped and welded. Impellers are fully enclosed, non-trimable to intermediate diameters. Casings are fitted with a diffuser for efficiency and for negligible radial shaft loading.

Close-coupled units have NEMA 48J or 56J motors with C-face mounting and threaded shaft extension. Frame-mounted units can be coupled to motors through a spacer coupling, or belt driven.

### 1. IMPORTANT:

- 1.1. Inspect unit for damage. Report any damage to carrier/dealer immediately.
- 1.2. Electrical supply must be a separate branch circuit with fuses or circuit breakers, wire sizes, etc., per national and local electrical codes. Install an all-leg disconnect switch near pump.

**⚠ CAUTION** Always disconnect electrical power when handling pump or controls.

- 1.3. Motors must be wired for proper voltage. Motor wiring diagram is on motor nameplate. Wire size must limit maximum voltage drop to 10% of nameplate voltage at motor terminals, or motor life and pump performance will be lowered.
- 1.4. Always use horsepower-rated switches, contactor and starters.
- 1.5. Motor Protection
  - 1.5.1. Single-phase: Thermal protection for single-phase units is sometimes built in (check nameplate). If no built-in protection is provided, use a contactor with a proper overload. Fusing is permissible.
  - 1.5.2. Three-phase: Provide three-leg protection with properly sized magnetic starter and thermal overloads.
- 1.6. Maximum Operating Limits:

Liquid Temperature:	250° F (120° C)
Pressure:	125 PSI
Starts Per Hour:	20, evenly distributed
- 1.7. Regular inspection and maintenance will increase service life. Base schedule on operating time. Refer to Section 8.

## 2. INSTALLATION:

### 2.1. General

- 2.1.1. Locate pump as near liquid source as possible (below level of liquid for automatic operation).
- 2.1.2. Protect from freezing or flooding.
- 2.1.3. Allow adequate space for servicing and ventilation.
- 2.1.4. All piping must be supported independently of the pump, and must “line-up” naturally.

**⚠ CAUTION** Never draw piping into place by forcing the pump suction and discharge connections.

- 2.1.5. Avoid unnecessary fittings. Select sizes to keep friction losses to a minimum.

### 2.2. Close-Coupled Units

- 2.2.1. Units may be installed horizontally, inclined or vertically.

**⚠ CAUTION** Do not install with motor below pump. Any leakage or condensation will affect the motor.

- 2.2.2. Foundation must be flat and substantial to eliminate strain when tightening bolts. Use rubber mounts to minimize noise and vibration.
- 2.2.3. Tighten motor hold-down bolts before connecting piping to pump.

### 2.3. Frame-Mounted Units

- 2.3.1. It is recommended that the bedplate be grouted to a foundation with solid footing. Refer to Figure 1.

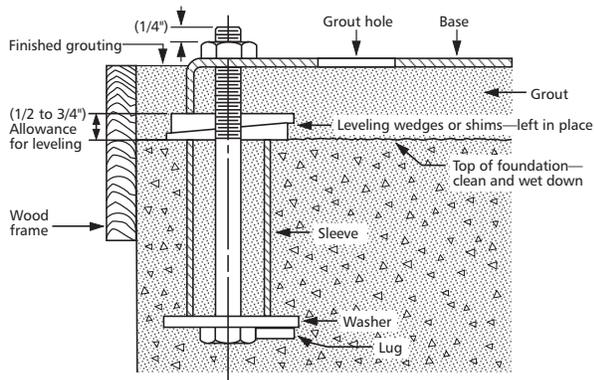


Figure 1

- 2.3.2. Place unit in position on wedges located at four points (two below approximate center of driver and two below approximate center of pump). Adjust wedges to level unit. Level or plumb suction and discharge flanges.
- 2.3.3. Make sure bedplate is not distorted and final coupling alignment can be made within the limits of movement of motor and by shimming, if necessary.
- 2.3.4. Tighten foundation bolts finger tight and build dam around foundation. Pour grout under bedplate making sure the areas under pump and motor feet are filled solid. Allow grout to harden 48 hours before fully tightening foundation bolts.
- 2.3.5. Tighten pump and motor hold-down bolts before connecting the piping to pump.

### 3. SUCTION PIPING:

- 3.1. Low static suction lift and short, direct, suction piping is desired. For suction lift over 10 feet and liquid temperatures over 120 F, consult pump performance curve for Net Positive Suction Head Required.
- 3.2. Suction pipe must be at least as large as the suction connection of the pump. Smaller size will degrade performance.
- 3.3. If larger pipe is required, an eccentric pipe reducer (with straight side up) must be installed at the pump.
- 3.4. Installation with pump below source of supply
  - 3.4.1. Install full flow isolation valve in piping for inspection and maintenance.

**CAUTION** Do not use suction isolation valve to throttle pump.

- 3.5. Installation with pump above source of supply
  - 3.5.1. Avoid air pockets. No part of piping should be higher than pump suction connection. Slope piping upward from liquid source.
  - 3.5.2. All joints must be airtight.
  - 3.5.3. Foot valve to be used only if necessary for priming, or to hold prime on intermittent service.
  - 3.5.4. Suction strainer open area must be at least triple the pipe area.

3.6. Size of inlet from liquid source, and minimum submergence over inlet, must be sufficient to prevent air entering pump through vortexing. See Figures 2-5.

3.7. Use 3-4 wraps of Teflon tape to seal threaded connections.

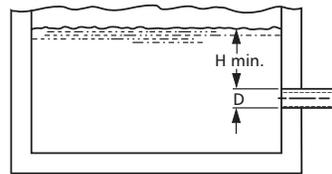


Figure 2

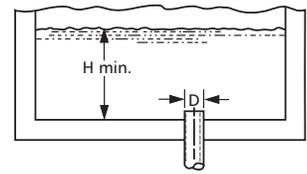


Figure 3

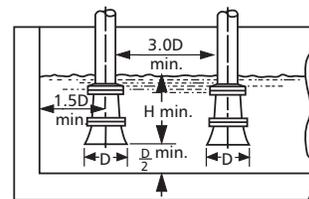


Figure 4

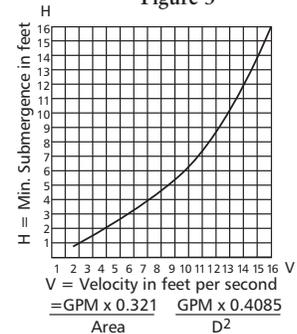


Figure 5

### 4. DISCHARGE PIPING:

- 4.1. Arrangement must include a check valve located between a gate valve and the pump. The gate valve is for regulation of capacity, or for inspection of the pump or check valve.
- 4.2. If an increaser is required, place between check valve and pump.
- 4.3. Use 3-4 wraps of Teflon tape to seal threaded connections.

### 5. MOTOR-TO-PUMP SHAFT ALIGNMENT:

- 5.1. Close-Coupled Units
  - 5.1.1. No field alignment necessary.
- 5.2. Frame-Mounted Units
  - 5.2.1. Even though the pump-motor unit may have a factory alignment, this could be disturbed in transit and must be checked prior to running. See Figure 6.

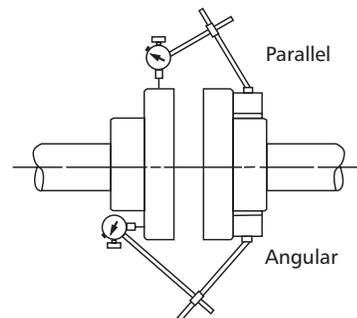


Figure 6

- 5.2.2. Tighten all hold-down bolts before checking the alignment.
- 5.2.3. If re-alignment is necessary, always move the motor. Shim as required.

- 5.2.4. Parallel misalignment - shafts with axis parallel but not concentric. Place dial indicator on one hub and rotate this hub 360 degrees while taking readings on the outside diameter of the other hub. Parallel alignment occurs when Total Indicator Reading is .005", or less.
- 5.2.5. Angular misalignment - shafts with axis concentric but not parallel. Place dial indicator on one hub and rotate this hub 360 degrees while taking readings on the face of the other hub. Angular alignment is achieved when Total Indicator Reading is .005", or less.
- 5.2.6. Final alignment is achieved when parallel and angular requirements are satisfied with motor hold-down bolts tight.

**CAUTION** Always recheck both alignments after making any adjustment.

## 6. ROTATION:

- 6.1. Correct rotation is right-hand (clockwise when viewed from the motor end). Switch power on and off quickly. Observe shaft rotation. To change rotation:
  - 6.1.1. Single-phase motor: Non-reversible.
  - 6.1.2. Three-phase motor: Interchange any two power supply leads.

## 7. OPERATION:

- 7.1. Before starting, pump must be primed (free of air and suction pipe full of liquid) and discharge valve partially open.

**CAUTION** Pumped liquid provides lubrication. If pump is run dry, rotating parts will seize and mechanical seal will be damaged. Do not operate at or near zero flow. Energy imparted to the liquid is converted into heat. Liquid may flash to vapor. Rotating parts require liquid to prevent scoring or seizing.

- 7.2. Make complete check after unit is run under operating conditions and temperature has stabilized. Check for expansion of piping. On frame-mounted units coupling alignment may have changed due to the temperature differential between pump and motor. Recheck alignment.

## 8. MAINTENANCE:

- 8.1. Close-Coupled Unit. Ball bearings are located in and are part of the motor. They are permanently lubricated. No greasing required.
- 8.2. Frame-Mounted Units
  - 8.2.1. Bearing frame should be regreased every 2,000 hours or 3 month interval, whichever occurs first. Use a #2 sodium or lithium based grease. Fill until grease comes out of relief fittings, or lip seals, then wipe off excess.
  - 8.2.2. Follow motor and coupling manufacturers' lubrication instructions.
  - 8.2.3. Alignment must be rechecked after any maintenance work involving any disturbance of the unit.

## 9. DISASSEMBLY:

Complete disassembly of the unit will be described. Proceed only as far as required to perform the maintenance work needed.

- 9.1. Turn off power.
- 9.2. Drain system. Flush if necessary.
- 9.3. Close-Coupled Units: Remove motor hold-down bolts.  
  
Frame-Mounted Units: Remove coupling, spacer, coupling guard and frame hold-down bolts.
- 9.4. Disassembly of Liquid End
  - 9.4.1. Remove casing bolts (370).
  - 9.4.2. Remove back pull-out assembly from casing (100).
  - 9.4.3. Remove impeller locknut (304).

**CAUTION** Do not insert screwdriver between impeller vanes to prevent rotation of close-coupled units. Remove cap at opposite end of motor. A screwdriver slot or a pair of flats will be exposed. Using them will prevent impeller damage.

- 9.4.4. Remove impeller (101) by turning counter-clockwise when looking at the front of the pump. Protect hand with rag or glove.

**CAUTION** Failure to remove the impeller in a counter-clockwise direction may damage threading on the impeller, shaft or both.

- 9.4.5. With two pry bars 180 degrees apart and inserted between the seal housing (184) and the motor adapter (108), carefully separate the two parts. The mechanical seal rotary unit (383) should come off the shaft with the seal housing.
- 9.4.6. Push out the mechanical seal stationary seat from the motor side of the seal housing.
- 9.5. Disassembly of Bearing Frame
  - 9.5.1. Remove bearing cover (109).
  - 9.5.2. Remove shaft assembly from frame (228).
  - 9.5.3. Remove lip seals (138 and 139) from bearing frame and bearing cover if worn and are being replaced.
  - 9.5.5. Use bearing puller or arbor press to remove ball bearings (112 and 168).

## 10. REASSEMBLY:

- 10.1. All parts should be cleaned before assembly.
- 10.2. Refer to parts list to identify required replacement items. Specify pump index or catalog number when ordering parts.
- 10.3. Reassembly is the reverse of disassembly.
  - 10.3.1. Impeller and impeller locknut assembled onto motor shaft with 10 ft-lbs of torque.
- 10.4. Observe the following when reassembling the bearing frame.
  - 10.4.1. Replace lip seals if worn or damaged.
  - 10.4.2. Replace ball bearings if loose, rough or noisy when rotated.
  - 10.4.3. Check shaft for runout. Maximum permissible is .002" T.I.R.
- 10.5. Observe the following when reassembling the liquid-end.
  - 10.5.1. All mechanical seal components must be in good condition or leakage may result. Replacement of complete seal assembly, whenever seal has been removed, is good standard practice.

It is permissible to use a light lubricant, such as glycerin, to facilitate assembly. Do not contaminate the mechanical seal faces with lubricant.
  - 10.5.2. Inspect casing O-ring (513) and replace if damaged. This O-ring may be lubricated with petroleum jelly to ease assembly.
  - 10.5.3. Inspect guidevane O-ring (349) and replace if worn.



**Do not lubricate guidevane O-ring (349). Insure it is not pinched by the impeller on reassembly.**

- 10.6. Check reassembled unit for binding. Correct as required.
- 10.7. Tighten casing bolts in a star pattern to prevent O-ring binding.

## 11. TROUBLE SHOOTING CHART:

### MOTOR NOT RUNNING:

(See causes 1 thru 6)

### LITTLE OR NO LIQUID DELIVERED:

(See causes 7 thru 17)

### POWER CONSUMPTION TOO HIGH:

(See causes 4, 17, 18, 19, 22)

### EXCESSIVE NOISE AND VIBRATION:

(See causes 4, 6, 9, 13, 15, 16, 18, 20, 21, 22)

### PROBABLE CAUSE:

1. Tripped thermal protector
2. Open circuit breaker
3. Blown fuse
4. Rotating parts binding
5. Motor wired improperly
6. Defective motor
7. Not primed
8. Discharge plugged or valve closed
9. Incorrect rotation
10. Foot valve too small, suction not submerged, inlet screen plugged
11. Low voltage
12. Phase loss (3-phase only)
13. Air or gasses in liquid
14. System head too high
15. NPSHA too low:  
Suction lift too high or suction losses excessive.  
Check with vacuum gauge.
16. Impeller worn or plugged
17. Incorrect impeller diameter
18. Head too low causing excessive flow rate
19. Viscosity or specific gravity too high
20. Worn bearings
21. Pump or piping loose
22. Pump and motor misaligned

## NPE STANDARD REPAIR PARTS LIST

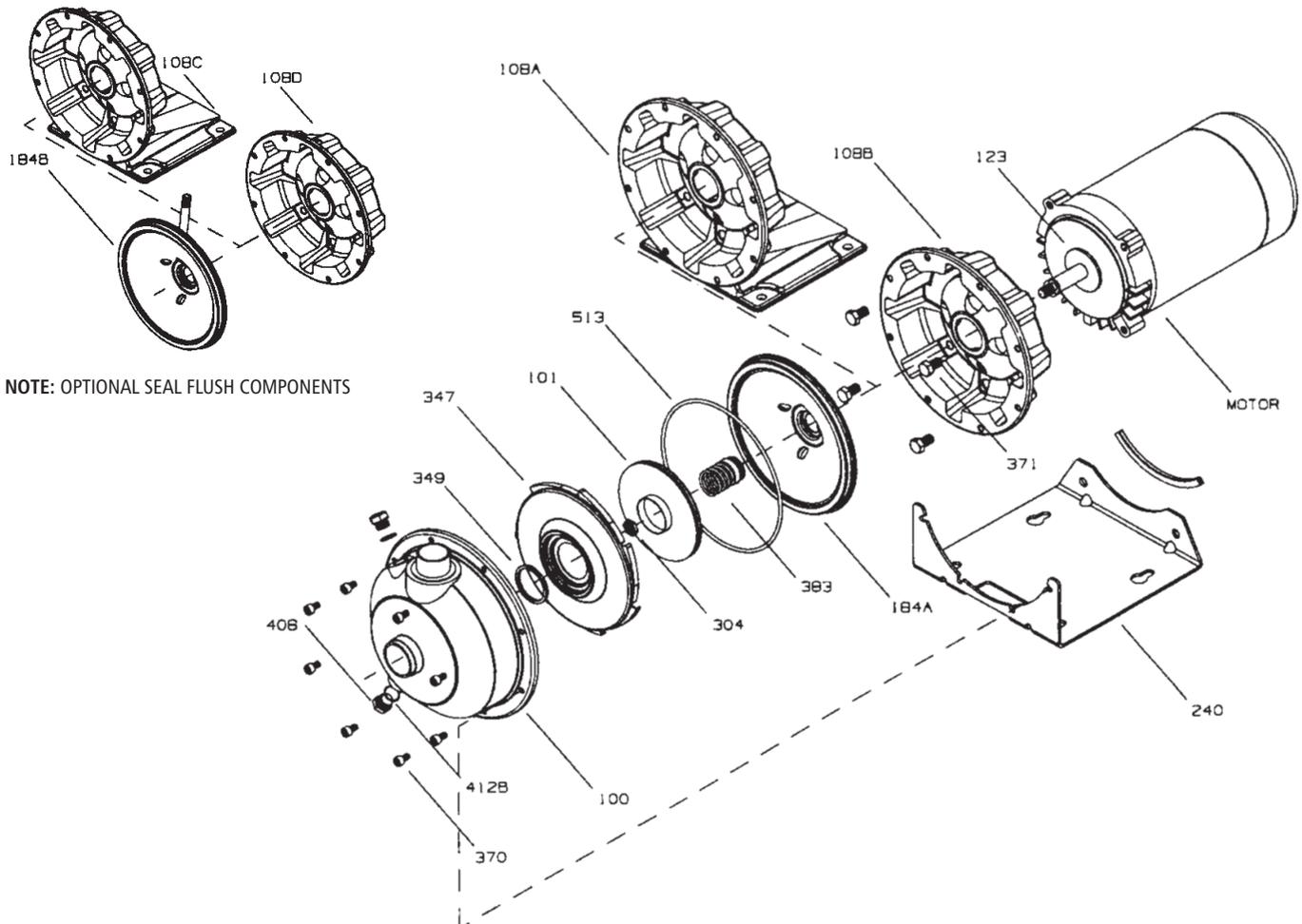
Item No.	Description	Materials of Construction
100	Casing	AISI 316L Stainless Steel
101	Impeller	
108A	Motor adapter with foot	
108B	Motor adapter less foot	
108C	Motor adapter with foot and flush	
108D	Motor adapter less foot with flush	
123	Deflector	BUNA-N
184A	Seal housing std.	AISI 316L S.S.
184B	Seal housing with seal flush	
240	Motor support	300 S.S.
	Rubber channel	Rubber
304	Impeller locknut	AISI 316 S.S.
347	Guidevane	AISI 316L S.S.
349	Seal-Ring, guidevane	Viton (standard)
		EPR
		BUNA
370	Socket head screw, casing	AISI 410 S.S.
371	Bolts, motor	Steel/plated
383	Mechanical seal	
408	Drain and vent plug, casing	AISI 316 S.S.
412B	O-Ring, drain plugs	Viton (standard)
		EPR
		BUNA
513	O-Ring, casing	Viton (standard)
		EPR
		BUNA

## MECHANICAL SEAL APPLICATION CHART

Item 383 Mechanical Seal (1/8" seal)				
Rotary	Stationary	Elastomers	Metal Parts	Part No.
Carbon	Sil-Carbide	EPR	316SS	10K18
		Viton		10K55
EPR		10K81		
Viton		10K62		

**NOTE:** Close coupled units supplied with 1/2 HP 1750 RPM, 1/2 - 3 HP Explosion Proof or 5 HP motors, utilize motor adapter less foot and a footed motor.

**NOTE:** Frame mounted units (NPE-F) utilize the XS Power frame and motor adapter less foot. For repair parts for the power frame refer to the XS-Power frame repair parts page in the parts section of your catalog. To order the power frame complete order item 14L61.



**NOTE:** OPTIONAL SEAL FLUSH COMPONENTS

### GOULDS WATER TECHNOLOGY LIMITED WARRANTY

This warranty applies to all water systems pumps manufactured by Goulds Water Technology.

Any part or parts found to be defective within the warranty period shall be replaced at no charge to the dealer during the warranty period. The warranty period shall exist for a period of twelve (12) months from date of installation or eighteen (18) months from date of manufacture, whichever period is shorter.

A dealer who believes that a warranty claim exists must contact the authorized Goulds Water Technology distributor from whom the pump was purchased and furnish complete details regarding the claim. The distributor is authorized to adjust any warranty claims utilizing the Goulds Water Technology Customer Service Department.

**The warranty excludes:**

- (a) Labor, transportation and related costs incurred by the dealer;
- (b) Reinstallation costs of repaired equipment;
- (c) Reinstallation costs of replacement equipment;
- (d) Consequential damages of any kind; and,
- (e) Reimbursement for loss caused by interruption of service.

**For purposes of this warranty, the following terms have these definitions:**

- (1) "Distributor" means any individual, partnership, corporation, association, or other legal relationship that stands between Goulds Water Technology and the dealer in purchases, consignments or contracts for sale of the subject pumps.
- (2) "Dealer" means any individual, partnership, corporation, association, or other legal relationship which engages in the business of selling or leasing pumps to customers.
- (3) "Customer" means any entity who buys or leases the subject pumps from a dealer. The "customer" may mean an individual, partnership, corporation, limited liability company, association or other legal entity which may engage in any type of business.

**THIS WARRANTY EXTENDS TO THE DEALER ONLY.**



Xylem, Inc.  
2881 East Bayard Street Ext., Suite A  
Seneca Falls, NY 13148  
Phone: (800) 453-6777  
Fax: (888) 322-5877  
[www.xylem.com/brands/gouldswatertechnology](http://www.xylem.com/brands/gouldswatertechnology)

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## Declaration of Conformity

---

We at,  
Goulds Water Technology / Xylem Inc.  
1 Goulds Drive  
Auburn, NY 13021

Declare that the following products: NPE, MCS, MCC, 3656, 3656 SP, GB, e-SV, SVI, NPO, Prime Line SP, HB, HMS, LC, NPV, LB, LBS comply with Machine Directive 06/42/EC. This equipment is intended to be incorporated with machinery covered by this directive, but must not be put into service until the machinery into which it is to be incorporated has been declared in conformity with the actual provisions of the directive.

## Declaración de Conformidad

---

Nosotros en  
Goulds Water Technology / Xylem Inc.  
1 Goulds Drive  
Auburn, NY 13021

Declaramos que los siguientes productos: NPE, MCS, MCC, 3656, 3656 SP, GB, e-SV, SVI, NPO, Prime Line SP, HB, HMS, LC, NPV, LB, LBS cumplen con las Directivas para Maquinarias 06/42/EC. Este equipo ha sido diseñado para ser incorporado a la maquinaria cubierta por esta directiva pero no debe ponerse en funcionamiento hasta que se declare que la maquinaria en la que será incorporado cumple con las disposiciones reales de la directiva.

## Déclaration de Conformité

---

Nous, à  
Goulds Water Technology, Xylem Inc.  
1 Goulds Drive  
Auburn, NY, U.S.A. 13021,

déclarons que les produits NPE, MCS, MCC, 3656, 3656 SP, GB, e-SV, SVI, NPO, Prime Line SP, HB, HMS, LC, NPV, LB et LBS sont conformes à la directive 06/42/EC (législation relative aux machines). Ils sont destinés à être intégrés dans la machinerie faisant l'objet de ladite directive, mais ne doivent pas être mis en service tant que la machinerie en question ne sera pas déclarée conforme aux stipulations de la directive.



Xylem, Inc.  
2881 East Bayard Street Ext., Suite A  
Seneca Falls, NY 13148  
Téléphone: (866) 325-4210  
Télécopie: (888) 322-5877  
[www.xylem.com/brands/gouldswatertechnology](http://www.xylem.com/brands/gouldswatertechnology)

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**REPAIR PARTS**

RNPE

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# NPE/NPE-F REPAIR PARTS

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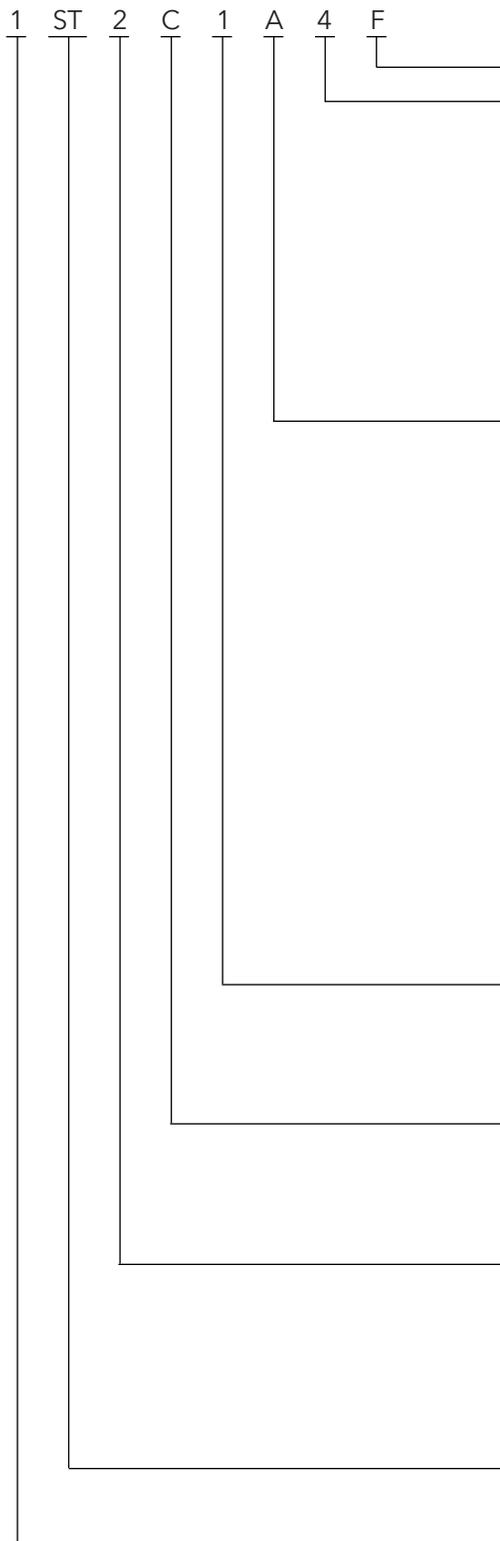
#### NOTE:

For units built before September, 1997

The following upgrades are interchangeable.

- (1) Item 349 Guidevane O-Ring was upgraded from O-Ring to Square Seal Ring.
- (2) Pump Components have been upgraded from 304 SS to 316L SS.
- (3) Mechanical Seal upgrades as noted on page 1.
- (4) Pump Mounting location for motor adapter with foot to pump support are interchangeable.

### NPE/NPE-F NUMBERING SYSTEM



#### SEAL VENT/FLUSH OPTION MECHANICAL SEAL and O-RING

4 = Pre-Engineered Standard. For Optional Mechanical Seal modify catalog order no. with Seal Code listed below.

21 Mechanical Seal ( $\frac{5}{8}$ " seal)						
Seal Code	Rotary	Stationary	Elastomers	Metal Parts	Part No.	Casing O-Ring
2	Carbon	Sil-Carbide	EPR	316 SS	10K18	EPR
4			Viton		10K55	Viton
5	Sil-Carbide		EPR		10K81	EPR
6			Viton		10K62	Viton

#### Impeller Option Code . . . No Adder Required

For Optional Impeller Diameters modify catalog order no. with Impeller code listed below.

Select Optional Impeller Diameter from Pump Performance Curve.

Impeller Code	Pump Size		
	1 x 1 $\frac{1}{4}$ -6 Diameter	1 $\frac{1}{4}$ x 1 $\frac{1}{2}$ -6 Diameter	1 $\frac{1}{2}$ x 2-6 Diameter
K		6 $\frac{1}{8}$	
G		5 $\frac{15}{16}$	5 $\frac{3}{8}$
H		5 $\frac{1}{2}$	5
A	6 $\frac{1}{8}$	5 $\frac{1}{4}$	4 $\frac{3}{4}$
B	5 $\frac{3}{4}$	5 $\frac{1}{16}$	4 $\frac{5}{8}$
C	5 $\frac{3}{16}$	4 $\frac{7}{8}$	4 $\frac{3}{8}$
D	4 $\frac{3}{4}$	4 $\frac{7}{8}$	4 $\frac{1}{16}$
E	4 $\frac{7}{16}$	4 $\frac{1}{4}$	3 $\frac{5}{8}$
F	4 $\frac{1}{16}$	3 $\frac{7}{8}$	

**Note:** Not recommended for operation beyond printed H-Q curve.

For critical application conditions, consult factory.

**Note:** Not all combinations of motor, impeller and seal options are available for every pump model. Please check with factory on non-cataloged numbers.

**Note:** Impeller diameter is measured at the vane. The overall diameter of the shroud may be greater.

#### DRIVER

1 = 1PH, ODP    4 = 1 PH, TEFC    7 = 3 PH, XP  
 2 = 3 PH, ODP    5 = 3 PH, TEFC    8 = 575 V, XP  
 3 = 575 V, ODP    6 = 575 V, TEFC    0 = 1 PH, XP

#### HP RATING

C =  $\frac{1}{2}$  HP    F = 1 $\frac{1}{2}$  HP    J = 5 HP  
 D =  $\frac{3}{4}$  HP    G = 2 HP  
 E = 1 HP    H = 3 HP

#### DRIVER: HERTZ/POLE/RPM

1 = 60 HZ, 2 pole, 3500 RPM  
 2 = 60 HZ, 4 pole, 1750 RPM  
 3 = 60 HZ, 6 pole, 1150 RPM  
 4 = 50 HZ, 2 pole, 2900 RPM  
 5 = 50 HZ, 4 pole, 1450 RPM

#### MATERIAL

ST = Stainless Steel

#### PUMP SIZE

1 = 1 x 1 $\frac{1}{4}$  - 6    2 = 1 $\frac{1}{4}$  x 1 $\frac{1}{2}$  - 6    3 = 1 $\frac{1}{2}$  x 2 - 6

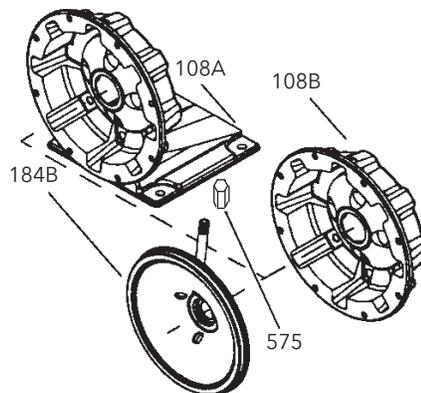
**For Frame Mounted version, substitute the letters "FRM" in these positions.**

### NPE STANDARD REPAIR PARTS LIST

Item No.	Description	Materials of Construction	1ST 1 x 1¼	2ST 1¼ x 1½	3ST 1½ x 2	QUANTITY
100	Casing	AISI 316L SS	1L81	1L82	1L83	1
101	Impeller		See Impeller chart on page 4			1
108A	Motor adapter with foot*		1L80	1		
108B	Motor adapter less foot*	1L87				
123	Deflector	BUNA-N	5K7		1	
184A	Seal housing standard	AISI 316L SS	1L79		1	
184B	Seal housing with seal flush		1L333			
240	Motor support	300 SS	4L320		1	
	Rubber channel	Rubber	9K188		1	
304	Impeller locknut	AISI 316 SS	13K286		1	
347	Guidevane	AISI 316L SS	3L23	3L24	3L25	1
349	Seal ring, guidevane	Viton standard	5K269	5K270		1
		EPR	5K273	5K274		
		BUNA	5K271	5K272		
370	Socket head screw, casing	AISI 410 SS	13L65		8	
371	Bolts, motor	Steel/plated	13K252		4	
383	Mechanical seal	See Mechanical Seal Chart on Page 11				
408	Drain and vent plug, casing	AISI 316 SS	6L3		2	
412B	O-ring, drain plugs	Viton, standard	5L99		2	
		EPR	5L80			
		BUNA	5L62			
513	O-ring, casing	Viton standard	5K206		1	
		EPR	5K193			
		BUNA	5K4			
575	Pipe Cap	304 SS	6K150		1	

\* Flush access hole provided.

**NOTE:**  
OPTIONAL SEAL FLUSH COMPONENTS

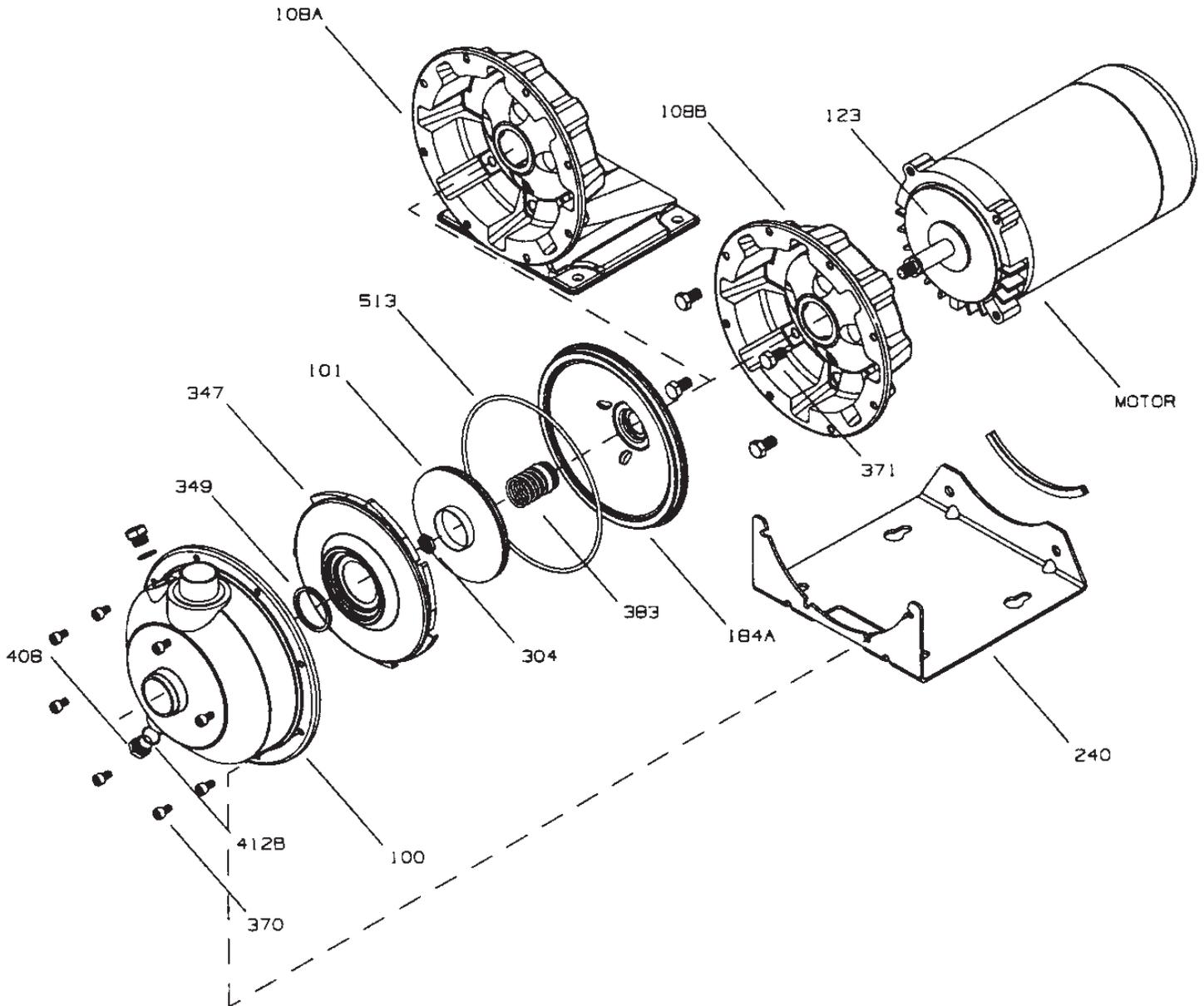


**NOTE:**

Close-coupled units using motors ½ - 1 HP (TEFC and ODP) will use footed motor adapter as standard.  
Close-coupled units using motors 1½ - 3 HP (TEFC and ODP) will use footless motor adapter as standard.  
Close-coupled units using motors 5 HP and all X-Proof will have a foot attached to the motor.

**NOTE:**

Frame mounted units (NPE-F) utilize the XS Power Frame and motor adapter less foot. For repair parts for the power frame refer to the XS-Power Frame repair parts page in the parts section of your catalog. To order the power frame complete order item 14L61.



### NPE STANDARD IMPELLERS

Impeller Code	Pump Size					
	1 x 1¼-6		1¼ x 1½-6		1½ x 2-6	
	Diameter	Part No.	Diameter	Part No.	Diameter	Part No.
K			6⅛	2L885		
G			5⅞	2L700	5⅞	2L702
H			5½	2L699	5	2L701
A	6⅛	2L47	5¼	2L48	4¾	2L49
B	5¾	2L44	5⅞	2L54	4⅞	2L58
C	5¾	2L46	4⅞	2L53	4⅞	2L57
D	4¾	2L42	4⅞	2L52	4⅞	2L56
E	4⅞	2L45	4¼	2L51	3⅞	2L55
F	4⅞	2L59	3⅞	2L50		

### NPE STANDARD IMPELLERS BY MOTOR SIZE AT 3500 RPM

For ODP/TEFC Units Built After September 1, 1997

HP	HP Code		1ST		2ST		3ST	
			ODP/TEFC		ODP/TEFC		ODP/TEFC	
½	C	Repair #	2L45					
		Dia.	4⅞					
		Imp. Code	E					
¾	D	Repair #	2L42		2L50			
		Dia.	4¾		3⅞			
		Imp. Code	D		F			
1	E	Repair #	2L46		2L51		2L55	
		Dia.	5⅞		4¼		3⅞	
		Imp. Code	C		E		E	
1½	F	Repair #	2L44		2L52		2L56	
		Dia.	5¾		4⅞		4⅞	
		Imp. Code	B		D		D	
2	G	Repair #	2L47		2L53		2L57	
		Dia.	6⅛		4⅞		4⅞	
		Imp. Code	A		C		C	
3	H	Repair #	2L47		2L48		2L49	
		Dia.	6⅛		5¼		4¾	
		Imp. Code	A		A		A	
5	J	Repair #			2L700	2L885	2L702	
		Dia.			5⅞	6⅛	5⅞	
		Imp. Code			G	K	G	

For Current Explosion Proof and All Units Built Before September 1, 1997

HP	HP Code		1ST		2ST		3ST	
			ODP	TEFC/EXP	ODP	TEFC/EXP	ODP	TEFC/EXP
½	C	Repair #	2L45	2L59				
		Dia.	4⅞	4⅞				
		Imp. Code	E	F				
¾	D	Repair #	2L42	2L45	2L50			
		Dia.	4¾	4⅞	3⅞			
		Imp. Code	D	E	F			
1	E	Repair #	2L46	2L42	2L51	2L50	2L55	
		Dia.	5⅞	4¾	4¼	3⅞	3⅞	
		Imp. Code	C	D	E	F	E	
1½	F	Repair #	2L44	2L46	2L52	2L51	2L56	2L55
		Dia.	5¾	5⅞	4⅞	4¼	4⅞	3⅞
		Imp. Code	B	C	D	E	D	E
2	G	Repair #	2L47	2L44	2L53	2L52	2L57	2L56
		Dia.	6⅛	5¾	4⅞	4⅞	4⅞	4⅞
		Imp. Code	A	B	C	D	C	D
3	H	Repair #	2L47	2L47	2L48	2L54	2L49	2L58
		Dia.	6⅛	6⅛	5¼	5⅞	4¾	4⅞
		Imp. Code	A	A	A	B	A	B
5	J	Repair #			2L700	2L885	2L702	
		Dia.			5⅞	6⅛	5⅞	
		Imp. Code			G	K	G	

Note:\*\* Max. Explosion Proof rating is 2 HP.

### NPE CLOSE-COUPLED MOTORS

#### MODEL NPE 3500 RPM

HP	Single-Phase, 60 Hz, 115/230 V**, 56J Frame								
	Open, Drip-Proof ①			Totally Enclosed, Fan Cooled			Explosion Proof		
	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)
½	E04853S	10.0/5.0	16	E04821S	6.2/3.1	21	BBC04825	6.2/3.1	47
¾	E05853S	14.0/7.0	19	E05821S	8.8/4.4	24	BBC05825	8.8/4.4	41
1	E06853S	16.0/8.0	22	E06821S	11.6/5.8	26	BBC06825	11.6/5.8	49
1½	E07858S	21.4/10.7	31	E07821S	16.2/8.1	35	BBC07825	16.2/8.1	56
2	E08854S	26.8/13.4	36	E08821S	20.8/10.4	39	BBC08825	20.8/10.4	60
3	E09854S	14.0	40	E09821S	11.89	44			
5	E10754S	14.4	55						

Note:\*\* 3 and 5 HP Single-Phase motors are 230 V only.

HP	Three-Phase, 60 Hz, 208-230/460 V, 56J Frame								
	Open, Drip-Proof ①			Totally Enclosed, Fan Cooled			Explosion Proof		
	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)
½	E04873S	2.6/1.3	19	E04876S	1.9/1.95	18	BBC04875	1.9/1.95	27
¾	E05873S	3.4/1.7	19	E05876S	2.3/1.15	21	BBC05875	2.3/1.15	30
1	E06873S	4.2/2.1	22	E06876S	3.2/1.6	21	BBC06875	3.2/1.6	30
1½	E07878S	5.8/2.9	25	E07876S	4.8/2.4	27	BBC07875	4.8/2.4	37
2	E08874S	6.9/3.3	39	E08876S	5.4/2.7	33	BBC08875	5.4/2.7	44
3	E09874S	7.2/3.6	31	E09876S	7.6/3.8	37			
5	E10774S	7.2/14.4	50	E10876S	6.2/12.4	48			

① For vertical mounting order motor canopy separately - 9K272 for ½, ¾ and 1 HP single phase or 9K273 for all other ODP motors.

#### MODEL NPE 1750 RPM

HP	Single-Phase, 60 HZ, 115/230 V, 56J Frame								
	Open, Drip-Proof ①			Totally Enclosed, Fan Cooled			Explosion Proof		
	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)
½	E04811	8.6/4.3	19	E04812	8.0/4.0	20	BBC04815	8.0/4.0	45

HP	Three-Phase, 60 HZ, 208-230/460 V, 56J Frame								
	Open, Drip-Proof ①			Totally Enclosed, Fan Cooled			Explosion Proof		
	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)
½	E04831	3.76/4.0/2.0	20	E04832	1.77/1.6/1.8	20	BBC04835	1.77/1.6/1.8	45

Note: Explosion Proof Motors are class 1 and 2, Group D

# Xylem |'zīləm|

- 1) The tissue in plants that brings water upward from the roots;
- 2) a leading global water technology company.

We're 12,500 people unified in a common purpose: creating innovative solutions to meet our world's water needs. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. We move, treat, analyze, and return water to the environment, and we help people use water efficiently, in their homes, buildings, factories and farms. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise, backed by a legacy of innovation.

**For more information on how Xylem can help you, go to [www.xylem.com](http://www.xylem.com)**



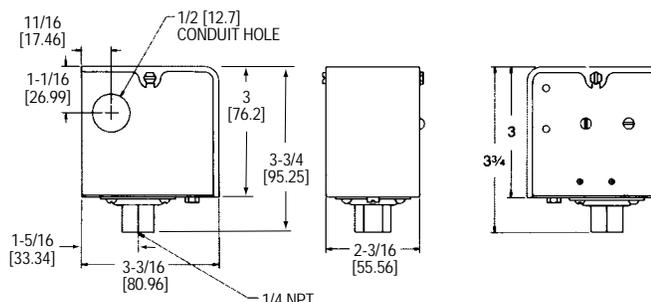
Xylem, Inc.  
2881 East Bayard Street Ext., Suite A  
Seneca Falls, NY 13148  
Phone: (800) 453-6777  
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## Series CS Low Cost Diaphragm Pressure Switches

### Specifications – Installation and Operating Instructions



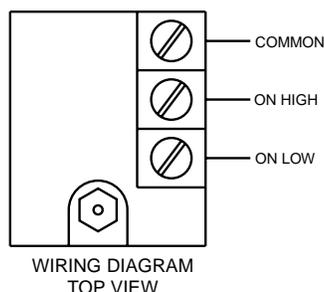
The Series CS Low Cost Diaphragm Pressure Switch is ideal for instrument panels, small compressors and general industrial applications. Visible set point and easy-to-wire SPDT snap switch reduce installation time. This switch operates in any position and is vibration resistant.

#### INSTALLATION/MOUNTING

The control can be pipe mounted. Do not twist the case when installing. Use wrench on the pressure connection flats.

#### WIRING

All wiring must conform to the National Electrical code and local regulations. Do not install control to handle loads in excess of electrical rating shown in specifications or as indicated on instructions inside control cover. Connect wiring to screw terminals depending on the action required. Common and High contacts will close and Common and Low contacts will open when increasing pressure (or vacuum) reaches set point. The reverse will occur when pressure (or vacuum) drops below the set point less the deadband.



**CAUTIONS:** Do not oil any parts. Mount control securely. Never exceed electrical rating for switch. Use only with compatible.

#### WARNING

A failure resulting in injury or damage can be caused by over-pressure, excessive vibration or pressure pulsation, excessive temperature, corrosion of pressure containing parts and movement assembly, electrical overload or other misuse.

#### PHYSICAL DATA

**Temperature Limits:** -30 to 150°F (-34.4 to 65.6°C)

**Pressure Connections:** 1/4" NPT(F)

**Electrical Ratings:** 12 A @ 120 VAC; 8 A @ 240 VAC; 7A @ 277 VAC; 1/8 HP @ 120 VAC; 1/4 HP @ 240 VAC

**Switch Type:** SPDT snap acting

**Conduit Opening:** 1/2"

**Wiring Connections:** Three screw type, common, N.O., N.C.

**Set Point Adjustment:** Screw type, inside cover

**Housing:** Galvanized steel, NEMA 1

**Diaphragm:** Buna-N/Nylon

**Calibration Spring:** Plated steel

**Installation:** Any position

**Weight:** 1/2 lb. (0.23 kg)

Model No.	Adjustable Operating Range	Fixed Deadband		Max. Pressure
		Maximum	Minimum	
CS-1	1-30" Hg. Vac. 2.5-75 cm Hg. Vac	1.5" Hg. 3.8 cm Hg. Vac	1" Hg. VAC 2.5 cm Hg. Vac	30 psig
CS-3	10-100" w.c. 2.5-250 cm w.c.	7" w.c. 17.8 cm w.c.	5" w.c. 12.7 cm w.c.	30 psig
CS-10	1-10 psig 0.07-0.7 kg/cm <sup>2</sup>	0.4 psig 0.03 kg/cm <sup>2</sup>	0.25 psig 0.02 kg/cm <sup>2</sup>	30 psig
CS-30	1-30 psig 0.07-2.1 kg/cm <sup>2</sup>	1.0 psig 0.07 kg/cm <sup>2</sup>	0.5 psig 0.035 kg/cm <sup>2</sup>	50 psig
CS-150	10-150 psig 0.07-10.5 kg/cm <sup>2</sup>	5 psig 0.35 kg/cm <sup>2</sup>	1.5 psig 0.1 kg/cm <sup>2</sup>	175 psig



### Bag Filter Housing, Alum, 2 In FNPT

Bag Filter Housing, Bottom Outlet, Overall Height 37.41 In. Aluminum Housing Material, Stainless Steel Basket, Max. Flow GPM 200, Size 2 In, Connection FNPT, 8.0 Dia. (In.), Max. Pressure (PSI) 150, Max. Water Temp. (F) 300, Filter Bag Size 2, Leg Type Eye Bolt

Grainger Item #	4BB26
Your Price (ea.)	
Brand	PENTEK
Mfr. Model #	156112-75
Ship Qty.	1
Sell Qty. (Will-Call)	1
Ship Weight (lbs.)	41.0
Availability	Ready to Ship
Catalog Page No.	4161

#### Additional Info

##### Single Eyebolt Bag Filter Housings

Feature a standard O-ring Viton® seal between the basket and housing to assure a positive seal and prevent bypass, while removing dirt, pipe scale, and other contaminants from process liquids. FNPT connections. Carbon steel housings have a 2-part epoxy paint finish.

- Max. pressure: 150 psi Max. temp.: 300°F, except No. 1YBN7 is 200°F

#### Tech Specs

**Item:** Bag Filter Housing

**Outlet:** Bottom

**Housing Material:** Aluminum

**Basket:** Stainless Steel

**Max. Flow GPM:** 200

**Size:** 2"

**Connection:** FNPT

**Dia. (In.):** 8

**Max. Pressure (PSI):** 150

**Max. Water Temp. (F):** 300

**Filter Bag Size:** 2

**Leg Type:** Eye Bolt

**Overall Height (In.):** 37.41

**Height:** 22"

#### Notes & Restrictions

There are currently no notes or restrictions for this item.

#### MSDS

This item does not require a **Material Safety Data Sheet (MSDS)**.

#### Required Accessories

There are currently no required accessories for this item.

# OPERATING INSTRUCTIONS

## LIQUID BAG MODELS 44, 66, 88

READ THE WARNING/SAFETY INFORMATION ON  
BACK BEFORE PROCEEDING

The housing you have purchased is manufactured with the highest quality materials and with the greatest pride to offer you a superior in-line housing for industrial applications.

If there is any damage to the housing or element, a **CLAIM MUST BE FILED WITH THE FREIGHT CARRIER. SHIPPER WILL NOT ACCEPT RETURNS WITHOUT PRIOR AUTHORIZATION, UNAUTHORIZED SHIPMENTS WILL BE REFUSED.**

### A. RECEIVING INSTRUCTIONS

1. Unpack the housing(s) and discard any shipping materials.
2. Place housing in the desired location on a flat surface. Secure support legs to the base if applicable.

### B. INSTALLATION INSTRUCTIONS

**\*\*flow to the housing should be turned off\*\***

1. Place housing on pipe connections:
  - a. **N.P.T. / Coupling style** - Krystil Klear does not recommend using any type of liquid sealant due to contamination of the pipe that may occur.
  - b. **Flange style** - put a small amount of clean, heavy oil on one side of the gaskets, place oiled side down onto existing flanges to hold gaskets.
2. Please note the labeling of the inlet and outlet connections for proper installation. Tighten housing with proper tension to seal housing on existing pipe or flange. Note: housing has been factory pressure tested to assure a leak proof vessel. If leaking occurs, check for improper connections.
3. Remove lid from housing by turning eye nuts until loosened and swing them down. Using the Lid Lift Handle, swing the lid until full view of the inner housing area is gained.
4. Check inner housing and pipe connections for foreign material and discard any items that have entered during shipping or unpacking.
5. Make sure that the strainer baskets are pushed fully into housing grooves. If using a filter bag, seat bag fully into strainer basket to assure a leak-proof seal between bag and basket. For best results, bag should be fully extended into the basket.
6. Close lid and alternately tighten the eye nuts until lid is fully seated onto the

O-Ring gasket.

7. Housing is now ready for start-up.

### C. START-UP OF HOUSING

1. Loosen vent plug to allow air to escape from housing  
Slowly open the inlet to gradually fill the housing body.
2. When housing body is full (liquid escapes from top vent), close the vent.
3. Open the outlet connection and fully open the inlet connection.  
Housing is now operating properly

### D. REMOVAL OF SPENT ELEMENT:

1. When the housing reaches your pre-determined differential pressure, stop flow to the housing and relieve housing pressure through housing drain.  
Remove enough liquid to show top of basket flange.
2. Loosen eye nuts on housing and, using the Lid Lift Handle, swing the lid to gain full access to the inside of housing.
3. If using a liquid bag, pull the element out of basket and discard the element in accordance with any required local and federal laws.
4. Remove filter baskets and clean thoroughly.
5. Housing debris and sludge should be removed to prolong filter efficiencies.
6. Replace filter baskets and bags into housing as noted in B-5 thru C-3 above.

### C. RECOMMENDED MAINTENANCE

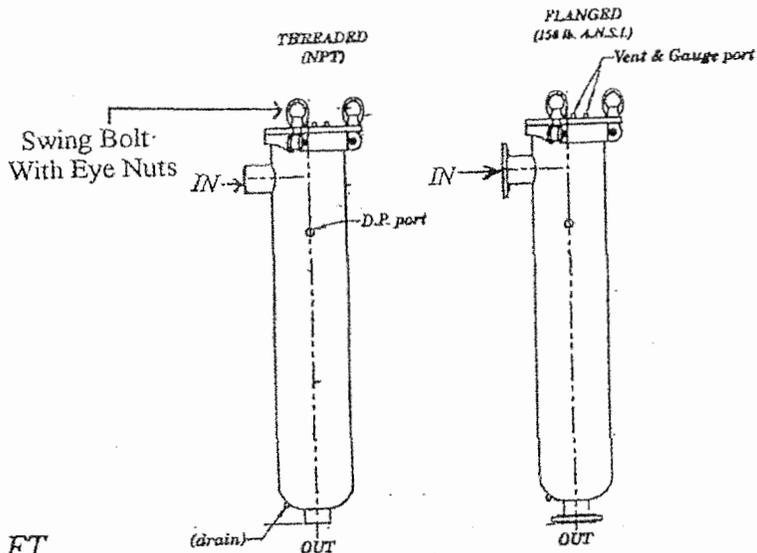
Periodic checks should be made on all housing lid and basket o-rings to ensure no cuts or damage has incurred that would cause the housing not to seal. If housing parts become damaged or worn, replace immediately.

<b>PART NUMBER</b>	<b>DESCRIPTION</b>
* LV	Viton Lid O-ring
88BV	Viton Basket O-ring
*LGCA	18" Tri-Pod Leg Assembly Carbon Steel
*LGSS	18" Tri-Pod Leg Assembly Stainless
EN	Eye Nut
RE	Rod End
CBA	Clevis Bolt Assembly
*LDCA	Lid Cover Carbon Steel
*LDSS304	Lid Cover Stainless Steel
PER APPLICATION **	Filter Bags
PER APPLICATION **	Filter Basket

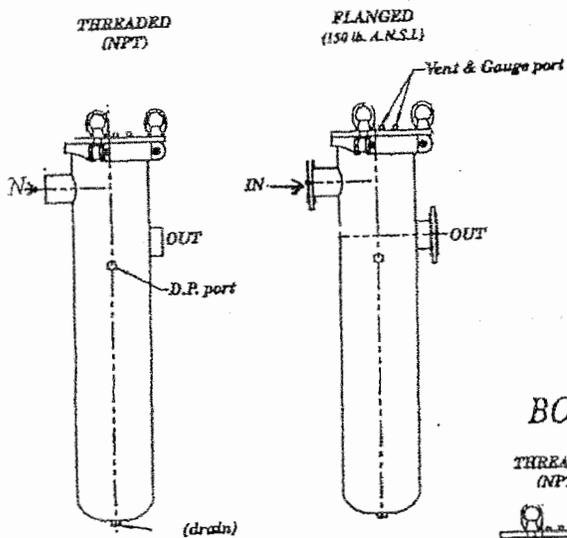
\* insert first two digits of housing model # (44,66, or 88)

\*\* Full line of replacement bags and baskets available

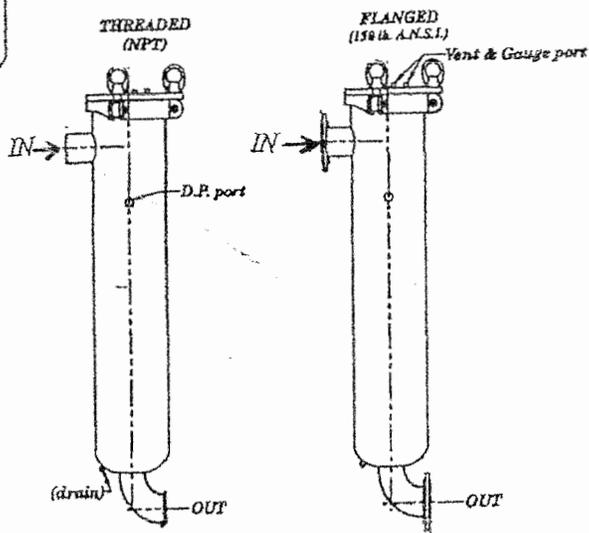
BOTTOM OUTLET



SIDE OUTLET



BOTTOM OUTLET 90°



## \*\*WARNING-SAFETY INFORMATION\*\*

- 1.) The housings in this catalog, if improperly used, can cause serious injury or death.
- 2.) Always wear proper protective clothing for the liquid being filtered. Check your M.S.D.S. for any instructions or suggestions.
- 3.) Do not run housing in excess of the rated pressure or temperature found on the housing tank label. (See warning #1)
- 4.) Check chemical compatibility of selected o-ring and housing material before housing installation.
- 5.) Do not open a housing when the system is under pressure; always relieve all pressure through housing before opening of housing lid.
- 6.) Stop all flow of liquid *before opening of lid.*
- 7.) Bolt housing to floor, as tipping may occur when lid is opened.



# T-10 METER

SIZES: 5/8", 3/4", and 1"



T-10 water meters are warranted for performance, materials, and workmanship.



Every T-10 water meter meets or exceeds the latest AWWA C700 Standard. Its nutating disc, positive displacement principle is time-proven for accuracy and dependability since 1892, ensuring maximum utility revenue.

**CONSTRUCTION**

The T-10 water meter consists of three major assemblies: a register, a no-lead high copper alloy maincase, and a nutating disc measuring chamber.

The T-10 meter is available with a variety of register types. For reading convenience, the register can be mounted in one of four positions on the meter.

The corrosion-resistant no-lead high copper alloy maincase will withstand most service conditions: internal water pressure, rough handling, and in-line piping stress.

The innovative floating chamber design of the nutating disc measuring element protects the chamber from frost damage while the unique chamber seal extends the low flow accuracy by sealing the chamber outlet port to the maincase outlet port. The nutating disc measuring element utilizes corrosion-resistant materials throughout and a thrust roller to minimize wear.

**WARRANTY**

Neptune provides a limited warranty with respect to its T-10 water meters for performance, materials and workmanship.

When desired, maintenance is easily accomplished either by replacement of major assemblies or individual components.

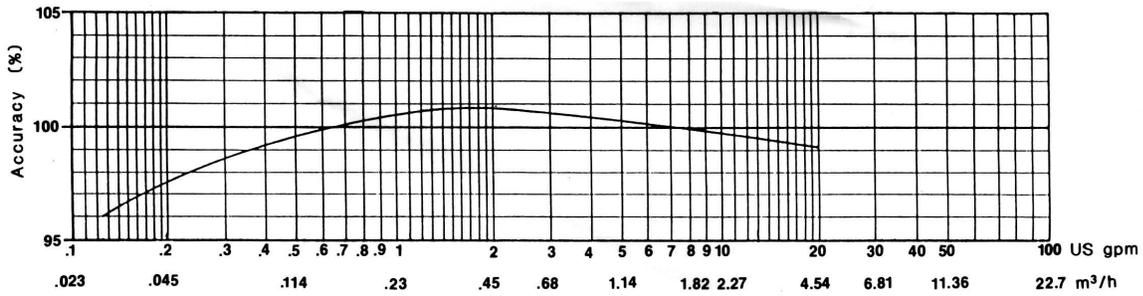
**KEY FEATURES**

- Register
  - Magnetic drive, low torque registration ensures accuracy
  - Impact-resistant register
  - High resolution, low flow leak detection
  - Bayonet style register mount allows in-line serviceability
  - Tamperproof seal pin deters theft
  - Date of manufacture, size, and model stamped on dial face
- No-Lead Maincase
  - Made from no-lead high copper alloy
  - ANSI/NSF 61 Certified
  - Lifetime guarantee
  - Resists internal pressure stresses and external damage
  - Handles in-line piping variations and stresses
  - No-lead high copper alloy provides residual value vs. plastic
  - Electrical grounding continuity
- Nutating Disc Measuring Chamber
  - Positive displacement
  - Widest effective flow range for maximum revenue
  - Proprietary polymer materials maximize long term accuracy
  - Floating chamber design is unaffected by meter position or in-line piping stresses

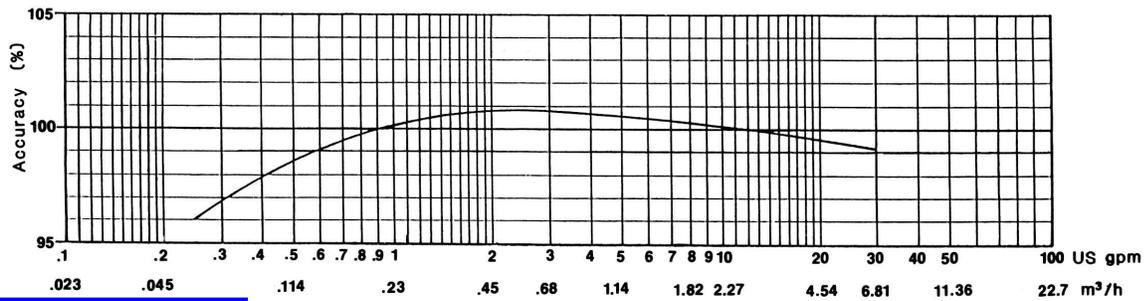
**SYSTEMS COMPATIBILITY**

Adaptability to all present and future systems for flexibility is available only with Neptune's ARB® Utility Management Systems™.

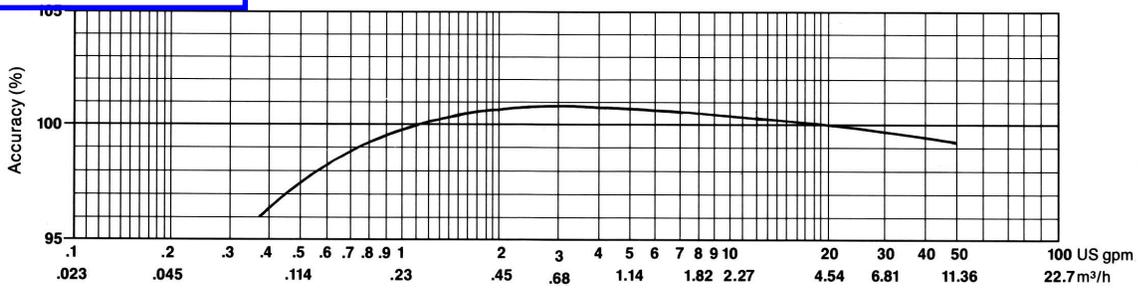
### 5/8" ACCURACY



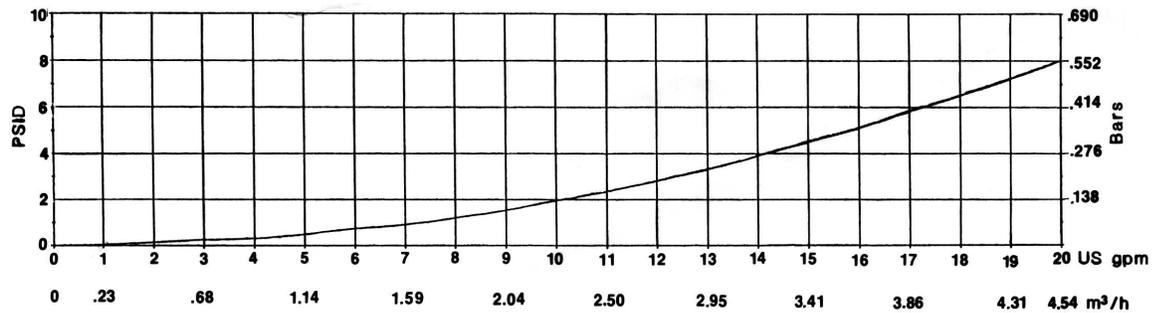
### 3/4" ACCURACY



### 1" ACCURACY

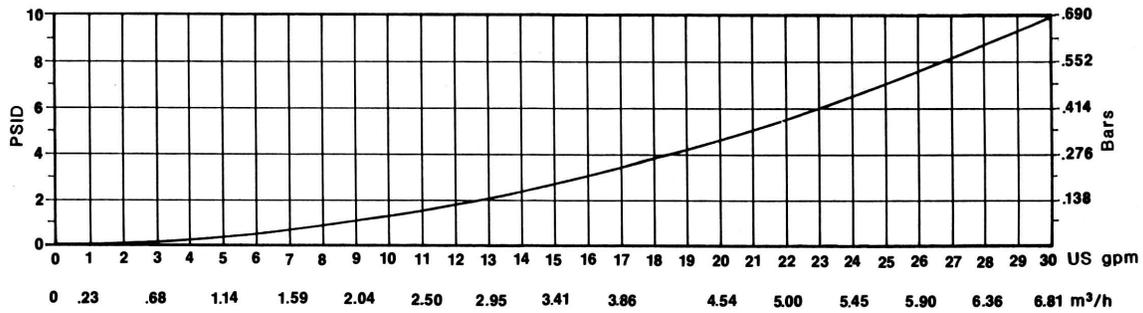


### 5/8" PRESSURE LOSS

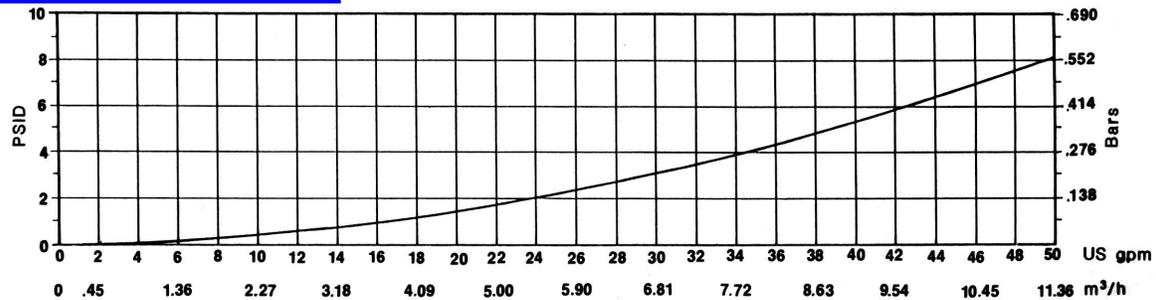


*These charts show typical meter performance. Individual results may vary.*

## 3/4" PRESSURE LOSS



## 1" PRESSURE LOSS

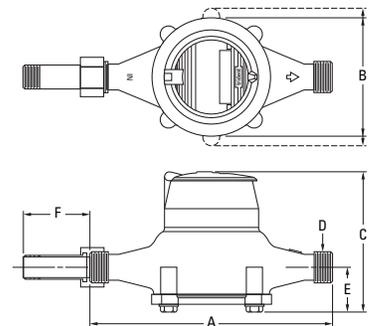


## OPERATING CHARACTERISTICS

Meter Size	Normal Operating Range @100% Accuracy (±1.5%)	AWWA Standard	Low Flow @ 95% Accuracy
5/8"	1/2 to 20 US gpm 0.11 to 4.55 m3/h	1 to 20 US gpm 0.23 to 4.5 m3/h	1/8 US gpm 0.03 m3/h
3/4"	3/4 to 30 US gpm 0.17 to 6.82 m3/h	2 to 30 US gpm 0.45 to 6.8 m3/h	1/4 US gpm 0.06 m3/h
1"	1 to 50 US gpm 0.23 to 11.36 m3/h	3 to 50 US gpm 0.68 to 11.4 m3/h	3/8 US gpm 0.09 m3/h

## DIMENSIONS

Meter Size	A	B	C-Std.	C-ARB	D-Threads	D-OD	E	F	Weight
	in/mm	in/mm	in/mm	in/mm	per inch	in/mm	in/mm	in/mm	lbs/kg
5/8"	7 1/2 191	3 5/8 92	4 7/8 124	5 3/8 137	14	1.030 26	1 5/8 41	2 1/2 64	3 3/4 1.7
5/8" x 3/4"	7 1/2 191	3 5/8 92	4 7/8 124	5 3/8 137	11 1/2	1.290 33	1 5/8 41	2 5/8 67	4 1.8
3/4"	9 229	4 3/8 111	5 1/2 140	5 13/16 148	11 1/2	1.290 33	1 7/8 48	2 5/8 67	6 2.7
3/4"SL	7 1/2 911	4 3/8 111	5 1/2 140	5 13/16 148	11 1/2	1.290 33	1 7/8 48	2 5/8 67	5 1/2 2.5
3/4"x1"	9 229	4 3/8 111	5 1/2 140	5 13/16 148	11 1/2	1.626 41	1 7/8 48	2 3/4 70	6 1/2 2.9
1"	10 3/4 273	6 1/2 165	6 3/8 162	6 5/8 168	11 1/2	1.626 41	2 1/8 54	2 3/4 70	9 3/4 4.4
1"x1 1/4"	10 3/4 273	6 1/2 165	6 3/8 162	6 5/8 168	11 1/2	1.865 47	2 1/8 54	2 13/16 71	10 1/4 4.6



## GUARANTEED SYSTEMS COMPATIBILITY

All T-10 water meters are guaranteed adaptable to our ARB®V, ProRead (ARB VI) AutoDetect, E-Coder™ (ARB VII), E-Coder)R900*i*, TRICON®/S, TRICON/E3®, and Neptune meter reading systems without removing the meter from service.

## REGISTRATION

<b>ProRead Registration</b>			
<b>(per sweep hand revolution)</b>			
	5/8"	3/4" & 1"	
10 US Gallons	✓	✓	✓
10 Imperial Gallons	✓	✓	✓
1 Cubic Foot	✓	✓	✓
0.1 Cubic Metre	✓	✓	✓
0.01 Cubic Metre	✓		
<b>Register Capacity</b>			
<b>ProRead &amp; E-Coder</b>			
	5/8"	3/4" & 1"	
10,000,000 US Gallons	✓	✓	✓
10,000,000 Imperial Gallons	✓	✓	✓
1,000,000 Cubic Feet	✓	✓	✓
100,000 Cubic Metres	✓	✓	✓
10,000 Cubic Metres	✓		
<b>E-Coder High Resolution</b>			
<b>(8-digit reading)</b>			
	5/8"	3/4" & 1"	
0.1 US Gallons	✓	✓	✓
0.1 Imperial Gallons	✓	✓	✓
0.01 Cubic Feet	✓	✓	✓
0.001 Cubic Metres	✓	✓	✓

## SPECIFICATIONS

- Certification: ANSI/NSF 61
- Application: Cold water measurement of flow in one direction
- Maximum operating water pressure: 150 psi (1034 kPa)
- Maximum operating water temperature: 80°F
- Measuring chamber: Nutating disc technology design made from proprietary synthetic polymer

## OPTIONS

- Sizes:
  - 5/8", 5/8" x 3/4"
  - 3/4", 3/4" SL, 3/4" x 1"
  - 1", 1" x 1 1/4"
- Units of measure: U.S. gallons, imperial gallons, cubic feet, cubic metres
- Register types:
  - Direct reading: Bronze box and cover (standard)
  - Remote reading: ProRead Encoder, E-Coder™, E-Coder)R900*i*, TRICON/S, TRICON/E3
  - Reclaim
- Bottom caps:
  - Synthetic polymer (5/8" only)
  - Cast iron
  - No-lead high copper alloy
- Connections:
  - No-lead high copper alloy, straight or bent
- Environmental conditions:
  - Operating temperature: 33°F to 149°F (0°C to 65°C)
  - Storage temperature: 33°F to 158°F (0°C to 70°C)

Neptune engages in ongoing research and development to improve and enhance its products. Therefore, Neptune reserves the right to change product or system specifications without notice.

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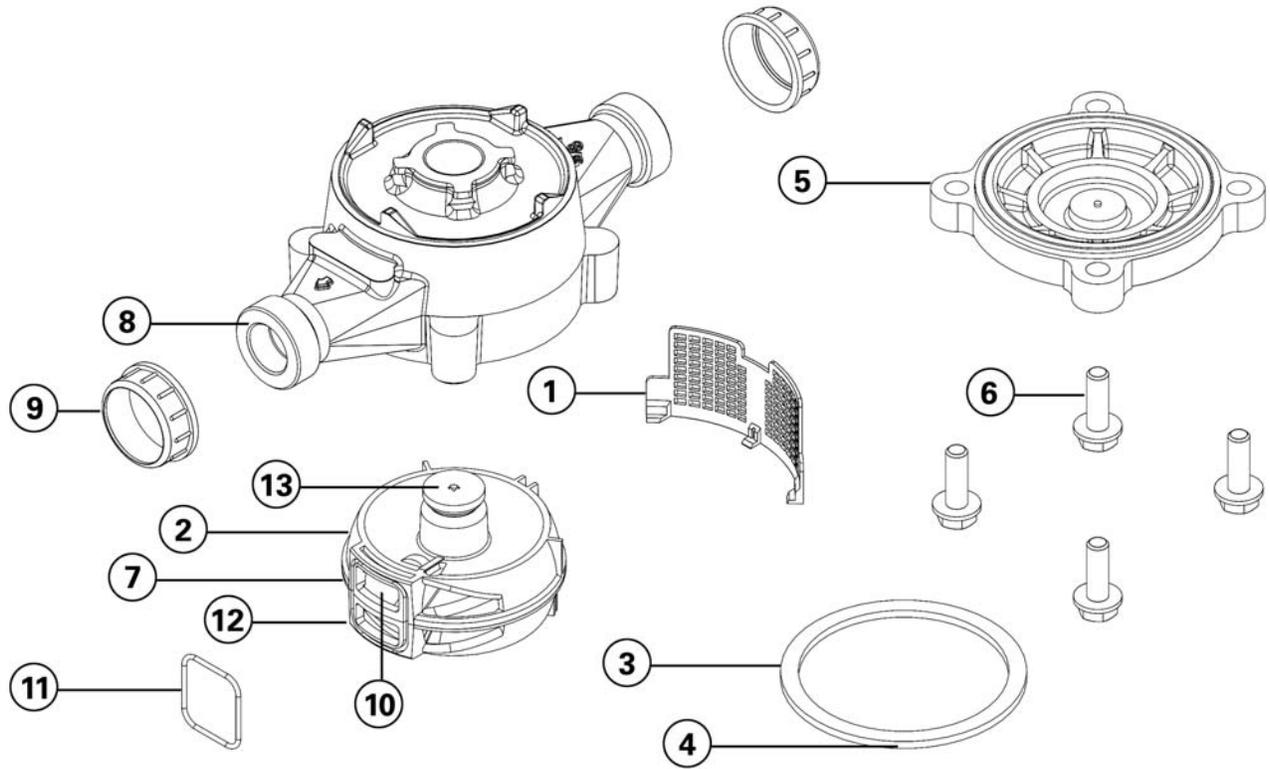


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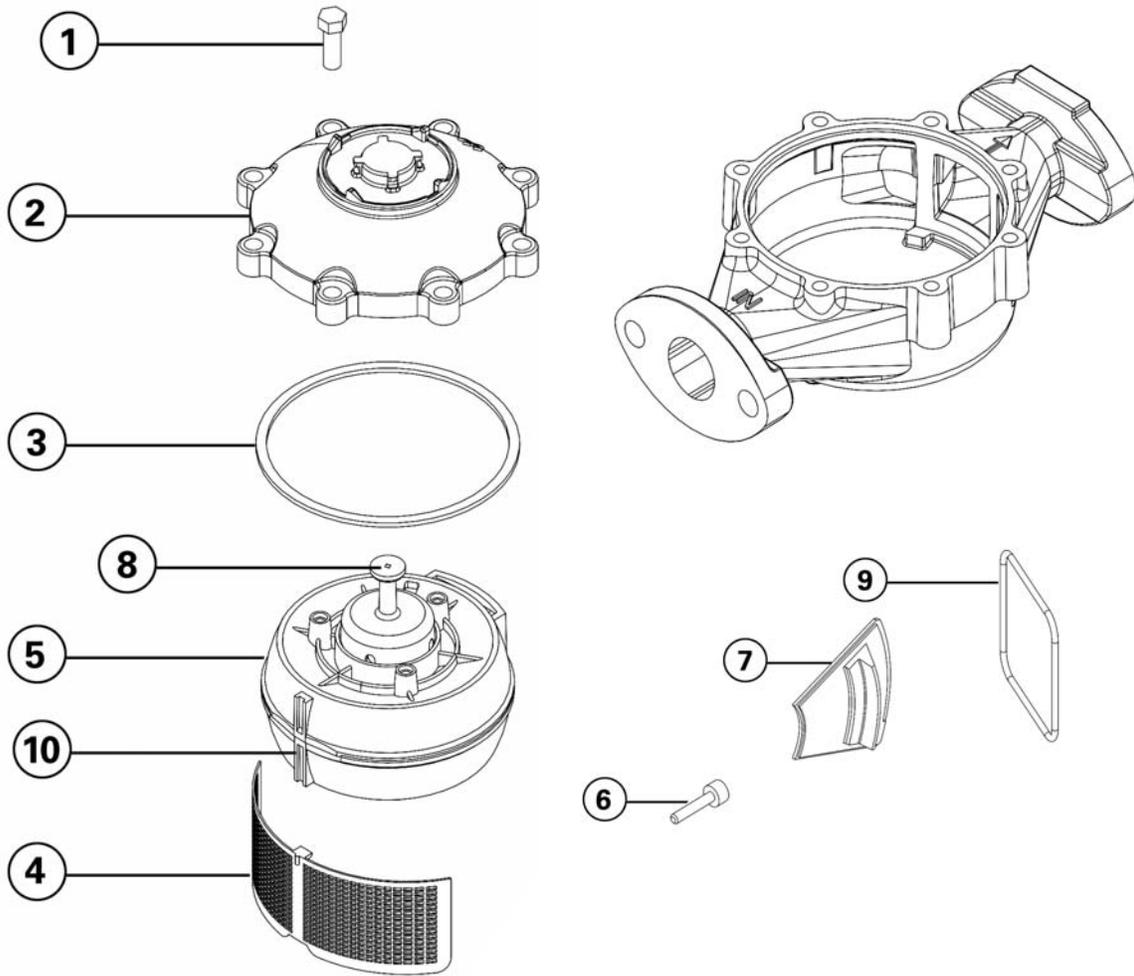
## T-10 Parts List





ITEM NO.	DESCRIPTION	PART NUMBER		
		5/8", 5/8" X 3/4"	3/4"	1"
	Register			
1	Strainer	9399-005	9831-001	9831-002
➔ 2	Chamber Complete	9400-600	9826-200	9826-300
3	Gasket, Bottom cap	8340-028	8340-034	8340-038
4	Liner, Bottom Cap*	9398-001	9832-001	9841-001
	Bottom Cap, Plastic	9397-501	-	-
5	Bronze	9397-023	9833-024	9842-024
	Cast Iron	9397-010	9833-010	9842-010
	Ductile Iron (Special Order)	9397-020	9833-003	9842-101
6	Bolt and Washer			
	SST-302 (w/washer)	8353-106	8353-106	8353-106
	SST-316 (w/washer)	8353-105	8353-105	8353-105
➔ 7	Thrust Roller	81-500	81-500	190-500
8	Spud Plug	1787-101	1787-101	1787-102
9	Spud Cap Plastic	1788-008	1789-008	1790-007
➔ 10	Diaphragm	9391-001	9829-001	9840-001
➔ 11	"O" Ring	9386-001	9386-002	9386-003
➔ 12	Drive Shaft	9393-001	9216-004	9233-002
➔ 13	Magnet	6724-003	6724-003	6724-003
	Control Block Assembly	N/A	N/A	N/A

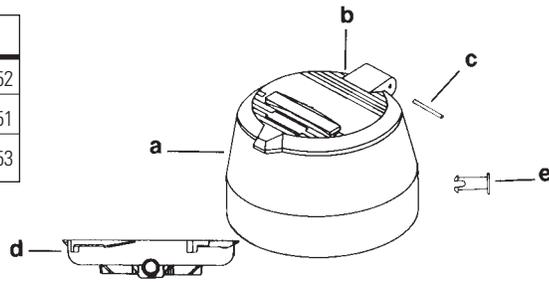
\* Not required with SP or Bronze bottom caps.



ITEM NO.	DESCRIPTION	PART NUMBER	
		SP Chamber	
		1-1/2"	2"
1	Bolts	8307-051	8307-051
2	Cover, Maincase	9082-002	9080-002
3	Gasket, Maincase	9083-001	9083-002
4	Strainer	9084-001	9084-002
5	Chamber Complete	9098-600	9098-610
6	Thrust Roller	9850-100	9850-100
7	Diaphragm	9086-101	9086-102
8	Control Block Assembly	9097-000	9097-010
9	"O" Ring	8316-607	8316-606
10	Drive Shaft	9096-001	9096-002
11	Magnet	6724-003	6724-003

**ROLL-SEALED REGISTER ASSEMBLIES**

REGISTRATION	5/8"	3/4"	1"	1-1/2"	2"
Cu. Ft.	9107-012	9107-022	9107-032	9107-042	9107-052
Gal.	9107-011	9107-021	9107-031	9107-041	9107-051
M <sup>3</sup>	9107-013	9107-023	9107-033	9107-043	9107-053



**REGISTER BOX PARTS**

ITEM NO.	GOLD DESCRIPTION	BRONZE	PLASTIC	COLOR
	Register Box Assembled	9131-100	9131-000	
a	Register Box (Brz Box & Lid only)	9133-202	9133-001	
b	Register Cover	9132-202	9132-001	
c	Hinge Pin, Register	8313-402	8350-007	
d	Retainer Ring	9105-001	9105-001	
	Seal Pin, D/R Register, ProRead Register	9106-002	9106-001	9106-002
e	Seal Pin, High Profile Reg Box		9309-501	
	Screw, Pulsar Register	8460-011		
	Seal Pin, Old Direct Read	9309-501		

**REGISTER ASSEMBLIES**

SIZE	REGISTRATION	DIRECT READ	ARB*V 4-WHEEL ENCODER	ARB*V 6-WHEEL ENCODER	PROREAD* 4-WHEEL ENCODER	PROREAD* 6-WHEEL ENCODER
5/8"	Cu. Ft.	R82F11	R52F11	R52F12	R62F11	R62F12
	Gal.	R82G11	R52G11	R52G12	R62G11	R62G12
	M <sup>3</sup>	R82M11	R52M11	R52M12	R62M11	R62M12
3/4"	Cu. Ft.	R82F21	R52F21	R52F22	R62F21	R62F22
	Gal.	R82G21	R52G21	R52G22	R62G21	R62G22
	M <sup>3</sup>	R82M21	R52M21	R52M22	R62M21	R62M22
1"	Cu. Ft.	R82F31	R52F31	R52F32	R62F31	R62F32
	Gal.	R82G31	R52G31	R52G32	R62G31	R62G32
	M <sup>3</sup>	R82M31	R52M31	R52M32	R62M31	R62M32
1-1/2"	Cu. Ft.	R82G42	R52F41	R52F42	R62F41	R62F42
	Gal.	R82G42	R52G41	R52G42	R62G41	R62G42
	M <sup>3</sup>	R82M42	R52M41	R52M42	R62M41	R62M42
2"	Cu. Ft.	R82F52	R52F51	R52F52	R62F51	R62F52
	Gal.	R82G52	R52G51	R52G52	R62G51	R62G52
	M <sup>3</sup>	R82M52	R52M51	R52M52	R62M51	R62M52

\* Registers do not include ARB\*V remote receptacles.  
When ordering 1" registers for 10 Cu.Ft. registration, add SA68.

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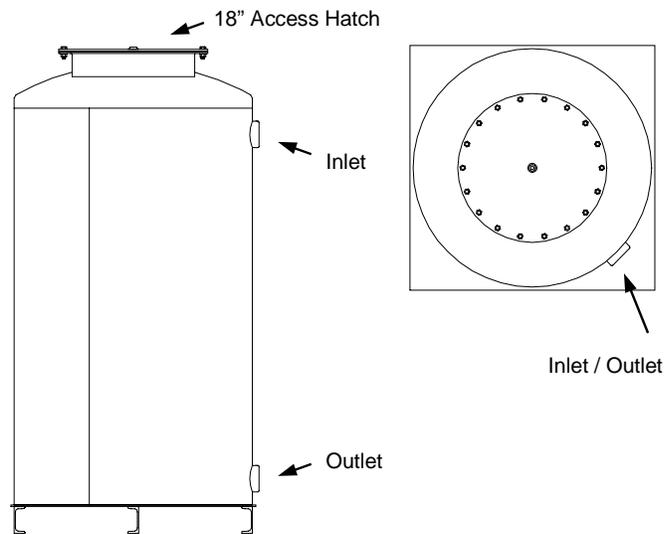
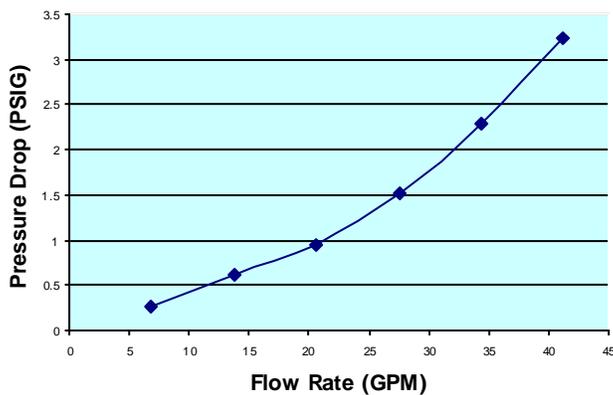


The AF-500 filter is a media filter vessel designed to treat liquid streams. While the typical design application is a activated carbon adsorption unit, the filter can easily accommodate many medias. Some applications include:

- Dissolved Organic Removal (Activated Carbon)
- Suspended Solids Removal (Sand Filter)
- Dissolved Minerals (Softener Resin)
- Oil and Grease Removal (Organo-Clays)
- Dissolved and Precipitated Metals Removal
- Special Organics (Resin/Carbon Blend)
- Catalytic Reactor (Chlorine and Peroxide Removal)
- Bio-Remediation Contactor Unit



**PRESSURE DROP GRAPH**  
(As Filled - 8\*30 GAC)



AF-500 SPECIFICATIONS			
Overall Height	5'2"	Vessel/Internal Piping Materials	CS (SA-36) / SCH 40 PVC
Diameter	30"	Internal Coating	Coal Tar Epoxy Resin
Inlet / Outlet (FNPT)	2"	External Coating	Epoxy Mastic
Drain / Vent (FNPT)	OPT / 1/4"	Maximum Pressure / Temp	40 PSIG / 140° F
GAC Fill (lbs)	500	Cross Sectional Bed Area	4.9 FT <sup>2</sup>
Shipping / Operational Weight (lbs)	875/1,765	Bed Depth/Volume	3.4 FT / 16.7 FT <sup>3</sup>



## HS-200 Series

Media to remove oil, heavy metals and similar organics from water.

The Key to successful water treatment and filtration is selecting the right combination of media and hardware. For treatment of hydrocarbons, heavy metals, and other organic contaminants, the optimal solution is efficient oil and water separation followed by the HS-200 series. Because HS-200 series can absorb up to 70% of its weight in hydrocarbons, its life inside a still bed canister is much longer than that of other process media such as granular activated carbon.

### HS-200 King of Liquid Filtration

- No swelling upon water exposure
- More active ingredients per cubic foot than other organoclays
- Can be used at full strength or custom blended
- Prolongs life of activated carbon and resins thereby reducing costs and increasing efficiency
- Cost effective and environmentally sound technology

### HS-200 Series Veratility

- **Free Standing Mode:**  
Used on its own, HS-200 series can be loaded in drums for use as an efficient stillbed filtration medium. Other applications include tank cleaning, oil spill mitigation, and lining/capping projects.
- **Pre-Treatment Mode**  
HS-200 Series can be used upstream to enhance the performance and extend the useful life of other filtration processes and media such as reverse osmosis, activated carbon and resins.
- **Post-Treatment Mode:**  
HS-200 Series utilized downstream of an oil-water separator or coalesce filter, has the ability to act as an effective cleaning and polishing agent.

The liquid phase filtration media HS-200 shall be 8 x 14 mesh zeolite impregnated with no less than 125 milimoles cetyl trimethyl ammonium chloride per kilogram of zeolite. The density of the product shall be 57-59 pounds per cubic foot.

### HS-200 Removes

#### Oil and Grease

- All types

#### Heavy Metals

- Aluminum
- Cadmium
- Chromium
- Copper
- Lead
- Mercury
- Nickel
- Selenate

Call Now to talk to a Sales Representative!

**1.800.PURPLE.1**

(1.800.787.7531)

### HS-200 Series

#### HS-200 MSDS

#### Water Filtration Brochure

Counterion Effects on the Sorption of Cationic Surfactant and Chromate on Natural Clinoptilolite

- Zinc

## Hydrocarbons and other contaminants

- Acenaphthene
- Ammonia
- Anthracene
- Benzo (a) Anthracene
- Benzo (b) Fluoranthene
- Benzo (a) Pyrene
- Benzo (g,h,i) Perylene
- BOD's
- BTEX
- 4-chloro-3-Methylphenol
- Chromate
- Chrysene
- COD's
- 1,1 Dichloroethane
- 1,2 Dichloroethane
- 1,4 Dioxane
- Fluoranthene
- Fluorine
- Gas Range Hydrocarbons
- 2-Methylnaphthalene
- Motor Oil
- Naphthalene
- PCP (pentachlorophenol)
- Phenanthrene
- Phenolics (recoverable)
- Pyrene
- TCE
- TOC
- Total Phosphorus
- TPH (Total-Petroleum Hydrocarbons)
- TSS's
- Vinyl Chloride

Constituents have had a 95%+ Reductions when treated with these media

If you're having problems with a pesky pollutant, check out our **Pollutant Guide** today!

### Welcome

Solutions  
Services  
Testing  
Pollutants

### Air Filtration

Why Gas Phase Pollution  
Control  
HS-600  
XB-17  
HS-CL  
Modules & Trays  
Air Filtration Housings  
Ethylene Removal  
Oil Mist Removal

### Water Filtration

HS-100  
HS-200 Series  
HS-300  
Vessels & Tanks

# 1.800.PURPLE.1

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**Hydrosil International Ltd.**  
1180 St. Charles Street  
Elgin, IL 60120

Your name \*

Your email \*

Comment(s) \*

### Remediation

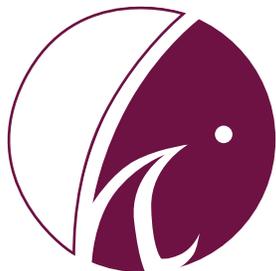
HS-100  
HS-200 Series  
HS-300  
HS-600  
Vessels & Tanks

### Activated Carbons

HS-AC  
HS-AC-P  
HS-AC-P-PO  
HS-AC-P-KOH  
HS-100-PO  
HS-AC-HG

Submit

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# HYDROSIL

## INTERNATIONAL LTD.

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Elgin, IL 60120

Phone: 1-800-787-7531  
Emergency Phone: 1-847-741-1600  
Telex\*: 1-847-741-1616

Hydrosil HS-200

Identity (Trade Name As Used On Label)



MSDS Number\*

CAS Number\*

January 1, 2013 to December 31, 2013

Date Prepared

William J. Waldschmidt

Prepared By\*

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

### SECTION 1 - MATERIAL IDENTIFICATION AND INFORMATION

COMPONENTS - Chemical Name & Common Names (Hazardous Components 1% or greater; Carcinogens 0.1% or greater)	%*	OSHA PEL	ACGIH TLV	OTHER LIMITS RECOMMENDED
N-Hexadecyl-N,N,N-trimethylammonium chloride	4.16%	N/A	N/A	None
Non-Hazardous Ingredients zeolite/water	95.84%			
<b>TOTAL</b>	<b>100</b>			

### SECTION 2 - PHYSICAL / CHEMICAL CHARACTERISTICS

Boiling Point N/A	Density 57.0-59.0 pounds/cubic foot
Vapor Pressure (mm Hg and Temperature) N/A	Melting Point N/A
Vapor Density (Air = 1) N/A	Evaporation Rate (_____ = 1) N/A
Solubility in Water N/A	Water Reactive N/A

Appearance and Odor white irregularly shaped solid, no odor

### SECTION 3 - FIRE AND EXPLOSION HAZARD DATA

Flash Point and Method Used N/A	Auto-Ignition Temperature N/A	Flammability Limits in Air % by Volume N/A	LEL N/A	UEL N/A
---------------------------------	-------------------------------	--	---------	---------

Extinguisher Media If involved in fire, flood with plenty of water

Special Fire Fighting Procedures None

Unusual Fire and Explosion Hazards Products of combustion are toxic

## SECTION 4 - REACTIVITY HAZARD DATA

<b>STABILITY</b> <input checked="" type="checkbox"/> Stable <input type="checkbox"/> Unstable	Conditions To Avoid None known
Incompatibility (Materials to Avoid)	Strong oxidizing and reducing agents
Hazardous Decomposition Products	Organic chlorides, amines, hydrogen chloride may be produced
<b>HAZARDOUS POLYMERIZATION</b> <input type="checkbox"/> May Occur <input checked="" type="checkbox"/> Will Not Occur	Conditions To Avoid None known

## SECTION 5 - HEALTH HAZARD DATA

<b>PRIMARY ROUTES OF ENTRY</b>	<input type="checkbox"/> Inhalation <input type="checkbox"/> Skin Absorption	<input type="checkbox"/> Ingestion <input checked="" type="checkbox"/> Not Hazardous	<b>CARCINOGEN LISTED IN</b>	<input type="checkbox"/> NTP <input type="checkbox"/> IARC Monograph	<input type="checkbox"/> OSHA <input checked="" type="checkbox"/> Not Listed
<b>HEALTH HAZARDS</b>	Acute None	Chronic None	Signs and Symptoms of Exposure None		
Medical Conditions Generally Aggravated by Exposure None					

**EMERGENCY FIRST AID PROCEDURES** - Seek medical assistance for further treatment, observation and support if necessary

<b>Eye Contact</b>	Immediately flush with large amounts of water for 15 minutes Get immediate medical attention
<b>Skin Contact</b>	Wash affected areas with plenty of water and soap if available, for several minutes. Seek medical attention if irritation develops.
<b>Inhalation</b>	Remove from area to fresh air. Seek medical attention if respiratory irritation develops or if breathing becomes difficult.
<b>Ingestion</b>	Give 3-4 glasses of milk (if unavailable, give water), but do not induce vomiting. If vomiting does occur, give fluids again. Seek medical attention.

## SECTION 6 - CONTROL AND PROTECTIVE MEASURES

<b>Respiratory Protection (Specify Type)</b>	Treat as low level nuisance dust, Use NIOSH/MSA #TC-21C-132		
<b>Protective Gloves</b>	Rubber or neoprene when needed	<b>Eye Protection</b>	Use safety glasses with side shields
<b>VENTILATION TO BE USED</b>	<input checked="" type="checkbox"/> Local Exhaust <input type="checkbox"/> Other (specify) None	<input checked="" type="checkbox"/> Mechanical (general)	<input type="checkbox"/> Special
<b>Other Protective Clothing and Equipment</b>	Eye wash, safety shower, protective clothing as appropriate		
<b>Hygienic Work Practices</b>	None		

## SECTION 7 - PRECAUTIONS FOR SAFE HANDLING AND USE/ LEAK PROCEDURES

<b>Steps to be Taken If Material is Spilled Or Released</b>	Keep containers closed until used.
<b>Waste Disposal Methods</b>	Dispose of in accordance with local, state, and federal regulations.
<b>Precautions to be Taken in Handling and Storage</b>	Protect containers against physical damage. Store in a cool dry area in closed containers
<b>Other Precautions and/or Special Hazards</b>	Wet carbon/coal removes oxygen from air causing a severe hazard to workers inside carbon vessels or confined spaces

<b>NFPA Rating*</b> Health _____ Flammability _____ Reactivity _____ Special _____	<b>HMIS Rating*</b> Health _____ Flammability _____ Reactivity _____ Special _____
--	--

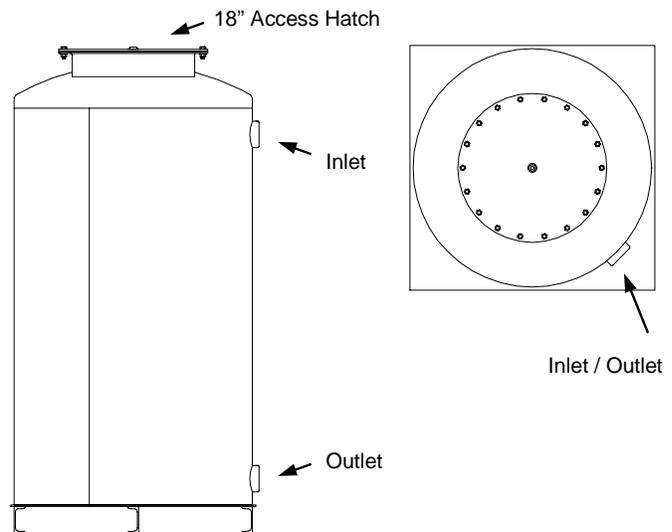
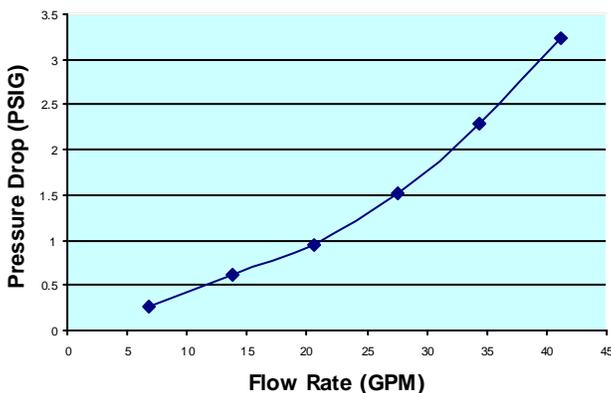
\* Optional

The AF-500 filter is a media filter vessel designed to treat liquid streams. While the typical design application is a activated carbon adsorption unit, the filter can easily accommodate many medias. Some applications include:

- Dissolved Organic Removal (Activated Carbon)
- Suspended Solids Removal (Sand Filter)
- Dissolved Minerals (Softener Resin)
- Oil and Grease Removal (Organo-Clays)
- Dissolved and Precipitated Metals Removal
- Special Organics (Resin/Carbon Blend)
- Catalytic Reactor (Chlorine and Peroxide Removal)
- Bio-Remediation Contactor Unit



**PRESSURE DROP GRAPH**  
(As Filled - 8\*30 GAC)



AF-500 SPECIFICATIONS			
Overall Height	5'2"	Vessel/Internal Piping Materials	CS (SA-36) / SCH 40 PVC
Diameter	30"	Internal Coating	Coal Tar Epoxy Resin
Inlet / Outlet (FNPT)	2"	External Coating	Epoxy Mastic
Drain / Vent (FNPT)	OPT / 1/4"	Maximum Pressure / Temp	40 PSIG / 140° F
GAC Fill (lbs)	500	Cross Sectional Bed Area	4.9 FT <sup>2</sup>
Shipping / Operational Weight (lbs)	875/1,765	Bed Depth/Volume	3.4 FT / 16.7 FT <sup>3</sup>



Liquid & Vapor Filtration  
Remedial • Industrial • Municipal

# Operation & Maintenance Manual

AFD • AF • HPP • HPAF SERIES

Tetrasolv Filtration Liquid Filters

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## 1.0 GENERAL DESCRIPTION

The liquid series filters utilize fixed bed filtration to treat water. The filters employ a variety of medias to remove or catalyze contaminants. Flow through the filter may be either up flow or down flow depending upon the media supplied and the operation parameters. Generally inlet and outlet locations are indicated on the filter and or the filter drawings.

Product data sheets, drawings, MSDS, etc are available from [www.tetrasolv.com](http://www.tetrasolv.com) or call the number below or email your request to [support@tetrasolv.com](mailto:support@tetrasolv.com).

## 2.0 SAFETY CONSIDERATIONS

It is important that the entire O&M manual be read prior to set up and operation of the carbon system.

- ◆ **WARNING: We strongly recommend the use of a relief device in all installations. Exceeding the maximum pressure of the filter could result in catastrophic failure of the vessel.**
- Always adhere to “lockout/tagout” procedures when servicing the system.
- Wear appropriate safety equipment when operating system.
- Review the MSDS sheet for the installed media prior to working with the installed carbon.
- ◆ **WARNING: Wet or dry activated carbon preferentially removes oxygen from air. In closed or partially closed containers, oxygen depletion may reach hazardous levels. If workers must enter a container containing carbon, appropriate sampling and work procedures should be followed for potentially low-oxygen spaces - including all applicable federal and state requirements.**
- Understand the potential hazards of the stream

being treated by the system. The media may contain higher concentrations of the contaminants being adsorbed than is in the influent stream. In addition the media may be considered hazardous material and therefore may require specific handling precautions unknown to Tetrasolv Filtration.

## 3.0 INSTALLATION

### 3.1 Shipment

Typically filters are shipped with media installed. However, in certain instances media is shipped to the site to be installed after installation. In very large systems it may be advisable to not install the media until adsorbers have been placed into final position and secured.

### 3.2 Unloading

Refer to the product data sheet for weight information for appropriate sizing information for the equipment to be used.

All components should be lifted either by crane or forklift as designated by the model.

- ◆ **WARNING: Failure to follow the procedures outlined below can result in catastrophic damage to the system.**

**Crane Lift** - If a crane lift is to be used we recommend the following method. A "spreader" equaling 75% of the distance between the opposing lifting eyes on each adsorber should be used to insure proper lifting force direction. Attach an appropriately sized spreader beam and lifting cables to each lift eye of the component. The use of an experienced crane operator and quality equipment is highly recommended.

**Fork-Lift** - When using a forklift we recommend that the fork tubes on the filter be used or a pallet if the unit was shipped on a pallet.

- ◆ **WARNING: Never attempt to pick up an adsorber which has wet carbon installed. The lifting eyes are designed only to lift the adsorber with dry carbon installed.**

### 3.3 Inspection

Perform the following inspections after un-loading the filter. Note any discrepancies and contact Tetrasolv

Filtration immediately.

- Check the vessel exterior for damage which may have occurred during shipment. Inspect the support structures and piping support for damage.
- Inspect the piping system for damage. Insure the valves operate properly. Check installed instruments and instrument installation points for damage.
- Visually inspect the interior (if possible) of the vessel for loose laterals and or internal damage.
- Inspect the carbon discharge, drain and vent valves for damage.

### 3.4 Set Up

The filter should be placed on a level concrete pad of appropriate thickness to support the system at it's maximum operational weight. The filter should be secured to the pad using appropriately sized anchor bolts.

Connect the site piping to the filter inlet and outlet connection points. It is important that all piping connected to the filter should be self supported. We also recommend in hard pipe installation that a flexible joint be used to further insulate the filter from vibration and stress.

Connect any gauges and instrumentation shipped loose with the system.

The outlet piping should be designed to allow flooded operation of the Adsorber at all times to assure effective operation. If the outlet line does not provide for back pressure on the Adsorber unit, then the discharge piping should include an elevated piping loop to assure flooded operation.

Siphoning can occur when the discharge line allows suction to be placed on the process discharge. Siphoning can cause air pockets to occur in the adsorbers. If channeling is likely to occur we recommend the installation of an appropriately sized vacuum breaker.

If the supply pump is capable of producing pressure greater than the design limitation of the filter it is recommended that a rupture disk or pressure relief valve be installed prior to the influent connection.

---

If water conditions such as high suspended solids exist a filter should be installed prior to the Adsorber. A simple cartridge or screen filter helps prevent pressure buildup in the media bed. Many other water issues may effect Adsorber operation and we therefore recommend you discuss your specific installation with a representative.

Connect the process inlet and outlet to the site influent and effluent process lines.

### 3.5 Wetting and Deaeration

Dry carbon and other medias must be wetted and deaerated prior to use. This procedure displaces air from the internal structure of the carbon granule, thus assuring that the liquid to be treated is in contact with the carbon surface.

Prior to operation, the filter must be filled with clean, uncontaminated liquid. The recommended method for filling the vessel is through the outlet line. Open the inlet line to purge air from the system. Feed water into the outlet line until water flows from the inlet line. The wet carbon or media should be allowed to set for a minimum of 1 hours.

This is also a good time to inspect the system for leaks which may have been caused in transit and unloading the system. If leaks are spotted, tighten the fitting or flange bolts carefully until the leak stops. Do not overtighten the bolt or fitting. If the leak persists contact Tetrasolv Filtration for assistance.

After wetting, the carbon bed can be deaerated by draining the adsorber, and again filling the adsorber upflow with uncontaminated water. This procedure will eliminate any air pockets which may have formed between the carbon granules.

After completing the wetting and Deaeration it is recommended that a backwash be performed. The backwash will remove media fines which can cause excess pressure drop in the system if not removed. In addition backwashing helps equalize the bed. Follow the directions outlined in Backwashing (*refer to section 4.2*).

After backwashing close the system valves and wait 1 hour.

The system is now ready for operation.

## 4.0 OPERATION

Flowrates to the filter should be determined based upon the required contact time between the liquid and the filtration media. The required contact time normally is determined prior to installation and operation of the filter.

It is important that the filters remain flooded at all times. If it is necessary to drain adsorbers while off-line it is recommend the procedures in section 3.5 "Wetting and Dearation" be repeated.

### 4.1 Modes of Operation

With certain applications (2) filters in series flow are utilized. Listed below are typical operational modes.

- Shutdown - Both filters completely off-line and isolated.
- Series Flow - Influent enters primary filter and exits through secondary adsorber (this is the preferred method of operation)
- Isolation Flow - Only one filter is receiving influent. This mode is typically used when the operator is maintaining the off-line filter.
- Parallel Flow - Both filters are receiving the influent as the primary. Flow is split equally between the filters. This mode is used when higher flow rates need to be achieved and contact times are not critical.
- Backwash Mode - Used when back-washing either filter.

### 4.2 Backwashing

**IMPORTANT: Backwashing is not advisable with AFD or AF Series Filters. If a backwash is required please contact the number below or support@tetrasolv.com for assistance.**

Usually backwashing is only performed in carbon adsorbers after new carbon has been installed or prior to removing the carbon from the adsorber. However, sometimes water conditions necessitate backwashing to remove suspended solids from the top of the carbon bed. Keep in mind that backwashing a carbon bed during normal service runs may cause the transfer zone to be disturbed leading to pre-mature breakthru of the carbon bed. Backwashing helps to reduce and equalize pressure drop across the media bed as well as removes

collected particulate from the top of the bed. Backwash rates for filters typically fall in the 5 to 20 gpm/ft<sup>2</sup>. Backwash rates are dependent upon temperature of the backwash water, filter design and the media conditions. Refer to the data sheet for the supplied filter to obtain the cross sectional bed area. Refer to the data sheet for the supplied media to obtain the recommended backwash rate. Backwashing should begin at a low rate and proceed upwards.

Clean, uncontaminated, sediment free water is introduced to the filter through the outlet connection. This liquid flows upwards through the filter and exits through the inlet line - directed to a back-wash water collection point or drain. The flow rate should not be high enough to cause a significant quantity of media to exit.

**IMPORTANT: Use only clean un-contaminated water free of sediments. If there is any question that sediments may be present the water should be filtered through a 100 micron filter or smaller. Sediments introduced into the lateral system during backwash can cause excessive pressure build-up in the underdrain leading to underdrain failure.**

If possible position an observer at the backwash discharge point. The observer should note excessive media loss and general appearance of the backwash effluent. If conditions warrant the observer should also instruct that the backwash be stopped.

Monitor the differential pressure for the filter being backwashed during the operation. If the differential pressure exceeds 30 PSIG discontinue the backwash and contact Tetrasolv Filtration.

**IMPORTANT: Differential Pressure exceeding 30 PSIG during backwash may damage the vessel underdrain.**

#### 4.3 Monitoring

Filter units only require periodic monitoring if properly installed. The following items may be monitored:

- Pressure: Check inlet and outlet pressure. Increase in pressure differential may indicate build-up of filtered solids. Never exceed maximum design pressure of filter. If the differential pressure exceeds 20 PSIG it may become necessary to perform a backwash (see **Backwashing Section 4.2**)
- Samples: Inlet and outlet sample points if provided for liquid analysis to determine system performance. Before pulling a sample

the sample valve should be opened and allowed to flow freely for a few minutes to insure a fresh sample is obtained.

- Air: Check for trapped air by opening upper vent valve and allowing small amount of liquid to flow out. If your system was provided with automatic vent systems it is still necessary to periodically verify their operation.
- Inspect the discharge stream periodically for filtration media. If filter media is present in the exit stream shut down the system and contact Tetrasolv Filtration immediately.

**Note: When the system is first started up small amounts of fines may be present. This is normal and should discontinue within a short period of time.**

## 5.0 FILTRATION MEDIA REPLACEMENT

Prior to servicing the unit should be closed off from influent and effluent lines and any electrical devices or connections should be tagged off.

After removal of the filtration media is complete, it is recommended that the inside of the filter be washed to remove all contamination and any trace of spent media. After the filter has been washed, the filter should also be checked thoroughly and any minor maintenance conducted.

### 5.1 Media Loading - Dry Method

Fill the adsorber 1/4 full of clean water to protect the lower manifold and limit the amount of dust generated.

◆ **WARNING - Dry activated carbon generates considerable dust. While activated carbon poses no health risk the dust can cause respiratory irritation and occasional skin rash. Therefore we recommend the use of proper clothing and dust mask during filling operation.**

Super Sacks - Hoist the bag over the manway and untie the outer bag exposing the inner chute. Untie the inner chute while clasp it shut. Remain holding the chute and carefully lower the chute into the manway. Un-clasp the chute and allow the carbon to discharge from the sack. The carbon should flow out very quickly and completely. When finished shake the bag and invert the chute into the bag.

---

If at any time you wish to stop the flow of carbon simply re-grasp the chute up high and cinch. Re-tie the bag.

## 5.2 Media Loading - Slurry Method

In this method dry-activated carbon will be delivered to the site in a slurry truck or slurry capable hoppers. To add the carbon to the filters use the following method:

◆ **WARNING: Carbon slurry operation is a potentially hazardous operation which should only be performed by experienced operators with prior slurry experience. If you are un-trained do not attempt to perform a slurry without assistance.**

1. Use an appropriate sized hose connected to the carbon supply line for the adsorber. **Be sure the slurry line is adequately secured and the cam-lock mechanism is completely engaged. If the slurry line disconnects or fails large amounts of carbon will be expelled.**

2. Fill the adsorber 1/4 full of water to cushion the vessel internals from the entering carbon.

3. Completely cover the fresh carbon with clean water. Connect air source to the slurry container capable of producing 10 PSIG of air at 175 cfm.

4. Open the adsorber process outlet valve to allow excess water to escape the system (note: depending upon your discharge piping configuration this may not allow sufficient water drainage under non-pressure operation, consult Tetrasolv Filtration). Open the slurry in valve. Fresh carbon should begin flowing quickly into the filter. During this process it may become necessary to stop the slurry and allow excess water to drain from the adsorber.

5. When transfer is complete the transfer hose will begin blowing air only. It may be necessary to inspect the transfer hopper for carbon which did not transfer. If a sufficient quantity is present wash the carbon to the center using clean water and add enough water to re-cover the carbon and repeat the above procedures.

6. Close the valves and proceed to Section 3.5 "Wetting and Deaeration" then perform a backwash.

## 5.3 Media Removal - Slurry Method

***This method can only be used with slurry equipped HPAF Series!***

In this method spent activated carbon will be removed from the spent adsorber into a slurry truck or slurry capable hoppers. To remove the carbon from the filter use the following method:

◆ **WARNING: Carbon slurry operation is a potentially hazardous operation which should only be performed by experienced operators with prior slurry experience. If you are un-trained do not attempt to perform a slurry without assistance.**

Backwashing the adsorber to be serviced for a few minutes prior to servicing will make the slurry occur more easily. It is important the the adsorber to be backwashed be full of water prior to attempting the slurry.

1. Connect the carbon discharge line to the carbon discharge connection on the adsorber to be emptied.

2. Connect an air source to the carbon fill line capable of producing 50 PSIG of air at 175 cfm.

◆ **WARNING - The inlet air should be closely monitored to insure the pressure does not exceed the design pressure leading to rupture disc activation. If this can not be done the use of a pressure limiting device which still allows adequate air flow should be used.**

3. Open the air vent valve and pressurize the adsorber to 15 PSIG.

**IMPORTANT: The initial pressure required for slurry transfer will be between 10 and 20 PSIG. Because of the compressibility of air the pressure should be reduced as the adsorber empties. If the operator supplying compressed air into the adsorber cannot see the pressure gauge there must be another operator who can call out the pressure reading during the transfer.**

4. Open the slurry out valve. Spent carbon should begin flowing quickly out of the carbon vessel.

5. When transfer is complete the transfer hose will begin blowing air only. Bleed all air from the adsorber, remove the manway and inspect the adsorber for carbon which did not transfer. If a sufficient quantity is present wash the carbon to the center using clean water and add enough water to re-cover the carbon and repeat the above procedures.

6. Inspect the internals prior to refilling the adsorber.

---

Inspect the interior lining. Do not place the adsorber back into operation if any defects are noted.

## 6.0 MAINTENANCE

### 6.1 Extended Shut Down

If the filter will be shutdown for extended periods certain procedures should be taken to protect the filter.

If possible backflush the filter. Drain all water from the adsorber utilizing the effluent connection and the drain port if available. When draining allow air to enter the system by venting the influent line. Store the drained filter with system vented.

Caution should be taken during system startup following exposure to freezing conditions as the media may still be in a frozen state days or weeks after.

Prior to placing the adsorber back into service it is recommended the procedures outlined in section 3.5 "Wetting and Dearation" be followed.

Monitor the filter closely after extended shutdown for signs of potential problems such as interior manifold failure or leaking valves and gaskets.

### 6.2 Manway Opening & Closing

When it becomes necessary to open a manway the following methods should be closely followed:

- ◆ **WARNING: Opening a manway while a vessel is pressurized can cause serious injury or death. Always verify pressure is relieved before attempting to remove a cover.**
- ◆ **WARNING: Opening the lower manway on an filter which contains media can result in large quantities of media being discharged. Worse still the manway may not be able to be successfully sealed without removal of the media.**

**Verify vessel is isolated and relieve pressure using filter vent valve.**

#### Round T-Bolt Closures

1. Carefully loosen retaining nuts around manway ring. If while loosening the bolts you hear a hissing or any other indication of pressure immediately re-tighten the bolts and verify pressure has been relieved.

3. Swing all T-Bolts away from manway cover and slowly open cover. If gasket sticks to manway cover gently pry away to avoid tearing the gasket.

4. Clean O-Ring surface. Lubricate gasket with petroleum jelly.

5. Close manway and tighten bolts. It may be necessary to further tighten bolts after pressure has been applied to filter to prevent leaking.

#### Elliptical Closures

1. Slip a bent bar between the manway handle and the flange frame. ***This is to insure the manway does not fall into the vessel when the yokes are removed.***

2. Carefully loosen both large nuts holding the yokes to the manway. Remove the yokes.

3. Slide the bar out of the handle while holding it. Push the manway in and tilt to allow the manway to be pulled out of the filter.

Closing the manways:

1. Clean the gasket surface and replace if necessary. Apply tape to the gasket and the cover to hold the gasket in place while it is placed into position.

2. Slip a bent bar between the manway handle and the flange frame. ***This is to insure the manway does not fall into the vessel when the yokes are removed.***

3. Place the yoke into the manway cover slot and hand tighten. Carefully inspect the gasket to be sure it can be seen around the inside surface of the manway opening.

4. Wrench tighten nuts.

## 7.0 Troubleshooting

The following situations are typical problems which may arise during the operation of filters. If these problems cannot be resolved by using this guide or problems occur which are not addressed in this guide please contact TetraSolv Filtration at the number listed below or e-mail [support@tetrasolv.com](mailto:support@tetrasolv.com)

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*Situation:*

High pressure drop or inadequate flow through filters at expected pressure drop levels.

*Probable Cause:*

- a) Verify effluent and influent lines to and from adsorber are not restricted.
- b) Sediments or solids may have clogged the surface of the media. Remove the top manway cover and inspect the surface of the media. Backwashing the media should resolve this issue. Explore the possibility of pre-filtration ahead of the media filter to limit future problems.
- c) Air is trapped in the top of the filter or the system piping. Relieve air using vent valves.
- d) Underdrain collection baskets clogged. Contact Tetrasolv Filtration for recommendations.

*Situation:*

Manways failing to seal. Water leaking from.

*Probable Cause:*

- a) Manway not installed properly.
- b) Missing or damaged gasket
- c) Debris trapped between gasket and ring

*Solution:*

Tighten the bolts on the manway first. If this does not solve the problem remove and reinstall manway as outlined in 6.4 if possible. If problem persists contact TetraSolv Filtration for further assistance.

*Situation:*

Premature filter exhaustion.

*Probable Cause:*

- a) Inadequate contact time between the media and the liquid stream.
- b) Contaminants in stream not originally accounted for in initial design or higher levels of contaminants than originally accounted for.

- c) Trapped air or solids on bed causing channeling.

*Solution:*

Sample and analyze the influent water stream. Verify proper conditions exist. Also look closely at suspended and dissolved solids.

Verify contact time sufficient for contaminant being adsorbed. Decrease flow rate or install additional media.

Inspect surface of filter for fouling.

Release excess air from top of filter through filter vent line.

*Situation:*

Activated Carbon bed discharge stream has higher level of contaminants than influent stream.

*Probable Cause:*

Carbon bed has reached saturation. Carbon beds will often release larger amounts of contaminants than they are adsorbing as the mechanical bonds are broken when the carbon has reached its saturation point.

Also, activated carbon will preferentially exchange more easily adsorbed compounds for ones already trapped in the carbon surface releasing the compounds trapped in unpredictable levels.

# Georg Fischer Signet LLC

## Signet 2551 Magmeter

### Certificate of Calibration and Conformance

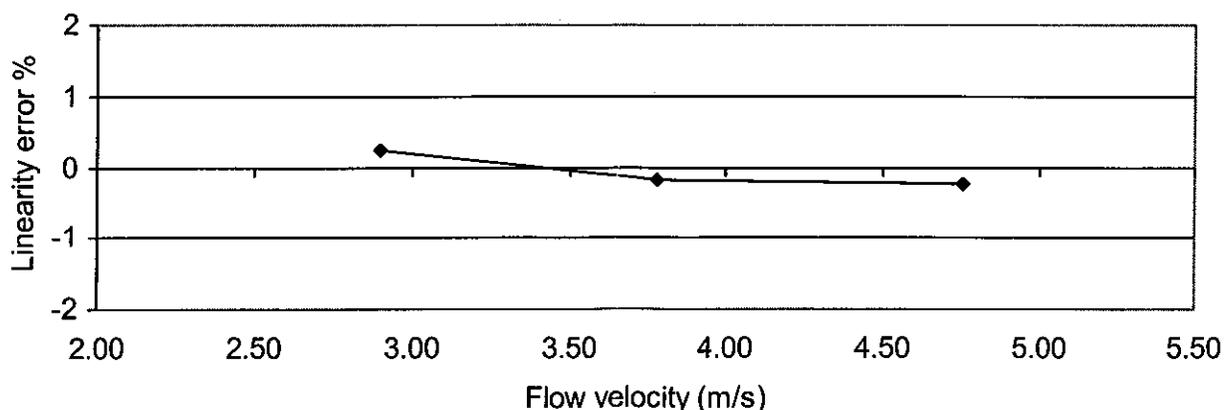
#### Part information

Part number: 3-2551-P0-42  
Type: PP/316L SS; mA output  
Serial number: 61210080495  
Calibration date: October 08, 2012

#### Test conditions

Test media: Water  
Pipe type: SYGEF PVDF d50  
Pipe fitting: PVDF Tee d50, SFMT015  
Output jumper: S<sup>3</sup>L (applies to 3-2551-XX-X1 only)  
Pipe size jumper: Off

Flow Velocity ft/s (m/s)	Reynolds Number	Linearity (% of reading)
9.51 (2.90)	128067.12	0.23
12.39 (3.78)	166930.96	-0.18
15.59 (4.75)	209994.10	-0.23



Refer to Signet 2551 Magmeter manual (PN 3-2551.090 or 3-2551.090-1) for technical specification.  
Reference flowmeter calibration is traceable to NIST and certified at preset intervals.



## SAFETY INSTRUCTIONS

1. Depressurize and vent system prior to installation or removal.
2. Confirm chemical compatibility before use.
3. Do not exceed maximum temperature/pressure specifications.
4. Wear safety goggles or faceshield during installation/service.
5. Do not alter product construction.



## 1. Description

The 2551 Magmeter measures the flow rate in a full pipe by monitoring the voltage produced when the (conductive) fluid moves through a magnetic field. Output options include a traditional frequency signal, a serial data (Digital (S<sup>3</sup>L)) output, and a 4 to 20 mA output.

The 2551 Magmeter is available in three sizes that will accommodate pipes from ½-inch through 36-inch diameters.

Select from three different material combinations to match the Magmeter to the application requirements.

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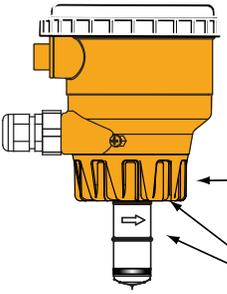


**WARNING!**

FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN THE SENSOR BEING EJECTED FROM THE PIPE!

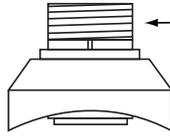
- DO NOT USE ANY TOOLS ON THE RETAINING CAP. HAND TIGHTEN ONLY.
- LUBRICATE O-RINGS WITH A NON-PETROLEUM BASED, VISCOUS LUBRICANT (GREASE) COMPATIBLE WITH THE SYSTEM.
- DO NOT USE THREAD SEALANT OR LUBRICANTS ON THE RETAINING CAP OR ON THE PLASTIC FITTING THREADS.
- IF LEAKING IS OBSERVED FROM THE RETAINING CAP, IT INDICATES DEFECTIVE OR WORN O-RINGS ON THE SENSOR. DO NOT ATTEMPT TO CORRECT BY FURTHER TIGHTENING.





Do not use any tools to tighten the yellow retaining cap. DO NOT USE thread sealant or lubricants on retaining cap!

Lubricate O-rings with a non-petroleum based, viscous lubricant (grease) compatible with the system.



DO NOT USE thread sealant or lubricants on the fitting threads!

## 2. Specifications

### General

- Pipe size range: DN15 to DN900 (½ to 36 in.)
- Flow Range: Minimum: 0.05 ms (0.15 ft/s) Maximum: 10 ms (33 ft/s)
- (Bi-directional)
- Linearity: ±1% of reading +0.01 ms (0.033 ft/s)
- Repeatability: ±0.5% of reading @ 25 °C (77 °F)
- Minimum Conductivity: 20 µS/cm

### Wetted Materials:

- Sensor body and Electrodes and Grounding ring:
  - -P0, -P1, -P2: Polypropylene and 316L SS
  - -T0, -T1, -T2: PVDF and Titanium
  - -V0, -V1, -V2: PVDF and Hastelloy-C
  - O-rings: FPM (standard) EPDM, FFFPM (optional)



The user is responsible for determining the chemical suitability of these materials for a specific application.

### Power Requirements

- 4 to 20 mA: 21.6 to 26.4 VDC, 22.1 mA max. 400 mV p-p maximum ripple voltage
- Frequency: 5 to 26.4 VDC, 15 mA max.
- Digital: 5 to 6.5 VDC, 15 mA max.
- Auxiliary (only required for units with relays): 9 to 24 VDC, 0.4A max
- Reverse polarity and short circuit protected

### Output Specifications

#### Current output (4 to 20 mA)

- Max Loop Resistance: 300 Ω
- Loop Accuracy: 32 µA max. error (25 °C @ 24 VDC)
- Temp. drift: ± 1 µA per °C max.
- Power supply rejection: ± 1 µA per V
- Isolation: Low voltage < 48 VAC/DC from electrodes and aux power
- Maximum cable: 300 m (1000 ft.)
- Error condition: 22.1 mA

#### Frequency output:

- Output modes: Freq, Freq+10, or Mirror Relay 1
- Max. Pullup Voltage: 30 VDC
- Max. Current Sink: 50 mA, current limited
- Maximum cable: 300 m (1000 ft.)
- Reverse Polarity Protected to -40 V

#### Digital (S<sup>3</sup>L) Output:

- Serial ASCII, TTL level 9600 bps
- Compatible with Signet 8900 and 9900

### Relay Specifications

- Relay 1 and 2 Type: Mechanical SPDT
  - Rating: 5 A @ 30 VDC max., 5 A @ 250 VAC max.
- Relay 3 Type: Solid State
  - Rating: 50 mA @ 30 VDC, 50 mA @ 42 VAC
- Hysteresis: Adjustable, plus timer delay
- Trigger Delay: Adjustable (0 to 9999.9 sec.)
- Relay Modes: Off, Low, High, Window, and Proportional Pulse
- Relay Source: Flow Rate, Resettable Totalizer
- Error Condition: Selectable; Fail Open or Fail Closed

### Display

- Characters: 2 x 16
- Contrast: User-set in four levels
- Backlighting (only on relay versions): Requires external 9-24 VDC, 0.4 mA max.

### Environmental Requirements

- Case: PBT
- Display window: Polyamide
- Storage Temperature: -20 to 70 °C (-4 to 158 °F)
- Relative Humidity: 0 to 95% (non-condensing)
- Operating Temperature
  - Ambient: -10 to 70 °C (14 to 158 °F)
  - Media: 0 to 85 °C (32 to 185 °F)
- Max. operating pressure:
  - 10.3 bar @ 25 °C (150 psi @ 77 °F)
  - 1.4 bar @ 85 °C (20 psi @ 185 °F)

### Standards and Approvals

- CE
- UL, CUL (for display versions with relays)
- NEMA 4X / IP65 Enclosure (with cap installed)



China RoHS

For more information go to [www.gfsignet.com](http://www.gfsignet.com)



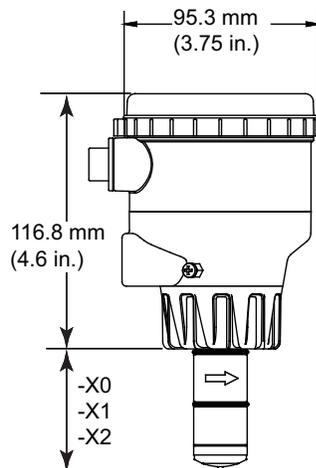
### Declaration of Conformity according to FCC Part 15

This device complies with Part 15 of the FCC rules.

Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and,
- (2) This device must accept any interference received, including interference that may cause undesired operation.

### Dimensions

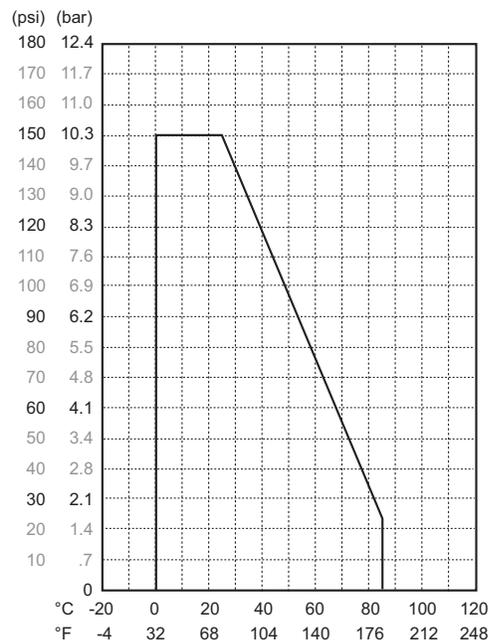


#### Pipe Range

- 1/2 to 4 in. -X0 = 58 mm (2.3 in.)
- 5 to 8 in. -X1 = 91 mm (3.6 in.)
- 10 to 36 in. -X2 = 167 mm (6.6 in.)

X = Sensor Body P, T, or V

### Operating Temperature/Pressure



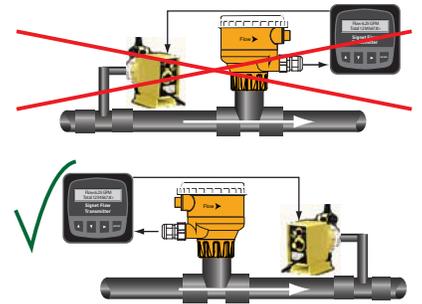
### 3. Installation: Pipe Fittings

Georg Fischer offers a wide selection of installation fittings that control the position of the Magmeter electrodes in relation to the dimensions of the pipe. You will find a complete list of order numbers for installation fittings in the Calibration Tables on pages 12-13.

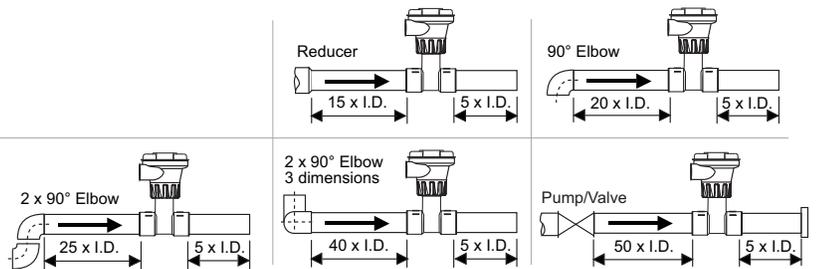
Type	Description	Type	Description
Plastic tees 	<ul style="list-style-type: none"> <li>• 0.5 to 2 inch versions</li> <li>• MPVC or CPVC</li> </ul>	Iron, Carbon Steel, 316 SS Threaded tees 	<ul style="list-style-type: none"> <li>• 0.5 to 2 in. versions</li> <li>• Mounts on threaded pipe ends</li> </ul>
PVC Glue-on Saddles 	<ul style="list-style-type: none"> <li>• Available in 10 and 12 inch sizes only</li> <li>• Cut 2-1/2 inch hole in pipe</li> <li>• Weld in place using solvent cement</li> </ul>	Carbon steel & stainless steel Weld-on Weldolets 	<ul style="list-style-type: none"> <li>• 2 to 4 inch, cut 1-7/16 inch hole in pipe</li> <li>• Over 4 inch, cut 2-1/8 inch hole in pipe</li> </ul>
PVC Clamp-on Saddles 	<ul style="list-style-type: none"> <li>• 2 to 4 inch, cut 1-7/16 inch hole in pipe</li> <li>• 6 to 8 inch, cut 2-1/8 inch hole in pipe</li> </ul>	Fiberglass tees 	<ul style="list-style-type: none"> <li>• 1.5 in. to 2 in. PVDF insert</li> </ul>
Iron Strap-on saddles 	<ul style="list-style-type: none"> <li>• 2 to 4 inch, cut 1-7/16 inch hole in pipe</li> <li>• Over 4 inch, cut 2-1/8 inch hole in pipe</li> <li>• Special order 14 in. to 36 in.</li> </ul>	Union Fittings and Wafers 	<ul style="list-style-type: none"> <li>• For pipes from DN 15 to 50 mm</li> <li>• PP or PVDF</li> </ul>

#### 3.1 Installation: Selecting a Location

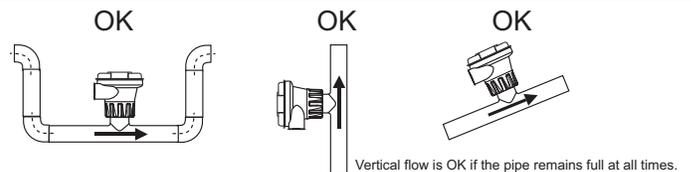
- The 2551 requires a full pipe and a fully developed turbulent flow profile for accurate measurement.
- If the piping system harbors air pockets or bubbles, take steps to locate the sensor so the air pockets will not contact the electrodes.
- In vertical installations, assemble the 2551 so the conduit ports are facing downward. This prevents condensation inside the conduit from being directed into the 2551 electronics housing.
- Chemical injection systems can temporarily alter the fluid conductivity and cause anomalies in the magmeter measurement. To avoid this problem, install the magmeter UPSTREAM of the injection point.



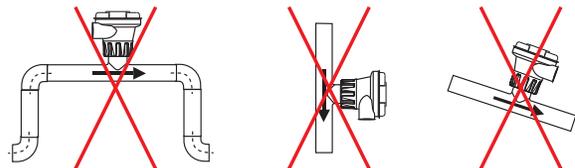
Select a location with sufficient distance of straight pipe immediately upstream of the sensor.



Locating the sensor in a trap or where the flow is upward helps to protect the sensor from exposure to air bubbles when the system is in operation.

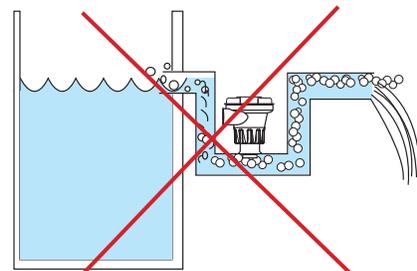


These configurations are not recommended because it is difficult to keep the pipe full.



In a gravity-flow system, the tank must be designed so the level does not drop below the outlet.

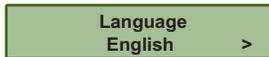
This causes the pipe to draw air in from the tank. If air bubbles pass across the Magmeter electrodes, the output will become erratic.



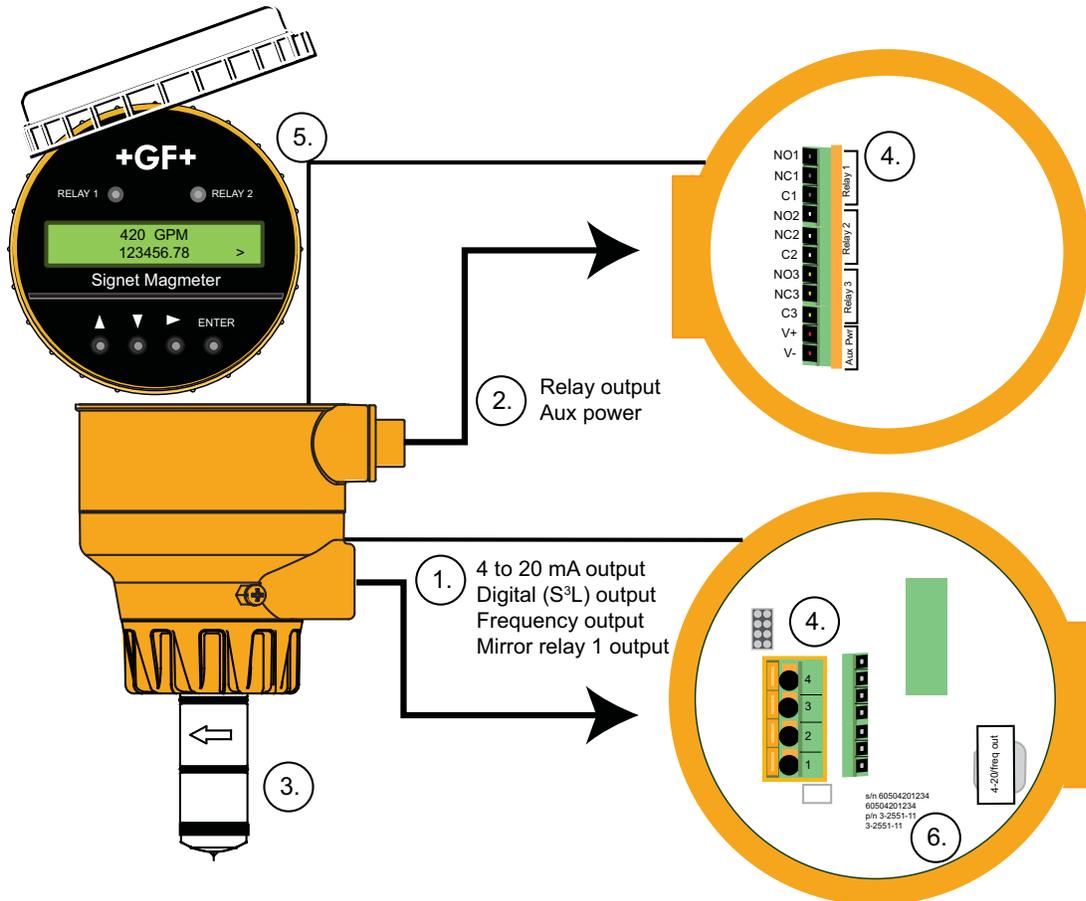
## 4. Overview of 2551 Display Magmeter

2551 Display Magmeters use a dual-sided electronics module and dual conduit ports. Unused ports must be sealed to protect the electronics from water damage.

1. The lower set of conduit ports provide access to the wiring terminals for:
  - Loop Power
  - Flow Output Signal (current loop, Digital (S<sup>3</sup>L), frequency or Mirror Relay 1 output).
2. The upper set of conduit ports provide access to the wiring terminals for:
  - Relay output wiring
  - Auxiliary power for relay coils and display backlight
3. The sensor is marked with a directional arrow to indicate the direction identified as forward flow.
  - An adhesive decal is also provided that can be affixed to the pipe to indicate the direction of forward flow.
  - Flow in the opposite direction from the arrow will be identified as reverse flow on the display by a "-" symbol.
4. The terminals in the magmeter are designed to accommodate 16 to 22 AWG conductors.
5. The display includes two LEDs that light when Relay 1 or Relay 2 are activated.
  - All three relays can be monitored by scrolling to the Relay Status display located in the View menu.
  - If the Language option has not been made, new magmeters will always open with the Select Language display.



6. The part number, serial number and output type are identified on the electronics module.



### Chemical Compatibility Warning

The retaining nuts of Magmeters are not designed for prolonged contact with aggressive substances. Strong acids, caustic substances and solvents or their vapor may lead to failure of the retaining nut, ejection of the sensor and loss of the process fluid with possibly serious consequences, such as damage to equipment and serious personal injury. Retaining nuts that may have been in contact with such substances e.g. due to leakage or spilling, must be replaced.

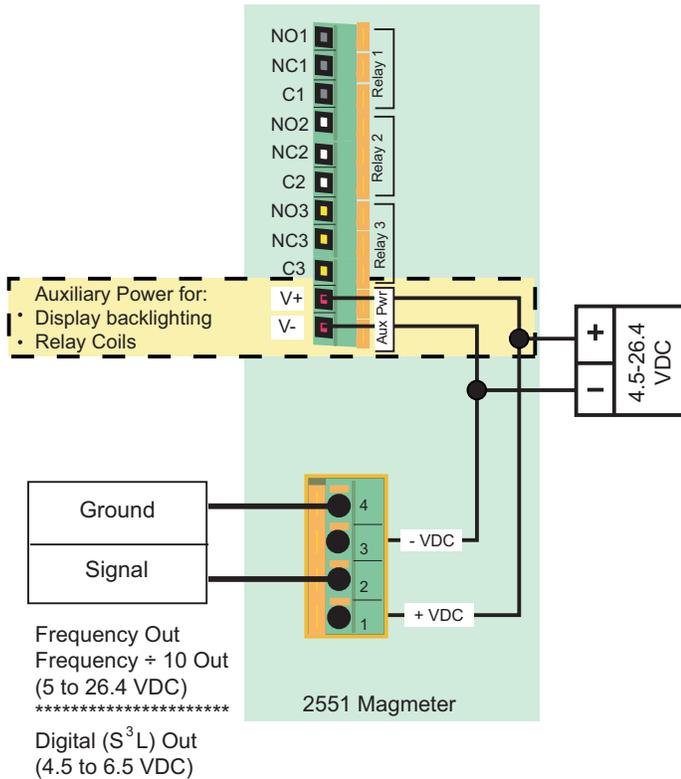
## 5. Wiring

### 5.1 Basic Wiring

#### Frequency output

3-2551-21 and -41 Magmeters may be programmed in the OPTIONS menu to provide an open collector FREQUENCY output.

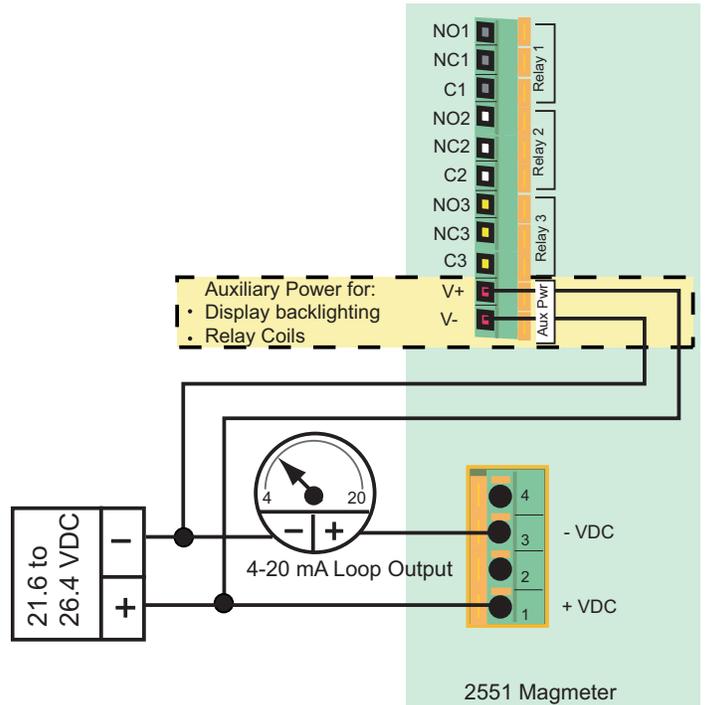
- The maximum frequency output is 1000 Hz (@ 10 meters per second)
- If the Frequency ÷ 10 output is selected, the maximum frequency is 100 Hz (@ 10 meters per second).
- AUX PWR must be connected to power the display backlighting and to power the relay coils if included.



#### 4 to 20 mA output

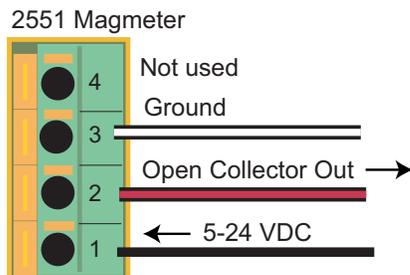
The 3-2551-22 and -42 Magmeters provide a passive 4 to 20 mA loop output.

- External loop power (24 VDC) is required.
- Factory standard calibration is 4 - 20 mA = 0 - 5 m/s.
- The 4 to 20 mA output can be spanned to any range, from -10 m/s to +10 m/s.
- AUX PWR must be connected to power the display backlighting and to power to the relay coils if included.



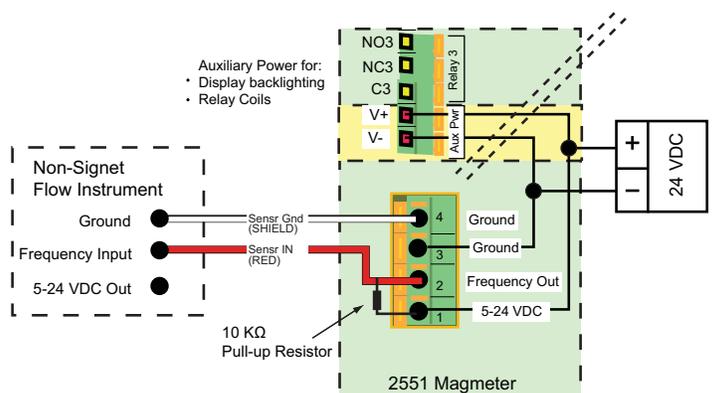
### 5.2 Wiring: Mirror Relay 1 output

The 3-2551-21 and -41 Magmeter can be configured in the OPTIONS menu to provide an Open Collector output in lieu of the sensor signal provided by Frequency or Digital (S<sup>3</sup>L) output selections. The Open Collector output can be programmed via the Relay 1 menu.



### 5.3 2551 and other manufacturer's instruments

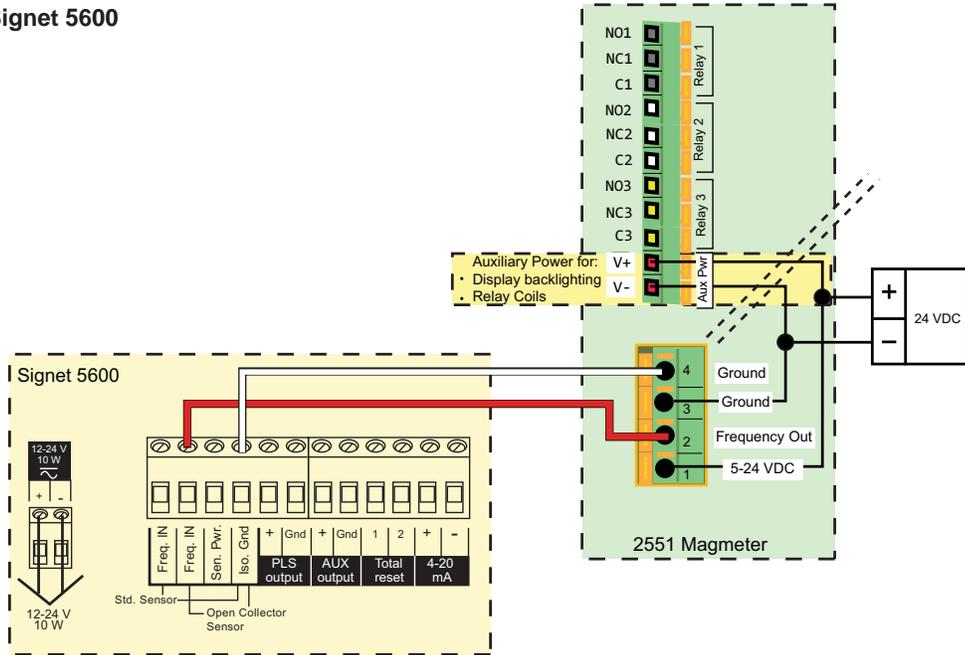
When using the 2551 in a system with other manufacturer's equipment, a 10 KΩ pull-up resistor (not supplied) may be required to power the open collector output.



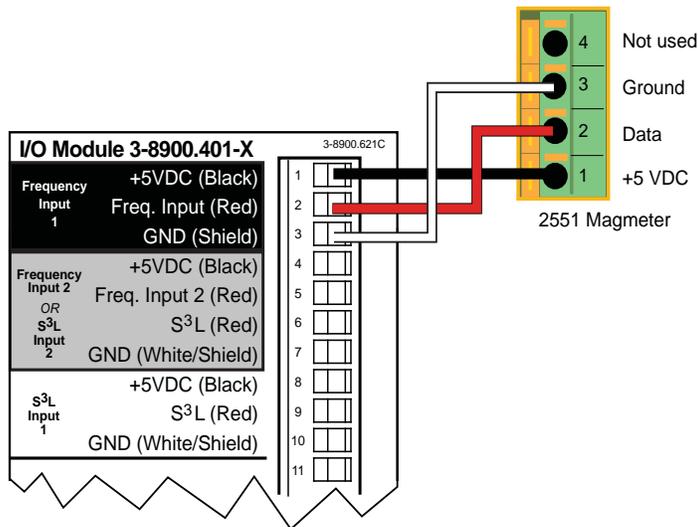
## 5.4 Wiring to Signet Flow Instruments

The 2551-21 and -41 Magmeter can be configured in the OPTIONS menu to provide a Frequency or Digital (S<sup>3</sup>L) output. Frequency output can be used by Signet 5600 Flow Transmitter, and by Signet 8900 Multi-Parameter Controller and 9900 Transmitter. The Digital (S<sup>3</sup>L) output can be used by the 8900 and 9900.

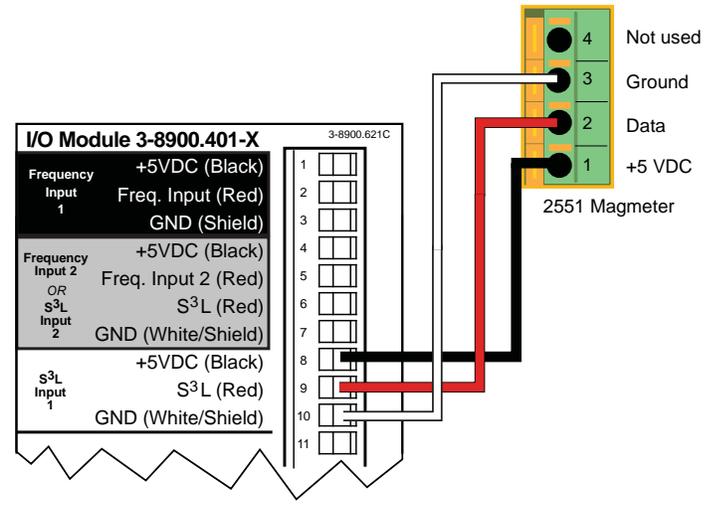
### 2551 Frequency Out to Signet 5600



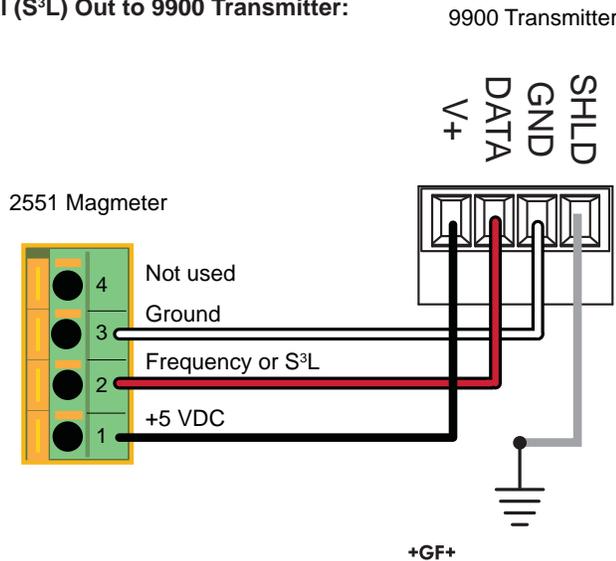
### 2551 Frequency Out to 8900 Controller:



### 2551 Digital (S<sup>3</sup>L) Out to 8900 Controller:



### 2551 Frequency or Digital (S<sup>3</sup>L) Out to 9900 Transmitter:



## 5.5 Wiring Relays

Relay 1, Relay 2 Type: Mechanical SPDT  
 Rating: 5A @ 30 VDC max., 5 A @ 250 VAC max

Relays 1 and 2 are dry contact relays rated for 5 A maximum current. They are best suited for switching high voltage loads, such as AC powered pumps and valves.

When used to switch inductive loads, dry contact relays may be damaged by arcing. Signet recommends the installation of a filter device to prevent such damage.

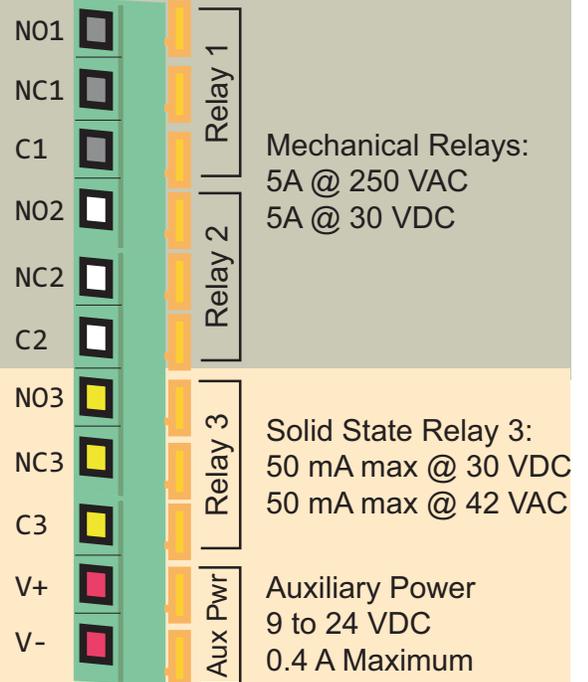
3-8050.396      159 000 617      RC Filter kit (for relay use)

Relay 3 Type: Solid State  
 Rating: 50 mA @ 30 VDC, 50 mA @ 42 VAC

Relay 3 is a solid state relay. It can be applied exactly the same as a dry contact relay, but the current rating is 0.2 A (200 mA) maximum. Relay 3 is best suited to pulse applications and low voltage loads.



Auxiliary power must be connected to operate the relays and to power the display backlighting. Auxiliary power is fully isolated. The Loop Power supply may be used for Aux power if the power source provides a sufficient current rating.



**Relay Terminal Legend:**  
**NO:** Normally Open  
**NC:** Normally Closed  
**C:** Common

### Application Notes: Relay Wiring

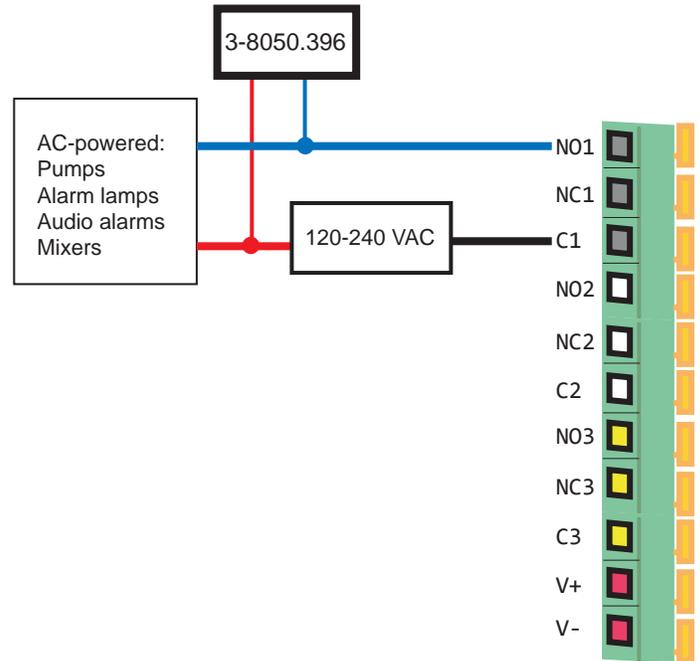
- Inductive relay loads may generate transient voltage spikes well in excess of the relay contact ratings. This will cause arcing across the contacts and consequently rapid relay wear. Signet recommends an RC-style filter ("snubber"), installed as illustrated here.
- The filter kit (3-8050.396) is available as an accessory item. See ordering information on back cover.
- Signet product warranty does not cover damage to relays due to contact burnout.

#### Definition:

An **inductive load** is an electrical device generally made of wire that is coiled to create a magnetic field to produce mechanical work when energized.

Examples of inductive loads include motors, solenoids, and relays.

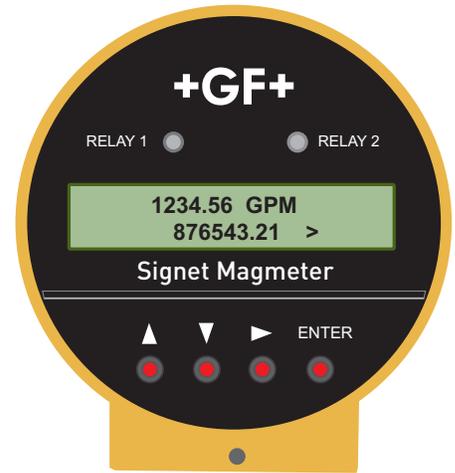
High voltage transients from these types of loads can cause arcing across mechanical switching contacts or can cause damage to solid-state contacts.



## 6. View Menu

The VIEW menu contains all of the basic information available from the Magmeter.

- The normal operating display shows the FLOW RATE on the top line of the display and the Resettable Totalizer on the lower line of the display.
- The Right Prompt symbol (>) always indicates a sub-menu associated with the current display. In this display it points the way to the TOTALIZER RESET function. See section 6.1 for detailed instructions.
- With AUXILIARY power connected to the magmeters with Relays, the display will be backlit. There is no switch to turn the backlight off.
-  A flashing character or text on the display indicates that the item is being edited. This manual uses a (red) star to illustrate a flashing display.
- The following information is viewed by scrolling ▲ or ▼. These displays will remain in the display for 10 minutes, then the normal operating display will return.



Show the permanent total. This totalizer cannot be reset.



Shows the current output. For 4 to 20 mA Output models only.



Relay States shown for units with a relay board.



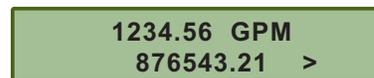
This display is a reminder to visit the Signet website for updates and information about Signet products.



Enter menus from this display. See section 6.2.



### 6.1 Resetting the Resettable Totalizer



1. From the normal operating display, press the ► key.
2. The resettable totalizer can be configured to require the security code before allowing the reset. If the Total Reset is set to "RESET OFF" this display will not appear. See section 11, Options Menu for instructions.
3. Press any arrow key to toggle the flashing selection from NO to YES.
4. Press the ENTER key. The totalizer will reset to all zeroes and the display will immediately return to the normal operating display.

## 6.2 Navigating the Menus

### Normal Operation Display

The normal operating display shows the Flow Rate on the top line and the Resettable Totalizer on the bottom line.

- All menu instructions in this manual assume that the instrument is showing this display.

### 2551 Menu Directory

The 2551 Magmeter uses seven main menus to provide access to the calibration and programming features. Each menu serves a specific function.

Starting from the normal operating display, there are two ways to access the menus:

- Press the ▲ key to scroll to the Enter Menu display, then press the ► key.
- Press the ENTER key and hold it for about three seconds.

### Setup Menu

This menu contains all of the settings and information that the magmeter requires to operate, including the K-Factor, the totalizer settings, low flow cutoff, and several display characteristics. See section 7.0 for details related to this menu.

### Calibration Menu

This menu provides two different methods for adjusting the calibration. See section 8.0 for details related to this menu.

### Relay Menus

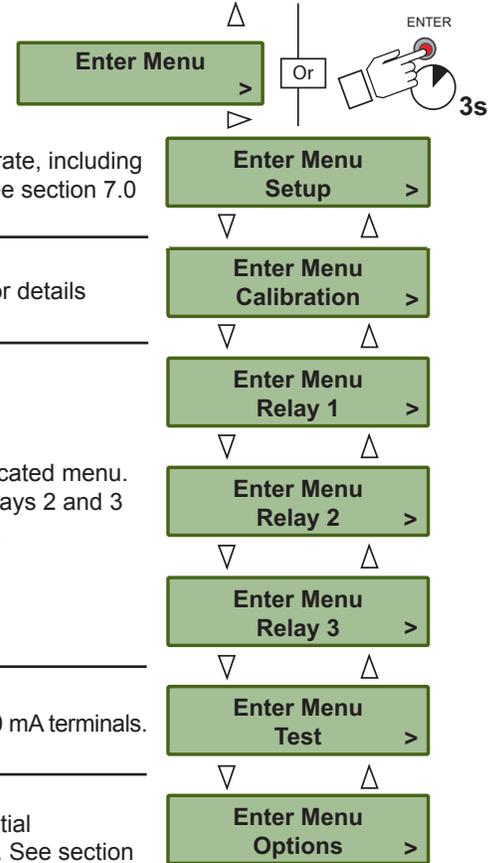
Each of the available relays in the 2551-21 and -22 are programmed from their own dedicated menu. See section 9 for details related to these menus. **NOTE:** Menu items associated with Relays 2 and 3 are suppressed in models without relays. See section 9.0 for details related to this menu.

### Test Menu

This menu is used to manually toggle relays or to induce a known value out of the 4 to 20 mA terminals. See section 10.0 for details related to this menu.

### Options Menu

This menu contains those settings and values that are usually programmed during the initial installation, and then seldom modified, including the SECURITY CODE (see section 6.4). See section 11.0 for details related to the Options menu.



## 6.3 Keypad Functions

- ▲ Scrolls UP through any menu. If the display shows any flashing character or selection, scrolls UP to the previous value or selection.
- ▼ Scrolls DOWN through any menu. If the display shows any flashing character or selection, scrolls DOWN to the next value or selection.
- ▲ ▼ Press the ▲ and ▼ keys together to abandon any unsaved edits and return to the previous display.
- Opens the menu currently being displayed. In Edit modes, advances the flashing character. In menus with only two options (Yes or No, On or Off) toggles between selections.
- ENTER Saves a new selection in any menu. From Normal Operation display, jumps to first selection in Menu directory (when held for three seconds)

## 6.4 Security Code

The 2551 has a security code that can be programmed to any four-digit numerical value.

- The factory setting is 0-0-0-0.
- To program the security code go to the Options menu.
- The security code will be required to edit any of the items in the menus. It is required only once for each editing session.
- Record the custom security code here or in a safe location.
- If the security code is lost, contact your Signet service center for instructions.



Security Code \_\_\_\_\_

**WRITE IT DOWN!**

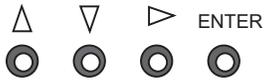
## 7. Setup Menu

The Setup menu contains all of the parameters necessary for the 2551 Magmeter to begin measuring flow.

**NOTE:** The Security Code must be entered before any changes can be made to the Setup menu. See the Options menu in section 11 for details.



Use the keypad to navigate through each setting.

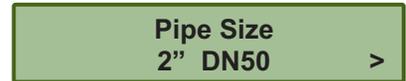


The values shown for each menu item represent the factory standard setting. All 2551 magmeters are packaged with these settings.

**K-Factor:** See the charts in section 7.3 for values in pulses per U.S. gallon or in pulses per liter. To use other units, convert the published values as appropriate.



**Pipe Size:** Select the pipe size that is nearest to the nominal pipe size.



**Flow Units:** Set the units for the application. Four characters are available. The first three characters can be set to any symbol or alpha character, upper or lower case. The following special symbols are located between the upper case and lower case menus:

- (centered dot)      μ (micro)      \_ (blank)
- (dash)              / (slash)        3 (for cubic units)



The last character selects the timebase for the flow rate measurement. Select S/s (seconds) M/m (minutes), H/h (hours) or D/d (days)

**Set 4 mA:** (2551-22 and -42 versions only) Set the flow rate where the current output will be 4 mA.



**Set 20 mA:** (2551-22 and -42 versions only) Set the flow rate where the current output will be 20 mA.

The 4 to 20 mA output may be spanned to monitor forward and reverse flow rates.



**Total Factor:** Set the factor by which the totalizer will count. This setting is made in the application units (i.e., gallons, liters, etc.)



**Totalizer Units:** Set the Totalizer Units. This setting serves as a label for the totalizer displays only. It has no effect on the measurement. The special characters listed in the Total Factor settings are available here also.



**Low Flow Cutoff:** Set a flow rate that the 2551 Magmeter will use as a minimum threshold. If the flow rate falls below this value, the 2551 will respond as if the flow were zero.



**Averaging:** Set the averaging period based on the installation and flow conditions. Smaller values allow the 2551 to respond to changes in flow rate quickly, while larger values smooth the fluctuations caused by installation and flow conditions. See section 7.1 for details.



**Sensitivity:** Set a percentage of maximum range by which the flow must change to override the averaging feature and "jump" quickly to the new flow rate. See detailed explanation in section 7.1.



## 7.1 Averaging and Sensitivity

Even the most carefully engineered flow systems may experience erratic and unstable conditions. If the instability is communicated to the output functions, the results may create problems for control devices.

To alleviate these issues, the 2551 provides two adjustments that operate in tandem. The information here will help in determining the appropriate settings for any specific application.

### Averaging

- The AVERAGING setting dictates the time over which the magmeter will average the flow signal.

The LCD display is updated every second. With averaging at 14 seconds, the flow rate on the display is an average of the previous 14 seconds input.

Short averaging times provide the fastest display and output response to changes in the flow rate.

Higher averaging times help to smooth the display and current output where the flow in the pipe is erratic or unstable due to installation limitations.

### Sensitivity

- The SENSITIVITY setting determines how the 2551 responds to sudden surges in the flow rate. It "overrides" the Averaging function just long enough to allow an actual change in flow rate to be displayed, then resumes the averaging. The result is a smooth flow display and a quick response to large shifts in the flow rate.

The settings for Sensitivity represent a percentage of the magmeter's maximum range, or 10 milliseconds (ms).

Example: A sensitivity setting of 25% means that the flow rate must change instantly and by more than 2.5 ms before the function is enabled.

**NOTE:** The SENSITIVITY function is ineffective if the AVERAGING function is set to zero.

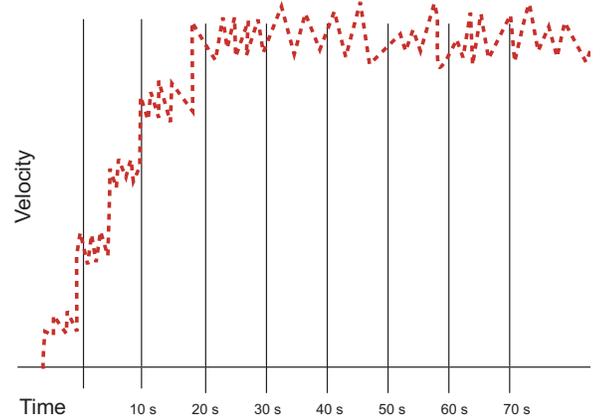


#### CAUTION

The SENSITIVITY function changes the response characteristics of the magmeter. If used as part of a tuned closed loop control system, such a change may be undesirable.

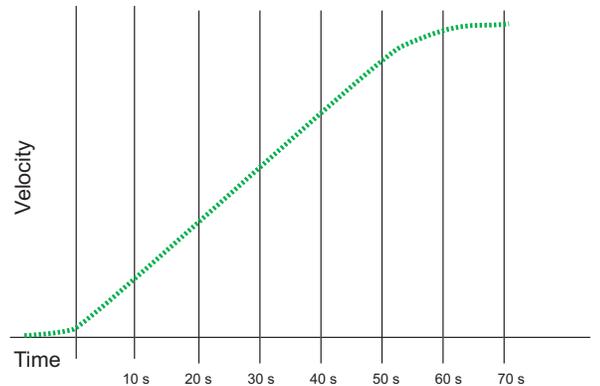
### No Averaging

With AVERAGING set to zero, the flow rate will be displayed immediately and with no filtering. This line represents the actual output of the flow sensor as it responds to unstable flow conditions in the pipe.



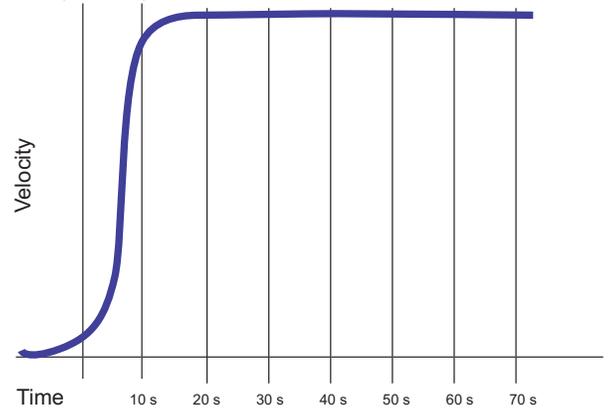
### Averaging Only

With AVERAGING set to 50 seconds and SENSITIVITY still set to zero the flow rate is stabilized, but a sharp change in flow rate is not represented on the display or at the output for 50 seconds or longer.



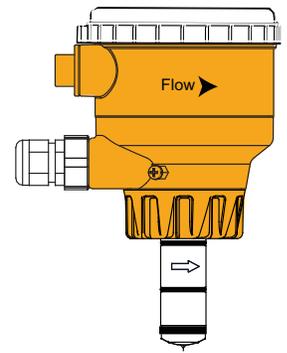
### Averaging and Sensitivity

With AVERAGING at 50 seconds and SENSITIVITY set to 25%, the flow rate is stabilized, while the sudden shift in flow is reflected very quickly.



## 7.2 Bi-Directional Flow

- The 2551 magmeter is designed to measure bi-directional flow.
- The forward flow direction is indicated by the directional arrow molded into the side of the 2551 sensor.
- The conduit ports are assembled at the factory to point UPSTREAM. They may be reversed by disassembling the components of the magmeter and reassembling.



**Flow Rate Display:** The "+" sign is suppressed during forward flow.  
"-123.45 GPM" during reverse flow.

**Totalizer Display:** The totalizer will count during forward flow conditions only.  
During reverse flow the totalizer will not increment.

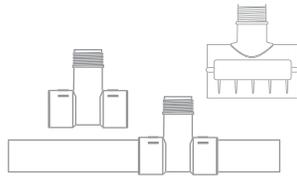
**Relay Outputs:** May be set to detect reverse flow: "Low Setpoint at -25 GPM."

**4 to 20 mA output:** May be scaled to span any flow range:  
For example: "4 to 20 mA = -100 GPM to +100 GPM"

**Frequency output, Frequency ÷ 10 output:** Reverse flow is processed same as forward flow in the frequency output magmeters.

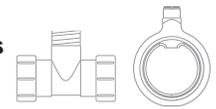
**Digital (S<sup>3</sup>L) output:** Reverse flow results in 0 flow rate output.

## 7.3 Calibration Data: K-Factors



### PVC Tees and Clamp-on Saddles

### Polypropylene True Union Tees and Wafers PVDF True Union Tees PVC True Union Tees



Pipe Size (In.)	Fitting Type	K-Factor Gallons	K-Factor Liters
<b>SCH 80 PVC-U TEES FOR SCH 80 PIPE</b>			
½	MPV8T005	2277.0	601.58
¾	MPV8T007	1407.6	371.90
1	MPV8T010	861.17	227.52
1¼	MPV8T012	464.91	122.83
1½	MPV8T015	331.43	87.56
2	MPV8T020	192.89	50.96

Pipe Size (In.)	Fitting Type	K-Factor Gallons	K-Factor Liters
<b>SCH 80 PVC TEES FOR SCH 80 PIPE</b>			
2½	PV8T025	131.46	34.73
3	PV8T030	82.52	21.80
4	PV8T040	44.78	11.83

Pipe Size (In.)	Fitting Type	K-Factor Gallons	K-Factor Liters
<b>SCH 80 CPVC TEES FOR SCH 80 PIPE</b>			
½	MCPV8T005	2277.0	601.58
¾	MCPV8T007	1407.6	371.90
1	MCPV8T010	861.17	227.52
1¼	MCPV8T012	464.91	122.83
1½	MCPV8T015	331.43	87.56
2	MCPV8T020	192.89	50.96

Pipe Size (In.)	Fitting Type	K-Factor Gallons	K-Factor Liters
<b>SCH 80 PVC CLAMP-ON SADDLES FOR SCH 80 PIPE</b>			
2	PV8S020	193.83	51.21
2½	PV8S025	138.01	36.46
3	PV8S030	83.89	22.16
4	PV8S040	40.88	10.80
6	PV8S060	22.53	5.95
8	PV8S080	12.52	3.31
10	PV8S100	7.94	2.10
12	PV8S120	5.71	1.51

Pipe Size (In.)	Fitting Type	K-Factor Gallons	K-Factor Liters
<b>SCH 80 PVC CLAMP-ON SADDLES FOR SCH 40 PIPE</b>			
2	PV8S020	180.01	47.56
2½	PV8S025	123.72	32.69
3	PV8S030	75.81	20.03
4	PV8S040	41.87	11.06
6	PV8S060	19.71	5.21
8	PV8S080	11.73	3.10
10	PV8S100	7.43	1.96
12	PV8S120	5.23	1.38

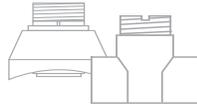
Pipe Size (Metric)	Fitting Type	K-Factor Gallons	K-Factor Liters
<b>POLYPROPYLENE FITTINGS (DIN/ISO, BS, ANSI)</b>			
DN15	PPMT005	2192.73	579.32
DN20	PPMT007	1327.81	350.81
DN25	PPMT010	737.16	194.76
DN32	PPMT012	453.46	119.81
DN40	PPMT015	275.03	72.66
DN50	PPMT020	164.17	43.35

Pipe Size (Metric)	Fitting Type	K-Factor Gallons	K-Factor Liters
<b>PVDF FITTINGS (DIN/ISO, BS, ANSI)</b>			
DN15	SFMT005	1946.49	514.26
DN20	SFMT007	1158.05	305.96
DN25	SFMT010	749.09	197.91
DN32	SFMT012	439.51	116.12
DN40	SFMT015	248.93	65.77
DN50	SFMT020	146.85	38.80

Pipe Size (Metric)	Fitting Type	K-Factor Gallons	K-Factor Liters
<b>PVC FITTINGS (DIN/ISO, BS, ANSI)</b>			
DN15	PVMT005	2067.76	546.30
DN20	PVMT007	1136.61	300.29
DN25	PVMT010	716.52	189.31
DN32	PVMT012	446.07	117.85
DN40	PVMT015	278.83	73.67
DN50	PVMT020	159.36	42.10

7.3 Calibration Data: K-Factors

Carbon Steel Tees and Weld-o-Lets  
Stainless Steel Tees and Weld-o-Lets  
Galvanized Iron Tees



Pipe Size (In.)	Fitting Type	K-Factor Gallons	K-Factor Liters
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**CARBON STEEL TEES ON SCH 40 PIPE**

1/2	CS4T005	1572.66	415.50
3/4	CS4T007	1086.73	287.11
1	CS4T010	582.34	153.86
1 1/4	CS4T012	377.48	99.73
1 1/2	CS4T015	267.79	70.75
2	CS4T020	167.85	44.35

**STAINLESS STEEL TEES ON SCH 40 PIPE**

1/2	CR4T005	1601.26	423.05
3/4	CR4T007	937.78	247.76
1	CR4T010	606.18	160.15
1 1/4	CR4T012	279.68	73.89
1 1/2	CR4T015	147.65	39.01
2	CR4T020	111.90	29.56

**STAINLESS STEEL WELDOLETS ON SCH 40 PIPE**

2 1/2	CR4W025	106.31	28.09
3	CR4W030	72.27	19.09
4	CR4W040	36.84	9.73
5	CR4W050	29.28	7.73
6	CR4W060	20.29	5.36
8	CR4W080	11.73	3.10
10	CR4W100	7.45	1.97
12	CR4W120	5.24	1.39

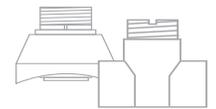
**CARBON STEEL WELDOLETS ON SCH 40 PIPE**

2 1/2	CS4W025	105.70	27.93
3	CS4W030	70.68	18.67
4	CS4W040	36.38	9.61
5	CS4W050	29.28	7.73
6	CS4W060	20.29	5.36
8	CS4W080	11.73	3.10
10	CS4W100	7.45	1.97
12	CS4W120	5.24	1.39

**GALVANIZED IRON TEES ON SCH 40 PIPE**

1	IR4T010	558.50	147.56
1 1/4	IR4T012	334.45	88.36
1 1/2	IR4T015	248.97	65.78
2	IR4T020	146.00	38.57

Bronze and Copper Tees and Brazolets



Pipe Size (In.)	Fitting Type	K-Factor Gallons	K-Factor Liters
-----------------	--------------	------------------	-----------------

**BRONZE TEES ON SCH 40 PIPE**

1	BR4T010	582.34	153.86
1 1/4	BR4T012	330.54	87.33
1 1/2	BR4T015	254.76	67.31
2	BR4T020	157.36	41.58

**COPPER TEES FITTING ON COPPER PIPE SCH K**

1/2	CUKT005	2459.19	649.72
3/4	CUKT007	1108.02	292.74
1	CUKT010	649.87	171.70
1 1/4	CUKT012	422.03	111.50
1 1/2	CUKT015	281.43	74.35
2	CUKT020	136.02	35.94

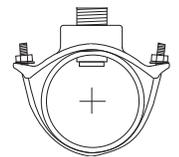
**COPPER TEES FITTING ON COPPER PIPE SCH L**

1/2	CUKT005	2406.30	635.75
3/4	CUKT007	1174.77	310.37
1	CUKT010	672.28	177.62
1 1/4	CUKT012	402.84	106.43
1 1/2	CUKT015	294.99	77.94
2	CUKT020	149.63	39.53

**COPPER/BRONZE BRAZOLET ON SCH 40 PIPE**

2 1/2	BR4B025	117.31	30.99
3	BR4B030	78.62	20.77
4	BR4B040	45.13	11.92
5	BR4B050	32.79	8.66
6	BR4B060	22.73	6.01
8	BR4B080	13.14	3.47
10	BR4B100	8.34	2.20
12	BR4B120	5.87	1.55

Iron Saddles



Pipe Size (In.)	Fitting Type	K-Factor Gallons	K-Factor Liters
-----------------	--------------	------------------	-----------------

**SCH 80 IRON SADDLE ON SCH 80 PIPE**

2	IR8S020	194.85	51.48
2 1/2	IR8S025	142.28	37.59
3	IR8S030	87.53	23.13
4	IR8S040	40.62	10.73
5	IR8S050	29.28	7.74
6	IR8S060	22.30	5.89
8	IR8S080	12.52	3.31
10	IR8S100	7.94	2.10
12	IR8S120	5.65	1.49

**SCH 80 IRON SADDLE ON SCH 40 PIPE**

2	IR8S020	185.35	48.97
2 1/2	IR8S025	127.47	33.68
3	IR8S030	76.62	20.24
4	IR8S040	40.23	10.63
5	IR8S050	27.32	7.22
6	IR8S060	19.71	5.21
8	IR8S080	11.61	3.07
10	IR8S100	7.36	1.94
12	IR8S120	5.18	1.37

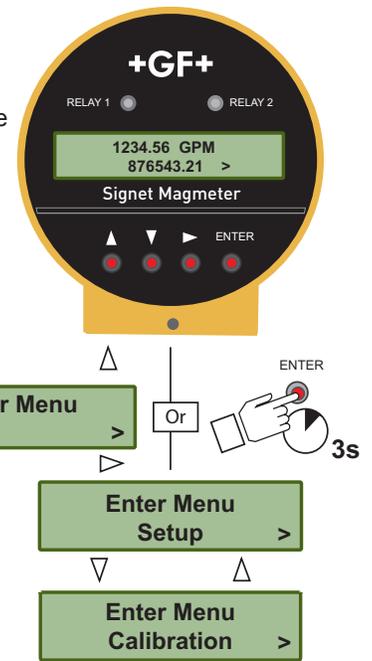
## 8. Calibration Menu

The K-Factors published in this manual assume that the flow conditions in the pipe are ideal.

Many factors that affect the flow rate are beyond the control of the magmeter; variations in actual pipe dimensions, pipe smoothness, and other flow conditions will contribute to the total system error.

Performing a custom calibration with the magmeter in place will adjust the K-Factor and can serve to compensate for installation conditions that may be less than ideal.

Select one of the calibration methods in this menu to achieve the most accurate measurement possible in a specific application.



**NOTE:** The Security Code must be entered before selecting the calibration method.

Enter Code  
0000

### 8.1 Volume Method of Calibration

Use the volume method of calibration if the fluid passing the magmeter can be measured by a volumetric method (as in a vessel of known volume, or by weight). It requires the ability to pump a known volume of water past the magmeter, and then input the volume into the 2551 program. It is most useful for small pipes and lower flow rates.

When performed properly, volumetric calibration is the most accurate method. For best results a five minute test period is recommended, and the test period should be no less than two minutes.

Press Enter To Start	At START, the 2551 begins counting the flow past the sensor.
Press Enter To Stop	At STOP, the 2551 stores the total flow accumulated since the START.
Enter Volume 000000. GPM	Enter the VOLUME that has been pumped past the sensor.
Value must be more than 0.0	This error message appears if volume entered or the accumulated flow is zero. Repeat the test after checking the system.
K-Factor Out of Range	This message appears if the new K-Factor is less than 0.0001 or greater than 999999. To correct the problem, perform the volumetric flow again, and be certain that the volume entered is accurate.
K-Factor 45.6789	Using the information from the VOLUME method, the 2551 will recalculate a new K-Factor. Press ENTER to accept the new value, or use the keypad to adjust the value.

### 8.2 Rate Method of Calibration

Use this method if the 2551 Magmeter must be calibrated to match a reference flow meter. This is the method most commonly used by monitoring agencies, and for large pipes where volumetric calibration is impractical. The accuracy of this calibration method is largely dependent on the accuracy of the reference meter and the proximity of the reference to the Signet 2551 Magmeter.

Set New Flowrate 45.6789	The flow rate shown is based on the existing calibration of the 2551. Use the keypad to modify the flow rate to match the reference meter. The 2551 will automatically calculate a new K-Factor based on the new flow rate.
K-Factor Out of Range	This message appears if the new K-Factor is less than 0.0001 or greater than 999999. To correct the problem, reexamine the flow rate and make certain it is accurate.
K-Factor 56.7890	Using the information from the RATE MATCHING method, the 2551 will recalculate a new K-Factor. Press ENTER to accept the new value, or use the keypad to adjust the value.

## 9. Relay Menus

Magmeter models 3-2551-21 and -22 have two dry contact relays (Relays 1 and 2) and one Solid State relay (Relay 3).

Any of these relays can be set to any of the operating modes listed below.

The setpoint values for HIGH, LOW and WINDOW modes can be set to negative values if required. For example, a LOW alarm might be set to activate if the flow rate falls below -10 GPM.

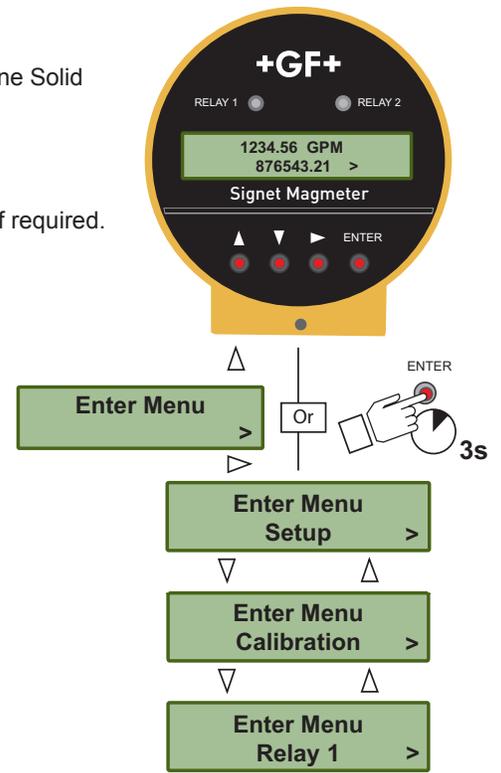
Negative values are not available for relays in PULSE or TOTAL modes.

**Off:** If a relay is not used, it can be turned Off to prevent contact wear.



**NOTE:** The Security Code must be entered before modifying the relay menu.

Enter Code  
0000



### 9.1 Pulse Relay mode

Program a relay to activate for a fixed period, for each volume of fluid that passes the sensor.

For example, program the relay to pulse once for 100 ms for every 3 gallons that pass by the sensor.

Relay 1 Mode  
Pulse >

Relay 1 Volume  
0.0000 Gal >

Relay 1 Width  
0.1 secs >

**Relay Volume:** Set the volume of fluid that the 2551 must measure before activating the relay for one pulse.

**Pulse Width:** Adjust the length of time the relay will remain activated. The pulse width setting is dependent on the type of external equipment being connected to the relay.

### 9.2 Total Relay mode

Program a relay to activate when the Resettable totalizer reaches a specific value. The maximum setting is 999999.

Application example: A filter must be replaced in an R.O. system every 10000 gallons. The service representative that installs a new filter sets relay 3 to Total mode, sets the setpoint at 10000 and resets the totalizer to 000000.00. Every time the Totalizer reaches 10000, the relay activates and lights a message indicator to remind the service representative to replace the filter.

When the totalizer is reset, the relay will be deactivated and the process begins anew.

Relay 1 Mode  
Total >

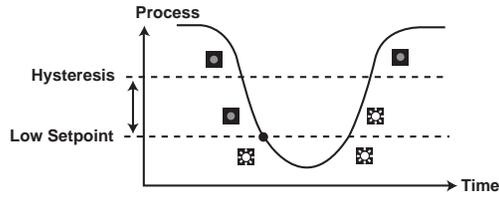
Relay 1 Set High  
000000 >

### 9.3 High, Low, or Window Relay modes

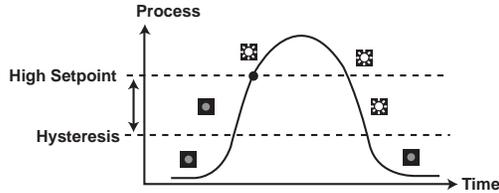
Program the relay to activate when the flow rate reaches a setpoint (High or Low) or when the flow rate moves outside of a prescribed range (Window).

#### Reverse Flow

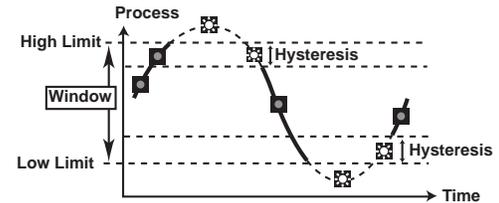
The setpoint values for HIGH, LOW and WINDOW modes can be set to negative values if required. For example, a LOW alarm might be set to activate if the flow rate falls to -10 GPM.



Relay behavior with LOW Setpoint

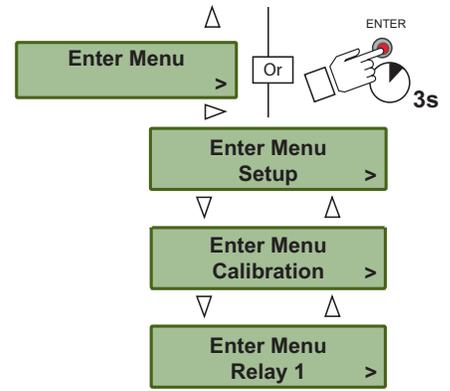


Relay behavior with HIGH Setpoint



Relay behavior with WINDOW Setpoints

Relay activated   
Relay deactivated 



**NOTE:** The Security Code must be entered before modifying the relay menu.

 Enter Code 0000

The values shown for each menu item represent the factory standard setting. All 2551 magmeters are packaged with these settings.

**Set Low:** Set the flow rate where a Low relay will be activated.

**Hysteresis:** Set a flow rate increment where the relay will be deactivated. The hysteresis setting serves to prevent relay "chatter" when the flow rate recovers from an alarm condition by requiring the low rate to move substantially within the setpoint.

**Set High:** Set the flow rate where a High relay will be activated.

**Delay:** Set a time period for the relay to wait after reaching the setpoint. This delay serves to prevent the relay "chatter" by allowing the flow rate time to move back within the setpoint.

Relay 1 Mode Low >	Relay 1 Set Low 00.000 GPM >
	Relay 1 Hys 00.000 GPM >
	Relay 1 Delay 0.1 secs >
Relay 1 Mode High >	Relay 1 Set High 00.000 GPM >
	Relay 1 Hys 00.000 GPM >
	Relay 1 Delay 0.1 secs >
Relay 1 Mode Window >	Relay 1 Set Low 00.000 GPM >
	Relay 1 Set High 00.000 GPM >
	Relay 1 Hys 00.000 GPM >
	Relay 1 Delay 0.1 secs >

The menu repeats for Relay 2 and Relay 3.

## 10. Test Menu

The Test menu provides a simple method to verify that the system is operating properly. Auxiliary power **MUST** be connected to the 2551 to activate the relays

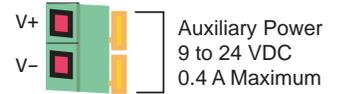


Test Output 4.20 mA >
Test Relay 1 Open Closed >
Test Relay 2 Open Closed >
Test Relay 3 Open Closed >

Shown for 4 to 20 mA models only (3-2551-XX-22, -42).  
Use the keypad to enter any current output from 4.0 mA minimum to 22.1 mA maximum.

Shown for Relay models Only  
Toggle any of these relays ON and OFF to verify that the system is operating properly.

Auxiliary power **MUST** be connected to the 2551 to test the relays.



## 11. Options Menu

The Options Menu contains those features and settings that will normally be set one time and then seldom changed. These include language preference, decimal placement, Security Code assignment, etc.



Language English >
Security Code **** >
Contrast 2 >
Total Reset Lock On >
Noise Rejection 60 Hz >
Flow Decimal ****. ** >
Total Decimal *****. ** >
Separator ddd.d >
Output Mode Frequency >

Select from English, French, German, Italian, Portuguese or Spanish. This selection will be displayed at first power-up of a new magmeter.

Security Code can be set to any four digit number. Factory standard setting is 0000.

Set for best view after the magmeter is installed. Larger number means display appears darker.

Lock ON requires the Security Code before resetting the Resettable Totalizer. Lock OFF reset with no security code.

Filters out common 50 or 60 Hz electrical noise.

Set the maximum resolution for the FLOW RATE display by limiting the decimal to this point. The Flow Rate display will auto-scale from this resolution up to whole units.

Set the maximum resolution for the TOTALIZER display by limiting the decimal to this point. The Totalizer display will always show this resolution.

Select decimal point or comma for use in numeric displays.

For Frequency/Digital models only: Select Freq output, Freq ÷ 10 output, Mirror Relay 1 output or S<sup>3</sup>L Digital output.

The values shown for each menu item represent the factory standard setting. All 2551 magmeters are packaged with these settings.

### 11.1 Output Modes

In **FREQUENCY** output mode, the 2551 serves as a traditional flow sensor and provides an output pulse that is compatible with all Signet POWERED flow instruments. It is not compatible with the 5090 Self-Powered Flow Meter or the 8150-1 Battery-Powered Flow Totalizer. The frequency output range is from 0 Hz to 1000 Hz.

The **FREQUENCY ÷ 10** output mode reduces the output frequency of the 2551 to a range that is useful for some programmable logic controllers (PLC). The frequency output range is from 0 Hz to 100 Hz. This shift does not affect the stated accuracy of the 2551 Magmeter's frequency output.

The **MIRROR RELAY 1** output mode allows 2551 Frequency/Digital models to use the Open Collector Output like a relay that can be programmed via the Relay 1 menu.

If the magmeter is equipped with relays, this mode will mirror the settings of Relay 1.

If the magmeter is not equipped with relays, this mode can still be selected and programmed via the Relay 1 menu.

The **S<sup>3</sup>L Digital** output mode switches the 2551 to the Signet serial data output called S<sup>3</sup>L (Signet Serial Sensor Link). In this mode the 2551 can be added to the serial bus of the Signet 8900 Multi-Parameter Controller or 9900 Transmitter.

## 12. Technical Information

### 12.1 Grounding

Precalibration conditioning: The magmeter may appear to be unstable immediately after installation. Allow the sensor to sit in a full pipe for **24 hours** before beginning calibration and operation.

- Use a cable gland or a liquid tight connector to seal the cable ports from water intrusion.
- Use PTFE tape or a suitable sealant on cable ports.
- The 2551 magmeter must be carefully grounded to eliminate electrical noise that may interfere with the measurement.
- Grounding requirements will vary with each installation.
- The following recommendations should be applied in sequence until the interference is eliminated.

- ① The ground terminal on the outside of the yellow housing is connected internally to the grounding ring at the tip of the sensor. Connect a conductor (14 AWG/1.5 mm<sup>2</sup> wire recommended) from this terminal directly to Earth ground to prevent electrical noise from interfering with the magmeter signal.

If the interference persists, apply step #2:

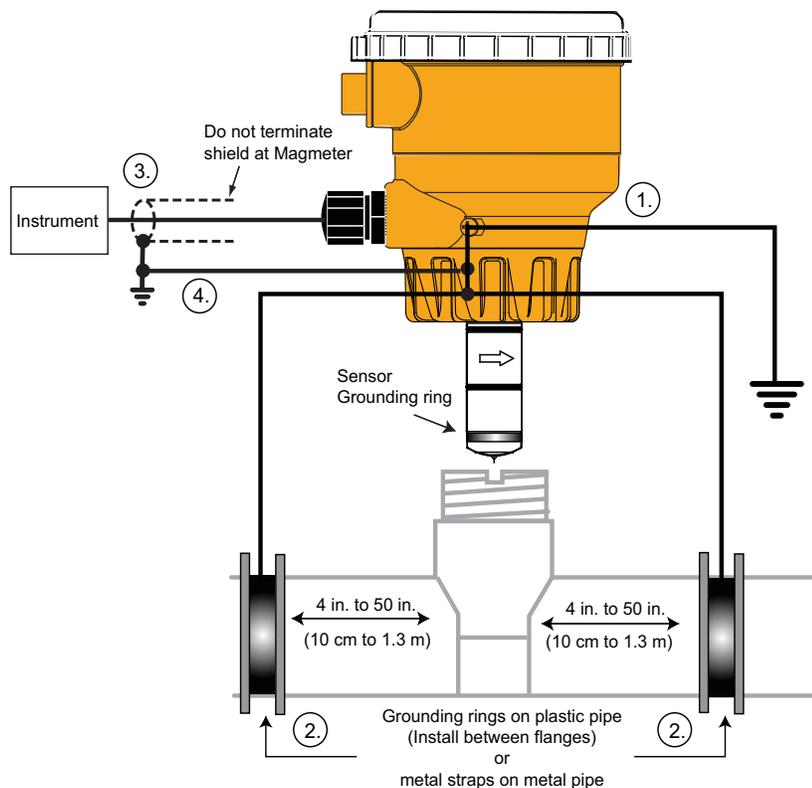
- ② Connect grounding rings, metal clamps or grounding electrodes to the pipe immediately upstream and downstream of the magmeter sensor location. These devices must be in contact with the fluid.

If the interference persists, apply step #3:

- ③ The shield from the output cable must be terminated at the remote instrument ONLY. This shield must not be connected at both ends!

If the interference persists, apply step #4:

- ④ Connect an additional wire (minimum AWG 14/1.5 mm<sup>2</sup>) from the remote instrument ground to the magmeter ground terminal.



### 12.2 Maintenance

The 2551 Magmeter requires very little maintenance. There are no user-serviceable components in the magmeter.

- If the fluid contains deposits and solids that may coat the electrodes, a regular cleaning regimen is recommended.
- Do not use abrasive materials on the metal electrodes. Clean with soft cloth and mild detergent only.
- Use a cotton swab and mild detergent to remove deposits on the metal electrodes.

#### Environmental Recommendations:

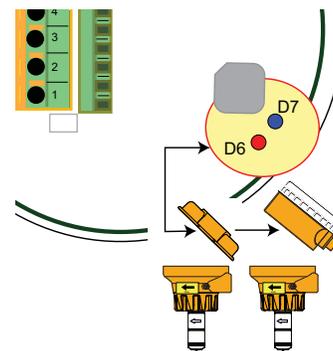
- When used properly, this product presents no inherent danger to the environment.
- Please follow local ordinance when disposing of this or any product with electronic components.

## 12.3 Troubleshooting

Symptom	Possible Cause	Solution
Output is erratic and unstable.	Magmeter installed too close to upstream obstruction.	Relocate the magmeter to have straight uninterrupted pipe upstream of the sensor for at least 10 x the pipe diameter.
	Magmeter located in area exposed to air bubbles/pockets.	Eliminate air bubbles in the pipe.
	Magmeter is installed in pipe backwards.	Remove the magmeter and reinstall with the flow direction arrow on the sensor body pointed DOWNSTREAM.
	Electrical noise is interfering with the measurement.	Review the grounding of the magmeter and the pipe. Install adequate Earth ground to allow the Magmeter to operate properly.
	Electrodes are coated with deposits or chemical oxide layers.	Carefully clean the electrodes. Refer to sensor manual for details.
Output is not 0 when flow is stopped.	Electrodes not adequately conditioned in fluid.	Allow the sensor to sit in full pipe for 24 hours then restart.
	Fluid is moving inside the pipe.	Increase the Low Flow Cutoff. (section 7.0)
No 4 to 20 mA output.	Loop power not connected correctly.	Connect 24 VDC $\pm$ 10% connected to loop terminals 1 and 3.
4 to 20 mA current output is incorrect.	4-20 mA is not scaled properly.	Check and reset in the Setup Menu.
No Frequency output. No S <sup>3</sup> L output.	2551 is wrong model.	Frequency/S <sup>3</sup> L model: 3-2551-21 (w/rlys) or -41 (w/o rlys).
	Incorrect setting in Options Menu.	Select Frequency in the Options menu.
	Wiring is not correct.	Check wiring, make corrections.
	Frequency input to other manufacturer's flow instrument does not have pull-up resistor.	Install 10 k $\Omega$ resistor. (section 5.1)
No flow rate, current output is 22 mA.	The fluid is too clean for Magmeter.	Unsuitable application for Magmeter.
	Electronic component failure.	Return 2551 to factory.
Blank display, no backlighting, no relay LEDs, but external equipment using output signal is still working.	2551 AUX power is not connected.	Connect AUX power (section 5.5) (9 to 24 VDC, 0.4 A max.)
Error Message: "Error Not Saved"	Main power is below specification.	Correct the main power deficiency.

### Troubleshooting with the RED and BLUE LEDs

- No Lights:** The power is off or the sensor is not connected
- Solid Blue:** The power is on but there is no flow in the pipe.
- Blinking Blue:** Normal operation, blink rate is proportional to the flow rate.
- Alternating Red-Blue:** Empty pipe indication (electrodes are not wet.)
- Blinking Red:** System errors (Electrical noise interference)
- Solid Red:** Instrument error (defective electronic component)



### Reverse flow:

- Frequency out cannot distinguish reverse flow from forward flow. The output will be the absolute value.
- Digital (S<sup>3</sup>L) output: Reverse flow results in 0 flow rate displayed on 8900, or with negative numbers on the 9900.
- 4 to 20 mA output can be spanned into negative flow range using the custom setup tool. (example: 4-20 mA = -100 to +100 GPM)

### Empty Pipe Detection

- Frequency output will be locked to 0 Hz if electrodes are not wet.
- Digital (S<sup>3</sup>L) output will be locked to 0 if electrodes are not wet.
- 4-20 mA will be locked to 4 mA if electrodes are not wet.
- Blue and Red LED indicators on the magmeter circuit will blink alternately if the electrodes are not wet.

### 13. Ordering Information

Sensor Part No.	
3-2551	
Sensor Body (Transducer) and electrodes/grounding ring materials - Choose one	
-P	Polypropylene and 316L SS
-T	PVDF and Titanium
-V	PVDF and Hastelloy-C
Pipe size - Choose one	
0	DN15 to DN100 (1/2 to 4 in.)
1	DN125 to DN200 (5 to 8 in.)
2	DN250 to DN900 (10 to 36 in.)
Display Options - Choose One	
-2	With Display, two SPDT relays, one solid state relay
-4	With Display, no relays
Output options - Choose One	
1	Open Collector Frequency out or Digital (S <sup>3</sup> L) out
2	4 to 20 mA output
3-2551	-P 0 -2 2 Example Part Number

Mfr. Part Number	Code	Mfr. Part Number	Code
3-2551-P0-21	159 001 267	3-2551-T2-21	159 001 454
3-2551-P0-22	159 001 273	3-2551-T2-22	159 001 455
3-2551-P0-41	159 001 261	3-2551-T2-41	159 001 460
3-2551-P0-42	159 001 279	3-2551-T2-42	159 001 461
3-2551-P1-21	159 001 268	3-2551-V0-21	159 001 269
3-2551-P1-22	159 001 274	3-2551-V0-22	159 001 275
3-2551-P1-41	159 001 262	3-2551-V0-41	159 001 263
3-2551-P1-42	159 001 280	3-2551-V0-42	159 001 281
3-2551-P2-21	159 001 435	3-2551-V1-21	159 001 270
3-2551-P2-22	159 001 438	3-2551-V1-22	159 001 276
3-2551-P2-41	159 001 432	3-2551-V1-41	159 001 264
3-2551-P2-42	159 001 441	3-2551-V1-42	159 001 282
3-2551-T0-21	159 001 436	3-2551-V2-21	159 001 456
3-2551-T0-22	159 001 439	3-2551-V2-22	159 001 457
3-2551-T0-41	159 001 433	3-2551-V2-41	159 001 462
3-2551-T0-42	159 001 442	3-2551-V2-42	159 001 463
3-2551-T1-21	159 001 437		
3-2551-T1-22	159 001 440		
3-2551-T1-41	159 001 434		
3-2551-T1-42	159 001 443		

### Replacement Parts and Accessories

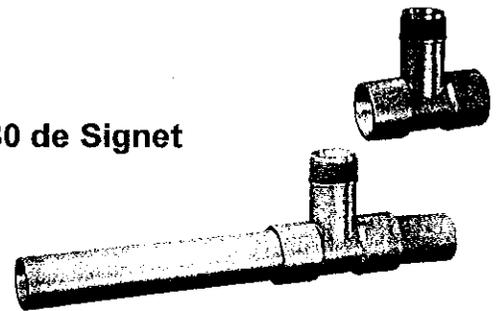
Mfr. Part No.	Code	Description
1220-0021	198 801 186	O-ring, FPM
1224-0021	198 820 006	O-ring, EPDM
1228-0021	198 820 007	O-ring, FFPDM
3-8050.390-1	159 001 702	Retaining Nut Replacement Kit, NPT, Valox®
3-8050.390-3	159 310 116	Retaining Nut Replacement Kit, NPT, PP
3-8050.390-4	159 310 117	Retaining Nut Replacement Kit, NPT, PVDF
3-8050.391	159 001 703	Retaining Nut Replacement Kit, NPT, Stainless Steel
3-8050.396	159 000 617	RC Filter kit (for relay protection)
3-8551.521	159 001 378	Clear plastic cap for display



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 For Worldwide Sales and Service, visit our website: [www.gfsignet.com](http://www.gfsignet.com) • Or call (in the U.S.): (800) 854-4090  
 For the most up-to-date information, please refer to our website at [www.gfsignet.com](http://www.gfsignet.com)

**Signet Schedule 80 PVC and CPVC Installation Fittings**  
**Raccords d'installation Signet PVC et CPVC norme 80**  
**Signet Schedule 80 PVC- und CPVC-Installationsfittings**  
**Accesorios de instalación de PVC y CPVC de catálogo 80 de Signet**

3-MXPV8.090 Rev B 03/10 (English, French, German, Spanish)



**English**



**SAFETY INSTRUCTIONS**

1. Confirm chemical compatibility before use.
2. Do not exceed maximum temperature or pressure specifications of fittings or sensors.
3. Do not use this product for any purpose other than for which it was designed.
4. Use schedule 80 pipe.
5. Use with liquids only.
6. Improper pipe fitting installation may result in pressure failure, personal injury, and/or property damage.
7. Always match fitting and piping materials.
8. Always use piping cement designed for your specific fitting and piping material.

**Compatibility**

These schedule 80 fittings are designed to be used with the Signet flow and pH sensors listed below.

**Français**



**CONSIGNES DE SÉCURITÉ**

1. Vérifier la compatibilité chimique avant l'utilisation.
2. Ne pas dépasser les spécifications maximales de température et de pression pour les raccords ou les capteurs.
3. Ne pas utiliser ce produit à d'autres fins que celle pour laquelle il a été conçu.
4. Utiliser un tuyau norme 80.
5. Utiliser uniquement avec des liquides.
6. Un raccord mal installé peut entraîner des chutes de pression et des dommages corporels ou matériels.
7. Utilisez toujours un raccord de même matériau que le tuyau sur lequel il doit être posé.
8. Utilisez toujours du mastic conçu spécialement pour le matériau de votre tuyau et de votre raccord.

**Compatibilité**

Ces raccords norme 80 sont conçus pour être utilisés avec les capteurs de pH et d'écoulement Signet répertoriés ci-dessous.

**Deutsch**



**SICHERHEITSVORSCHRIFTEN**

1. Vor dem Einsatz die Chemikalienverträglichkeit bestätigen.
2. Die angegebenen maximalen Temperatur- oder Druckwerte von Fittings oder Sensoren nicht überschreiten.
3. Das Produkt ausschließlich für den beabsichtigten Zweck verwenden.
4. Schedule 80 Rohr verwenden.
5. Nur mit Flüssigkeiten verwenden.
6. Unsachgemäße Installation des Fittings kann zu Druck-, Personen- oder Sachschäden führen.
7. Fitting- und Rohrleitungsmaterial muß stets aufeinander abgestimmt sein.
8. Stets einen für das spezielle Material von Fitting und Rohrleitungen geeigneten Klebstoff verwenden.

**Kompatibilität**

Diese Schedule 80 Fittings sind zur Verwendung mit den nachstehend aufgeführten Durchfluss- und pH-Sensoren von Signet konzipiert.

**Español**



**INSTRUCCIONES DE SEGURIDAD**

1. Confirme la compatibilidad química antes de utilizar este producto.
2. No exceda las especificaciones de temperatura o presión máximas de los accesorios o sensores.
3. No use este producto para ningún fin que no sea para el que se ha diseñado.
4. Use tuberías de catálogo 80.
5. Use con líquidos solamente.
6. La instalación indebida del conector de tubería puede producir fallas de presión, lesión personal y/o daños a la propiedad.
7. Siempre haga coincidir los materiales del conector y de la tubería.
8. Siempre use el cemento de tubería diseñado para su conector y material de tubería específicos.

**Compatibilidad**

Estos accesorios de catálogo 80 están diseñados para ser usados con los sensores de caudal y pH de Signet indicados abajo.

Flow Sensors Capteurs d'écoulement Durchflusssensoren Sensores de caudal	pH/ORP Electrodes Électrodes indicatrices de pH/ORP pH/ORP-Elektroden Electrodos de pH/ORP (pH/potencial redox)
P51530-X0	3-2714 - 2717
3-8510-X0	3-2724 - 2726
3-8512-X0	
3-2536-X0	
3-2537-XC-X0	
3-2551-X0-XX	

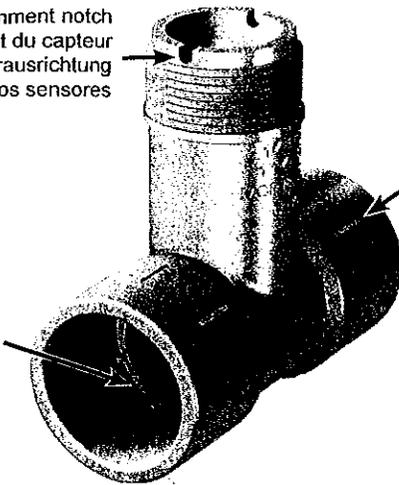
**Identification**

**Identificación**

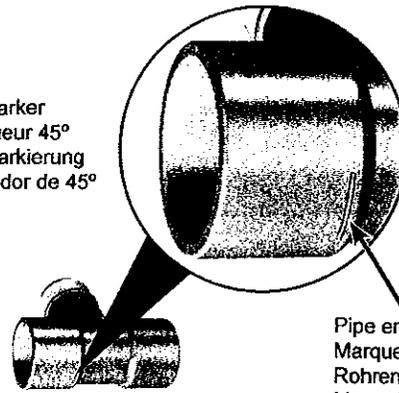
**Identifizierung**

**Identificación**

Sensor alignment notch  
Encoche d'alignement du capteur  
Kerbe zur Sensorausrichtung  
Muesca de alineación de los sensores



45° marker  
Marqueur 45°  
45°-Markierung  
Marcador de 45°



Pipe end marker  
Marqueur d'extrémité de tuyau  
Rohrendenmarkierung  
Marcador de extremo de tubería

Glue trap  
Collecteur de colle  
Kleberfalle  
Interceptor de pegamento

**Fitting only**

**Raccord uniquement**

**Nur Fitting**

**Accesorio solamente**

SCH 80 PVC		SCH 80 CPVC		Size (inches) Dim. (pouces) Größe (Zoll) Tamaño (pulgadas)	L (inches) (pouces) (Zoll) (pulgadas)	H (inches) (pouces) (Zoll) (pulgadas)	i.d. (inches) (pouces) (Zoll) (pulgadas)
Part No. Référence Teile-Nr. N° de pieza	Code Code Code Código	Part No. Référence Teile-Nr. N° de pieza	Code Code Code Código				
MPV8T005F	159.001.614	MCPV8T005F	159.001.632	1/2"	3.75	3.50	0.85
MPV8T007F	159.001.615	MCPV8T007F	159.001.633	3/4"	3.75	3.70	1.06
MPV8T010F	159.001.616	MCPV8T010F	159.001.634	1"	4.30	4.00	1.33
MPV8T012F	159.001.617	MCPV8T012F	159.001.635	1-1/4"	4.40	4.30	1.67
MPV8T015F	159.001.618	MCPV8T015F	159.001.636	1-1/2"	5.00	4.60	1.91
MPV8T020F	159.001.619	MCPV8T020F	159.001.637	2"	5.50	5.00	2.40

**Fitting with pipe**

**Raccord avec tuyau**

**Fitting mit Rohr**

**Accesorio con tubería**

SCH 80 PVC		SCH 80 CPVC		Size (inches) Dim. (pouces) Größe (Zoll) Tamaño (pulgadas)	L (inches) (pouces) (Zoll) (pulgadas)	H (inches) (pouces) (Zoll) (pulgadas)	o.d. (inches) (pouces) (Zoll) (pulgadas)
Part No. Référence Teile-Nr. N° de pieza	Code Code Code Código	Part No. Référence Teile-Nr. N° de pieza	Code Code Code Código				
MPV8T005	159.001.623	MCPV8T005	159.001.641	1/2"	14	3.50	0.84
MPV8T007	159.001.624	MCPV8T007	159.001.642	3/4"	14	3.70	1.05
MPV8T010	159.001.625	MCPV8T010	159.001.643	1"	17	4.00	1.32
MPV8T012	159.001.626	MCPV8T012	159.001.644	1-1/4"	20	4.30	1.66
MPV8T015	159.001.627	MCPV8T015	159.001.645	1-1/2"	24	4.60	1.90
MPV8T020	159.001.628	MCPV8T020	159.001.646	2"	26.5	5.02	2.38

### K-Factors

A **K-Factor** is the number of pulses (P) a sensor will generate for each engineering unit of fluid that passes the sensor. K-factors for water are listed below in U.S. gallons and liters. For example, in a 1 inch SCH 80 PVC pipe, the 515 paddlewheel generates 172.07 pulses per gallon of water passing the rotor.

**K-Factors are for schedule 80 pipe.**

### Facteurs K

Un **Facteur K** est le nombre d'impulsions (P) qu'un capteur produit pour chaque unité d'ingénierie de fluide qui y passe. Les facteurs K pour l'eau sont indiqués ci-dessous en gallons U.S. et en litres. Par exemple, dans un tuyau en PVC de 25,4 mm (1 pouce), la roue à palettes 515 produit 172.07 impulsions par gallon (3,78 litres) d'eau qui passe dans le rotor.

**Les facteurs K sont pour les tuyaux de norme 80.**

### K-Faktoren

Der **K-Faktor** repräsentiert die Anzahl der Impulse (P), die vom Sensor für jede physikalische Einheit durchfließender Flüssigkeit erzeugt wird. K-Faktoren für Wasser sind nachstehend in US-Gallonen und Liter aufgeführt. Beispielsweise erzeugt das 515 Schaufelrad in einem 1-Zoll-PVC-Rohr 172.07 Impulse pro Gallone Wasser, das durch den Rotor fließt.

**K-Faktoren sind für Schedule 80 Rohre.**

### Factores K

El **Factor K** es el número de impulsos (P) que genera un sensor por cada unidad de líquido que pasa por el sensor. En las tablas de abajo se muestran los factores K para agua (en unidades de galones norteamericanos [EE. UU.] y litros). Por ejemplo, en una tubería de PVC de 1 pulg., la 515 rueda de paletas genera 172.07 impulsos por galón de agua que pasa por el rotor.

**Los factores K son para tuberías del catálogo 80**

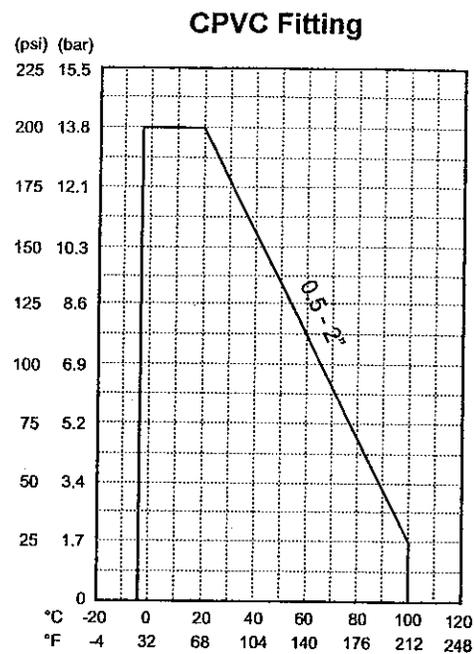
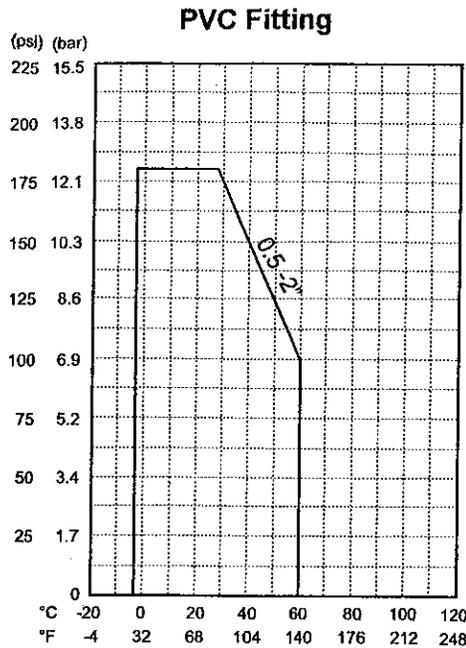
PIPE SIZE TAILLE DE TUYAU ROHRGRÖSSE TAMAÑO DE LA TUBERÍA	SCH. 80 FITTING RACCORD DE NORME 80 SCHEDULE 80 FITTING ACCESORIO DE CATÁLOGO 80	515/8510		2536/2537/8512		2551	
		P/LITERS P/LITRES P/LITROS	P/U.S. GAL	P/LITERS P/LITRES P/LITROS	P/U.S. GAL	P/LITERS P/LITRES P/LITROS	P/U.S. GAL
1/2"	MPV8T005F MCPV8T005F MPV8T005 MCPV8T005	137.42	520.12	271.37	1027.1	601.58	2277.0
3/4"	MPV8T007F MCPV8T007F MPV8T007 MCPV8T007	78.61	297.52	154.08	583.19	371.90	1407.6
1"	MPV8T010F MCPV8T010F MPV8T010 MCPV8T010	45.46	172.07	88.65	335.53	227.52	861.17
1-1/4"	MPV8T012F MCPV8T012F MPV8T012 MCPV8T012	24.19	91.54	47.24	178.79	122.83	464.91
1-1/2"	MPV8T015F MCPV8T015F MPV8T015 MCPV8T015	16.44	62.22	32.08	121.42	87.56	331.43
2"	MPV8T020F MCPV8T020F MPV8T020 MCPV8T020	9.60	36.32	18.87	71.44	50.96	192.89

**Specifications**

**Spécifications**

**Spezifikationen**

**Especificaciones**



The pressure ratings are for the fitting only. NEVER EXCEED the pressure rating of the installed sensor.

Follow plastic piping cement manufacturer's recommended preparation and gluing instructions. Avoid excess cement in fitting joints to prevent any port obstruction.

Les niveaux de pression ne concernent que le raccord. NE JAMAIS DÉPASSER le niveau de pression du capteur installé.

Suivez les instructions de préparation et d'application du mastic données par le fournisseur de celui-ci. Evitez d'appliquer le mastic en trop grande quantité pour ne risquer aucune obstruction.

Die Drucknennwerte beziehen sich nur auf die Fittinge. Den Drucknennwert des installierten Sensors NIEMALS ÜBERSCHREITEN.

Anweisungen des Klebstoff-Herstellers befolgen. Nicht zuviel Klebstoff an den Verbindungsstellen auftragen, um Verstopfungen der Öffnungen zu vermeiden.

Las presiones nominales son para el accesorio solamente. NO EXCEDA NUNCA la presión nominal del sensor instalado.

Siga las instrucciones recomendadas por el fabricante para la preparación y el engomado del cemento para tuberías plásticas. Evite el exceso de cemento en las juntas de los conectores para prevenir obstrucciones en los orificios.

Rigid PVC and CPVC Material Compounds Specification: ASTM D 1784

Dimensional and Compound Plastic Pipe Fittings Specifications: ASTM D 2467 ASTM F 439

Standard Test Methods Specification: ASTM F 1970

Matériau PVC et CPVC rigide Spécifications des composés : ASTM D 1784

Dimensions et composé Raccords pour tuyau en plastique Spécifications : ASTM D 2467 ASTM F 439

Méthodes standard de test Spécifications : ASTM F 1970

Verbundstoffspezifikation für unbiegsames PVC- und CPVC-Material: ASTM D 1784

Abmessungs- und Verbundstoffspezifikationen für Rohrfittinge aus Kunststoff: ASTM D 2467 ASTM F 439

Spezifikation für Standardtestmethoden: ASTM F 1970

PVC y CPVC rígidos Especificación de los compuestos: ASTM D 1784

Dimensiones y composición Accesorios de tuberías de plástico Especificaciones: ASTM D 2467 ASTM F 439

Métodos de prueba estándar Especificación: ASTM F 1970

**+GF+**

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 For Worldwide Sales and Service, visit our website: [www.gfsignet.com](http://www.gfsignet.com) • Or call (in the U.S.): (800) 854-4090  
 For the most up-to-date information, please refer to our website at [www.gfsignet.com](http://www.gfsignet.com)

**APPENDIX E**  
**As-Built Drawings and Selected Photographs for the Active  
Depressurization (ASD) System**



engineering and constructing a better tomorrow

August 10, 2009

Mr. Joseph T. Martella II, Senior Engineer  
RIDEM Office of Waste Management  
Site Remediation Program  
235 Providence Street  
Providence, RI 02908

**RE: Short Term Response Action Closure Report  
Retail Complex Sub-Slab Soil Mitigation  
Former Gorham Manufacturing Facility  
333 Adelaide Avenue, Providence, Rhode Island  
MACTEC Project No. 3650080114.10**

Dear Mr. Martella:

This letter presents the Short Term Response Action Closure Report for the installation of vapor mitigation systems at the Retail Complex referenced above. The purpose of this report is to document the installation of the system components and present record information. An Active Soil Depressurization (ASD) system was installed in each of the four retail spaces. The objective of these ASD systems was to remove the soil vapor from beneath the building slab so that it does not migrate into the indoor air of the retail spaces. These mitigation activities were conducted consistent with Short Term Response Action Work Plan, submitted by MACTEC Engineering and Consulting, Inc. (MACTEC) to Rhode Island Department of Environmental Management (RIDEM) on May 9, 2008 and the Order of Approval (July 24, 2008) and Order of Approval Addendum (August 7, 2008).

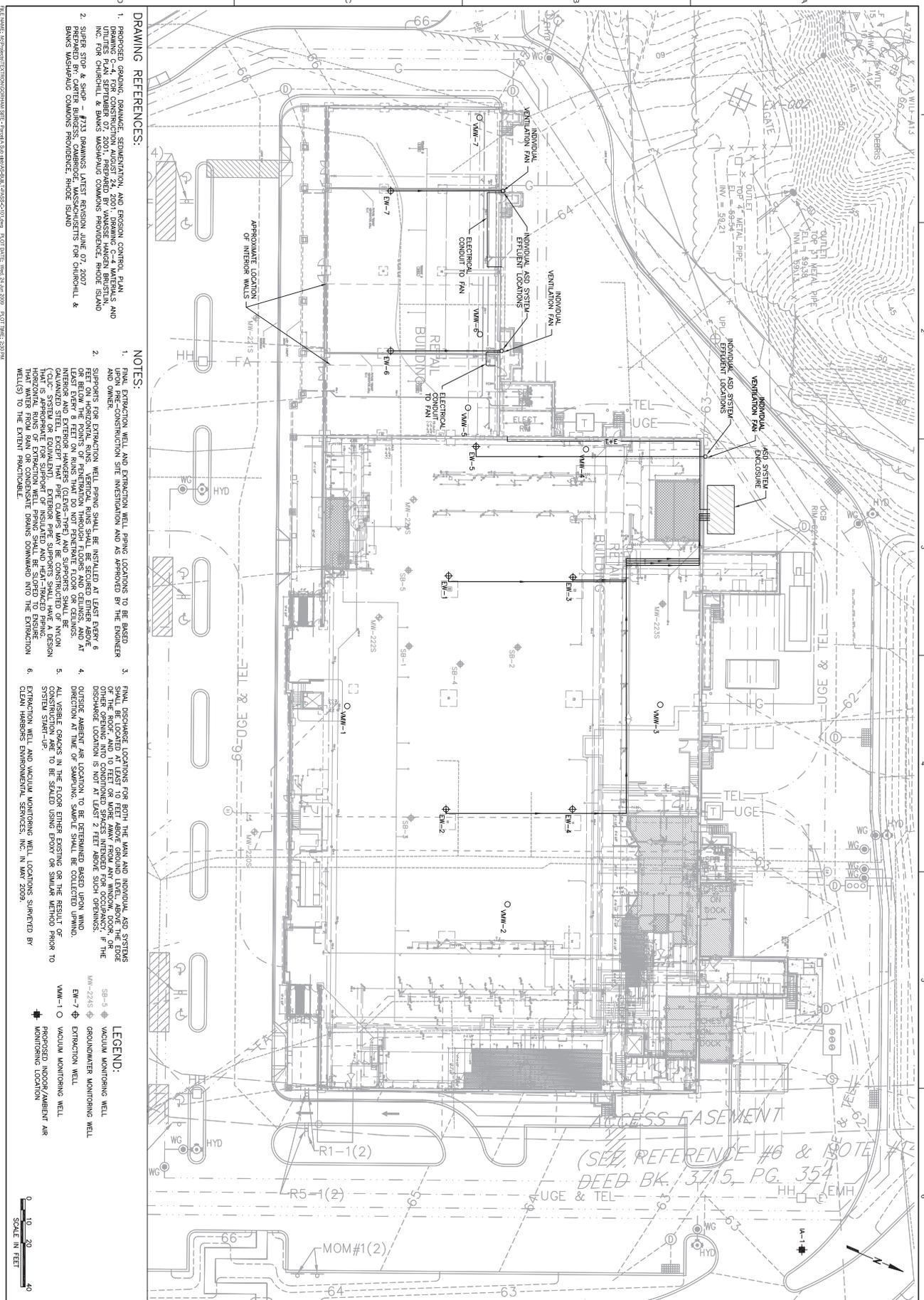
#### **ASD SYSTEM INSTALLATION**

A community notice was prepared in English and Spanish and distributed to residents, on August 18, 2008, in the Reservoir Triangle Neighborhood describing the proposed work. Textron's subcontractor Clean Harbors Environmental Services (CHES) of Norwell, MA mobilized to the Site on October 7, 2008 and began preparation for the system installation.

Five extraction wells were installed in the large retail space (EW-1 through EW-5), and one well

## **APPENDIX A**

### **Record Drawings**



**DRAWING REFERENCES:**

1. PROPOSED GRADING, DRAINAGE, SEWERIZATION, AND EROSION CONTROL PLAN UTILITIES PLAN SEPTEMBER 07 2001, PREPARED BY VANASSE HANGEN BRUSTLIN, INC. FOR CHURCHILL & BAWES WASHINGTON COMMONS PROVIDENCE, RHODE ISLAND
2. SUPER SITE & SHED - #233 DRAWINGS LATEST REVISION JUNE 07 2007
3. SUPER SITE & SHED - #233 DRAWINGS LATEST REVISION JUNE 07 2007
4. BAWES WASHINGTON COMMONS PROVIDENCE, RHODE ISLAND

**NOTES:**

1. FINAL EXHAUSTION WELL AND EXHAUSTION WELL PILING LOCATIONS TO BE BASED UPON PRE-CONSTRUCTION SITE INVESTIGATION AND AS APPROVED BY THE ENGINEER AND OWNER.
2. SUPPORTS FOR EXHAUSTION WELL PILING SHALL BE INSTALLED AT LEAST EVERY 8 FEET OR BELOW THE POINTS OF PENETRATION THROUGH FLOORS AND CEILINGS, AND AT LEAST EVERY 8 FEET ON RUNS THAT DO NOT PENETRATE FLOOR OR CEILINGS, AND AT UNANNOUNCED STEEL EXCEPT THAT PIPE CLAMPS MAY BE CONSTRUCTED OF RIGID GALVANIZED STEEL OR EQUIVALENT. EXTERIOR PIPE SUPPORTS SHALL HAVE A DESIGN (L.C.C. SYSTEM OR EQUIVALENT). EXTERIOR PIPE SUPPORTS SHALL HAVE A DESIGN THAT WATER FLOW FROM RAIN OR CONDENSATE DRAINS DOWNWARD INTO THE EXHAUSTION WELLS TO THE EXTENT PRACTICABLE.
3. FINAL DISCHARGE LOCATIONS FOR BOTH THE MAIN AND INDIVIDUAL ASD SYSTEMS SHALL BE LOCATED AT LEAST 10 FEET ABOVE GROUND LEVEL, ABOVE THE EDGE OF OTHER OPENING INTO CONDENSED SPACES INTENDED FOR OCCUPANCY, AND THE DISCHARGE LOCATION IS NOT AT LEAST 2 FEET ABOVE SUCH OPENINGS.
4. OUTSIDE AMBIENT AIR LOCATION TO BE DETERMINED BASED UPON WIND DIRECTION AT TIME OF SAMPLING. SAMPLE SHALL BE COLLECTED UPWIND.
5. ALL VISIBLE CRACKS IN THE FLOOR EITHER EXISTING OR THE RESULT OF CONSTRUCTION ARE TO BE SEALED USING EPOXY OR SIMILAR METHOD PRIOR TO SYSTEM START-UP.
6. EXHAUSTION WELL AND VACUUM MONITORING WELL LOCATIONS SURVEYED BY ELLEN WASHINGTON SURVEYING SERVICES, INC. IN JAN 2009.

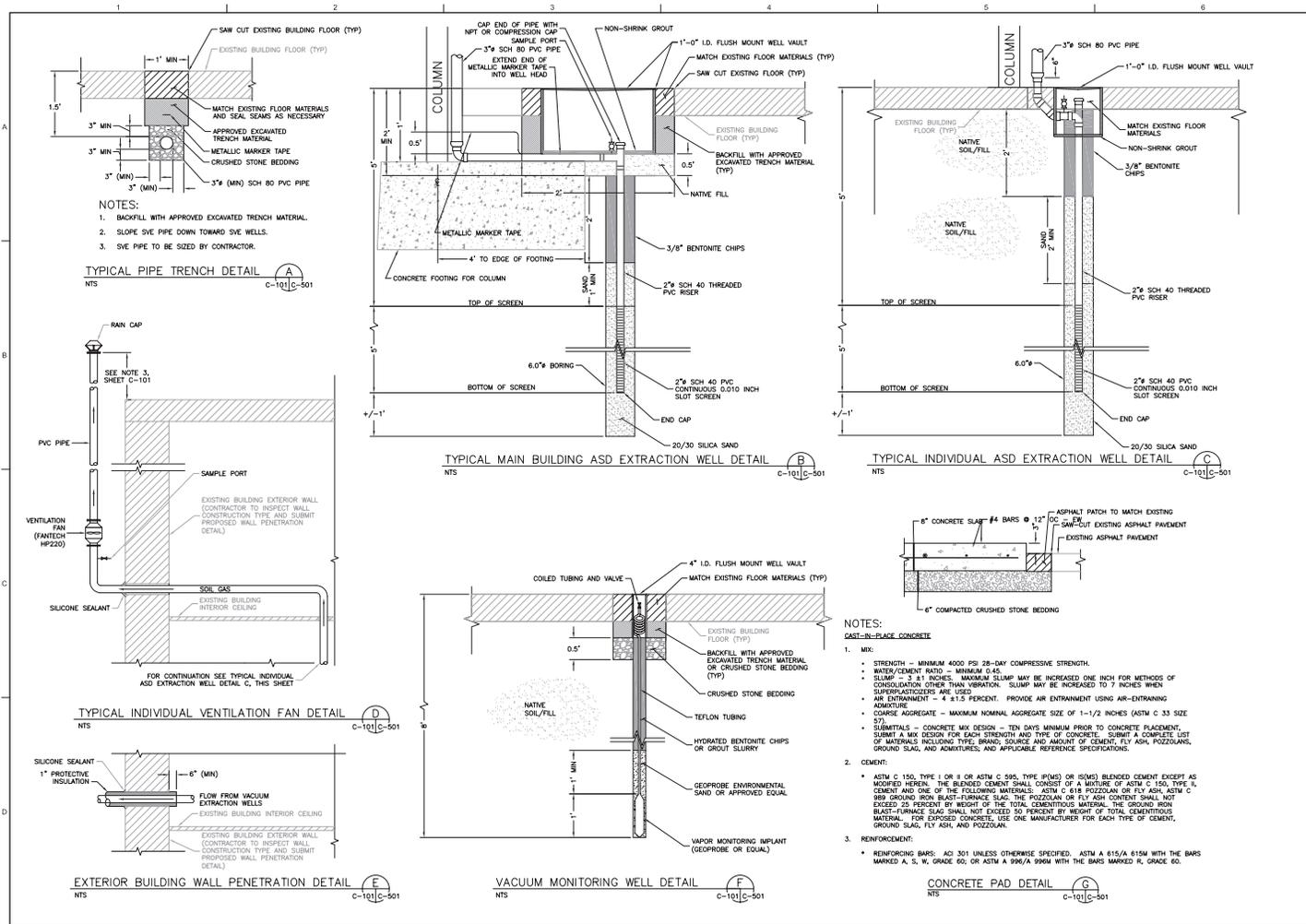
**LEGEND:**

- SB-4-6 VACUUM MONITORING WELL
- SB-2-3-5 GROUNDWATER MONITORING WELL
- EM-1-7 EXHAUSTION WELL
- MW-1-7 VACUUM MONITORING WELL
- PROPOSED INDOOR/AMBIENT AIR MONITORING LOCATION

0 10 20 40  
SCALE IN FEET

		<b>MACTEC Engineering and Consulting, Inc.</b> P.O. Box 7050, 511 Congress Street Portland, Maine 04112-7050 (207) 775-5401			
<b>Civil</b> <b>EXISTING CONDITIONS PLAN</b> <b>AND PROPOSED LAYOUT</b>					
Active Soil Depressurization System Design Former Gorham Manufacturing Facility Parcel A Retail Complex 333 Adalate Avenue, Providence, Rhode Island					
NO.	DATE	REVISION	BY	APVD	
2	06/24/08	RECORD DRAWING			
1	09/15/08	ISSUED FOR CONSTRUCTION			
0	08/05/08	ISSUED FOR BID	SCP	CAC	
C	07/08/08	FINAL TO RIDEM FOR APPROVAL	SCP	CAC	
B	04/01/08	SUBMITTAL TO RIDEM	SCP	DEH	
A	02/04/08	DRAFT FOR CLIENT REVIEW	SCP	DEH	
NO.		DATE	REVISION	BY	APVD
DSGN			DEL	CHK	APVD
			SCP	APVD	CAC

THIS DRAWING IS THE PROPERTY OF MACTEC, INCLUDING ALL PATENTED AND PATENTABLE FEATURES, AND/OR CONFIDENTIAL INFORMATION AND ITS USE IS CONDITIONED UPON THE USER'S AGREEMENT NOT TO REPRODUCE THE DRAWING, IN WHOLE OR PART, NOR THE MATERIAL DESCRIBED THEREON, NOR THE USE OF THE DRAWING FOR ANY PURPOSE OTHER THAN SPECIFICALLY PERMITTED BY WRITING BY MACTEC.



RECORD DRAWING	DATE	BY	CHKD
ISSUED FOR CONSTRUCTION	1/20/2008	J. BOYD	CAC
FINAL TO SUBMIT FOR PERMIT	3/17/2008	C. BOYD	CAC
FINAL TO SUBMIT FOR APPROVAL	3/17/2008	C. BOYD	CAC
SUBMITTAL TO IDEM	B. BOYD	SCD	DEH
DRAW FOR CLIENT REVIEW	A. BOYD	SCD	DEH
REVISION	NO. DATE	BY	CHKD
1	01/20/08	J. BOYD	CAC
2	07/20/08	J. BOYD	CAC
3	07/20/08	C. BOYD	CAC
4	07/20/08	C. BOYD	CAC
5	07/20/08	C. BOYD	CAC
6	07/20/08	C. BOYD	CAC
7	07/20/08	C. BOYD	CAC
8	07/20/08	C. BOYD	CAC
9	07/20/08	C. BOYD	CAC
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98	07/20/08	C. BOYD	CAC
99	07/20/08	C. BOYD	CAC
100	07/20/08	C. BOYD	CAC

**MACTEC**  
 CIVIL  
 CIVIL DETAILS

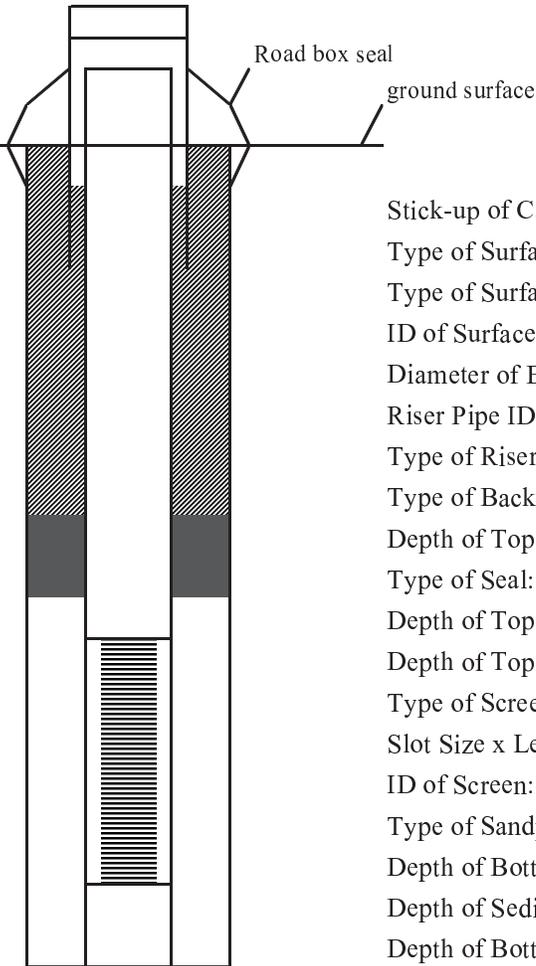
VERIFY SCALE  
 BASE ON DESIGN  
 ONE FINAL SETBACK

DATE: 3650-08-0114  
 DWG: C-501  
 SHEET: 3 of 5

**APPENDIX B**  
**Well Diagrams**

## MONITORING WELL DIAGRAM

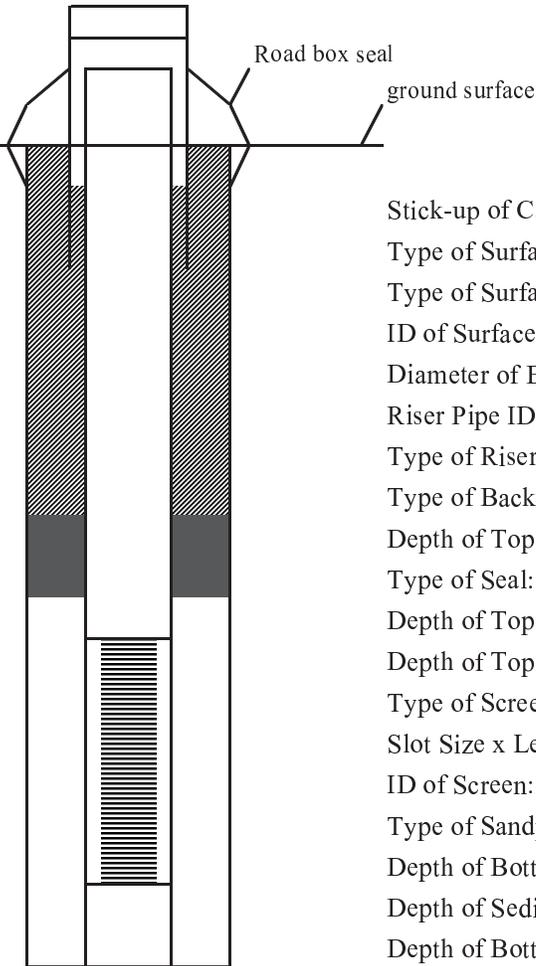
<b>Project Name:</b> Textron Gorham ASD Installation	<b>Boring No:</b> EW-1
<b>Date Installed:</b> 10/8/2008	<b>Contractor:</b> Geotech
<b>Project No.:</b> 3650080114	<b>Drilling Method:</b> HSE/Direct Push
<b>Field Geologist:</b> M.Maggiore	<b>Development Method:</b> None



Stick-up of Casing Above Ground Surface:	Flush
Type of Surface Seal/Other Protection:	Concrete
Type of Surface Casing:	Aluminum/steel
ID of Surface Casing:	12"
Diameter of Borehole:	6.5"
Riser Pipe ID:	2"
Type of Riser Pipe:	Sch 80 pvc
Type of Backfill:	Crushed stone
Depth of Top Seal:	2'
Type of Seal:	3/8" Bentonite chips
Depth of Top of Sand:	4'
Depth of Top of Screen:	5'
Type of Screen:	2" pvc
Slot Size x Length:	.010 x 5'
ID of Screen:	2"
Type of Sandpack:	20/30 silica sand
Depth of Bottom of Screen:	10
Depth of Sediment Sump with Plug:	10'
Depth of Bottom of Borehole:	11'

## MONITORING WELL DIAGRAM

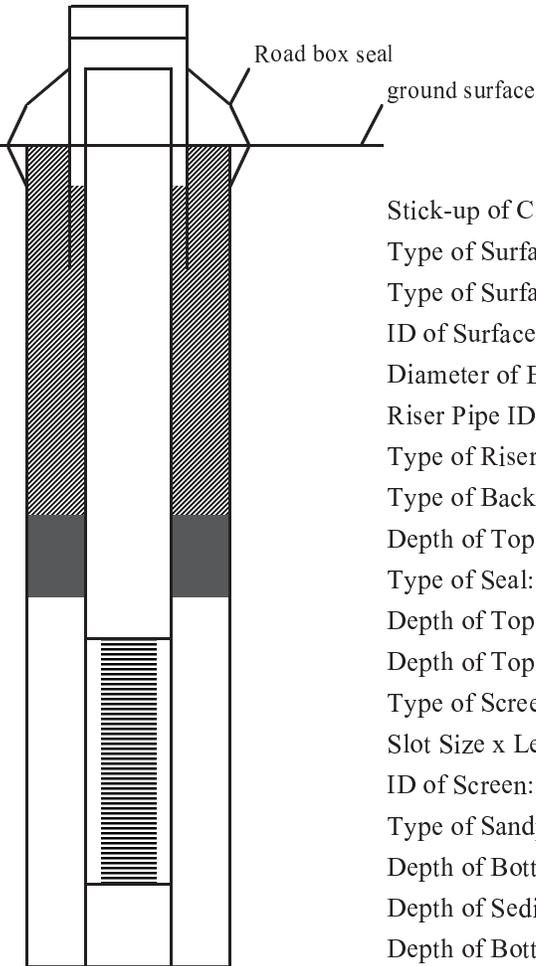
<b>Project Name:</b> Textron Gorham ASD Installation	<b>Boring No:</b> EW-2
<b>Date Installed:</b> 10/9/2008	<b>Contractor:</b> Geotech
<b>Project No.:</b> 3650080114	<b>Drilling Method:</b> HSE/Direct Push
<b>Field Geologist:</b> M.Maggiore	<b>Development Method:</b> None



Stick-up of Casing Above Ground Surface:	<u>Flush</u>
Type of Surface Seal/Other Protection:	<u>Concrete</u>
Type of Surface Casing:	<u>Aluminum/steel</u>
ID of Surface Casing:	<u>12"</u>
Diameter of Borehole:	<u>6.5"</u>
Riser Pipe ID:	<u>2"</u>
Type of Riser Pipe:	<u>Sch 80 pvc</u>
Type of Backfill:	<u>Crushed stone</u>
Depth of Top Seal:	<u>2'</u>
Type of Seal:	<u>3/8" Bentonite chips</u>
Depth of Top of Sand:	<u>4'</u>
Depth of Top of Screen:	<u>5'</u>
Type of Screen:	<u>PVC</u>
Slot Size x Length:	<u>.010 x 5'</u>
ID of Screen:	<u>2"</u>
Type of Sandpack:	<u>20/30 silica sand</u>
Depth of Bottom of Screen:	<u>10</u>
Depth of Sediment Sump with Plug:	<u>10'</u>
Depth of Bottom of Borehole:	<u>11'</u>

## MONITORING WELL DIAGRAM

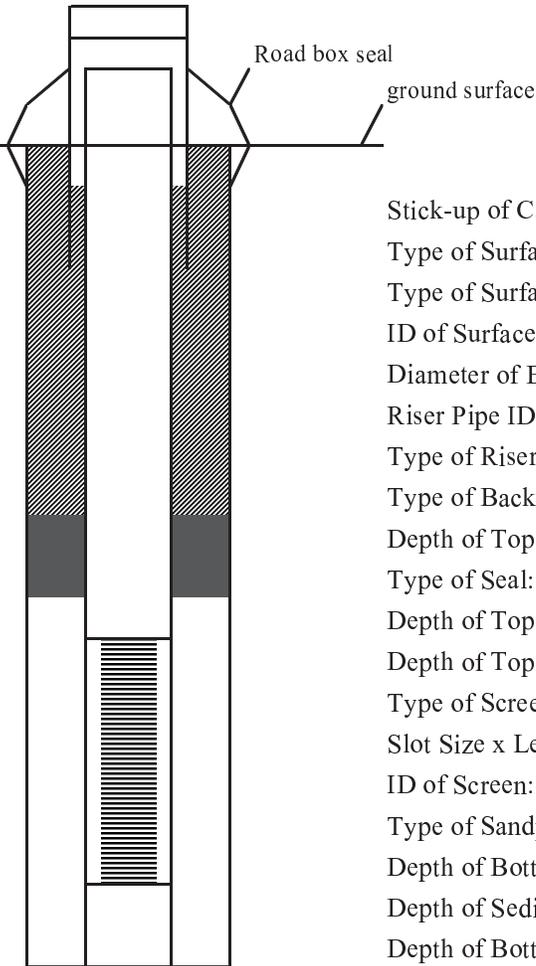
<b>Project Name:</b> Textron Gorham ASD Installation	<b>Boring No:</b> EW-3
<b>Date Installed:</b> 10/8/2008	<b>Contractor:</b> Geotech
<b>Project No.:</b> 3650080114	<b>Drilling Method:</b> HSE/Direct Push
<b>Field Geologist:</b> M.Maggiore	<b>Development Method:</b> None



Stick-up of Casing Above Ground Surface:	Flush
Type of Surface Seal/Other Protection:	Concrete
Type of Surface Casing:	Aluminum/steel
ID of Surface Casing:	12"
Diameter of Borehole:	6.5"
Riser Pipe ID:	2"
Type of Riser Pipe:	Sch 80 pvc
Type of Backfill:	Crushed stone
Depth of Top Seal:	1'
Type of Seal:	3/8" Bentonite chips
Depth of Top of Sand:	3'
Depth of Top of Screen:	4'
Type of Screen:	2" pvc
Slot Size x Length:	.010 x 5'
ID of Screen:	2"
Type of Sandpack:	20/30 silica sand
Depth of Bottom of Screen:	9'
Depth of Sediment Sump with Plug:	9'
Depth of Bottom of Borehole:	9.5'

## MONITORING WELL DIAGRAM

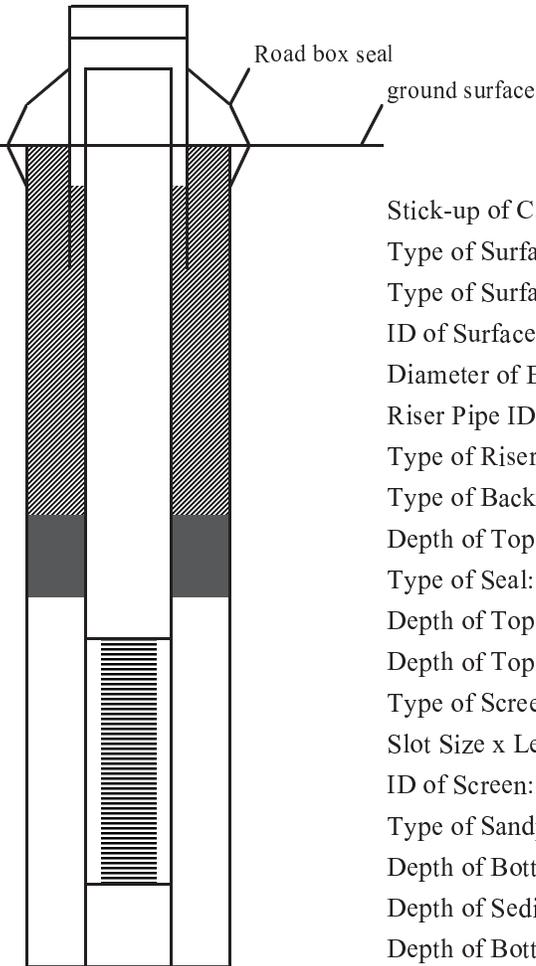
<b>Project Name:</b> Textron Gorham ASD Installation	<b>Boring No:</b> EW-4
<b>Date Installed:</b> 10/8/2008	<b>Contractor:</b> Geotech
<b>Project No.:</b> 3650080114	<b>Drilling Method:</b> HSE/Direct Push
<b>Field Geologist:</b> M.Maggiore	<b>Development Method:</b> None



Stick-up of Casing Above Ground Surface:	Flush
Type of Surface Seal/Other Protection:	Concrete
Type of Surface Casing:	Aluminum/steel
ID of Surface Casing:	12"
Diameter of Borehole:	6.5"
Riser Pipe ID:	2"
Type of Riser Pipe:	Sch 80 pvc
Type of Backfill:	Crushed stone
Depth of Top Seal:	2'
Type of Seal:	3/8" Bentonite chips
Depth of Top of Sand:	4'
Depth of Top of Screen:	5'
Type of Screen:	2" PVC
Slot Size x Length:	.010 x 5'
ID of Screen:	2"
Type of Sandpack:	20/30 silica sand
Depth of Bottom of Screen:	10
Depth of Sediment Sump with Plug:	10'
Depth of Bottom of Borehole:	11'

## MONITORING WELL DIAGRAM

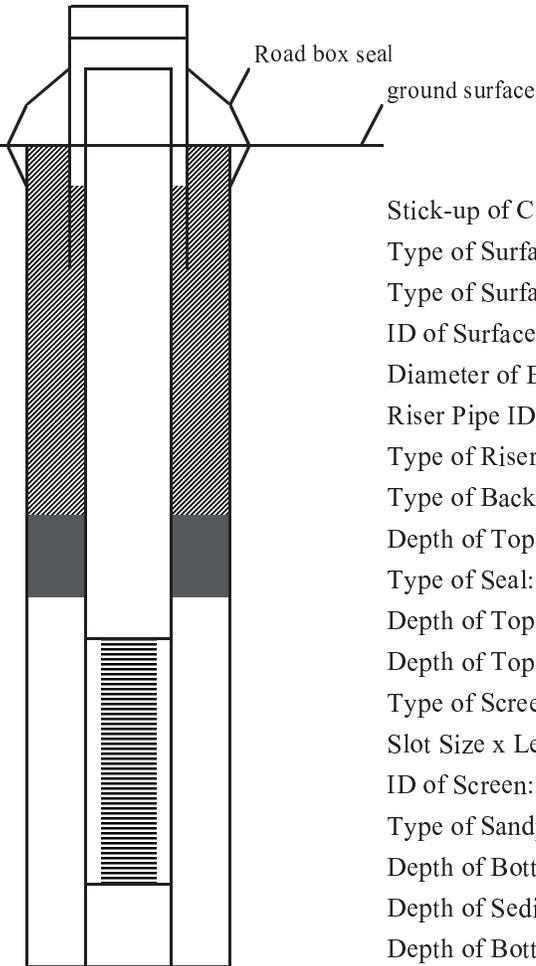
<b>Project Name:</b> Textron Gorham ASD Installation	<b>Boring No:</b> EW-5
<b>Date Installed:</b> 10/8/2008	<b>Contractor:</b> Geotech
<b>Project No.:</b> 3650080114	<b>Drilling Method:</b> HSE/Direct Push
<b>Field Geologist:</b> M.Maggiore	<b>Development Method:</b> None



Stick-up of Casing Above Ground Surface:	Flush
Type of Surface Seal/Other Protection:	Concrete
Type of Surface Casing:	Aluminum/steel
ID of Surface Casing:	12"
Diameter of Borehole:	6.5"
Riser Pipe ID:	2"
Type of Riser Pipe:	Sch 80 pvc
Type of Backfill:	Crushed stone
Depth of Top Seal:	1'
Type of Seal:	3/8" Bentonite chips
Depth of Top of Sand:	3'
Depth of Top of Screen:	4'
Type of Screen:	2" pvc
Slot Size x Length:	.010 x 5'
ID of Screen:	2"
Type of Sandpack:	20/30 silica sand
Depth of Bottom of Screen:	9'
Depth of Sediment Sump with Plug:	10'
Depth of Bottom of Borehole:	10'

## MONITORING WELL DIAGRAM

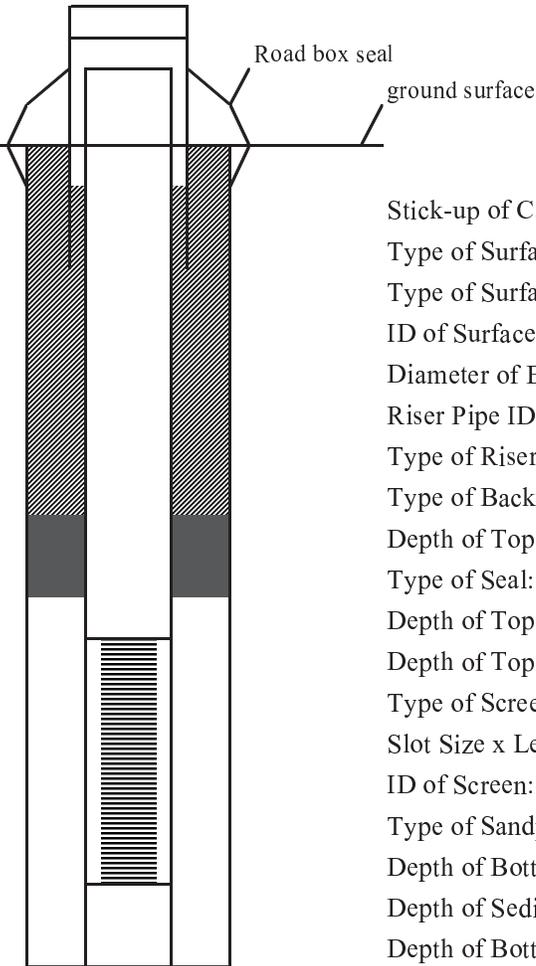
<b>Project Name:</b> Textron Gorham ASD Installation	<b>Boring No:</b> EW-6
<b>Date Installed:</b> 10/8/2008	<b>Contractor:</b> Geotech
<b>Project No.:</b> 3650080114	<b>Drilling Method:</b> HSE/Direct Push
<b>Field Geologist:</b> M.Maggiore	<b>Development Method:</b> None



Stick-up of Casing Above Ground Surface:	<u>Flush</u>
Type of Surface Seal/Other Protection:	<u>Concrete</u>
Type of Surface Casing:	<u>Aluminum/steel</u>
ID of Surface Casing:	<u>12"</u>
Diameter of Borehole:	<u>6.5"</u>
Riser Pipe ID:	<u>2"</u>
Type of Riser Pipe:	<u>Sch 80 pvc</u>
Type of Backfill:	<u>Crushed stone</u>
Depth of Top Seal:	<u>1'</u>
Type of Seal:	<u>3/8" Bentonite chips</u>
Depth of Top of Sand:	<u>3'</u>
Depth of Top of Screen:	<u>4'</u>
Type of Screen:	<u>2" PVC</u>
Slot Size x Length:	<u>.010 x 5'</u>
ID of Screen:	<u>2"</u>
Type of Sandpack:	<u>20/30 silica sand</u>
Depth of Bottom of Screen:	<u>9'</u>
Depth of Sediment Sump with Plug:	<u>10'</u>
Depth of Bottom of Borehole:	<u>10'</u>

## MONITORING WELL DIAGRAM

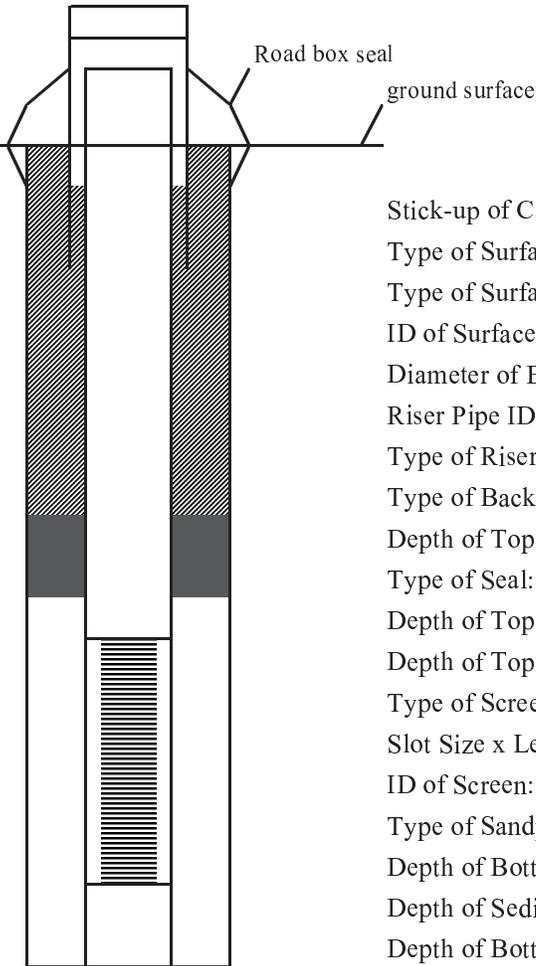
<b>Project Name:</b> Textron Gorham ASD Installation	<b>Boring No:</b> EW-7
<b>Date Installed:</b> 10/9/2008	<b>Contractor:</b> Geotech
<b>Project No.:</b> 3650080114	<b>Drilling Method:</b> HSE/Direct Push
<b>Field Geologist:</b> M.Maggiore	<b>Development Method:</b> None



Stick-up of Casing Above Ground Surface:	<u>Flush</u>
Type of Surface Seal/Other Protection:	<u>Concrete</u>
Type of Surface Casing:	<u>Aluminum/steel</u>
ID of Surface Casing:	<u>12"</u>
Diameter of Borehole:	<u>6.5"</u>
Riser Pipe ID:	<u>2"</u>
Type of Riser Pipe:	<u>Sch 80 pvc</u>
Type of Backfill:	<u>Crushed stone</u>
Depth of Top Seal:	<u>1'</u>
Type of Seal:	<u>3/8" Bentonite chips</u>
Depth of Top of Sand:	<u>3'</u>
Depth of Top of Screen:	<u>4'</u>
Type of Screen:	<u>2" PVC</u>
Slot Size x Length:	<u>.010 x 5'</u>
ID of Screen:	<u>2"</u>
Type of Sandpack:	<u>20/30 silica sand</u>
Depth of Bottom of Screen:	<u>9'</u>
Depth of Sediment Sump with Plug:	<u>10'</u>
Depth of Bottom of Borehole:	<u>10'</u>

## MONITORING WELL DIAGRAM

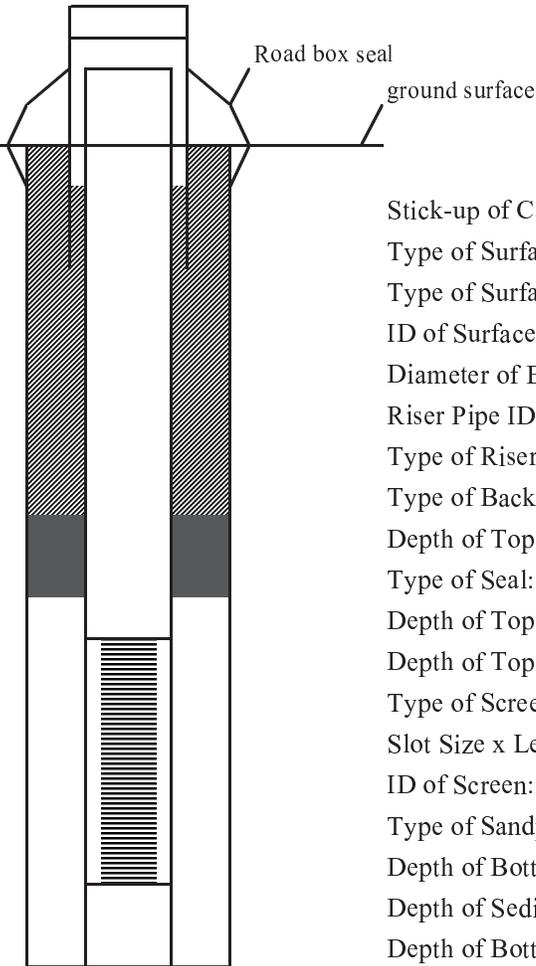
<b>Project Name:</b> Textron Gorham ASD Installation	<b>Boring No:</b> VMW-1
<b>Date Installed:</b> 10/10/2008	<b>Contractor:</b> Geotech
<b>Project No.:</b> 3650080114.09	<b>Drilling Method:</b> Direct Push
<b>Field Geologist:</b> M. Maggiore	<b>Development Method:</b> N/A



Stick-up of Casing Above Ground Surface:	Flush
Type of Surface Seal/Other Protection:	Concrete
Type of Surface Casing:	Aluminum
ID of Surface Casing:	4"
Diameter of Borehole:	3"
Riser Pipe ID:	N/A
Type of Riser Pipe:	N/A
Type of Backfill:	Approved excavated material
Depth of Top Seal:	1"
Type of Seal:	Hydrated bentonite slurry
Depth of Top of Sand:	8'
Depth of Top of Screen:	N/A
Type of Screen:	N/A
Slot Size x Length:	N/A
ID of Screen:	N/A
Type of Sandpack:	20/30 silica sand
Depth of Bottom of Screen:	N/A
Depth of Sediment Sump with Plug:	N/A
Depth of Bottom of Borehole:	10'

## MONITORING WELL DIAGRAM

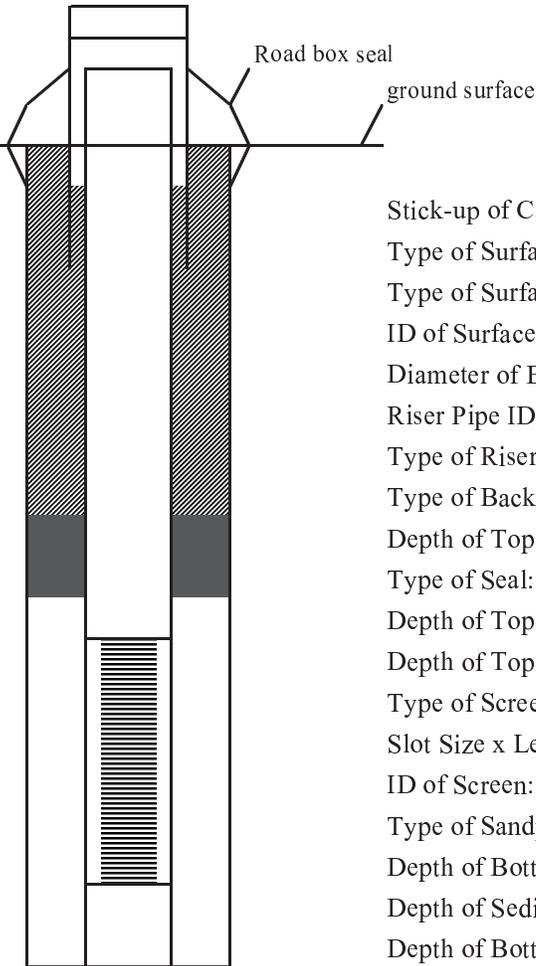
<b>Project Name:</b> Textron Gorham ASD Installation	<b>Boring No:</b> VMW-2
<b>Date Installed:</b> 10/10/2008	<b>Contractor:</b> Geotech
<b>Project No.:</b> 3650080114.09	<b>Drilling Method:</b> Direct Push
<b>Field Geologist:</b> M. Maggiore	<b>Development Method:</b> N/A



Stick-up of Casing Above Ground Surface:	Flush
Type of Surface Seal/Other Protection:	Concrete
Type of Surface Casing:	Aluminum
ID of Surface Casing:	4"
Diameter of Borehole:	3"
Riser Pipe ID:	N/A
Type of Riser Pipe:	N/A
Type of Backfill:	Approved excavated material
Depth of Top Seal:	1"
Type of Seal:	Hydrated bentonite slurry
Depth of Top of Sand:	6'
Depth of Top of Screen:	N/A
Type of Screen:	N/A
Slot Size x Length:	N/A
ID of Screen:	N/A
Type of Sandpack:	20/30 silica sand
Depth of Bottom of Screen:	N/A
Depth of Sediment Sump with Plug:	N/A
Depth of Bottom of Borehole:	8'

## MONITORING WELL DIAGRAM

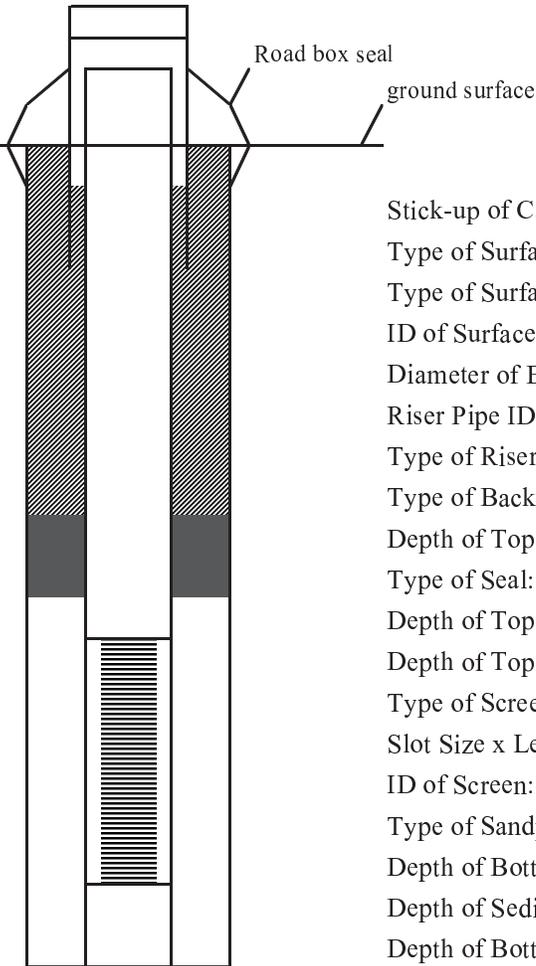
<b>Project Name:</b> Textron Gorham ASD Installation	<b>Boring No:</b> VMW-3
<b>Date Installed:</b> 10/10/2008	<b>Contractor:</b> Geotech
<b>Project No.:</b> 3650080114.09	<b>Drilling Method:</b> Direct Push
<b>Field Geologist:</b> M. Maggiore	<b>Development Method:</b> N/A



Stick-up of Casing Above Ground Surface:	<u>Flush</u>
Type of Surface Seal/Other Protection:	<u>Concrete</u>
Type of Surface Casing:	<u>Aluminum</u>
ID of Surface Casing:	<u>4"</u>
Diameter of Borehole:	<u>3"</u>
Riser Pipe ID:	<u>N/A</u>
Type of Riser Pipe:	<u>N/A</u>
Type of Backfill:	<u>Approved excavated material</u>
Depth of Top Seal:	<u>1"</u>
Type of Seal:	<u>Hydrated bentonite slurry</u>
Depth of Top of Sand:	<u>8'</u>
Depth of Top of Screen:	<u>N/A</u>
Type of Screen:	<u>N/A</u>
Slot Size x Length:	<u>N/A</u>
ID of Screen:	<u>N/A</u>
Type of Sandpack:	<u>20/30 silica sand</u>
Depth of Bottom of Screen:	<u>N/A</u>
Depth of Sediment Sump with Plug:	<u>N/A</u>
Depth of Bottom of Borehole:	<u>10'</u>

## MONITORING WELL DIAGRAM

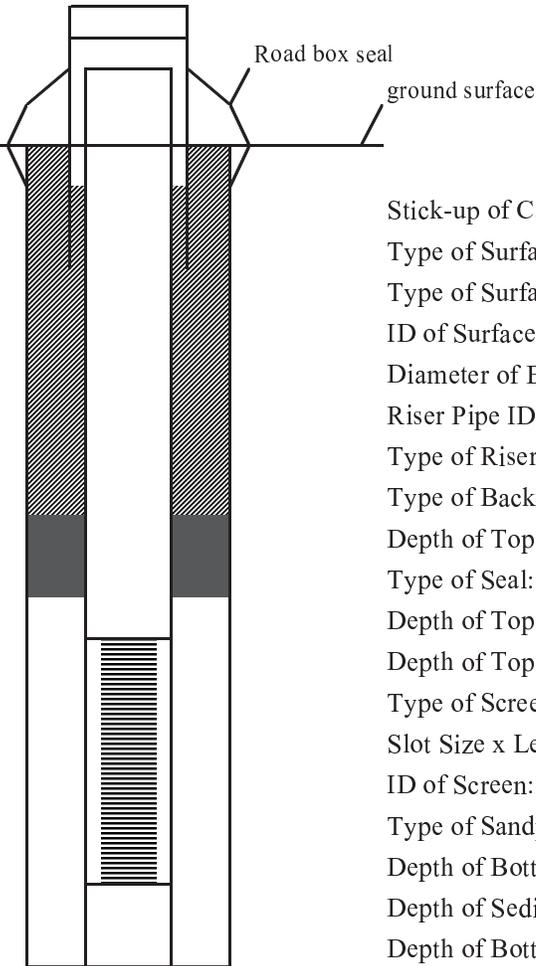
<b>Project Name:</b> Textron Gorham ASD Installation	<b>Boring No:</b> VMW-4
<b>Date Installed:</b> 10/10/2008	<b>Contractor:</b> Geotech
<b>Project No.:</b> 3650080114.09	<b>Drilling Method:</b> Direct Push
<b>Field Geologist:</b> M. Maggiore	<b>Development Method:</b> N/A



Stick-up of Casing Above Ground Surface:	<u>Flush</u>
Type of Surface Seal/Other Protection:	<u>Concrete</u>
Type of Surface Casing:	<u>Aluminum</u>
ID of Surface Casing:	<u>4"</u>
Diameter of Borehole:	<u>3"</u>
Riser Pipe ID:	<u>N/A</u>
Type of Riser Pipe:	<u>N/A</u>
Type of Backfill:	<u>Approved excavated material</u>
Depth of Top Seal:	<u>1"</u>
Type of Seal:	<u>Hydrated bentonite slurry</u>
Depth of Top of Sand:	<u>6'</u>
Depth of Top of Screen:	<u>N/A</u>
Type of Screen:	<u>N/A</u>
Slot Size x Length:	<u>N/A</u>
ID of Screen:	<u>N/A</u>
Type of Sandpack:	<u>20/30 silica sand</u>
Depth of Bottom of Screen:	<u>N/A</u>
Depth of Sediment Sump with Plug:	<u>N/A</u>
Depth of Bottom of Borehole:	<u>8'</u>

## MONITORING WELL DIAGRAM

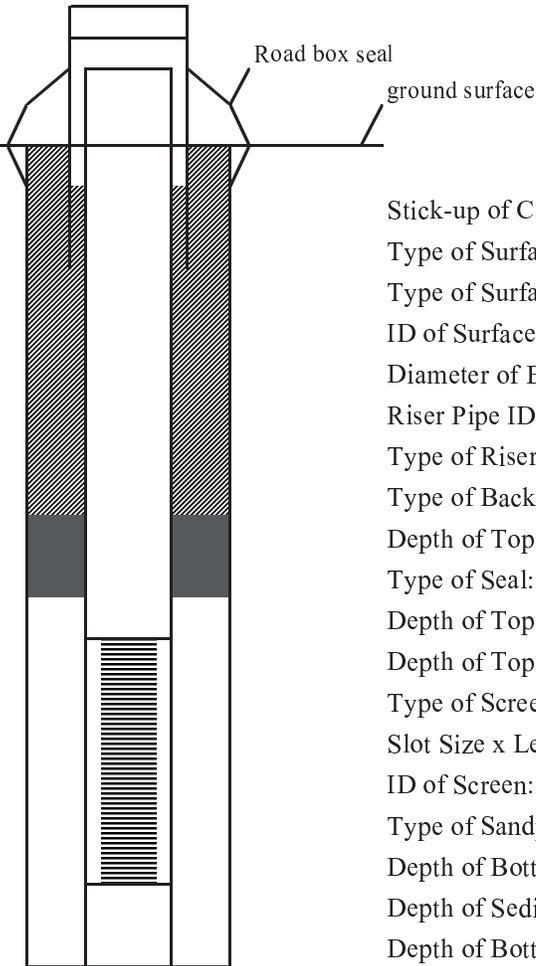
<b>Project Name:</b> Textron Gorham ASD Installation	<b>Boring No:</b> VMW-5
<b>Date Installed:</b> 10/10/2008	<b>Contractor:</b> Geotech
<b>Project No.:</b> 3650080114.09	<b>Drilling Method:</b> Direct Push
<b>Field Geologist:</b> M. Maggiore	<b>Development Method:</b> N/A



Stick-up of Casing Above Ground Surface:	<u>Flush</u>
Type of Surface Seal/Other Protection:	<u>Concrete</u>
Type of Surface Casing:	<u>Aluminum</u>
ID of Surface Casing:	<u>4"</u>
Diameter of Borehole:	<u>3"</u>
Riser Pipe ID:	<u>N/A</u>
Type of Riser Pipe:	<u>N/A</u>
Type of Backfill:	<u>Approved excavated material</u>
Depth of Top Seal:	<u>1"</u>
Type of Seal:	<u>Hydrated bentonite slurry</u>
Depth of Top of Sand:	<u>8'</u>
Depth of Top of Screen:	<u>N/A</u>
Type of Screen:	<u>N/A</u>
Slot Size x Length:	<u>N/A</u>
ID of Screen:	<u>N/A</u>
Type of Sandpack:	<u>20/30 silica sand</u>
Depth of Bottom of Screen:	<u>N/A</u>
Depth of Sediment Sump with Plug:	<u>N/A</u>
Depth of Bottom of Borehole:	<u>10'</u>

## MONITORING WELL DIAGRAM

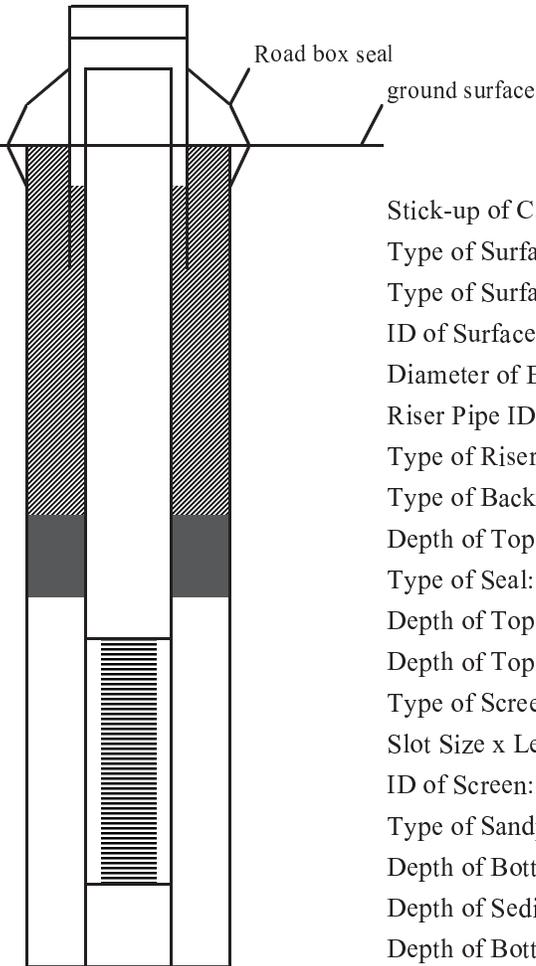
<b>Project Name:</b> Textron Gorham ASD Installation	<b>Boring No:</b> VMW-6
<b>Date Installed:</b> 10/9/2008	<b>Contractor:</b> Geotech
<b>Project No.:</b> 3650080114.09	<b>Drilling Method:</b> Direct Push
<b>Field Geologist:</b> M. Maggiore	<b>Development Method:</b> N/A



Stick-up of Casing Above Ground Surface:	<u>Flush</u>
Type of Surface Seal/Other Protection:	<u>Concrete</u>
Type of Surface Casing:	<u>Aluminum</u>
ID of Surface Casing:	<u>4"</u>
Diameter of Borehole:	<u>3"</u>
Riser Pipe ID:	<u>N/A</u>
Type of Riser Pipe:	<u>N/A</u>
Type of Backfill:	<u>Approved excavated material</u>
Depth of Top Seal:	<u>1"</u>
Type of Seal:	<u>Hydrated bentonite slurry</u>
Depth of Top of Sand:	<u>6'</u>
Depth of Top of Screen:	<u>N/A</u>
Type of Screen:	<u>N/A</u>
Slot Size x Length:	<u>N/A</u>
ID of Screen:	<u>N/A</u>
Type of Sandpack:	<u>20/30 silica sand</u>
Depth of Bottom of Screen:	<u>N/A</u>
Depth of Sediment Sump with Plug:	<u>N/A</u>
Depth of Bottom of Borehole:	<u>8'</u>

## MONITORING WELL DIAGRAM

<b>Project Name:</b> Textron Gorham ASD Installation	<b>Boring No:</b> VMW-7
<b>Date Installed:</b> 10/10/2008	<b>Contractor:</b> Geotech
<b>Project No.:</b> 3650080114.09	<b>Drilling Method:</b> Direct Push
<b>Field Geologist:</b> M. Maggiore	<b>Development Method:</b> N/A



Stick-up of Casing Above Ground Surface:	Flush
Type of Surface Seal/Other Protection:	Concrete
Type of Surface Casing:	Aluminum
ID of Surface Casing:	4"
Diameter of Borehole:	3"
Riser Pipe ID:	N/A
Type of Riser Pipe:	N/A
Type of Backfill:	Approved excavated material
Depth of Top Seal:	1"
Type of Seal:	Hydrated bentonite slurry
Depth of Top of Sand:	6'
Depth of Top of Screen:	N/A
Type of Screen:	N/A
Slot Size x Length:	N/A
ID of Screen:	N/A
Type of Sandpack:	20/30 silica sand
Depth of Bottom of Screen:	N/A
Depth of Sediment Sump with Plug:	N/A
Depth of Bottom of Borehole:	8'

## **APPENDIX G**

### **Select Photos**



EW-1 and EW-3



EW-5 Vault



EW-2 and EW-4



EW-7 Blower and Exhaust



ASD System Enclosure Delivery



EW-7 Installation on Column



EW-6 Above Drop Ceiling



Extraction Well Vault Pre-pour



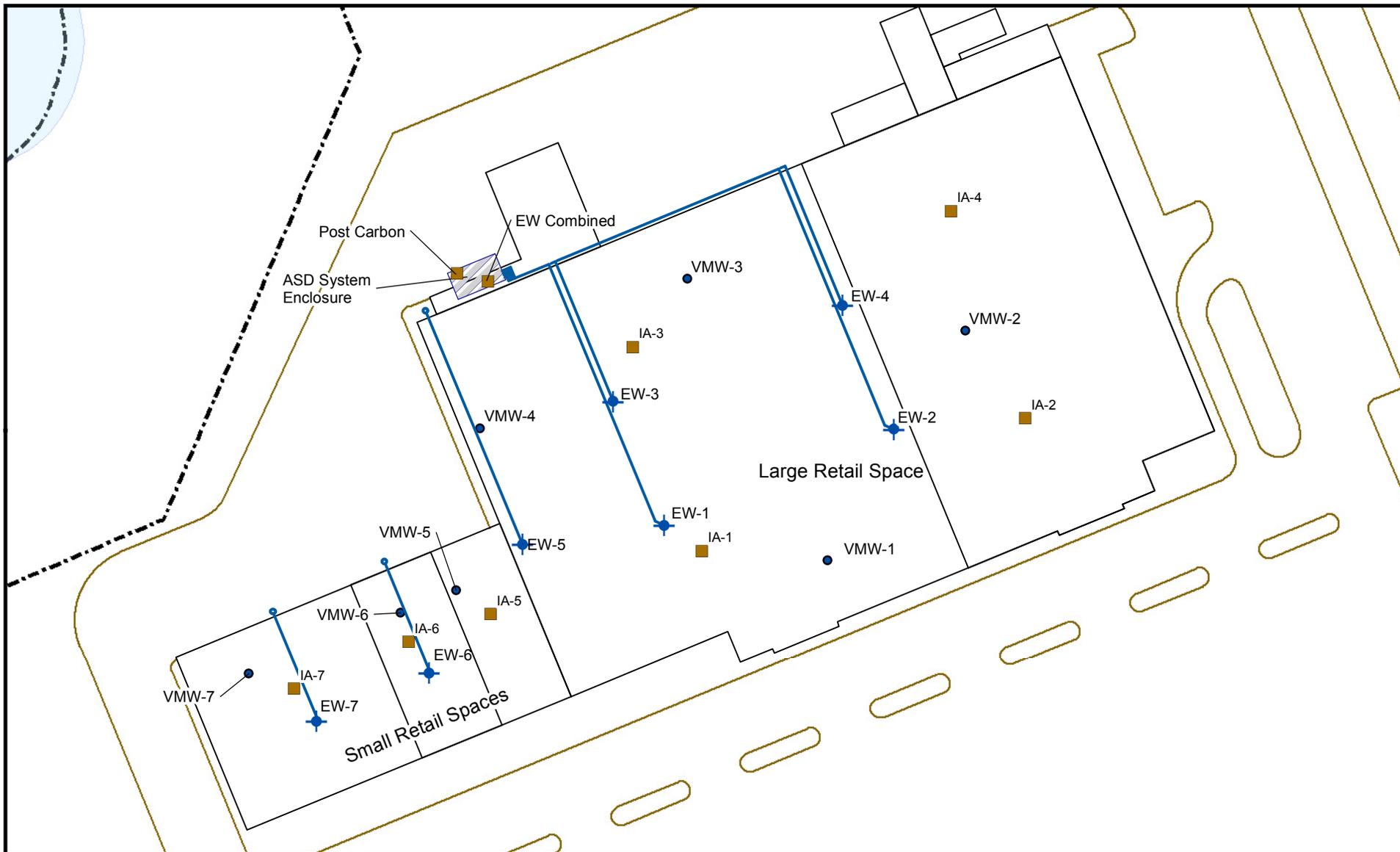
Drop Ceiling Penetration



ASD Enclosure Inside 8 ft Chain Link Fence



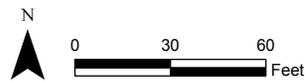
Extraction Well Piping at Manifold Inside ASD Enclosure



All locations are approximate

**Legend**

- Air Sample Location
- Vacuum Monitoring Well
- ◆ Extraction Well
- Extraction Well Piping
- Current Building
- Pavement Outline
- Effluent Location



Prepared/Date: BJR 04/15/13 | Checked/Date: MAM 04/15/13

Figure 1  
Vapor Mitigation  
Sample Locations

Former Gorham Manufacturing Facility  
333 Adelaide Avenue  
Providence, Rhode Island



**APPENDIX F**  
**Laboratory Analytical Report (January 2018 Round)**



**ESS Laboratory**

*Division of Thielsch Engineering, Inc.*

**BAL Laboratory**

*The Microbiology Division  
of Thielsch Engineering, Inc.*



*CERTIFICATE OF ANALYSIS*

Denise King  
AMEC Foster Wheeler  
271 Mill Road  
Chelmsford, MA 01824

Reviewed 2/02/2018  
Elizabeth Penta  
Wood. PLC

**RE: Textron Gorham - Groundwater (3652150005)**

**ESS Laboratory Work Order Number: 1801306**

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard  
Laboratory Director

**REVIEWED**

**By ESS Laboratory at 1:17 pm, Jan 26, 2018**

**Analytical Summary**

The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801306

**SAMPLE RECEIPT**

The following samples were received on January 17, 2018 for the analyses specified on the enclosed Chain of Custody Record.

<b>Lab Number</b>	<b>Sample Name</b>	<b>Matrix</b>	<b>Analysis</b>
1801306-01	MW-217S	Ground Water	8260B
1801306-02	MW-217D	Ground Water	8260B
1801306-03	MW-116S	Ground Water	8260B
1801306-04	MW-116D	Ground Water	8260B
1801306-05	MW-216D	Ground Water	8260B
1801306-06	CW-1	Ground Water	8260B
1801306-07	MW-216S	Ground Water	8260B
1801306-08	CW-2	Ground Water	8260B
1801306-09	MW-225S	Ground Water	8260B
1801306-10	MW-225D	Ground Water	8260B
1801306-11	MW-223D	Ground Water	8260B
1801306-12	MW-228S	Ground Water	8260B
1801306-13	MW-227S	Ground Water	8260B
1801306-14	DUP-01	Ground Water	8260B
1801306-15	DUP-02	Ground Water	8260B
1801306-16	MW-228D	Ground Water	8260B



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801306

**PROJECT NARRATIVE**

**8260B Volatile Organic Compounds**

CA82218-MSD1 Matrix Spike recovery is above upper control limit (M+).  
Vinyl Chloride (133% @ 70-130%)

**No other observations noted.**

**End of Project Narrative.**

**DATA USABILITY LINKS**

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[Definitions of Quality Control Parameters](#)

[Semivolatile Organics Internal Standard Information](#)

[Semivolatile Organics Surrogate Information](#)

[Volatile Organics Internal Standard Information](#)

[Volatile Organics Surrogate Information](#)

[EPH and VPH Alkane Lists](#)



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler

Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801306

**CURRENT SW-846 METHODOLOGY VERSIONS**

**Analytical Methods**

1010A - Flashpoint  
6010C - ICP  
6020A - ICP MS  
7010 - Graphite Furnace  
7196A - Hexavalent Chromium  
7470A - Aqueous Mercury  
7471B - Solid Mercury  
8011 - EDB/DBCP/TCP  
8015C - GRO/DRO  
8081B - Pesticides  
8082A - PCB  
8100M - TPH  
8151A - Herbicides  
8260B - VOA  
8270D - SVOA  
8270D SIM - SVOA Low Level  
9014 - Cyanide  
9038 - Sulfate  
9040C - Aqueous pH  
9045D - Solid pH (Corrosivity)  
9050A - Specific Conductance  
9056A - Anions (IC)  
9060A - TOC  
9095B - Paint Filter  
MADEP 04-1.1 - EPH / VPH

**Prep Methods**

3005A - Aqueous ICP Digestion  
3020A - Aqueous Graphite Furnace / ICP MS Digestion  
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion  
3060A - Solid Hexavalent Chromium Digestion  
3510C - Separatory Funnel Extraction  
3520C - Liquid / Liquid Extraction  
3540C - Manual Soxhlet Extraction  
3541 - Automated Soxhlet Extraction  
3546 - Microwave Extraction  
3580A - Waste Dilution  
5030B - Aqueous Purge and Trap  
5030C - Aqueous Purge and Trap  
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-217S  
 Date Sampled: 01/16/18 09:45  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801306  
 ESS Laboratory Sample ID: 1801306-01  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/24/18 14:08	C8A0297	CA82421
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/24/18 14:08	C8A0297	CA82421
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/24/18 14:08	C8A0297	CA82421
<b>cis-1,2-Dichloroethene</b>	<b>0.0002</b> (0.0010)		8260B		1	01/24/18 14:08	C8A0297	CA82421
<b>Tetrachloroethene</b>	<b>0.0007</b> (0.0010)		8260B		1	01/24/18 14:08	C8A0297	CA82421
<b>Trichloroethene</b>	<b>0.0008</b> (0.0010)		8260B		1	01/24/18 14:08	C8A0297	CA82421
Vinyl Chloride	ND (0.0010)		8260B		1	01/24/18 14:08	C8A0297	CA82421

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	97 %		70-130
<i>Surrogate: 4-Bromofluorobenzene</i>	97 %		70-130
<i>Surrogate: Dibromofluoromethane</i>	93 %		70-130
<i>Surrogate: Toluene-d8</i>	91 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater  
Client Sample ID: MW-217D  
Date Sampled: 01/16/18 10:45  
Percent Solids: N/A  
Initial Volume: 5  
Final Volume: 5  
Extraction Method: 5030B

ESS Laboratory Work Order: 1801306  
ESS Laboratory Sample ID: 1801306-02  
Sample Matrix: Ground Water  
Units: mg/L  
Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/24/18 15:27	C8A0297	CA82421
<b>1,1-Dichloroethane</b>	<b>0.0003</b> (0.0010)		8260B		1	01/24/18 15:27	C8A0297	CA82421
<b>1,1-Dichloroethene</b>	<b>0.0007</b> (0.0010)		8260B		1	01/24/18 15:27	C8A0297	CA82421
<b>cis-1,2-Dichloroethene</b>	<b>0.0679</b> (0.0010)		8260B		1	01/24/18 15:27	C8A0297	CA82421
Tetrachloroethene	ND (0.0010)		8260B		1	01/24/18 15:27	C8A0297	CA82421
<b>Trichloroethene</b>	<b>0.0118</b> (0.0010)		8260B		1	01/24/18 15:27	C8A0297	CA82421
<b>Vinyl Chloride</b>	<b>0.0058</b> (0.0010)		8260B		1	01/24/18 15:27	C8A0297	CA82421

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	<i>98 %</i>		<i>70-130</i>
<i>Surrogate: 4-Bromofluorobenzene</i>	<i>98 %</i>		<i>70-130</i>
<i>Surrogate: Dibromofluoromethane</i>	<i>94 %</i>		<i>70-130</i>
<i>Surrogate: Toluene-d8</i>	<i>91 %</i>		<i>70-130</i>



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-116S  
 Date Sampled: 01/16/18 10:50  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801306  
 ESS Laboratory Sample ID: 1801306-03  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: DMC

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/22/18 15:21	C8A0255	CA82218
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/22/18 15:21	C8A0255	CA82218
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 15:21	C8A0255	CA82218
cis-1,2-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 15:21	C8A0255	CA82218
Tetrachloroethene	ND (0.0010)		8260B		1	01/22/18 15:21	C8A0255	CA82218
Trichloroethene	ND (0.0010)		8260B		1	01/22/18 15:21	C8A0255	CA82218
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 15:21	C8A0255	CA82218

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	98 %		70-130
<i>Surrogate: 4-Bromofluorobenzene</i>	81 %		70-130
<i>Surrogate: Dibromofluoromethane</i>	97 %		70-130
<i>Surrogate: Toluene-d8</i>	104 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-116D  
 Date Sampled: 01/16/18 12:45  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801306  
 ESS Laboratory Sample ID: 1801306-04  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: DMC

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/22/18 15:48	C8A0255	CA82218
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/22/18 15:48	C8A0255	CA82218
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 15:48	C8A0255	CA82218
cis-1,2-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 15:48	C8A0255	CA82218
Tetrachloroethene	ND (0.0010)		8260B		1	01/22/18 15:48	C8A0255	CA82218
<b>Trichloroethene</b>	<b>0.0002</b> (0.0010)		8260B		1	01/22/18 15:48	C8A0255	CA82218
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 15:48	C8A0255	CA82218

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	98 %		70-130
<i>Surrogate: 4-Bromofluorobenzene</i>	81 %		70-130
<i>Surrogate: Dibromofluoromethane</i>	98 %		70-130
<i>Surrogate: Toluene-d8</i>	103 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-216D  
 Date Sampled: 01/16/18 12:55  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801306  
 ESS Laboratory Sample ID: 1801306-05  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: DMC

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/22/18 16:15	C8A0255	CA82218
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/22/18 16:15	C8A0255	CA82218
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 16:15	C8A0255	CA82218
<b>cis-1,2-Dichloroethene</b>	<b>0.0006</b> (0.0010)		8260B		1	01/22/18 16:15	C8A0255	CA82218
Tetrachloroethene	ND (0.0010)		8260B		1	01/22/18 16:15	C8A0255	CA82218
<b>Trichloroethene</b>	<b>0.0028</b> (0.0010)		8260B		1	01/22/18 16:15	C8A0255	CA82218
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 16:15	C8A0255	CA82218

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	101 %		70-130
<i>Surrogate: 4-Bromofluorobenzene</i>	80 %		70-130
<i>Surrogate: Dibromofluoromethane</i>	100 %		70-130
<i>Surrogate: Toluene-d8</i>	103 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: CW-1  
 Date Sampled: 01/16/18 14:20  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801306  
 ESS Laboratory Sample ID: 1801306-06  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: DMC

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/22/18 16:42	C8A0255	CA82218
<b>1,1-Dichloroethane</b>	<b>0.0005</b> (0.0010)		8260B		1	01/22/18 16:42	C8A0255	CA82218
<b>1,1-Dichloroethene</b>	<b>0.0219</b> (0.0010)		8260B		1	01/22/18 16:42	C8A0255	CA82218
<b>cis-1,2-Dichloroethene</b>	<b>0.119</b> (0.0200)		8260B		20	01/24/18 12:42	C8A0255	CA82218
<b>Tetrachloroethene</b>	<b>0.0006</b> (0.0010)		8260B		1	01/22/18 16:42	C8A0255	CA82218
<b>Trichloroethene</b>	<b>1.43</b> (0.0200)		8260B		20	01/24/18 12:42	C8A0255	CA82218
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 16:42	C8A0255	CA82218

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	98 %		70-130
<i>Surrogate: 4-Bromofluorobenzene</i>	80 %		70-130
<i>Surrogate: Dibromofluoromethane</i>	99 %		70-130
<i>Surrogate: Toluene-d8</i>	103 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-216S  
 Date Sampled: 01/16/18 14:50  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801306  
 ESS Laboratory Sample ID: 1801306-07  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: DMC

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/22/18 21:11	C8A0255	CA82218
<b>1,1-Dichloroethane</b>	<b>0.0004</b> (0.0010)		8260B		1	01/22/18 21:11	C8A0255	CA82218
<b>1,1-Dichloroethene</b>	<b>0.0006</b> (0.0010)		8260B		1	01/22/18 21:11	C8A0255	CA82218
<b>cis-1,2-Dichloroethene</b>	<b>0.228</b> (0.0100)		8260B		10	01/24/18 12:15	C8A0255	CA82218
<b>Tetrachloroethene</b>	<b>0.0009</b> (0.0010)		8260B		1	01/22/18 21:11	C8A0255	CA82218
<b>Trichloroethene</b>	<b>0.0007</b> (0.0010)		8260B		1	01/22/18 21:11	C8A0255	CA82218
<b>Vinyl Chloride</b>	<b>0.0007</b> (0.0010)		8260B		1	01/22/18 21:11	C8A0255	CA82218

	<u>%Recovery</u>	<u>Qualifier</u>	<u>Limits</u>
Surrogate: 1,2-Dichloroethane-d4	97 %		70-130
Surrogate: 4-Bromofluorobenzene	83 %		70-130
Surrogate: Dibromofluoromethane	96 %		70-130
Surrogate: Toluene-d8	102 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: CW-2  
 Date Sampled: 01/16/18 15:45  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801306  
 ESS Laboratory Sample ID: 1801306-08  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/24/18 14:34	C8A0297	CA82421
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/24/18 14:34	C8A0297	CA82421
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/24/18 14:34	C8A0297	CA82421
cis-1,2-Dichloroethene	ND (0.0010)		8260B		1	01/24/18 14:34	C8A0297	CA82421
Tetrachloroethene	ND (0.0010)		8260B		1	01/24/18 14:34	C8A0297	CA82421
Trichloroethene	ND (0.0010)		8260B		1	01/24/18 14:34	C8A0297	CA82421
Vinyl Chloride	ND (0.0010)		8260B		1	01/24/18 14:34	C8A0297	CA82421

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	98 %		70-130
<i>Surrogate: 4-Bromofluorobenzene</i>	97 %		70-130
<i>Surrogate: Dibromofluoromethane</i>	96 %		70-130
<i>Surrogate: Toluene-d8</i>	89 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater  
Client Sample ID: MW-225S  
Date Sampled: 01/17/18 10:15  
Percent Solids: N/A  
Initial Volume: 5  
Final Volume: 5  
Extraction Method: 5030B

ESS Laboratory Work Order: 1801306  
ESS Laboratory Sample ID: 1801306-09  
Sample Matrix: Ground Water  
Units: mg/L  
Analyst: DMC

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/22/18 12:40	C8A0255	CA82218
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/22/18 12:40	C8A0255	CA82218
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 12:40	C8A0255	CA82218
cis-1,2-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 12:40	C8A0255	CA82218
<b>Tetrachloroethene</b>	<b>0.0006</b> (0.0010)		8260B		1	01/22/18 12:40	C8A0255	CA82218
<b>Trichloroethene</b>	<b>0.0004</b> (0.0010)		8260B		1	01/22/18 12:40	C8A0255	CA82218
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 12:40	C8A0255	CA82218

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	<i>97 %</i>		<i>70-130</i>
<i>Surrogate: 4-Bromofluorobenzene</i>	<i>81 %</i>		<i>70-130</i>
<i>Surrogate: Dibromofluoromethane</i>	<i>98 %</i>		<i>70-130</i>
<i>Surrogate: Toluene-d8</i>	<i>104 %</i>		<i>70-130</i>



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-225D  
 Date Sampled: 01/17/18 11:50  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801306  
 ESS Laboratory Sample ID: 1801306-10  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: DMC

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/22/18 17:36	C8A0255	CA82218
<b>1,1-Dichloroethane</b>	<b>0.0002</b> (0.0010)		8260B		1	01/22/18 17:36	C8A0255	CA82218
<b>1,1-Dichloroethene</b>	<b>0.0003</b> (0.0010)		8260B		1	01/22/18 17:36	C8A0255	CA82218
<b>cis-1,2-Dichloroethene</b>	<b>0.0005</b> (0.0010)		8260B		1	01/22/18 17:36	C8A0255	CA82218
Tetrachloroethene	ND (0.0010)		8260B		1	01/22/18 17:36	C8A0255	CA82218
<b>Trichloroethene</b>	<b>0.0032</b> (0.0010)		8260B		1	01/22/18 17:36	C8A0255	CA82218
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 17:36	C8A0255	CA82218

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	101 %		70-130
<i>Surrogate: 4-Bromofluorobenzene</i>	80 %		70-130
<i>Surrogate: Dibromofluoromethane</i>	101 %		70-130
<i>Surrogate: Toluene-d8</i>	104 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-223D  
 Date Sampled: 01/17/18 10:55  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801306  
 ESS Laboratory Sample ID: 1801306-11  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: DMC

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/22/18 18:03	C8A0255	CA82218
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/22/18 18:03	C8A0255	CA82218
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 18:03	C8A0255	CA82218
cis-1,2-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 18:03	C8A0255	CA82218
Tetrachloroethene	ND (0.0010)		8260B		1	01/22/18 18:03	C8A0255	CA82218
<b>Trichloroethene</b>	<b>0.0004</b> (0.0010)		8260B		1	01/22/18 18:03	C8A0255	CA82218
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 18:03	C8A0255	CA82218

	<u>%Recovery</u>	<u>Qualifier</u>	<u>Limits</u>
Surrogate: 1,2-Dichloroethane-d4	100 %		70-130
Surrogate: 4-Bromofluorobenzene	79 %		70-130
Surrogate: Dibromofluoromethane	99 %		70-130
Surrogate: Toluene-d8	104 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-228S  
 Date Sampled: 01/17/18 13:45  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801306  
 ESS Laboratory Sample ID: 1801306-12  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: DMC

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	0.0965 (0.0010)		8260B		1	01/22/18 18:30	C8A0255	CA82218
1,1-Dichloroethane	0.0128 (0.0010)		8260B		1	01/22/18 18:30	C8A0255	CA82218
1,1-Dichloroethene	0.0232 (0.0010)		8260B		1	01/22/18 18:30	C8A0255	CA82218
cis-1,2-Dichloroethene	0.0049 (0.0010)		8260B		1	01/22/18 18:30	C8A0255	CA82218
Tetrachloroethene	1.19 (0.0500)		8260B		50	01/24/18 13:35	C8A0255	CA82218
Trichloroethene	0.152 (0.0500)		8260B		50	01/24/18 13:35	C8A0255	CA82218
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 18:30	C8A0255	CA82218

	<u>%Recovery</u>	<u>Qualifier</u>	<u>Limits</u>
Surrogate: 1,2-Dichloroethane-d4	102 %		70-130
Surrogate: 4-Bromofluorobenzene	80 %		70-130
Surrogate: Dibromofluoromethane	100 %		70-130
Surrogate: Toluene-d8	102 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-227S  
 Date Sampled: 01/17/18 15:05  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801306  
 ESS Laboratory Sample ID: 1801306-13  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: DMC

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	0.0455 (0.0010)		8260B		1	01/22/18 18:57	C8A0255	CA82218
1,1-Dichloroethane	0.0200 (0.0010)		8260B		1	01/22/18 18:57	C8A0255	CA82218
1,1-Dichloroethene	0.0027 (0.0010)		8260B		1	01/22/18 18:57	C8A0255	CA82218
cis-1,2-Dichloroethene	0.0005 (0.0010)		8260B		1	01/22/18 18:57	C8A0255	CA82218
Tetrachloroethene	0.0100 (0.0010)		8260B		1	01/22/18 18:57	C8A0255	CA82218
Trichloroethene	0.107 (0.0100)		8260B		10	01/24/18 11:49	C8A0255	CA82218
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 18:57	C8A0255	CA82218

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	102 %		70-130
<i>Surrogate: 4-Bromofluorobenzene</i>	83 %		70-130
<i>Surrogate: Dibromofluoromethane</i>	101 %		70-130
<i>Surrogate: Toluene-d8</i>	103 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: DUP-01  
 Date Sampled: 01/17/18 00:00  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801306  
 ESS Laboratory Sample ID: 1801306-14  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/24/18 15:01	C8A0297	CA82421
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/24/18 15:01	C8A0297	CA82421
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/24/18 15:01	C8A0297	CA82421
cis-1,2-Dichloroethene	ND (0.0010)		8260B		1	01/24/18 15:01	C8A0297	CA82421
<b>Tetrachloroethene</b>	<b>0.0005</b> (0.0010)		8260B		1	01/24/18 15:01	C8A0297	CA82421
<b>Trichloroethene</b>	<b>0.0005</b> (0.0010)		8260B		1	01/24/18 15:01	C8A0297	CA82421
Vinyl Chloride	ND (0.0010)		8260B		1	01/24/18 15:01	C8A0297	CA82421

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	97 %		70-130
<i>Surrogate: 4-Bromofluorobenzene</i>	99 %		70-130
<i>Surrogate: Dibromofluoromethane</i>	95 %		70-130
<i>Surrogate: Toluene-d8</i>	90 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: DUP-02  
 Date Sampled: 01/17/18 00:00  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801306  
 ESS Laboratory Sample ID: 1801306-15  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: DMC

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	0.0914 (0.0010)		8260B		1	01/22/18 19:50	C8A0255	CA82218
1,1-Dichloroethane	0.0123 (0.0010)		8260B		1	01/22/18 19:50	C8A0255	CA82218
1,1-Dichloroethene	0.0217 (0.0010)		8260B		1	01/22/18 19:50	C8A0255	CA82218
cis-1,2-Dichloroethene	0.0047 (0.0010)		8260B		1	01/22/18 19:50	C8A0255	CA82218
Tetrachloroethene	1.16 (0.0500)		8260B		50	01/24/18 14:02	C8A0255	CA82218
Trichloroethene	0.152 (0.0500)		8260B		50	01/24/18 14:02	C8A0255	CA82218
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 19:50	C8A0255	CA82218

	<u>%Recovery</u>	<u>Qualifier</u>	<u>Limits</u>
Surrogate: 1,2-Dichloroethane-d4	100 %		70-130
Surrogate: 4-Bromofluorobenzene	84 %		70-130
Surrogate: Dibromofluoromethane	99 %		70-130
Surrogate: Toluene-d8	99 %		70-130



## CERTIFICATE OF ANALYSIS

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-228D  
 Date Sampled: 01/16/18 16:30  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801306  
 ESS Laboratory Sample ID: 1801306-16  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

### 8260B Volatile Organic Compounds

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	0.0043 (0.0010)		8260B		1	01/24/18 15:53	C8A0297	CA82421
1,1-Dichloroethane	0.0039 (0.0010)		8260B		1	01/24/18 15:53	C8A0297	CA82421
1,1-Dichloroethene	0.0203 (0.0010)		8260B		1	01/24/18 15:53	C8A0297	CA82421
cis-1,2-Dichloroethene	0.0469 (0.0010)		8260B		1	01/24/18 15:53	C8A0297	CA82421
Tetrachloroethene	0.0011 (0.0010)		8260B		1	01/24/18 15:53	C8A0297	CA82421
Trichloroethene	0.727 (0.0200)		8260B		20	01/24/18 13:09	C8A0297	CA82421
Vinyl Chloride	0.0007 (0.0010)		8260B		1	01/24/18 15:53	C8A0297	CA82421

	<u>%Recovery</u>	<u>Qualifier</u>	<u>Limits</u>
Surrogate: 1,2-Dichloroethane-d4	97 %		70-130
Surrogate: 4-Bromofluorobenzene	101 %		70-130
Surrogate: Dibromofluoromethane	91 %		70-130
Surrogate: Toluene-d8	90 %		70-130



CERTIFICATE OF ANALYSIS

Client Name: AMEC Foster Wheeler

Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801306

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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8260B Volatile Organic Compounds

Batch CA82218 - 5030B

**Blank**

1,1,1,2-Tetrachloroethane	ND	0.0010	mg/L							
1,1,1-Trichloroethane	ND	0.0010	mg/L							
1,1,2,2-Tetrachloroethane	ND	0.0005	mg/L							
1,1,2-Trichloroethane	ND	0.0010	mg/L							
1,1-Dichloroethane	ND	0.0010	mg/L							
1,1-Dichloroethene	ND	0.0010	mg/L							
1,1-Dichloropropene	ND	0.0020	mg/L							
1,2,3-Trichlorobenzene	ND	0.0010	mg/L							
1,2,3-Trichloropropane	ND	0.0010	mg/L							
1,2,4-Trichlorobenzene	ND	0.0010	mg/L							
1,2,4-Trimethylbenzene	ND	0.0010	mg/L							
1,2-Dibromo-3-Chloropropane	ND	0.0050	mg/L							
1,2-Dibromoethane	ND	0.0010	mg/L							
1,2-Dichlorobenzene	ND	0.0010	mg/L							
1,2-Dichloroethane	ND	0.0010	mg/L							
1,2-Dichloropropane	ND	0.0010	mg/L							
1,3,5-Trimethylbenzene	ND	0.0010	mg/L							
1,3-Dichlorobenzene	ND	0.0010	mg/L							
1,3-Dichloropropane	ND	0.0010	mg/L							
1,4-Dichlorobenzene	ND	0.0010	mg/L							
1,4-Dioxane - Screen	ND	0.500	mg/L							
1-Chlorohexane	ND	0.0010	mg/L							
2,2-Dichloropropane	ND	0.0010	mg/L							
2-Butanone	ND	0.0100	mg/L							
2-Chlorotoluene	ND	0.0010	mg/L							
2-Hexanone	ND	0.0100	mg/L							
4-Chlorotoluene	ND	0.0010	mg/L							
4-Isopropyltoluene	ND	0.0010	mg/L							
4-Methyl-2-Pentanone	ND	0.0250	mg/L							
Acetone	ND	0.0100	mg/L							
Benzene	ND	0.0010	mg/L							
Bromobenzene	ND	0.0020	mg/L							
Bromochloromethane	ND	0.0010	mg/L							
Bromodichloromethane	ND	0.0006	mg/L							
Bromoform	ND	0.0010	mg/L							
Bromomethane	ND	0.0020	mg/L							
Carbon Disulfide	ND	0.0010	mg/L							
Carbon Tetrachloride	ND	0.0010	mg/L							
Chlorobenzene	ND	0.0010	mg/L							
Chloroethane	ND	0.0020	mg/L							
Chloroform	ND	0.0010	mg/L							
Chloromethane	ND	0.0020	mg/L							
cis-1,2-Dichloroethene	ND	0.0010	mg/L							
cis-1,3-Dichloropropene	ND	0.0004	mg/L							



CERTIFICATE OF ANALYSIS

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801306

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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8260B Volatile Organic Compounds

**Batch CA82218 - 5030B**

Dibromochloromethane	ND	0.0010	mg/L							
Dibromomethane	ND	0.0010	mg/L							
Dichlorodifluoromethane	ND	0.0020	mg/L							
Diethyl Ether	ND	0.0010	mg/L							
Di-isopropyl ether	ND	0.0010	mg/L							
Ethyl tertiary-butyl ether	ND	0.0010	mg/L							
Ethylbenzene	ND	0.0010	mg/L							
Hexachlorobutadiene	ND	0.0006	mg/L							
Hexachloroethane	ND	0.0010	mg/L							
Isopropylbenzene	ND	0.0010	mg/L							
Methyl tert-Butyl Ether	ND	0.0010	mg/L							
Methylene Chloride	ND	0.0020	mg/L							
Naphthalene	ND	0.0010	mg/L							
n-Butylbenzene	ND	0.0010	mg/L							
n-Propylbenzene	ND	0.0010	mg/L							
sec-Butylbenzene	ND	0.0010	mg/L							
Styrene	ND	0.0010	mg/L							
tert-Butylbenzene	ND	0.0010	mg/L							
Tertiary-amyl methyl ether	ND	0.0010	mg/L							
Tetrachloroethene	ND	0.0010	mg/L							
Tetrahydrofuran	ND	0.0050	mg/L							
Toluene	ND	0.0010	mg/L							
trans-1,2-Dichloroethene	ND	0.0010	mg/L							
trans-1,3-Dichloropropene	ND	0.0004	mg/L							
Trichloroethene	ND	0.0010	mg/L							
Trichlorofluoromethane	ND	0.0010	mg/L							
Vinyl Acetate	ND	0.0050	mg/L							
Vinyl Chloride	ND	0.0010	mg/L							
Xylene O	ND	0.0010	mg/L							
Xylene P,M	ND	0.0020	mg/L							
Surrogate: 1,2-Dichloroethane-d4	0.0236		mg/L	0.02500		94	70-130			
Surrogate: 4-Bromofluorobenzene	0.0201		mg/L	0.02500		80	70-130			
Surrogate: Dibromofluoromethane	0.0241		mg/L	0.02500		96	70-130			
Surrogate: Toluene-d8	0.0257		mg/L	0.02500		103	70-130			

**LCS**

1,1,1,2-Tetrachloroethane	9.26		ug/L	10.00		93	70-130			
1,1,1-Trichloroethane	10.9		ug/L	10.00		109	70-130			
1,1,2,2-Tetrachloroethane	10.8		ug/L	10.00		108	70-130			
1,1,2-Trichloroethane	10.2		ug/L	10.00		102	70-130			
1,1-Dichloroethane	10.1		ug/L	10.00		101	70-130			
1,1-Dichloroethene	10.8		ug/L	10.00		108	70-130			
1,1-Dichloropropene	10.8		ug/L	10.00		108	70-130			
1,2,3-Trichlorobenzene	10.9		ug/L	10.00		109	70-130			
1,2,3-Trichloropropane	10.3		ug/L	10.00		103	70-130			
1,2,4-Trichlorobenzene	10.8		ug/L	10.00		108	70-130			



CERTIFICATE OF ANALYSIS

Client Name: AMEC Foster Wheeler

Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801306

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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8260B Volatile Organic Compounds

**Batch CA82218 - 5030B**

1,2,4-Trimethylbenzene	9.37		ug/L	10.00		94	70-130			
1,2-Dibromo-3-Chloropropane	12.1		ug/L	10.00		121	70-130			
1,2-Dibromoethane	9.91		ug/L	10.00		99	70-130			
1,2-Dichlorobenzene	10.7		ug/L	10.00		107	70-130			
1,2-Dichloroethane	10.0		ug/L	10.00		100	70-130			
1,2-Dichloropropane	10.0		ug/L	10.00		100	70-130			
1,3,5-Trimethylbenzene	9.14		ug/L	10.00		91	70-130			
1,3-Dichlorobenzene	10.7		ug/L	10.00		107	70-130			
1,3-Dichloropropane	10.4		ug/L	10.00		104	70-130			
1,4-Dichlorobenzene	10.4		ug/L	10.00		104	70-130			
1,4-Dioxane - Screen	221		ug/L	200.0		110	0-332			
1-Chlorohexane	10.2		ug/L	10.00		102	70-130			
2,2-Dichloropropane	10.3		ug/L	10.00		103	70-130			
2-Butanone	50.1		ug/L	50.00		100	70-130			
2-Chlorotoluene	10.5		ug/L	10.00		105	70-130			
2-Hexanone	47.1		ug/L	50.00		94	70-130			
4-Chlorotoluene	10.2		ug/L	10.00		102	70-130			
4-Isopropyltoluene	10.4		ug/L	10.00		104	70-130			
4-Methyl-2-Pentanone	48.1		ug/L	50.00		96	70-130			
Acetone	53.0		ug/L	50.00		106	70-130			
Benzene	10.3		ug/L	10.00		103	70-130			
Bromobenzene	10.6		ug/L	10.00		106	70-130			
Bromochloromethane	9.77		ug/L	10.00		98	70-130			
Bromodichloromethane	10.5		ug/L	10.00		105	70-130			
Bromoform	10.3		ug/L	10.00		103	70-130			
Bromomethane	12.3		ug/L	10.00		123	70-130			
Carbon Disulfide	11.5		ug/L	10.00		115	70-130			
Carbon Tetrachloride	9.20		ug/L	10.00		92	70-130			
Chlorobenzene	10.2		ug/L	10.00		102	70-130			
Chloroethane	10.9		ug/L	10.00		109	70-130			
Chloroform	10.2		ug/L	10.00		102	70-130			
Chloromethane	10.4		ug/L	10.00		104	70-130			
cis-1,2-Dichloroethene	9.85		ug/L	10.00		98	70-130			
cis-1,3-Dichloropropene	9.43		ug/L	10.00		94	70-130			
Dibromochloromethane	8.50		ug/L	10.00		85	70-130			
Dibromomethane	10.2		ug/L	10.00		102	70-130			
Dichlorodifluoromethane	9.51		ug/L	10.00		95	70-130			
Diethyl Ether	11.0		ug/L	10.00		110	70-130			
Di-isopropyl ether	9.84		ug/L	10.00		98	70-130			
Ethyl tertiary-butyl ether	9.72		ug/L	10.00		97	70-130			
Ethylbenzene	8.73		ug/L	10.00		87	70-130			
Hexachlorobutadiene	12.2		ug/L	10.00		122	70-130			
Hexachloroethane	10.6		ug/L	10.00		106	70-130			
Isopropylbenzene	10.1		ug/L	10.00		101	70-130			
Methyl tert-Butyl Ether	10.4		ug/L	10.00		104	70-130			



CERTIFICATE OF ANALYSIS

Client Name: AMEC Foster Wheeler

Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801306

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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8260B Volatile Organic Compounds

**Batch CA82218 - 5030B**

Methylene Chloride	10.9		ug/L	10.00		109	70-130			
Naphthalene	10.3		ug/L	10.00		103	70-130			
n-Butylbenzene	10.6		ug/L	10.00		106	70-130			
n-Propylbenzene	10.7		ug/L	10.00		107	70-130			
sec-Butylbenzene	9.37		ug/L	10.00		94	70-130			
Styrene	9.18		ug/L	10.00		92	70-130			
tert-Butylbenzene	10.6		ug/L	10.00		106	70-130			
Tertiary-amyl methyl ether	9.77		ug/L	10.00		98	70-130			
Tetrachloroethene	7.68		ug/L	10.00		77	70-130			
Tetrahydrofuran	11.4		ug/L	10.00		114	70-130			
Toluene	10.1		ug/L	10.00		101	70-130			
trans-1,2-Dichloroethene	10.6		ug/L	10.00		106	70-130			
trans-1,3-Dichloropropene	9.18		ug/L	10.00		92	70-130			
Trichloroethene	10.5		ug/L	10.00		105	70-130			
Trichlorofluoromethane	10.8		ug/L	10.00		108	70-130			
Vinyl Acetate	10.7		ug/L	10.00		107	70-130			
Vinyl Chloride	11.7		ug/L	10.00		117	70-130			
Xylene O	8.50		ug/L	10.00		85	70-130			
Xylene P,M	16.7		ug/L	20.00		83	70-130			
Surrogate: 1,2-Dichloroethane-d4	0.0254		mg/L	0.02500		102	70-130			
Surrogate: 4-Bromofluorobenzene	0.0222		mg/L	0.02500		89	70-130			
Surrogate: Dibromofluoromethane	0.0262		mg/L	0.02500		105	70-130			
Surrogate: Toluene-d8	0.0268		mg/L	0.02500		107	70-130			

**LCS Dup**

1,1,1,2-Tetrachloroethane	9.22		ug/L	10.00		92	70-130	0.4	25	
1,1,1-Trichloroethane	10.8		ug/L	10.00		108	70-130	0.7	25	
1,1,2,2-Tetrachloroethane	10.8		ug/L	10.00		108	70-130	0.09	25	
1,1,2-Trichloroethane	10.6		ug/L	10.00		106	70-130	4	25	
1,1-Dichloroethane	10.2		ug/L	10.00		102	70-130	0.3	25	
1,1-Dichloroethene	11.1		ug/L	10.00		111	70-130	3	25	
1,1-Dichloropropene	11.0		ug/L	10.00		110	70-130	1	25	
1,2,3-Trichlorobenzene	11.0		ug/L	10.00		110	70-130	0.8	25	
1,2,3-Trichloropropane	10.6		ug/L	10.00		106	70-130	3	25	
1,2,4-Trichlorobenzene	10.6		ug/L	10.00		106	70-130	1	25	
1,2,4-Trimethylbenzene	9.27		ug/L	10.00		93	70-130	1	25	
1,2-Dibromo-3-Chloropropane	12.1		ug/L	10.00		121	70-130	0.3	25	
1,2-Dibromoethane	10.6		ug/L	10.00		106	70-130	6	25	
1,2-Dichlorobenzene	11.0		ug/L	10.00		110	70-130	2	25	
1,2-Dichloroethane	10.4		ug/L	10.00		104	70-130	4	25	
1,2-Dichloropropane	10.7		ug/L	10.00		107	70-130	6	25	
1,3,5-Trimethylbenzene	9.19		ug/L	10.00		92	70-130	0.5	25	
1,3-Dichlorobenzene	10.7		ug/L	10.00		107	70-130	0.2	25	
1,3-Dichloropropane	10.7		ug/L	10.00		107	70-130	3	25	
1,4-Dichlorobenzene	10.4		ug/L	10.00		104	70-130	1	25	
1,4-Dioxane - Screen	238		ug/L	200.0		119	0-332	7	200	



CERTIFICATE OF ANALYSIS

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801306

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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8260B Volatile Organic Compounds

**Batch CA82218 - 5030B**

1-Chlorohexane	10.2		ug/L	10.00		102	70-130	0.1	25	
2,2-Dichloropropane	10.4		ug/L	10.00		104	70-130	1	25	
2-Butanone	50.9		ug/L	50.00		102	70-130	1	25	
2-Chlorotoluene	10.5		ug/L	10.00		105	70-130	0.4	25	
2-Hexanone	48.8		ug/L	50.00		98	70-130	4	25	
4-Chlorotoluene	10.4		ug/L	10.00		104	70-130	2	25	
4-Isopropyltoluene	10.3		ug/L	10.00		103	70-130	2	25	
4-Methyl-2-Pentanone	49.1		ug/L	50.00		98	70-130	2	25	
Acetone	53.3		ug/L	50.00		107	70-130	0.7	25	
Benzene	10.6		ug/L	10.00		106	70-130	3	25	
Bromobenzene	10.5		ug/L	10.00		105	70-130	1	25	
Bromochloromethane	10.1		ug/L	10.00		101	70-130	4	25	
Bromodichloromethane	11.1		ug/L	10.00		111	70-130	6	25	
Bromoform	10.5		ug/L	10.00		105	70-130	2	25	
Bromomethane	12.9		ug/L	10.00		129	70-130	4	25	
Carbon Disulfide	11.7		ug/L	10.00		117	70-130	2	25	
Carbon Tetrachloride	9.50		ug/L	10.00		95	70-130	3	25	
Chlorobenzene	10.3		ug/L	10.00		103	70-130	2	25	
Chloroethane	11.2		ug/L	10.00		112	70-130	2	25	
Chloroform	10.4		ug/L	10.00		104	70-130	2	25	
Chloromethane	11.1		ug/L	10.00		111	70-130	7	25	
cis-1,2-Dichloroethene	10.5		ug/L	10.00		105	70-130	6	25	
cis-1,3-Dichloropropene	9.62		ug/L	10.00		96	70-130	2	25	
Dibromochloromethane	8.53		ug/L	10.00		85	70-130	0.4	25	
Dibromomethane	10.2		ug/L	10.00		102	70-130	0.3	25	
Dichlorodifluoromethane	9.81		ug/L	10.00		98	70-130	3	25	
Diethyl Ether	11.4		ug/L	10.00		114	70-130	4	25	
Di-isopropyl ether	10.0		ug/L	10.00		100	70-130	2	25	
Ethyl tertiary-butyl ether	10.2		ug/L	10.00		102	70-130	5	25	
Ethylbenzene	8.78		ug/L	10.00		88	70-130	0.6	25	
Hexachlorobutadiene	11.9		ug/L	10.00		119	70-130	2	25	
Hexachloroethane	10.2		ug/L	10.00		102	70-130	4	25	
Isopropylbenzene	10.0		ug/L	10.00		100	70-130	1	25	
Methyl tert-Butyl Ether	10.7		ug/L	10.00		107	70-130	3	25	
Methylene Chloride	11.4		ug/L	10.00		114	70-130	5	25	
Naphthalene	10.3		ug/L	10.00		103	70-130	0.3	25	
n-Butylbenzene	10.5		ug/L	10.00		105	70-130	0.7	25	
n-Propylbenzene	10.7		ug/L	10.00		107	70-130	0.5	25	
sec-Butylbenzene	9.47		ug/L	10.00		95	70-130	1	25	
Styrene	9.34		ug/L	10.00		93	70-130	2	25	
tert-Butylbenzene	10.5		ug/L	10.00		105	70-130	1	25	
Tertiary-amyl methyl ether	10.1		ug/L	10.00		101	70-130	4	25	
Tetrachloroethene	7.90		ug/L	10.00		79	70-130	3	25	
Tetrahydrofuran	11.0		ug/L	10.00		110	70-130	3	25	
Toluene	10.6		ug/L	10.00		106	70-130	5	25	



CERTIFICATE OF ANALYSIS

Client Name: AMEC Foster Wheeler

Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801306

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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8260B Volatile Organic Compounds

**Batch CA82218 - 5030B**

trans-1,2-Dichloroethene	10.9		ug/L	10.00		109	70-130	3	25	
trans-1,3-Dichloropropene	9.36		ug/L	10.00		94	70-130	2	25	
Trichloroethene	10.7		ug/L	10.00		107	70-130	2	25	
Trichlorofluoromethane	11.1		ug/L	10.00		111	70-130	3	25	
Vinyl Acetate	11.2		ug/L	10.00		112	70-130	5	25	
Vinyl Chloride	12.3		ug/L	10.00		123	70-130	5	25	
Xylene O	8.53		ug/L	10.00		85	70-130	0.4	25	
Xylene P,M	17.0		ug/L	20.00		85	70-130	2	25	
Surrogate: 1,2-Dichloroethane-d4	0.0263		mg/L	0.02500		105	70-130			
Surrogate: 4-Bromofluorobenzene	0.0220		mg/L	0.02500		88	70-130			
Surrogate: Dibromofluoromethane	0.0268		mg/L	0.02500		107	70-130			
Surrogate: Toluene-d8	0.0268		mg/L	0.02500		107	70-130			

**Matrix Spike Source: 1801306-09**

1,1,1-Trichloroethane	11.2		ug/L	10.00	0.00	112	70-130			
1,1-Dichloroethane	10.8		ug/L	10.00	0.00	108	70-130			
1,1-Dichloroethene	12.1		ug/L	10.00	0.00	121	70-130			
cis-1,2-Dichloroethene	10.8		ug/L	10.00	0.00	108	70-130			
Tetrachloroethene	8.57		ug/L	10.00	0.600	80	70-130			
Trichloroethene	11.7		ug/L	10.00	0.370	113	70-130			
Vinyl Chloride	13.0		ug/L	10.00	0.00	130	70-130			
Surrogate: 1,2-Dichloroethane-d4	0.0264		mg/L	0.02500		106	70-130			
Surrogate: 4-Bromofluorobenzene	0.0224		mg/L	0.02500		89	70-130			
Surrogate: Dibromofluoromethane	0.0266		mg/L	0.02500		106	70-130			
Surrogate: Toluene-d8	0.0267		mg/L	0.02500		107	70-130			

**Matrix Spike Dup Source: 1801306-09**

1,1,1-Trichloroethane	11.2		ug/L	10.00	0.00	112	70-130	0.09	30	
1,1-Dichloroethane	10.9		ug/L	10.00	0.00	109	70-130	1	30	
1,1-Dichloroethene	12.1		ug/L	10.00	0.00	121	70-130	0.4	30	
cis-1,2-Dichloroethene	10.9		ug/L	10.00	0.00	109	70-130	0.8	30	
Tetrachloroethene	8.67		ug/L	10.00	0.600	81	70-130	1	30	
Trichloroethene	11.8		ug/L	10.00	0.370	114	70-130	1	30	
Vinyl Chloride	13.3		ug/L	10.00	0.00	133	70-130	3	30	M+
Surrogate: 1,2-Dichloroethane-d4	0.0266		mg/L	0.02500		106	70-130			
Surrogate: 4-Bromofluorobenzene	0.0193		mg/L	0.02500		77	70-130			
Surrogate: Dibromofluoromethane	0.0271		mg/L	0.02500		109	70-130			
Surrogate: Toluene-d8	0.0270		mg/L	0.02500		108	70-130			

**Batch CA82421 - 5030B**

Blank										
1,1,1,2-Tetrachloroethane	ND	0.0010	mg/L							
1,1,1-Trichloroethane	ND	0.0010	mg/L							
1,1,2,2-Tetrachloroethane	ND	0.0005	mg/L							
1,1,2-Trichloroethane	ND	0.0010	mg/L							
1,1-Dichloroethane	ND	0.0010	mg/L							
1,1-Dichloroethene	ND	0.0010	mg/L							
1,1-Dichloropropene	ND	0.0020	mg/L							



CERTIFICATE OF ANALYSIS

Client Name: AMEC Foster Wheeler

Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801306

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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8260B Volatile Organic Compounds

**Batch CA82421 - 5030B**

1,2,3-Trichlorobenzene	ND	0.0010	mg/L							
1,2,3-Trichloropropane	ND	0.0010	mg/L							
1,2,4-Trichlorobenzene	ND	0.0010	mg/L							
1,2,4-Trimethylbenzene	ND	0.0010	mg/L							
1,2-Dibromo-3-Chloropropane	ND	0.0050	mg/L							
1,2-Dibromoethane	ND	0.0010	mg/L							
1,2-Dichlorobenzene	ND	0.0010	mg/L							
1,2-Dichloroethane	ND	0.0010	mg/L							
1,2-Dichloropropane	ND	0.0010	mg/L							
1,3,5-Trimethylbenzene	ND	0.0010	mg/L							
1,3-Dichlorobenzene	ND	0.0010	mg/L							
1,3-Dichloropropane	ND	0.0010	mg/L							
1,4-Dichlorobenzene	ND	0.0010	mg/L							
1,4-Dioxane - Screen	ND	0.500	mg/L							
1-Chlorohexane	ND	0.0010	mg/L							
2,2-Dichloropropane	ND	0.0010	mg/L							
2-Butanone	ND	0.0100	mg/L							
2-Chlorotoluene	ND	0.0010	mg/L							
2-Hexanone	ND	0.0100	mg/L							
4-Chlorotoluene	ND	0.0010	mg/L							
4-Isopropyltoluene	ND	0.0010	mg/L							
4-Methyl-2-Pentanone	ND	0.0250	mg/L							
Acetone	ND	0.0100	mg/L							
Benzene	ND	0.0010	mg/L							
Bromobenzene	ND	0.0020	mg/L							
Bromochloromethane	ND	0.0010	mg/L							
Bromodichloromethane	ND	0.0006	mg/L							
Bromoform	ND	0.0010	mg/L							
Bromomethane	ND	0.0020	mg/L							
Carbon Disulfide	ND	0.0010	mg/L							
Carbon Tetrachloride	ND	0.0010	mg/L							
Chlorobenzene	ND	0.0010	mg/L							
Chloroethane	ND	0.0020	mg/L							
Chloroform	ND	0.0010	mg/L							
Chloromethane	ND	0.0020	mg/L							
cis-1,2-Dichloroethene	ND	0.0010	mg/L							
cis-1,3-Dichloropropene	ND	0.0004	mg/L							
Dibromochloromethane	ND	0.0010	mg/L							
Dibromomethane	ND	0.0010	mg/L							
Dichlorodifluoromethane	ND	0.0020	mg/L							
Diethyl Ether	ND	0.0010	mg/L							
Di-isopropyl ether	ND	0.0010	mg/L							
Ethyl tertiary-butyl ether	ND	0.0010	mg/L							
Ethylbenzene	ND	0.0010	mg/L							
Hexachlorobutadiene	ND	0.0006	mg/L							



CERTIFICATE OF ANALYSIS

Client Name: AMEC Foster Wheeler

Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801306

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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8260B Volatile Organic Compounds

**Batch CA82421 - 5030B**

Hexachloroethane	ND	0.0010	mg/L							
Isopropylbenzene	ND	0.0010	mg/L							
Methyl tert-Butyl Ether	ND	0.0010	mg/L							
Methylene Chloride	ND	0.0020	mg/L							
Naphthalene	ND	0.0010	mg/L							
n-Butylbenzene	ND	0.0010	mg/L							
n-Propylbenzene	ND	0.0010	mg/L							
sec-Butylbenzene	ND	0.0010	mg/L							
Styrene	ND	0.0010	mg/L							
tert-Butylbenzene	ND	0.0010	mg/L							
Tertiary-amyl methyl ether	ND	0.0010	mg/L							
Tetrachloroethene	ND	0.0010	mg/L							
Tetrahydrofuran	ND	0.0050	mg/L							
Toluene	ND	0.0010	mg/L							
trans-1,2-Dichloroethene	ND	0.0010	mg/L							
trans-1,3-Dichloropropene	ND	0.0004	mg/L							
Trichloroethene	ND	0.0010	mg/L							
Trichlorofluoromethane	ND	0.0010	mg/L							
Vinyl Acetate	ND	0.0050	mg/L							
Vinyl Chloride	ND	0.0010	mg/L							
Xylene O	ND	0.0010	mg/L							
Xylene P,M	ND	0.0020	mg/L							
Surrogate: 1,2-Dichloroethane-d4	0.0233		mg/L	0.02500		93	70-130			
Surrogate: 4-Bromofluorobenzene	0.0242		mg/L	0.02500		97	70-130			
Surrogate: Dibromofluoromethane	0.0223		mg/L	0.02500		89	70-130			
Surrogate: Toluene-d8	0.0222		mg/L	0.02500		89	70-130			

**LCS**

1,1,1,2-Tetrachloroethane	9.71		ug/L	10.00		97	70-130			
1,1,1-Trichloroethane	9.49		ug/L	10.00		95	70-130			
1,1,2,2-Tetrachloroethane	10.4		ug/L	10.00		104	70-130			
1,1,2-Trichloroethane	9.32		ug/L	10.00		93	70-130			
1,1-Dichloroethane	9.72		ug/L	10.00		97	70-130			
1,1-Dichloroethene	9.70		ug/L	10.00		97	70-130			
1,1-Dichloropropene	10.7		ug/L	10.00		107	70-130			
1,2,3-Trichlorobenzene	10.6		ug/L	10.00		106	70-130			
1,2,3-Trichloropropane	10.2		ug/L	10.00		102	70-130			
1,2,4-Trichlorobenzene	10.4		ug/L	10.00		104	70-130			
1,2,4-Trimethylbenzene	9.83		ug/L	10.00		98	70-130			
1,2-Dibromo-3-Chloropropane	8.75		ug/L	10.00		88	70-130			
1,2-Dibromoethane	9.98		ug/L	10.00		100	70-130			
1,2-Dichlorobenzene	10.2		ug/L	10.00		102	70-130			
1,2-Dichloroethane	10.1		ug/L	10.00		101	70-130			
1,2-Dichloropropane	10.1		ug/L	10.00		101	70-130			
1,3,5-Trimethylbenzene	9.96		ug/L	10.00		100	70-130			
1,3-Dichlorobenzene	10.2		ug/L	10.00		102	70-130			



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801306

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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8260B Volatile Organic Compounds

**Batch CA82421 - 5030B**

1,3-Dichloropropane	11.0		ug/L	10.00		110	70-130			
1,4-Dichlorobenzene	10.3		ug/L	10.00		103	70-130			
1,4-Dioxane - Screen	211		ug/L	200.0		106	0-332			
1-Chlorohexane	10.7		ug/L	10.00		107	70-130			
2,2-Dichloropropane	9.74		ug/L	10.00		97	70-130			
2-Butanone	51.3		ug/L	50.00		103	70-130			
2-Chlorotoluene	10.5		ug/L	10.00		105	70-130			
2-Hexanone	51.2		ug/L	50.00		102	70-130			
4-Chlorotoluene	10.4		ug/L	10.00		104	70-130			
4-Isopropyltoluene	9.98		ug/L	10.00		100	70-130			
4-Methyl-2-Pentanone	52.3		ug/L	50.00		105	70-130			
Acetone	45.8		ug/L	50.00		92	70-130			
Benzene	10.2		ug/L	10.00		102	70-130			
Bromobenzene	10.1		ug/L	10.00		101	70-130			
Bromochloromethane	9.71		ug/L	10.00		97	70-130			
Bromodichloromethane	8.39		ug/L	10.00		84	70-130			
Bromoform	8.34		ug/L	10.00		83	70-130			
Bromomethane	12.2		ug/L	10.00		122	70-130			
Carbon Disulfide	10.9		ug/L	10.00		109	70-130			
Carbon Tetrachloride	9.27		ug/L	10.00		93	70-130			
Chlorobenzene	10.1		ug/L	10.00		101	70-130			
Chloroethane	10.7		ug/L	10.00		107	70-130			
Chloroform	9.63		ug/L	10.00		96	70-130			
Chloromethane	9.88		ug/L	10.00		99	70-130			
cis-1,2-Dichloroethene	10.1		ug/L	10.00		101	70-130			
cis-1,3-Dichloropropene	10.0		ug/L	10.00		100	70-130			
Dibromochloromethane	9.10		ug/L	10.00		91	70-130			
Dibromomethane	9.53		ug/L	10.00		95	70-130			
Dichlorodifluoromethane	9.77		ug/L	10.00		98	70-130			
Diethyl Ether	10.4		ug/L	10.00		104	70-130			
Di-isopropyl ether	10.1		ug/L	10.00		101	70-130			
Ethyl tertiary-butyl ether	10.4		ug/L	10.00		104	70-130			
Ethylbenzene	10.2		ug/L	10.00		102	70-130			
Hexachlorobutadiene	11.6		ug/L	10.00		116	70-130			
Hexachloroethane	8.13		ug/L	10.00		81	70-130			
Isopropylbenzene	9.54		ug/L	10.00		95	70-130			
Methyl tert-Butyl Ether	10.2		ug/L	10.00		102	70-130			
Methylene Chloride	10.2		ug/L	10.00		102	70-130			
Naphthalene	9.76		ug/L	10.00		98	70-130			
n-Butylbenzene	10.6		ug/L	10.00		106	70-130			
n-Propylbenzene	10.2		ug/L	10.00		102	70-130			
sec-Butylbenzene	9.63		ug/L	10.00		96	70-130			
Styrene	9.59		ug/L	10.00		96	70-130			
tert-Butylbenzene	9.76		ug/L	10.00		98	70-130			
Tertiary-amyl methyl ether	10.3		ug/L	10.00		103	70-130			



CERTIFICATE OF ANALYSIS

Client Name: AMEC Foster Wheeler

Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801306

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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8260B Volatile Organic Compounds

**Batch CA82421 - 5030B**

Tetrachloroethene	8.70		ug/L	10.00		87	70-130			
Tetrahydrofuran	11.5		ug/L	10.00		115	70-130			
Toluene	9.69		ug/L	10.00		97	70-130			
trans-1,2-Dichloroethene	9.67		ug/L	10.00		97	70-130			
trans-1,3-Dichloropropene	9.86		ug/L	10.00		99	70-130			
Trichloroethene	9.71		ug/L	10.00		97	70-130			
Trichlorofluoromethane	9.83		ug/L	10.00		98	70-130			
Vinyl Acetate	11.1		ug/L	10.00		111	70-130			
Vinyl Chloride	9.65		ug/L	10.00		96	70-130			
Xylene O	10.3		ug/L	10.00		103	70-130			
Xylene P,M	20.2		ug/L	20.00		101	70-130			
Surrogate: 1,2-Dichloroethane-d4	0.0256		mg/L	0.02500		102	70-130			
Surrogate: 4-Bromofluorobenzene	0.0245		mg/L	0.02500		98	70-130			
Surrogate: Dibromofluoromethane	0.0236		mg/L	0.02500		94	70-130			
Surrogate: Toluene-d8	0.0248		mg/L	0.02500		99	70-130			

**LCS Dup**

1,1,1,2-Tetrachloroethane	8.88		ug/L	10.00		89	70-130	9	25	
1,1,1-Trichloroethane	9.14		ug/L	10.00		91	70-130	4	25	
1,1,2,2-Tetrachloroethane	10.6		ug/L	10.00		106	70-130	1	25	
1,1,2-Trichloroethane	9.42		ug/L	10.00		94	70-130	1	25	
1,1-Dichloroethane	9.99		ug/L	10.00		100	70-130	3	25	
1,1-Dichloroethene	9.74		ug/L	10.00		97	70-130	0.4	25	
1,1-Dichloropropene	10.5		ug/L	10.00		105	70-130	2	25	
1,2,3-Trichlorobenzene	9.36		ug/L	10.00		94	70-130	12	25	
1,2,3-Trichloropropane	10.6		ug/L	10.00		106	70-130	4	25	
1,2,4-Trichlorobenzene	9.08		ug/L	10.00		91	70-130	13	25	
1,2,4-Trimethylbenzene	9.21		ug/L	10.00		92	70-130	7	25	
1,2-Dibromo-3-Chloropropane	9.30		ug/L	10.00		93	70-130	6	25	
1,2-Dibromoethane	9.66		ug/L	10.00		97	70-130	3	25	
1,2-Dichlorobenzene	9.84		ug/L	10.00		98	70-130	4	25	
1,2-Dichloroethane	9.83		ug/L	10.00		98	70-130	3	25	
1,2-Dichloropropane	10.5		ug/L	10.00		105	70-130	4	25	
1,3,5-Trimethylbenzene	9.74		ug/L	10.00		97	70-130	2	25	
1,3-Dichlorobenzene	9.64		ug/L	10.00		96	70-130	5	25	
1,3-Dichloropropane	10.9		ug/L	10.00		109	70-130	2	25	
1,4-Dichlorobenzene	10.1		ug/L	10.00		101	70-130	2	25	
1,4-Dioxane - Screen	203		ug/L	200.0		101	0-332	4	200	
1-Chlorohexane	10.1		ug/L	10.00		101	70-130	6	25	
2,2-Dichloropropane	9.88		ug/L	10.00		99	70-130	1	25	
2-Butanone	51.4		ug/L	50.00		103	70-130	0.3	25	
2-Chlorotoluene	9.81		ug/L	10.00		98	70-130	7	25	
2-Hexanone	52.2		ug/L	50.00		104	70-130	2	25	
4-Chlorotoluene	10.2		ug/L	10.00		102	70-130	2	25	
4-Isopropyltoluene	9.85		ug/L	10.00		98	70-130	1	25	
4-Methyl-2-Pentanone	53.0		ug/L	50.00		106	70-130	1	25	





*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler

Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801306

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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**8260B Volatile Organic Compounds**

**Batch CA82421 - 5030B**

Acetone	50.7		ug/L	50.00		101	70-130	10	25	
Benzene	10.4		ug/L	10.00		104	70-130	2	25	
Bromobenzene	9.77		ug/L	10.00		98	70-130	3	25	
Bromochloromethane	9.26		ug/L	10.00		93	70-130	5	25	
Bromodichloromethane	8.39		ug/L	10.00		84	70-130	0	25	
Bromoform	7.99		ug/L	10.00		80	70-130	4	25	
Bromomethane	11.6		ug/L	10.00		116	70-130	5	25	
Carbon Disulfide	10.8		ug/L	10.00		108	70-130	0.5	25	
Carbon Tetrachloride	9.09		ug/L	10.00		91	70-130	2	25	
Chlorobenzene	9.70		ug/L	10.00		97	70-130	4	25	
Chloroethane	10.4		ug/L	10.00		104	70-130	2	25	
Chloroform	9.51		ug/L	10.00		95	70-130	1	25	
Chloromethane	9.77		ug/L	10.00		98	70-130	1	25	
cis-1,2-Dichloroethene	9.91		ug/L	10.00		99	70-130	2	25	
cis-1,3-Dichloropropene	10.1		ug/L	10.00		101	70-130	0.7	25	
Dibromochloromethane	8.76		ug/L	10.00		88	70-130	4	25	
Dibromomethane	9.40		ug/L	10.00		94	70-130	1	25	
Dichlorodifluoromethane	9.47		ug/L	10.00		95	70-130	3	25	
Diethyl Ether	10.1		ug/L	10.00		101	70-130	4	25	
Di-isopropyl ether	10.2		ug/L	10.00		102	70-130	0.9	25	
Ethyl tertiary-butyl ether	10.2		ug/L	10.00		102	70-130	2	25	
Ethylbenzene	10.1		ug/L	10.00		101	70-130	0.7	25	
Hexachlorobutadiene	9.56		ug/L	10.00		96	70-130	19	25	
Hexachloroethane	7.76		ug/L	10.00		78	70-130	5	25	
Isopropylbenzene	9.33		ug/L	10.00		93	70-130	2	25	
Methyl tert-Butyl Ether	10.3		ug/L	10.00		103	70-130	2	25	
Methylene Chloride	9.81		ug/L	10.00		98	70-130	4	25	
Naphthalene	9.15		ug/L	10.00		92	70-130	6	25	
n-Butylbenzene	9.48		ug/L	10.00		95	70-130	11	25	
n-Propylbenzene	9.98		ug/L	10.00		100	70-130	2	25	
sec-Butylbenzene	9.62		ug/L	10.00		96	70-130	0.1	25	
Styrene	9.47		ug/L	10.00		95	70-130	1	25	
tert-Butylbenzene	9.60		ug/L	10.00		96	70-130	2	25	
Tertiary-amyl methyl ether	9.82		ug/L	10.00		98	70-130	4	25	
Tetrachloroethene	8.37		ug/L	10.00		84	70-130	4	25	
Tetrahydrofuran	11.4		ug/L	10.00		114	70-130	1	25	
Toluene	9.68		ug/L	10.00		97	70-130	0.1	25	
trans-1,2-Dichloroethene	9.50		ug/L	10.00		95	70-130	2	25	
trans-1,3-Dichloropropene	9.92		ug/L	10.00		99	70-130	0.6	25	
Trichloroethene	9.23		ug/L	10.00		92	70-130	5	25	
Trichlorofluoromethane	9.66		ug/L	10.00		97	70-130	2	25	
Vinyl Acetate	12.0		ug/L	10.00		120	70-130	8	25	
Vinyl Chloride	9.51		ug/L	10.00		95	70-130	1	25	
Xylene O	9.84		ug/L	10.00		98	70-130	4	25	
Xylene P,M	19.5		ug/L	20.00		97	70-130	3	25	



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler

Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801306

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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8260B Volatile Organic Compounds

**Batch CA82421 - 5030B**

<i>Surrogate: 1,2-Dichloroethane-d4</i>	<i>0.0257</i>		mg/L	<i>0.02500</i>		<i>103</i>	<i>70-130</i>			
<i>Surrogate: 4-Bromofluorobenzene</i>	<i>0.0243</i>		mg/L	<i>0.02500</i>		<i>97</i>	<i>70-130</i>			
<i>Surrogate: Dibromofluoromethane</i>	<i>0.0246</i>		mg/L	<i>0.02500</i>		<i>99</i>	<i>70-130</i>			
<i>Surrogate: Toluene-d8</i>	<i>0.0244</i>		mg/L	<i>0.02500</i>		<i>98</i>	<i>70-130</i>			



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler

Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801306

**Notes and Definitions**

- U Analyte included in the analysis, but not detected
- M+ Matrix Spike recovery is above upper control limit (M+).
- D Diluted.
- ND Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
- dry Sample results reported on a dry weight basis
- RPD Relative Percent Difference
- MDL Method Detection Limit
- MRL Method Reporting Limit
- LOD Limit of Detection
- LOQ Limit of Quantitation
- DL Detection Limit
- I/V Initial Volume
- F/V Final Volume
- § Subcontracted analysis; see attached report
- 1 Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
- 2 Range result excludes concentrations of target analytes eluting in that range.
- 3 Range result excludes the concentration of the C9-C10 aromatic range.
- Avg Results reported as a mathematical average.
- NR No Recovery
- [CALC] Calculated Analyte
- SUB Subcontracted analysis; see attached report
- RL Reporting Limit
- EDL Estimated Detection Limit



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801306

**ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS**

**ENVIRONMENTAL**

Rhode Island Potable and Non Potable Water: LAI00179  
<http://www.health.ri.gov/find/labs/analytical/ESS.pdf>

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750  
[http://www.ct.gov/dph/lib/dph/environmental\\_health/environmental\\_laboratories/pdf/OutOfStateCommercialLaboratories.pdf](http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutOfStateCommercialLaboratories.pdf)

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002  
<http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml>

Massachusetts Potable and Non Potable Water: M-RI002  
<http://public.dep.state.ma.us/Labcert/Labcert.aspx>

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424  
<http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm>

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313  
<http://www.wadsworth.org/labcert/elap/comm.html>

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006  
[http://datamine2.state.nj.us/DEP\\_OPRA/OpraMain/pi\\_main?mode=pi\\_by\\_site&sort\\_order=PI\\_NAMEA&Select+a+Site:=58715](http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715)

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752  
<http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx>

## ESS Laboratory Sample and Cooler Receipt Checklist

Client: AMEC Foster Wheeler - KP/B/HDM  
 Shipped/Delivered Via: Client

ESS Project ID: 1801306  
 Date Received: 1/17/2018  
 Project Due Date: 1/24/2018  
 Days for Project: 5 Day

1. Air bill manifest present?  No  
 Air No.: NA
2. Were custody seals present?  No
3. Is radiation count <100 CPM?  Yes
4. Is a Cooler Present?  Yes  
 Temp: 4.2 Iced with: Ice
5. Was COC signed and dated by client?  Yes

6. Does COC match bottles?  No
7. Is COC complete and correct?  Yes
8. Were samples received intact?  Yes
9. Were labs informed about short holds & rushes? Yes / No / NA
10. Were any analyses received outside of hold time? Yes / No

11. Any Subcontracting needed? Yes / No  
 ESS Sample IDs: \_\_\_\_\_  
 Analysis: \_\_\_\_\_  
 TAT: \_\_\_\_\_

12. Were VOAs received?  Yes / No  
 a. Air bubbles in aqueous VOAs? Yes / No  
 b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved?  Yes / No  
 a. If metals preserved upon receipt: Date: \_\_\_\_\_ Time: \_\_\_\_\_ By: \_\_\_\_\_  
 b. Low Level VOA vials frozen: Date: \_\_\_\_\_ Time: \_\_\_\_\_ By: \_\_\_\_\_

Sample Receiving Notes:

Added -16 per HDM w 1/18/18

14. Was there a need to contact Project Manager? Yes / No  
 a. Was there a need to contact the client? Yes / No  
 Who was contacted? \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_ By: \_\_\_\_\_

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	196303	Yes	No	Yes	VOA Vial - HCl	HCl	
01	196305	Yes	No	Yes	VOA Vial - HCl	HCl	
02	196300	Yes	No	Yes	VOA Vial - HCl	HCl	
02	196301	Yes	No	Yes	VOA Vial - HCl	HCl	
02	196302	Yes	No	Yes	VOA Vial - HCl	HCl	
03	196297	Yes	No	Yes	VOA Vial - HCl	HCl	
03	196298	Yes	No	Yes	VOA Vial - HCl	HCl	
03	196299	Yes	No	Yes	VOA Vial - HCl	HCl	
04	196294	Yes	No	Yes	VOA Vial - HCl	HCl	
04	196295	Yes	No	Yes	VOA Vial - HCl	HCl	
04	196296	Yes	No	Yes	VOA Vial - HCl	HCl	
05	196291	Yes	No	Yes	VOA Vial - HCl	HCl	
05	196292	Yes	No	Yes	VOA Vial - HCl	HCl	
05	196293	Yes	No	Yes	VOA Vial - HCl	HCl	
06	196288	Yes	No	Yes	VOA Vial - HCl	HCl	
06	196289	Yes	No	Yes	VOA Vial - HCl	HCl	
06	196290	Yes	No	Yes	VOA Vial - HCl	HCl	
07	196285	Yes	No	Yes	VOA Vial - HCl	HCl	
07	196286	Yes	No	Yes	VOA Vial - HCl	HCl	
07	196287	Yes	No	Yes	VOA Vial - HCl	HCl	
08	196282	Yes	No	Yes	VOA Vial - HCl	HCl	
08	196283	Yes	No	Yes	VOA Vial - HCl	HCl	
08	196284	Yes	No	Yes	VOA Vial - HCl	HCl	
09	196279	Yes	No	Yes	VOA Vial - HCl	HCl	

## ESS Laboratory Sample and Cooler Receipt Checklist

Client: AMEC Foster Wheeler - KPB/HDM

ESS Project ID: 1801306  
Date Received: 1/17/2018

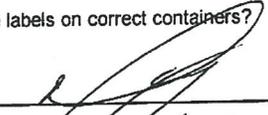
09	196280	Yes	No	Yes	VOA Vial - HCl	HCl
09	196281	Yes	No	Yes	VOA Vial - HCl	HCl
09	196306	Yes	No	Yes	VOA Vial - HCl	HCl
09	196307	Yes	No	Yes	VOA Vial - HCl	HCl
09	196308	Yes	No	Yes	VOA Vial - HCl	HCl
09	196309	Yes	No	Yes	VOA Vial - HCl	HCl
09	196310	Yes	No	Yes	VOA Vial - HCl	HCl
09	196311	Yes	No	Yes	VOA Vial - HCl	HCl
10	196276	Yes	No	Yes	VOA Vial - HCl	HCl
10	196277	Yes	No	Yes	VOA Vial - HCl	HCl
10	196278	Yes	No	Yes	VOA Vial - HCl	HCl
11	196273	Yes	No	Yes	VOA Vial - HCl	HCl
11	196274	Yes	No	Yes	VOA Vial - HCl	HCl
11	196275	Yes	No	Yes	VOA Vial - HCl	HCl
12	196270	Yes	No	Yes	VOA Vial - HCl	HCl
12	196271	Yes	No	Yes	VOA Vial - HCl	HCl
12	196272	Yes	No	Yes	VOA Vial - HCl	HCl
13	196267	Yes	No	Yes	VOA Vial - HCl	HCl
13	196268	Yes	No	Yes	VOA Vial - HCl	HCl
13	196269	Yes	No	Yes	VOA Vial - HCl	HCl
14	196264	Yes	No	Yes	VOA Vial - HCl	HCl
14	196265	Yes	No	Yes	VOA Vial - HCl	HCl
14	196266	Yes	No	Yes	VOA Vial - HCl	HCl
15	196261	Yes	No	Yes	VOA Vial - HCl	HCl
15	196262	Yes	No	Yes	VOA Vial - HCl	HCl
15	196263	Yes	No	Yes	VOA Vial - HCl	HCl
16	196413	Yes	No	Yes	VOA Vial - HCl	HCl
16	196414	Yes	No	Yes	VOA Vial - HCl	HCl
16	196415	Yes	No	Yes	VOA Vial - HCl	HCl

**2nd Review**

Are barcode labels on correct containers?

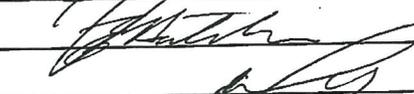
Yes / No

Completed

By: 

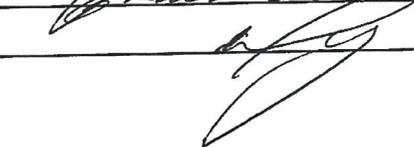
Date & Time: 1/18/18 1157

Reviewed

By: 

Date & Time: 1/18/18 1342

Delivered

By: 

Date & Time: 1/18/18 1431

## ESS Laboratory Sample and Cooler Receipt Checklist

Client: AMEC Foster Wheeler - KP/B/HDM

ESS Project ID: 1801306

Date Received: 1/17/2018

Project Due Date: 1/24/2018

Days for Project: 5 Day

Shipped/Delivered Via: Client

1. Air bill manifest present?  No  
Air No.: NA

6. Does COC match bottles?  No

2. Were custody seals present?  No

7. Is COC complete and correct?  Yes

3. Is radiation count <100 CPM?  Yes

8. Were samples received intact?  Yes

4. Is a Cooler Present?  Yes  
Temp: 4.2 Iced with: Ice

9. Were labs informed about short holds & rushes? Yes / No  NA

5. Was COC signed and dated by client?  Yes

10. Were any analyses received outside of hold time? Yes / No  No

11. Any Subcontracting needed? Yes /  No  
ESS Sample IDs: \_\_\_\_\_  
Analysis: \_\_\_\_\_  
TAT: \_\_\_\_\_

12. Were VOAs received?  Yes /  No  
a. Air bubbles in aqueous VOAs? Yes / No  No  
b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved?  Yes / No  
a. If metals preserved upon receipt: Date: \_\_\_\_\_ Time: \_\_\_\_\_ By: \_\_\_\_\_  
b. Low Level VOA vials frozen: Date: \_\_\_\_\_ Time: \_\_\_\_\_ By: \_\_\_\_\_

Sample Receiving Notes:

**COC=MW-223S, Rec'd=MW-223D, Rec'd 3vials Label=MW-228D collected@1630 1/16/18, not listed on COC**

**MW-217S- rec'd 1 vial broken in transit, Several vials covered in thick packing tape**

*[Handwritten signature]*

**1-17-18**

14. Was there a need to contact Project Manager?  Yes / No  
a. Was there a need to contact the client?  Yes / No  
Who was contacted? \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_ By: \_\_\_\_\_

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	196303	Yes	No	Yes	VOA Vial - HCl	HCl	
01	196305	Yes	No	Yes	VOA Vial - HCl	HCl	
02	196300	Yes	No	Yes	VOA Vial - HCl	HCl	
02	196301	Yes	No	Yes	VOA Vial - HCl	HCl	
02	196302	Yes	No	Yes	VOA Vial - HCl	HCl	
03	196297	Yes	No	Yes	VOA Vial - HCl	HCl	
03	196298	Yes	No	Yes	VOA Vial - HCl	HCl	
03	196299	Yes	No	Yes	VOA Vial - HCl	HCl	
04	196294	Yes	No	Yes	VOA Vial - HCl	HCl	
04	196295	Yes	No	Yes	VOA Vial - HCl	HCl	
04	196296	Yes	No	Yes	VOA Vial - HCl	HCl	
05	196291	Yes	No	Yes	VOA Vial - HCl	HCl	
05	196292	Yes	No	Yes	VOA Vial - HCl	HCl	
05	196293	Yes	No	Yes	VOA Vial - HCl	HCl	
06	196288	Yes	No	Yes	VOA Vial - HCl	HCl	
06	196289	Yes	No	Yes	VOA Vial - HCl	HCl	
06	196290	Yes	No	Yes	VOA Vial - HCl	HCl	
07	196285	Yes	No	Yes	VOA Vial - HCl	HCl	
07	196286	Yes	No	Yes	VOA Vial - HCl	HCl	
07	196287	Yes	No	Yes	VOA Vial - HCl	HCl	
08	196282	Yes	No	Yes	VOA Vial - HCl	HCl	
08	196283	Yes	No	Yes	VOA Vial - HCl	HCl	
08	196284	Yes	No	Yes	VOA Vial - HCl	HCl	

## ESS Laboratory Sample and Cooler Receipt Checklist

Client: AMEC Foster Wheeler - KP/B/HDM

ESS Project ID: 1801306

Date Received: 1/17/2018

09	196279	Yes	No	Yes	VOA Vial - HCI	HCI
09	196280	Yes	No	Yes	VOA Vial - HCI	HCI
09	196281	Yes	No	Yes	VOA Vial - HCI	HCI
09	196306	Yes	No	Yes	VOA Vial - HCI	HCI
09	196307	Yes	No	Yes	VOA Vial - HCI	HCI
09	196308	Yes	No	Yes	VOA Vial - HCI	HCI
09	196309	Yes	No	Yes	VOA Vial - HCI	HCI
09	196310	Yes	No	Yes	VOA Vial - HCI	HCI
09	196311	Yes	No	Yes	VOA Vial - HCI	HCI
10	196276	Yes	No	Yes	VOA Vial - HCI	HCI
10	196277	Yes	No	Yes	VOA Vial - HCI	HCI
10	196278	Yes	No	Yes	VOA Vial - HCI	HCI
11	196273	Yes	No	Yes	VOA Vial - HCI	HCI
11	196274	Yes	No	Yes	VOA Vial - HCI	HCI
11	196275	Yes	No	Yes	VOA Vial - HCI	HCI
12	196270	Yes	No	Yes	VOA Vial - HCI	HCI
12	196271	Yes	No	Yes	VOA Vial - HCI	HCI
12	196272	Yes	No	Yes	VOA Vial - HCI	HCI
13	196267	Yes	No	Yes	VOA Vial - HCI	HCI
13	196268	Yes	No	Yes	VOA Vial - HCI	HCI
13	196269	Yes	No	Yes	VOA Vial - HCI	HCI
14	196264	Yes	No	Yes	VOA Vial - HCI	HCI
14	196265	Yes	No	Yes	VOA Vial - HCI	HCI
14	196266	Yes	No	Yes	VOA Vial - HCI	HCI
15	196261	Yes	No	Yes	VOA Vial - HCI	HCI
15	196262	Yes	No	Yes	VOA Vial - HCI	HCI
15	196263	Yes	No	Yes	VOA Vial - HCI	HCI

2nd Review

Are barcode labels on correct containers?

Yes / No

Completed

By: [Signature]

Date & Time: 1/17/18 1940

Reviewed

By: [Signature]

Date & Time: 1/17/18 1950

Delivered

By: [Signature]

Date & Time: 1/17/18 1950

PS 1012

ESS Lab # **K601306**

**CHAIN OF CUSTODY**

**ESS Laboratory**  
 Division of Thielsch Engineering, Inc.  
 185 Frances Avenue, Cranston RI 02910  
 Tel. (401) 461-7181 Fax (401) 461-4486  
 www.esslaboratory.com

Reporting Limits **RIDE M**  
 Limit Checker  
 Other (Please Specify --) **See PM**  
 Standard Excel

Turn Time **5-Day** Rush  
 Regulatory State **RI**  
 Is this project for any of the following?  
 OCT RCP  OMA MCP  ORGP

Project # **365-170008** Project Name **Textron Cranston**  
 Address **271 Mill Rd** PO #  
 State **MA** Zip Code **01824**  
 Email Address **He-b.Cooby@wamplic.com**

Company Name **AmeC Foster Wheeler**  
 Contact Person **Dense Kings**

City **Chelmsford**  
 Telephone Number **978-648-5090**

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis
1	11/6/18	9:45	water	GW	MW-217S	X
2	11/6/18	10:45	water	GW	MW-217D	X
3	11/6/18	10:50	water	GW	MW-116S	X
4	11/6/18	12:45	water	GW	MW-116D	X
5	11/6/18	12:55	water	GW	MW-216D	X
6	11/6/18	14:20	water	GW	CW-1	X
7	11/6/18	14:50	water	GW	MW-216S	X
8	11/6/18	15:45	water	GW	CW-2	X
9	11/7/18	10:15	water	GW	MW-225S (run ms MSD)	X
10	11/7/18	11:50	water	GW	MW-225D	X

Container Type: AC-Air Cassette 2-2.5 gal 3-250 ml 4-HNO3 5-NaOH 6-Methanol 7-NH2S2O3 8-ZnAcAc, NaOH 9-NH4Cl 10-DI H2O 11-Other\*  
 Container Volume: 1-100 ml 2-2.5 gal 3-250 ml 4-300 mL 5-500 mL 6-1L 7-VOA 8-oz 9-4 oz 10-8 oz 11-Other\*  
 Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-NH2S2O3 8-ZnAcAc, NaOH 9-NH4Cl 10-DI H2O 11-Other\*  
 Number of Containers per Sample: **3**

**Laboratory Use Only**

Cooler Present: **Yes**  
 Seals Intact: **N/A**  
 Cooler Temperature: **4.2 °C** **iced**

Sampled by: **Mark Muscione Jacob Poirier**  
 Comments: Please specify "Other" preservative and container types in this space  
**Please Report: (1,1-DCA), (1,1-DCE), (1,1,1,2-DCE), (1,1,1,1-TCA), (TCE), (PCE), and (VC)**

Relinquished by: (Signature, Date & Time)  
**Jacob Poirier 11/17/18 15:45**

Relinquished By: (Signature, Date & Time)  
**[Signature] 11/17/18 5:47**

Relinquished By: (Signature, Date & Time)  
 Received By: (Signature, Date & Time)

PS 2 012

# CHAIN OF CUSTODY

ESS Lab # **1601306**

ESS Laboratory  
 Division of Thielsch Engineering, Inc  
 185 Frances Avenue, Cranston RI 02910  
 Tel. (401) 461-7181 Fax (401) 461-4486  
 www.esslaboratory.com

Turn Time (5-Day) Rush  
 Regulatory State RI  
 Is this project any of the following:  
 OCT RCP  Other  Standard Excel

Reporting Limits **RIDEN**

Electronic Deliverables  Limit Checker  Other (Please Specify --) **Scarf**

Company Name  
 Contact Person  
 Project Name  
 Address  
 PO #

City  
 Telephone Number  
 State  
 Zip Code  
 Email Address

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID
11	1/17/18	1055	Water	GW	<del>MW-2235</del> MW-223D (hdm 1/18/18)
12	1/17/18	1345	Water	GW	MW-2285
13	1/17/18	1505	Water	GW	MW-2275
14	1/17/18	-	Water	GW	Dup-01
15	1/17/18	-	Water	GW	Dup-02
16	1/16/18	1630	GW	GW	MW-228D

Container Type	AG-Air Cassette	AG-Amber Glass	B-BOD Bottle	C-Cubittainer	G-Glass	J-Other
Container Volume	1-100 mL	2-2.5 gal	3-250 mL	4-300 mL	5-500 mL	6-Other
Preservation Code	1-Non Preserved	2-HCl	3-H2SO4	4-HNO3	5-NaOH	6-Methanol
	7-Na2S2O3	8-ZnAc2	9-NaCH			

### Laboratory Use Only

Cooler Present: Yes  
 Seals Intact: NA  
 Cooler Temperature: 42 °C

Sampled by:  
 Comments:  
Please Report 7 CWC see page 1

Please specify "Other" preservative and container types in this space

Relinquished by: (Signature, Date & Time)  
Jacob Peric 1/17/18 15:45

Relinquished By: (Signature, Date & Time)  
[Signature] 1/17/18 1543

Relinquished By: (Signature, Date & Time)  
 Relinquished By: (Signature, Date & Time)

PS 1072

### CHAIN OF CUSTODY

ESS Laboratory

Division of Thielsch Engineering, Inc.  
 185 Frances Avenue, Cranston RI 02910  
 Tel. (401) 461-7181 Fax (401) 461-4486  
 www.esslaboratory.com

Turn Time: 5-Day Rush  
 Regulatory State: RI  
 Is this project for any of the following?  
 OCT RCP  OMA MCP  ORGP

Company Name  
 Amec Foster Wheeler  
 Contact Person  
 Denise King

Project #  
 365170008  
 Project Name  
 Textron Cranston

Address  
 271 Mill Rd.  
 Zip Code  
 01824  
 Email Address  
 He-b.Cooby@wco.wpl.com

ESS Lab #  
 K601306

Reporting Limits  
 RIDEM  
 Limit Checker  
 Other (Please Specify --) See PM

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample #	Analysis
1	1/16/18	945	water	GW	MW-217S	X
2	1/16/18	1045	water	GW	MW-217D	X
3	1/16/18	1050	water	GW	MW-116S	X
4	1/16/18	1245	water	GW	MW-116D	X
5	1/16/18	1255	water	GW	MW-216D	X
6	1/16/18	1420	water	GW	CW-1	X
7	1/16/18	1450	water	GW	MW-216S	X
8	1/16/18	1545	water	GW	CW-2	X
9	1/17/18	1015	water	GW	MW-225S (run MS MSD)	X
10	1/17/18	1150	water	GW	MW-225P	X

Container Type: AC Air Cassette 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-20oz 9-4 oz 10-8 oz 11-Other\*  
 Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-Na2S2O3 8-ZnAc2, NPOH 9-NH4Cl 10-DI H2O 11-Other\*  
 Number of Containers per Sample: 3

#### Laboratory Use Only

Cooler Present: Yes  
 Seals Intact: N/A  
 Cooler Temperature: 4.2 °C (iced)

Sampled by: Mark Messore, Jacob Poines

Comments: Please specify "Other" preservative and containers types in this space  
 Please Report: (1,1-DCA), (1,1-DCE), (1,1,1,1-TCA), (TCE), (PCE), and (VC)

Relinquished by: (Signature, Date & Time)

Jacob Poines - 1/17/18 15:45

Relinquished By: (Signature, Date & Time)

Mark Messore 1/17/18 5:47

Relinquished By: (Signature, Date & Time)

Received By: (Signature, Date & Time)

Relinquished By: (Signature, Date & Time)

Received By: (Signature, Date & Time)

PS 2 012

ESS Lab # **1801306**

Reporting Limits **RIDEM**

Electronic Deliverables  Limit Checker  Other (Please Specify) **Scrap**  Standard Excel

**CHAIN OF CUSTODY**

Turn Time **(5-Day)** Rush

Regulatory State **RI** Is this project any of the following  OCT RCP  ORG

Project # **365117005** Project Name **Texton Gorman**

Address **271 M. H. Rd**

City **Providence** State **RI** Zip Code **01824**

Telephone Number **978-692-521** FAX Number **978-692-521** Email Address **Hwb.celby@wardpl.com**

**ESS Laboratory**

Division of Thielsch Engineering, Inc.  
185 Frances Avenue, Cranston RI 02910  
Tel. (401) 461-7131 Fax (401) 461-4486  
www.esslaboratory.com

Company Name **Ameel Fuchs-Wheel**  
Contact Person **Denise Fuchs**

City **Providence** State **RI**

Telephone Number **978-692-521**

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis
11	11/17/18	1055	Water	Water	MW-2235	X
12	11/17/18	1345	Water	Water	MW-2285	X
13	11/17/18	1505	Water	Water	MW-2275	X
14	11/17/18	-	Water	Water	Dup-01	X
15	11/17/18	-	Water	Water	Dup-02	X

Container Type: AC-Air Cassette 2-2.5 gal 3-250 ml 4-300 ml 5-500 ml 6-Methanol 7-NaOH 8-ZnAc, NaOH  
 Container Volume: 1-100 ml 2-2.5 gal 3-250 ml 4-300 ml 5-500 ml 6-Methanol 7-NaOH 8-ZnAc, NaOH  
 Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-Na2S2O3 8-ZnAc, NaOH

Number of Containers per Sample: **3**

Cooler Present: **Yes**  
 Seals Intact: **NA**  
 Cooler Temperature: **42 °C**

Relinquished by: (Signature, Date & Time) **Jacob Perier 11/17/18 15:45**

Relinquished by: (Signature, Date & Time) **Jacob Perier 11/17/18 15:45**

Relinquished by: (Signature, Date & Time)



**ESS Laboratory**

*Division of Thielsch Engineering, Inc.*

**BAL Laboratory**

*The Microbiology Division  
of Thielsch Engineering, Inc.*



*CERTIFICATE OF ANALYSIS*

Denise King  
AMEC Foster Wheeler  
271 Mill Road  
Chelmsford, MA 01824

Reviewed 2/02/2018  
Elizabeth Penta  
Wood. PLC

**RE: Textron Gorham - Groundwater (3651170068)**

**ESS Laboratory Work Order Number: 1801362**

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard  
Laboratory Director

**REVIEWED**

**By ESS Laboratory at 4:51 pm, Jan 26, 2018**

**Analytical Summary**

The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801362

**SAMPLE RECEIPT**

The following samples were received on January 19, 2018 for the analyses specified on the enclosed Chain of Custody Record.

<b>Lab Number</b>	<b>Sample Name</b>	<b>Matrix</b>	<b>Analysis</b>
1801362-01	MW-226S	Ground Water	8260B
1801362-02	MW-226D	Ground Water	8260B
1801362-03	MW-224S	Ground Water	8260B
1801362-04	MW-223S	Ground Water	8260B
1801362-05	MW-234D	Ground Water	8260B
1801362-06	MW-227D	Ground Water	8260B
1801362-07	MW-234S	Ground Water	8260B
1801362-08	MW-202D	Ground Water	8260B
1801362-09	MW-202S	Ground Water	8260B
1801362-10	MW-206S	Ground Water	8260B
1801362-11	MW-206D	Ground Water	8260B
1801362-12	MW-218D	Ground Water	8260B
1801362-13	MW-218S	Ground Water	8260B
1801362-14	MW-231S	Ground Water	8260B
1801362-15	MW-231D	Ground Water	8260B
1801362-16	MW-232S	Ground Water	8260B
1801362-17	MW-232D	Ground Water	8260B
1801362-18	Dup-03	Ground Water	8260B
1801362-19	Trip Blank-01	Aqueous	8260B



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler

Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801362

**PROJECT NARRATIVE**

**8260B Volatile Organic Compounds**

CA82219-MS1 Matrix Spike recovery is below lower control limit (M-).

Trichloroethene (42% @ 70-130%)

CA82219-MSD1 Matrix Spike recovery is below lower control limit (M-).

Trichloroethene (22% @ 70-130%)

**No other observations noted.**

**End of Project Narrative.**

**DATA USABILITY LINKS**

*To ensure you are viewing the most current version of the documents below, please clear your internet cookies for [www.ESSLaboratory.com](http://www.ESSLaboratory.com). Consult your IT Support personnel for information on how to clear your internet cookies.*

[Definitions of Quality Control Parameters](#)

[Semivolatile Organics Internal Standard Information](#)

[Semivolatile Organics Surrogate Information](#)

[Volatile Organics Internal Standard Information](#)

[Volatile Organics Surrogate Information](#)

[EPH and VPH Alkane Lists](#)



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler

Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801362

**CURRENT SW-846 METHODOLOGY VERSIONS**

**Analytical Methods**

- 1010A - Flashpoint
- 6010C - ICP
- 6020A - ICP MS
- 7010 - Graphite Furnace
- 7196A - Hexavalent Chromium
- 7470A - Aqueous Mercury
- 7471B - Solid Mercury
- 8011 - EDB/DBCP/TCP
- 8015C - GRO/DRO
- 8081B - Pesticides
- 8082A - PCB
- 8100M - TPH
- 8151A - Herbicides
- 8260B - VOA
- 8270D - SVOA
- 8270D SIM - SVOA Low Level
- 9014 - Cyanide
- 9038 - Sulfate
- 9040C - Aqueous pH
- 9045D - Solid pH (Corrosivity)
- 9050A - Specific Conductance
- 9056A - Anions (IC)
- 9060A - TOC
- 9095B - Paint Filter
- MADEP 04-1.1 - EPH / VPH

**Prep Methods**

- 3005A - Aqueous ICP Digestion
- 3020A - Aqueous Graphite Furnace / ICP MS Digestion
- 3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
- 3060A - Solid Hexavalent Chromium Digestion
- 3510C - Separatory Funnel Extraction
- 3520C - Liquid / Liquid Extraction
- 3540C - Manual Soxhlet Extraction
- 3541 - Automated Soxhlet Extraction
- 3546 - Microwave Extraction
- 3580A - Waste Dilution
- 5030B - Aqueous Purge and Trap
- 5030C - Aqueous Purge and Trap
- 5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-226S  
 Date Sampled: 01/18/18 07:50  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801362  
 ESS Laboratory Sample ID: 1801362-01  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
<b>1,1,1-Trichloroethane</b>	<b>0.0060</b> (0.0010)		8260B		1	01/22/18 17:17	C8A0263	CA82219
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/22/18 17:17	C8A0263	CA82219
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 17:17	C8A0263	CA82219
<b>cis-1,2-Dichloroethene</b>	<b>0.0061</b> (0.0010)		8260B		1	01/22/18 17:17	C8A0263	CA82219
<b>Tetrachloroethene</b>	<b>0.331</b> (0.0100)		8260B		10	01/24/18 18:02	C8A0263	CA82219
<b>Trichloroethene</b>	<b>0.0397</b> (0.0010)		8260B		1	01/22/18 17:17	C8A0263	CA82219
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 17:17	C8A0263	CA82219

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	85 %		70-130
<i>Surrogate: 4-Bromofluorobenzene</i>	101 %		70-130
<i>Surrogate: Dibromofluoromethane</i>	91 %		70-130
<i>Surrogate: Toluene-d8</i>	95 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-226D  
 Date Sampled: 01/18/18 08:35  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801362  
 ESS Laboratory Sample ID: 1801362-02  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	0.0108 (0.0010)		8260B		1	01/22/18 17:44	C8A0263	CA82219
1,1-Dichloroethane	0.0124 (0.0010)		8260B		1	01/22/18 17:44	C8A0263	CA82219
1,1-Dichloroethene	0.0688 (0.0010)		8260B		1	01/22/18 17:44	C8A0263	CA82219
cis-1,2-Dichloroethene	0.200 (0.100)		8260B		100	01/24/18 19:22	C8A0263	CA82219
Tetrachloroethene	0.0083 (0.0010)		8260B		1	01/22/18 17:44	C8A0263	CA82219
Trichloroethene	2.25 (0.100)		8260B		100	01/24/18 19:22	C8A0263	CA82219
Vinyl Chloride	0.0016 (0.0010)		8260B		1	01/22/18 17:44	C8A0263	CA82219

	<u>%Recovery</u>	<u>Qualifier</u>	<u>Limits</u>
Surrogate: 1,2-Dichloroethane-d4	88 %		70-130
Surrogate: 4-Bromofluorobenzene	101 %		70-130
Surrogate: Dibromofluoromethane	95 %		70-130
Surrogate: Toluene-d8	98 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-224S  
 Date Sampled: 01/18/18 08:50  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801362  
 ESS Laboratory Sample ID: 1801362-03  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/24/18 14:28	C8A0296	CA82420
<b>1,1-Dichloroethane</b>	<b>0.0014</b> (0.0010)		8260B		1	01/24/18 14:28	C8A0296	CA82420
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/24/18 14:28	C8A0296	CA82420
cis-1,2-Dichloroethene	ND (0.0010)		8260B		1	01/24/18 14:28	C8A0296	CA82420
Tetrachloroethene	ND (0.0010)		8260B		1	01/24/18 14:28	C8A0296	CA82420
<b>Trichloroethene</b>	<b>0.0089</b> (0.0010)		8260B		1	01/24/18 14:28	C8A0296	CA82420
Vinyl Chloride	ND (0.0010)		8260B		1	01/24/18 14:28	C8A0296	CA82420

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	81 %		70-130
<i>Surrogate: 4-Bromofluorobenzene</i>	103 %		70-130
<i>Surrogate: Dibromofluoromethane</i>	91 %		70-130
<i>Surrogate: Toluene-d8</i>	97 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-223S  
 Date Sampled: 01/18/18 09:00  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801362  
 ESS Laboratory Sample ID: 1801362-04  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/26/18 12:08	C8A0331	CA82627
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/26/18 12:08	C8A0331	CA82627
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/26/18 12:08	C8A0331	CA82627
cis-1,2-Dichloroethene	ND (0.0010)		8260B		1	01/26/18 12:08	C8A0331	CA82627
Tetrachloroethene	ND (0.0010)		8260B		1	01/26/18 12:08	C8A0331	CA82627
Trichloroethene	ND (0.0010)		8260B		1	01/26/18 12:08	C8A0331	CA82627
Vinyl Chloride	ND (0.0010)		8260B		1	01/26/18 12:08	C8A0331	CA82627

	<u>%Recovery</u>	<u>Qualifier</u>	<u>Limits</u>
Surrogate: 1,2-Dichloroethane-d4	118 %		70-130
Surrogate: 4-Bromofluorobenzene	89 %		70-130
Surrogate: Dibromofluoromethane	121 %		70-130
Surrogate: Toluene-d8	104 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-234D  
 Date Sampled: 01/18/18 14:15  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801362  
 ESS Laboratory Sample ID: 1801362-05  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/22/18 19:05	C8A0263	CA82219
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/22/18 19:05	C8A0263	CA82219
<b>1,1-Dichloroethene</b>	<b>0.0022</b> (0.0010)		8260B		1	01/22/18 19:05	C8A0263	CA82219
<b>cis-1,2-Dichloroethene</b>	<b>0.0158</b> (0.0010)		8260B		1	01/22/18 19:05	C8A0263	CA82219
Tetrachloroethene	ND (0.0010)		8260B		1	01/22/18 19:05	C8A0263	CA82219
<b>Trichloroethene</b>	<b>0.0022</b> (0.0010)		8260B		1	01/22/18 19:05	C8A0263	CA82219
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 19:05	C8A0263	CA82219

	<u>%Recovery</u>	<u>Qualifier</u>	<u>Limits</u>
Surrogate: 1,2-Dichloroethane-d4	87 %		70-130
Surrogate: 4-Bromofluorobenzene	100 %		70-130
Surrogate: Dibromofluoromethane	95 %		70-130
Surrogate: Toluene-d8	94 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-227D  
 Date Sampled: 01/18/18 12:05  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801362  
 ESS Laboratory Sample ID: 1801362-06  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	0.0050 (0.0010)		8260B		1	01/22/18 19:32	C8A0263	CA82219
1,1-Dichloroethane	0.0056 (0.0010)		8260B		1	01/22/18 19:32	C8A0263	CA82219
1,1-Dichloroethene	0.0074 (0.0010)		8260B		1	01/22/18 19:32	C8A0263	CA82219
cis-1,2-Dichloroethene	0.0116 (0.0010)		8260B		1	01/22/18 19:32	C8A0263	CA82219
Tetrachloroethene	0.0026 (0.0010)		8260B		1	01/22/18 19:32	C8A0263	CA82219
Trichloroethene	0.667 (0.0200)		8260B		20	01/24/18 18:56	C8A0263	CA82219
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 19:32	C8A0263	CA82219

	<u>%Recovery</u>	<u>Qualifier</u>	<u>Limits</u>
Surrogate: 1,2-Dichloroethane-d4	85 %		70-130
Surrogate: 4-Bromofluorobenzene	103 %		70-130
Surrogate: Dibromofluoromethane	90 %		70-130
Surrogate: Toluene-d8	96 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-234S  
 Date Sampled: 01/18/18 14:30  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801362  
 ESS Laboratory Sample ID: 1801362-07  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/24/18 15:22	C8A0296	CA82420
<b>1,1-Dichloroethane</b>	<b>0.0043</b> (0.0010)		8260B		1	01/24/18 15:22	C8A0296	CA82420
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/24/18 15:22	C8A0296	CA82420
cis-1,2-Dichloroethene	ND (0.0010)		8260B		1	01/24/18 15:22	C8A0296	CA82420
Tetrachloroethene	ND (0.0010)		8260B		1	01/24/18 15:22	C8A0296	CA82420
Trichloroethene	ND (0.0010)		8260B		1	01/24/18 15:22	C8A0296	CA82420
Vinyl Chloride	ND (0.0010)		8260B		1	01/24/18 15:22	C8A0296	CA82420

	<u>%Recovery</u>	<u>Qualifier</u>	<u>Limits</u>
Surrogate: 1,2-Dichloroethane-d4	81 %		70-130
Surrogate: 4-Bromofluorobenzene	103 %		70-130
Surrogate: Dibromofluoromethane	92 %		70-130
Surrogate: Toluene-d8	96 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater  
Client Sample ID: MW-202D  
Date Sampled: 01/18/18 14:20  
Percent Solids: N/A  
Initial Volume: 5  
Final Volume: 5  
Extraction Method: 5030B

ESS Laboratory Work Order: 1801362  
ESS Laboratory Sample ID: 1801362-08  
Sample Matrix: Ground Water  
Units: mg/L  
Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/22/18 20:25	C8A0263	CA82219
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/22/18 20:25	C8A0263	CA82219
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 20:25	C8A0263	CA82219
cis-1,2-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 20:25	C8A0263	CA82219
<b>Tetrachloroethene</b>	<b>0.0390</b> (0.0010)		8260B		1	01/22/18 20:25	C8A0263	CA82219
<b>Trichloroethene</b>	<b>0.0120</b> (0.0010)		8260B		1	01/22/18 20:25	C8A0263	CA82219
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 20:25	C8A0263	CA82219

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	<i>90 %</i>		<i>70-130</i>
<i>Surrogate: 4-Bromofluorobenzene</i>	<i>101 %</i>		<i>70-130</i>
<i>Surrogate: Dibromofluoromethane</i>	<i>96 %</i>		<i>70-130</i>
<i>Surrogate: Toluene-d8</i>	<i>98 %</i>		<i>70-130</i>



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-202S  
 Date Sampled: 01/18/18 15:55  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801362  
 ESS Laboratory Sample ID: 1801362-09  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/22/18 20:52	C8A0263	CA82219
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/22/18 20:52	C8A0263	CA82219
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 20:52	C8A0263	CA82219
cis-1,2-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 20:52	C8A0263	CA82219
<b>Tetrachloroethene</b>	<b>0.0114</b> (0.0010)		8260B		1	01/22/18 20:52	C8A0263	CA82219
<b>Trichloroethene</b>	<b>0.0022</b> (0.0010)		8260B		1	01/22/18 20:52	C8A0263	CA82219
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 20:52	C8A0263	CA82219

	<u>%Recovery</u>	<u>Qualifier</u>	<u>Limits</u>
Surrogate: 1,2-Dichloroethane-d4	92 %		70-130
Surrogate: 4-Bromofluorobenzene	99 %		70-130
Surrogate: Dibromofluoromethane	96 %		70-130
Surrogate: Toluene-d8	92 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-206S  
 Date Sampled: 01/19/18 08:40  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801362  
 ESS Laboratory Sample ID: 1801362-10  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/22/18 21:19	C8A0263	CA82219
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/22/18 21:19	C8A0263	CA82219
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 21:19	C8A0263	CA82219
cis-1,2-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 21:19	C8A0263	CA82219
<b>Tetrachloroethene</b>	<b>0.0206</b> (0.0010)		8260B		1	01/22/18 21:19	C8A0263	CA82219
<b>Trichloroethene</b>	<b>0.0414</b> (0.0010)		8260B		1	01/22/18 21:19	C8A0263	CA82219
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 21:19	C8A0263	CA82219

	<u>%Recovery</u>	<u>Qualifier</u>	<u>Limits</u>
Surrogate: 1,2-Dichloroethane-d4	87 %		70-130
Surrogate: 4-Bromofluorobenzene	100 %		70-130
Surrogate: Dibromofluoromethane	93 %		70-130
Surrogate: Toluene-d8	98 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater  
Client Sample ID: MW-206D  
Date Sampled: 01/19/18 10:10  
Percent Solids: N/A  
Initial Volume: 5  
Final Volume: 5  
Extraction Method: 5030B

ESS Laboratory Work Order: 1801362  
ESS Laboratory Sample ID: 1801362-11  
Sample Matrix: Ground Water  
Units: mg/L  
Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/22/18 21:45	C8A0263	CA82219
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/22/18 21:45	C8A0263	CA82219
<b>1,1-Dichloroethene</b>	<b>0.0032</b> (0.0010)		8260B		1	01/22/18 21:45	C8A0263	CA82219
<b>cis-1,2-Dichloroethene</b>	<b>0.0091</b> (0.0010)		8260B		1	01/22/18 21:45	C8A0263	CA82219
<b>Tetrachloroethene</b>	<b>0.121</b> (0.0100)		8260B		10	01/24/18 18:29	C8A0263	CA82219
<b>Trichloroethene</b>	<b>0.183</b> (0.0100)		8260B		10	01/24/18 18:29	C8A0263	CA82219
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 21:45	C8A0263	CA82219

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	<i>84 %</i>		<i>70-130</i>
<i>Surrogate: 4-Bromofluorobenzene</i>	<i>100 %</i>		<i>70-130</i>
<i>Surrogate: Dibromofluoromethane</i>	<i>89 %</i>		<i>70-130</i>
<i>Surrogate: Toluene-d8</i>	<i>97 %</i>		<i>70-130</i>



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-218D  
 Date Sampled: 01/19/18 11:40  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801362  
 ESS Laboratory Sample ID: 1801362-12  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	0.0024 (0.0010)		8260B		1	01/22/18 22:12	C8A0263	CA82219
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/22/18 22:12	C8A0263	CA82219
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 22:12	C8A0263	CA82219
cis-1,2-Dichloroethene	0.0033 (0.0010)		8260B		1	01/22/18 22:12	C8A0263	CA82219
Tetrachloroethene	17.2 (1.00)		8260B		1000	01/26/18 12:59	C8A0263	CA82219
Trichloroethene	0.0572 (0.0010)		8260B		1	01/22/18 22:12	C8A0263	CA82219
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 22:12	C8A0263	CA82219

	<u>%Recovery</u>	<u>Qualifier</u>	<u>Limits</u>
Surrogate: 1,2-Dichloroethane-d4	84 %		70-130
Surrogate: 4-Bromofluorobenzene	98 %		70-130
Surrogate: Dibromofluoromethane	93 %		70-130
Surrogate: Toluene-d8	90 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-218S  
 Date Sampled: 01/19/18 12:25  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801362  
 ESS Laboratory Sample ID: 1801362-13  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/22/18 22:38	C8A0263	CA82219
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/22/18 22:38	C8A0263	CA82219
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 22:38	C8A0263	CA82219
cis-1,2-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 22:38	C8A0263	CA82219
<b>Tetrachloroethene</b>	<b>2.71</b> (0.100)		8260B		100	01/24/18 20:15	C8A0263	CA82219
<b>Trichloroethene</b>	<b>0.0032</b> (0.0010)		8260B		1	01/22/18 22:38	C8A0263	CA82219
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 22:38	C8A0263	CA82219

	<u>%Recovery</u>	<u>Qualifier</u>	<u>Limits</u>
Surrogate: 1,2-Dichloroethane-d4	91 %		70-130
Surrogate: 4-Bromofluorobenzene	101 %		70-130
Surrogate: Dibromofluoromethane	95 %		70-130
Surrogate: Toluene-d8	95 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-231S  
 Date Sampled: 01/19/18 12:05  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801362  
 ESS Laboratory Sample ID: 1801362-14  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/24/18 15:48	C8A0296	CA82420
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/24/18 15:48	C8A0296	CA82420
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/24/18 15:48	C8A0296	CA82420
<b>cis-1,2-Dichloroethene</b>	<b>0.0086</b> (0.0010)		8260B		1	01/24/18 15:48	C8A0296	CA82420
Tetrachloroethene	ND (0.0010)		8260B		1	01/24/18 15:48	C8A0296	CA82420
Trichloroethene	ND (0.0010)		8260B		1	01/24/18 15:48	C8A0296	CA82420
<b>Vinyl Chloride</b>	<b>0.0097</b> (0.0010)		8260B		1	01/24/18 15:48	C8A0296	CA82420

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	88 %		70-130
<i>Surrogate: 4-Bromofluorobenzene</i>	100 %		70-130
<i>Surrogate: Dibromofluoromethane</i>	93 %		70-130
<i>Surrogate: Toluene-d8</i>	95 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-231D  
 Date Sampled: 01/19/18 14:45  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801362  
 ESS Laboratory Sample ID: 1801362-15  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	0.0026 (0.0010)		8260B		1	01/24/18 17:36	C8A0296	CA82420
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/24/18 17:36	C8A0296	CA82420
1,1-Dichloroethene	0.0026 (0.0010)		8260B		1	01/24/18 17:36	C8A0296	CA82420
cis-1,2-Dichloroethene	0.0074 (0.0010)		8260B		1	01/24/18 17:36	C8A0296	CA82420
Tetrachloroethene	0.0010 (0.0010)		8260B		1	01/24/18 17:36	C8A0296	CA82420
Trichloroethene	0.0271 (0.0010)		8260B		1	01/24/18 17:36	C8A0296	CA82420
Vinyl Chloride	0.0023 (0.0010)		8260B		1	01/24/18 17:36	C8A0296	CA82420

	<u>%Recovery</u>	<u>Qualifier</u>	<u>Limits</u>
Surrogate: 1,2-Dichloroethane-d4	79 %		70-130
Surrogate: 4-Bromofluorobenzene	100 %		70-130
Surrogate: Dibromofluoromethane	87 %		70-130
Surrogate: Toluene-d8	95 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater  
Client Sample ID: MW-232S  
Date Sampled: 01/19/18 13:50  
Percent Solids: N/A  
Initial Volume: 5  
Final Volume: 5  
Extraction Method: 5030B

ESS Laboratory Work Order: 1801362  
ESS Laboratory Sample ID: 1801362-16  
Sample Matrix: Ground Water  
Units: mg/L  
Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	0.0077 (0.0010)		8260B		1	01/24/18 17:09	C8A0296	CA82420
1,1-Dichloroethane	0.0100 (0.0010)		8260B		1	01/24/18 17:09	C8A0296	CA82420
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/24/18 17:09	C8A0296	CA82420
cis-1,2-Dichloroethene	0.0047 (0.0010)		8260B		1	01/24/18 17:09	C8A0296	CA82420
Tetrachloroethene	ND (0.0010)		8260B		1	01/24/18 17:09	C8A0296	CA82420
Trichloroethene	0.0010 (0.0010)		8260B		1	01/24/18 17:09	C8A0296	CA82420
Vinyl Chloride	ND (0.0010)		8260B		1	01/24/18 17:09	C8A0296	CA82420

	<u>%Recovery</u>	<u>Qualifier</u>	<u>Limits</u>
Surrogate: 1,2-Dichloroethane-d4	91 %		70-130
Surrogate: 4-Bromofluorobenzene	102 %		70-130
Surrogate: Dibromofluoromethane	97 %		70-130
Surrogate: Toluene-d8	96 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-232D  
 Date Sampled: 01/19/18 14:55  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801362  
 ESS Laboratory Sample ID: 1801362-17  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/24/18 16:15	C8A0296	CA82420
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/24/18 16:15	C8A0296	CA82420
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/24/18 16:15	C8A0296	CA82420
<b>cis-1,2-Dichloroethene</b>	<b>0.0011</b> (0.0010)		8260B		1	01/24/18 16:15	C8A0296	CA82420
Tetrachloroethene	ND (0.0010)		8260B		1	01/24/18 16:15	C8A0296	CA82420
Trichloroethene	ND (0.0010)		8260B		1	01/24/18 16:15	C8A0296	CA82420
Vinyl Chloride	ND (0.0010)		8260B		1	01/24/18 16:15	C8A0296	CA82420

	<u>%Recovery</u>	<u>Qualifier</u>	<u>Limits</u>
Surrogate: 1,2-Dichloroethane-d4	85 %		70-130
Surrogate: 4-Bromofluorobenzene	103 %		70-130
Surrogate: Dibromofluoromethane	95 %		70-130
Surrogate: Toluene-d8	97 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater  
Client Sample ID: Dup-03  
Date Sampled: 01/19/18 00:00  
Percent Solids: N/A  
Initial Volume: 5  
Final Volume: 5  
Extraction Method: 5030B

ESS Laboratory Work Order: 1801362  
ESS Laboratory Sample ID: 1801362-18  
Sample Matrix: Ground Water  
Units: mg/L  
Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/24/18 16:42	C8A0296	CA82420
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/24/18 16:42	C8A0296	CA82420
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/24/18 16:42	C8A0296	CA82420
cis-1,2-Dichloroethene	ND (0.0010)		8260B		1	01/24/18 16:42	C8A0296	CA82420
<b>Tetrachloroethene</b>	<b>0.0201</b> (0.0010)		8260B		1	01/24/18 16:42	C8A0296	CA82420
<b>Trichloroethene</b>	<b>0.0401</b> (0.0010)		8260B		1	01/24/18 16:42	C8A0296	CA82420
Vinyl Chloride	ND (0.0010)		8260B		1	01/24/18 16:42	C8A0296	CA82420

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	87 %		70-130
<i>Surrogate: 4-Bromofluorobenzene</i>	99 %		70-130
<i>Surrogate: Dibromofluoromethane</i>	94 %		70-130
<i>Surrogate: Toluene-d8</i>	96 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: Trip Blank-01  
 Date Sampled: 01/19/18 00:00  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1801362  
 ESS Laboratory Sample ID: 1801362-19  
 Sample Matrix: Aqueous  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	01/22/18 16:51	C8A0263	CA82219
1,1-Dichloroethane	ND (0.0010)		8260B		1	01/22/18 16:51	C8A0263	CA82219
1,1-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 16:51	C8A0263	CA82219
cis-1,2-Dichloroethene	ND (0.0010)		8260B		1	01/22/18 16:51	C8A0263	CA82219
Tetrachloroethene	ND (0.0010)		8260B		1	01/22/18 16:51	C8A0263	CA82219
Trichloroethene	ND (0.0010)		8260B		1	01/22/18 16:51	C8A0263	CA82219
Vinyl Chloride	ND (0.0010)		8260B		1	01/22/18 16:51	C8A0263	CA82219

	<u>%Recovery</u>	<u>Qualifier</u>	<u>Limits</u>
Surrogate: 1,2-Dichloroethane-d4	89 %		70-130
Surrogate: 4-Bromofluorobenzene	103 %		70-130
Surrogate: Dibromofluoromethane	92 %		70-130
Surrogate: Toluene-d8	96 %		70-130



CERTIFICATE OF ANALYSIS

Client Name: AMEC Foster Wheeler

Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801362

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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8260B Volatile Organic Compounds

Batch CA82219 - 5030B

Blank

1,1,1-Trichloroethane	ND	0.0010	mg/L							
1,1-Dichloroethane	ND	0.0010	mg/L							
1,1-Dichloroethene	ND	0.0010	mg/L							
cis-1,2-Dichloroethene	ND	0.0010	mg/L							
Tetrachloroethene	ND	0.0010	mg/L							
Trichloroethene	ND	0.0010	mg/L							
Vinyl Chloride	ND	0.0010	mg/L							
Surrogate: 1,2-Dichloroethane-d4	0.0219		mg/L	0.02500		87	70-130			
Surrogate: 1,2-Dichloroethane-d4	0.0219		mg/L	0.02500		87	70-130			
Surrogate: 4-Bromofluorobenzene	0.0250		mg/L	0.02500		100	70-130			
Surrogate: 4-Bromofluorobenzene	0.0250		mg/L	0.02500		100	70-130			
Surrogate: Dibromofluoromethane	0.0226		mg/L	0.02500		91	70-130			
Surrogate: Dibromofluoromethane	0.0226		mg/L	0.02500		91	70-130			
Surrogate: Toluene-d8	0.0236		mg/L	0.02500		94	70-130			
Surrogate: Toluene-d8	0.0236		mg/L	0.02500		94	70-130			

LCS

1,1,1-Trichloroethane	8.55		ug/L	10.00		86	70-130			
1,1-Dichloroethane	8.30		ug/L	10.00		83	70-130			
1,1-Dichloroethene	9.22		ug/L	10.00		92	70-130			
cis-1,2-Dichloroethene	8.97		ug/L	10.00		90	70-130			
Tetrachloroethene	9.68		ug/L	10.00		97	70-130			
Trichloroethene	8.90		ug/L	10.00		89	70-130			
Vinyl Chloride	8.15		ug/L	10.00		82	70-130			
Surrogate: 1,2-Dichloroethane-d4	0.0238		mg/L	0.02500		95	70-130			
Surrogate: 1,2-Dichloroethane-d4	0.0238		mg/L	0.02500		95	70-130			
Surrogate: 4-Bromofluorobenzene	0.0261		mg/L	0.02500		104	70-130			
Surrogate: 4-Bromofluorobenzene	0.0261		mg/L	0.02500		104	70-130			
Surrogate: Dibromofluoromethane	0.0250		mg/L	0.02500		100	70-130			
Surrogate: Dibromofluoromethane	0.0250		mg/L	0.02500		100	70-130			
Surrogate: Toluene-d8	0.0263		mg/L	0.02500		105	70-130			
Surrogate: Toluene-d8	0.0263		mg/L	0.02500		105	70-130			

LCS Dup

1,1,1-Trichloroethane	9.08		ug/L	10.00		91	70-130	6	25	
1,1-Dichloroethane	8.29		ug/L	10.00		83	70-130	0.1	25	
1,1-Dichloroethene	9.13		ug/L	10.00		91	70-130	1	25	
cis-1,2-Dichloroethene	9.00		ug/L	10.00		90	70-130	0.3	25	
Tetrachloroethene	9.44		ug/L	10.00		94	70-130	3	25	
Trichloroethene	9.16		ug/L	10.00		92	70-130	3	25	
Vinyl Chloride	8.18		ug/L	10.00		82	70-130	0.4	25	
Surrogate: 1,2-Dichloroethane-d4	0.0238		mg/L	0.02500		95	70-130			
Surrogate: 1,2-Dichloroethane-d4	0.0238		mg/L	0.02500		95	70-130			
Surrogate: 4-Bromofluorobenzene	0.0256		mg/L	0.02500		102	70-130			
Surrogate: 4-Bromofluorobenzene	0.0256		mg/L	0.02500		102	70-130			
Surrogate: Dibromofluoromethane	0.0260		mg/L	0.02500		104	70-130			



CERTIFICATE OF ANALYSIS

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801362

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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8260B Volatile Organic Compounds

**Batch CA82219 - 5030B**

Surrogate: Dibromofluoromethane	0.0260		mg/L	0.02500		104	70-130			
Surrogate: Toluene-d8	0.0259		mg/L	0.02500		104	70-130			
Surrogate: Toluene-d8	0.0259		mg/L	0.02500		104	70-130			

**Matrix Spike Source: 1801362-10**

1,1,1-Trichloroethane	9.30		ug/L	10.00	0.220	91	70-130			
1,1-Dichloroethane	8.67		ug/L	10.00	0.00	87	70-130			
1,1-Dichloroethene	9.68		ug/L	10.00	0.00	97	70-130			
cis-1,2-Dichloroethene	10.0		ug/L	10.00	0.340	97	70-130			
Tetrachloroethene	32.7		ug/L	10.00	20.6	121	70-130			
Trichloroethene	45.6		ug/L	10.00	41.4	42	70-130			M-
Vinyl Chloride	8.71		ug/L	10.00	0.00	87	70-130			
Surrogate: 1,2-Dichloroethane-d4	0.0239		mg/L	0.02500		96	70-130			
Surrogate: 1,2-Dichloroethane-d4	0.0239		mg/L	0.02500		96	70-130			
Surrogate: 4-Bromofluorobenzene	0.0252		mg/L	0.02500		101	70-130			
Surrogate: 4-Bromofluorobenzene	0.0252		mg/L	0.02500		101	70-130			
Surrogate: Dibromofluoromethane	0.0260		mg/L	0.02500		104	70-130			
Surrogate: Dibromofluoromethane	0.0260		mg/L	0.02500		104	70-130			
Surrogate: Toluene-d8	0.0256		mg/L	0.02500		103	70-130			
Surrogate: Toluene-d8	0.0256		mg/L	0.02500		103	70-130			

**Matrix Spike Dup Source: 1801362-10**

1,1,1-Trichloroethane	9.67		ug/L	10.00	0.220	94	70-130	4	30	
1,1-Dichloroethane	8.20		ug/L	10.00	0.00	82	70-130	6	30	
1,1-Dichloroethene	9.39		ug/L	10.00	0.00	94	70-130	3	30	
cis-1,2-Dichloroethene	9.42		ug/L	10.00	0.340	91	70-130	6	30	
Tetrachloroethene	30.1		ug/L	10.00	20.6	94	70-130	8	30	
Trichloroethene	43.7		ug/L	10.00	41.4	22	70-130	4	30	M-
Vinyl Chloride	8.41		ug/L	10.00	0.00	84	70-130	4	30	
Surrogate: 1,2-Dichloroethane-d4	0.0234		mg/L	0.02500		94	70-130			
Surrogate: 1,2-Dichloroethane-d4	0.0234		mg/L	0.02500		94	70-130			
Surrogate: 4-Bromofluorobenzene	0.0248		mg/L	0.02500		99	70-130			
Surrogate: 4-Bromofluorobenzene	0.0248		mg/L	0.02500		99	70-130			
Surrogate: Dibromofluoromethane	0.0254		mg/L	0.02500		101	70-130			
Surrogate: Dibromofluoromethane	0.0254		mg/L	0.02500		101	70-130			
Surrogate: Toluene-d8	0.0261		mg/L	0.02500		104	70-130			
Surrogate: Toluene-d8	0.0261		mg/L	0.02500		104	70-130			

**Batch CA82420 - 5030B**

**Blank**

1,1,1-Trichloroethane	ND	0.0010	mg/L							
1,1-Dichloroethane	ND	0.0010	mg/L							
1,1-Dichloroethene	ND	0.0010	mg/L							
cis-1,2-Dichloroethene	ND	0.0010	mg/L							
Tetrachloroethene	ND	0.0010	mg/L							
Trichloroethene	ND	0.0010	mg/L							
Vinyl Chloride	ND	0.0010	mg/L							



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler

Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801362

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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8260B Volatile Organic Compounds

**Batch CA82420 - 5030B**

Surrogate: 1,2-Dichloroethane-d4	0.0205		mg/L	0.02500		82	70-130			
Surrogate: 4-Bromofluorobenzene	0.0258		mg/L	0.02500		103	70-130			
Surrogate: Dibromofluoromethane	0.0225		mg/L	0.02500		90	70-130			
Surrogate: Toluene-d8	0.0244		mg/L	0.02500		98	70-130			

**LCS**

1,1,1-Trichloroethane	8.80		ug/L	10.00		88	70-130			
1,1-Dichloroethane	9.69		ug/L	10.00		97	70-130			
1,1-Dichloroethene	9.97		ug/L	10.00		100	70-130			
cis-1,2-Dichloroethene	10.0		ug/L	10.00		100	70-130			
Tetrachloroethene	10.2		ug/L	10.00		102	70-130			
Trichloroethene	9.75		ug/L	10.00		98	70-130			
Vinyl Chloride	9.10		ug/L	10.00		91	70-130			

Surrogate: 1,2-Dichloroethane-d4	0.0221		mg/L	0.02500		88	70-130			
Surrogate: 4-Bromofluorobenzene	0.0264		mg/L	0.02500		106	70-130			
Surrogate: Dibromofluoromethane	0.0251		mg/L	0.02500		100	70-130			
Surrogate: Toluene-d8	0.0273		mg/L	0.02500		109	70-130			

**LCS Dup**

1,1,1-Trichloroethane	8.60		ug/L	10.00		86	70-130	2	25	
1,1-Dichloroethane	9.67		ug/L	10.00		97	70-130	0.2	25	
1,1-Dichloroethene	10.0		ug/L	10.00		100	70-130	0.7	25	
cis-1,2-Dichloroethene	9.67		ug/L	10.00		97	70-130	3	25	
Tetrachloroethene	9.71		ug/L	10.00		97	70-130	5	25	
Trichloroethene	9.44		ug/L	10.00		94	70-130	3	25	
Vinyl Chloride	8.36		ug/L	10.00		84	70-130	8	25	

Surrogate: 1,2-Dichloroethane-d4	0.0232		mg/L	0.02500		93	70-130			
Surrogate: 4-Bromofluorobenzene	0.0255		mg/L	0.02500		102	70-130			
Surrogate: Dibromofluoromethane	0.0258		mg/L	0.02500		103	70-130			
Surrogate: Toluene-d8	0.0266		mg/L	0.02500		106	70-130			

**Batch CA82627 - 5030B**

**Blank**

1,1,1-Trichloroethane	ND	0.0010	mg/L							
1,1-Dichloroethane	ND	0.0010	mg/L							
1,1-Dichloroethene	ND	0.0010	mg/L							
cis-1,2-Dichloroethene	ND	0.0010	mg/L							
Tetrachloroethene	ND	0.0010	mg/L							
Trichloroethene	ND	0.0010	mg/L							
Vinyl Chloride	ND	0.0010	mg/L							

Surrogate: 1,2-Dichloroethane-d4	0.0292		mg/L	0.02500		117	70-130			
Surrogate: 4-Bromofluorobenzene	0.0223		mg/L	0.02500		89	70-130			
Surrogate: Dibromofluoromethane	0.0286		mg/L	0.02500		114	70-130			
Surrogate: Toluene-d8	0.0256		mg/L	0.02500		102	70-130			



CERTIFICATE OF ANALYSIS

Client Name: AMEC Foster Wheeler

Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801362

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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8260B Volatile Organic Compounds

Batch CA82627 - 5030B

LCS

1,1,1-Trichloroethane	11.1		ug/L	10.00		111	70-130			
1,1-Dichloroethane	10.8		ug/L	10.00		108	70-130			
1,1-Dichloroethene	10.4		ug/L	10.00		104	70-130			
cis-1,2-Dichloroethene	10.1		ug/L	10.00		101	70-130			
Tetrachloroethene	8.40		ug/L	10.00		84	70-130			
Trichloroethene	10.5		ug/L	10.00		105	70-130			
Vinyl Chloride	11.5		ug/L	10.00		115	70-130			
Surrogate: 1,2-Dichloroethane-d4	0.0267		mg/L	0.02500		107	70-130			
Surrogate: 4-Bromofluorobenzene	0.0236		mg/L	0.02500		94	70-130			
Surrogate: Dibromofluoromethane	0.0271		mg/L	0.02500		108	70-130			
Surrogate: Toluene-d8	0.0252		mg/L	0.02500		101	70-130			

LCS Dup

1,1,1-Trichloroethane	10.9		ug/L	10.00		109	70-130	2	25	
1,1-Dichloroethane	10.8		ug/L	10.00		108	70-130	0.3	25	
1,1-Dichloroethene	10.2		ug/L	10.00		102	70-130	3	25	
cis-1,2-Dichloroethene	10.2		ug/L	10.00		102	70-130	0.7	25	
Tetrachloroethene	8.05		ug/L	10.00		80	70-130	4	25	
Trichloroethene	10.7		ug/L	10.00		107	70-130	2	25	
Vinyl Chloride	11.2		ug/L	10.00		112	70-130	2	25	
Surrogate: 1,2-Dichloroethane-d4	0.0263		mg/L	0.02500		105	70-130			
Surrogate: 4-Bromofluorobenzene	0.0234		mg/L	0.02500		94	70-130			
Surrogate: Dibromofluoromethane	0.0270		mg/L	0.02500		108	70-130			
Surrogate: Toluene-d8	0.0252		mg/L	0.02500		101	70-130			



**ESS Laboratory**

*Division of Thielsch Engineering, Inc.*

**BAL Laboratory**

*The Microbiology Division  
of Thielsch Engineering, Inc.*



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler

Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801362

**Notes and Definitions**

- U Analyte included in the analysis, but not detected
- M- Matrix Spike recovery is below lower control limit (M-).
- D Diluted.
- ND Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
- dry Sample results reported on a dry weight basis
- RPD Relative Percent Difference
- MDL Method Detection Limit
- MRL Method Reporting Limit
- LOD Limit of Detection
- LOQ Limit of Quantitation
- DL Detection Limit
- I/V Initial Volume
- F/V Final Volume
- § Subcontracted analysis; see attached report
- 1 Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
- 2 Range result excludes concentrations of target analytes eluting in that range.
- 3 Range result excludes the concentration of the C9-C10 aromatic range.
- Avg Results reported as a mathematical average.
- NR No Recovery
- [CALC] Calculated Analyte
- SUB Subcontracted analysis; see attached report
- RL Reporting Limit
- EDL Estimated Detection Limit



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler

Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1801362

**ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS**

**ENVIRONMENTAL**

Rhode Island Potable and Non Potable Water: LAI00179

<http://www.health.ri.gov/find/labs/analytical/ESS.pdf>

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750

[http://www.ct.gov/dph/lib/dph/environmental\\_health/environmental\\_laboratories/pdf/OutofStateCommercialLaboratories.pdf](http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf)

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002

<http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml>

Massachusetts Potable and Non Potable Water: M-RI002

<http://public.dep.state.ma.us/Labcert/Labcert.aspx>

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424

<http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm>

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313

<http://www.wadsworth.org/labcert/elap/comm.html>

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006

[http://datamine2.state.nj.us/DEP\\_OPRa/OpraMain/pi\\_main?mode=pi\\_by\\_site&sort\\_order=PI\\_NAMEA&Select+a+Site:=58715](http://datamine2.state.nj.us/DEP_OPRa/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715)

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752

<http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx>



pg 1 of 2

**ESS Laboratory**

Division of Thielsch Engineering, Inc.  
 185 Frances Avenue, Cranston RI 02910  
 Tel. (401) 461-7181 Fax (401) 461-4486  
 www.esslaboratory.com

**CHAIN OF CUSTODY**

Turn Time: 5-Day  Rush   
 Regulatory State:   
 Is this project for any of the following?  
 OCT RCP  OMA MCP  Other

Company Name: Amec Foster Wheeler  
 Contact Person: Danase King  
 Project # 363112068  
 Project Name: Texton Gashum

City: Chelmsford State: MA  
 Zip Code: 01824  
 Email Address: Mark.Culley@multiple.com

ESS Lab # 1801362

Reporting Limits: RIDEM  
 Limit Checker  
 Other (Please Specify ->) See pg  
 Standard Excel

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample #	Analysis
1	11/18/18	0750	water	GW	MW-226S	X
2	11/18/18	835	water	GW	MW-226D	X
3	11/18/18	850	water	GW	MW-224S	X
4	11/18/18	900	water	GW	MW-223S 2, 2, 3, 5	X
5	11/18/18	1415	water	GW	MW-234D	X
6	11/18/18	1205	water	GW	MW-227D	X
7	11/18/18	1430	water	GW	MW-234S	X
8	11/18/18	1420	water	GW	MW-202D	X
9	11/18/18	1555	water	GW	MW-207S	X
10	11/19/18	840	water	GW	MW-206S (run in MSD)	X

Container Type: AC-Air Cassette AG-Amber Glass B-BCD Bottle C-Cubittainer G-Glass J-Jar  
 Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VQA 8-Other  
 Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-Na2S2O3 8-Zn-Ace, NaO

Cooler Present: Yes  
 Seals Intact: MA  
 Cooler Temperature: 5.9 °C AKC

Relinquished by: (Signature, Date & Time) [Signature] 1/19/18 15:47  
 Received by: (Signature, Date & Time) [Signature] 1/19/18 15:47

Relinquished by: (Signature, Date & Time) \_\_\_\_\_  
 Received by: (Signature, Date & Time) \_\_\_\_\_

PS 2 STD

**ESS Laboratory**

Division of Thielsch Engineering, Inc.  
 185 Frances Avenue, Cranston RI 02910  
 Tel. (401) 461-7181 Fax (401) 461-4486  
 www.esslaboratory.com

**CHAIN OF CUSTODY**

Turn Time: 5-Day  Rush   
 Regulatory State: OCT RCP  OMA MCP  Other   
 Is this project for any of the following?  
 Project # 365117006  
 Project Name: Tecton/Gochum  
 Address: 271 Mill Rd  
 Zip Code: 01821  
 PO #  
 Email Address: H-b. Gochum

ESS Lab # **K601362**

Reporting Limits: **RIDEW**  
 Electronic Deliverables:  Limit Checker   
 Other (Please Specify →)  Standard Excel

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis
11	1/14/18	1010	water	GW	<del>MW-202D</del> MW-206D (hdm 1/22/18)	X
12	1/14/18	1110	water	GW	MW-218P	X
13	1/14/18	1225	water	GW	MW-218S	X
14	1/14/18	1205	water	GW	MW-231S	X
15	1/14/18	1415	water	GW	MW-231D	X
16	1/14/18	1350	water	GW	MW-232S	X
17	1/14/18	1455	water	GW	<del>MW-232D</del> MW-232D	X
18	1/14/18	-	water	GW	Dup-03	X
19	1/14/18	-	water	TD	Trp blank-c1	X

Container Type	AC-Air Cassette	AG-Amber Glass	B-BOD Bottle	C-Cubitainer	G-Glass	D-Other	P-Poly	S-Sterile	V-Vial		
Container Volume:	1-100 mL	2-2.5 gal	3-250 mL	4-300 mL	5-500 mL	6-1L	7-VOA	8-oz	9-4 oz	10-8 oz	11-Other*
Preservation Code:	1-Non Preserved	2-HCl	3-H2SO4	4-HNO3	5-NaOH	6-Methanol	7-Na2S2O3	8-ZnAc2	9-NaOH	10-DI H2O	11-Other*
Number of Containers per Sample: <b>3</b>											

**Laboratory Use Only**

Cooler Present: Yes  
 Seals Intact: N/A  
 Cooler Temperature: 5.7 °C 100 Q

Sampled by: Mark Massie / Jacob Poirier  
 Comments: See page 1 comments  
 Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time) Jacob Poirier 1/19/18 15:47 Received By: (Signature, Date & Time) \_\_\_\_\_  
 Relinquished by: (Signature, Date & Time) \_\_\_\_\_ Received By: (Signature, Date & Time) \_\_\_\_\_

PS 1 072

# ESS Laboratory

Division of Thielsch Engineering, Inc.  
 185 Frances Avenue, Cranston RI 02910  
 Tel. (401) 461-7181 Fax (401) 461-4486  
 www.esslaboratory.com

## CHAIN OF CUSTODY

Turn Time: 5-Day          Rush  
 Regulatory State:           
 Is this project for any of the follow:  
 OCT RCP  MA MCP  Other

Company Name: Amec Foster Wheeler  
 Contact Person: Denise King  
 Project #: 365117066  
 Project Name: Texton Gashorn

City: Chelmsford State: MA Zip Code: 01821 PO #:  
 Telephone Number: 978-692-9690 FAX Number:          Email Address:         

ESS Lab # 1801362

Reporting Limits: RIDEM  
 Electronic Deliverables:  Limit Checker  Standard Excel  
 Other (Please Specify ->) Selfy

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample	Analysis
1	11/18/18	0750	water	AW	MW-226S	X
2	11/18/18	835	water	AW	MW-226D	X
3	11/18/18	850	water	AW	MW-224S	X
4	11/18/18	900	water	AW	MW-223S	X
5	11/18/18	1415	water	AW	MW-234D	X
6	11/18/18	1205	water	AW	MW-227D	X
7	11/18/18	1730	water	AW	MW-234S	X
8	11/18/18	1720	water	AW	MW-202D	X
9	11/18/18	1555	water	AW	MW-202S	X
10	11/18/18	840	water	AW	MW-206S (run ms/msd)	X

Container Type: AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer G-Glass J-JOZ  
 Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VDA 8-10Z  
 Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-Na2S2O3 8-ZnAcce, NaO  
 Number:          containers per Sample: 3

Laboratory Use Only  
 Cooler Present: Yes  
 Seals Intact: NA  
 Cooler Temperature: 5.9 °C AKR  
 Sampled by: Mark Messinger / Jacob Poire  
 Comments: Please specify "Other" preservative and containers used in this space  
Please Report (1,1-DCA), (1,1-DCE), (1,1,1-TCA), (1,1,1-TCE) (PCE) and (VOC)

Relinquished by: (Signature, Date & Time) Jacob Poire 1/19/18 15:47 Relinquished By: (Signature, Date & Time)  
 Received by: (Signature, Date & Time)          Received By: (Signature, Date & Time)

PS 2 of 2

**ESS Laboratory**

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 Tel. (401) 461-7181 Fax (401) 461-4486  
 www.esslaboratory.com

**CHAIN OF CUSTODY**

Turn Time: 5 Day Rush   
 Regulatory State: RI  
 Is this project for any of the following?:  
 OCT RCP  OMA MCP  Other  
 Project # 365117006 Project Name Texton Gochum  
 Address 271 M. 11 Rd PO #   
 State MA Zip Code 01827  
 FAX Number  Email Address h-b.61@texton.com

ESS Lab # 1801362  
 Reporting Limits RIDEM  
 Electronic Deliverables  Limit Checker   
 Other (Please Specify ->)

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis
11	1/14/18	1010	water	GW	MW-202D	X
12	1/14/18	1110	water	GW	MW-218P	X
13	1/14/18	1225	water	GW	MW-218S	X
14	1/14/18	1205	water	GW	MW-231S	X
15	1/14/18	1415	water	GW	MW-231D	X
16	1/14/18	1350	water	GW	MW-232S	X
17	1/14/18	1455	water	GW	<del>MW-232D</del>	X
18	1/14/18	-	water	GW	Dup-03	X
19	1/14/18	-	water	TD	TRP-blk-01	X

Container Type: AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer G-Glass J-Other P-Poly S-Sterile V-Vial  
 Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-oz 9-4 oz 10-8 oz 11-Other\*  
 Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-Na2S2O3 8-ZnAcAc, NaOH 9-NH4Cl 10-DI H2O 11-Other\*  
 Number of Containers per Sample: 3

Laboratory Use Only  
 Cooler Present: Yes  
 Seals Intact: N/A  
 Cooler Temperature: 5.7 °C 100 g  
 Sampled by: Mark Messinger Jacob Poirier  
 Comments: See page 1 comments

Relinquished by (Signature, Date & Time): Jacob Poirier 1/19/18 15:47  
 Received By (Signature, Date & Time): [Signature] 1/19/18 15:48  
 Relinquished by (Signature, Date & Time):   
 Received By (Signature, Date & Time):

**APPENDIX G**  
**Laboratory Analytical Report (April 2018 Round)**

## CERTIFICATE OF ANALYSIS

Reviewed 04/26/2018

Denise King  
AMEC Foster Wheeler  
271 Mill Road  
Chelmsford, MA 01824Elizabeth Penta  
Wood. PLC**RE: Textron Gorham - Groundwater (3651170068)****ESS Laboratory Work Order Number: 1804477**

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard  
Laboratory Director**REVIEWED****By ESS Laboratory at 2:55 pm, Apr 25, 2018****Analytical Summary**

The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1804477

**SAMPLE RECEIPT**

The following samples were received on April 18, 2018 for the analyses specified on the enclosed Chain of Custody Record.

<b>Lab Number</b>	<b>Sample Name</b>	<b>Matrix</b>	<b>Analysis</b>
1804477-01	MW-218D	Ground Water	8260B
1804477-02	MW-218S	Ground Water	8260B
1804477-03	DUP-01	Ground Water	8260B
1804477-04	Trip Blank	Aqueous	8260B

CERTIFICATE OF ANALYSIS

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1804477

PROJECT NARRATIVE

**8260B Volatile Organic Compounds**

CD81929-MS1 [Due to high target values, matrix spike analyte\(s\) is masked \(MT\).](#)  
Tetrachloroethene (-63700% @ 70-130%)

CD81929-MS1 [Matrix Spike recovery is below lower control limit \(M-\).](#)  
Trichloroethene (-60% @ 70-130%)

CD81929-MS1 [Reported above the quantitation limit; Estimated value \(E\).](#)  
Tetrachloroethene

CD81929-MSD1 [Due to high target values, matrix spike analyte\(s\) is masked \(MT\).](#)  
Tetrachloroethene (-63600% @ 70-130%)

CD81929-MSD1 [Matrix Spike recovery is below lower control limit \(M-\).](#)  
Trichloroethene (-71% @ 70-130%)

CD81929-MSD1 [Reported above the quantitation limit; Estimated value \(E\).](#)  
Tetrachloroethene

No other observations noted.

End of Project Narrative.

DATA USABILITY LINKS

*To ensure you are viewing the most current version of the documents below, please clear your internet cookies for [www.ESSLaboratory.com](http://www.ESSLaboratory.com). Consult your IT Support personnel for information on how to clear your internet cookies.*

[Definitions of Quality Control Parameters](#)

[Semivolatile Organics Internal Standard Information](#)

[Semivolatile Organics Surrogate Information](#)

[Volatile Organics Internal Standard Information](#)

[Volatile Organics Surrogate Information](#)

[EPH and VPH Alkane Lists](#)



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1804477

**CURRENT SW-846 METHODOLOGY VERSIONS**

**Analytical Methods**

- 1010A - Flashpoint
- 6010C - ICP
- 6020A - ICP MS
- 7010 - Graphite Furnace
- 7196A - Hexavalent Chromium
- 7470A - Aqueous Mercury
- 7471B - Solid Mercury
- 8011 - EDB/DBCP/TCP
- 8015C - GRO/DRO
- 8081B - Pesticides
- 8082A - PCB
- 8100M - TPH
- 8151A - Herbicides
- 8260B - VOA
- 8270D - SVOA
- 8270D SIM - SVOA Low Level
- 9014 - Cyanide
- 9038 - Sulfate
- 9040C - Aqueous pH
- 9045D - Solid pH (Corrosivity)
- 9050A - Specific Conductance
- 9056A - Anions (IC)
- 9060A - TOC
- 9095B - Paint Filter
- MADEP 04-1.1 - EPH / VPH

**Prep Methods**

- 3005A - Aqueous ICP Digestion
- 3020A - Aqueous Graphite Furnace / ICP MS Digestion
- 3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
- 3060A - Solid Hexavalent Chromium Digestion
- 3510C - Separatory Funnel Extraction
- 3520C - Liquid / Liquid Extraction
- 3540C - Manual Soxhlet Extraction
- 3541 - Automated Soxhlet Extraction
- 3546 - Microwave Extraction
- 3580A - Waste Dilution
- 5030B - Aqueous Purge and Trap
- 5030C - Aqueous Purge and Trap
- 5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-218D  
 Date Sampled: 04/18/18 09:35  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1804477  
 ESS Laboratory Sample ID: 1804477-01  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	0.0020 (0.0010)		8260B		1	04/19/18 16:34	C8D0338	CD81929
1,1-Dichloroethane	ND (0.0010)		8260B		1	04/19/18 16:34	C8D0338	CD81929
1,1-Dichloroethene	0.0026 (0.0010)		8260B		1	04/19/18 16:34	C8D0338	CD81929
cis-1,2-Dichloroethene	0.0114 (0.0010)		8260B		1	04/19/18 16:34	C8D0338	CD81929
Tetrachloroethene	7.94 (0.500)		8260B		500	04/20/18 16:58	C8D0338	CD81929
Trichloroethene	0.0791 (0.0010)		8260B		1	04/19/18 16:34	C8D0338	CD81929
Vinyl Chloride	ND (0.0010)		8260B		1	04/19/18 16:34	C8D0338	CD81929

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	111 %		70-130
<i>Surrogate: 4-Bromofluorobenzene</i>	104 %		70-130
<i>Surrogate: Dibromofluoromethane</i>	106 %		70-130
<i>Surrogate: Toluene-d8</i>	97 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: MW-218S  
 Date Sampled: 04/18/18 10:35  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1804477  
 ESS Laboratory Sample ID: 1804477-02  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)		8260B		1	04/19/18 17:01	C8D0338	CD81929
1,1-Dichloroethane	ND (0.0010)		8260B		1	04/19/18 17:01	C8D0338	CD81929
1,1-Dichloroethene	ND (0.0010)		8260B		1	04/19/18 17:01	C8D0338	CD81929
cis-1,2-Dichloroethene	ND (0.0010)		8260B		1	04/19/18 17:01	C8D0338	CD81929
<b>Tetrachloroethene</b>	<b>0.127</b> (0.0100)		8260B		10	04/20/18 16:32	C8D0338	CD81929
Trichloroethene	ND (0.0010)		8260B		1	04/19/18 17:01	C8D0338	CD81929
Vinyl Chloride	ND (0.0010)		8260B		1	04/19/18 17:01	C8D0338	CD81929

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	111 %		70-130
<i>Surrogate: 4-Bromofluorobenzene</i>	105 %		70-130
<i>Surrogate: Dibromofluoromethane</i>	105 %		70-130
<i>Surrogate: Toluene-d8</i>	98 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: DUP-01  
 Date Sampled: 04/18/18 00:00  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1804477  
 ESS Laboratory Sample ID: 1804477-03  
 Sample Matrix: Ground Water  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	0.0023 (0.0010)		8260B		1	04/19/18 17:27	C8D0338	CD81929
1,1-Dichloroethane	ND (0.0010)		8260B		1	04/19/18 17:27	C8D0338	CD81929
1,1-Dichloroethene	0.0026 (0.0010)		8260B		1	04/19/18 17:27	C8D0338	CD81929
cis-1,2-Dichloroethene	0.0127 (0.0010)		8260B		1	04/19/18 17:27	C8D0338	CD81929
Tetrachloroethene	7.74 (0.500)		8260B		500	04/20/18 17:24	C8D0338	CD81929
Trichloroethene	0.0859 (0.0010)		8260B		1	04/19/18 17:27	C8D0338	CD81929
Vinyl Chloride	ND (0.0010)		8260B		1	04/19/18 17:27	C8D0338	CD81929

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	114 %		70-130
<i>Surrogate: 4-Bromofluorobenzene</i>	102 %		70-130
<i>Surrogate: Dibromofluoromethane</i>	108 %		70-130
<i>Surrogate: Toluene-d8</i>	92 %		70-130



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
 Client Project ID: Textron Gorham - Groundwater  
 Client Sample ID: Trip Blank  
 Date Sampled: 04/18/18 00:00  
 Percent Solids: N/A  
 Initial Volume: 5  
 Final Volume: 5  
 Extraction Method: 5030B

ESS Laboratory Work Order: 1804477  
 ESS Laboratory Sample ID: 1804477-04  
 Sample Matrix: Aqueous  
 Units: mg/L  
 Analyst: MD

**8260B Volatile Organic Compounds**

<u>Analyte</u>	<u>Results (MRL)</u>	<u>MDL</u>	<u>Method</u>	<u>Limit</u>	<u>DF</u>	<u>Analyzed</u>	<u>Sequence</u>	<u>Batch</u>
1,1,1-Trichloroethane	ND (0.0010)	0.0002	8260B		1	04/19/18 15:42	C8D0338	CD81929
1,1-Dichloroethane	ND (0.0010)	0.0002	8260B		1	04/19/18 15:42	C8D0338	CD81929
1,1-Dichloroethene	ND (0.0010)	0.0003	8260B		1	04/19/18 15:42	C8D0338	CD81929
cis-1,2-Dichloroethene	ND (0.0010)	0.0002	8260B		1	04/19/18 15:42	C8D0338	CD81929
Tetrachloroethene	ND (0.0010)	0.0002	8260B		1	04/19/18 15:42	C8D0338	CD81929
Trichloroethene	ND (0.0010)	0.0002	8260B		1	04/19/18 15:42	C8D0338	CD81929
Vinyl Chloride	ND (0.0010)	0.0002	8260B		1	04/19/18 15:42	C8D0338	CD81929

	<i>%Recovery</i>	<i>Qualifier</i>	<i>Limits</i>
<i>Surrogate: 1,2-Dichloroethane-d4</i>	109 %		70-130
<i>Surrogate: 4-Bromofluorobenzene</i>	106 %		70-130
<i>Surrogate: Dibromofluoromethane</i>	106 %		70-130
<i>Surrogate: Toluene-d8</i>	99 %		70-130



CERTIFICATE OF ANALYSIS

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1804477

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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8260B Volatile Organic Compounds

**Batch CD81929 - 5030B**

**Blank**

1,1,1-Trichloroethane	ND	0.0010	mg/L							
1,1-Dichloroethane	ND	0.0010	mg/L							
1,1-Dichloroethene	ND	0.0010	mg/L							
cis-1,2-Dichloroethene	ND	0.0010	mg/L							
Tetrachloroethene	ND	0.0010	mg/L							
Trichloroethene	ND	0.0010	mg/L							
Vinyl Chloride	ND	0.0010	mg/L							
Surrogate: 1,2-Dichloroethane-d4	0.0261		mg/L	0.02500		104	70-130			
Surrogate: 1,2-Dichloroethane-d4	0.0261		mg/L	0.02500		104	70-130			
Surrogate: 4-Bromofluorobenzene	0.0259		mg/L	0.02500		104	70-130			
Surrogate: 4-Bromofluorobenzene	0.0259		mg/L	0.02500		104	70-130			
Surrogate: Dibromofluoromethane	0.0249		mg/L	0.02500		100	70-130			
Surrogate: Dibromofluoromethane	0.0249		mg/L	0.02500		100	70-130			
Surrogate: Toluene-d8	0.0240		mg/L	0.02500		96	70-130			
Surrogate: Toluene-d8	0.0240		mg/L	0.02500		96	70-130			

**LCS**

1,1,1-Trichloroethane	10.7		ug/L	10.00		107	70-130			
1,1-Dichloroethane	11.5		ug/L	10.00		115	70-130			
1,1-Dichloroethene	11.7		ug/L	10.00		117	70-130			
cis-1,2-Dichloroethene	10.6		ug/L	10.00		106	70-130			
Tetrachloroethene	8.37		ug/L	10.00		84	70-130			
Trichloroethene	11.0		ug/L	10.00		110	70-130			
Vinyl Chloride	11.0		ug/L	10.00		110	70-130			
Surrogate: 1,2-Dichloroethane-d4	0.0280		mg/L	0.02500		112	70-130			
Surrogate: 1,2-Dichloroethane-d4	0.0280		mg/L	0.02500		112	70-130			
Surrogate: 4-Bromofluorobenzene	0.0259		mg/L	0.02500		103	70-130			
Surrogate: 4-Bromofluorobenzene	0.0259		mg/L	0.02500		103	70-130			
Surrogate: Dibromofluoromethane	0.0257		mg/L	0.02500		103	70-130			
Surrogate: Dibromofluoromethane	0.0257		mg/L	0.02500		103	70-130			
Surrogate: Toluene-d8	0.0244		mg/L	0.02500		98	70-130			
Surrogate: Toluene-d8	0.0244		mg/L	0.02500		98	70-130			

**LCS Dup**

1,1,1-Trichloroethane	10.3		ug/L	10.00		103	70-130	4	25	
1,1-Dichloroethane	11.3		ug/L	10.00		113	70-130	2	25	
1,1-Dichloroethene	11.6		ug/L	10.00		116	70-130	0.6	25	
cis-1,2-Dichloroethene	10.7		ug/L	10.00		107	70-130	1	25	
Tetrachloroethene	8.13		ug/L	10.00		81	70-130	3	25	
Trichloroethene	10.8		ug/L	10.00		108	70-130	1	25	
Vinyl Chloride	9.97		ug/L	10.00		100	70-130	10	25	
Surrogate: 1,2-Dichloroethane-d4	0.0281		mg/L	0.02500		112	70-130			
Surrogate: 1,2-Dichloroethane-d4	0.0281		mg/L	0.02500		112	70-130			
Surrogate: 4-Bromofluorobenzene	0.0251		mg/L	0.02500		100	70-130			
Surrogate: 4-Bromofluorobenzene	0.0251		mg/L	0.02500		100	70-130			
Surrogate: Dibromofluoromethane	0.0259		mg/L	0.02500		104	70-130			



CERTIFICATE OF ANALYSIS

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1804477

**Quality Control Data**

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
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8260B Volatile Organic Compounds

**Batch CD81929 - 5030B**

Surrogate: Dibromofluoromethane	0.0259		mg/L	0.02500		104	70-130			
Surrogate: Toluene-d8	0.0241		mg/L	0.02500		96	70-130			
Surrogate: Toluene-d8	0.0241		mg/L	0.02500		96	70-130			

**Matrix Spike Source: 1804477-01**

1,1,1-Trichloroethane	12.7		ug/L	10.00	2.01	107	70-130			
1,1-Dichloroethane	12.4		ug/L	10.00	0.390	120	70-130			
1,1-Dichloroethene	14.0		ug/L	10.00	2.64	114	70-130			
cis-1,2-Dichloroethene	20.7		ug/L	10.00	11.4	93	70-130			
Tetrachloroethene	1570		ug/L	10.00	7940	NR	70-130			E, MT
Trichloroethene	73.1		ug/L	10.00	79.1	NR	70-130			M-
Vinyl Chloride	10.3		ug/L	10.00	0.00	103	70-130			
Surrogate: 1,2-Dichloroethane-d4	0.0301		mg/L	0.02500		120	70-130			
Surrogate: 1,2-Dichloroethane-d4	0.0301		mg/L	0.02500		120	70-130			
Surrogate: 4-Bromofluorobenzene	0.0252		mg/L	0.02500		101	70-130			
Surrogate: 4-Bromofluorobenzene	0.0252		mg/L	0.02500		101	70-130			
Surrogate: Dibromofluoromethane	0.0280		mg/L	0.02500		112	70-130			
Surrogate: Dibromofluoromethane	0.0280		mg/L	0.02500		112	70-130			
Surrogate: Toluene-d8	0.0240		mg/L	0.02500		96	70-130			
Surrogate: Toluene-d8	0.0240		mg/L	0.02500		96	70-130			

**Matrix Spike Dup Source: 1804477-01**

1,1,1-Trichloroethane	12.5		ug/L	10.00	2.01	105	70-130	2	30	
1,1-Dichloroethane	12.1		ug/L	10.00	0.390	117	70-130	3	30	
1,1-Dichloroethene	13.8		ug/L	10.00	2.64	112	70-130	1	30	
cis-1,2-Dichloroethene	20.6		ug/L	10.00	11.4	92	70-130	0.5	30	
Tetrachloroethene	1580		ug/L	10.00	7940	NR	70-130	0.9	30	E, MT
Trichloroethene	72.0		ug/L	10.00	79.1	NR	70-130	1	30	M-
Vinyl Chloride	10.3		ug/L	10.00	0.00	103	70-130	0.1	30	
Surrogate: 1,2-Dichloroethane-d4	0.0294		mg/L	0.02500		118	70-130			
Surrogate: 1,2-Dichloroethane-d4	0.0294		mg/L	0.02500		118	70-130			
Surrogate: 4-Bromofluorobenzene	0.0258		mg/L	0.02500		103	70-130			
Surrogate: 4-Bromofluorobenzene	0.0258		mg/L	0.02500		103	70-130			
Surrogate: Dibromofluoromethane	0.0282		mg/L	0.02500		113	70-130			
Surrogate: Dibromofluoromethane	0.0282		mg/L	0.02500		113	70-130			
Surrogate: Toluene-d8	0.0247		mg/L	0.02500		99	70-130			
Surrogate: Toluene-d8	0.0247		mg/L	0.02500		99	70-130			



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1804477

**Notes and Definitions**

- U Analyte included in the analysis, but not detected
- MT Due to high target values, matrix spike analyte(s) is masked (MT).
- M- Matrix Spike recovery is below lower control limit (M-).
- E Reported above the quantitation limit; Estimated value (E).
- D Diluted.
- ND Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
- dry Sample results reported on a dry weight basis
- RPD Relative Percent Difference
- MDL Method Detection Limit
- MRL Method Reporting Limit
- LOD Limit of Detection
- LOQ Limit of Quantitation
- DL Detection Limit
- I/V Initial Volume
- F/V Final Volume
- § Subcontracted analysis; see attached report
- 1 Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
- 2 Range result excludes concentrations of target analytes eluting in that range.
- 3 Range result excludes the concentration of the C9-C10 aromatic range.
- Avg Results reported as a mathematical average.
- NR No Recovery
- [CALC] Calculated Analyte
- SUB Subcontracted analysis; see attached report
- RL Reporting Limit
- EDL Estimated Detection Limit



*CERTIFICATE OF ANALYSIS*

Client Name: AMEC Foster Wheeler  
Client Project ID: Textron Gorham - Groundwater

ESS Laboratory Work Order: 1804477

**ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS**

**ENVIRONMENTAL**

Rhode Island Potable and Non Potable Water: LAI00179  
<http://www.health.ri.gov/find/labs/analytical/ESS.pdf>

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750  
[http://www.ct.gov/dph/lib/dph/environmental\\_health/environmental\\_laboratories/pdf/OutofStateCommercialLaboratories.pdf](http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf)

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002  
<http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml>

Massachusetts Potable and Non Potable Water: M-RI002  
<http://public.dep.state.ma.us/Labcert/Labcert.aspx>

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424  
<http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm>

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313  
<http://www.wadsworth.org/labcert/elap/comm.html>

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006  
[http://datamine2.state.nj.us/DEP\\_OPRA/OpraMain/pi\\_main?mode=pi\\_by\\_site&sort\\_order=PI\\_NAMEA&Select+a+Site:=58715](http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715)

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752  
<http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx>

## ESS Laboratory Sample and Cooler Receipt Checklist

Client: AMEC Foster Wheeler - KPB/HDM

ESS Project ID: 1804477

Shipped/Delivered Via: Client

Date Received: 4/18/2018

Project Due Date: 4/25/2018

Days for Project: 5 Day

- |  |   |
|--|---|
| <p>1. Air bill manifest present? <input type="checkbox"/> No<br/>Air No.: <u>NA</u></p> <p>2. Were custody seals present? <input type="checkbox"/> No</p> <p>3. Is radiation count &lt;100 CPM? <input type="checkbox"/> Yes</p> <p>4. Is a Cooler Present? <input type="checkbox"/> Yes<br/>Temp: <u>4.7</u> Iced with: <u>Ice</u></p> <p>5. Was COC signed and dated by client? <input type="checkbox"/> Yes</p> | <p>6. Does COC match bottles? <input type="checkbox"/> No</p> <p>7. Is COC complete and correct? <input type="checkbox"/> Yes</p> <p>8. Were samples received intact? <input type="checkbox"/> Yes</p> <p>9. Were labs informed about <u>short holds &amp; rushes</u>? Yes / No <input checked="" type="checkbox"/> NA</p> <p>10. Were any analyses received outside of hold time? Yes <input checked="" type="checkbox"/> No</p> |
|--|---|

- |   |  |
|---|--|
| <p>11. Any Subcontracting needed? Yes / <input checked="" type="checkbox"/> No<br/>ESS Sample IDs: _____<br/>Analysis: _____<br/>TAT: _____</p> | <p>12. Were VOAs received? <input checked="" type="checkbox"/> Yes / No<br/>a. Air bubbles in aqueous VOAs? Yes / <input checked="" type="checkbox"/> No<br/>b. Does methanol cover soil completely? Yes / No / NA</p> |
|---|--|

13. Are the samples properly preserved?  Yes / No
- a. If metals preserved upon receipt: Date: \_\_\_\_\_ Time: \_\_\_\_\_ By: \_\_\_\_\_
- b. Low Level VOA vials frozen: Date: \_\_\_\_\_ Time: \_\_\_\_\_ By: \_\_\_\_\_

Sample Receiving Notes:

**COC = MW-18S ; Labels = MW-218S** wa 4/18/18

14. Was there a need to contact Project Manager?  Yes / No
- a. Was there a need to contact the client?  Yes / No
- Who was contacted? \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_ By: \_\_\_\_\_

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	219436	Yes	No	Yes	VOA Vial - HCl	HCl	
01	219437	Yes	No	Yes	VOA Vial - HCl	HCl	
01	219438	Yes	No	Yes	VOA Vial - HCl	HCl	
01	219439	Yes	No	Yes	VOA Vial - HCl	HCl	
01	219440	Yes	No	Yes	VOA Vial - HCl	HCl	
01	219441	Yes	No	Yes	VOA Vial - HCl	HCl	
01	219442	Yes	No	Yes	VOA Vial - HCl	HCl	
01	219443	Yes	No	Yes	VOA Vial - HCl	HCl	
01	219444	Yes	No	Yes	VOA Vial - HCl	HCl	
02	219433	Yes	No	Yes	VOA Vial - HCl	HCl	
02	219434	Yes	No	Yes	VOA Vial - HCl	HCl	
02	219435	Yes	No	Yes	VOA Vial - HCl	HCl	
03	219430	Yes	No	Yes	VOA Vial - HCl	HCl	
03	219431	Yes	No	Yes	VOA Vial - HCl	HCl	
03	219432	Yes	No	Yes	VOA Vial - HCl	HCl	
04	219427	Yes	No	Yes	VOA Vial - HCl	HCl	

2nd Review  
Are barcode labels on correct containers?  Yes / No

Completed By: DJA Date & Time: 4/18/18 1303

# ESS Laboratory Sample and Cooler Receipt Checklist

Client: AMEC Foster Wheeler - KPB/HDM ESS Project ID: 1804477  
By: [Signature] Date Received: 4/18/2018  
Delivered Date & Time: 4/18/18 14:6  
By: [Signature] 4/18/18 1412



**APPENDIX H**  
**Groundwater Analytical Results Summary (all rounds)**

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1-Trichloroethane	1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride			
Units:		MG/L	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L			
RI GB:		3.1	NS		0.007		2.4		0.15		0.54		NS			
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q		
CW-1	3/31/2004	CW-01	0.016	U	0.022	U	0.14		0.38		0.016	U	2.2		0.04	U
	2/23/2006	CW-01	0.02	U	0.028		0.11		0.36		0.032		5.3		0.02	U
	8/22/2006	CW-01	0.0034		0.03		0.17		0.44	D	0.016		6.4	D	0.0039	
	2/17/2007	CW-1	0.2	U	0.2	U	0.18		0.35		0.2	U	5.9		0.2	U
	8/14/2007	CW-1	0.2	U	0.2	U	0.16		0.41		0.2	U	4.9		0.2	U
	2/7/2008	CW-01	0.04	U	0.04	U	0.18		0.46		0.04	U	5.7		0.04	U
	8/20/2008	CW-1	0.04	U	0.04	U	0.13		0.42		0.04	U	5.5		0.04	U
	2/25/2009	CW-1	0.0005	U	0.0005	U	0.0038		0.012		0.015		0.25		0.0005	U
	8/28/2009	CW-1	0.0005	U	0.0005	U	0.011		0.054		0.0054		0.77		0.0005	U
	2/11/2010	CW-1	0.005	U	0.029		0.28		1		0.005	U	4.8		0.005	U
	8/31/2010	CW-1	0.04	U	0.04	U	0.17		0.32		0.21		2.3		0.04	U
	2/28/2011	CW-1	0.02	U	0.02	U	0.19		0.56		0.02	U	4.3		0.02	U
	8/23/2011	CW-1	0.04	U	0.04	U	0.07		1.6		0.04	U	0.48		0.04	U
	2/9/2012	CW-1	0.02	U	0.02	U	0.13		2.6		0.02		0.042		0.02	U
	8/28/2012	CW-1	0.02	U	0.02	U	0.055		1.1		0.028		0.55		0.02	U
	2/15/2013	CW-1	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	8/13/2013	CW-1	0.0012		0.017		0.11		0.36		0.29		4.7		0.002	U
	11/13/2013	CW-1	0.05	U	0.05	U	0.11		0.36		0.24		4.3		0.1	U
	2/14/2014	CW-1	0.05	U	0.05	U	0.094		0.23		0.05	U	5		0.1	U
	5/2/2014	CW-1	0.05	U	0.05	U	0.05	U	0.16		0.05	U	2.3		0.1	U
	8/22/2014	CW-1	0.0047	U	0.0079	U	0.053		0.17		0.092		3.7		0.0066	U
	11/24/2014	CW-1	0.1	U	0.1	U	0.1	U	0.84		0.1	U	3.6		0.2	U
	3/26/2015	CW-1	0.05	U	0.05	U	0.05	U	0.26		0.05	U	2.5		0.1	U
	5/12/2015	CW-1	0.025	U	0.025	U	0.037		0.16		0.025	U	3.1		0.05	U
	8/5/2015	CW-1	0.025	U	0.025	U	0.025	U	0.14		0.026		3.7		0.05	U
	11/5/2015	CW-1	0.05	U	0.05	U	0.05	U	0.7		0.05	U	2		0.1	U
5/4/2016	CW-1	0.05	U	0.05	U	0.05	U	0.094		0.05	U	1.8		0.1	U	
11/1/2016	CW-1	0.04	U	0.04	U	0.04	U	0.18		0.04	U	3.9		0.08	U	
5/17/2017	CW-1	0.02	U	0.02	U	0.02	U	0.36		0.02	U	0.97		0.04	U	
11/28/2017	CW-1	0.02	U	0.02	U	0.02	U	0.8		0.02	U	0.02	U	0.04	U	
1/16/2018	CW-1	0.001	U	0.0005	U	0.0219		0.119	D	0.0006	U	1.43	D	0.001	U	
CW-2	3/31/2004	CW-02	0.00016	U	0.00022	U	0.00029	U	0.0002	U	0.00016	U	0.0013		0.0004	U

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride		
Units:		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		
RI GB:		3.1		NS		0.007		2.4		0.15		0.54		NS		
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
CW-2	2/23/2006	CW-02	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	8/22/2006	CW-02	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	2/17/2007	CW-2	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	8/14/2007	CW-2	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	2/7/2008	CW-02	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	8/20/2008	CW-2	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	2/25/2009	CW-2	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0086		0.003		0.0005	U
	8/28/2009	CW-2	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U
	2/11/2010	CW-2	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U
	8/31/2010	CW-2	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	2/28/2011	CW-2	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	8/23/2011	CW-2	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	2/9/2012	CW-2	0.13		0.002	U	0.001	U	0.002	U	0.14		0.002	U	0.13	
	8/28/2012	CW-2	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	2/14/2013	CW-2	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	8/13/2013	CW-2	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	11/13/2013	CW-2	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	2/14/2014	CW-2	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	5/2/2014	CW-2	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	8/22/2014	CW-2	9.4E-05	U	0.00016	U	0.00021	U	0.00015	U	8E-05	U	7.7E-05	U	0.00013	U
	11/24/2014	CW-2	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.0014		0.002	U
	3/26/2015	CW-2	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	5/12/2015	CW-2	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
8/5/2015	CW-2	0.001	U	0.001	U	0.001	U	0.001	U	0.0015		0.0027		0.002	U	
11/5/2015	CW -2	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
5/4/2016	CW-2	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
11/1/2016	CW-2	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
5/17/2017	CW-2	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
11/28/2017	CW-2	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
1/16/2018	CW-2	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	
CW-6	3/31/2004	CW-06	0.00016	U	0.0033		0.00029	U	0.0051		0.00051	J	0.0015		0.017	
	9/4/2009	CW-6	0.0005	U	0.0026		0.0005	U	0.0038		0.0005	U	0.0005	U	0.014	

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1-Trichloroethane	1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride			
Units:		MG/L	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L			
RI GB:		3.1	NS		0.007		2.4		0.15		0.54		NS			
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q		
MW-101D	1/4/1995	GMMW101DXX01X X	1.25	U	1.25	U	1.25	U	1.25	U	19.5		1.25	U	2.5	U
	9/28/1995	GMMW101DXX02X X	2.5	U	2.5	U	2.5	U	2.5	U	25.5		2.5	U	5	U
	5/21/1996	MW-101D	1.25	U	1.25	U	1.25	U	1.25	U	29.3		1.25	U	2.5	U
	10/16/1997	MW-101D	0.125	U	0.125	U	0.125	U	0.125	U	28.8		0.125	U	0.25	U
	12/10/1998	MW-101D	0.006		0.002		0.071		0.009		22.9		1.03		0.002	
	12/19/2000	MW-101D	1	U	1	U	1	U	1	U	49.9		1	U	2	U
	3/4/2002	MW-101D	1	U	1	U	1	U	1	U	47		1	U	2	U
	5/8/2002	MW-101D	0.005	U	0.005	U	0.005	U	0.2	U	6.2		0.2	U	0.01	U
	7/8/2002	MW-101D	0.2	U	0.2	U	0.2	U	0.2	U	9.44		0.372		0.4	U
	10/2/2002	MW-101D	0.2	U	0.2	U	0.2	U	0.2	U	5.28		0.2	U	0.4	U
	1/15/2003	MW-101D	0.2	U	0.2	U	0.2	U	0.2	U	9.87		0.2	U	0.2	U
		MW-101D DUP	0.2	U	0.2	U	0.2	U	0.2	U	14.5		0.2	U	0.2	U
	4/2/2003	MW-101D	1	U	1	U	1	U	1	U	41		1	U	1	U
	3/30/2004	MW-101D	0.08	U	0.11	U	0.14	U	0.1	U	28		0.09	U	0.2	U
	11/29/2004	MW-101D	0.001	U	0.001	U	0.001	U	0.001	U	0.017		0.001	U	0.001	U
	2/3/2005	MW-101D	0.1	U	0.1	U	0.1	U	0.1	U	20		0.17		0.1	U
	5/9/2005	MW-101D	0.05	U	0.05	U	0.05	U	0.05	U	1.5		0.05	U	0.05	U
	8/2/2005	MW-101D	0.25	U	0.25	U	0.25	U	0.54		20		0.18	J	0.25	U
	11/28/2005	MW-101D	0.1	U	0.1	U	0.1	U	0.1	U	10		0.086	J	0.1	U
	2/23/2006	MW-101D	0.04	U	0.04	U	0.02	U	0.04	U	9.2		0.11		0.04	U
	5/3/2006	MW-101D	0.002	U	0.002	U	0.001	U	0.0059		0.08		0.006		0.002	U
	8/21/2006	MW-101D	0.2	U	0.2	U	0.1	U	0.43		33	D	0.2	U	0.2	U
	11/28/2006	MW-101D	0.002	U	0.002	U	0.0064		0.13		1.4	D	0.11		0.017	
	2/17/2007	MW-101D	0.02	U	0.02	U	0.011		0.28		19		0.16		0.03	
	5/20/2007	MW-101D	0.02	U	0.02	U	0.01	U	0.02	U	0.3		0.02	U	0.02	U
	8/14/2007	MW-101D	0.008		0.002	U	0.0048		0.61		36		0.29		0.022	
	11/1/2007	MW-101D	0.2	U	0.2	U	0.1	U	1.6		27		0.67		0.2	U
	2/7/2008	MW-101D	0.02	U	0.02	U	0.01	U	0.02	U	2.1		0.02	U	0.02	U
5/6/2008	MW-101D	0.02	U	0.02	U	0.01	U	0.02	U	6.4		0.053		0.02	U	
8/20/2008	MW-101D	0.2	U	0.2	U	0.1	U	0.2	U	28		0.2	U	0.2	U	
11/11/2008	MW-101D	0.05	U	0.05	U	0.05	U	0.05	U	9		0.05	U	0.05	U	

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride		
Units:		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		
RI GB:		3.1		NS		0.007		2.4		0.15		0.54		NS		
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-101D	2/25/2009	MW-101D	0.005	U	0.005	U	0.005	U	0.053		2.3		0.005	U	0.005	U
	8/27/2009	MW-101D	0.005	U	0.005	U	0.005	U	0.005	U	63		0.19		0.005	U
	2/11/2010	MW-101 D	0.005	U	0.005	U	0.005	U	0.005	U	0.89		0.005	U	0.005	U
	8/31/2010	MW-101 D	0.02	U	0.02	U	0.01	U	0.23		7.7		0.17		0.02	U
	2/28/2011	MW 101D	0.02	U	0.02	U	0.01	U	0.02	U	0.57		0.02	U	0.02	U
	8/23/2011	MW-101D	0.02	U	0.02	U	0.01	U	0.02	U	3.8		0.02	U	0.02	U
	2/8/2012	MW-101D	0.02	U	0.02	U	0.01	U	0.02	U	0.49		0.02	U	0.02	U
	8/28/2012	MW-101D	0.02	U	0.02	U	0.01	U	0.2		0.22		0.058		0.02	U
	2/13/2013	MW-101D	0.001	U	0.001	U	0.001	U	0.001	U	0.014		0.001	U	0.002	U
	8/12/2013	MW-101D	0.005	U	0.005	U	0.005	U	0.005	U	0.26		0.0056		0.01	U
	11/12/2013	MW-101D	0.001	U	0.001	U	0.001	U	0.001	U	0.0064		0.001	U	0.002	U
	2/14/2014	MW 101D	0.01	U	0.01	U	0.01	U	0.078		0.66		0.018		0.02	U
	5/1/2014	MW-101D	0.001	U	0.001	U	0.001	U	0.001	U	0.01		0.001	U	0.002	U
	8/22/2014	MW-101D	9.4E-05	U	0.00016	U	0.00021	U	0.0056		0.017		7.7E-05	U	0.00013	U
	11/24/2014	MW-101D	0.001	U	0.001	U	0.001	U	0.001	U	0.0036		0.001	U	0.002	U
	3/26/2015	MW-101D	0.0015		0.001	U	0.0015		0.019		0.28		0.02		0.0032	
	5/12/2015	MW-101D	0.001	U	0.001	U	0.001	U	0.001	U	0.016		0.001	U	0.002	U
	8/5/2015	MW-101D	0.004	U	0.004	U	0.004	U	0.017		0.12		0.006		0.008	U
	11/5/2015	MW 101D	0.002	U	0.002	U	0.002	U	0.0023		2.5		0.015		0.004	U
	5/4/2016	MW-101D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
11/1/2016	MW 101D	0.001	U	0.001	U	0.001	U	0.4		0.42		0.026		0.002	U	
5/16/2017	MW-101D	0.001	U	0.001	U	0.001	U	0.001	U	0.013		0.001	U	0.002	U	
11/27/2017	MW-101D	0.001	U	0.001	U	0.001	U	0.001		0.013		0.001	U	0.002	U	
MW-101S	1/4/1995	GMMW101SXX01XX	0.01	U	0.01	U	0.01	U	0.01	U	0.216		0.01	U	0.02	U
	9/28/1995	GMMW101SXX02XX	2.5	U	2.5	U	2.5	U	2.5	U	33		2.5	U	5	U
	5/21/1996	MW-101S	0.025	U	0.025	U	0.025	U	0.025	U	0.565		0.025	U	0.05	U
		MW-101S (Dup)	0.025	U	0.025	U	0.025	U	0.025	U	0.625		0.025	U	0.05	U
	10/16/1997	MW-101S	0.125	U	0.125	U	0.125	U	0.125	U	21.5		0.125	U	0.25	U
	12/10/1998	MW-101S	0.003		0.001	U	0.001	U	0.001	U	12.4		0.018		0.002	U
	12/19/2000	MW-101S	0.5	U	0.5	U	0.5	U	0.5	U	29.6		0.5	U	1	U
	3/4/2002	MW-101S	2	U	2	U	2	U	2	U	77		2	U	4	U
5/8/2002	MW-101S	0.5	U	0.5	U	0.5	U	0.5	U	16.8		0.5	U	1	U	

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride		
Units:		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		
RI GB:		3.1		NS		0.007		2.4		0.15		0.54		NS		
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-101S	7/8/2002	MW-101S	0.2	U	0.2	U	0.2	U	0.2	U	9.96		0.2	U	0.5	U
	10/2/2002	MW-101S	0.2	U	0.2	U	0.2	U	0.2	U	6.87		0.2	U	0.4	U
	1/15/2003	MW-101S	0.1	U	0.1	U	0.1	U	0.1	U	4.14		0.1	U	0.1	U
	4/2/2003	MW-101S	0.01	U	0.01	U	0.01	U	0.006	J	0.43		0.01	U	0.01	U
	3/30/2004	MW-101S	0.32	U	0.44	U	0.58	U	0.4	U	91		0.36	U	0.8	U
	11/29/2004	MW-101S	0.25	U	0.25	U	0.25	U	0.19	J	16		0.25	U	0.25	U
	2/3/2005	MW-101S	0.2	U	0.2	U	0.2	U	0.2	U	71		0.2	U	0.2	U
		MW-101S DUP	0.2	U	0.2	U	0.2	U	0.11	J	68		0.2	U	0.2	U
	5/9/2005	MW-101S	1	U	1	U	1	U	1	U	60		1	U	1	U
		MW-101S DUP	1	U	1	U	1	U	1	U	55		1	U	1	U
	8/2/2005	MW-101S	1	U	1	U	1	U	0.83	J	67		1	U	1	U
		MW-101S DUP	2.5	U	2.5	U	2.5	U	2.5	U	61		2.5	U	2.5	U
	11/28/2005	MW-101S	0.5	U	0.5	U	0.5	U	0.38	J	42		0.5	U	0.5	U
		MW-101S DUP	0.5	U	0.5	U	0.5	U	0.35	J	46		0.5	U	0.5	U
	2/23/2006	MW-101S	0.02	U	0.02	U	0.01	U	0.17		6		0.053		0.02	U
	5/10/2006	MW-101S	0.002	U	0.002	U	0.001	U	0.66		0.35		0.014		0.0039	
	8/21/2006	MW-101S	0.2	U	0.2	U	0.1	U	1.4		85	D	0.2	U	0.2	U
		MW-101S DUP	0.2	U	0.2	U	0.1	U	1.5		85	D	0.2	U	0.2	U
	11/28/2006	MW-101S	0.0055		0.002	U	0.0018		1	D	46	D	0.1		0.26	
		MW-101S DUP	0.0055		0.002	U	0.0018		1	D	220	D	0.1		0.26	
	2/17/2007	MW-101S	0.2	U	0.2	U	0.1	U	0.51		45		0.2	U	0.52	
		MW-101S DUP	0.2	U	0.2	U	0.1	U	0.5		44		0.2	U	0.46	
	5/20/2007	MW-101S	0.002	U	0.002	U	0.001	U	0.002	U	0.039		0.002	U	0.002	U
		MW-101S DUP	0.002	U	0.002	U	0.001	U	0.002	U	0.049		0.002	U	0.002	U
	8/14/2007	MW-101S	0.0078		0.002	U	0.001	U	0.033		39		0.048		0.002	U
		MW-101S DUP	0.008		0.002	U	0.001	U	0.031		38		0.046		0.002	U
	11/1/2007	MW-101S	0.4	U	0.4	U	0.2	U	0.4	U	38		0.4	U	0.4	U
		MW-101S DUP	0.4	U	0.4	U	0.2	U	0.4	U	39		0.4	U	0.4	U
	2/7/2008	MW-101S	0.02	U	0.02	U	0.01	U	0.02	U	0.63		0.02	U	0.02	U
		MW-101S DUP	0.02	U	0.02	U	0.01	U	0.02	U	0.63		0.02	U	0.02	U
5/6/2008	MW-101S	0.02	U	0.02	U	0.01	U	0.02	U	1.5		0.034		0.02	U	
	MW-101S DUP	0.02	U	0.02	U	0.01	U	0.02	U	1.4		0.032		0.02	U	

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride		
Units:		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		
RI GB:		3.1		NS		0.007		2.4		0.15		0.54		NS		
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-101S	8/20/2008	MW-101S	0.02	U	0.02	U	0.01	U	0.11		45		0.05		0.024	
		MW-101S DUP	0.02	U	0.02	U	0.01	U	0.11		43		0.047		0.025	
	11/11/2008	MW-101S	0.05	U	0.05	U	0.05	U	0.05	U	12		0.05	U	0.05	U
		MW-101S DUP	0.05	U	0.05	U	0.05	U	0.05	U	12		0.05	U	0.05	U
	2/25/2009	MW-101 Dupe	0.005	U	0.005	U	0.005	U	0.16		1.3		0.04		0.005	U
		MW-101S	0.005	U	0.005	U	0.005	U	0.11		1.6		0.031		0.005	U
	8/27/2009	MW-101S	0.0005	U	0.0005	U	0.0005	U	0.096		0.088		0.0049		0.013	
		MW-101S DUP	0.0005	U	0.0005	U	0.0005	U	0.1		0.085		0.005		0.014	
	2/11/2010	MW-101 S	0.0005	U	0.0005	U	0.0005	U	0.016		0.021		0.0005	U	0.002	
		MW-101 S DUP	0.0005	U	0.0005	U	0.0005	U	0.014		0.02		0.0005	U	0.0005	U
	8/31/2010	MW-101 S	0.002	U	0.002	U	0.001	U	0.0047		0.013		0.002	U	0.002	U
		MW-101 S DUP	0.002	U	0.002	U	0.001	U	0.0041		0.015		0.002	U	0.002	U
	2/28/2011	MW-101S	0.002	U	0.002	U	0.001	U	0.011		0.016		0.002	U	0.002	U
		MW-101S DUP	0.002	U	0.002	U	0.001	U	0.0093		0.017		0.002	U	0.002	U
	8/23/2011	MW-101S	0.11		0.002	U	0.077		0.09		0.15		0.095		0.1	
		MW-101S DUP	0.002	U	0.002	U	0.001	U	0.0031		0.033		0.002	U	0.002	U
	2/8/2012	MW-101S	0.002	U	0.002	U	0.001	U	0.014		0.029		0.002	U	0.002	U
		MW-101S Dup	0.002	U	0.002	U	0.001	U	0.012		0.024		0.002	U	0.002	U
	8/28/2012	MW-101S	0.002	U	0.002	U	0.001	U	0.0069		0.045		0.002	U	0.002	U
		MW-101S Dup	0.002	U	0.002	U	0.001	U	0.0073		0.042		0.002	U	0.002	U
	2/13/2013	MW-101S	0.001	U	0.001	U	0.001	U	0.0022		0.0031		0.001	U	0.002	U
		MW-101S DUP	0.001	U	0.001	U	0.001	U	0.0023		0.003		0.001	U	0.002	U
	8/12/2013	MW-101S	0.001	U	0.001	U	0.001	U	0.01		0.025		0.0011		0.002	U
		MW-101S Dup	0.001	U	0.001	U	0.001	U	0.01		0.024		0.001	U	0.002	U
	11/12/2013	MW-101S	0.001	U	0.001	U	0.001	U	0.0048		1.2		0.0016		0.002	U
		MW-101S DUP	0.001	U	0.001	U	0.001	U	0.0064		1		0.0018		0.002	U
	2/14/2014	MW 101S	0.02	U	0.02	U	0.02	U	0.02	U	1.7		0.02	U	0.04	U
		MW 101S Dup	0.02	U	0.02	U	0.02	U	0.02	U	1.8		0.02	U	0.04	U
	5/1/2014	MW-101S	0.001	U	0.001	U	0.001	U	0.001	U	0.01		0.001	U	0.002	U
		MW-101S DUP	0.001	U	0.001	U	0.001	U	0.001	U	0.01		0.001	U	0.002	U
8/22/2014	MW-101S	9.4E-05	U	0.00016	U	0.00021	U	0.11		14		0.016		0.007		
	MW-101S DUP	9.4E-05	U	0.00016	U	0.00021	U	0.11		14		0.017		0.007		

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

		Analyte:	1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride	
		Units:	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L	
		RI GB:	3.1		NS		0.007		2.4		0.15		0.54		NS	
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-101S	11/24/2014	MW-101S	0.001	U	0.001	U	0.001	U	0.001	U	0.0068		0.001	U	0.002	U
		MW-101S DUP	0.001	U	0.001	U	0.001	U	0.001	U	0.0088		0.001	U	0.002	U
	3/26/2015	MW-101S	0.001	U	0.001	U	0.001	U	0.003		0.032		0.001	U	0.002	U
		MW-101S Dup	0.001	U	0.001	U	0.001	U	0.0011		0.032		0.001	U	0.002	U
	5/12/2015	MW-101S	0.001	U	0.001	U	0.001	U	0.067		2.1		0.018		0.002	U
		MW-101S Dup	0.001	U	0.001	U	0.001	U	0.064		1.9		0.019		0.002	U
	8/5/2015	MW-101S	0.001	U	0.001	U	0.001	U	0.24		0.4		0.028		0.002	U
		MW-101S DUP	0.001	U	0.001	U	0.001	U	0.24		0.39		0.028		0.002	U
	11/5/2015	MW 101S	0.005	U	0.005	U	0.005	U	0.011		0.62		0.01		0.01	U
		MW 101S Dup	0.005	U	0.005	U	0.005	U	0.01		0.58		0.0094		0.01	U
	5/4/2016	MW-101S	0.025	U	0.025	U	0.025	U	0.025	U	1.4		0.027		0.05	U
		MW-101S DUP	0.025	U	0.025	U	0.025	U	0.025	U	1.3		0.025	UD	0.05	U
	11/1/2016	MW 101S	0.25	U	0.25	U	0.25	U	0.25	U	24		0.25	U	0.5	U
		MW 101S DUP	0.25	U	0.25	U	0.25	U	0.25	U	24		0.25	U	0.5	U
	5/16/2017	MW-101S	0.25	U	0.25	U	0.25	U	0.25	U	9.2		0.25	U	0.5	U
		MW-101S Dup	0.25	U	0.25	U	0.25	U	0.25	U	8.7		0.25	U	0.5	U
11/27/2017	MW-101S	0.1	U	0.1	U	0.1	U	0.1	U	7.3		0.1	U	0.2	U	
	MW-101S Dup	0.1	U	0.1	U	0.1	U	0.1	U	6.8		0.1	U	0.2	U	
MW-109D	12/29/1994	MW-109	0.005	U	0.005	U	0.005	U	0.005	U	0.005	U	0.005	U	0.01	U
	9/27/1995	GMMW109DXX02X X	0.005	U	0.005	U	0.005	U	0.005	U	0.005	U	0.005	U	0.01	U
	3/1/2007	MW-109D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	8/14/2007	MW-109D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	2/7/2008	MW-109D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	8/20/2008	MW-109D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	2/25/2009	MW-109D	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U
	9/4/2009	MW-109D	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U
	2/11/2010	MW-109 D	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U
	8/31/2010	MW-109 D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	2/28/2011	MW-109D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	8/23/2011	MW-109D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	2/9/2012	MW-109D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
8/28/2012	MW-109D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U	

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride		
Units:		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		
RI GB:		3.1		NS		0.007		2.4		0.15		0.54		NS		
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-109D	2/13/2013	MW-109D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	8/13/2013	MW-109D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	11/13/2013	MW-109D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	3/6/2014	MW-109D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	5/2/2014	MW-109	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	8/22/2014	MW-109D	9.4E-05	U	0.00016	U	0.00021	U	0.00015	U	8E-05	U	7.7E-05	U	0.00013	U
	11/24/2014	MW-109D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	3/26/2015	MW-109D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	5/12/2015	MW109D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	8/5/2015	MW-109D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	11/5/2015	MW 109D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	5/5/2016	MW-109D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	11/2/2016	MW-109D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	5/17/2017	MW-109D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
12/11/2017	MW-109D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
MW-112/CW-3	9/28/1995	GMMW112SXX02XX	0.125	U	0.125	U	0.125	U	0.125	U	2.05		0.125	U	0.25	U
	5/21/1996	MW-112S	0.25	U	0.25	U	0.25	U	0.25	U	4.55		0.25	U	0.5	U
	10/16/1997	MW-112	0.005	U	0.005	U	0.005	U	0.005	U	0.85		0.089		0.01	U
	12/10/1998	MW-112	0.001	U	0.001	U	0.001	U	0.001	U	0.064		0.001	U	0.002	U
	12/19/2000	MW-112	0.5	U	0.5	U	0.5	U	0.5	U	4.68		0.5	U	1	U
	3/4/2002	MW-112	0.05	U	0.05	U	0.05	U	0.05	U	1.5		0.21		0.1	U
	5/8/2002	MW-112	0.05	U	0.05	U	0.05	U	0.05	U	1.97		0.208		0.1	U
	7/8/2002	MW-112	0.05	U	0.05	U	0.05	U	0.05	U	2.45		0.147		0.1	U
	10/2/2002	MW-112	0.05	U	0.05	U	0.05	U	0.05	U	3.75		0.15		0.1	U
	1/15/2003	MW-112	0.05	U	0.05	U	0.05	U	0.05	U	1.52		0.05	U	0.05	U
	4/2/2003	MW-112	0.05	U	0.05	U	0.05	U	0.05	U	1.1		0.046	J	0.05	U
	3/31/2004	MW-112	0.0008	U	0.0011	U	0.0014	U	0.001	U	0.14		0.037		0.002	U
	11/29/2004	MW-112	0.005	U	0.005	U	0.005	U	0.005	U	0.16		0.032		0.005	U
	2/4/2005	MW-112	0.005	U	0.005	U	0.005	U	0.005	U	0.093		0.031		0.005	U
	5/10/2005	MW-112	0.002	U	0.002	U	0.002	U	0.002	U	0.076		0.024		0.002	U
8/2/2005	MW-112	0.001	U	0.001	U	0.001	U	0.00099	J	0.065		0.024		0.001	U	
11/28/2005	MW-112	0.001	U	0.001	U	0.001	U	0.00072	J	0.074		0.015		0.001	U	

**Appendix H**  
**Groundwater Results**  
**Former Gorham Manufacturing Site**  
**Providence, RI**

Analyte:		1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride		
Units:		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		
RI GB:		3.1		NS		0.007		2.4		0.15		0.54		NS		
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-112/CW-3	2/24/2006	MW-112	0.002	U	0.002	U	0.001	U	0.002	U	0.067		0.014		0.002	U
	5/3/2006	MW-112	0.002	U	0.002	U	0.001	U	0.002	U	0.062		0.019		0.002	U
	8/22/2006	MW-112	0.002	U	0.002	U	0.001	U	0.002	U	0.062		0.016		0.002	U
	11/28/2006	MW-112	0.002	U	0.002	U	0.001	U	0.002	U	0.14		0.0048		0.002	U
	2/17/2007	MW-112	0.002	U	0.002	U	0.001	U	0.002	U	0.042		0.0039		0.002	U
	5/20/2007	MW-112	0.002	U	0.002	U	0.001	U	0.002	U	0.047		0.003		0.002	U
	8/14/2007	MW-112	0.002	U	0.002	U	0.001	U	0.002	U	0.034		0.0025		0.002	U
	11/1/2007	MW-112	0.002	U	0.002	U	0.001	U	0.002	U	0.042		0.002	U	0.002	U
	2/7/2008	MW-112	0.002	U	0.002	U	0.001	U	0.002	U	0.76		0.0045		0.002	U
	5/6/2008	MW-112	0.02	U	0.02	U	0.01	U	0.02	U	0.13		0.02	U	0.02	U
	8/20/2008	MW-112	0.002	U	0.002	U	0.001	U	0.002	U	0.34		0.0035		0.002	U
	11/11/2008	MW-112	0.005	U	0.005	U	0.005	U	0.005	U	0.91		0.005	U	0.005	U
	2/25/2009	MW-112	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.11		0.0045		0.0005	U
	8/27/2009	MW-112	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.53		0.0035		0.0005	U
	2/11/2010	MW-112	0.005	U	0.005	U	0.005	U	0.005	U	0.54		0.005	U	0.005	U
	8/30/2010	MW-112	0.02	U	0.02	U	0.01	U	0.02	U	0.26		0.02	U	0.02	U
	2/28/2011	MW-112	0.002	U	0.002	U	0.001	U	0.002	U	1.4		0.002	U	0.002	U
	8/23/2011	MW-112	0.02	U	0.02	U	0.01	U	0.02	U	0.55		0.02	U	0.02	U
	2/9/2012	MW-112	0.02	U	0.02	U	0.01	U	0.02	U	0.9		0.02	U	0.02	U
	8/28/2012	MW-112	0.02	U	0.02	U	0.01	U	0.02	U	1.2		0.02	U	0.02	U
	2/13/2013	MW-112	0.5	U	0.5	U	0.5	U	0.5	U	25		0.5	U	1	U
	6/21/2013	MW-112	0.01	U	0.01	U	0.01	U	0.01	U	0.51		0.075		0.02	U
	8/12/2013	MW-112	0.02	U	0.02	U	0.02	U	0.02	U	3.2		0.02	U	0.04	U
	9/16/2013	MW-112	0.05	U	0.05	U	0.05	U	0.05	U	6.4		0.05	U	0.1	U
	10/26/2013	MW-112	0.1	U	0.1	U	0.1	U	0.1	U	4.7		0.1	U	0.2	U
	11/12/2013	MW-112	0.05	U	0.05	U	0.05	U	0.05	U	4.6		0.05	U	0.1	U
1/14/2014	MW-112	0.025	U	0.025	U	0.025	U	0.025	U	1.8		0.025	U	0.05	U	
2/15/2014	MW-112	0.1	U	0.1	U	0.1	U	0.1	U	3.2		0.1	U	0.2	U	
3/6/2014	MW-112	0.001	U	0.001	U	0.001	U	0.001	U	1.2		0.0039		0.002	U	
4/4/2014	MW-112	0.02	U	0.02	U	0.02	U	0.02	U	2.2		0.02	U	0.04	U	
5/1/2014	MW-112	0.025	U	0.025	U	0.025	U	0.025	U	5.6		0.025	U	0.05	U	
6/10/2014	MW-112	0.001	U	0.001	U	0.001	U	0.001	U	3.5		0.004		0.002	U	

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride		
Units:		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		
RI GB:		3.1		NS		0.007		2.4		0.15		0.54		NS		
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-112/CW-3	7/11/2014	MW-112	0.025	U	0.025	U	0.025	U	0.025	U	1.7		0.025	U	0.05	U
	8/22/2014	MW-112	0.0094	U	0.016	U	0.021	U	0.015	U	2.6		0.0077	U	0.013	U
	9/30/2014	MW-112	0.1	U	0.1	U	0.1	U	0.1	U	4.6		0.1	U	0.2	U
	10/20/2014	MW-112	0.5	U	0.1	U	0.1	U	0.1	U	8.6		0.1	U	0.2	U
	11/24/2014	MW-112	0.05	U	0.05	U	0.05	U	0.05	U	0.78		0.05	U	0.1	U
	12/10/2014	MW-112	0.005	U	0.005	U	0.005	U	0.005	U	0.22		0.008		0.01	U
	1/13/2015	MW-112	0.01	U	0.01	U	0.01	U	0.01	U	0.61		0.011		0.02	U
	3/26/2015	MW-112	0.01	U	0.01	U	0.01	U	0.01	U	0.31		0.01	U	0.02	U
	4/24/2015	MW-112	0.005	U	0.005	U	0.005	U	0.005	U	1.2		0.005	U	0.01	U
	5/12/2015	MW-112	0.004	U	0.004	U	0.004	U	0.004	U	0.16		0.004	U	0.008	U
	6/5/2015	MW-112	0.005	U	0.005	U	0.005	U	0.005	U	0.25		0.005	U	0.01	U
	7/10/2015	MW-112	0.01	U	0.01	U	0.01	U	0.01	U	0.59		0.01	U	0.02	U
	8/5/2015	MW-112	0.002	U	0.002	U	0.002	U	0.002	U	0.53		0.011		0.004	U
	9/10/2015	MW-112	0.005	U	0.005	U	0.005	U	0.005	U	2.1		0.0094		0.01	U
	10/1/2015	MW-112	0.05	U	0.05	U	0.05	U	0.05	U	2.5		0.05	U	0.1	U
	11/5/2015	MW-112	0.01	U	0.01	U	0.01	U	0.01	U	10		0.012		0.02	U
	12/3/2015	MW-112	0.01	U	0.01	U	0.01	U	0.01	U	10		0.011		0.02	U
	1/3/2016	MW-112	0.05	U	0.05	U	0.05	U	0.05	U	5.9		0.05	U	0.1	U
	2/23/2016	MW-112	0.004	U	0.004	U	0.004	U	0.004	U	2.5		0.012		0.008	U
	3/21/2016	MW-112	0.004	U	0.004	U	0.004	U	0.004	U	4.4		0.011		0.008	U
	4/20/2016	MW-112	0.04	U	0.04	U	0.04	U	0.04	U	1.8		0.04	U	0.08	U
	5/4/2016	MW-112	0.001		0.001	U	0.0046		0.021		0.33		0.11		0.002	U
	6/10/2016	MW-112	0.004	U	0.004	U	0.004	U	0.004	U	1.4		0.0058		0.008	U
	7/7/2016	MW-112	0.02	U	0.02	U	0.02	U	0.02	U	2		0.02	U	0.04	U
	8/1/2016	MW-112	0.02	U	0.02	U	0.02	U	0.02	U	2.9		0.02	U	0.04	U
	9/13/2016	MW-112	0.02	U	0.02	U	0.02	U	0.02	U	0.67		0.02	U	0.04	U
	10/4/2016	MW-112	0.005	U	0.005	U	0.005	U	0.005	U	0.5		0.0074		0.01	U
11/1/2016	MW-112	0.005	U	0.005	U	0.005	U	0.005	U	0.42		0.0092		0.01	U	
12/6/2016	MW-112	0.005	U	0.005	U	0.005	U	0.005	U	0.17		0.011		0.01	U	
1/11/2017	MW-112	0.005	U	0.005	U	0.005	U	0.005	U	0.45		0.027		0.01	U	
2/14/2017	MW-112	0.005	U	0.005	U	0.005	U	0.005	U	0.4		0.032		0.01	U	
5/16/2017	MW-112	0.005	U	0.005	U	0.005	U	0.005	U	0.4		0.0098		0.01	U	

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1-Trichloroethane	1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride			
Units:		MG/L	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L			
RI GB:		3.1	NS		0.007		2.4		0.15		0.54		NS			
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-112/CW-3	8/17/2017	MW-112	0.005	U	0.005	U	0.005	U	0.005	U	0.18		0.005	U	0.01	U
	11/28/2017	MW-112	0.002	U	0.002	U	0.002	U	0.002	U	0.13		0.011		0.004	U
	2/21/2018	MW-112	0.002	U	0.002	U	0.002	U	0.002	U	0.095		0.015		0.004	U
MW-116D	3/4/2002	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.021		0.0077		0.002	U
	7/8/2002	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001		0.003		0.002	U
	10/2/2002	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002		0.002	U
	1/15/2003	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.002		0.002		0.001	U
	4/2/2003	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002		0.001	U
	3/31/2004	MW-116D	0.00016	U	0.00022	U	0.00029	U	0.0002	U	0.0036		0.00078	J	0.0004	U
	2/4/2005	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.0018		0.00066	J	0.001	U
	5/10/2005	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.0011		0.001	U
	8/2/2005	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.00092	J	0.001	U	0.001	U
	11/28/2005	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.0023		0.001	U
	2/24/2006	MW-116D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002		0.002	U
	5/3/2006	MW-116D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	8/22/2006	MW-116D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	11/28/2006	MW-116D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.0027		0.002	U
	2/17/2007	MW-116D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	5/20/2007	MW-116D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	8/14/2007	MW-116D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	11/1/2007	MW-116D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	2/7/2008	MW-116D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	5/7/2008	MW-116D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	8/20/2008	MW-116D	0.002	U	0.002	U	0.001	U	0.002	U	0.0029		0.002	U	0.002	U
	11/11/2008	MW-116D	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U
	2/25/2009	MW-116D	0.0005	U	0.0005	U	0.0005	U	0.0021		0.0041		0.0005	U	0.0005	U
	8/28/2009	MW-116D	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.074		0.02		0.0005	U
	2/11/2010	MW-116 D	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U
8/31/2010	MW-116 D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U	
2/28/2011	MW-116D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U	
8/23/2011	MW-116D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U	
2/9/2012	MW-116D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U	

**Appendix H**  
**Groundwater Results**  
**Former Gorham Manufacturing Site**  
**Providence, RI**

		Analyte:	1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride	
		Units:	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L	
		RI GB:	3.1		NS		0.007		2.4		0.15		0.54		NS	
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-116D	8/28/2012	MW-116D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	2/14/2013	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	6/21/2013	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	8/12/2013	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	9/16/2013	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	10/26/2013	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	11/12/2013	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	1/14/2014	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	2/15/2014	MW 116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	3/6/2014	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	4/4/2014	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	5/2/2014	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	6/10/2014	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	7/11/2014	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	8/22/2014	MW-116D	9.4E-05	U	0.00016	U	0.00021	U	0.00015	U	8E-05	U	7.7E-05	U	0.00013	U
	9/30/2014	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	10/20/2014	MW-116D	0.005	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	11/24/2014	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	12/10/2014	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	1/13/2015	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	3/26/2015	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	4/24/2015	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	5/12/2015	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	6/5/2015	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	7/10/2015	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	8/5/2015	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	9/10/2015	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	10/1/2015	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
11/5/2015	MW 116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
12/3/2015	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
1/3/2016	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
2/23/2016	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride		
Units:		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		
RI GB:		3.1		NS		0.007		2.4		0.15		0.54		NS		
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-116D	3/21/2016	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	4/20/2016	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	5/5/2016	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	6/10/2016	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	7/7/2016	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	8/1/2016	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	9/13/2016	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	10/4/2016	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	11/2/2016	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.0025		0.002	U
	12/6/2016	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	1/11/2017	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	2/14/2017	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	5/17/2017	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	8/17/2017	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	11/28/2017	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
1/16/2018	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.0002	U	0.001	U	
2/21/2018	MW-116D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
MW-116S/B-3	4/29/1996	B-3	0.005	U	0.005	U	0.005	U	0.005	U	0.026		0.005	U	0.01	U
	5/21/1996	MW-116	0.005	U	0.005	U	0.005	U	0.005	U	0.077		0.005	U	0.01	U
	10/16/1997	MW-116	0.005	U	0.005	U	0.005	U	0.005	U	0.005	U	0.005	U	0.01	U
	12/8/1998	MW-116	0.001	U	0.001	U	0.001	U	0.001	U	0.039		0.001	U	0.002	U
	12/20/2000	MW-116	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	7/11/2002	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.004		0.001	U	0.002	U
	10/2/2002	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.003		0.001	U	0.002	U
	1/15/2003	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001		0.001	U	0.001	U
	4/2/2003	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.004		0.001	U	0.001	U
	3/31/2004	MW-116S	0.00016	U	0.00022	U	0.00029	U	0.0002	U	0.00071	J	0.00018	U	0.0004	U
	2/4/2005	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.0017		0.001	U	0.001	U
	5/10/2005	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.0018		0.001	U	0.001	U
	8/2/2005	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.0013		0.001	U
11/28/2005	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.0018		0.001	U	0.001	U	
3/9/2006	MW-116S	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U	

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1- Trichloroethane	1,1- Dichloroethane		1,1- Dichloroethene		cis-1,2- Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride			
Units:		MG/L	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L			
RI GB:		3.1	NS		0.007		2.4		0.15		0.54		NS			
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-116S/B-3	3/9/2006	MW-116S DUP	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	5/3/2006	MW-116S	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	8/22/2006	MW-116S	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	11/28/2006	MW-116S	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	2/17/2007	MW-116S	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	5/20/2007	MW-116S	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	8/14/2007	MW-116S	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	11/1/2007	MW-116S	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	2/7/2008	MW-116S	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	5/7/2008	MW-116S	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	8/20/2008	MW-116S	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	11/11/2008	MW-116S	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0027		0.0005	U	0.0005	U
	2/25/2009	MW-116S	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U
	8/28/2009	MW-116S	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U
	2/11/2010	MW-116 S	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U
	8/31/2010	MW-116 S	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	2/28/2011	MW-116S	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	8/23/2011	MW-116S	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	2/9/2012	MW-116S	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	8/28/2012	MW-116S	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	2/14/2013	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	6/21/2013	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	8/12/2013	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	9/16/2013	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	10/26/2013	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	11/12/2013	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
1/14/2014	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
2/15/2014	MW 116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
3/6/2014	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
4/4/2014	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
5/2/2014	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
6/10/2014	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride			
Units:		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L			
RI GB:		3.1		NS		0.007		2.4		0.15		0.54		NS			
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	
MW-116S/B-3	7/11/2014	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	8/22/2014	MW-116S	9.4E-05	U	0.00016	U	0.00021	U	0.00015	U	8E-05	U	7.7E-05	U	0.00013	U	
	9/30/2014	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	10/20/2014	MW-116S	0.005	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	11/24/2014	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	12/10/2014	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	1/13/2015	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	3/26/2015	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	4/24/2015	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	5/12/2015	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	6/5/2015	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	7/10/2015	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	8/5/2015	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	9/10/2015	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	10/1/2015	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	11/5/2015	MW 116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	12/3/2015	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	1/3/2016	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	2/23/2016	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	3/21/2016	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	4/20/2016	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	5/5/2016	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	6/10/2016	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	7/7/2016	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	8/1/2016	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
	9/13/2016	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	
10/4/2016	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U		
11/2/2016	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.15		0.001	U	0.001	U	0.002	U
12/6/2016	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
1/11/2017	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
2/14/2017	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
5/17/2017	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

		Analyte:	1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride	
		Units:	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L	
		RI GB:	3.1		NS		0.007		2.4		0.15		0.54		NS	
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-116S/B-3	8/17/2017	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	11/28/2017	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
	1/16/2018	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U
	2/21/2018	MW-116S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U
MW-201D	3/4/2002	MW-201D	0.5	U	0.5	U	0.5	U	0.5	U	18		0.54		1	U
	5/8/2002	MW-201D	0.5	U	0.5	U	0.5	U	0.5	U	15.8		0.625		1	U
	7/8/2002	MW-201D	0.5	U	0.5	U	0.5	U	0.5	U	23		0.5	U	1	U
		MW-201D DUP	0.5	U	0.5	U	0.5	U	0.5	U	14.9		0.55		1	U
	10/2/2002	MW-201D	0.1	U	0.1	U	0.1	U	0.1	U	3.82		0.208		0.2	U
	1/15/2003	MW-201D	0.1	U	0.1	U	0.1	U	0.1	U	4.52		0.223		0.1	U
	4/2/2003	MW-201D	0.1	U	0.1	U	0.1	U	0.1	U	6		0.47		0.1	U
	3/31/2004	MW-201D	0.008	U	0.011	U	0.014	U	0.01	U	1.6		0.39		0.02	U
	2/4/2005	MW-201D	0.05	U	0.05	U	0.05	U	0.05	U	6.1		0.42		0.05	U
	5/9/2005	MW-201D	0.2	U	0.2	U	0.2	U	0.2	U	9.5		0.55		0.2	U
	8/2/2005	MW-201D	0.2	U	0.2	U	0.2	U	0.2	U	9.5		0.62		0.2	U
	11/28/2005	MW-201D	0.1	U	0.1	U	0.1	U	0.1	U	10		0.94		0.1	U
	2/24/2006	MW-201D	0.02	U	0.02	U	0.019		0.046		6.1		0.91		0.02	U
	5/3/2006	MW-201D	0.002	U	0.0037		0.0096		0.026		3.3		0.35		0.002	U
	8/21/2006	MW-201D	0.2	U	0.2	U	0.1	U	0.2	U	15		1		0.2	U
	11/28/2006	MW-201D	0.0029		0.0063		0.021		0.029		12	D	1	D	0.002	U
	2/17/2007	MW-201D	0.2	U	0.2	U	0.1	U	0.2	U	7.6		0.97		0.2	U
	5/20/2007	MW-201D	0.04	U	0.04	U	0.02	U	0.04	U	11		0.92		0.04	U
	8/14/2007	MW-201D	0.2	U	0.2	U	0.1	U	0.2	U	10		0.96		0.2	U
	11/1/2007	MW-201D	0.2	U	0.2	U	0.1	U	0.2	U	8.6		0.92		0.2	U
	2/7/2008	MW-201D	0.2	U	0.2	U	0.1	U	0.2	U	7		0.87		0.2	U
	5/6/2008	MW-201D	0.2	U	0.2	U	0.1	U	0.2	U	5.8		0.72		0.2	U
	8/20/2008	MW-201D	0.2	U	0.2	U	0.1	U	0.2	U	5.9		0.53		0.2	U
	11/11/2008	MW-201D	0.05	U	0.05	U	0.05	U	0.05	U	8		0.9		0.05	U
	2/25/2009	MW-201D	0.025	U	0.025	U	0.025	U	2.8		0.2		0.025	U	0.025	U
	8/28/2009	MW-201D	0.05	U	0.05	U	0.05	U	0.05	U	8.5		0.56		0.05	U
8/31/2010	MW-201 D	0.2	U	0.2	U	0.1	U	0.2	U	11		0.61		0.2	U	
2/28/2011	MW-201D	0.2	U	0.2	U	0.1	U	0.2	U	9.6		0.38		0.2	U	

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride		
Units:		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		
RI GB:		3.1		NS		0.007		2.4		0.15		0.54		NS		
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-201D	8/23/2011	MW-201D	0.02	U	0.02	U	0.01	U	0.02	U	8.4		0.23		0.02	U
	2/8/2012	MW-201D	0.02	U	0.02	U	0.01	U	0.02	U	6.6		0.21		0.02	U
	8/28/2012	MW-201D	0.1	U	0.1	U	0.05	U	0.1	U	10		0.15		0.1	U
	2/13/2013	MW-201D	0.0046		0.001	U	0.001	U	0.0034		6		0.13		0.002	U
	8/12/2013	MW-201D	0.1	U	0.1	U	0.1	U	0.1	U	6.6		0.13		0.2	U
	11/12/2013	MW-201D	0.1	U	0.1	U	0.1	U	0.1	U	1.1		0.15		0.2	U
	5/1/2014	MW-201D	0.2	U	0.2	U	0.2	U	0.2	U	9.8		0.2	U	0.4	U
	8/22/2014	MW-201D	0.019	U	0.032	U	0.042	U	0.029	U	14		0.32		0.027	U
	11/24/2014	MW-201D	0.05	U	0.05	U	0.05	U	0.05	U	11		0.24		0.1	U
	5/12/2015	MW-201D	0.1	U	0.1	U	0.1	U	0.1	U	6.1		0.19		0.2	U
	8/4/2015	MW-201D	0.1	U	0.1	U	0.1	U	0.1	U	10		0.27		0.2	U
	11/5/2015	MW 201D	0.1	U	0.1	U	0.1	U	0.1	U	12		0.26		0.2	U
	5/4/2016	MW-201D	0.1	U	0.1	U	0.1	U	0.1	U	5		0.1	U	0.2	U
	11/1/2016	MW 201D	0.05	U	0.05	U	0.05	U	0.05	U	8.8		0.26		0.1	U
5/16/2017	MW-201D	0.05	U	0.05	U	0.05	U	0.05	U	5.5		0.16		0.1	U	
11/27/2017	MW-201D	0.1	U	0.1	U	0.1	U	0.2		6.7		0.3		0.2	U	
MW-201S	3/4/2002	MW-201S	0.014	J	0.02	U	0.02	U	0.02	U	0.43		0.26		0.04	U
	5/8/2002	MW-201S	0.01	U	0.01	U	0.01	U	0.01	U	0.328		0.12		0.02	U
	7/8/2002	MW-201S	0.01	U	0.01	U	0.01	U	0.01	U	0.33		0.129		0.02	U
	10/2/2002	MW-201S	0.011		0.01	U	0.01	U	0.01	U	0.261		0.088		0.02	U
	1/15/2003	MW-201S	0.011		0.005	U	0.005	U	0.005	U	0.253		0.07		0.005	U
	4/2/2003	MW-201S	0.008		0.005	U	0.005	U	0.005	U	0.3		0.056		0.005	U
	3/31/2004	MW-201S	0.0086	J	0.0022	U	0.0029	U	0.002	U	0.34		0.058		0.004	U
	2/4/2005	MW-201S	0.0064	J	0.01	U	0.01	U	0.01	U	0.41		0.084		0.01	U
	5/9/2005	MW-201S	0.0058	J	0.01	U	0.01	U	0.01	U	0.77		0.19		0.01	U
	8/2/2005	MW-201S	0.0057	J	0.01	U	0.01	U	0.01	U	0.68		0.13		0.01	U
	11/28/2005	MW-201S	0.02	U	0.02	U	0.02	U	0.02	U	1.4		0.19		0.02	U
	2/24/2006	MW-201S	0.02	U	0.02	U	0.01	U	0.02	U	1		0.12		0.02	U
	5/3/2006	MW-201S	0.0082		0.002	U	0.001	U	0.002	U	1.2		0.16		0.002	U
8/21/2006	MW-201S	0.02	U	0.02	U	0.01	U	0.02	U	2		0.15		0.02	U	
11/28/2006	MW-201S	0.0068		0.002	U	0.001	U	0.0022		1.1	D	0.13		0.002	U	
MW-202D	3/4/2002	MW-202D	1	U	1	U	1	U	1	U	47		1	U	2	U

**Appendix H**  
**Groundwater Results**  
**Former Gorham Manufacturing Site**  
**Providence, RI**

		Analyte:	1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride	
		Units:	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L	
		RI GB:	3.1		NS		0.007		2.4		0.15		0.54		NS	
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-202D	5/8/2002	MW-202D	1	U	1	U	1	U	1	U	38.4		1	U	2	U
	7/8/2002	MW-202D	1	U	1	U	1	U	1	U	37.6		1	U	2	U
	10/2/2002	MW-202D	1	U	1	U	1	U	1	U	38		1	U	2	U
	1/15/2003	MW-202D	1	U	1	U	1	U	1	U	33.1		1	U	1	U
	4/2/2003	MW-202D	1	U	1	U	1	U	1	U	41		1	U	1	U
	3/30/2004	MW-202D	0.08	U	0.11	U	0.14	U	0.1	U	15		0.09	U	0.2	U
	11/29/2004	MW-202D	0.25	U	0.25	U	0.25	U	0.25	U	13		0.25	U	0.25	U
	2/3/2005	MW-202D	0.05	U	0.05	U	0.05	U	0.05	U	9.4		0.14		0.05	U
	5/9/2005	MW-202D	1	U	1	U	1	U	1	U	34		1	U	1	U
	8/2/2005	MW-202D	1	U	1	U	1	U	1	U	51		1	U	1	U
	11/28/2005	MW-202D	1	U	1	U	1	U	1	U	55		1	U	1	U
	2/22/2006	MW-202D	0.04	U	0.04	U	0.02	U	0.04	U	13		0.15		0.04	U
	5/3/2006	MW-202D	0.0051		0.002	U	0.001	U	0.044		35		0.14		0.002	U
	8/21/2006	MW-202D	0.2	U	0.2	U	0.1	U	0.2	U	88	D	0.2	U	0.2	U
	11/28/2006	MW-202D	0.02	U	0.02	U	0.01	U	0.036		13	D	0.22		0.02	U
	2/17/2007	MW-202D	0.2	U	0.2	U	0.1	U	0.2	U	29		0.2	U	0.2	U
	5/20/2007	MW-202D	0.2	U	0.2	U	0.1	U	0.2	U	4.8		0.2	U	0.2	U
	8/14/2007	MW-202D	0.1	U	0.1	U	0.05	U	0.1	U	47		0.1	U	0.1	U
	11/1/2007	MW-202D	0.4	U	0.4	U	0.2	U	0.4	U	46		0.4	U	0.4	U
	2/7/2008	MW-202D	0.4	U	0.4	U	0.2	U	0.4	U	9.5		0.4	U	0.4	U
	5/6/2008	MW-202D	0.2	U	0.2	U	0.1	U	0.2	U	6.2		0.2	U	0.2	U
	8/20/2008	MW-202D	0.2	U	0.2	U	0.1	U	0.2	U	31		0.2	U	0.2	U
	11/11/2008	MW-202D	0.05	U	0.05	U	0.05	U	0.05	U	16		0.05	U	0.05	U
	2/25/2009	MW-202D	0.005	U	0.005	U	0.005	U	0.005	U	0.33		0.005	U	0.005	U
	8/27/2009	MW-202D	0.005	U	0.005	U	0.005	U	0.12		19		0.032		0.005	U
	2/11/2010	MW-202 D	0.005	U	0.005	U	0.005	U	0.06		0.58		0.005	U	0.005	U
	8/30/2010	MW-202 D	0.02	U	0.02	U	0.01	U	0.02	U	0.33		0.02	U	0.02	U
	2/28/2011	MW-202D	0.02	U	0.02	U	0.01	U	0.02	U	5.1		0.02	U	0.02	U
	8/23/2011	MW-202D	0.002	U	0.002	U	0.001	U	0.0029		0.21		0.002	U	0.002	U
	2/8/2012	MW-202D	0.002	U	0.002	U	0.001	U	0.002	U	0.61		0.002	U	0.002	U
8/28/2012	MW-202D	0.02	U	0.02	U	0.01	U	0.02	U	0.2		0.02	U	0.02	U	
2/13/2013	MW-202D	0.001	U	0.001	U	0.001	U	0.0037		0.43		0.0024		0.002	U	

**Appendix H**  
**Groundwater Results**  
**Former Gorham Manufacturing Site**  
**Providence, RI**

Analyte:		1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride		
Units:		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		
RI GB:		3.1		NS		0.007		2.4		0.15		0.54		NS		
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-202D	8/12/2013	MW-202D	0.01	U	0.01	U	0.01	U	0.01	U	0.99		0.01	U	0.02	U
	11/12/2013	MW-202D	0.02	U	0.02	U	0.02	U	0.02	U	1.2		0.02	U	0.04	U
	2/14/2014	MW 202D	0.02	U	0.02	U	0.02	U	0.02	U	2.9		0.032		0.04	U
	5/1/2014	MW-202D	0.001	U	0.001	U	0.001	U	0.001	U	0.067		0.001	U	0.002	U
	8/22/2014	MW-202D	9.4E-05	U	0.00016	U	0.00021	U	0.00015	U	0.21		0.0017		0.00013	U
	11/24/2014	MW-202D	0.001	U	0.001	U	0.001	U	0.001	U	0.0038		0.001	U	0.002	U
	3/26/2015	MW-202D	0.001	U	0.001	U	0.001	U	0.001	U	0.024		0.0014		0.002	U
	5/12/2015	MW-202D	0.001	U	0.001	U	0.001	U	0.0052		0.13		0.008		0.002	U
	8/4/2015	MW-202D	0.001	U	0.0011		0.001	U	0.0085		0.17		0.018		0.002	U
	11/5/2015	MW 202D	0.002	U	0.002	U	0.002	U	0.024		0.27		0.0089		0.004	U
	5/4/2016	MW-202D	0.001	U	0.001	U	0.001	U	0.001	U	0.012		0.001	U	0.002	U
	11/1/2016	MW 202D	0.001	U	0.001	U	0.001	U	0.001	U	0.0068		0.001	U	0.002	U
	5/16/2017	MW-202D	0.001	U	0.001	U	0.001	U	0.001	U	0.028		0.0014		0.002	U
	11/27/2017	MW-202D	0.001	U	0.001	U	0.001	U	0.001	U	0.0047		0.001	U	0.002	U
1/18/2018	MW-202D	0.001	U	0.001	U	0.001	U	0.001	U	0.039		0.012		0.001	U	
MW-202S	3/4/2002	MW-202S	0.5	U	0.5	U	0.5	U	0.5	U	23		0.5	U	1	U
	5/8/2002	MW-202S	1	U	1	U	1	U	1	U	58.1		1	U	2	U
	7/8/2002	MW-202S	0.5	U	0.5	U	0.5	U	0.5	U	24		0.5	U	1	U
	10/2/2002	MW-202S	1	U	1	U	1	U	1	U	47.8		1	U	2	U
	1/15/2003	MW-202S	1	U	1	U	1	U	1	U	34.2		1	U	1	U
	4/2/2003	MW-202S	0.2	U	0.2	U	0.2	U	0.2	U	8.7		0.2	U	0.2	U
	3/30/2004	MW-202S	0.08	U	0.11	U	0.14	U	0.1	U	36		0.09	U	0.2	U
	11/29/2004	MW-202S	0.5	U	0.5	U	0.5	U	0.5	U	44		0.5	U	0.5	U
	2/3/2005	MW-202S	0.1	U	0.1	U	0.1	U	0.1	U	41		0.065	J	0.1	U
	5/9/2005	MW-202S	1	U	1	U	1	U	1	U	51		1	U	1	U
	8/2/2005	MW-202S	1	U	1	U	1	U	1	U	41		1	U	1	U
	11/28/2005	MW-202S	1	U	1	U	1	U	1	U	74		1	U	1	U
	2/22/2006	MW-202S	0.2	U	0.2	U	0.1	U	0.2	U	43		0.2	U	0.2	U
	5/3/2006	MW-202S	0.0072		0.002	U	0.001	U	0.09		46		0.053		0.002	U
MW-202S DUP		0.0037		0.002	U	0.001	U	0.043		26		0.026		0.002	U	
8/21/2006	MW-202S	0.0056		0.002	U	0.001	U	0.33		75	D	0.096		0.0025		
11/28/2006	MW-202S	0.02	U	0.02	U	0.01	U	0.086		62	D	0.1		0.02	U	

**Appendix H**  
**Groundwater Results**  
**Former Gorham Manufacturing Site**  
**Providence, RI**

		Analyte:	1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride	
		Units:	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L	
		RI GB:	3.1		NS		0.007		2.4		0.15		0.54		NS	
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-202S	2/17/2007	MW-202S	0.2	U	0.2	U	0.1	U	0.2	U	51		0.2	U	0.2	U
	5/20/2007	MW-202S	0.2	U	0.2	U	0.1	U	0.2	U	76		0.2	U	0.2	U
	8/14/2007	MW-202S	0.2	U	0.2	U	0.1	U	0.2	U	56		0.2	U	0.2	U
	11/1/2007	MW-202S	0.4	U	0.4	U	0.2	U	0.4	U	45		0.4	U	0.4	U
	2/7/2008	MW-202S	0.4	U	0.4	U	0.2	U	0.4	U	25		0.4	U	0.4	U
	5/6/2008	MW-202S	0.2	U	0.2	U	0.1	U	0.2	U	12		0.2	U	0.2	U
	8/20/2008	MW-202S	0.2	U	0.2	U	0.1	U	0.2	U	9.3		0.2	U	0.2	U
	11/11/2008	MW-202S	0.05	U	0.05	U	0.05	U	0.05	U	25		0.05	U	0.05	U
	2/25/2009	MW-202S	0.05	U	0.05	U	0.05	U	0.05	U	15		0.05	U	0.05	U
	8/27/2009	MW-202S	0.005	U	0.005	U	0.005	U	0.15		2.6		0.005	U	0.005	U
	2/11/2010	MW-202 S	0.005	U	0.005	U	0.005	U	0.062		0.27		0.005	U	0.005	U
	8/30/2010	MW-202 S	0.002	U	0.002	U	0.001	U	0.075		0.091		0.0037		0.002	U
	2/28/2011	MW-202S	0.002	U	0.002	U	0.001	U	0.002	U	0.03		0.002	U	0.002	U
	8/23/2011	MW-202S	0.002	U	0.002	U	0.001	U	0.0057		0.056		0.002	U	0.002	U
	2/8/2012	MW-202S	0.002	U	0.002	U	0.001	U	0.0025		0.073		0.002	U	0.002	U
	8/28/2012	MW-202S	0.002	U	0.002	U	0.001	U	0.003		0.12		0.002	U	0.002	U
	2/13/2013	MW-202S	0.001	U	0.001	U	0.001	U	0.001	U	0.038		0.001	U	0.002	U
	8/12/2013	MW-202S	0.001	U	0.001	U	0.001	U	0.0049		0.043		0.0024		0.002	U
	11/12/2013	MW-202S	0.001	U	0.001	U	0.001	U	0.0038		0.87		0.0053		0.002	U
	2/14/2014	MW 202S	0.01	U	0.01	U	0.01	U	0.01	U	1.2		0.01	U	0.02	U
	5/1/2014	MW-202S	0.001	U	0.001	U	0.001	U	0.001	U	0.029		0.001	U	0.002	U
	11/24/2014	MW-202S	0.005	U	0.005	U	0.005	U	0.005	U	0.16		0.005	U	0.01	U
	3/26/2015	MW-202S	0.004	U	0.004	U	0.004	U	0.004	U	0.27		0.005		0.008	U
	5/12/2015	MW-202S	0.004	U	0.004	U	0.004	U	0.004	U	0.34		0.004	U	0.008	U
8/4/2015	MW-202S	0.004	U	0.004	U	0.004	U	0.004	U	0.27		0.0062		0.008	U	
11/5/2015	MW 202S	0.004	U	0.004	U	0.004	U	0.004	U	0.12		0.006		0.008	U	
5/4/2016	MW-202S	0.001	U	0.001	U	0.001	U	0.001	U	0.042		0.0045		0.002	U	
11/1/2016	MW 202S	0.001	U	0.001	U	0.001	U	0.001	U	0.023		0.0027		0.002	U	
5/16/2017	MW-202S	0.001	U	0.001	U	0.001	U	0.001	U	0.0089		0.001	U	0.002	U	
11/27/2017	MW-202S	0.001	U	0.001	U	0.001	U	0.001	U	0.01		0.001	U	0.002	U	
1/18/2018	MW-202S	0.001	U	0.001	U	0.001	U	0.001	U	0.0114		0.0022		0.001	U	
MW-204D	3/4/2002	MW-204D	0.29		0.028		0.01	U	0.01	U	0.066		0.043		0.02	U

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1-Trichloroethane	1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride			
Units:		MG/L	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L			
RI GB:		3.1	NS		0.007		2.4		0.15		0.54		NS			
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q		
MW-204D	5/8/2002	MW-204D	0.186		0.0122		0.005	U	0.005	U	0.0426		0.0247		0.01	U
	7/8/2002	MW-204D	0.14		0.011		0.005	U	0.002	U	0.039		0.024		0.01	U
	10/2/2002	MW-204D	0.242		0.015		0.005	U	0.005	U	0.013		0.031		0.01	U
	1/15/2003	MW-204D	0.18		0.008		0.005	U	0.005	U	0.016		0.026		0.005	U
	4/2/2003	MW-204D	0.22		0.027		0.006		0.005	U	0.031		0.043		0.005	U
	3/30/2004	MW-204D	0.079		0.023		0.0058	U	0.004	U	0.92		0.043		0.008	U
	2/3/2005	MW-204D	0.05		0.013	J	0.02	U	0.02	U	0.82		0.079		0.02	U
	5/9/2005	MW-204D	0.033		0.022		0.02	U	0.02	U	1.7		0.2		0.02	U
	8/2/2005	MW-204D	0.023		0.013	J	0.02	U	0.02	U	1.6		0.15		0.02	U
	11/28/2005	MW-204D	0.05	U	0.05	U	0.05	U	0.05	U	4.1		0.37		0.05	U
	2/22/2006	MW-204D	0.016		0.012		0.0011		0.0048		4.3		0.27		0.002	U
	5/3/2006	MW-204D	0.002	U	0.002	U	0.001	U	0.002	U	0.086		0.0066		0.002	U
	8/21/2006	MW-204D	0.019		0.038		0.001	U	0.016		1.1	D	0.15		0.002	U
11/28/2006	MW-204D	0.02	U	0.041		0.01	U	0.02	U	0.99		0.12		0.02	U	
MW-204S	3/4/2002	MW-204S	0.16		0.011		0.0015	J	0.002	U	0.0095		0.028		0.004	U
	5/8/2002	MW-204S	0.0972		0.005	U	0.005	U	0.005	U	0.0147		0.0252		0.01	U
	7/8/2002	MW-204S	0.065		0.002		0.005	U	0.005	U	0.013		0.017		0.002	U
	10/2/2002	MW-204S	0.12		0.006		0.005	U	0.005	U	0.012		0.028		0.01	U
	1/15/2003	MW-204S	0.104		0.005	U	0.005	U	0.005	U	0.009		0.039		0.005	U
	4/2/2003	MW-204S	0.12		0.046		0.004	J	0.005	U	0.015		0.037		0.005	U
	3/30/2004	MW-204S	0.064		0.0072		0.0037		0.0002	U	0.025		0.048		0.0004	U
	2/3/2005	MW-204S	0.086		0.013		0.006		0.005	U	0.041		0.05		0.005	U
	5/9/2005	MW-204S	0.0012		0.001	U	0.001	U	0.00082	J	0.016		0.0019		0.001	U
	8/2/2005	MW-204S	0.014	J	0.02	J	0.025	U	0.025	U	1.8		0.06		0.025	U
	11/28/2005	MW-204S	0.043		0.026		0.02	U	0.011	J	1.2		0.14		0.02	U
	2/22/2006	MW-204S	0.038		0.05		0.0029		0.026		1.6		0.13		0.002	U
	5/3/2006	MW-204S	0.002	U	0.002	U	0.001	U	0.002	U	0.015		0.002	U	0.002	U
8/21/2006	MW-204S	0.015		0.027		0.001	U	0.013		1.1	D	0.17		0.002	U	
11/28/2006	MW-204S	0.023		0.022		0.01	U	0.02	U	1.7		0.17		0.02	U	
MW-206D	3/4/2002	MW-206D	0.053	J	0.1	U	0.1	U	0.1	U	0.52		2.3		0.2	U
	5/8/2002	MW-206D	0.05	U	0.05	U	0.05	U	0.05	U	0.312		1.08		0.1	U
	7/8/2002	MW-206D	0.05	U	0.05	U	0.05	U	0.05	U	0.449		1.04		0.1	U

**Appendix H**  
**Groundwater Results**  
**Former Gorham Manufacturing Site**  
**Providence, RI**

Analyte:		1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride		
Units:		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		
RI GB:		3.1		NS		0.007		2.4		0.15		0.54		NS		
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-206D	10/2/2002	MW-206D	0.032		0.02	U	0.02	U	0.02	U	0.418		0.921		0.04	U
	1/15/2003	MW-206D	0.02	U	0.02	U	0.02	U	0.02	U	1.09		0.372		0.02	U
	4/2/2003	MW-206D	0.021		0.02	U	0.02	U	0.02	U	0.44		0.62		0.02	U
	2/3/2005	MW-206D	0.01	U	0.01	U	0.01	U	0.01	U	0.21		0.092		0.01	U
	5/9/2005	MW-206D	0.005	U	0.005	U	0.005	U	0.003	J	0.43		0.12		0.005	U
	8/2/2005	MW-206D	0.005	U	0.005	U	0.005	U	0.005	U	0.21		0.06		0.005	U
	11/28/2005	MW-206D	0.01	U	0.01	U	0.01	U	0.01	U	0.32		0.17		0.01	U
	2/22/2006	MW-206D	0.002	U	0.002	U	0.0024		0.0058		0.56		0.26		0.002	U
	5/3/2006	MW-206D	0.0076		0.002	U	0.001	U	0.002	U	0.091		0.18		0.002	U
	8/22/2006	MW-206D	0.02	U	0.02	U	0.01	U	0.02	U	0.27		0.13		0.02	U
	11/28/2006	MW-206D	0.02	U	0.02	U	0.01	U	0.02	U	0.36		0.18		0.02	U
1/19/2018	MW-206D	0.001	U	0.001	U	0.0032		0.0091		0.121	D	0.183	D	0.001	U	
MW-206S	3/4/2002	MW-206S	0.03		0.01	U	0.01	U	0.01	U	0.087		0.24		0.02	U
	5/8/2002	MW-206S	0.031		0.005	U	0.005	U	0.005	U	0.081		0.209		0.01	U
	7/8/2002	MW-206S	0.023		0.005	U	0.005	U	0.005	U	0.06		0.204		0.01	U
	10/2/2002	MW-206S	0.025		0.005	U	0.005	U	0.005	U	0.054		0.199		0.01	U
	1/15/2003	MW-206S	0.024		0.005	U	0.005	U	0.005	U	0.072		0.174		0.005	U
	4/2/2003	MW-206S	0.023		0.005	U	0.005	U	0.005	U	0.19		0.35		0.005	U
	2/3/2005	MW-206S	0.011		0.01	U	0.01	U	0.01	U	0.086		0.26		0.01	U
	5/9/2005	MW-206S	0.0088		0.005	U	0.005	U	0.005	U	0.094		0.21		0.005	U
	8/2/2005	MW-206S	0.011		0.005	U	0.005	U	0.005	U	0.16		0.24		0.005	U
	11/28/2005	MW-206S	0.009	J	0.01	U	0.01	U	0.01	U	0.078		0.23		0.01	U
	2/22/2006	MW-206S	0.015		0.002	U	0.001	U	0.002	U	0.27		0.29		0.002	U
	5/3/2006	MW-206S	0.002	U	0.002	U	0.001	U	0.002	U	0.0098		0.0032		0.002	U
	8/22/2006	MW-206S	0.011		0.002	U	0.001	U	0.002	U	0.14		0.24		0.002	U
	11/28/2006	MW-206S	0.02	U	0.02	U	0.01	U	0.02	U	0.12		0.22		0.02	U
1/19/2018	Dup-03		0.001	U	0.001	U	0.001	U	0.001	U	0.0201		0.0401		0.001	U
	MW-206S		0.001	U	0.001	U	0.001	U	0.001	U	0.0206		0.0414		0.001	U
MW-207D	3/4/2002	MW-207D	0.05	U	0.05	U	0.05	U	0.05	U	2.1		0.05	U	0.1	U
	5/8/2002	MW-207D	0.05	U	0.05	U	0.05	U	0.05	U	1.87		0.05	U	0.1	U
	7/8/2002	MW-207D	0.05	U	0.05	U	0.05	U	0.05	U	1.8		0.05	U	0.1	U
	10/2/2002	MW-207D	0.05	U	0.05	U	0.05	U	0.05	U	1.4		0.05	U	0.1	U

**Appendix H**  
**Groundwater Results**  
**Former Gorham Manufacturing Site**  
**Providence, RI**

Analyte:		1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride		
Units:		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		
RI GB:		3.1		NS		0.007		2.4		0.15		0.54		NS		
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-207D	1/15/2003	MW-207D	0.05	U	0.05	U	0.05	U	0.05	U	1.53		0.05	U	0.05	U
	4/2/2003	MW-207D	0.05	U	0.05	U	0.05	U	0.05	U	2		0.05	U	0.05	U
	3/30/2004	MW-207D	0.016	U	0.022	U	0.029	U	0.02	U	2.1		0.018	U	0.04	U
	2/3/2005	MW-207D	0.028	J	0.05	U	0.05	U	0.05	U	2.6		0.05	U	0.05	U
	5/9/2005	MW-207D	0.1	U	0.1	U	0.1	U	0.1	U	5.4		0.1	U	0.1	U
	8/2/2005	MW-207D	0.1	U	0.1	U	0.1	U	0.1	U	4.9		0.062	J	0.1	U
	11/28/2005	MW-207D	0.1	U	0.1	U	0.1	U	0.1	U	5.6		0.1		0.1	U
	2/22/2006	MW-207D	0.02	U	0.02	U	0.01	U	0.02	U	5.5		0.15		0.02	U
	5/3/2006	MW-207D	0.0095		0.002	U	0.0022		0.0021		6.7		0.16		0.002	U
	8/21/2006	MW-207D	0.0093		0.002	U	0.0013		0.0055		14	D	0.18		0.002	U
	11/28/2006	MW-207D	0.02	U	0.02	U	0.01	U	0.02	U	10	D	0.15		0.02	U
	2/17/2007	MW-207D	0.2	U	0.2	U	0.1	U	0.2	U	7.7		0.2	U	0.2	U
	5/20/2007	MW-207D	0.02	U	0.02	U	0.01	U	0.02	U	2		0.044		0.02	U
	8/14/2007	MW-207D	0.02	U	0.02	U	0.01	U	0.02	U	0.22		0.02	U	0.02	U
	11/1/2007	MW-207D	0.0041		0.002	U	0.001	U	0.019		3.6		0.18		0.002	U
	2/7/2008	MW-207D	0.002	U	0.002	U	0.001	U	0.019		1.6		0.076		0.002	U
	5/6/2008	MW-207D	0.02	U	0.02	U	0.01	U	0.036		4.7		0.15		0.02	U
	8/20/2008	MW-207D	0.04	U	0.04	U	0.02	U	0.04	U	4.8		0.14		0.04	U
	11/11/2008	MW-207D	0.01	U	0.01	U	0.01	U	0.01	U	4.4		0.14		0.01	U
	2/25/2009	MW-207D	0.01	U	0.01	U	0.01	U	0.01	U	3.6		0.11		0.01	U
	8/27/2009	MW-207D	0.01	U	0.01	U	0.01	U	0.01	U	3.2		0.089		0.01	U
	2/11/2010	MW-207 D	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.14		0.0022		0.0005	U
	8/30/2010	MW-207 D	0.002	U	0.002	U	0.001	U	0.022		4.1		0.016		0.002	
	2/28/2011	MW-207D	0.002	U	0.002	U	0.001	U	0.002	U	0.01		0.002	U	0.002	U
	8/23/2011	MW-207D	0.002	U	0.002	U	0.001	U	0.03		1.1		0.023		0.002	U
	2/8/2012	MW-207D	0.002	U	0.002	U	0.001	U	0.002	U	0.034		0.002	U	0.002	U
	8/28/2012	MW-207D	0.002	U	0.002	U	0.001	U	0.002	U	0.12		0.002	U	0.002	U
	2/13/2013	MW-207D	0.001	U	0.001	U	0.001	U	0.001	U	0.0025		0.001	U	0.002	U
8/12/2013	MW-207D	0.001	U	0.001	U	0.001	U	0.0021		0.074		0.0013		0.002	U	
11/12/2013	MW-207D	0.001	U	0.001	U	0.001	U	0.0017		0.1		0.0015		0.002	U	
2/14/2014	MW 207D	0.002	U	0.002	U	0.002	U	0.11		0.083		0.0098		0.004	U	
5/1/2014	MW-207D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.002	U	

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride		
Units:		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		
RI GB:		3.1		NS		0.007		2.4		0.15		0.54		NS		
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-207D	8/22/2014	MW-207D	9.4E-05	U	0.00016	U	0.00021	U	0.018		0.011		0.0016		0.00013	U
	11/24/2014	MW-207D	0.001	U	0.001	U	0.001	U	0.001	U	0.0033		0.001	U	0.002	U
	3/26/2015	MW-207D	0.001	U	0.001	U	0.001	U	0.001	U	0.0031		0.001	U	0.002	U
	5/12/2015	MW-207D	0.001	U	0.001	U	0.001	U	0.001	U	0.0074		0.001	U	0.002	U
	8/5/2015	MW-207D	0.001	U	0.001	U	0.001	U	0.001	U	0.022		0.002		0.002	U
	11/5/2015	MW 207D	0.001	U	0.001	U	0.001	U	0.017		0.009		0.0018		0.002	U
	5/4/2016	MW-207D	0.001	U	0.001	U	0.001	U	0.001	U	0.013		0.0015		0.002	U
	11/1/2016	MW 207D	0.001	U	0.001	U	0.001	U	0.001	U	0.0018		0.001	U	0.002	U
	5/16/2017	MW-207D	0.001	U	0.001	U	0.001	U	0.004		0.0043		0.001	U	0.002	U
11/28/2017	MW-207D	0.001	U	0.001	U	0.001	U	0.001	U	0.0021		0.001	U	0.002	U	
MW-207S	3/4/2002	MW-207S	0.1	U	0.1	U	0.1	U	0.1	U	4		0.1	U	0.2	U
	5/8/2002	MW-207S	0.1	U	0.1	U	0.1	U	0.1	U	3.89		0.1	U	0.2	U
	7/8/2002	MW-207S	0.1	U	0.1	U	0.1	U	0.1	U	3.64		0.1	U	0.2	U
	10/2/2002	MW-207S	0.05	U	0.05	U	0.05	U	0.05	U	1.96		0.05	U	0.1	U
	1/15/2003	MW-207S	0.05	U	0.05	U	0.05	U	0.05	U	1.58		0.05	U	0.05	U
	4/2/2003	MW-207S	0.05	U	0.05	U	0.05	U	0.05	U	2.2		0.05	U	0.05	U
	3/30/2004	MW-207S	0.0008	U	0.0011	U	0.0014	U	0.001	U	0.18		0.0009	U	0.002	U
	2/3/2005	MW-207S	0.025	J	0.05	U	0.05	U	0.05	U	4.4		0.05	U	0.05	U
	5/9/2005	MW-207S	0.025	U	0.025	U	0.025	U	0.025	U	1.2		0.025	U	0.025	U
	8/2/2005	MW-207S	0.12	U	0.12	U	0.12	U	0.12	U	7		0.12	U	0.12	U
	11/28/2005	MW-207S	0.2	U	0.2	U	0.2	U	0.2	U	8.4		0.2	U	0.2	U
	2/22/2006	MW-207S	0.015		0.0033		0.0021		0.002	U	5.7		0.12		0.002	U
	5/3/2006	MW-207S	0.015		0.0039		0.0022		0.017		9.7		0.13		0.002	U
	8/21/2006	MW-207S	0.0023		0.002	U	0.001	U	0.012		18	D	0.023		0.002	U
	11/28/2006	MW-207S	0.02	U	0.02	U	0.01	U	0.045		8.1	D	0.09		0.02	U
	2/17/2007	MW-207S	0.2	U	0.2	U	0.1	U	0.2	U	12		0.2	U	0.2	U
	5/20/2007	MW-207S	0.02	U	0.02	U	0.01	U	0.02	U	7.6		0.14		0.02	U
	8/14/2007	MW-207S	0.1	U	0.1	U	0.05	U	0.1	U	4.4		0.14		0.1	U
	11/1/2007	MW-207S	0.04	U	0.04	U	0.02	U	0.04	U	3.3		0.12		0.04	U
	2/7/2008	MW-207S	0.04	U	0.04	U	0.02	U	0.04	U	1.3		0.073		0.04	U
5/6/2008	MW-207S	0.02	U	0.02	U	0.01	U	0.02	U	1.4		0.079		0.02	U	
8/20/2008	MW-207S	0.02	U	0.02	U	0.01	U	0.02	U	2		0.11		0.02	U	

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride		
Units:		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		
RI GB:		3.1		NS		0.007		2.4		0.15		0.54		NS		
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-207S	11/11/2008	MW-207S	0.005	U	0.005	U	0.005	U	0.005	U	1.8		0.13		0.005	U
	2/25/2009	MW-207S	0.005	U	0.005	U	0.005	U	0.005	U	2		0.088		0.005	U
	8/27/2009	MW-207S	0.005	U	0.005	U	0.005	U	0.034		9.6		0.065		0.005	U
	2/11/2010	MW-207 S	0.005	U	0.005	U	0.005	U	0.028		26		0.093		0.005	U
	8/30/2010	MW-207 S	0.2	U	0.2	U	0.1	U	0.2	U	3.9		0.2	U	0.2	U
	2/28/2011	MW-207S	0.02	U	0.02	U	0.01	U	0.04		1.3		0.045		0.02	U
	8/23/2011	MW-207S	0.11		0.091		0.073		0.002	U	0.25		0.1		0.002	U
	2/8/2012	MW-207S	0.002	U	0.002	U	0.001	U	0.015		0.53		0.023		0.002	U
	8/28/2012	MW-207S	0.02	U	0.02	U	0.01	U	0.02		0.34		0.02	U	0.02	U
	2/13/2013	MW-207S	0.001	U	0.001	U	0.001	U	0.012		0.19		0.0026		0.002	U
	8/12/2013	MW-207S	0.005	U	0.005	U	0.005	U	0.0064		0.24		0.005	U	0.01	U
	11/12/2013	MW-207S	0.005	U	0.005	U	0.005	U	0.014		1.6		0.0064		0.01	U
	2/14/2014	MW 207S	0.004	U	0.004	U	0.004	U	0.016		0.25		0.007		0.008	U
	5/1/2014	MW-207S	0.001	U	0.001	U	0.001	U	0.001	U	0.0022		0.001	U	0.002	U
	8/22/2014	MW-207S	9.4E-05	U	0.001		0.00021	U	0.0032		0.062		0.0037		0.00013	U
	11/24/2014	MW-207S	0.001	U	0.001	U	0.001	U	0.001	U	0.003		0.001	U	0.002	U
3/26/2015	MW-207S	0.001	U	0.001	U	0.001	U					0.0021		0.002	U	
8/5/2015	MW-207S	0.001	U	0.001	U	0.001	U	0.001	U	0.018		0.0022		0.002	U	
MW-209D	3/31/2004	MW-209D	0.008	U	0.011	U	0.014	U	0.01	U	0.65		0.26		0.02	U
	11/29/2004	MW-209D	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U
	5/10/2005	MW-209D	0.01	U	0.01	U	0.01	U	0.01	U	0.54		0.056		0.01	U
	8/2/2005	MW-209D	0.01	U	0.01	U	0.01	U	0.0053	J	0.72		0.11		0.01	U
	11/28/2005	MW-209D	0.05	U	0.05	U	0.05	U	0.05	U	1.7		0.19		0.05	U
	2/24/2006	MW-209D	0.002	U	0.002	U	0.0011		0.0032		0.44		0.044		0.002	U
	5/3/2006	MW-209D	0.002	U	0.002	U	0.0011		0.0029		0.5		0.037		0.002	U
	8/22/2006	MW-209D	0.02	U	0.02	U	0.01	U	0.02	U	0.31		0.034		0.02	U
	11/28/2006	MW-209D	0.02	U	0.02	U	0.01	U	0.02	U	1.6		0.18		0.02	U
	2/17/2007	MW-209D	0.02	U	0.02	U	0.01	U	0.02	U	0.43		0.11		0.02	U
	8/14/2007	MW-209D	0.02	U	0.02	U	0.01	U	0.02	U	0.52		0.074		0.02	U
	11/1/2007	MW-209D	0.02	U	0.02	U	0.01	U	0.02	U	0.37		0.037		0.02	U
2/7/2008	MW-209D	0.002	U	0.002	U	0.001	U	0.0023		0.074		0.024		0.002	U	
5/6/2008	MW-209D	0.002	U	0.002	U	0.001	U	0.0022		0.16		0.02		0.002	U	

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1-Trichloroethane	1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride			
Units:		MG/L	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L			
RI GB:		3.1	NS		0.007		2.4		0.15		0.54		NS			
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-209D	8/20/2008	MW-209D	0.002	U	0.002	U	0.004		0.01		0.69		0.19		0.002	U
	11/11/2008	MW-209D	0.005	U	0.005	U	0.012		0.005	U	2.9		0.2		0.005	U
	2/25/2009	MW-209D	0.005	U	0.005	U	0.005	U	0.005	U	0.78		0.28		0.005	U
	8/28/2009	MW-209D	0.005	U	0.005	U	0.005	U	0.005	U	0.49		0.12		0.005	U
	2/11/2010	MW-209 D	0.0005	U	0.0005	U	0.0041		0.011		0.81		0.36		0.0005	U
	8/30/2010	MW-209 D	0.02	U	0.02	U	0.01	U	0.02	U	0.62		0.071		0.02	U
	2/28/2011	MW-209D	0.02	U	0.02	U	0.01	U	0.02	U	1.4		0.26		0.02	U
	8/23/2011	MW-209D	0.02	U	0.02	U	0.01	U	0.02	U	1.5		0.2		0.02	U
	2/9/2012	MW-209D	0.23		0.02	U	0.01	U	0.29		0.6		0.16		0.02	U
8/5/2015	MW-209D	0.01	U	0.01	U	0.01	U	0.017		0.27		0.043		0.02	U	
MW-210	4/20/2006	MW-210	0.5	U	0.5	U	0.5	U	0.5	U	13		0.41	J	0.5	U
MW-211	4/20/2006	MW-211	0.5	U	0.5	U	0.5	U	0.5	U	33		0.5	U	0.5	U
MW-213	4/20/2006	MW-213	0.2	U	0.2	U	0.2	U	0.2	U	4.9		0.19	J	0.2	U
MW-216D	5/10/2006	MW-216D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.0042		0.002	U
	11/28/2006	MW-216D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.0045		0.002	U
	2/17/2007	MW-216D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.0064		0.002	U
	5/20/2007	MW-216D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.0052		0.002	U
	8/14/2007	MW-216D	0.002	U	0.002	U	0.001	U	0.002	U	0.0067		0.0034		0.002	U
	11/1/2007	MW-216D	0.002	U	0.002	U	0.001	U	0.002	U	0.002		0.0021		0.002	U
	2/7/2008	MW-216D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	5/7/2008	MW-216D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.0044		0.002	U
	8/20/2008	MW-216D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.0022		0.002	U
	11/11/2008	MW-216D	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0029		0.0005	U
	2/25/2009	MW-216D	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0039		0.0005	U
	8/28/2009	MW-216D	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0031		0.0005	U
	2/11/2010	MW-216 D	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0022		0.0005	U
	8/30/2010	MW-216 D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.0023		0.002	U
	2/28/2011	MW-216D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	8/23/2011	MW-216D	0.002	U	0.002	U	0.001	U	0.003		0.002	U	0.002	U	0.0039	
	2/9/2012	MW-216D	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
8/4/2015	MW-216D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.0022		0.002	U	
1/16/2018	MW-216D	0.001	U	0.001	U	0.001	U	0.0006	U	0.001	U	0.0028		0.001	U	

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1- Trichloroethane	1,1- Dichloroethane		1,1- Dichloroethene		cis-1,2- Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride	
Units:		MG/L	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L	
RI GB:		3.1	NS		0.007		2.4		0.15		0.54		NS	
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-216S	5/10/2006	MW-216S	0.002	U	0.002	U	0.001	U	0.17		0.002	U	0.002	U
	11/28/2006	MW-216S	0.002	U	0.002	U	0.001	U	0.14		0.002	U	0.002	U
	2/17/2007	MW-216S	0.002	U	0.002	U	0.001	U	0.14		0.002	U	0.002	U
	5/20/2007	MW-216S	0.002	U	0.002	U	0.001	U	0.1		0.002	U	0.002	U
	8/14/2007	MW-216S	0.002	U	0.002	U	0.001	U	0.06		0.007		0.002	U
	11/1/2007	MW-216S	0.002	U	0.002	U	0.001	U	0.064		0.0022		0.002	U
	2/7/2008	MW-216S	0.002	U	0.0021		0.001	U	0.058		0.002	U	0.002	U
	5/7/2008	MW-216S	0.002	U	0.002	U	0.001	U	0.054		0.0022		0.002	U
	8/20/2008	MW-216S	0.002	U	0.002		0.001	U	0.063		0.002	U	0.002	U
	11/11/2008	MW-216S	0.0005	U	0.0035		0.0005	U	0.1		0.0005	U	0.0005	U
	2/25/2009	MW-216S	0.0005	U	0.0005	U	0.0005	U	0.076		0.0005	U	0.0005	U
	8/28/2009	MW-216S	0.0005	U	0.002		0.0005	U	0.059		0.0005	U	0.0005	U
	2/11/2010	MW-216 S	0.0005	U	0.002		0.0005	U	0.066		0.0005	U	0.0005	U
	8/30/2010	MW-216 S	0.002	U	0.002	U	0.001	U	0.049		0.002	U	0.002	U
	2/28/2011	MW-216S	0.002	U	0.002	U	0.001	U	0.066		0.002	U	0.002	U
	8/23/2011	MW-216S	0.002	U	0.002	U	0.001	U	0.052		0.002	U	0.002	U
2/9/2012	MW-216S	0.002	U	0.002	U	0.001	U	0.062		0.002	U	0.002	U	
8/4/2015	MW-216S	0.002	U	0.002	U	0.002	U	0.11		0.002	U	0.002	U	
1/16/2018	MW-216S	0.001	U	0.0004	U	0.0006	U	0.228	D	0.0009	U	0.0007	U	
MW-217D	5/10/2006	MW-217D	0.002	U	0.002	U	0.001	U	0.068		0.002	U	0.069	
	11/28/2006	MW-217D	0.002	U	0.002	U	0.001	U	0.037		0.002	U	0.071	
	2/17/2007	MW-217D	0.002	U	0.002	U	0.001	U	0.06		0.002	U	0.075	
	5/20/2007	MW-217D	0.002	U	0.002	U	0.001	U	0.062		0.0037		0.049	
	8/14/2007	MW-217D	0.002	U	0.002	U	0.001	U	0.13		0.0087		0.044	
	11/1/2007	MW-217D	0.002	U	0.002	U	0.001	U	0.043		0.002	U	0.027	
	2/7/2008	MW-217D	0.002	U	0.002	U	0.001	U	0.042		0.002	U	0.023	
	5/7/2008	MW-217D	0.002	U	0.002	U	0.001	U	0.027		0.002	U	0.0035	
	8/20/2008	MW-217D	0.002	U	0.002	U	0.001	U	0.11		0.002	U	0.025	
	11/11/2008	MW-217D	0.0005	U	0.0005	U	0.0005	U	0.031		0.0041		0.024	
	2/25/2009	MW-217D	0.0005	U	0.0005	U	0.0005	U	0.017		0.0005	U	0.0005	U
	8/28/2009	MW-217D	0.0005	U	0.0005	U	0.0005	U	0.026		0.0005	U	0.011	
2/11/2010	MW-217 D	0.0005	U	0.0005	U	0.0005	U	0.0086		0.0005	U	0.012		

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1- Trichloroethane	1,1- Dichloroethane		1,1- Dichloroethene		cis-1,2- Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride			
Units:		MG/L	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L			
RI GB:		3.1	NS		0.007		2.4		0.15		0.54		NS			
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q		
MW-217D	8/30/2010	MW-217 D	0.002	U	0.002	U	0.001	U	0.063		0.002	U	0.008		0.002	U
	2/28/2011	MW-217D	0.002	U	0.002	U	0.001	U	0.028		0.002	U	0.0088		0.002	U
	8/23/2011	MW-217D	0.002	U	0.002	U	0.001	U	0.0091		0.002	U	0.0062		0.002	U
	2/9/2012	MW-217D	0.002	U	0.002	U	0.001	U	0.0046		0.002	U	0.0081		0.002	U
	8/4/2015	MW-217D	0.001	U	0.001	U	0.001	U	0.015		0.001	U	0.0065		0.002	U
	1/16/2018	MW-217D	0.001	U	0.0003	U	0.0007	U	0.0679		0.001	U	0.0118		0.0058	
MW-217S	5/10/2006	MW-217S	0.002	U	0.002	U	0.001	U	0.033		0.002	U	0.002	U	0.002	U
	11/28/2006	MW-217S	0.002	U	0.002	U	0.001	U	0.0053		0.016		0.002	U	0.002	U
	2/17/2007	MW-217S	0.002	U	0.002	U	0.001	U	0.0098		0.023		0.002	U	0.002	U
	5/20/2007	MW-217S	0.002	U	0.002	U	0.001	U	0.011		0.021		0.002	U	0.002	U
	8/14/2007	MW-217S	0.002	U	0.002	U	0.001	U	0.053		0.02		0.002	U	0.002	U
	11/1/2007	MW-217S	0.002	U	0.002	U	0.001	U	0.066		0.011		0.002	U	0.002	U
	2/7/2008	MW-217S	0.002	U	0.002	U	0.001	U	0.025		0.0078		0.002	U	0.002	U
	5/7/2008	MW-217S	0.002	U	0.002	U	0.001	U	0.039		0.0081		0.002	U	0.0021	
	8/20/2008	MW-217S	0.002	U	0.002	U	0.001	U	0.055		0.0034		0.002	U	0.0049	
	11/11/2008	MW-217S	0.0005	U	0.0005	U	0.0005	U	0.11		0.0061		0.0005	U	0.01	
	2/25/2009	MW-217S	0.0005	U	0.0005	U	0.0005	U	0.017		0.016		0.0005	U	0.003	
	8/28/2009	MW-217S	0.0005	U	0.0005	U	0.0005	U	0.076		0.0086		0.0005	U	0.0041	
	2/11/2010	MW-217 S	0.0005	U	0.0005	U	0.0005	U	0.021		0.017		0.0005	U	0.0005	U
	8/30/2010	MW-217 S	0.002	U	0.002	U	0.001	U	0.031		0.016		0.002	U	0.011	
	2/28/2011	MW-217S	0.002	U	0.002	U	0.001	U	0.0068		0.012		0.0024		0.011	
	8/23/2011	MW-217S	0.12		0.088		0.001	U	0.097		0.004		0.002	U	0.012	
	2/9/2012	MW-217S	0.002	U	0.002	U	0.001	U	0.0041		0.017		0.002	U	0.002	U
8/4/2015	MW-217S	0.001	U	0.001	U	0.001	U	0.0074		0.0016		0.001	U	0.0025		
1/16/2018	MW-217S	0.001	U	0.001	U	0.001	U	0.0002	U	0.0007	U	0.0008	U	0.001	U	
MW-218D	5/10/2006	MW-218D	0.002	U	0.002	U	0.019		0.025		0.99		0.44		0.002	U
	11/28/2006	MW-218D	0.02	U	0.02	U	0.014		0.054		1.1		0.43		0.02	U
	2/17/2007	MW-218D	0.02	U	0.02	U	0.023		0.028		0.6		0.84		0.02	U
	5/20/2007	MW-218D	0.02	U	0.02	U	0.02		0.076		0.65		0.8		0.02	U
	8/14/2007	MW-218D	0.02	U	0.02	U	0.026		0.031		0.74		0.88		0.02	U
	11/1/2007	MW-218D	0.02	U	0.02	U	0.02		0.026		0.6		0.88		0.02	U
	2/7/2008	MW-218D	0.02	U	0.02	U	0.022		0.02	U	1.4		0.58		0.02	U

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1-Trichloroethane		1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride		
Units:		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		
RI GB:		3.1		NS		0.007		2.4		0.15		0.54		NS		
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-218D	5/6/2008	MW-218D	0.02	U	0.02	U	0.013		0.022		0.9		0.5		0.02	U
	8/20/2008	MW-218D	0.02	U	0.02	U	0.019		0.02	U	1.1		0.45		0.02	U
	11/11/2008	MW-218D	0.005	U	0.005	U	0.017		0.005	U	1.2		0.42		0.005	U
	2/25/2009	MW-218D	0.005	U	0.005	U	0.014		0.023		0.84		0.67		0.005	U
	8/27/2009	MW-218D	0.005	U	0.005	U	0.005	U	0.005	U	0.8		0.078		0.005	U
	2/11/2010	MW-218 D	0.005	U	0.005	U	0.005	U	0.005	U	0.59		0.038		0.005	U
	8/30/2010	MW-218 D	0.02	U	0.02	U	0.01	U	0.02	U	0.4		0.028		0.02	U
	2/28/2011	MW-218D	0.02	U	0.02	U	0.01	U	0.02	U	0.3		0.02	U	0.02	U
	8/23/2011	MW-218D	0.002	U	0.002	U	0.001	U	0.002	U	0.3		0.012		0.002	U
	2/8/2012	MW-218D	0.002	U	0.002	U	0.001	U	0.0027		0.23		0.017		0.002	U
	8/4/2015	MW-218D	0.001	U	0.001	U	0.001	U	0.001	U	0.39		0.017		0.002	U
	1/19/2018	MW-218D	0.0024		0.001	U	0.001	U	0.0033		17.2	D	0.0572		0.001	U
4/18/2018	DUP-01	0.0023		0.001	U	0.0026		0.0127		7.74	D	0.0859		0.001	U	
	MW-218D	0.002		0.001	U	0.0026		0.0114		7.94	D	0.0791		0.001	U	
MW-218S	5/10/2006	MW-218S	0.002	U	0.002	U	0.001	U	0.45		0.29		0.025		0.022	
	11/28/2006	MW-218S	0.02	U	0.02	U	0.01	U	0.27		0.7		0.028		0.026	
	2/17/2007	MW-218S	0.02	U	0.02	U	0.01	U	0.65		0.37		0.049		0.05	
	5/20/2007	MW-218S	0.02	U	0.02	U	0.02		0.085		0.62		0.73		0.02	U
	8/14/2007	MW-218S	0.02	U	0.02	U	0.01	U	0.55		0.39		0.02	U	0.036	
	11/1/2007	MW-218S	0.02	U	0.02	U	0.01	U	0.11		0.28		0.02	U	0.02	U
	2/7/2008	MW-218S	0.02	U	0.02	U	0.01	U	0.087		0.17		0.02	U	0.02	U
	5/6/2008	MW-218S	0.002	U	0.002	U	0.0018		0.44		0.36		0.045		0.03	
	8/20/2008	MW-218S	0.02	U	0.02	U	0.01	U	0.59		0.1		0.025		0.042	
	11/11/2008	MW-218S	0.005	U	0.005	U	0.005	U	0.59		0.078		0.005	U	0.062	
	2/25/2009	MW-218S	0.0005	U	0.0005	U	0.001		0.55		0.1		0.013		0.025	
	8/27/2009	MW-218S	0.0005	U	0.0005	U	0.0005	U	0.0047		0.017		0.0005	U	0.0025	
	2/11/2010	MW-218 S	0.0005	U	0.0005	U	0.0005	U	0.0034		0.0005	U	0.0005	U	0.0031	
	8/30/2010	MW-218 S	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	2/28/2011	MW-218S	0.002	U	0.002	U	0.001	U	0.002	U	0.002	U	0.002	U	0.002	U
	8/23/2011	MW-218S	0.002	U	0.002	U	0.001	U	0.002	U	0.0023		0.002	U	0.002	U
2/8/2012	MW-218S	0.002	U	0.002	U	0.001	U	0.0085		0.0023		0.002	U	0.0045		
8/4/2015	MW-218S	0.001	U	0.001	U	0.001	U	0.001	U	0.012		0.001	U	0.002	U	

**Appendix H**  
**Groundwater Results**  
**Former Gorham Manufacturing Site**  
**Providence, RI**

Analyte:		1,1,1-Trichloroethane	1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride	
Units:		MG/L	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L	
RI GB:		3.1	NS		0.007		2.4		0.15		0.54		NS	
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
MW-218S	1/19/2018	MW-218S	0.001	U	0.001	U	0.001	U	0.001	U	2.71	D	0.0032	U
	4/18/2018	MW-218S	0.001	U	0.001	U	0.001	U	0.001	U	0.127	D	0.001	U
MW-220S	3/30/2004	MW-220	0.0008	U	0.0011	U	0.0014	U	0.001	U	0.15	U	0.0009	U
	3/1/2007	MW-220S	0.21	U	0.29	U	0.011	U	0.24	U	0.02	U	0.049	U
	3/31/2008	MW 220S01	0.0696	U	0.131	D	0.0045	U	0.108	D	0.0011	U	0.0232	U
MW-221S	3/1/2007	MW-221S	0.025	U	0.14	U	0.0012	U	0.0085	U	0.0045	U	0.012	U
	3/31/2008	MW 221S01	0.0248	U	0.102	D	0.001	U	0.0264	U	0.003	U	0.0175	U
MW-222S	11/19/2007	MW-222S	7.42	D	5.79	D	0.287	D	0.404	D	0.0128	U	7.09	D
	3/28/2008	MW222S01	4.55	D	0.27	D	0.139	D	0.1	UD	0.1	UD	2.07	D
MW-223D	3/27/2008	MW223D01	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U
	1/17/2018	MW-223D	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.0004	U
MW-223S	11/19/2007	MW-223S	0.0656	U	0.0023	U	0.0011	U	0.001	U	0.001	U	0.0077	U
	3/27/2008	MW223S01	0.022	U	0.0012	U	0.001	U	0.001	U	0.001	U	0.0027	U
	1/18/2018	MW-223S	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U
MW-224S	11/19/2007	MW-224S	1.75	D	0.19	D	0.0525	U	0.0925	D	0.0021	U	0.883	D
		MW-224S-Dup	1.96	D	0.19	D	0.0618	U	0.0955	D	0.0022	U	0.878	D
	3/28/2008	MW224S01	17.8	D	0.577	D	0.447	D	0.244	D	0.1	UD	6.44	D
	1/18/2018	MW-224S	0.001	U	0.0014	U	0.001	U	0.001	U	0.001	U	0.0089	U
MW-225D/DP-6	3/27/2008	MW225D01	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.0159	U
	1/17/2018	MW-225D	0.001	U	0.0002	U	0.0003	U	0.0005	U	0.001	U	0.0032	U
MW-225S	3/27/2008	MW225S01	0.0609	U	0.0311	U	0.0033	U	0.0433	U	0.001	U	0.0114	U
	1/17/2018	DUP-01	0.001	U	0.001	U	0.001	U	0.001	U	0.0005	U	0.0005	U
		MW-225S	0.001	U	0.001	U	0.001	U	0.001	U	0.0006	U	0.0004	U
MW-226D/DP-5	4/2/2008	MW 226D01	0.0045	U	0.0069	U	0.0798	U	0.162	D	0.0107	U	4.87	D
	1/18/2018	MW-226D	0.0108	U	0.0124	U	0.0688	U	0.2	D	0.0083	U	2.25	D
MW-226S	4/2/2008	MW 226S01	0.348	D	0.0632	U	0.0099	U	0.014	U	0.418	D	0.324	D
	1/18/2018	MW-226S	0.006	U	0.001	U	0.001	U	0.0061	U	0.331	D	0.0397	U
MW-227D	3/31/2008	MW 227D01	0.224	D	0.0143	U	0.158	D	0.0985	D	0.0047	U	3.94	D
	1/18/2018	MW-227D	0.005	U	0.0056	U	0.0074	U	0.0116	U	0.0026	U	0.667	D
MW-227S	3/31/2008	MW 227S01	0.432	D	0.105	D	0.0128	U	0.0389	U	0.0221	U	0.348	D
		MW 227S01 Dup	0.4	D	0.101	D	0.013	U	0.0384	U	0.0213	U	0.312	D
	1/17/2018	MW-227S	0.0455	U	0.02	U	0.0027	U	0.0005	U	0.01	U	0.107	D

**Appendix H**  
**Groundwater Results**  
**Former Gorham Manufacturing Site**  
**Providence, RI**

Analyte:		1,1,1-Trichloroethane	1,1-Dichloroethane		1,1-Dichloroethene		cis-1,2-Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride			
Units:		MG/L	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L			
RI GB:		3.1	NS		0.007		2.4		0.15		0.54		NS			
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q		
MW-228D/DP-4	4/1/2008	MW 228D01	0.0035		0.0097		0.0422		0.0764		0.0054		0.912	D	0.0019	
	1/16/2018	MW-228D	0.0043		0.0039		0.0203		0.0469		0.0011		0.727	D	0.0007	U
MW-228S	4/1/2008	MW 228S01	0.114	D	0.0443		0.0103		0.0165		3.61	D	0.578	D	0.001	U
		MW 228S01 Dup	0.106	D	0.0432		0.0096		0.0162		3.52	D	0.542	D	0.001	U
	1/17/2018	DUP-02	0.0914		0.0123		0.0217		0.0047		1.16	D	0.152	D	0.001	U
		MW-228S	0.0965		0.0128		0.0232		0.0049		1.19	D	0.152	D	0.001	U
MW-229S	4/2/2008	MW 229S01	0.001	U	0.001	U	0.001	U	0.001	U	0.0744	D	0.001	U	0.001	U
MW-231D	12/1/2009	GWMW231D	0.001	U	0.0024		0.0014		0.0987	D	0.001	U	0.0452		0.0039	
	1/19/2018	MW-231D	0.0026		0.001	U	0.0026		0.0074		0.001		0.0271		0.0023	
MW-231S	12/1/2009	GWMW231S	0.001	U	0.0014		0.0026		0.0342		0.0104		0.0293		0.0203	
	1/19/2018	MW-231S	0.001	U	0.001	U	0.001	U	0.0086		0.001	U	0.001	U	0.0097	
MW-232D	12/1/2009	GWMW232D	0.333	D	0.0317		0.0485		0.0644		0.0008	J	0.601	D	0.0013	
	1/19/2018	MW-232D	0.001	U	0.001	U	0.001	U	0.0011		0.001	U	0.001	U	0.001	U
MW-232S	12/1/2009	GWMW232S	0.189	D	0.0952	D	0.0964		0.118	D	0.0228		1	D	0.0023	
	1/19/2018	MW-232S	0.0077		0.01		0.001	U	0.0047		0.001	U	0.001		0.001	U
MW-234D	12/2/2009	GWMW234D	0.012		0.0037		0.0196		0.0979		0.001	U	0.0232		0.0027	
	1/18/2018	MW-234D	0.001	U	0.001	U	0.0022		0.0158		0.001	U	0.0022		0.001	U
MW-234S	11/30/2009	GWMW234S	1.06	D	0.166	D	0.0371		0.1	D	0.0026		0.489	D	0.0005	J
	1/18/2018	MW-234S	0.001	U	0.0043		0.001	U	0.001	U	0.001	U	0.001	U	0.001	U
MW-308	1/21/2008	GSP MW-308	0.0066		0.0028		0.001	U	0.001	U	0.0014		0.0045		0.001	U
MW-GZA3	3/19/1986	GZA-3	0.001	U	0.001	U	0.001				0.15		0.1		0.001	U
	9/21/1994	GMGZAX3XXX01XX	0.01		0.005		0.005	U	0.012		0.013		0.03		0.01	U
	9/27/1995	GMGZAX3XXX02XD	0.005	U	0.006		0.005	U	0.022		0.006		0.019		0.01	U
		GMGZAX3XXX02XX	0.005	U	0.005		0.005	U	0.019		0.007		0.016		0.01	U
	10/16/1997	GZA-3	0.005	U	0.01		0.005	U	0.027		0.005	U	0.006		0.014	
	12/9/1998	GZA-3	0.001	U	0.016		0.004		0.041		0.024		0.044		0.007	
		GZA-3Dup	0.001	U	0.016		0.004		0.04		0.023		0.041		0.007	
	8/14/2007	GZA-3	0.002	U	0.0024		0.001	U	0.0098		0.002	U	0.0036		0.0051	
	2/7/2008	GZA-3	0.002	U	0.0026		0.001	U	0.02		0.002	U	0.0025		0.0086	
	8/20/2008	GZA-3	0.002	U	0.0024		0.001	U	0.0092		0.002	U	0.0027		0.024	
	2/25/2009	GZA-3	0.0005	U	0.0005	U	0.0005	U	0.0095		0.0005	U	0.0042		0.013	
9/4/2009	GZA-3	0.0005	U	0.0005	U	0.0017		0.033		0.003		0.024		0.02		

**Appendix H  
Groundwater Results  
Former Gorham Manufacturing Site  
Providence, RI**

Analyte:		1,1,1- Trichloroethane	1,1- Dichloroethane		1,1- Dichloroethene		cis-1,2- Dichloroethene		Tetrachloroethene		Trichloroethene		Vinyl chloride			
Units:		MG/L	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L			
RI GB:		3.1	NS		0.007		2.4		0.15		0.54		NS			
Location	Sample Date	Sample ID	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q		
MW-GZA3	2/11/2010	GZA-3	0.0005	U	0.0005	U	0.0018		0.057		0.0037		0.029		0.0095	
	8/31/2010	GZA-3	0.002	U	0.002	U	0.0012		0.042		0.002	U	0.016		0.014	
	2/28/2011	GZA-3	0.002	U	0.002	U	0.0013		0.071		0.002	U	0.018		0.012	
	8/23/2011	GZA-3	0.002	U	0.002	U	0.0011		0.057		0.002	U	0.02		0.0069	
	2/9/2012	GZA-3	0.002	U	0.002	U	0.0012		0.077		0.002	U	0.02		0.0076	
	8/28/2012	GZA-3	0.002	U	0.002	U	0.0014		0.099		0.002	U	0.013		0.015	
	2/13/2013	GZA-3	0.001	U	0.0011		0.0011		0.058		0.001	U	0.0032		0.027	
	8/13/2013	GZA-3	0.001	U	0.0011		0.001	U	0.034		0.001	U	0.0028		0.033	
	11/13/2013	GZA-3	0.001	U	0.0011		0.001	U	0.055		0.001	U	0.0015		0.019	
	3/6/2014	GZA-3	0.001	U	0.0014		0.001	U	0.047		0.001	U	0.0042		0.03	
	5/2/2014	GZA-3	0.001	U	0.0012		0.001	U	0.076		0.001	U	0.0018		0.015	
	8/22/2014	GZA-3	0.00019	U	0.00032	U	0.00042	U	0.03		0.00016	U	0.00015	U	0.03	
	11/24/2014	GZA-3	0.001	U	0.0015		0.001	U	0.0092		0.001	U	0.001	U	0.051	
	3/26/2015	GZA-3	0.001	U	0.001	U	0.001	U	0.016		0.001	U	0.001	U	0.031	
	5/12/2015	GZA3	0.001	U	0.001	U	0.001	U	0.0086		0.001	U	0.001	U	0.028	
	8/5/2015	GZA-3	0.001	U	0.001	U	0.001	U	0.0085		0.001	U	0.001	U	0.012	
	11/5/2015	GZA-3	0.001	U	0.0012		0.001	U	0.0035		0.001	U	0.001	U	0.018	
	5/5/2016	GZA-3	0.001	U	0.001	U	0.001	U	0.0091		0.001	U	0.001	U	0.0085	
11/2/2016	GZA-3	0.001	U	0.001	U	0.001	U	0.0055		0.001	U	0.001	U	0.017		
5/17/2017	GZA-3	0.001	U	0.001	U	0.001	U	0.0026		0.001	U	0.001	U	0.012		
12/11/2017	GZA-3	0.001	U	0.0012		0.001	U	0.001	U	0.001	U	0.001	U	0.018		

Notes:  
 mg/L - milligrams per liter  
 NS - No Standard Established  
 U - Not detected  
 J - Estimated Value  
 D - Dilution  
 Yellow highlighted cells exceed the applicable GB Criteria

Prepared by: AJN 8/22/18 Reviewed by: HWC 8/22/18
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