REDACTED VERSION

Final Remedial Design Report
Soil Vapor Extraction System
Circle Court Ground Water Plume Superfund Site
Willow Park, Parker County, Texas
EPA Identification No.: TXN000606965

Remedial Acquisition Framework
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ACRONYMS AND ABBREVIATIONS

µg/L	Microgram(s) per liter
µg/m^3	Microgram(s) per cubic meter
amsl	Above mean sea level
ARAR	Applicable or relevant and appropriate requirement
bgs	Below ground surface
btoc	Below top of casing
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Contaminant of concern
DCE	Dichloroethene
EA	EA Engineering, Science, and Technology, Inc., PBC
EPA	U.S. Environmental Protection Agency
ft	Foot (feet)
GAC	Granular activated carbon
HDPE	High-density polyethylene
HP	Horsepower
I-20	U.S. Interstate Highway 20
in.	Inch (inches)
IROD	Interim Record of Decision
MCL	Maximum Contaminant Level
O&M	Operations and maintenance
PVC	Polyvinyl chloride
PWS	Public water supply
RA	Remedial Action
RAO	Remedial Action Objective
RD	Remedial Design
Report	Final Remedial Design Report
RI	Remedial Investigation
ROI	Radius of influence
ROW	Right(s)-of-way

ACRONYMS AND ABBREVIATIONS (CONTINUED)

scfm	Standard cubic foot (feet) per minute
Site	Circle Court Ground Water Plume Superfund Site
SVE	Soil vapor extraction
TCE	Trichloroethene
TCEQ	Texas Commission on Environmental Quality
TDLR	Texas Department of Licensing and Regulation
TEFC	Totally enclosed, fan-cooled
TWDB	Texas Water Development Board
USGS	U. S. Geological Survey
VI	Vapor intrusion
VOC	Volatile organic compound
WBZ	Water-bearing zone

1. INTRODUCTION

EA Engineering, Science, and Technology, Inc., PBC (EA) has prepared this Final Remedial Design Report for the Circle Court Ground Water Plume Superfund Site (Site) under U.S. Environmental Protection Agency (EPA) Remedial Acquisition Framework, Design and Engineering Services Contract No. 68HE0318D0005, Task Order 68HERH23F0156 (EPA Identification No. TXN000606965).

The purpose of this Final Remedial Design Report (Report) is to present the Remedial Design (RD) criteria, basis of the RD, and technical documents for construction of the remedial system. The design is developed in support of the Interim Record of Decision (IROD) for the site (EPA 2022). The *Remedial Design/Remedial Action Handbook* (EPA 1995) was used as guidance for this Report. The Report describes the design criteria, assumptions, design approach, and cost estimate. EA has incorporated comments received from the EPA and other stakeholders on the Preliminary Design Report (EA 2024), which was submitted in March 2024. This Report is the 90 percent completion of the final design. Accordingly, this Report addresses (1) the contaminants of concern (COCs) in the source area within the vadose zone; (2) the physical and chemical characteristics and volumes of the media to be remediated; (3) the remedial strategy; (4) the estimated timeframe to complete the Remedial Action (RA); and (5) the Final RD cost estimate.

In addition to the discussion presented in the text, this Report is supported by documents provided in the following appendixes:

- Appendix A presents the design drawings.
- Appendix B presents the calculations supporting the design.
- Appendix C presents product cut sheets.
- Appendix D presents the specifications.
- Appendix E presents the Final RD cost estimate.

1.1 PROJECT DESCRIPTION

1.1.1 Site Description

The Site is located in Parker County, in part within the City of Hudson Oaks and the City of Willow Park. The Site is to the south of U.S. Interstate Highway 20 (I-20) along an approximately 0.5-mile-long section of Russell Road. Figures 1 and 2 show the Site location and the Site layout, respectively.

1.1.2 Site Geology and Hydrology

The Site is located within the Grand Prairie physiographic province of Texas (Bureau of Economic Geology 1996), with an approximate elevation of 975 feet (ft) above mean sea level (amsl). The local geology consists of thin, calcareous surficial soils underlain by the Walnut Clay Formation, with a thickness of about 30 ft. The Walnut Clay Formation is underlain by the

Paluxy Formation, which is underlain by the Glen Rose Formation and below that, the Twin Mountain Formation.

1.1.2.1 Surficial Geology

Thin surface soils with minimal overburden are present atop the Walnut Clay Formation at the Site, except where fill material has been placed.

1.1.2.2 Walnut Clay Formation

The Walnut Clay Formation is the basal formation of the Fredericksburg Group. It contains beds of clay and limestone in equal abundance, with a total thickness of approximately 30 ft. The bench-forming limestone (Wackestone to Packstone) is locally fossiliferous and nodular, with the abundant presence of Lower Cretaceous Mollusk, *Gryphaea marcoui* (Hill and Vaughn 1898). The basal portion of the Walnut Clay Formation is reported to contain varying amounts of sand (Bureau of Economic Geology 1925), making the boundary with the underlying Paluxy Formation difficult to distinguish.

1.1.2.3 Paluxy Formation

The Paluxy Formation is a water-bearing formation that is the uppermost of the three formations of the Trinity Group Aquifer and underlays the Walnut Clay Formation. The Paluxy Formation outcrops northeast of the Site on the south side of I-20 along Annetta Road. The Paluxy Formation is composed of well-sorted, poorly cemented, fine-grained quartz sands and clays. The Paluxy Formation is composed of three or four generalized zones consisting of beds with thicknesses ranging from approximately 5 to 30 ft, separated by layers of silt and clay of varying thickness. These four zones are referred to as the: (1) Upper Sands, (2) Shallow Water-bearing Zone (WBZ), (3) Intermediate WBZ, and (4) Deep WBZ (EA 2021). The Deep WBZ has historically been considered to be part of the Paluxy Formation: however, it is currently considered to be part of the underlying Glen Rose Formation. While generalized for ease of reference, the local Paluxy Formation represents a complex series of inter-fingered sands and clays. A notable exception to this pattern is MW-12, in which continuous sand was encountered from 40 to 125.5 ft below ground surface (bgs). A cross-section location map and cross-sections showing WBZs within the Paluxy are shown as Figures 3, 4, 5, and 6.

The second sand zone of the Paluxy Formation is the uppermost of the saturated zone, referred to as the Shallow WBZ. This second sand zone appears to be laterally discontinuous and of varying thickness but generally occurs from 75 to 95 ft bgs.

The third sand zone encountered at the Site generally occurs from 130 to 165 ft bgs and is referred to as the Intermediate WBZ. This interval contains more silts and clays than those sands found above and appears to have varying thicknesses. Lignite coal has been noted at varying depths and amounts throughout this zone.

1.1.2.4 Glen Rose Formation

The fourth uppermost sand zone occurs from approximately 170 to 250 ft bgs and is referred to as the Deep WBZ. This interval is predominantly fine-grained quartz sand with more cementation than the other sand zones.

The Glen Rose Formation typically consists primarily of marine carbonates, mainly limestone, with some shale, sandy shale, and anhydrite. The formation yields small amounts of water in localized areas (TCEQ 2012).

1.1.2.5 Twin Mountain Formation

The Twin Mountain Formation is the basal formation of the Trinity Group aquifer and consists mainly of medium- to coarse-grained sands, red and gray clays, and siliceous conglomerates of chert, quartzite, and quartz pebbles. The sand strata are more thickly bedded and larger grained in the lower part of the formation than in the upper and middle parts (TCEQ 2012).

1.1.2.6 Site Hydrology and Hydrogeology

The Site is part of the Trinity River watershed and is underlain by the regionally significant Trinity aquifer; Clear Fork of the Trinity River is located approximately 0.75 miles northeast of the Site. Surface water drains from the topographic highs near Parker County Airport toward low-lying areas in the northeast and southern portions of the Site.

The vadose zone at the Site is composed of the Walnut Clay Formation and the Upper Sands of the Paluxy Formation. The primary lithology of the Walnut Clay Formation suggests low permeability. That is, the migration of fluids and/or vapors through this formation is relatively slow. However, due to the nodular bedding of the Walnut Clay Formation, preferential transport pathways may exist. The Upper Sands of the Paluxy Formation are generally dry. However, while drilling monitoring wells MW-09 and MW-15 and during sampling of soil vapor wells SV-04 and SV-05 (which are located near MW-09 and MW-15), small amounts of water were observed on top of (i.e., perched on) clay lenses in this zone. No water was observed in the other soil vapor wells (SV-01A, SV-01B, SV-02, and SV-03) screened in this zone. Table 1 presents well information.

The groundwater in the vicinity of the Site is contained within the three formations: the Paluxy, Glen Rose, and Twin Mountains Formations. The aquifer is considered to be the saturated portion of these formations. A majority of the private and public water supply wells at the Site are screened In the Paluxy Formation, as evidenced by a water well report compiled by Banks Environmental Data, Inc. (EA 2015). At least one well, located immediately to the north of GW-05 and part of the City of Willow Park public water supply (PWS), is screened within the Twin Mountains Formation.

The Shallow WBZ is perched on an aquitard, has a saturated thickness of approximately 10 to 15 ft and is encountered between about 80 to 100 ft bgs. The Shallow WBZ occurs where the aquitard is present. In areas where the aquitard is absent, so too is the Shallow WBZ. For

example, on Cross Section A-A' (Figure 4), the Shallow WBZ is seen present where the aquitard exists at well pairs MW-03/MW-04, MW-05/MW-06, and MW-16/MW-18. Because the Shallow WBZ is perched, it exhibits a non-uniform water table with varied local flow directions, indicating it is not in communication with the regional aquifer. Discharge of groundwater from the Shallow WBZ into the Intermediate WBZ is via the lateral discharge at the boundary of the aquitard and vertical seepage across the aquitard. The same is true for the path for contaminant migration from the Shallow into the Intermediate WBZ.

The Intermediate WBZ exhibits a uniform hydraulic gradient to the southeast and is first encountered at around 100 ft bgs and goes down to about 160 ft bgs. The Deep WBZ is encountered beginning at about 160 ft bgs.

1.1.3 Site History

Trichloroethene (TCE) was first detected in March 2006 during routine monitoring of the City of Willow Park's PWS at a concentration of 6.03 micrograms per liter (µg/L), which exceeds the 5.0 µg/L EPA Maximum Contaminant Level (MCL) for drinking water. The water sample that exceeded the MCL was collected from the distribution system point of entry for the City of Willow Park PWS Well No. 20 (GW-05). As a result of the TCE exceedance from Well No. 20, the well was taken out of service on 1 April 2006. This well has a well depth of approximately 235 ft bgs according to Texas Water Development Board (TWDB) Report No. 32-19-221 (TWDB 2016). On 19 June 2006, the City of Willow Park installed a granular activated carbon (GAC) filtration system downstream of the impacted well, and the public supply well was subsequently placed back into service. In 2012, the City of Willow Park installed a new PWS well (TWDB 2016) that is screened in the deeper Twin Mountains Formation with screens set at 404 to 532 feet (ft) and 550 to 605 ft bgs, respectively. The new well was installed adjacent to impacted well GW-05, which is currently not being used.

The Site contains a TCE groundwater plume within portions of the Trinity aquifer, specifically within the Paluxy Formation and the upper portion of the Glen Rose Formation. The plume boundary is estimated based on TCE detections in groundwater samples collected from private wells, PWS wells, and monitoring wells installed as part of the Remedial Investigation (RI). The samples were collected from wells screened in the Paluxy Formation down to approximately 170 ft bgs and the upper portion of the Glen Rose Formation from approximately 170 to 405 ft bgs. The highest groundwater TCE concentrations detected at the Site were collected from monitoring wells MW-09, MW-19, and MW-24; values ranged from 100 to 200 µg/L or 20 to 40 times the MCL. As part of an EPA investigation in 2012, a TCE labeled drum that contained TCE was discovered near inactive irrigation well, GW-41.

Contaminants of potential concern include TCE and its degradation products: 1,1-dichloroethene (DCE); *cis*-1,2-DCE; *trans*-1,2-DCE; and vinyl chloride. However, TCE is the only COC that has been detected in groundwater (EA 2021). The following exposure areas were identified based on surface features and available groundwater, soil gas, and vapor intrusion (VI) data:

Groundwater

- Shallow WBZ
- Intermediate WBZ
- Deep WBZ

Soil Gas

- Upper Sands

VI

- Residences within the groundwater plume.

1.2 INTERIM RECORD OF DECISION

The Interim Record of Decision (IROD) was completed in August 2022. The Remedial Action Objective (RAO) for the IROD is to prevent or minimize further migration of TCE in the vadose zone at a source area that could result in further groundwater contamination in excess of federal or state drinking water standards (EPA 2022).

Figure 7 shows soil gas results overlaid on the 2016 TCE groundwater plume.

1.3 SELECTED REMEDY

Two remedial alternatives were considered to address minimizing future migration of TCE in the vadose zone within the source area. Soil vapor extraction (SVE) is considered to be the EPA's presumptive remedy for VOC contamination in soil. The SVE remedy was weighed against the no action alternative. The SVE remedy was selected.

The extent of TCE soil contamination has not been fully delineated; however, soil gas sample concentrations correlate with the underlying TCE groundwater plume.

The target treatment area is 261,300 ft^2, with a treatment thickness of 25 feet. The impacted area's total soil volume within the treatment area is approximately 6,532,500 ft^3 with an estimated effective porosity of 25%; therefore, the estimated impacted soil pore volume is 1,633,125 ft^3 (Tables 2 and 3).

2. REMEDIAL DESIGN CRITERIA

The following sections describe the technical parameters upon which the design is based.

2.1 DESIGN CRITERIA

The key design criteria are provided below. The SVE design is based on the extent and concentration of contamination in the target zone.

- Vapor emission limits for COCs will be based on EPA Clean Air Act emissions standards, specifically by meeting the emission requirements specified in Texas Administrative Code (TAC) §106.533.g.5.

- SVE pilot testing was conducted in 2018 (EA 2018b). It was determined that at an applied vacuum of 50 inches (in.) water column (W.C.), well yield ranging from 1.8 – 2.7 standard cubic feet per minute (scfm) could be achieved per linear foot of screen.

2.2 TECHNICAL DESIGN APPROACH

The selected remedy will use two horizontal SVE wells. The proposed horizontal well alignments are shown on Figure 7.

- The number of pore volume (PV) exchanges necessary to achieve remediation was estimated to be approximately 500 PV, based on site-specific conditions and professional judgment. The soil matrix is primarily sands with a high effective porosity and, based on similar systems, a goal of 500 PV is reasonable.

- Cost consideration – The cost to install and run conveyance piping to a vertical well array with the same coverage would be considerably more expensive than two horizontal wells without a corresponding perceived benefit.

- Disruption to residents – The horizontal SVE well design limits the disturbance area and minimizes damage to residential properties. It also avoids having spots that cannot be treated due to surface constraint in the way of a proposed vertical SVE well (e.g., buildings, etc.).

- Due to the approach length to reach the target depth of 52 ft bgs, daylighting would have required either the horizontal well entry or exit location to be placed in close proximity to structures on private land. A horizontal blind well installation was chosen to avoid this scenario.

2.2.1 Horizontal Soil Vapor Extraction Wells

Following SVE pilot testing in 2018, it was determined that at an applied vacuum of 50 in. water column (W.C.), well yield ranging from 1.8 – 2.7 scfm could be achieved per linear foot of screen. Based on 2.25 scfm per foot of well screen (average of 1.8 to 2.7 scfm) at 50 in. W.C.,

the two 500-foot-long horizontal well screens could extract at flow rate of 2,250 scfm. Assuming that TCE mass removal is not governed by volatilization rates, the TCE mass could be removed from the target zone within a few months. If the volatilization inefficiency is ignored, a 350 scfm mass removal timeframe is not appreciably different than the 2,250 scfm timeframe. Because the rate of TCE volatilization will govern mass removal, 350 scfm at 50-in. W.C. is more cost-effective and, therefore, was used to size the blower.

Contaminant mass removal was determined by calculating daily mass removal based on volumetric flow rate multiplied by concentration, and then subtracting that from the initial mass within the treatment area (pore volume of treatment area multiplied by initial concentration). Based on the remaining concentration, the calculation was repeated. This formula was reiterated until concentrations approached zero. Based on this calculation, complete removal was attained in less than 3 months at 350 scfm. At 2,250 scfm, complete removal occurred even more rapidly. Because of this, the difference in blower rate is not expected to significantly affect the cleanup timeline.

Based on data presented in the SVE Pilot Test Report, a 75-foot ROI is conservative and, therefore, a 120 ft spacing between horizontal wells is appropriate. Assuming a 120-foot screen separation, this configuration will provide adequate coverage to treat 6,532,500 ft^3. It should be noted that the SVE pilot test was based on vertical wells. Because the target zone is generally uniform and comprised of sands that exhibited a large ROI, it is assumed that anisotropic effects are minimal and, therefore, ROIs for vertical and horizontal wells are similar.

For a 75-foot ROI, two horizontal wells will be set at a well target depth of 52 ft bgs, with well screen and blank lengths of 1,000 and 700 ft, respectively.

Provided below are details of the horizontal well construction. The layout is presented in Appendix A:

- Available property access on the Hudson Park RV Park will be utilized for the well heads and installation of the horizontal wells.
- Using a blind installation, horizontal wells will be drilled from the Hudson Park RV Park towards Circle Court, east of the City of Willow Park's water tower.
- Fully biodegradable drilling fluids were specified because well development in the vadose zone is limited due to the unsaturated nature of the soil.
- The borehole will be advanced using a 6-in.-diameter drill bit.
- A 4-in.-diameter Schedule 80 polyvinyl chloride (PVC) or high-density polyethylene (HDPE) DR 11 well casing will be used to construct the horizontal wells.
- The minimal entrance/exit slope for wells is 5H:1V as limited by available drilling equipment.

- The PVC well screen will be slotted with 0.020-in.-wide perforations at a rate of four 2-in. x 0.020-in. openings per foot of screen. If HDPE is to be used, the slot size will be 0.025 in.

- The horizontal SVE wells will be developed by flushing a thoroughly mixed solution comprised of 500 gallons of clean water mixed with 1 pint of liquid enzyme blocker, followed by jetting using a jetting tool to be lowered and raised for 6 passes along the entire length of the screen.

2.2.2 Conveyance Piping

The well conveyance piping for the SVE system will be constructed using Schedule 80 PVC pipe or SR 11 HDPE, which will be rated to meet or exceed the maximum expected vacuum for the appropriate SVE system. Four-in.-diameter dedicated conveyance pipes will be run and connect both wells to each other and the 5-in. dedicated trunk line. It is not anticipated that there would be a need to operate only one of the horizontal wells. In the unlikely event that this is considered, a well plug could be inserted to isolate a single well. The conveyance piping layout for all the systems and details of the piping configuration are shown on the Drawings in Appendix A. Pipe head loss calculations are shown in Appendix B.

The conveyance piping will be set in trenches leading to the well locations. The trench bottom will be prepared with sand bedding before the piping is laid down. The pipes will be pressure tested, and then the trenches will be backfilled and compacted. Pavement, not anticipated, that is removed during the trenching will be restored to match pre-existing conditions.

2.2.3 Treatment System Enclosure and Components

The treatment system will be held in a 20-ft standard sized sea box container that will be placed in the Hudson Park RV Park in the city of Hudson Oaks, Texas.

The proposed system at the Site consists of the following major elements:

- Remediation enclosure, a standard International Standards Organization seabox measuring 8 ft wide by 20 ft long by 8.5 ft tall having R-20 insulated walls and sound attenuation

- The SVE compartment is rated as Class 1 Division 2; the controls are located outside of the structure.

- SVE blower – Ametek EN909BG72WL with a Baldor 15-horsepower (HP), 480-Volt, 3-Phase, explosion-proof motor or engineer approved equivalent

- Moisture separator – PRM MS-120 with integral filter Solberg 235P, or engineer approved equivalent

- Moisture separator transfer pump – AMT 370C-98 3/4-HP, 480-Volt, 3-Phase, totally enclosed, fan-cooled (TEFC), or engineer approved equivalent

- The enclosure will be set within a fenced area.

Additional system components are presented in Appendixes A and C.

Vapors will be extracted from the horizontal wells and conveyed into the subsurface trunk line through dedicated lines to the treatment compound. An air dilution valve with a silencer will be used to regulate the vacuum and dilute extracted vapors with ambient air.

Condensation accumulation is projected to amount to 25 gallons over the course of the anticipated system operation. In 645 days of operation, the SVE system formerly utilized at the Sandy Beach Road Ground Water Plume site generated 15 gallons of water in the moisture separator. This system is similar. At the Sandy Beach Ground Water Plume site, the average flow rate was 357 scfm, and the system was located less than 20 miles from the planned system location at the Circle Court Site (EA 2018a). Using the design criteria, the following condensation accumulation amount is anticipated:

$$\frac{15\ gallons * 350\ scfm * 1095\ days}{357\ scfm * 645\ days} = 25\ gallons$$

The 25 gallons of condensate will drain into a double-walled 250-gallon storage tank, as shown in Appendix A, Drawing C-403. The tank will be equipped with a float switch that will trigger system shutdown in the event that the tank is filled. The tank was sized to minimize the number of times that condensate would need to be characterized, hauled off, and disposed of, thereby reducing operations and maintenance (O&M) costs. At the end of the system's lifetime, proper removal and disposal for condensate waste will need to occur.

After the air stream enters the system, moisture will be separated from the air stream in a moisture separator. From the moisture separator, the air stream will be directed into the SVE blower. From the blower, the air will be discharged into the atmosphere.

Based on emission rate calculations, treatment of vapors is not required (Table 4). Air samples will be collected periodically to confirm the emission concentrations and rates.

2.2.4 Input and Output Rates

Based on 2018 SVE pilot test data and the existing blower specifications, the anticipated volumetric extraction flow rate for the SVE system will be approximately 350 scfm at a vacuum of 50 in. W.C. at the well heads. Flow rate head loss calculations are summarized in Appendix B.

Wells will be operated simultaneously, during which the SVE unit flow rate will be approximately 0.37 scfm per foot of screen. Based on the mass removal rates and assuming effective porosity, concentrations would be expected to decline by 95% within a few months of operation. Based on engineering judgment and experience, removal will actually be governed by

the rate of volatilization of the adsorbed residual mass. Because of this, the maximum sized blower was not selected as this would have increased initial and O&M costs with very limited return on investment.

The estimated clean-up time is approximately 3 years. During that time, approximately 500 pore volumes will be exchanged during continuous operation. System operation may be extended if mass removal rates and concentration trends justify continued system operation. The criteria utilized to determine if the RAO is met will be the TCE MCL of 5 µg/L, its equivalent soil vapor concentration, or *de minimis* SVE.

2.2.5 Long-Term Performance and Maintenance Requirements

A five-year review will be conducted to evaluate the continued protectiveness of the remedy. The statutory and legal basis for conducting five-year reviews is provided in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) §121(c), 42 United States Code § 9621(c) and the National Oil and Hazardous Substances Pollution Contingency Plan §300.430(f)(5)(iii)(C). The current guidance on five-year reviews is provided in the EPA Office of Solid Waste and Emergency Response Directive 9355.7-03B-P, Comprehensive Five-Year Review Guidance (EPA 2001). The Site will be monitored for settling and unauthorized drilling, excavation, digging, trenching, or other activities that might expose contaminated soil.

Over the course of remediation, routine maintenance will include the following:

- Initially weekly and then at more extended intervals (as justified), monitor and record flow rates, system readings, moisture collection levels, and pressure differentials.

- Initially weekly and then at more extended intervals (as justified), monitor influent and effluent concentrations with a photoionization detector.

- Initially weekly and then at more extended intervals (as justified), collect influent and effluent soil vapor samples using Summa® canisters and analysis by Method TO-15.

- General site inspection, including adverse weathering of equipment, improperly functioning components, potential short-circuiting or damage to nearby vapor profile wells, etc.

3. COMPLIANCE WITH ARARS

This section describes the applicable or relevant and appropriate requirements (ARARs), pertinent codes, and standards that have been identified for the Site.

3.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Applicable requirements are those cleanup standards; standards of control; and other substantive requirements, criteria, or limitations promulgated under federal or state environmental laws that specifically address a hazardous substance, pollutant, contaminant, RA, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable.

Relevant and appropriate requirements are those cleanup standards; standards of control; and other substantive requirements, criteria, or limitations promulgated under federal or state environmental laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, RA, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site, that their use is well suited to the particular site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be relevant and appropriate. ARARs are divided into chemical-specific, action-specific, and location-specific categories. Table 7 lists the ARARs and describes their applicability or relevance and appropriateness.

A list of applicable ARARs are included as Table 7.

3.2 PERMITS

- Regulations of the City of Willow Park Right-of-Way (ROW) division for the use of ROWs and roads—Will apply to the installation of SVE wells under Russell Road.

- National Electrical Code—2017 National Energy [Electrical] Code will apply to any temporary or permanent electrical work to be performed at the Site.

- International Mechanical Code—2018 International Mechanical Code will apply to any mechanical systems at the Site, specifically the treatment compound heating, ventilation, and air-conditioning system.

3.3 EASEMENT AND ACCESS REQUIREMENTS

Acquisition of access agreements will need to be handled by the RA Contractor and EPA prior to construction activities. EA may assist EPA, if necessary, in obtaining access agreements from property owners prior to any construction activities at the Site. RA-related activities will be conducted only after a copy of the fully executed access agreement is available.

4. REMEDIATION IMPLEMENTATION APPROACH

This section provides a general approach of RA implementation. The implementation activities will include the following components:

- Update existing access agreements and obtain new access agreements, if necessary
- Mobilization to the Site
- Utility clearance
- Surveying
- Site preparation
- SVE well installation
- Trenching and piping
- Treatment compound construction
- SVE system installation
- Power connection
- Systems programming
- SVE system start-up
- Site restoration
- Demobilization from the Site.

4.1 MOBILIZATION

The RA Contractor will mobilize all personnel, equipment, and materials to the Site for field efforts. EA will mobilize construction oversight personnel during the field efforts.

4.2 UTILITY CLEARANCE

Utilities shall be located and marked prior to subsurface exaction. Texas 811 shall be instructed to mark utilities within ROWs. For utility location on private land, a private utility locator service will be used.

4.3 SURVEY

Both proposed well locations and proposed trenches will be marked with flags or paint prior to surveying. Actual drilling locations may be field adjusted by the project geologist or project engineer to avoid subsurface utilities or other obstructions. Trenching locations can be moved by the project engineer to avoid subsurface utilities or other obstructions.

Surveys will be conducted before and after certain work tasks to determine quantities for payment.

Final well surveys will measure and report, at a minimum, easting, northing, ground surface elevation, and top of well casing elevations. Horizontal coordinates of the SVE well locations will be surveyed to the nearest 0.1 ft relative to State plane coordinates by a land surveyor

registered in Texas. Elevations will be measured relative to mean sea level at ground surface to the nearest 0.01 ft.

4.4 SITE PREPARATION

Site preparation will include documentation of baseline conditions at the Site, clearance, and setup of the RA Contractor's work and staging areas. These activities are described below.

- Baseline conditions will be recorded prior to any field activities during a site visit using photographs and notes.

- Work zones will be set up and a fence will enclose the area where only project personnel will be allowed to enter. This area will include the remediation enclosure for the SVE system, a staging and storage area for construction material and equipment, an exclusion zone, and a decontamination zone where equipment is decontaminated.

- Access for construction vehicles and equipment to the work zone are described in the Design Drawings and Technical Specifications. Traffic control measures will be established, as necessary.

- Fence installation for the Treatment Compound

- Installation of erosion control around work areas to prevent erosion and eroded materials entering waterways in accordance with an approved Stormwater Pollution Prevention Plan.

4.5 POWER SUPPLY

The local electrical distribution company has been identified as Oncor Electric Delivery Company LLC (Oncor). Before starting construction activities, Oncor will be provided the following information:

- Proposed loads
- One-line diagram
- Site plan in AutoCAD format
- Construction starting date.

Then, Oncor representatives will:

- Schedule a site visit.

- Review customer documentation.

- Perform preliminary research of the project site.

- During the site visit, identify the desired location of the service, potential obstacles, and design preliminary concept based on customer expectations.

- After the site visit, the RA Contractor will receive either a temporary or a permanent account.

- Design the project and draft applicable documents.

- If necessary, during Site preparation, move any obstacles or obstructions (trim trees, clear brush, etc.) to provide access to project site.

Coordination with Oncor and installation of the electrical service will occur during the RA phase.

All electrical components will operate on 3-phase, 60-Hertz, 480-Volt power.

4.6 SVE WELL INSTALLATION

Two horizontal SVE wells will be installed. The proposed layout and details are presented in the Design Drawings and Construction Specifications in Appendix A and Appendix D, respectively. All proposed SVE wells will be provided with surface completions, including an access vault, vacuum gauge, and connection to the conveyance piping. The wells will be developed following the completion of each well.

Horizontal wells will be drilled to a depth of approximately 52 ft bgs and the screened sections shall be horizontal and set at a depth of 52 ft bgs; locations are shown in Appendix A. Horizontal wells shall be drilled using a directional drilling rig and the progress will be tracked with a specially designed sond that will provide real-time feedback depth and angle information to the driller. The wells shall be constructed of 300 to 350 ft of 4 in. nominal blank Schedule 80 PVC in 20-ft threaded sections with Viton® gaskets between each section or HDPE and 500 ft of 4 in. nominal Schedule 80 PVC in 20-ft threaded sections with Viton gaskets between each section or HDPE and four 2-in. long x 0.020-in. openings per linear foot of screen for PVC or 2-in. long x 0.025-in. openings per linear foot of screen for HDPE. The well shall be terminated with a 6-in. long 3-in. nominal Schedule 80 PVC or HDPE cone-shaped sump. Two rubber grout collars shall be installed and secured with hose clamps at the base of the blank screen to prevent grout from reaching the screen. Using a tremie pipe, a Portland cement and bentonite hole plug mixture shall be pumped from the grout collar to the well entry pit. The well entry pit shall be set within a 24-in. x 24-in. by 24-in. traffic-rated vault set within a minimum 3-ft x 3-ft x 6-in. deep concrete pad reinforced with #3 rebar around the vault and sloped to allow water to drain away from the vault.

4.7 WELL DEVELOPMENT

Upon completing well installation, a thoroughly mixed solution comprised of 500 gallons of clean water mixed with one pint of liquid enzyme blocker shall be pumped down each well and a jetting tool shall be lowered and raised for six passes along the entire length of screen. The

enzyme blocker shall be Minerals Technologies® CETCO® LEB-CD™ Liquid Enzyme Breaker or engineer approved equivalent.

4.8 CONVEYANCE PIPING

The conveyance piping will consist of Schedule 80 PVC pipe that will be solvent welded in the field. The pipe will appropriately pressure rated for the expected operating conditions. The pipe will be installed in open cut trenches. Bedding material and piping will be placed in the trenches. The surface will be restored with grass seeding or sod, or base aggregate and concrete or asphaltic pavement to match the surrounding surface.

4.9 SVE SYSTEM INSTALLATION

The bulk of the SVE system will be plant-fabricated. Onsite installation will include placement of the enclosure and moisture accumulation tank, connection of power supply, and installation of interconnection piping between the conveyance piping and enclosure. Qualified mechanical and electrical contractors will be employed for the piping and electrical connections.

4.10 SVE SYSTEM STARTUP

System start-up will be conducted in order to ensure all automation and safety controls are functioning correctly. Startup is expected to take one week and will include the following activities:

- A safety review meeting to confirm that the system construction and final installations were done as planned.
- Pressure and leak check in all major piping.
- Check all motors and electrical equipment for proper grounding.
- Verify all instrument signals and calibrate, if required.
- Set all valves to proper start position.
- Perform baseline soil vapor sampling.
- Monitor vacuum pressure and airflow data.
- Regular influent and effluent air sampling.

4.11 INVESTIGATION-DERIVED WASTE

The investigation-derived waste will be containerized, characterized, profiled, and disposed of in accordance with current ordinances and regulations. Following the characterization, soil and fluid waste generated during the horizontal well and piping installation and groundwater extracted during development and sampling will be manifested and disposed of at an approved off-site facility.

5. FINAL REMEDIAL ACTION COST ESTIMATE

The Final RD cost estimate is detailed in Appendix E. The costs are based on values provided in cost estimating software (RS Means 2020), vendor estimates, and engineer estimates. Quantities are based on estimated design quantities and calculations. The costs are estimated (-20 percent and +30 percent accuracy) below.

Discount Rate = 7%	Capital Cost	O&M Cost (Present Value)	Total Cost (Present Value)
Soil Vapor Extraction and Treatment System	(b) (4)	(b) (4)	(b) (4)

Note: All values are rounded to three significant figures.

6. FINAL DRAWINGS AND SPECIFICATIONS

6.1 DRAWINGS AND SCHEMATICS

The drawings completed for the Final Design submittal are listed below.

Drawing No.	Title
G-001	Title Sheet
GENERAL	
G-002	Legend and Abbreviation Sheet
G-003	General Notes
G-004	General Notes Sheet
CIVIL	
C-101	Proposed SVE System Layout
C-201	Boring Profile I
C-202	Boring Profile II
C-301	Soil Vapor Extraction Horizontal Well Detail
C-302	Security Fence Detail
C-401	Process and Instrumentation Diagram
C-402	Process and Instrumentation Diagram Legend
C-403	Equipment Layout
ELECTRICAL	
E-101	Notes, Legend, Abbreviations, Site Plan, and One-Line Diagram
E-102	Soil Vapor Extraction System Installation
E-103	Control Panel
E-104	Control Panel Elementary
E-105	Control Panel Elementary

6.2 OUTLINE OF GENERAL SPECIFICATIONS

Specifications will follow the Construction Specifications Institute format. The specifications included in this Final Design submittal include the following:

DIVISION 1 – GENERAL REQUIREMENTS

01 10 00.01	SUMMARY
01 25 00.01	SUBSTITUTION PROCEDURES
01 33 00.01	SUBMITTAL PROCEDURES
01 40 00.01	QUALITY REQUIREMENTS
01 60 00.01	PRODUCT REQUIREMENTS
01 70 00.01	EXECUTION AND CLOSEOUT REQUIREMENTS

DIVISION 2 – EXISTING CONDITIONS

02 62 16	SOIL VAPOR EXTRACTION SYSTEM

DIVISION 3 – CONCRETE

03 20 00	CONCRETE REINFORCING
03 30 00	CAST-IN-PLACE CONCRETE

DIVISION 26 – ELECTRICAL

26 00 00	ELECTRICAL GENERAL
26 05 19	CONDUCTORS AND CABLES
26 05 26	ELECTRICAL GROUNDING
26 05 33.01	CONDUITS AND RACEWAY SYSTEMS
26 05 53	IDENTIFICATION FOR ELECTRICAL SYSTEMS
26 09 00	INSTRUMENTATION
26 09 10	CONTROL PANELS
26 09 16.01	MISCELLANEOUS ELECTRICAL CONTROLS
26 22 00	LOW VOLTAGE TRANSFORMERS
26 27 16	ENCLOSURES
26 27 26	WIRING DEVICES
26 28 00	PANELBOARDS AND CIRCUIT PROTECTIVE DEVICES
26 29 13	MOTOR CONTROLLERS
26 43 13	TRANSIENT VOLTAGE SUPPRESSION
26 51 00	LIGHTING
27 27 10	MANAGED CONNECTED ROUTER WIRELESS COMMUNICATIONS SYSTEM

DIVISION 31 – EARTHWORK

31 23 17	TRENCHING

DIVISION 32 – EXTERIOR IMPROVEMENTS

32 31 13	CHAIN-LINK FENCES AND GATES

DIVISION 33 – UTILITIES

33 05 24	UTILITY HORIZONTAL DIRECTIONAL DRILLING
33 23 16	SOIL VAPOR EXTRACTION WELL INSTALLATION

DIVISION 40 – PROCESS INTEGRATION

40 05 13.74	PLASTIC PROCESS PIPING
40 05 23.01	COMMON WORK RESULTS FOR PROCESS VALVES

40 05 29.01 HANGERS AND SUPPORTS FOR PROCESS PIPING AND EQUIPMENT

7. REMEDIAL ACTION SCHEDULE

The construction schedule for the RA activities will be determined by the RA Contractor.

8. REFERENCES

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Tables

Table 1. Groundwater Monitoring Well Information and Depth to Water Data Summary

Well ID	Water-bearing Zone	Top of Screen (ft btoc)	Bottom of Screen (ft btoc)	Total Well Depth (ft btoc)	TOC Elevation (ft amsl)	Recompleted TOC Elevation	Northing	Easting	Latitude	Longitude	DTW 24 Jul 2019 (ft btoc)	GW Elevation 24 Jul 2019 (ft amsl)
MW-01	Intermediate	120	140	145.5	961.57	---	6955964.688	2220514.238	32.74776231	-97.68027059	81.43	880.14
MW-02	Shallow	80	100	105.5	961.76	---	6955972.704	2220512.925	32.74778437	-97.68027465	77.62	884.14
MW-03	Intermediate	125	145	146.5	975.57	---	6955541.024	2220616.385	32.74659561	-97.67994910	94.88	880.69
MW-04	Shallow	72	92	94.5	975.03	---	6955522.293	2220622.825	32.74654399	-97.67992863	63.81	911.22
MW-05	Intermediate	115	135	140.5	968.41	---	6955125.501	2220840.789	32.74544866	-97.67922978	92.74	875.67
MW-06	Shallow	66	86	91.5	968.96	---	6955124.276	2220824.280	32.74544565	-97.67928350	60.85	908.11
MW-07 [1]	Shallow	84	94	99	978.10	974.64	6955466.992	2220800.318	32.74638817	-97.67935273	61.51	913.13
MW-08 [2]	Shallow	82	92	97	976.12	972.57	6955522.578	2221031.555	32.74653599	-97.67859921	DRY	---
MW-09	Shallow	72	82	87	967.80	---	6954917.908	2221050.266	32.74487356	-97.67855373	62.10	905.70
MW-10	Intermediate	90	110	115	960.20	---	6955111.319	2221131.700	32.74540343	-97.67828395	85.03	875.17
MW-11	Shallow	78	88	93	975.96	---	6954669.552	2220860.396	32.74419499	-97.67917759	70.06	905.90
MW-12	Intermediate	100	120	125	986.54	---	6956900.960	2219743.710	32.75035230	-97.68275310	85.60	900.94
MW-13	Shallow	78	88	93	975.33	---	6955846.981	2220170.575	32.74744614	-97.68139136	70.28	905.05
MW-14	Shallow	86	96	101	982.66	---	6955367.782	2220181.547	32.74612875	-97.68136782	75.30	907.36
MW-15	Intermediate	124	139	139	968.13	---	6954939.046	2221041.199	32.74493186	-97.67858269	94.59	873.54
MW-16	Intermediate	110	130	135	980.54	---	6954666.212	2220685.208	32.74418957	-97.67974747	102.93	877.61
MW-17	Shallow	87	97	99	983.56	---	6954843.306	2220656.082	32.74467697	-97.67983770	76.79	906.77
MW-18	Shallow	85	95	100	980.77	---	6954672.445	2220670.186	32.74420703	-97.67979617	74.85	905.92
MW-19	Shallow	70	90	95	979.35	---	6954850.668	2220846.128	32.74469313	-97.67921940	72.65	906.70
MW-20	Intermediate	135	155	160	978.25	---	6954847.201	2220874.061	32.74468300	-97.67912864	104.21	874.04
MW-21	Deep	180	220	225	979.63	---	6954066.113	2220732.404	32.74253910	-97.67960921	128.24	851.39
MW-22	Shallow	85	100	100	979.18	---	6954068.208	2220763.958	32.74254418	-97.67950653	79.73	899.45
MW-23	Intermediate	140	160	162	979.36	---	6954066.851	2220747.616	32.74254080	-97.67955972	109.58	869.78
MW-24	Deep	180	220	225	981.24	---	6953801.917	2220778.611	32.74181192	-97.67946564	128.16	853.08

Table 1. Groundwater Monitoring Well Information and Depth to Water Data Summary

Well ID	Water-bearing Zone	Top of Screen (ft btoc)	Bottom of Screen (ft btoc)	Total Well Depth (ft btoc)	TOC Elevation (ft amsl)	Recompleted TOC Elevation	Northing	Easting	Latitude	Longitude	DTW 24 Jul 2019 (ft btoc)	GW Elevation 24 Jul 2019 (ft amsl)
MW-25	Shallow	90	100	102	981.57	---	6953804.282	2220760.952	32.74181880	-97.67952301	84.30	897.27
MW-26	Intermediate	145	165	167	981.64	---	6953803.028	2220747.69	32.74181564	-97.67956617	113.87	867.77
MW-27	Shallow	90	100	102	985.09	---	6954326.265	2220240.744	32.74326471	-97.68120168	78.63	906.46
MW-28	Shallow	93	103	105	985.49	---	6954674.964	2220211.28	32.74422379	-97.68128867	77.38	908.11
MW-31	Shallow	80	100	105	984.93	---	6954025.536	2220238.633	32.74243815	-97.68121617	---	---
MW-33	Shallow	78	98	103	974.10	---	6954610.797	2221377.126	32.74402239	-97.67749845	---	---

NOTES:

[1] MW-07 and MW-08 were recompleted in March 2016 to a lower surface grade; screen interval and total depth are based upon original TOC elevation.

[2] MW-08 water level data may not be representative due to partially saturated screen interval.

--- = Not applicable/not measured
amsl = Above mean sea level
btoc = Below top of casing
DTW = Depth to water
ft = Feet
GW = Groundwater
MW = Groundwater monitoring well
SV = Soil vapor monitoring well
TOC = Top of casing
WBZ = Water-bearing zone

Table 2. Final Design Calculations

Parameter	Value	Units	Notes
Treatment Area	175,000	square feet	75-foot ROI, two horizontal wells
Treatment Thickness	25	feet	Upper Sands, from 40 to 65 feet
Well Target Depth	52	feet bgs	Middle of the Upper Sands
Well Screen Length	1,000	feet	Two 500-LF screens
Well Blank Length	500	feet	Two 250-LF blanks
Borehole Length	2,000	feet	
Soil Volume	4,375,000	cubic feet	
Estimated Effective Porosity	25%		
Pore Volume	1,093,750	cubic feet	
Blower Capacity	350	cubic feet per minute	
Number of Pore Volume Flushings	0.461	per day	100% Run time
Number of Pore Volume Flushings	168	per year	100% Run time
Target Number of Pore Volume Flushings	500		
Time to Remediate	3.0	years	100% Run time

Notes:

bgs = Below ground surface

LF = Linear feet

ROI = Radius of influence

Table 3. Soil Vapor Gas Calculations

Contour Low Concentration ($\mu g/m^3$)	Contour High Concentration ($\mu g/m^3$)	Band Average Concentration ($\mu g/m^3$)	Contour Total Area (square feet)	Band Range Area (square feet)	Impacted Soil Volume (cubic feet)	Impacted Soil Pore Volume (cubic feet)	Impacted Soil Mass (pounds)	TCE Mass in Soil Vapor (pounds)	TCE Concentration in Soil ($\mu g/kg$)	TCE Mass in Soil (pounds)	TCE Total Mass (pounds)	Adjusted TCE Total Mass (pounds)	Adjusted TCE Volume (gallons)
0	20,000	10,000	261,300	132,000	3,300,000	825,000	330,000,000	0.52	50	17	17.02	51	3.8
20,000	40,000	30,000	129,300	79,300	1,982,500	495,625	198,250,000	0.93	150	30	30.67	92	6.8
40,000	60,000	50,000	50,000	44,000	1,100,000	275,000	110,000,000	0.86	250	28	28.36	85	6.3
60,000	80,000	70,000	6,000	6,000	150,000	37,500	15,000,000	0.16	350	5	5.41	16	1.2
Total				**261,300**	**6,532,500**	**1,633,125**	**653,250,000**	**2.5**		**79**	**81**	**244**	**18.1**

Inputs:

Impacted Thickness	h	25	feet
Soil Density	ρ_{soil}	100	pounds per cubic foot
Effective Porosity, Sandy Soil	η	25%	
TCE Soil Vapor to Soil Partitioning in Sand	K	5	liters per kilogram
Adjustment Factor to Account for the Aquitard Sorption	F	3	
TCE Density	ρ_{TCE}	13.5	pounds per gallon

Reference: https://www.waterboards.ca.gov/rwqcb4/water_issues/programs/ust/docs/CttoCg1996.pdf

Notes:

$\mu g/kg$ = Microgram(s) per kilogram
$\mu g/m^3$ = Microgram(s) per cubic meter
TCE = Trichloroethene

Table 4: Evaluation of Potential Emissions and Need for Emission Control

	ALLOWABLE[1]				ACTUAL			
Chemical	**Limit (mg/m^3)**	**Distance to the Nearest Off-Site Receptor (feet)**	**Adjustment Factor**	**Adjusted Emission Rate (lb/hr)**	**Design Flowrate (scfm)**	**Representative Concentration (mg/m^3)**	**Potential Emission (lb/hr)**	**Required Reduction[2] (unitless)**
Symbol	**"L"**	**"D"**	**"K"**	**"E = L/K"**	**Q**	**C**	**E' = Q * C**	**E'/E**
Trichloroethene	135	100	326	0.414	350	82.00	0.107	0.259
Methylene chloride	26	100	326	0.080	350	0.18	0.000236	0.003

Notes:

1. Texas Administrative Code Title 30 Part 1 Chapter 106 Subchapter K Rule 106.262
2. E'/E values below 1.0 require no reduction in emission rate.
3. Concentrations are based on maximum soil gas concentrations collected on 21 December 2017.

No emissions control is required as potential emissions are below the allowable limits.

lb/hr	Pounds per hour
mg/m^3	Milligrams per cubic meter
scfm	Standard cubic feet per minute

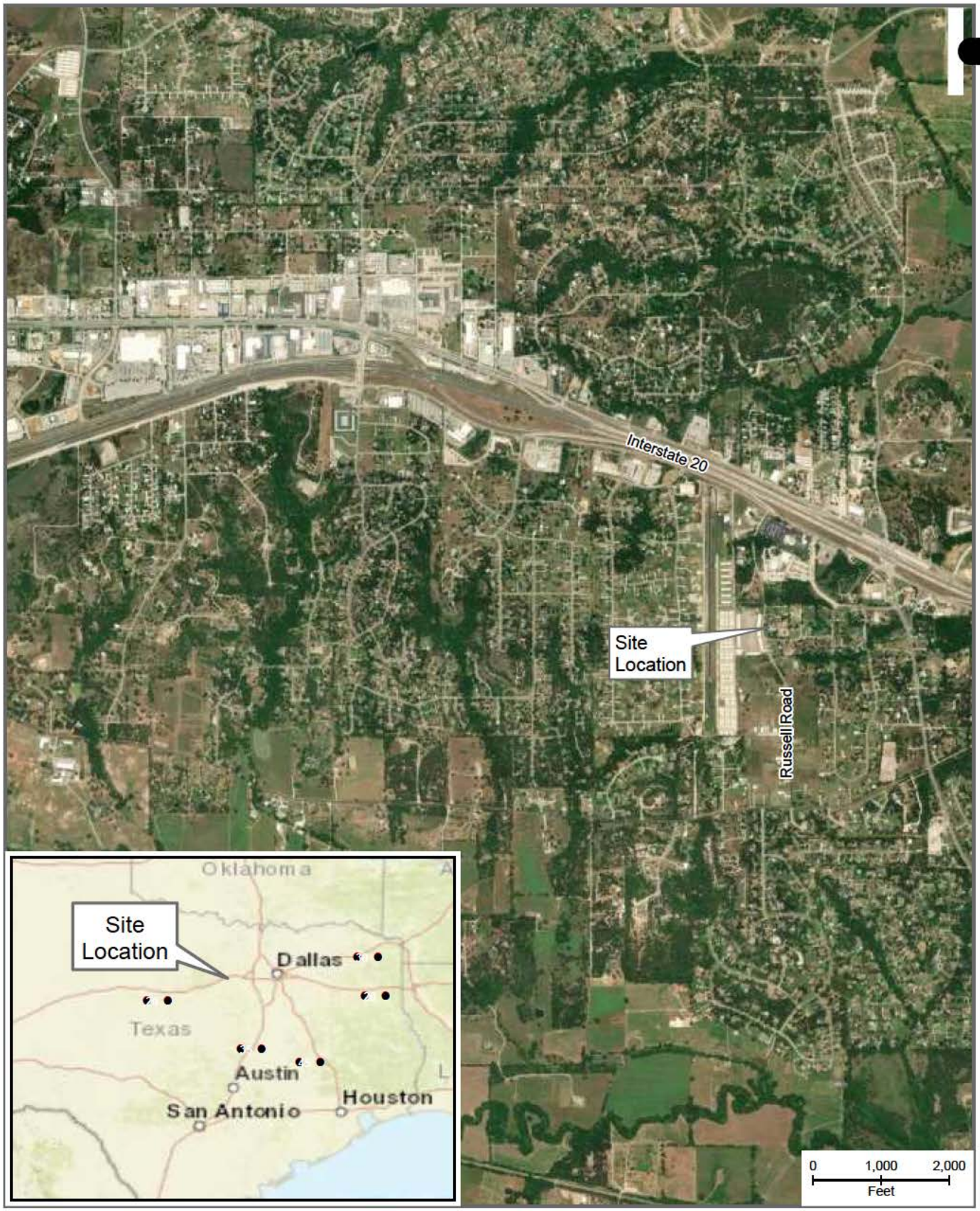
Table 5. Screening of Applicable or Relevant and Appropriate Requirements

ARAR Citation	Description	Rationale for Use	Type of Requirement
Chemical-Specific ARARs			
Texas Risk Reduction Program (30 Texas Administrative Code [TAC] §350)	This section specifies the requirements for reestablishing cleanup levels for air, ground water, and soil, including use of media-specific adjustments.	For establishing site cleanup levels for contaminated air, ground water, and soil.	Applicable
Action-Specific ARARs			
Federal Water Pollution Control Act (40 CFR 403)	Establishes responsibilities of Federal, State, and local government, industry and the public to implement National Pretreatment Standards to control pollutants which pass through or interfere with treatment processes in POTWs or which may contaminate sewage sludge.	May apply because ground water may be extracted and delivered to POTWs.	Applicable
National Primary and Secondary Ambient Air Quality Standards (40 CFR 50.4, 50.6, 50.8, 50.9, 50.11, 50.12)	NAAQS define levels of air quality to protect the public health or the public welfare from any known or anticipated adverse effects of a federally regulated pollutant. NAAQS for sulfur dioxide, nitrogen dioxide, and carbon monoxide apply to incineration.	Applicable if selected remedial action emits regulated pollutants.	Applicable
New Source Review and Prevention of Significant Deterioration Requirements (40 CFR 52)	New sources or modifications which emit greater than the defined threshold for listed pollutants must perform ambient impact analysis and install controls which meet best available control technology.	Applicable if selected remedial action emits regulated pollutants.	Applicable
National Emission Standards for Hazardous Air Pollutants: Equipment Leaks (40 CFR 61 Subpart V)	Establishes requirements for controlling fugitive emissions of volatile hazardous air pollutants from designated equipment.	Applicable if remedial alternative includes regulated compounds or equipment.	Applicable
Texas Clean Air Act (Texas Health and Safety Code Section 382)	The policy of this state and the purpose of this chapter are to safeguard the state's air resources from pollution by controlling or abating air pollution and emissions of air contaminants, consistent with the protection of public health, general welfare, and physical property.	Applicable if selected remedial action emits regulated pollutants.	Applicable
Texas Administrative Code - Air Quality (30 TAC § 101.4)	No person shall discharge from any source whatsoever one or more air contaminants or combinations thereof, in such concentration and of such duration as are or may tend to be injurious to or to adversely affect human health or welfare, animal life, vegetation, or property, or as to interfere with the normal use and enjoyment of animal life, vegetation, or property.	Applicable if selected remedial action emits regulated pollutants.	Applicable
Permit by Rule for Air Emissions During Remedial Activities (30 TAC § 106.533)	Equipment used to extract, handle, process, condition, reclaim, or destroy contaminants for the purpose of remediation is permitted by rule, provided conditions specified in the rule are met for the site.	Applicable because equipment will be used to destroy contaminants for the purpose of remediation.	Applicable
Texas Administrative Code (30 TAC § 115)	Control of air pollution from volatile organic compounds.	Applicable if selected remedial action emits regulated pollutants.	Applicable
Criteria for Identifying the Characteristics of Hazardous Waste and for Listing Hazardous Waste (40 CFR 261.20 and 261.30, 30 TAC Subchapter R (§ 335))	Provides the criteria for identifying a characteristic or listed waste. Solid waste is a hazardous waste if it exhibits any of the characteristics of ignitability, corrosivity, reactivity, and toxicity or if it is a listed waste. Applicable to offsite waste disposal.	Applicable if hazardous waste is generated during the remedial action.	Applicable
Standards Applicable to Generators of Hazardous Waste (40 CFR 262.20 and 262.30, 30 TAC § 335.61-70)	Provides requirements for preparation of waste manifests, waste packaging, labeling and handling. Provides criteria for hazardous waste classification.	Applicable if hazardous waste is generated during the remedial action.	Applicable
Standards Applicable to Transporters of Hazardous Waste (40 CFR Part 263, 49 CFR Parts 171-172, 30 TAC 335.91)	Requires that hazardous material to be transported off site be labeled and placarded according to the regulations and that contractors who transport the hazardous waste provide proper documentation.	Applicable if remedial action generates necessary off-site waste transportation	Applicable
Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities. (40 CFR 265)	Specifies standards for generators of hazardous waste for use and management of container storage in Subpart I, and use and management of tanks in Subpart J.	Applicable if hazardous waste is generated during the remedial action.	Applicable
Land Disposal Restrictions (40 CFR 268, 30 TAC Subchapter O (§ 335.431))	Restricts the land disposal of most hazardous wastes, and specifies specific treatment standards that must be met before these wastes can be land disposed.	Applicable if waste disposal is necessary during the remedial action.	Applicable
Procedures of Planning and Implementing Off-site Response Actions (40 CFR 300.400)	Hazardous waste generated from CERCLA cleanups must go to RCRA permitted treatment, storage, and disposal facilities that are in compliance with RCRA and state rules and that do not have releases to the environment.	Applicable if waste disposal is necessary during the remedial action.	Applicable
Spill Prevention and Control (30 TAC § 327.4)	Defines the reportable quantities in the event of a spill or release to environment.	Applicable if any releases or spills to the environment occur during the remedial action.	Applicable
Waste Classification (30 TAC § 335.505, 30 TAC § 335.508)	Provides procedure for implementation of Texas waste notification system and establishes standards for classification of industrial solid waste managed in Texas, including Class 1, Class 2, and Class 3 wastes.	Applicable if waste is generated during remedial activities.	Applicable
National Pollutant Discharge Elimination System (40 CFR 122, 40 CFR 125)	Provides conditions that must be incorporated into NPDES permits. Applicable to discharge of storm water from the Site.	Applicable if water is discharged from the site during remedial activities.	Applicable
TPDES Construction General Permit (TXR150000, 30 TAC § 205)	General permit to discharge water from construction activities.	Applicable if construction activities are performed onsite during the remedial action.	Applicable
Institutional Controls (30 TAC § 350.111)	Requires the creation of institutional controls for response actions that will take greater than 15 years to complete (§350.31(h)).	Applicable because a response action will be completed.	Potentially Applicable
Texas Department of Licensing and Regulation (TDLR), Title 12, Chapter 1901	Outlines and addresses requirements for well installation.	Applicable because wells will be installed.	
To Be Considered			
Institutional Controls (30 TAC § 350.31(h) and § 350.111)	Requires the placement of institutional controls (e.g., deed notices or restrictive covenants as defined in §350.4(a)(47)) on affected property in different circumstances as part of completing a response action. Institutional controls are also created for response actions that will take greater than 15 years to complete (§350.31(h)).	TBC because a response action will be completed.	Potentially Applicable

Notes:

ARAR = Applicable or relevant and appropriate requirement
CERCLA = Comprehensive Environmental Response, Compensation and Liability Act
CFR = Code of Federal Regulations
COC = Contaminant of concern
GWBU = Ground water-bearing unit
LDR = Land Disposal Restrictions
MCL = Maximum Contaminant Level
NAAQS = National Ambient Air Quality Standards
NPDES = National Pollutant Discharge Elimination System
OERR = Office of Emergency and Remedial Response (U.S. Environmental Protection Agency)
OSWER = EPA Office of Solid Waste and Emergency Response (U.S. Environmental Protection Agency)
PCL = Protective Concentration Level
POTW = Publicly Owned Treatment Works
RAO = Remedial action objective
RCRA = Resource Conservation and Recovery Act
TAC = Texas Administrative Code
TBC = To be considered
TCEQ = Texas Commission on Environmental Quality
TPDES = Texas Pollutant Discharge Elimination System
TRRP = Texas Risk Reduction Program
VOC = Volatile organic compound

Figures



Source: ESRI ArcGIS Online and data partners including USGS and © 2007 National Geographic Society, 2009 Redlands, CA: Environmental Systems Research Institute

Circle Court Ground Water Plume Superfund Site
Willow Park, Parker County, Texas

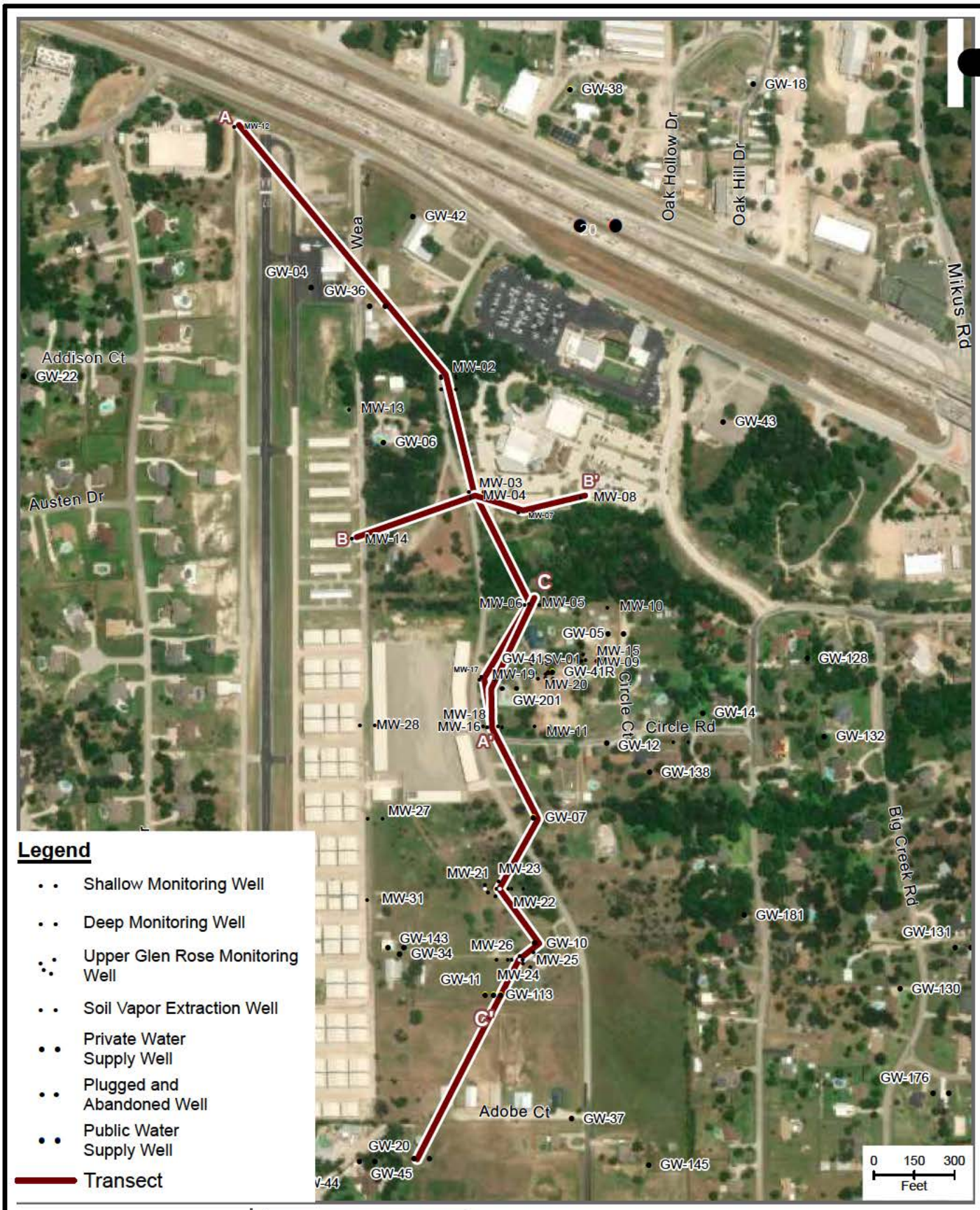
Figure 1
Site Location

2024-06-26 K:\Projects\1578540 - Circle Court GW Plume\PROJECTS\1578540 - Circle Court SVE\1578540 - Circle Court SVE.aprx EA-Dallas jmather

Circle Court Ground Water
Plume Superfund Site
Willow Park, Parker County, Texas

Figure 2
Site Layout

2024 -06-28 K:\Projects\1578540 - Circle Court GW Plume\PROJECTS\1578540 - Circle Court SVE\1578540 - Circle Court SVE.aprx EA-Dallas jmather



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Circle Court Ground Water Plume Superfund Site
Willow Park, Parker County, Texas

Figure 3
Location of Hydrogeological Cross-sections

2024-06-26 K:\Projects\11578540 - Circle Court GW Plume\PROJECTS\11578540 - Circle Court SVE\11578540 - Circle Court SVE.aprx EA-Dallas jmather

A (Northwest) MW-12 MW-02 MW-01 MW-03 MW-04 MW-05 MW-06 MW-17 MW-16 MW-18 A' (Southeast - South)

Depth Below Ground Surface (ft bgs)

0 20 40 60 80 100 120 140 160 180

Upper Sands

Shallow WBZ

Intermediate WBZ

Deep WBZ (Projected)

Limestone (Projected)

1.1*
TD = 125.5 ft bgs

<1.0*
TD = 107 ft bgs

<1.0*
TD = 150 ft bgs

10.2*
TD = 100 ft bgs

<1.0*
TD = 157 ft bgs.

9.9
TD = 97 ft bgs

<0.50
TD = 160 ft bgs

34
TD = 103 ft bgs

59
TD = 101 ft bgs

14
TD = 163 ft bgs

35 ft.
210 ft.
Vertical exaggeration of 1:6

Note:
- API = American Petroleum Institute units
- Gamma logs are positioned such that the greatest response is equivalent to ~45 API.
- Gamma logs normalized to account for differing scale maximums (API).
- WBZ = Water-bearing zone
- TD = Total depth of boring, indicated by gray line

LEGEND

- Walnut Clay Formation (clay and limestone)
- Water-bearing Zones (sand, silt, clay, quartz sand)
- Aquitard
- Glen Rose Formation (limestone)
- Shallow WBZ Potentiometric Surface
- Intermediate WBZ Potentiometric Surface
- Well Screen Interval
- TCE concentration greater than 50 µg/L
- TCE concentration between 25 & 50 µg/L
- TCE concentration between 5 & 25 µg/L
- <1.0 Trichloroethene concentration in micrograms per liter (µg/L)

(Samples collected July 2019, only highest concentration shown. *Indicates well not sampled in July 2019; May 2016 data shown.)

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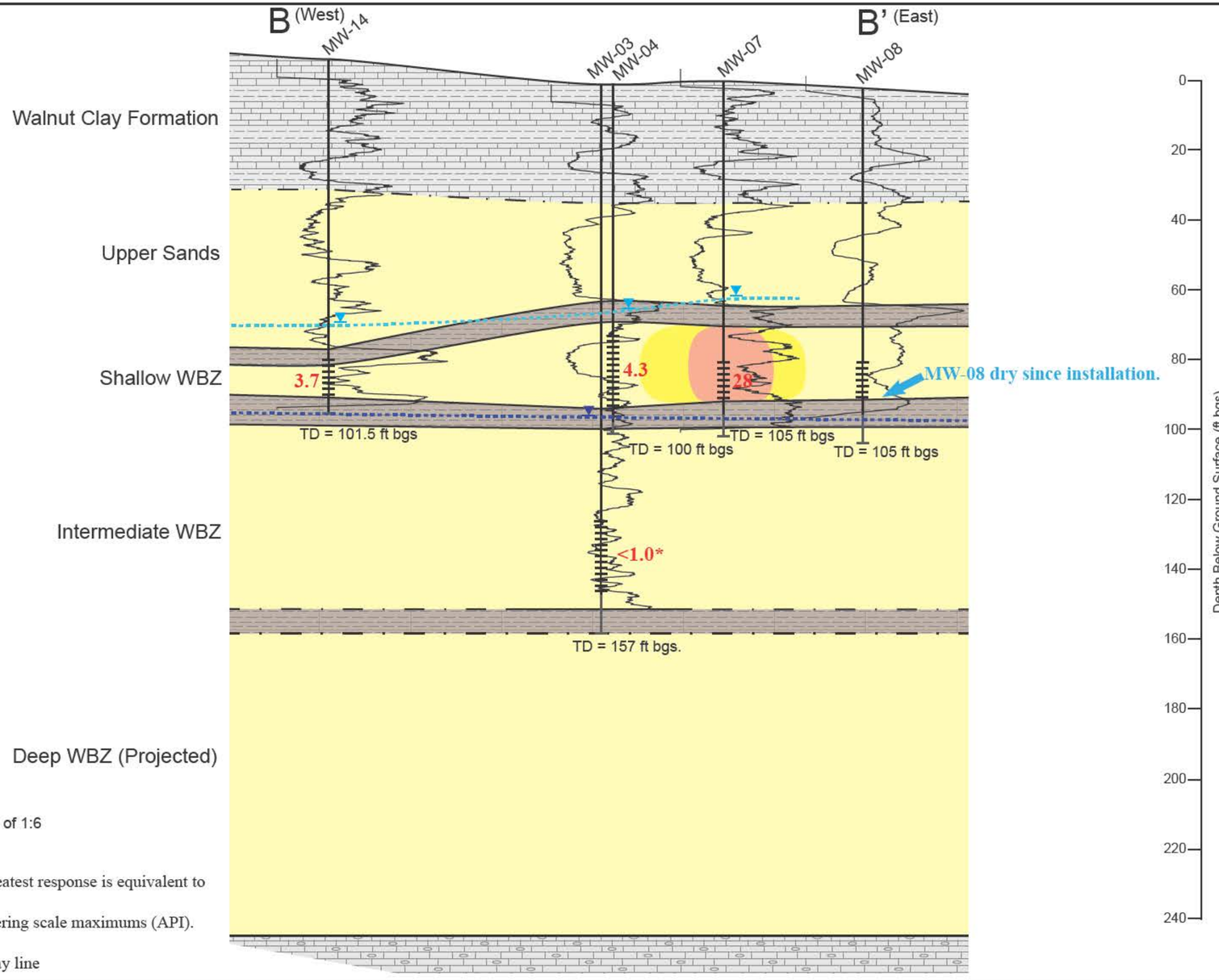
Figure 4
Generalized Hydrogeologic Cross Section A - A'

Circle Court Ground Water Plume Superfund Site
Willow Park, Parker County, Texas



Note:
- API = American Petroleum Institute units
- Gamma logs are positioned such that the greatest response is equivalent to ~45 API.
- Gamma logs normalized to account for differing scale maximums (API).
- WBZ = Water-bearing zone
- TD = Total depth of boring, indicated by gray line

LEGEND

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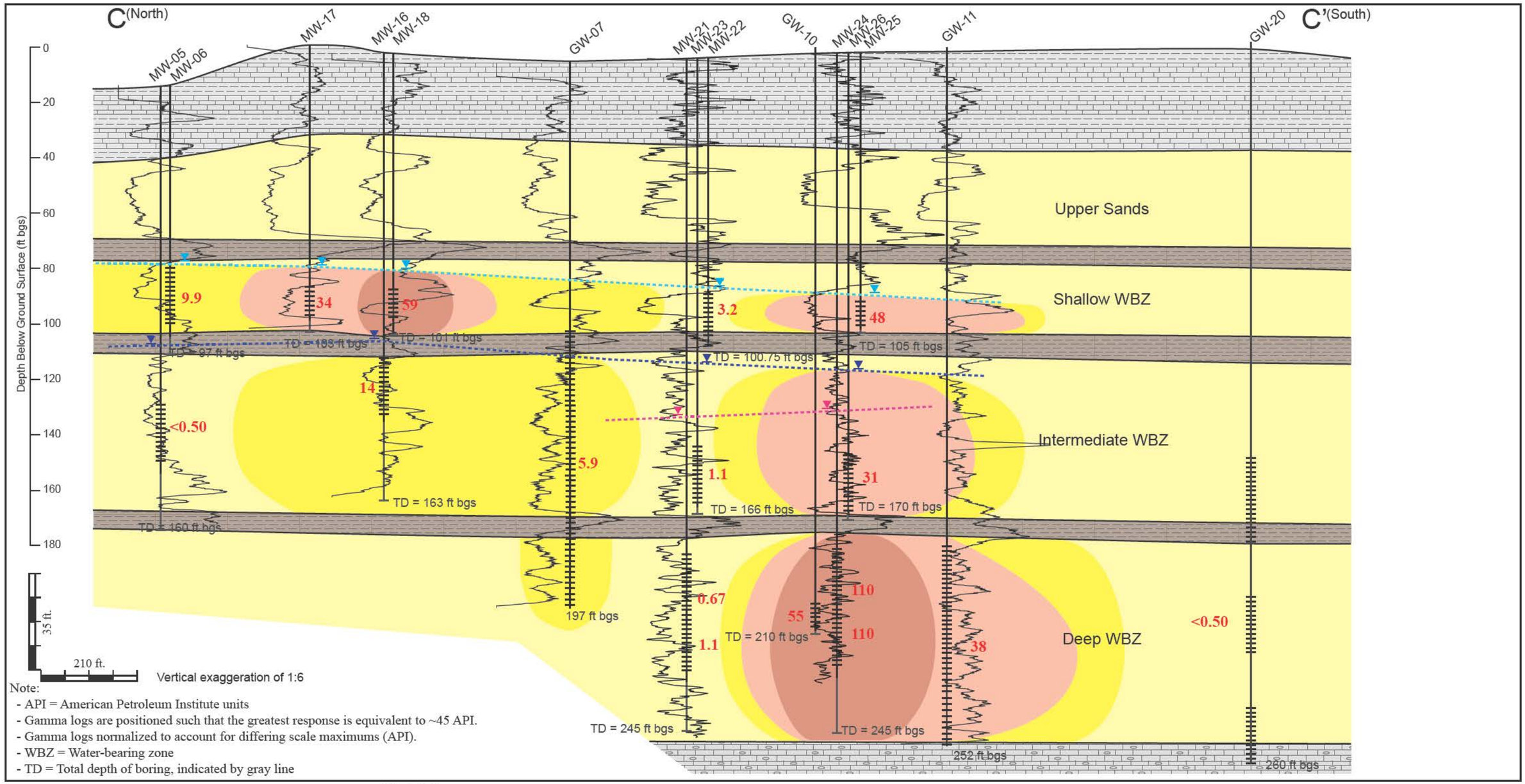
- TCE concentration between 25 & 50 µg/L
- TCE concentration between 5 & 25 µg/L
- <1.0 Trichloroethene concentration in micrograms per liter (µg/L)

(Samples collected July 2019, only highest concentration shown. *Indicates well not sampled July 2019, May 2016 data shown.)

EA Engineering, Science, and Technology, Inc., PBC

Figure 5
Generalized Hydrogeologic Cross Section B - B'

Circle Court Ground Water Plume Superfund Site
Willow Park, Parker County, Texas



Note:
- API = American Petroleum Institute units
- Gamma logs are positioned such that the greatest response is equivalent to ~45 API.
- Gamma logs normalized to account for differing scale maximums (API).
- WBZ = Water-bearing zone
- TD = Total depth of boring, indicated by gray line

LEGEND

- Walnut Clay Formation (clay and limestone)
- Water-bearing Zones (sand, silt, clay, quartz sand)
- Aquitard
- Glen Rose Formation (limestone)
- Shallow WBZ Potentiometric Surface
- Intermediate WBZ Potentiometric Surface
- Deep WBZ Potentiometric Surface
- Well Screen Interval
- TCE concentration greater than 50 µg/L
- TCE concentration between 25 & 50 µg/L
- TCE concentration between 5 & 25 µg/L
- <1.0 Trichloroethene concentration in micrograms per liter (µg/L) (Samples collected July 2019, only highest concentration shown)

EA Engineering, Science, and Technology, Inc., PBC

Figure 6
Generalized Hydrogeologic Cross Section C- C'

Circle Court Ground Water Plume Superfund Site
Willow Park, Parker County, Texas

N

5 µg/L

MW-06
MW-05
MW-10

SV-01A
11/9/2016: 58,000
12/21/2017: 82,000

GW-05

SV-02
12/21/2017: 62,000
1/16/2018: 1H: ND
1/16/2018: 3H: 110
1/16/2018: 5.5H: 7,700
1/16/2018: 6.5H: 8,200
1/16/2018: 7.5H: 13,000

SV-01B
11/9/2016: 83,000 (90,000)
12/21/2017: 73,000 (76,000)
1/17/2018: 690

MW-15
MW-09

SV-05
12/21/2017: 15,000
1/17/2018: 310

SV-04
12/21/2017: 43,000
1/17/2018: 530

SV-03
12/21/2017: 58,000
1/17/2018: 310

GW-41R
MW-19
MW-20
MW-17

50 µg/L
25 µg/L

GW-201

MW-18
MW-16
MW-11

GW-07

Note:
Soil vapor result units are µg/m^3.
() indicate duplcate results
Results are presented as:
Date: time interval: result.
Time interval as appropriate.

0 80 160
Feet

Legend

- Shallow Monitoring Well
- Intermediate Monitoring Well
- Deep Monitoring Well
- Soil Vapor Extraction Well
- Private Water Supply Well
- Public Water Supply Well
- Plugged and Abandoned Well
- Horizontal SVE Well Screen
- SVE Radius of Influence

Trichloroethene Plume in Shallow Ground Water

- ≥ 5 µg/L contour
- ≥ 25 µg/L contour
- ≥ 50 µg/L contour
- Dashes Denote Implied Contour

Image Source: GoogleEarth Pro, 2016

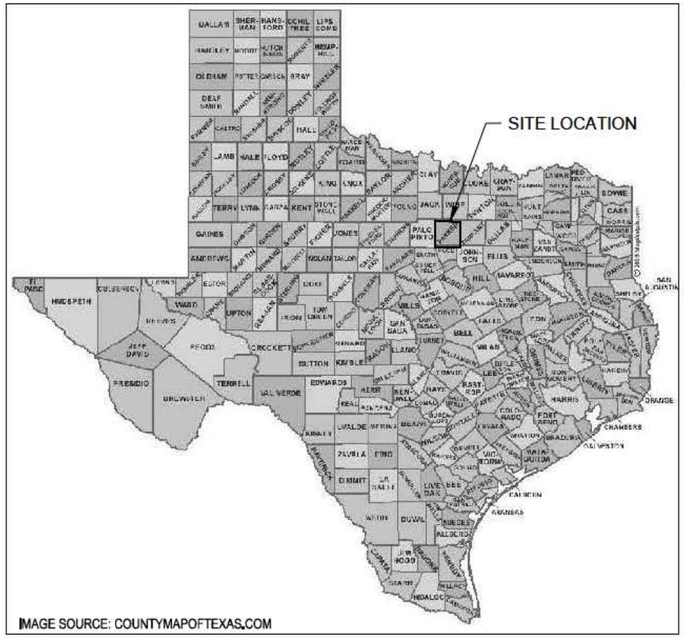
Circle Court Ground Water
Plume Superfund Site
Willow Park, Parker County, Texas

Figure 7
Proposed Horizontal Soil Vapor Extraction Well Locations

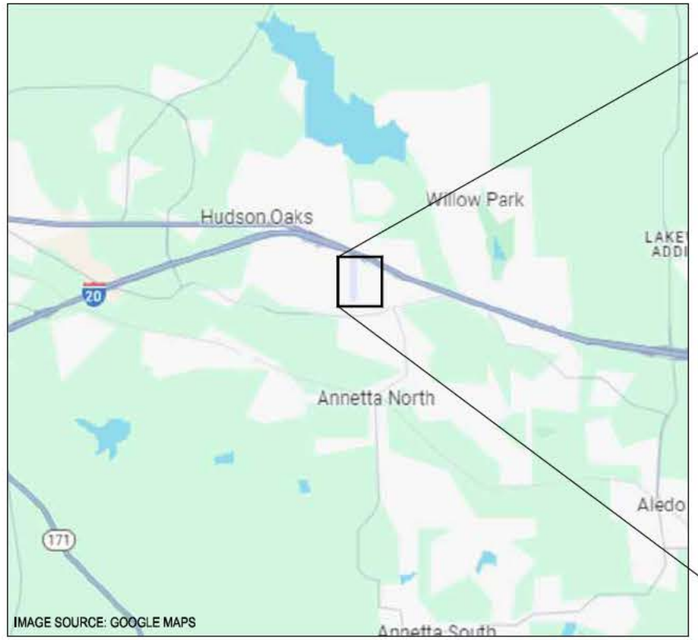
2024-06-28 C:\Data\Federal\EPA\RAC III\Save\2020041\0092-Circle Court RIFS\GIS\MXDs\HorizSVEWell202406\SoilVapor_TCEResults201803.mxd EA-Dallas jschwertz

Appendix A

Drawings



TEXAS MAP
NOT TO SCALE



LOCAL AREA MAP
NOT TO SCALE

VICINITY MAP
NOT TO SCALE

SOIL VAPOR EXTRACTION SYSTEM

REMEDIAL DESIGN

CIRCLE COURT GROUND WATER PLUME SUPERFUND SITE

PARKER COUNTY, TEXAS
PREPARED FOR
EPA REGION 6
DALLAS, TEXAS

EA Engineering, Science, and Technology, Inc., PBC
405 State Highway 121 (Bypass)
Building C, Suite 100
Lewisville, Texas 75067
(972) 315-3922
www.eaest.com

SOIL VAPOR EXTRACTION SYSTEM REMEDIAL DESIGN CIRCLE COURT GROUND WATER PLUME SUPERFUND SITE PARKER COUNTY, TEXAS	TITLE SHEET	DESIGN BY: AS	PROJECT MGR: LV
		DRAWING BY: CNS	SCALE: AS

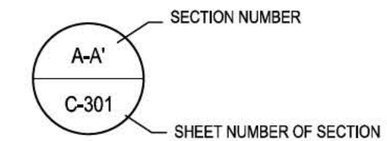
DATE: JUNE 2024	FIGURE: 1 OF 17	
PROJECT NO: 1578540	DRAWING NO: G-001	

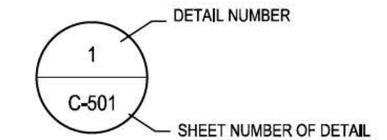
ABBREVIATIONS

AC	ACRES
AC	ALTERNATING CURRENT
APPRX	APPROXIMATELY
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
BGS	BENEATH GROUND SURFACE
BLDG	BUILDING
CMP	CORRUGATED METAL PIPE
CONC	CONCRETE
DA	DRAINAGE AREA
DIA	DIAMETER
DIP	DUCTILE IRON PIPE
DOT	DEPARTMENT OF TRANSPORTATION
DR	DIMENSION RATIO
EL/ELEV	ELEVATION
EPA	ENVIRONMENTAL PROTECTION AGENCY
ESD	ENVIRONMENTAL SITE DESIGN
EX/EXIST	EXISTING
FM	FORCEMAIN
FT	FEET
FT BGS	FEET BELOW GROUND SURFACE
GAC	GRANULATED ACTIVATED CARBON
GAL	GALLON
GALV	GALVANIZED
GPS	GLOBAL POSITIONING SYSTEM
HDPE	HIGH DENSITY POLY ETHYLENE
HMAC	HOT MIX ASPHALT CONCRETE
INV	INVERT
MAX	MAXIMUM
MHW	MEAN HIGH WATER
MIN	MINIMUM
MSL	MEAN SEA LEVEL
NA	NOT APPLICABLE
NAD 83	NORTH AMERICAN DATUM OF 1983
NAVD 88	NORTH AMERICAN VERICAL DATUM OF 1988
NEC	NATIONAL ELECTRIC CODE
NGS	NATIONAL GEODETIC SURVEY
NO.	NUMBER
NRCS	NATIONAL RESOURCE CONSERVATION SERVICE
NTS	NOT TO SCALE
PSI	POUNDS PER SQUARE INCH
PR	PROPOSED
PVC	POLYVINYL CHLORIDE
RCP	REINFORCED CONCRETE PIPE
RTK	REAL-TIME KINEMATIC
SCH	SCHEDULE
SD	STORM DRAIN
SQ FT	SQUARE FEET
SVE	SOIL VAPOR EXTRACTION
SWM	STORMWATER MANAGEMENT
SWPPP	STORMWATER POLLUTION PREVENTION PLAN
TYP	TYPICAL
U.S.	UNITED STATES
USACE	U.S. ARMY CORPS OF ENGINEERS
USDA	U.S. DEPARTMENT OF AGRICULTURE
USGS	U.S. GEOLOGICAL SURVEY
W/	WITH
WSEL	WATER SURFACE ELEVATION

LEGEND

LOD — LOD	LIMITS OF BOUNDARY
OHE — OHE	OVERHEAD ELECTRIC
	EXISTING ROAD
W — W — W	EXISTING WATER MAIN
	EXISTING POWER POLE
T	EXISTING TRANSFORMER
	EXISTING LIGHT POLE
WV	EXISTING WATER VALVE
	EXISTING BUILDING
	EXISTING TREES
SA1-02	EXISTING EVO INJECTION WELL
SA1-IW-1	PROPOSED EVO INJECTION WELL
SA1-01	EXISTING HORIZONTAL NESTED, SEGMENTED WELL
SA1-HSVE-2	PROPOSED DEEP WELLS
SA1-HSVE-1	EXISTING DEEP WELLS
G	EXISTING UNDERGROUND GAS LINE
SD — SD — SD	EXISTING STORM
X — X	SECURITY FENCE
	TREE LINE
SF — SF	SILT FENCE
	CONVEYANCE LINES





NOTE:

1. IF THE SECTION, DETAIL, SCHEMATIC, OR DIAGRAM IS REFERENCED ON MULTIPLE SHEETS, ALL SHEETS ARE REFERENCED WITHIN THE DETAIL BUBBLE.

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SOIL VAPOR EXTRACTION SYSTEM
REMEDIAL DESIGN
CIRCLE COURT GROUND WATER PLUME SUPERFUND SITE
PARKER COUNTY, TEXAS

LEGEND AND ABBREVIATION SHEET

DESIGN BY	PROJECT MGR	DATE	FIGURE
AS	LV	JUNE 2024	2 OF 17
DRAWING BY	SCALE	PROJECT NO	DRAWING NO
CNS	AS	1578540	G-002

GENERAL NOTES

1. ALL WORK ON THIS PROJECT SHALL BE PERFORMED IN ACCORDANCE WITH APPLICABLE FEDERAL, STATE, AND LOCAL LAWS, ORDINANCES AND REGULATIONS CONCERNING CONSTRUCTION SAFETY AND HEALTH.

2. THE CONTRACTOR IS RESPONSIBLE FOR OBTAINING ALL REQUIRED CONSTRUCTION PERMITS AND APPROVALS OF LIKE KIND PRIOR TO START OF CONSTRUCTION.

3. PROJECT DOCUMENTS CONSISTS OF THESE PLAN SHEETS, PROJECT SPECIFICATIONS, PROJECT CONTRACTS, AND ANY AND ALL SUBSEQUENT EXECUTED PROJECT DOCUMENTATION ISSUED AS, OR WITH, CHANGE ORDERS, AND RFI'S (REQUEST FOR INFORMATION). THE CONTRACTOR SHALL REVIEW ALL PROJECT DOCUMENTS AND VERIFY ALL DIMENSIONS, QUANTITIES, AND FIELD CONDITIONS. ANY CONFLICTS OR OMISSIONS WITH THE DOCUMENTS SHALL BE REPORTED TO THE ENGINEER/PROJECT MANAGER FOR CLARIFICATION PRIOR TO PERFORMANCE OF ANY WORK IN QUESTION. IN THE EVENT THE CONSTRUCTOR DOES NOT NOTIFY THE ENGINEER/PROJECT MANAGER, THE CONTRACTOR ASSUMES FULL RESPONSIBILITY AND ANY AND ALL EXPENSE FOR ANY REVISIONS NECESSARY OR CORRECTIONAL WORK REQUIRED.

4. HORIZONTAL UTILITY LOCATIONS ARE APPROXIMATE AND ARE BASED ON FIELD LOCATED UTILITIES. CONTRACTOR IS RESPONSIBLE FOR LOCATING UTILITIES PRIOR TO CONSTRUCTION. CONTRACTOR IS RESPONSIBLE FOR COORDINATING CONSTRUCTION ACTIVITIES WITH UTILITIES PROVIDERS. EXISTING BURIED UTILITIES SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO CONSTRUCTION. THE CONTRACTOR SHALL USE ANY MEANS APPROVED BY THE ENGINEER/PROJECT MANAGER TO LOCATE UNDERGROUND UTILITIES INCLUDING, BUT NOT LIMITED TO, ELECTRONIC LOCATING EQUIPMENT AND/OR POT HOLING. ANY DAMAGE TO ANY OTHER UTILITIES AND/OR COLLATERAL DAMAGE CAUSED BY THE CONTRACTOR SHALL BE THE FULL RESPONSIBILITY OF THE CONTRACTOR.

5. EXISTING FENCING OR WALLS THAT ARE NOT DESIGNATED FOR REMOVAL SHALL NOT BE DISTURBED. ANY FENCING OR WALLS THAT ARE DISTURBED OR ALTERED BY THE CONTRACTOR SHALL BE RESTORED TO ITS ORIGINAL CONDITION AT THE CONTRACTOR'S EXPENSE. IF THE CONTRACTOR DESIRES TO REMOVE FENCING TO ACCOMMODATE CONSTRUCTION ACTIVITIES, THE CONTRACTOR SHALL OBTAIN THE OWNER'S WRITTEN PERMISSION BEFORE FENCE IS REMOVED. CONTRACTOR SHALL RESTORE THE FENCE TO ITS ORIGINAL CONDITION AT THE EARLIEST OPPORTUNITY TO THE SATISFACTION OF THE OWNER. WHILE ANY FENCING IS REMOVED, THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR SECURITY OF THE SITE UNTIL THE FENCE IS RESTORED.

6. AT THE END OF EACH WORK DAY, THE CONTRACTOR SHALL CLEAN AND PICK UP THE WORK AREA TO THE SATISFACTION OF THE ENGINEER/PROJECT MANAGER OR THEIR REPRESENTATIVE. AT NO TIME SHALL THE WORK BE LEFT IN A MANNER THAT COULD ENDANGER WORKERS OR THE PUBLIC.

7. ALL MATERIALS AND WORKMANSHIP SHALL CONFORM TO THE PROJECT SPECIFICATION AND PLANS, AS AMENDED AND REVISED BY THE ENGINEER. ALL INSTALLATION DETAILS ARE TYPICAL AND MAY BE CHANGED TO BETTER FIT EXISTING LOCAL CONDITIONS UPON APPROVAL BY THE ENGINEER/PROJECT MANAGER.

8. ONLY THE CONTRACTOR SHALL BE RESPONSIBLE FOR SAFETY OF ALL WORK. ALL WORK, INCLUDING WORK WITHIN TRENCHES, AND EXCAVATIONS SHALL BE IN ACCORDANCE WITH THE OCCUPATIONAL SAFETY AND HEALTH ACT (OSHA).

9. THE CONTRACTOR SHALL NOT INSTALL ITEMS AS SHOWN ON THESE PLANS WHEN IT IS OBVIOUS THAT FIELD CONDITIONS ARE DIFFERENT THAN SHOWN IN THE PLANS. SUCH CONDITIONS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER IN A TIMELY MANNER. IN THE EVENT OF REWORK CAUSED BY DIFFERING FIELD CONDITIONS, THE CONTRACTOR ASSUMES FULL RESPONSIBILITY AND EXPENSE FOR ANY REVISIONS NECESSARY, INCLUDING ENGINEERING DESIGN FEES.

10. EXISTING SITE IMPROVEMENTS WHICH ARE DAMAGED OR DISPLACED BY THE CONTRACTOR SHALL BE REMOVED AND REPLACED BY THE CONTRACTOR AT THE CONTRACTOR'S EXPENSE. REPAIRS SHALL BE APPROVED BY THE ENGINEER PRIOR TO CONSTRUCTION OF THE REPAIRS. REPAIRS SHALL BE ACCEPTED BY THE ENGINEER PRIOR TO FINAL PAYMENT.

11. CONTRACTOR SHALL COORDINATE CONSTRUCTION ACTIVITIES WITH OTHER CONTRACTORS AND UTILITY COMPANIES WORKING IN THE SAME AREA.

TEMPORARY TRAFFIC CONTROL GENERAL NOTES

1. IF WORK WITHIN THE RIGHT-OF-WAY IS REQUIRED, THEN CONTRACTOR MUST OBTAIN AN APPROPRIATE PERMIT FROMPARKER COUNTY AT LEAST FIVE WORKING DAYS BEFORE ENGAGING IN ANY CONSTRUCTION, MAINTENANCE, OR REPAIR WORK IN ANY OF THE RIGHTS-OF-WAY.

2. CONTRACTOR SHALL AT THE TIME OF PERMIT REQUEST, SUBMIT FOR REVIEW BY ENGINEER, A TRAFFIC CONTROL PLAN DETAILING ALL EXISTING CONDITIONS SUCH AS LANE WIDTH, DRIVEWAYS, AND BUSINESS/RESIDENTIAL ACCESSES. THE TRAFFIC CONTROL PLAN SHALL INCLUDE ALL PHASES OF WORK AND SCHEDULES INVOLVED IN THE CONSTRUCTION PROJECT.

3. ALL CONSTRUCTION TRAFFIC CONTROL DEVICES SHALL COMPLY TO THE TEXAS MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (TMUTCD), LATEST EDITION. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO INSTALL, SERVICE AND MAINTAIN ALL TRAFFIC CONTROL DEVICES. TRAFFIC CONTROL DEVICES SHALL NOT BE REMOVED OR ALTERED IN ANY WAY WITHOUT THE APPROVAL OF THE ENGINEER.

4. IF REQUIRED, CONTRACTOR IS RESPONSIBLE TO MAINTAIN AND SERVICE ALL TRAFFIC CONTROL DEVICES 24 HOURS A DAY, 7 DAYS A WEEK THROUGHOUT LENGTH OF PROJECT, CONTRACTOR IS RESPONSIBLE THAT ALL TRAFFIC CONTROL DEVICES COMPLY WITH THE TMUTCO, LATEST EDITION.

5. EQUIPMENT OR MATERIALS SHALL NOT BE STORED WITHIN 15 FEET OF A TRAVELED TRAFFIC LANE DURING NON-WORKING HOURS WITHOUT THE APPROVAL OF ENGINEER.

6. CONTRACTOR SHALL PROVIDE AND MAINTAIN A SAFE AND ADEQUATE MEANS OF CHANNELIZING PEDESTRIAN AND VEHICLE TRAFFIC AROUND AND THROUGH THE CONSTRUCTION AREA TO BUSINESSES AT THE SITE.

7. CONTRACTOR SHALL MAINTAIN ACCESS TO ALL FACILITIES, BUSINESSES AND/OR RESIDENCES AT ALL TIMES.

8. ANY FIELD ADJUSTMENTS SHALL BE APPROVED BY ENGINEER.

9. CONTRACTORS SHALL AT ALL TIMES COMPLY WITH THE STANDARDS AND REQUIREMENTS SET FORTH IN THE TMUTCD, LATEST EDITION.

10. FAILURE TO COMPLY WITH ANY OF THE ABOVE MENTIONED WILL BE ADEQUATE CAUSE TO CEASE ALL WORK ON ANY CONSTRUCTION PROJECT. WORK WILL NOT RESUME UNTIL ALL REQUIREMENTS ARE ADDRESSED AND APPROVED BY ENGINEER.

11. ALL TRAFFIC CONTROL DEVICES SHALL BE KEPT IN NEW/CLEAN CONDITION, WASHING OF EQUIPMENT IS INCIDENTAL TO ITS PLACEMENT AND MAINTENANCE.

WORK WITHIN ADJACENT RIGHT-OF-WAY OR PROPERTIES

1. PRIOR TO BEGINNING ANY CONSTRUCTION ACTIVITIES WITHIN ADJACENT RIGHT-OF-WAYS OR WITHIN PROPERTY NOT OWNED BY THE OWNER OF THE PROJECT SITE, THE CONTRACTOR SHALL ENSURE THAT ALL PERMITS AND PERMISSIONS REQUIRED HAVE BEEN OBTAINED IN WRITING BY THE ENGINEER.

SURVEY MONUMENTS, PROPERTY CORNERS, BENCHMARKS

1. THE CONTRACTOR SHALL NOTIFY THE ENGINEER BEFORE BEGINNING ANY CONSTRUCTION ACTIVITY THAT COULD DAMAGE OR DISPLACE SURVEY MONUMENTS, PROPERTY CORNERS, OR PROJECT BENCHMARKS SO THESE ITEMS MAY BE RELOCATED.

2. ALL HORIZONTAL LOCATIONS ARE REFERENCED TO TEXAS STATE PLAN COORDINATE SYSTEM, NORTH CENTRAL ZONE, NORTH AMERICAN DATUM 1983 (NAD83)

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SOIL VAPOR EXTRACTION SYSTEM
REMEDIAL DESIGN
CIRCLE COURT GROUND WATER PLUME SUPERFUND SITE
PARKER COUNTY, TEXAS

GENERAL NOTES

DESIGN BY	PROJECT MGR	DATE	FIGURE
AS	LV	JUNE 2024	3 OF 17
DRAWING BY	SCALE	PROJECT NO	DRAWING NO
CNS	AS	1578540	G-003

GENERAL NOTES

UTILITIES

1. UTILITY LINES, PIPELINES, OR UNDERGROUND UTILITY LINES SHOWN ON THESE DRAWINGS ARE SHOWN IN AN APPROXIMATE LOCATION ONLY BASED ON THE INFORMATION PROVIDED TO THE ENGINEER BY OTHERS. THIS INFORMATION MAY BE INACCURATE OR INCOMPLETE; UNDERGROUND LINES MAY EXIST THAT ARE NOT SHOWN. THE CONTRACTOR SHALL VERIFY THE LOCATION OF ANY UTILITY LINE, PIPELINE, OR UNDERGROUND UTILITY LINE IN OR NEAR THE AREA OF THE WORK.

2. THE CONTRACTOR SHALL CONTACT THE STATEWIDE UTILITY LOCATOR SERVICE AT LEAST TWO WORKING DAYS BEFORE BEGINNING CONSTRUCTION. AFTER THE UTILITIES ARE SPOTTED, THE CONTRACTOR SHALL EXPOSE ALL PERTINENT UTILITIES TO VERIFY THEIR VERTICAL AND HORIZONTAL LOCATION. IF A CONFLICT EXISTS BETWEEN EXISTING UTILITIES AND PROPOSED CONSTRUCTION, THE CONTRACTOR SHALL NOTIFY THE ENGINEER SO THAT THE CONFLICT CAN BE RESOLVED WITH MINIMAL DELAY.

3. THE CONTRACTOR SHALL EXERCISE DUE CARE TO AVOID DISTURBING ANY EXISTING UTILITIES, ABOVE OR BELOW THE GROUND. UTILITIES THAT ARE DAMAGED BY CONSTRUCTION SHALL BE REPAIRED OR REPLACED AT THE CONTRACTOR'S EXPENSE.

4. THE CONTRACTOR SHALL COORDINATE ANY REQUIRED UTILITY INTERRUPTIONS WITH THE AFFECTED PROPERTY OWNERS, ENGINEER, AND AFFECTED UTILITY COMPANY A MINIMUM OF THREE (3) WORKING DAYS BEFORE THE INTERRUPTION.

5. THE CONTRACTOR SHALL MAINTAIN A RECORD DRAWING SET OF PLANS AND PROMPTLY LOCATE ALL UTILITIES, EXISTING OR NEW, IN THEIR CORRECT LOCATION, HORIZONTAL AND VERTICAL. THIS RECORD SET OF DRAWINGS SHALL BE MAINTAINED ON THE PROJECT SITE AND SHALL BE AVAILABLE TO THE OWNER AND ENGINEER AT ANY TIME DURING CONSTRUCTION. RECORD INFORMATION SHALL INCLUDE HORIZONTAL AND VERTICAL COORDINATE CALLOUTS, LINE SIZES, LINE TYPES, BURIAL DEPTHS, AND ALL OTHER PERTINENT INSTALLATION INFORMATION. IN ADDITION ALL ITEMS THAT ARE INSTALLED EXACTLY DESIGNED SHALL BE NOTED AS SUCH.

EROSION CONTROL, ENVIRONMENTAL PROTECTION, AND STORM WATER POLLUTION PREVENTION PLAN

1. THE CONTRACTOR SHALL CONFORM TO ALL STATE AND FEDERAL DUST AND EROSION CONTROL REGULATIONS. THE CONTRACTOR SHALL PREPARE AND OBTAIN ANY DUST CONTROL AND EROSION CONTROL PERMITS FROM THE APPROPRIATE REGULATORY AGENCIES.

2. THE CONTRACTOR SHALL PROMPTLY REMOVE OR STABILIZE ANY MATERIAL EXCAVATED WITHIN THE RIGHT-OF-WAY OR ADJACENT PROPERTY TO KEEP IT FROM WASHING OFF THE PROJECT SITE.

3. THE CONTRACTOR SHALL ENSURE THAT NO SOIL ERODES FROM THE SITE ONTO ADJACENT PROPERTY BY CONSTRUCTION OF TEMPORARY EROSION CONTROL BERMS OR INSTALLING SILT FENCES AT THE PROPERTY LINES (OR LIMITS OF CONSTRUCTION WHERE DESIGNATED) AND WETTING SOIL TO PREVENT IT FROM BLOWING.

4. WATERING, AS REQUIRED FOR CONSTRUCTION DUST CONTROL, SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION AND NO MEASUREMENT OR PAYMENT SHALL BE MADE. CONSTRUCTION AREAS SHALL BE WATERED FOR DUST CONTROL IN COMPLIANCE WITH STATE ORDINANCES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE AVAILABILITY AND USE OF WATER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR SUPPLYING ALL EQUIPMENT AND MATERIALS NECESSARY FOR OBTAINING WATER.

5. THE CONTRACTOR SHALL COORDINATE FINAL TREATMENT OF ALL DISTURBED AREAS WITH THE ENGINEER.

6. CONTRACTOR SHALL PROPERLY HANDLE AND DISPOSE OF ALL ASPHALT AND CONCRETE REMOVED ON THE PROJECT BY HAULING TO AN APPROVED DISPOSAL SITE IN ACCORDANCE WITH THE REQUIREMENTS OF THE STATE OF TEXAS.

7. ALL WASTE PRODUCTS FROM THE CONSTRUCTION SITE, INCLUDING ITEMS DESIGNED FOR REMOVAL, CONSTRUCTION WASTE, CONSTRUCTION EQUIPMENT WASTE PRODUCTS (OIL, GAS, TIRES, ETC.), GARBAGE, GRUBBING, EXCESS CUT MATERIAL, VEGETATIVE DEBRIS, ETC. SHALL BE APPROPRIATELY DISPOSED OF OFFSITE. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO OBTAIN ANY PERMITS REQUIRED FOR HAUL OR DISPOSAL OF WASTE PRODUCTS. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO FOLLOW APPROPRIATE REGULATIONS REGARDING THE ENVIRONMENT, ENDANGERED SPECIES, AND ARCHAEOLOGICAL RESOURCES.

8. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE CLEANUP AND REPORTING OF SPILLS OF HAZARDOUS MATERIALS ASSOCIATED WITH THE CONSTRUCTION SITE. HAZARDOUS MATERIALS INCLUDES GASOLINE, DIESEL FUEL, MOTOR OIL, SOLVENTS, CHEMICALS, PAINT, ETC. WHICH MAY BE A THREAT TO THE ENVIRONMENT. THE CONTRACTOR SHALL REPORT THE DISCOVERY OF PAST OR PRESENT SPILLS TO THE ENGINEER.

9. THE CONTRACTOR SHALL COMPLY WITH ALL APPLICABLE REGULATIONS CONCERNING SURFACE AND UNDERGROUND WATER. CONTACT WITH SURFACE WATER BY CONSTRUCTION EQUIPMENT AND PERSONNEL SHALL BE MINIMIZED. EQUIPMENT MAINTENANCE AND REFUELING OPERATIONS SHALL BE PERFORMED IN AN ENVIRONMENTALLY SAFE MANNER IN COMPLIANCE WITH STATE AND FEDERAL REGULATIONS.

10. THE CONTRACTOR SHALL COMPLY WITH ALL APPLICABLE REGULATIONS CONCERNING CONSTRUCTION NOISE AND HOURS OF OPERATION AS STATED IN THE SPECIFICATIONS OR IMPOSED BY THE ENGINEER OR STATE OR LOCAL AUTHORITIES.

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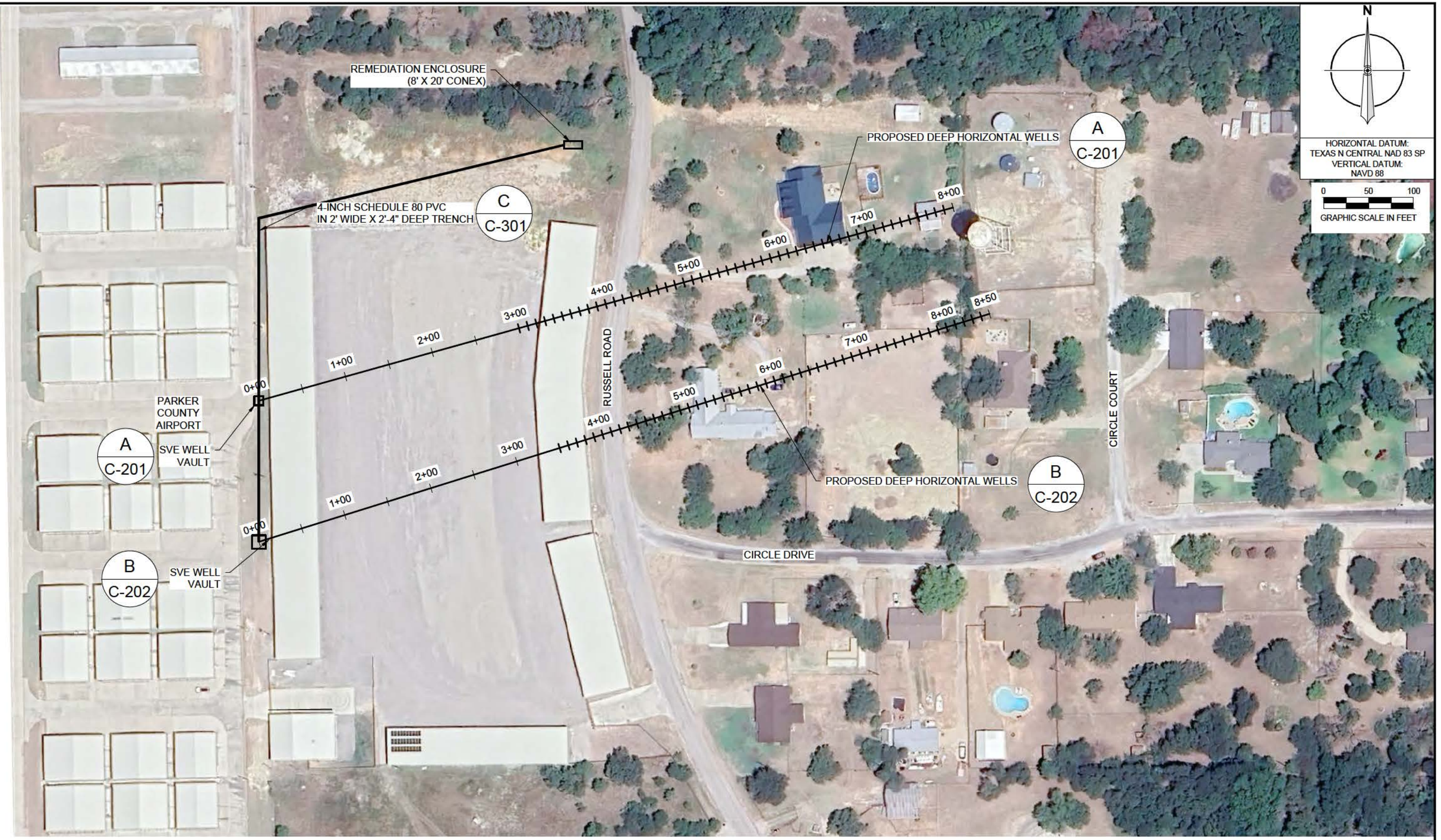
SOIL VAPOR EXTRACTION SYSTEM
REMEDIAL DESIGN
CIRCLE COURT GROUND WATER PLUME SUPERFUND SITE
PARKER COUNTY, TEXAS

GENERAL NOTES SHEET

DESIGN BY	PROJECT MGR	DATE	FIGURE
AS	LV	JUNE 2024	4 OF 17
DRAWING BY	**SCALE**	**PROJECT NO**	**DRAWING NO**
CNS	AS	1578540	G-004



FILE PATH: F:\FEDERAL\NON DOD\EPA\PROJECTS\1578540 - CIRCLE CT GROUND WATER PLUME\1- CADD\4- FIGURES\1578540 - PROPOSED SVE SYSTEM LAYOUT.DWG [C-101] 6/27/2024 10:39 AM

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REMEDIAL DESIGN
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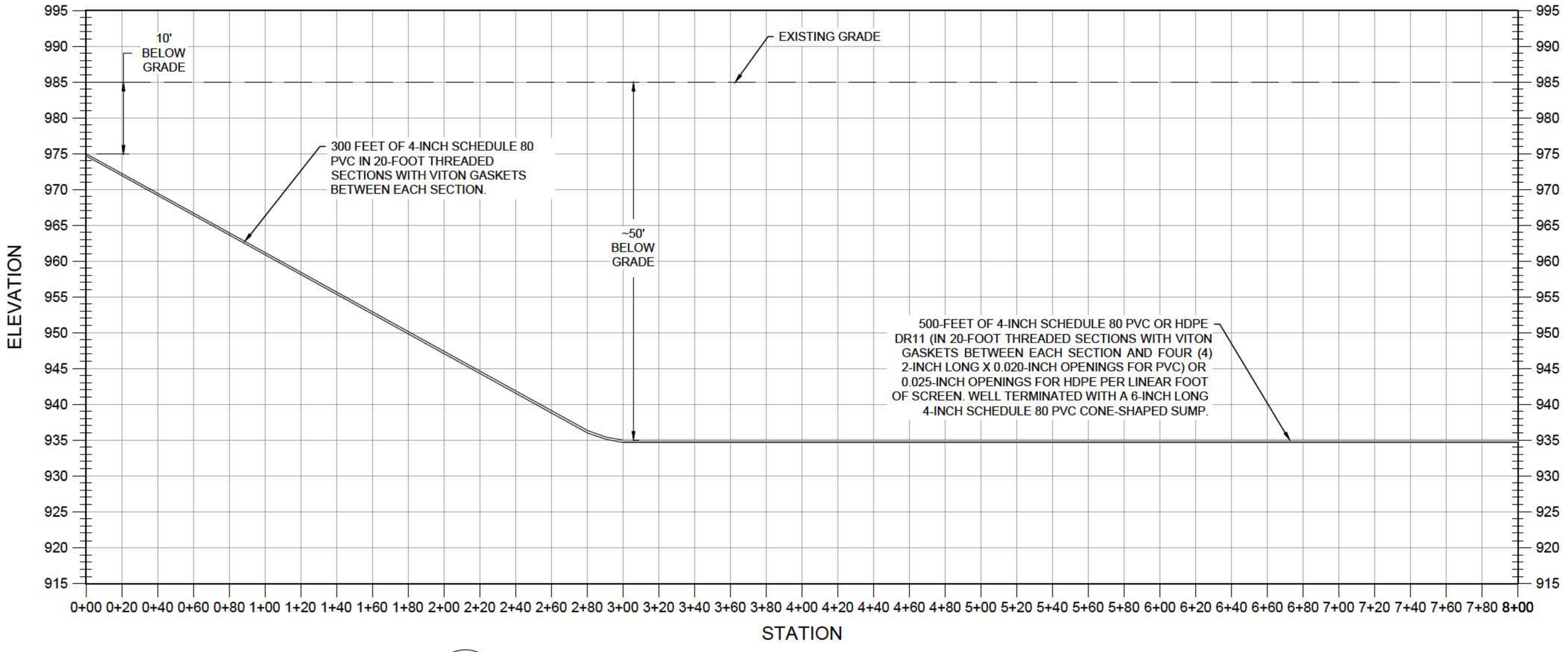
PARKER COUNTY, TEXAS

PROPOSED SVE SYSTEM LAYOUT

DESIGN BY	PROJECT MGR	DATE	FIGURE
AS	LV	JUNE 2024	5 OF 16
DRAWING BY	SCALE	PROJECT NO	DRAWING NO
CNS	AS	1578540	C-101



A
C-201

DIRECTIONAL BORING FOR DEEP HORIZONTAL WELLS - PROFILE I

HORIZONTAL SCALE: 0 30 60

VERTICAL SCALE: 0 7.5 15

FILE PATH: F:\FEDERAL\NON DOD\EPA\PROJECTS\1578540 - CIRCLE CT GROUND WATER PLUME\1- CADD\4- FIGURES\1578540 - BORING PROFILES.DWG [C-201] 6/27/2024 10:40 AM

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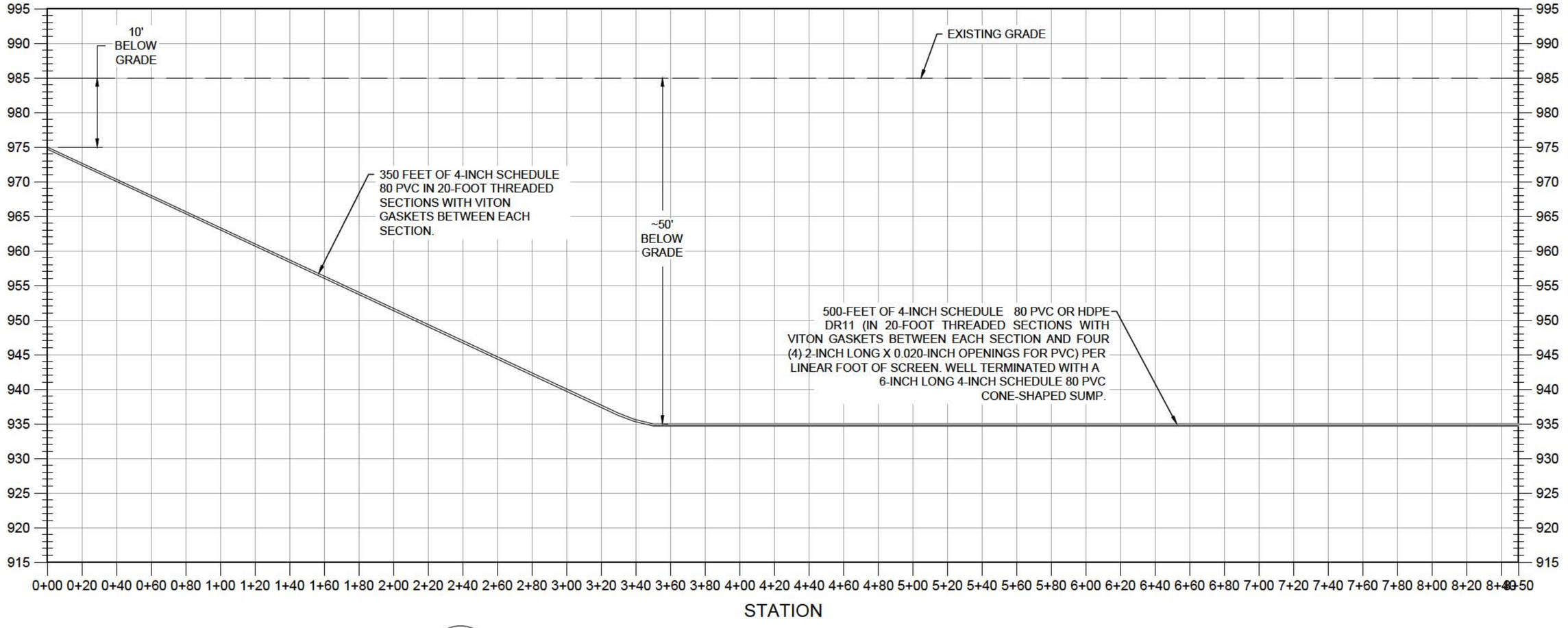
BORING PROFILE I

DESIGN BY	PROJECT MGR	DATE	FIGURE
AS	LV	JUNE 2024	6 OF 17
DRAWING BY	**SCALE**	**PROJECT NO**	**DRAWING NO**
CNS	AS	1578540	C-201



B
C-202

DIRECTIONAL BORING FOR DEEP HORIZONTAL WELLS - PROFILE II

HORIZONTAL SCALE: 0 30 60

VERTICAL SCALE: 0 7.5 15

FILE PATH: F:\FEDERAL\NON DOD\EPA\PROJECTS\1578540 - CIRCLE CT GROUND WATER PLUME\1- CADD\4- FIGURES\1578540 - BORING PROFILES.DWG [C-202] 6/27/2024 10:40 AM

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BORING PROFILE II

DESIGN BY	PROJECT MGR	DATE	FIGURE
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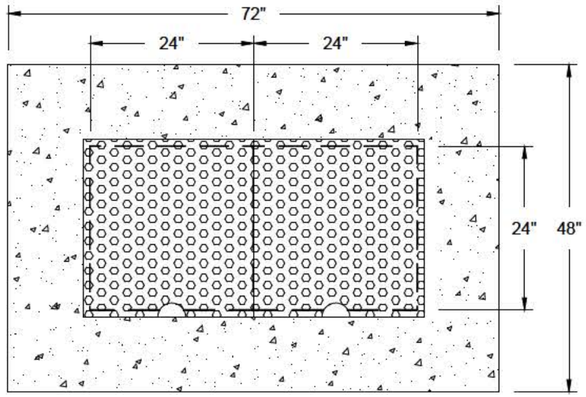
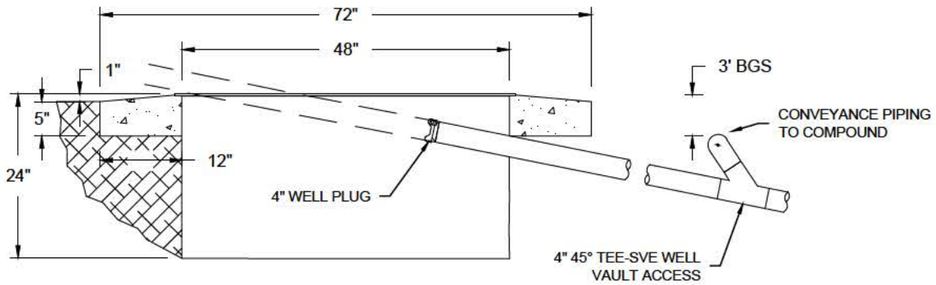
DRAWING BY	**SCALE**	**PROJECT NO**	**DRAWING NO**
CNS	AS	1578540	C-202

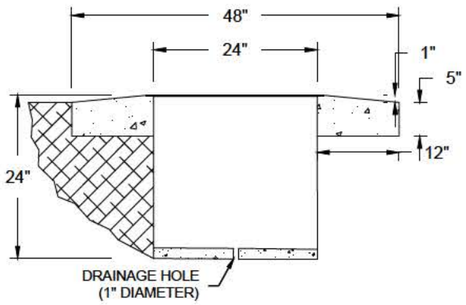


VAULT PLAN VIEW

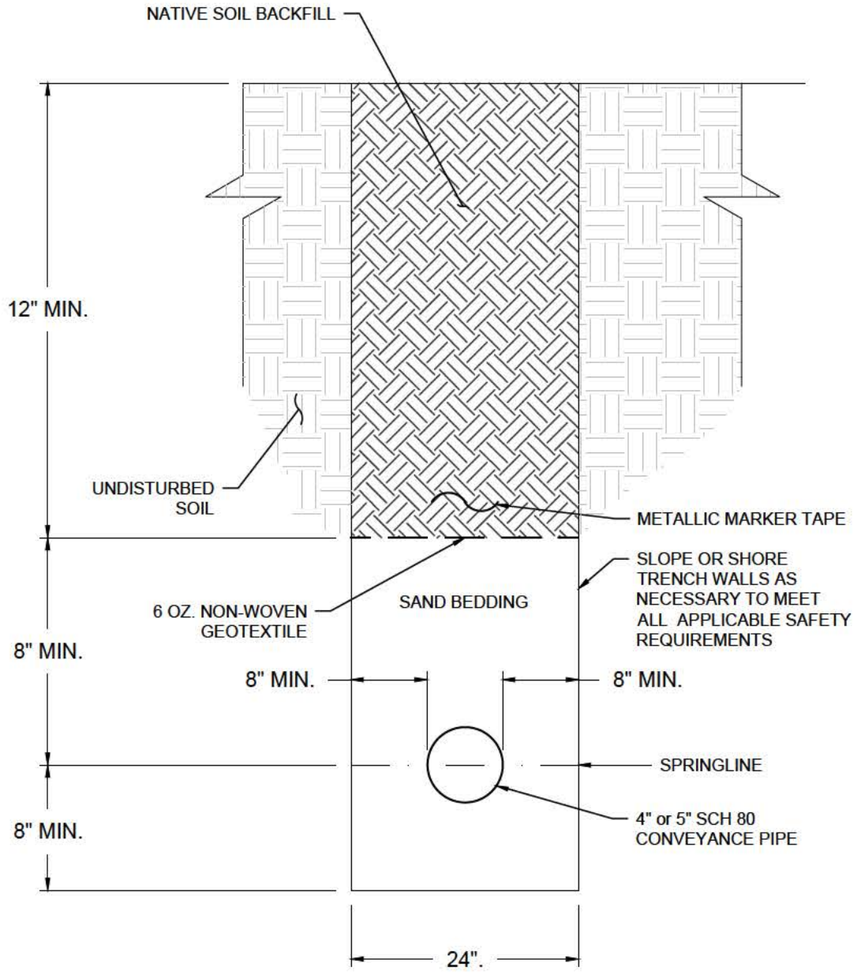
CONSTRUCTION NOTES:
1. VAULTS ARE CONSTRUCTED WITH 4,000 PSI CONCRETE WITH REINFORCEMENT.
2. COVERS CONSIST OF 4'X2' H-20 RATED STEEL HATCHES EQUIPPED WITH DROP HANDLES, SPRING ASSISTED HINGES, AND LOCKING MECHANISM.
3. VAULT WERE CONSTRUCTED TO ALLOW ACCESS TO THE WELL.
4. A 4-INCH 45° TEE WAS USED TO CONNECT CONVEYANCE LINES TO EACH WELL.
5. THE 45° TEES WERE INSTALLED APPROXIMATELY 3' BELOW GRADE.
6. CONVEYANCE LINES CONSIST OF 4-INCH SCH. 80 PVC.



VAULT PROFILE VIEW



VAULT PROFILE VIEW
NOT TO SCALE



C / C-101 **TRENCH DETAIL**
NOT TO SCALE

WELL SCHEDULE

CONSTRUCTION NOTES:
1. WELL CASING AND WELL SCREEN WERE CONSTRUCTED WITH 4-INCH Ø SCH 80 PVC HPDE.
2. WELL SCREEN PERFORATIONS: 4 2"X0.020 OPENINGS PER FOOT FOR SCHEDULE 80 PVC OR 4 2"X0.025 OPENINGS PER FOOT FOR HDPE.
3. SEE DRAWING C-1 FOR WELL ALIGNMENT

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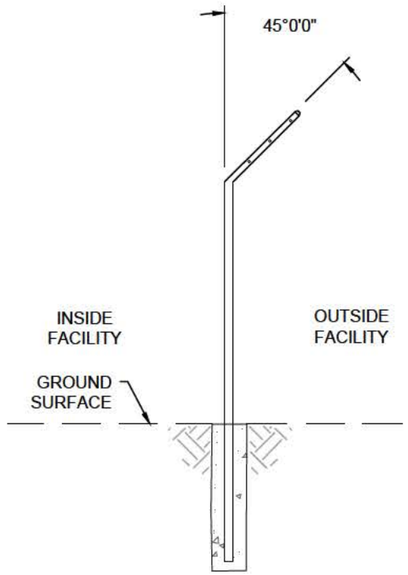
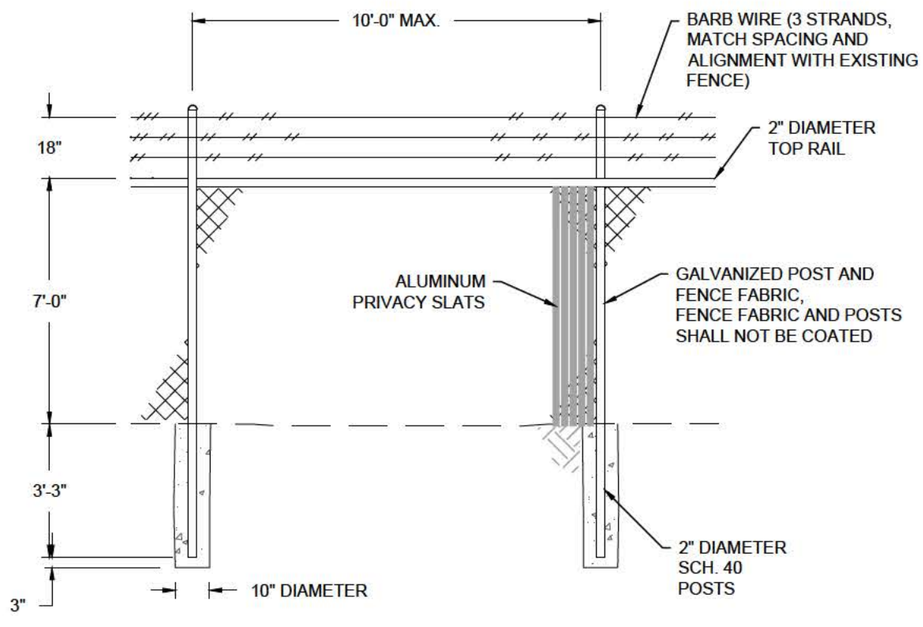
SOIL VAPOR EXTRACTION HORIZONTAL WELL DETAIL

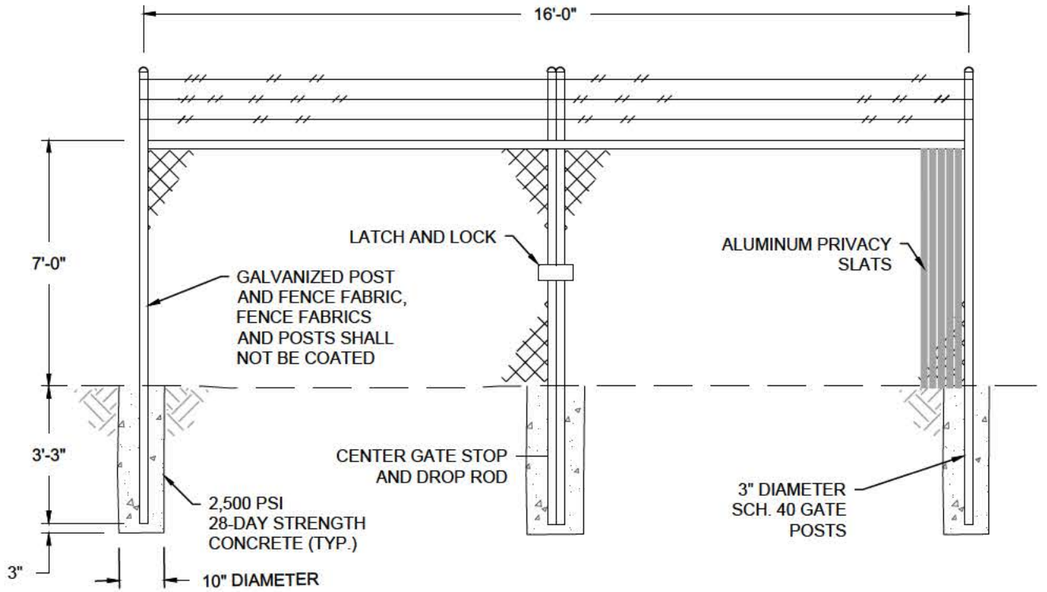
DESIGN BY	PROJECT MGR	DATE	FIGURE
AS	LV	JUNE 2024	8 OF 17
DRAWING BY	**SCALE**	**PROJECT NO**	**DRAWING NO**
CNS	AS	1578540	C-301



FENCE POST - PROFILE



TYPICAL FENCE SECTION



DOUBLE SWING GATE

D
C-403

SECURITY FENCE DETAIL

SCALE:NOT TO SCALE

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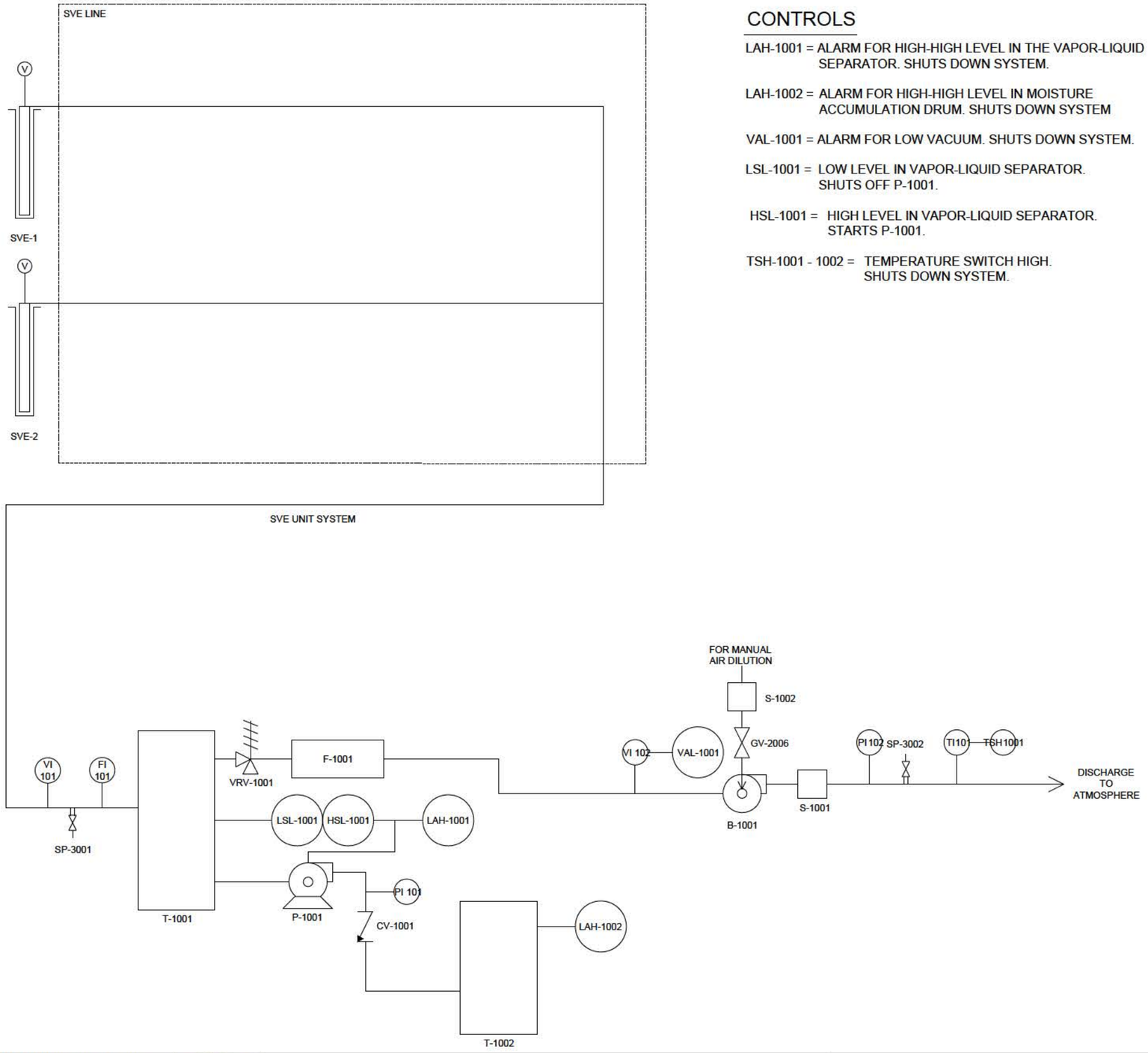
PARKER COUNTY, TEXAS

SECURITY FENCE DETAIL

DESIGN BY	PROJECT MGR	DATE	FIGURE
AS	LV	JUNE 2024	9 OF 17
DRAWING BY	SCALE	PROJECT NO	DRAWING NO
CNS	AS	1578540	C-302



CONTROLS

LAH-1001 = ALARM FOR HIGH-HIGH LEVEL IN THE VAPOR-LIQUID SEPARATOR. SHUTS DOWN SYSTEM.

LAH-1002 = ALARM FOR HIGH-HIGH LEVEL IN MOISTURE ACCUMULATION DRUM. SHUTS DOWN SYSTEM

VAL-1001 = ALARM FOR LOW VACUUM. SHUTS DOWN SYSTEM.

LSL-1001 = LOW LEVEL IN VAPOR-LIQUID SEPARATOR. SHUTS OFF P-1001.

HSL-1001 = HIGH LEVEL IN VAPOR-LIQUID SEPARATOR. STARTS P-1001.

TSH-1001 - 1002 = TEMPERATURE SWITCH HIGH. SHUTS DOWN SYSTEM.

LEGEND

T-1001
VAPOR-LIQUID SEPARATOR

T-1002
MOISTURE ACCUMULATION DRUM

B-1001
BLOWER

P-1001
TRANSFER PUMP

F-1001
AIR FILTER

S-1001
IN-LINE DISCHARGE SILENCER

S-1002
DILUTION AIR SILENCER

HX-1001
HEAT EXCHANGER

SP = SAMPLING PORT
GV = GATE VALVE
CV = CHECK VALVE
BV = BALL VALVE
VRV = VACUUM RELIEF VALVE
LSL = LOW SWITCH LEVEL
HSL = HIGH SWITCH LEVEL
LAH = LEVEL ALARM HIGH
VAL = VACUUM ALARM LOW
FAV = FLOW ADJUSTMENT VALVE
VAS = VAPOR ANALYSIS SYSTEM

(V) = VACUUM GAUGE PORT
(PI 01) = PRESSURE INDICATOR
(TI 01) = TEMPERATURE INDICATOR
(VI 01) = VACUUM INDICATOR
(FT 01) = FLOW TRANSMITTER
(FI 101) = FLOW INDICATOR

FILE PATH: F:\FEDERAL\NON DOD\EPA\PROJECTS\1578540 - CIRCLE CT GROUND WATER PLUME\1- CADD\4- FIGURES\1578540 - P_ID.DWG [C-401] 6/27/2024 10:41 AM

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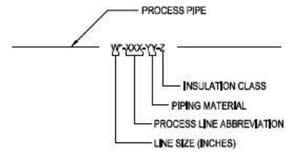
CIRCLE COURT GROUND WATER PLUME SUPERFUND SITE
PARKER COUNTY, TEXAS

PROCESS AND INSTRUMENTATION DIAGRAM

DESIGN BY	PROJECT MGR	DATE	FIGURE
AS	LV	JUNE 2024	10 OF 17
DRAWING BY	SCALE	PROJECT NO	DRAWING NO
CNS	AS	1578540	C-401

LINE IDENTIFICATION CODES

LINE NUMBERING



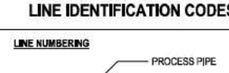
PIPING MATERIAL IDENTIFICATION

CPVC	CHLORINATED POLYVINYL CHLORIDE
CS	CARBON STEEL
COP	COPPER
CPP	CORRUGATED PLASTIC PIPE
CIP	CAST IRON PIPE
DIP	DUCTILE IRON PIPE
FH	FLEXIBLE HOSE
GAL	GALVANIZED STEEL PIPE
NYL	NYLON
PE	POLYETHYLENE PIPE
PP	POLYPROPYLENE PIPE
PVC	POLYVINYL PIPE
RUB	RUBBER HOSE
SS	STAINLESS STEEL

PROCESS LINE ABBREVIATIONS

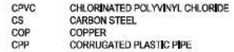
AIR	AIR, ATMOSPHERIC PRESSURE
BW	BACKWASH
CA	COMPRESSED AIR
CD	CONDENSATE
CF	CHEMICAL FEED
CGW	CONTAMINATED GROUNDWATER
D	DRAIN
EFF	EFFLUENT
EXH	EXHAUST
GW	GROUNDWATER
LFG	LANDFILL GAS
NPW	NON-POTABLE WATER
P	PRODUCT
PW	POTABLE WATER
S	SANITARY
SL	SLUDGE
SP	SAMPLE PORT
STS	STORM SEWER
TF	TOTAL FLUIDS
V	VENT
VAP	VAPOR

LINE CODING



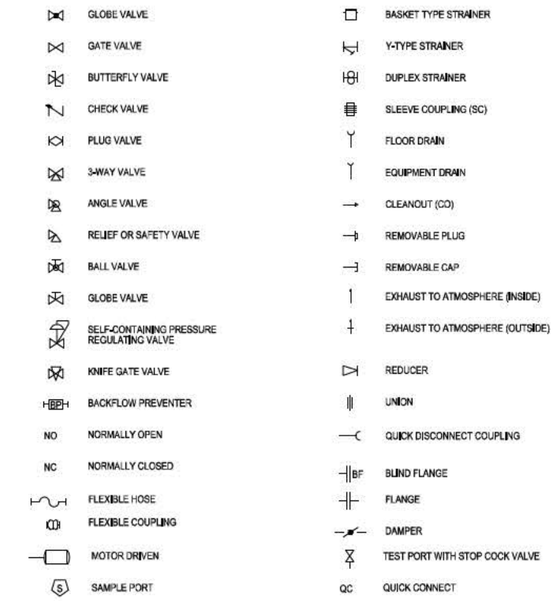
ELECTRICAL SIGNALS

PROCESS PIPE CONVEYANCE

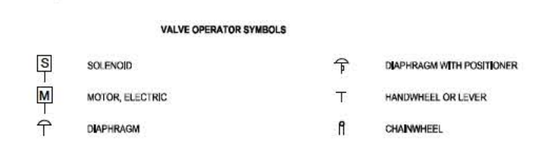


PROCESS AND INSTRUMENTATION DIAGRAM LEGEND WAS PROVIDED BY PRM IN THE SYSTEM OPERATION AND MAINTENANCE MANUAL

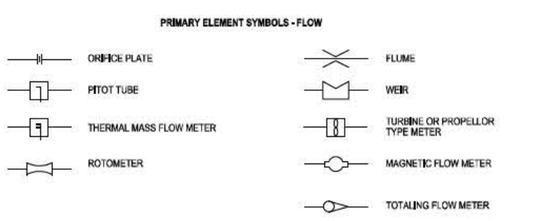
VALVE AND PIPING SYMBOLS



VALVE OPERATOR SYMBOLS



PRIMARY ELEMENT SYMBOLS - FLOW



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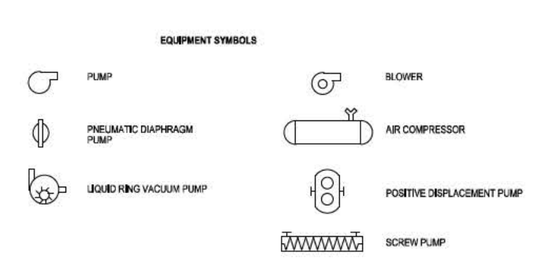
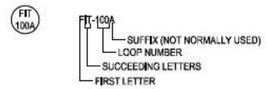
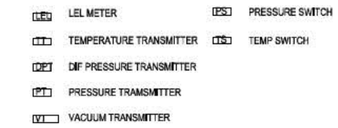


INSTRUMENT IDENTIFICATION

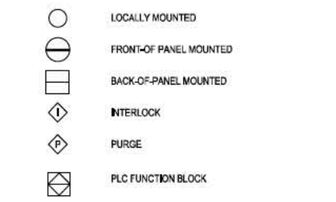


FUNCTIONAL ABBREVIATIONS

DO	DISSOLVED OXYGEN	OC	OPEN-CLOSE
FC	FAIL CLOSED	OO	ON-OFF (MAINTAINED)
FI	FAIL INTERMINATE	ORP	OXIDATION REDUCTION POTENTIAL
FL	FAIL LOCKED	OSC	OPEN-STOP-CLOSE (MOMENTARY)
FO	FAIL OPEN	SS	START-STOP (MONENTARY)
HOA	HAND-OFF-AUTOMATIC	>	HIGH SELECT
I/I	CURRENT-TO-CURRENT	<	LOW SELECT
I/P	CURRENT-TO-PNEUMATIC		
LEL	LOWER EXPLOSIVE LIMIT		
LR	LOCAL-REMOTE		



GENERAL INSTRUMENT SYMBOLS



INSTRUMENT IDENTIFICATION TABLE

	FIRST LETTER		SUCCEEDING LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER FLAME				
C	CONDUCTIVITY			CONTROL	
D	DENSITY (SP, GR)	DIFFERENTIAL		DRIVE	
E	VOLTAGE		PRIMARY ELEMENT		
F	FLOW RATE	RATIO			
G	GAUGING (DIMENSIONAL)		GLASS		
H	HAND (MANUAL)				HIGH
I	CURRENT		INDICATE		
J	POWER	SCAN			
K	TIME OR SCHEDULE			CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW
M	MOISTURE OR HUMIDITY				MIDDLE
N					
O			ORIFICE		
P	PRESSURE		POINT (TEST)		
Q	QUANT. OR EVENT	INTEGRATE			
R	RADIOACTIVITY		RECORD OR PRINT		
S	SPEED OR FREQ.	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	ULTRAVIOLET		MULTIFUNCTION		
V	VISCOSITY			VALVE OR DAMPER	
W	WEIGHT OR FORCE		WELL		
X	THERMOCOUPLE		UNCLASSIFIED		
Y	VIBRATION			RELAY OR COMPUTE	
Z	POSITION			DRIVE, ACTUATE	

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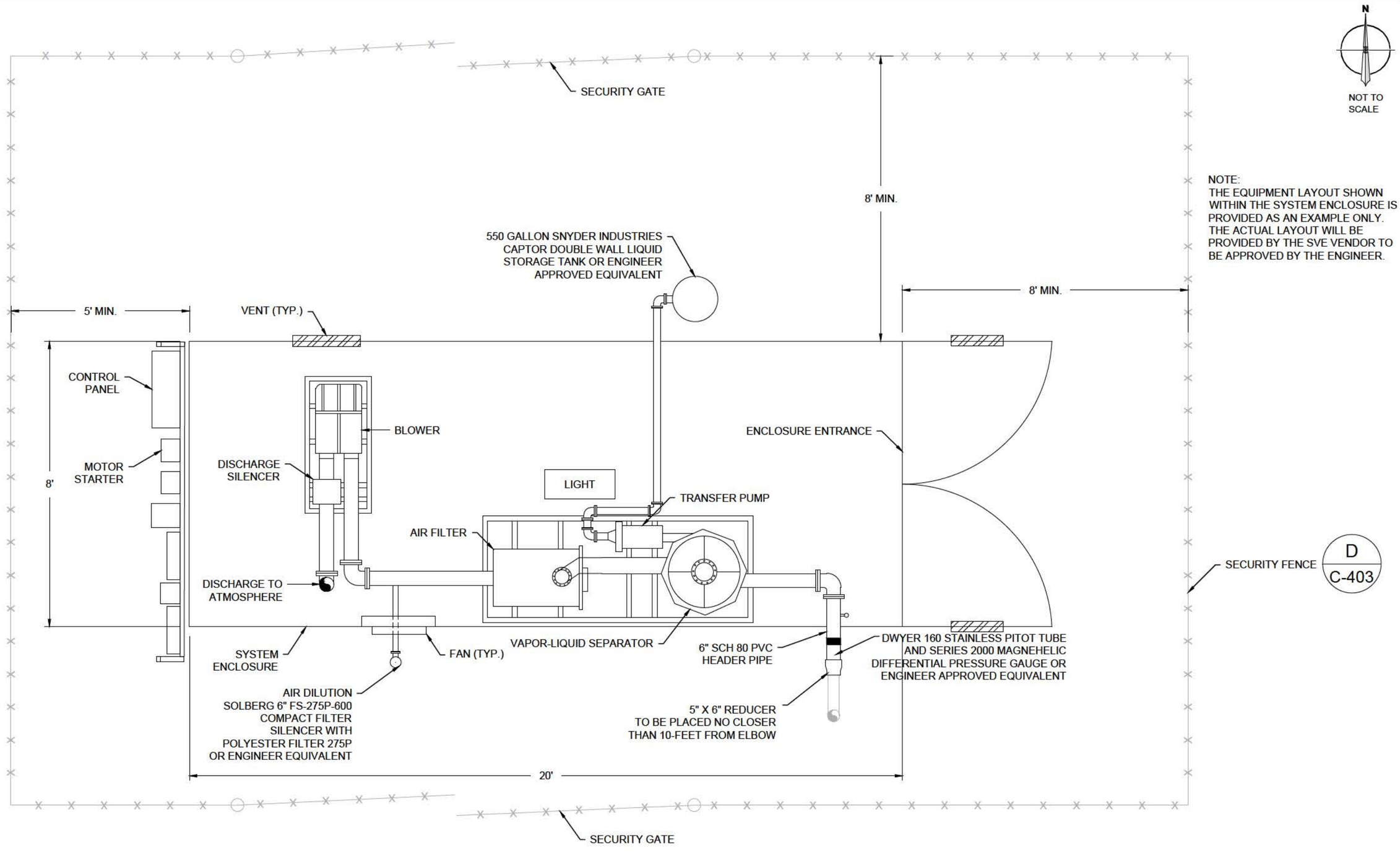
SOIL VAPOR EXTRACTION SYSTEM
REMEDIAL DESIGN
CIRCLE COURT GROUND WATER PLUME SUPERFUND SITE
PARKER COUNTY, TEXAS

PROCESS AND INSTRUMENTATION DIAGRAM LEGEND

DESIGN BY	PROJECT MGR	DATE	FIGURE
AS	LV	JUNE 2024	11 OF 17
DRAWING BY	**SCALE**	**PROJECT NO**	**DRAWING NO**
CNS	AS	1578540	C-402



NOTE:
THE EQUIPMENT LAYOUT SHOWN WITHIN THE SYSTEM ENCLOSURE IS PROVIDED AS AN EXAMPLE ONLY. THE ACTUAL LAYOUT WILL BE PROVIDED BY THE SVE VENDOR TO BE APPROVED BY THE ENGINEER.

FILE PATH: F:\FEDERAL\NON DOD\EPA\PROJECTS\1578540 - CIRCLE CT GROUND WATER PLUME\1- CADD\4- FIGURES\1578540 - P_ID.DWG [C-403] 6/27/2024 10:42 AM

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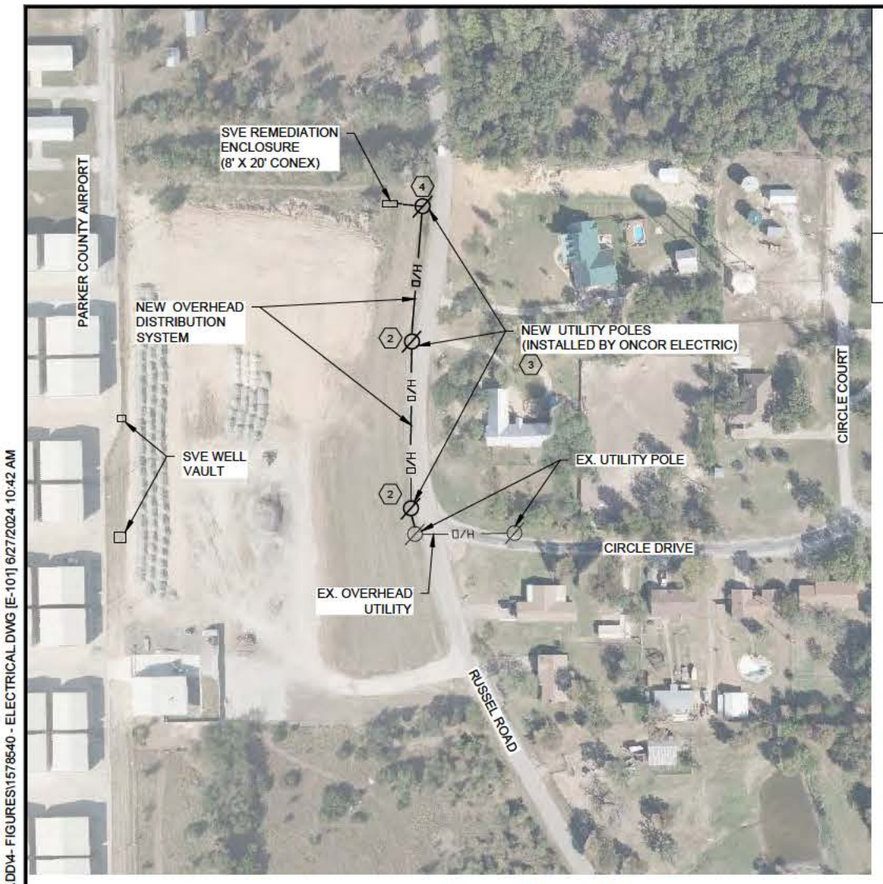
SOIL VAPOR EXTRACTION SYSTEM
REMEDIAL DESIGN
CIRCLE COURT GROUND WATER PLUME SUPERFUND SITE
PARKER COUNTY, TEXAS

EQUIPMENT LAYOUT

DESIGN BY	PROJECT MGR	DATE	FIGURE
AS	LV	JUNE 2024	12 OF 17
DRAWING BY	SCALE	PROJECT NO	DRAWING NO
CNS	AS	1578540	C-403

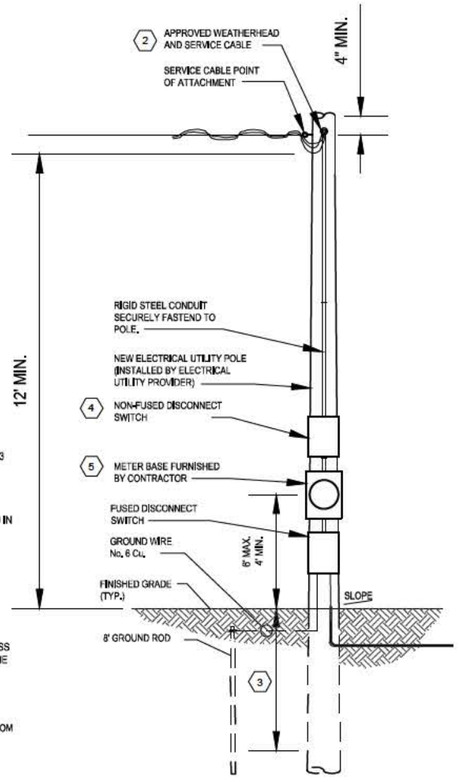


SITE PLAN
SCALE: 1" = 200'

0 100 200
GRAPHIC SCALE IN FEET

N

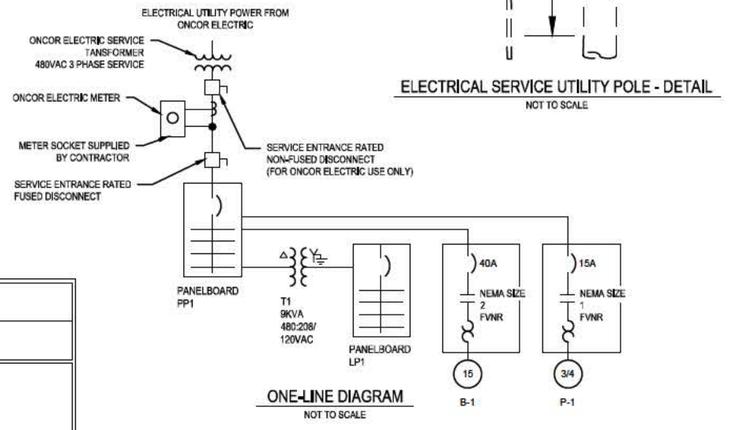
HORIZONTAL DATUM:
TEXAS N CENTRAL NAD 83 SP
VERTICAL DATUM:
NAVD 88



ELECTRICAL SERVICE UTILITY POLE - DETAIL
NOT TO SCALE

ELECTRICAL SERVICE UTILITY POLE NOTES:

1. ELECTRICAL UTILITY SUPPLIER TO PROVIDE NEW 480 VAC 3 PHASE SERVICE FOR THE SYSTEM CONTRACTOR SHALL CONTACT ONCOR AND COORDINATE OBTAINING THIS SERVICE.
2. MARK NEUTRAL CONDUCTOR AT THE WEATHER HEAD AND IN THE METER BASE. LEAVE A MINIMUM OF 24" OF WIRE EXPOSED OUT OF WEATHER HEAD FOR CONNECTION OF SERVICE WIRES AND DRIP LOOP.
3. 5' MINIMUM DEPTH; GREATER DEPTH NECESSARY WHEN POLE EXCEEDS 30'
4. FOR ELECTRICAL UTILITY PROVIDER USE.
5. METER BASE SHALL BE 200 AMP WITH LOCKING JAW BYPASS LEVER AND INCLUDE 600V LIGHTNING ARRESTORS. ASSUME METER BASE SUPPLIED BY CONTRACTOR.



ONE-LINE DIAGRAM
NOT TO SCALE

SITE PLAN NOTES:

1. OBTAIN NEW THREE PHASE SERVICE FOR THE SVE SYSTEM FROM ONCOR ELECTRIC. COORDINATE WORK WITH ONCOR ELECTRIC.
2. INSTALL UTILITY POLE AND OVERHEAD SERVICE LATERAL CONDUCTORS TO PROVIDE THREE PHASE POWER (480 VAC 200A) FROM ONCOR ELECTRIC POLE TO SVE COMPOUND. INSTALL METER BASE AT NEW UTILITY POLE IN ACCORDANCE WITH TRI-COUNTY ELECTRIC COOPERATIVE STANDARDS. INSTALL SERVICE ENTRANCE CONDUCTORS FROM METER TO PANELBOARD PP1.
3. NEW UTILITY POLE AND OVERHEAD CONDUCTORS TO BE INSTALLED BY ONCOR ELECTRIC TO PROVIDE THREE PHASE ELECTRICAL SERVICE TO SVE COMPOUND.
4. INSTALL UTILITY POLE AND OVERHEAD SERVICE LATERAL CONDUCTORS TO PROVIDE THREE PHASE POWER FROM ONCOR ELECTRIC UTILITY POLE TO SVE REMEDIATION ENCLOSURE. INSTALL METER BASE AT THE NEW UTILITY POLE IN ACCORDANCE WITH ONCOR ELECTRIC STANDARDS. INSTALL SERVICE ENTRANCE CONDUCTORS FROM METER TO SERVICE ENTRANCE RATED DISCONNECT AT SVE REMEDIATION COMPOUND.

LEGEND	
GRAPHIC SYMBOL	DESCRIPTION
	EXISTING PARCEL LINES
	EXISTING RIGHT OF WAY LINES
W	WATER SUPPLY
	TRAFFIC BOLLARDS
	DRIVEWAY
O/H	EXISTING OVERHEAD POWER LINE
UT	EXISTING UNDERGROUND TELEPHONE LINE
W	EXISTING WATER LINE
	EXISTING POWER POLE
	EXISTING GUY WIRE
	EXISTING TREE
X X	EXISTING PIPE FENCE WITH WIRE

ELECTRICAL NOTES:

1. ALL WORK SHOWN ON THE ELECTRICAL DRAWINGS IS NEW UNLESS OTHERWISE NOTED AS EXISTING. FOR THE CONVENIENCE OF THE CONTRACTOR, ON THE DRAWINGS WHICH CONTAIN BOTH NEW AND EXISTING FEATURES, A DISTINCTION BETWEEN NEW AND EXISTING MATERIALS, EQUIPMENT, AND STRUCTURES HAS BEEN MADE BY LINE WEIGHT. HEAVY LINE WEIGHT REPRESENTS NEW FEATURES AND LIGHT LINE WEIGHT REPRESENTS EXISTING FEATURES.

ELECTRICAL LEGEND

- CIRCUIT CONNECTION
- CIRCUIT BREAKER
- (#) CODED NOTE.
- (M) COMBINATION MAGNETIC OR MANUAL MOTOR STARTER
- COMBINATION MOTOR STARTER
- CONTACTOR
- Δ, Y DELTA, Y
- DISCONNECT SWITCH
- DISCRETE INPUT SIGNAL
- DISCRETE OUTPUT SIGNAL
- CS CONTROL STATION
- FE FLOW ELEMENT
- FIT FLOW INDICATING TRANSMITTER
- PE PRESSURE ELEMENT
- PIT PRESSURE INDICATING TRANSMITTER
- INDICATOR LIGHT
- MS# MOTOR STARTER COIL
- CR# (CR) RELAY COIL
- CR# RELAY CONTACT
- TRANSFORMER
- ANALOG INPUT SIGNAL
- ANALOG OUTPUT SIGNAL
- 600V, HD, NEMA 4X ENCLOSURE UNLESS OTHERWISE NOTED
- J JUNCTION BOX
- OR (M) PUMP MOTOR
- PUMP CONTROL PANEL
- (#) MOTOR, W/ HP
- OVERLOAD
- PANELBOARD
- GROUND ROD
- CONDUIT EXPOSED
- CONDUIT CONCEALED BELOW SLAB OR GRADE (UNLESS NOTED OTHERWISE)
- CONDUIT DOWN
- CONDUIT UP
- GROUND GRID OR CONNECTING CONDUCTOR
- LE LEVEL ELEMENT
- LIT LEVEL INDICATING TRANSMITTER
- UTILITY POLE

ABBREVIATIONS

A	AMPERE
AC	ALTERNATING CURRENT
AF	AMPS FRAME
AFF	ABOVE FINISHED FLOOR
AI	ANALOG INPUT
AO	ANALOG OUTPUT
APPROX.	APPROXIMATELY
AT	AMPS TRIP
ATS	AUTOMATIC TRANSFER SWITCH
AWG	AMERICAN WIRE GAGE
BKR	BREAKER
BLDG.	BUILDING
CB	CIRCUIT BREAKER
CC-()	CONTROL CONDUIT
CEP	CONCRETE EQUIPMENT PAD
CFR	CODE OF FEDERAL REGULATIONS
CKT,CIRC.	CIRCUIT
CP,C.P.	CONTROL PANEL
CPT	CONTROL POWER TRANSFORMER
DC	DIRECT CURRENT
dB	DECIBEL
dBm	DECIBELS ABOVE I MILLIWATT
DI	DIGITAL INPUT
DIA	DIAMETER
DO	DIGITAL OUTPUT
D.S.	DISCONNECT SWITCH
DWG	DRAWING
ELEC	ELECTRICAL
EMR	EQUIPMENT MOUNTING RACK
ENCL.	ENCLOSURE
EQ	EQUALIZATION
EX.,EXIST	EXISTING
FVNR	FULL VOLTAGE NON-REVERSING
G	GREEN OR GROUNDING CONDUCTOR
GFI	GROUND FAULT INTERRUPTER
GRD	GROUND
HOA	HAND-OFF-AUTOMATIC
HZ	HERTZ
IC-()	INSTRUMENTATION CONDUIT
JB OR JB-()	JUNCTION BOX OR JUNCTION BOX W/DESIGNATION
KCMIL	KILO (THOUSAND) CIRCULAR MILS
KV	KILOVOLT
KVA	KILOVOLT AMPERE
KW	KILOWATT
LP	LIGHTING PANELBOARD
M-()	MOTOR STARTER COIL W/DESIGNATION
MAX	MAXIMUM
MCM	THOUSAND CIRCULAR MILS
MIN.	MINIMUM
MTG	MOUNTING
N	NEUTRAL
NEC	NATIONAL ELECTRICAL CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NFSS	NON-FUSED SAFETY SWITCH
NO.	NUMBER
NTS	NOT TO SCALE
OIT	OPERATOR INTERFACE TERMINAL
OL	OVERLOAD
PF-()	POWER FEEDER W/SOURCE DESIGNATION &
PH	PHASE
PLC	PROGRAMMABLE LOGIC CONTROLLER
PP-()	POWER PANELBOARD
PT	POTENTIAL TRANSFORMER
P-()	PUMP W/DESIGNATION
QTY	QUANTITY
S.E.	SERVICE ENTRANCE
SH	SHIELDED
S.S.	STAINLESS STEEL
SVE	SOIL VAPOR EXTRACTION
SYS.	SYSTEM
T-()	TRANSFORMER W/DESIGNATION
TEMP	TEMPERATURE
TSP	TWISTED SHIELDED PAIR
TVSS	TRANSIENT VOLTAGE SURGE SUPRESSION
TYP.	TYPICAL
UTIL.	UTILITY
V	VOLT
VA	VOLT AMPERE
VAC	VOLTS ALTERNATING CURRENT
W/	WITH
XFMR	TRANSFORMER

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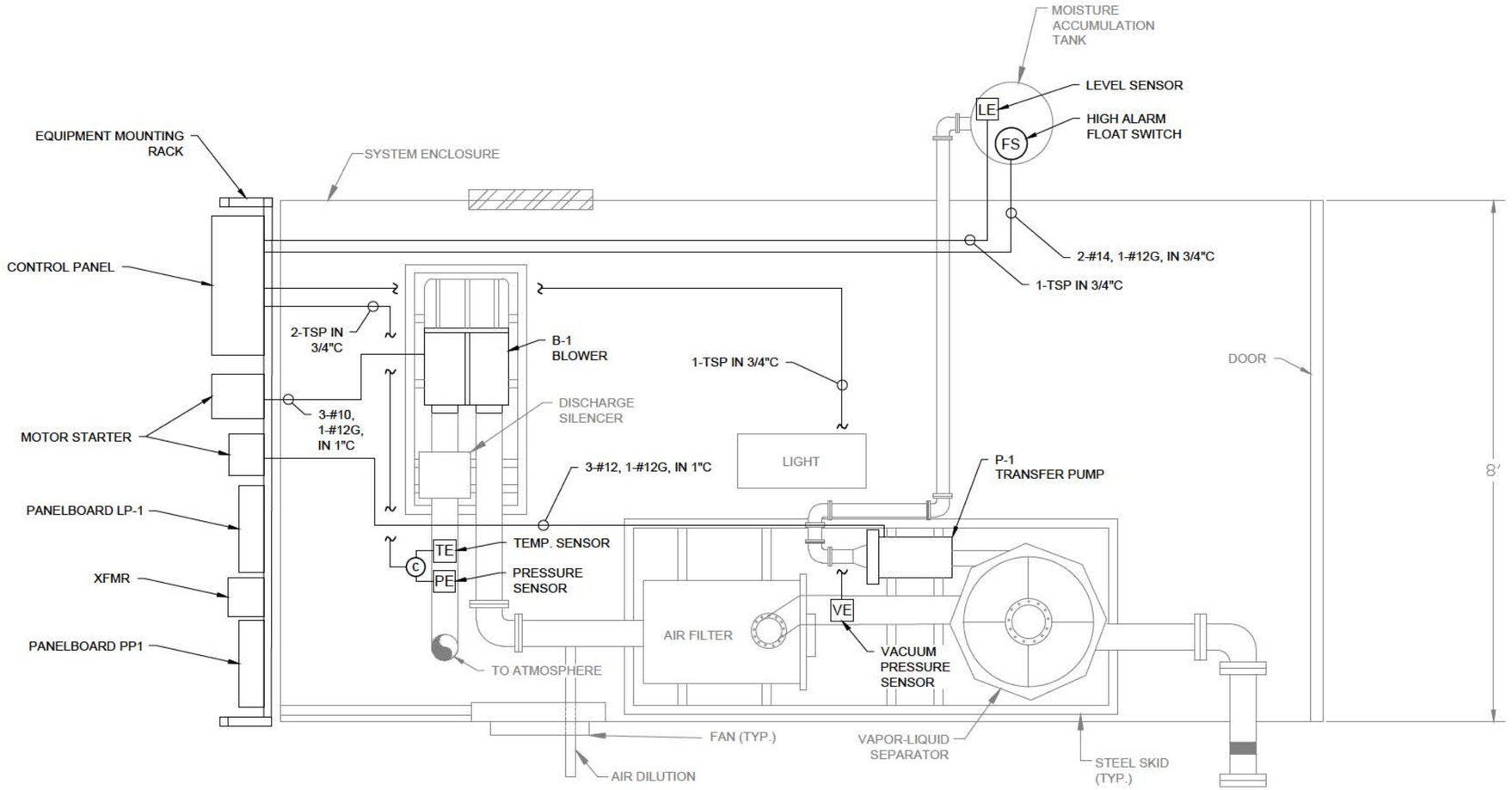
SOIL VAPOR EXTRACTION SYSTEM
REMEDIAL DESIGN
CIRCLE COURT GROUND WATER PLUME SUPERFUND SITE
PARKER COUNTY, TEXAS

NOTES, LEGEND, ABBREVIATIONS, SITE PLAN, AND ONE-LINE DIAGRAM

DESIGN BY	PROJECT MGR	DATE	FIGURE
AS	LV	JUNE 2024	13 OF 17
DRAWING BY	SCALE	PROJECT NO	DRAWING NO
CNS	AS	1578540	E-101



POWER AND CONTROL PLAN
SCALE: 1" = 2'

0 1' 2'
GRAPHIC SCALE IN FEET

NOTES:
1. THE EQUIPMENT LAYOUT SHOWN WITHIN THE SYSTEM ENCLOSURE IS PROVIDED AS AN EXAMPLE ONLY. THE ACTUAL LAYOUT WILL BE PROVIDED BY THE SVE VENDOR TO BE APPROVED BY THE ENGINEER.

2. PROVIDE SWITCHES.

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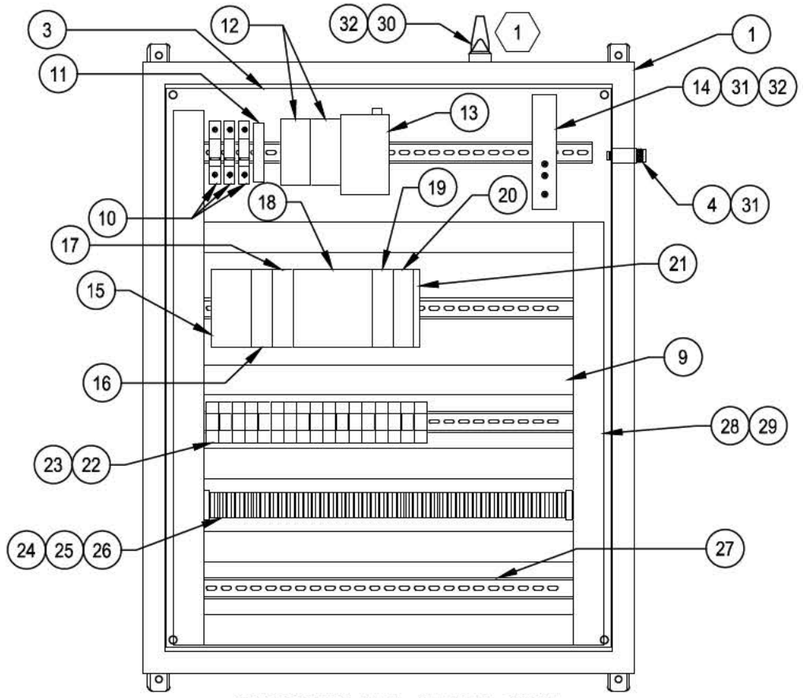
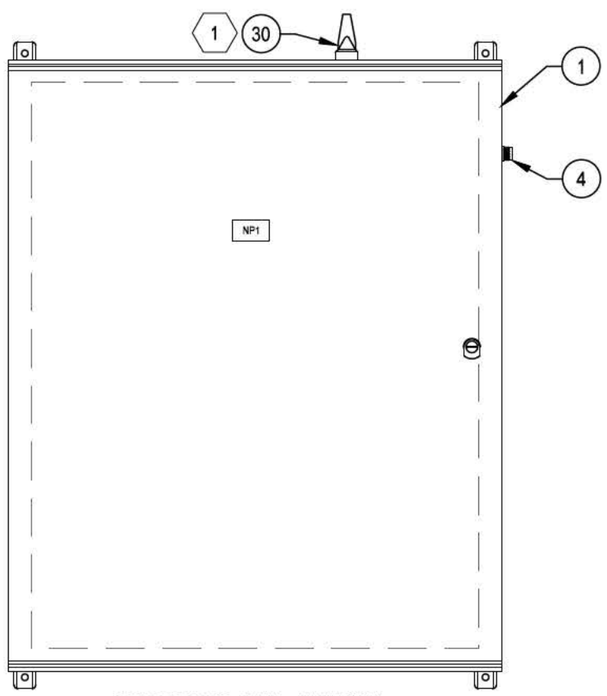
SOIL VAPOR EXTRACTION SYSTEM
REMEDIAL DESIGN
CIRCLE COURT GROUND WATER PLUME SUPERFUND SITE
PARKER COUNTY, TEXAS

SOILS VAPOR EXTRACTION SYSTEM INSTALLATION

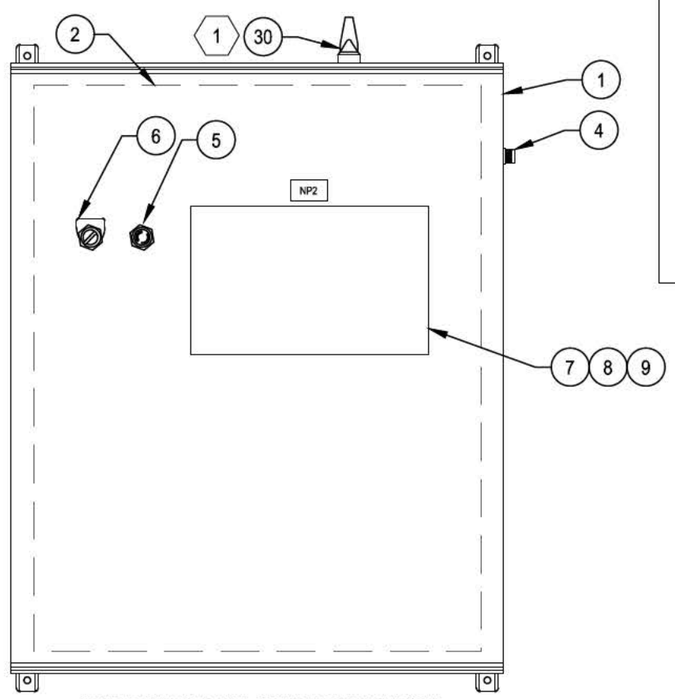
DESIGN BY	PROJECT MGR	DATE	FIGURE
AS	LV	JUNE 2024	14 OF 17
DRAWING BY	SCALE	PROJECT NO	DRAWING NO
CNS	AS	1578540	E-102



SCADA CONTROL PANEL - SUB-PANEL LAYOUT
NOT TO SCALE

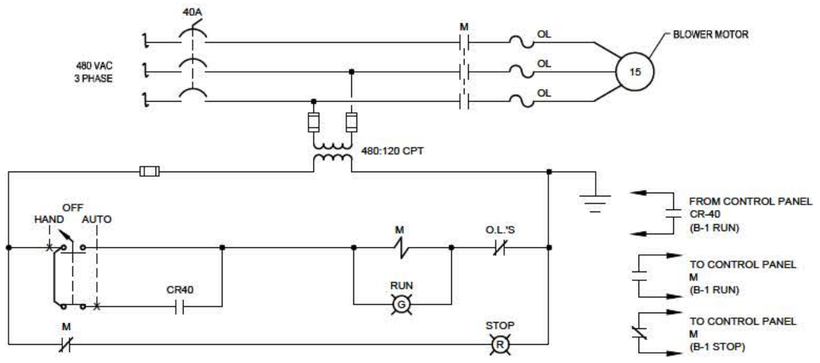


SCADA CONTROL PANEL - ELEVATION
NOT TO SCALE



SCADA CONTROL PANEL - INNER-DOOR ELEVATION
NOT TO SCALE

NOTE:
(1) INSTALL ANTENNA AND SEAL WATER-TIGHT WITH SILICONE CAULK



B-1 BLOWER ELEMENTARY
NOT TO SCALE

NOTE:
(1) ELEMENTARY FOR TRANSFER PUMP P-1 SIMILAR.

PARTS LIST

ITEM #	QUANTITY	MANUFACTURER	PART NUMBER	DESCRIPTION
1	1	HOFFMAN	UU1008030	ULTRX ENCLOSURE, NEMA 4, 40X32X12 (40.35X35.48X12.84)
2	1	HOFFMAN	UU1008SP	ULTRX SWING-OUT PANEL
3	1	HOFFMAN	A40P30	BACK PLATE 37X29
4	1	POLYPHASER	IS-B50LN-C2	ANTENNA SURGE PROTECTION, 50 kA, 125-1000 MHz
5	1	ALLEN-BRADLEY	800H-QRTH2G	PILOT LIGHT FULL VOLTAGE LED, 120VAC, PUSH TO TEST
6	1	ALLEN-BRADLEY	800H-HR2A	SELECTOR SWITCH, 2 POS, MAINTAINED, 1 N.O. 1 N.C. CONTACT
7	1	ALLEN-BRADLEY	2711P-RP8A	PANELVIEW PLUS 6 1000 LOGIC MODULE, 512 MB FLASH/RAM, (USE WITH HIGH BRIGHT DISPLAY TOUCHSCREEN)
8	1	ALLEN-BRADLEY	2711P-RDT12H	PANELVIEW PLUS DISPLAY TOUCHSCREEN, 12.1 INCH TFT DISPLAY, HIGH BRIGHT DISPLAY MODULE TOUCHSCREEN
9	1	ALLEN-BRADLEY	2711P-RGT12	ANTI-GLARE OVERLAY
10	3	ABB	S201UR-Z15	CIRCUIT BREAKER, 1 POLE, 480Y/277 VAC, UL489 LISTED
11	1	PHOENIX CONTACT	2856812	PANEL ENTRANCE SURGE SUPPRESSOR PT 2-PE/S-120AC
12	2	PHOENIX CONTACT	2938730	POWER SUPPLY, 24VDC, 2A, MINI-PS-100-240AC/24DC/2
13	1	MOXA	EDS-505A	5-PORT MANAGED ETHERNET SWITCH
14	1	GE	MXNC-U91E4V-S1N	ORBIT MCR 900M HZ RADIO AND 4G CELLULAR MODEM
15	1	ALLEN-BRADLEY	1769-L33ER	MODULAR COMPACTLOGIX CONTROLLER, 2MB RAM, DUAL ETHERNET/IP PORT, 1 USB PORT, 2MB MEMORY
16	1	PROSOFT	MVI69-GSC	ASCII SERIAL COMMUNICATION MODULE
17	1	ALLEN-BRADLEY	1769-IF8	8 CHANNEL ANALOG CURRENT/VOLTAGE INPUT MODULE
18	1	ALLEN-BRADLEY	1769-PA4	1769 COMPACT I/O POWER SUPPLY, 120/240VAC 4A@5V 2A@24V

PARTS LIST

ITEM #	QUANTITY	MANUFACTURER	PART NUMBER	DESCRIPTION
19	1	ALLEN-BRADLEY	1769-IA16	16 POINT AD DIGITAL INPUT MODULE, 100/120 VAC
20	1	ALLEN-BRADLEY	1769-OW16	16 POINT DRY CONTACT RELAY OUTPUT MODULE, 5-265 VAC
21	1	ALLEN-BRADLEY	1769-ECR	RIGHT END CAP/TERMINATOR
22	17	AUTOMATION DIRECT	728-1C-120A	RELAY
23	17	AUTOMATION DIRECT	728-1C-SKT	RELAY SOCKET
24	AR	PHOENIX CONTACT	30 46 18 4	TERMINAL BLOCK, 6.2mm WIDE, 26-10AWG, GRAY, TYPE UT 4-MTD
25	AR	PHOENIX CONTACT	30 47 14 1	END BARRIER, COVER, 1.8mm WIDE, GRAY, TYPE UT 4-MTD
26	AR	PHOENIX CONTACT	80 00 88 6	END BRACKET, 8.5mm WIDE, GRAY, E/NS 35 N
27	AR	ALLEN-BRADLEY	199-OR1	DIN RAIL
28	AR	THOMAS AND BETTS	T2X2HDG	WIREDUCT, 1" X 2", GRAY
29	AR	THOMAS AND BETTS	T2CG	WIREDUCT COVER, 2", GRAY
30	1	PULSE ELECTRONICS/LARSEN ANTENNAS	SLPT698/2170DMN	LTE MULTI BAND EXTERNAL VEHICLE OR ENCLOSURE DIRECT MOUNT ANTENNA
31	1	WIRELESS SOLUTIONS	392411TS	3' ANTENNA CABLE W/TNC-MALE AND N-MALE CONNECTORS
32	1	WIRELESS SOLUTIONS	322085TS	6' FLEXIBLE CABLE W/ SMA-MALE AND N-MALE CONNECTORS

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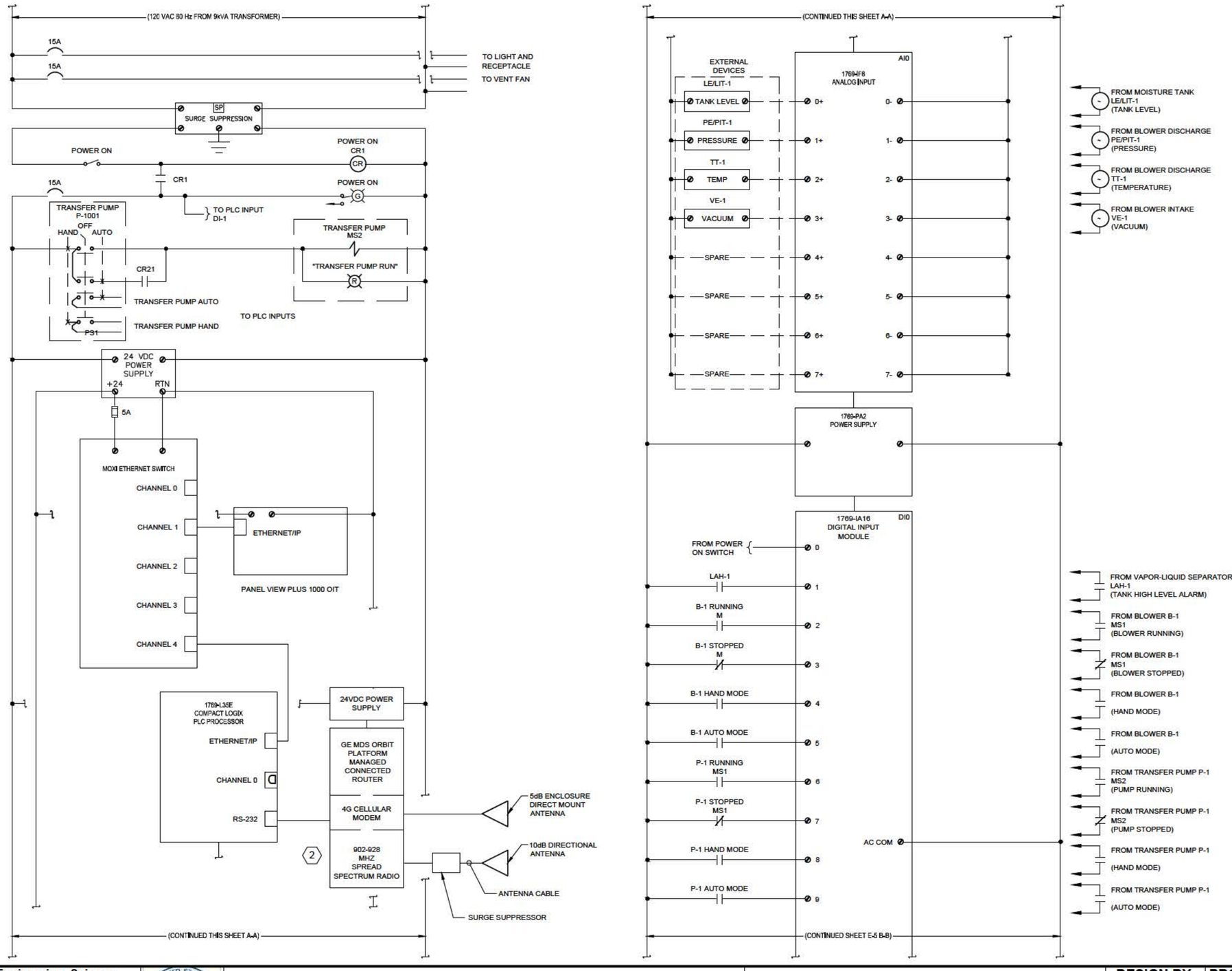
SOIL VAPOR EXTRACTION SYSTEM
REMEDIAL DESIGN
CIRCLE COURT GROUND WATER PLUME SUPERFUND SITE
PARKER COUNTY, TEXAS

CONTROL PANEL

DESIGN BY	PROJECT MGR	DATE	FIGURE
AS	LV	JUNE 2024	15 OF 17
DRAWING BY	SCALE	PROJECT NO	DRAWING NO
CNS	AS	1578540	E-103



FILE PATH: F:\FEDERAL\NON DOD\EPA\PROJECTS\1578540 - CIRCLE CT GROUND WATER PLUME\1- CADD\4- FIGURES\1578540 - E-104] 6/27/2024 10:43 AM

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SOIL VAPOR EXTRACTION SYSTEM
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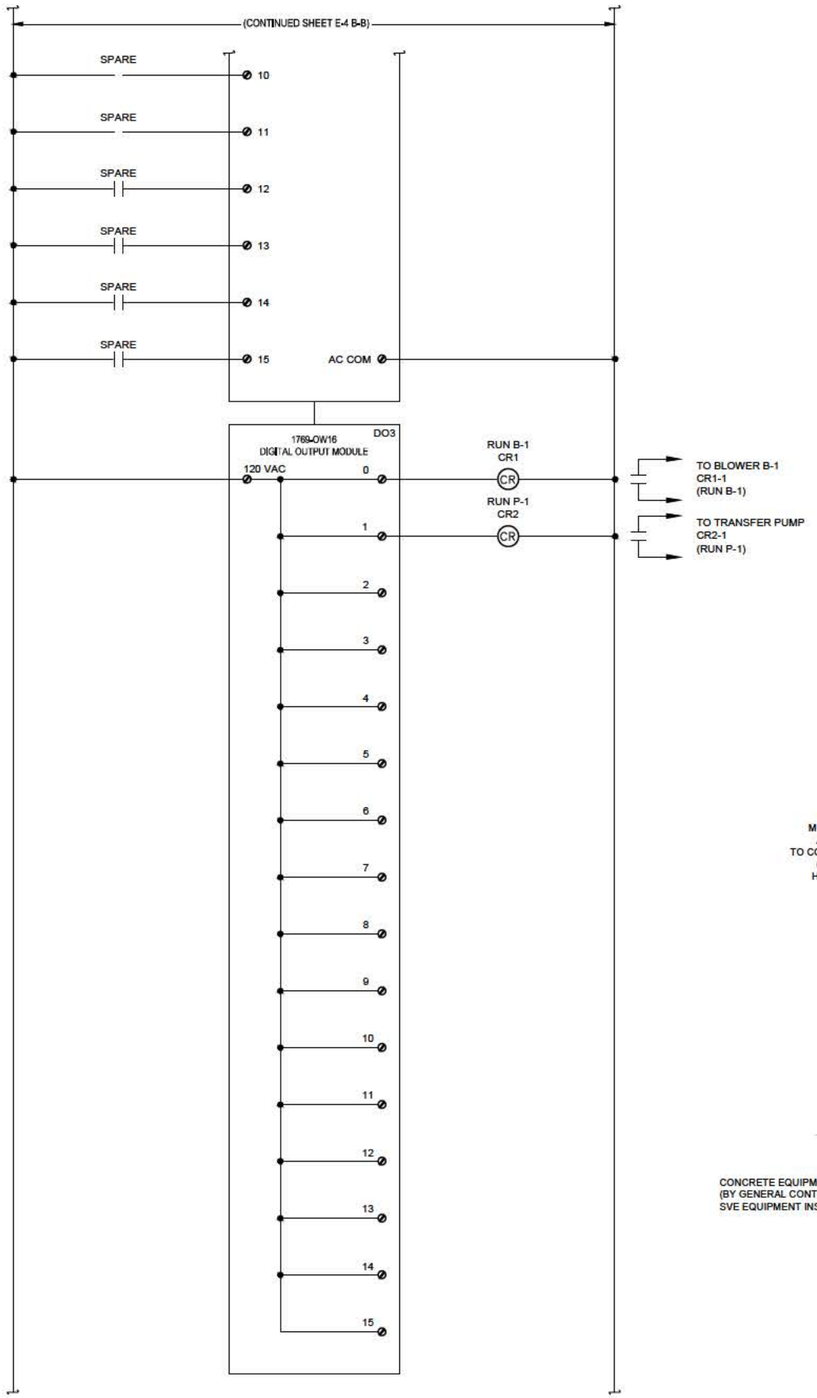
PARKER COUNTY, TEXAS

CONTROL PANEL ELEMENTARY

DESIGN BY	PROJECT MGR	DATE	FIGURE
AS	LV	JUNE 2024	16 OF 17
DRAWING BY	**SCALE**	**PROJECT NO**	**DRAWING NO**
CNS	AS	1578540	E-104



PANEL SCHEDULE

PANELBOARD LP1 LOCATION - INSTALLATION SURFACE

RATINGS 100 AMPS, 208/120 VOLTS, 3 PH, 4 WIRE, 60 HZ., GRD BAR -

MAIN LUGS - BKR INTERRUPTING RATING 10,000 RMS, SYMM. AMPS

MAIN CIRCUIT BREAKER 30 AMPS, CONNECTED LOAD - KVA PANEL SIZE -

DESCRIPTION	NOTES	BKR AMPS	CKT	A	B	C	CKT	BKR AMPS	NOTES	DESCRIPTION
RECEPTACLES		20/1P	1				2	20/1P		CONTROL PANEL
LIGHT		20/1P	3				4			
VENT FAN		20/1P	5				6			
INSTRUMENTATION		20/1P	7				8			
INSTRUMENTATION		15/1P	9				10			
			11				12			
			13				14			
			15				16			
			17				18			
			19				20			
			21				22			
			23				24			
			25				26			
			27				28			
			29				30			

PANEL SCHEDULE

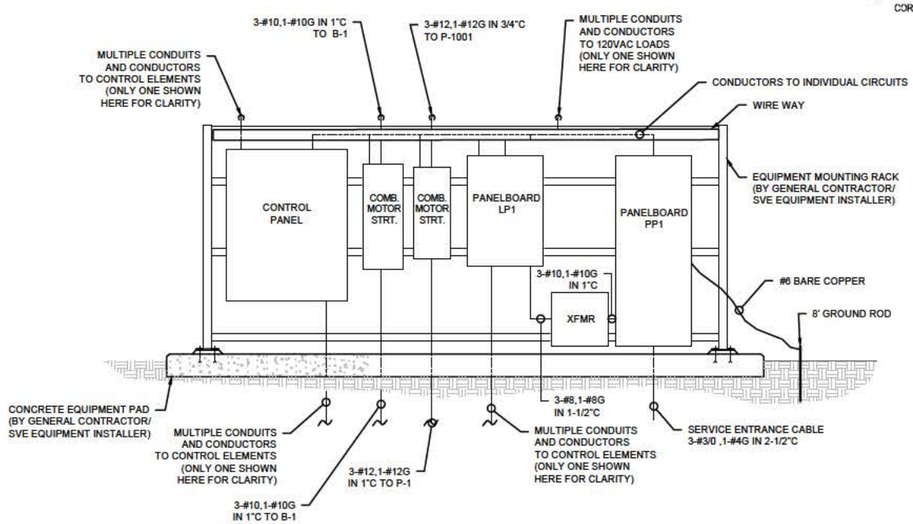
PANELBOARD PP1 LOCATION - INSTALLATION SURFACE

RATINGS 100 AMPS, 480/277 VOLTS, 3 PH, 4 WIRE, 60 HZ., GRD BAR -

MAIN LUGS - BKR INTERRUPTING RATING 42,000 RMS, SYMM. AMPS

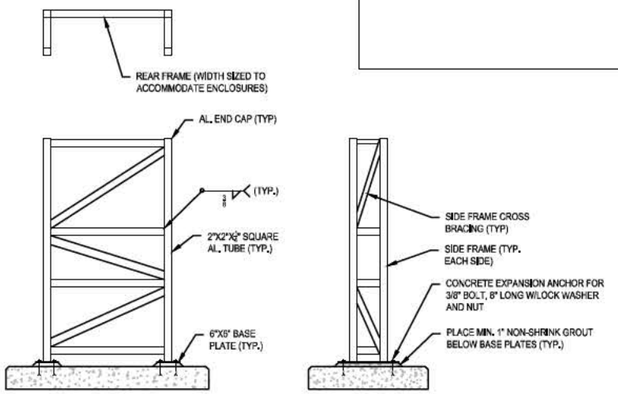
MAIN CIRCUIT BREAKER 100 AMPS, CONNECTED LOAD - KVA PANEL SIZE -

DESCRIPTION	NOTES	BKR AMPS	CKT	A	B	C	CKT	BKR AMPS	NOTES	DESCRIPTION
BLOWER B-1		40/3P	1				2			
			3				4			
			5				6			
TRANSFER PUMP P-1		15/3P	7				8			
			9				10			
			11				12			
SPARE		15/3P	13				14			
			15				16			
			17				18			
			19				20			
			21				22			
			23				24			
			25				26	20/3P		TRANSFORMER T-1
			27				28			
			29				30			



EQUIPMENT MOUNTING RACK ELEVATION

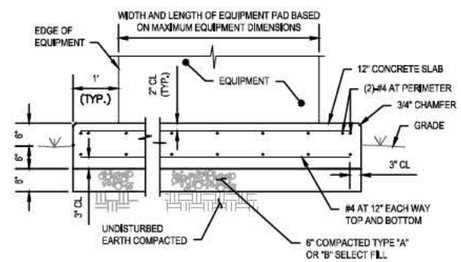
NOT TO SCALE



EQUIPMENT MOUNTING RACK DETAIL

NOT TO SCALE

NOTES:
1. SIDE FRAME SHALL BE 10" DEEP MINIMUM. THE SIDE FRAME SHALL BE APPROXIMATELY TWO THIRDS THE SIZE OF THE LARGEST ENCLOSURE DEPTH.
2. CROSS BRACING SHALL BE PROVIDED ON THE REAR FRAME ASSEMBLY FOR EMRs 24" WIDE AND LARGER. CROSS BRACING SHALL BE PROVIDED ON THE SIDE FRAME FOR EMRs 18" DEEP OR LARGER.
3. ENCLOSURES SHALL BE MOUNTED USING STAINLESS STEEL HARDWARE. THE EMR SHALL BE FASTENED TO THE CEP WITH CORROSION RESISTANT EXPANSION ANCHORS.



EXTERIOR CONCRETE EQUIPMENT PAD DETAIL

NOT TO SCALE

NOTE:
1. COORDINATE ANCHOR BOLT LOCATIONS W/ MECHANICAL DRAWINGS AND EQUIPMENT MANUFACTURER.

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CONTROL PANEL ELEMENTARY

DESIGN BY	PROJECT MGR	DATE	FIGURE
AS	LV	JUNE 2024	17 OF 17
DRAWING BY	**SCALE**	**PROJECT NO**	**DRAWING NO**
CNS	AS	1578540	E-105

Appendix B

Calculations

Minor Losses

	175 scfm								350 scfm				Total Minor Losses
	4-inch Riser		4-inch Connector		Elbow		Reducer 4 to 5-inch		5-inch Connector		Elbow		
	Length (ft)	Head Loss (in. W.C.)	Length (ft)	Head Loss (in. W.C.)	Equivalent Length (ft)	Head Loss (in. W.C.)	Equivalent Length (ft)	Head Loss (in. W.C.)	Length (ft)	Head Loss (in. W.C.)	Equivalent Length (ft)	Head Loss (in. W.C.)	Head Loss (in. W.C.)
North Well	300	5.1	0	0	13	0.2	2	0	552	10.7	13	0.2	**16.2**
South Well	350	6	157	2.7	13	0.2	2	0	552	10.7	13	0.2	**19.8**

Notes:
Head losses were calculated by equivalent pipe length method.
ft = feet
in. = inches
scfm = standard cubic foot per minute
W.C. = water column

OBJECTIVE: Estimate pipe friction loss in SVE wells
Conveyence Piping 4 − *inch* Elbow

REFERENCE: Environmental Engineering Reference Manual. M. Linderburg. 2001
Section 17. Fluid Dynamics. Friction Losses for Steam and Gases

INPUT:

$p0 := 14.18\ \text{psi}$ Pressure at approximately 980 ft msl

$vac := \frac{50}{407} \cdot 1\ \text{atm} = 1.8\ \text{psi}$ Anticipated vacuum at the branch

$p1 := p0 - vac = 12.4\ \text{psi}$ SVE Applied Asolute Pressure

$L := 13\ \text{ft}$ Conveyance Pipe Length

$R' := \frac{0.08206\ \text{atm L}}{\text{mol K}}$ Universal Constant

$T := 60\ ^\circ\text{F}$ Soil vapor average temperature

$D := 3.768\ \text{in}$ Blank Internal Diameter - Assume 4" Sch 80 PVC

$MW := 28.98\ \frac{\text{g}}{\text{mol}}$ Air

$Q := \frac{175\ \text{ft}^3}{\text{min}}$ Design volumetric flowrate - branch

$d := 1.293\ \frac{\text{kg}}{\text{m}^3}$ Density of air at 0 degrees Celcius

$mu := 1.709 \cdot 10^{-5}\ \text{Pa s}$ Absolute viscosity of air at 0 degrees Celcius

$e := 1.5 \cdot 10^{-6}\ \text{m}$ Specific Roughness for Plastic Pipe

CALCULATIONS:

$Area := \frac{3.14 \cdot D^2}{4} = 0.0774\ ft^2$ Area of pipe

$m := Q \cdot d \cdot \frac{p1}{1\ atm} \cdot \frac{32\ °F}{T} = 0.0851\ \frac{kg}{s}$ Mass flowrate

$G := \frac{m}{Area} = 11.8318\ \frac{kg}{m^2\ s}$ Mass flowrate per area

$Re := \frac{D \cdot G}{mu} = 66260$ Reynold's Number

$er := \frac{e}{D} = 1.5673 \cdot 10^{-5}$ Relative roughness

$$f := \frac{0.25}{\left(\log_{10}\left(\frac{er}{3.7} + \frac{5.74}{Re^{0.9}}\right)\right)^2} = 0.0196$$

$B := \frac{f \cdot L \cdot G^2 \cdot R' \cdot T}{D \cdot MW} = 9.4 \cdot 10^6\ \frac{kg\ Pa}{m\ s^2}$

$p2 := \sqrt{p1^2 - B} = 85264.7651\ Pa$ Final pressure at discharge

$dP := p1 - p2 = 55.1046\ Pa$

$dP = 0.008\ psi$ Pressure loss in pipe

$inwc := 1 \cdot \frac{atm}{407} = 249\ Pa$

$dP = 0.2\ inwc$ Loss is acceptable, therefore, selected well diameter is appropriate

OBJECTIVE: Estimate pipe friction loss in SVE wells
Conveyence Piping $5 - inch$ Elbow

REFERENCE: Environmental Engineering Reference Manual. M. Linderburg. 2001
Section 17. Fluid Dynamics. Friction Losses for Steam and Gases

INPUT:

$p0 := 14.18\ psi$ Pressure at approximately 980 ft msl

$vac := \frac{50}{407} \cdot 1\ atm = 1.8\ psi$ Anticipated vacuum at the branch

$p1 := p0 - vac = 12.4\ psi$ SVE Applied Asolute Pressure

$L := 13\ ft$ Conveyance Pipe Length

$R' := \frac{0.08206\ atm\ L}{mol\ K}$ Universal Constant

$T := 60\ °F$ Soil vapor average temperature

$D := 4.768\ in$ Blank Internal Diameter - Assume 5" Sch 80 PVC

$MW := 28.98\ \frac{g}{mol}$ Air

$Q := \frac{350\ ft^3}{min}$ Design volumetric flowrate - branch

$d := 1.293\ \frac{kg}{m^3}$ Density of air at 0 degrees Celcius

$mu := 1.709 \cdot 10^{-5}\ Pa\ s$ Absolute viscosity of air at 0 degrees Celcius

$e := 1.5 \cdot 10^{-6}\ m$ Specific Roughness for Plastic Pipe

CALCULATIONS:

$Area := \frac{3.14 \cdot D^2}{4} = 0.1239\ ft^2$ Area of pipe

$m := Q \cdot d \cdot \frac{p1}{1\ atm} \cdot \frac{32\ °F}{T} = 0.1702\ \frac{kg}{s}$ Mass flowrate

$G := \frac{m}{Area} = 14.7785\ \frac{kg}{m^2\ s}$ Mass flowrate per area

$Re := \frac{D \cdot G}{mu} = 1 \cdot 10^5$ Reynold's Number

$er := \frac{e}{D} = 1.2386 \cdot 10^{-5}$ Relative roughness

$$f := \frac{0.25}{\left(\log_{10}\left(\frac{er}{3.7} + \frac{5.74}{Re^{0.9}}\right)\right)^2} = 0.0178$$

$B := \frac{f \cdot L \cdot G^2 \cdot R' \cdot T}{D \cdot MW} = 1.0518 \cdot 10^7\ \frac{kg\ Pa}{m\ s^2}$

$p2 := \sqrt{p1^2 - B} = 85258.2093\ Pa$ Final pressure at discharge

$dP := p1 - p2 = 61.6604\ Pa$

$dP = 0.0089\ psi$ Pressure loss in pipe

$inwc := 1 \cdot \frac{atm}{407} = 249\ Pa$

$dP = 0.2\ inwc$ Loss is acceptable, therefore, selected well diameter is appropriate

OBJECTIVE: Estimate pipe friction loss in SVE wells
Conveyence Pipe Between Wells

REFERENCE: Environmental Engineering Reference Manual. M. Linderburg. 2001
Section 17. Fluid Dynamics. Friction Losses for Steam and Gases

INPUT:

$p0 := 14.18\ \text{psi}$ Pressure at approximately 980 ft msl

$vac := \frac{50}{407} \cdot 1\ \text{atm} = 1.8\ \text{psi}$ Anticipated vacuum at the branch

$p1 := p0 - vac = 12.4\ \text{psi}$ SVE Applied Asolute Pressure

$L := 157\ \text{ft}$ Conveyance Pipe Length

$R' := \frac{0.08206\ \text{atm L}}{\text{mol K}}$ Universal Constant

$T := 60\ °\text{F}$ Soil vapor average temperature

$D := 3.768\ \text{in}$ Blank Internal Diameter - Assume 4" Sch 80 PVC

$MW := 28.98\ \frac{\text{g}}{\text{mol}}$ Air

$Q := \frac{175\ \text{ft}^3}{\text{min}}$ Design volumetric flowrate - branch

$d := 1.293\ \frac{\text{kg}}{\text{m}^3}$ Density of air at 0 degrees Celcius

$mu := 1.709 \cdot 10^{-5}\ \text{Pa s}$ Absolute viscosity of air at 0 degrees Celcius

$e := 1.5 \cdot 10^{-6}\ \text{m}$ Specific Roughness for Plastic Pipe

CALCULATIONS:

$Area := \frac{3.14 \cdot D^2}{4} = 0.0774\ ft^2$ Area of pipe

$m := Q \cdot d \cdot \frac{p1}{1\ atm} \cdot \frac{32\ °F}{T} = 0.0851\ \frac{kg}{s}$ Mass flowrate

$G := \frac{m}{Area} = 11.8318\ \frac{kg}{m^2\ s}$ Mass flowrate per area

$Re := \frac{D \cdot G}{mu} = 66260$ Reynold's Number

$er := \frac{e}{D} = 1.5673 \cdot 10^{-5}$ Relative roughness

$f := \frac{0.25}{\left(\log_{10}\left(\frac{er}{3.7} + \frac{5.74}{Re^{0.9}}\right)\right)^2} = 0.0196$

$B := \frac{f \cdot L \cdot G^2 \cdot R' \cdot T}{D \cdot MW} = 1.1352 \cdot 10^8\ \frac{kg\ Pa}{m\ s^2}$

$p2 := \sqrt{p1^2 - B} = 84651.9764\ Pa$ Final pressure at discharge

$dP := p1 - p2 = 667.8933\ Pa$

$dP = 0.0969\ psi$ Pressure loss in pipe

$inwc := 1 \cdot \frac{atm}{407} = 249\ Pa$

$dP = 2.7\ inwc$ Loss is acceptable, therefore, selected well diameter is appropriate

OBJECTIVE: Estimate pipe friction loss in SVE wells
Well Riser Northern Well

REFERENCE: Environmental Engineering Reference Manual. M. Linderburg. 2001
Section 17. Fluid Dynamics. Friction Losses for Steam and Gases

INPUT:

$p0 := 14.18\ psi$ Pressure at approximately 980 ft msl

$vac := \frac{50}{407} \cdot 1\ atm = 1.8\ psi$ Anticipated vacuum at the branch

$p1 := p0 - vac = 12.4\ psi$ SVE Applied Asolute Pressure

$L := 300\ ft$ Conveyance Pipe Length

$R' := \frac{0.08206\ atm\ L}{mol\ K}$ Universal Constant

$T := 60\ °F$ Soil vapor average temperature

$D := 3.768\ in$ Blank Internal Diameter - Assume 4" Schedule 80 PVC

$MW := 28.98\ \frac{g}{mol}$ Air

$Q := \frac{175\ ft^3}{min}$ Design volumetric flowrate - branch

$d := 1.293\ \frac{kg}{m^3}$ Density of air at 0 degrees Celcius

$mu := 1.709 \cdot 10^{-5}\ Pa\ s$ Absolute viscosity of air at 0 degrees Celcius

$e := 1.5 \cdot 10^{-6}\ m$ Specific Roughness for Plastic Pipe

CALCULATIONS:

$Area := \frac{3.14 \cdot D^2}{4} = 0.0774\ ft^2$ Area of pipe

$m := Q \cdot d \cdot \frac{p1}{1\ atm} \cdot \frac{32\ °F}{T} = 0.0851\ \frac{kg}{s}$ Mass flowrate

$G := \frac{m}{Area} = 11.8318\ \frac{kg}{m^2\ s}$ Mass flowrate per area

$Re := \frac{D \cdot G}{mu} = 66260$ Reynold's Number

$er := \frac{e}{D} = 1.5673 \cdot 10^{-5}$ Relative roughness

$$f := \frac{0.25}{\left(\log\left(\frac{er}{3.7} + \frac{5.74}{Re^{0.9}}\right)\right)^2} = 0.0196$$

$B := \frac{f \cdot L \cdot G^2 \cdot R' \cdot T}{D \cdot MW} = 2.1692 \cdot 10^8\ \frac{kg\ Pa}{m\ s^2}$

$p2 := \sqrt{p1^2 - B} = 84039.0215\ Pa$ Final pressure at discharge

$dP := p1 - p2 = 1280.8482\ Pa$

$dP = 0.1858\ psi$ Pressure loss in pipe

$inwc := 1 \cdot \frac{atm}{407} = 249\ Pa$

$dP = 5.1\ inwc$ Loss is acceptable, therefore, selected well diameter is appropriate

OBJECTIVE: Estimate pipe friction loss in SVE wells
Conveyence Piping $4-inch$ to $5-inch$ Elbow

REFERENCE: Environmental Engineering Reference Manual. M. Linderburg. 2001
Section 17. Fluid Dynamics. Friction Losses for Steam and Gases

INPUT:

$p0 := 14.18\ psi$ Pressure at approximately 980 ft msl

$vac := \frac{50}{407} \cdot 1\ atm = 1.8\ psi$ Anticipated vacuum at the branch

$p1 := p0 - vac = 12.4\ psi$ SVE Applied Asolute Pressure

$L := 2\ ft$ Conveyance Pipe Length

$R' := \frac{0.08206\ atm\ L}{mol\ K}$ Universal Constant

$T := 60\ °F$ Soil vapor average temperature

$D := 3.768\ in$ Blank Internal Diameter - Assume 4" Sch 80 PVC

$MW := 28.98\ \frac{g}{mol}$ Air

$Q := \frac{175\ ft^3}{min}$ Design volumetric flowrate - branch

$d := 1.293\ \frac{kg}{m^3}$ Density of air at 0 degrees Celcius

$mu := 1.709 \cdot 10^{-5}\ Pa\ s$ Absolute viscosity of air at 0 degrees Celcius

$e := 1.5 \cdot 10^{-6}\ m$ Specific Roughness for Plastic Pipe

CALCULATIONS:

$Area := \frac{3.14 \cdot D^2}{4} = 0.0774\ ft^2$ Area of pipe

$m := Q \cdot d \cdot \frac{p1}{1\ atm} \cdot \frac{32\ °F}{T} = 0.0851\ \frac{kg}{s}$ Mass flowrate

$G := \frac{m}{Area} = 11.8318\ \frac{kg}{m^2\ s}$ Mass flowrate per area

$Re := \frac{D \cdot G}{mu} = 66260$ Reynold's Number

$er := \frac{e}{D} = 1.5673 \cdot 10^{-5}$ Relative roughness

$$f := \frac{0.25}{\left(\log_{10}\left(\frac{er}{3.7} + \frac{5.74}{Re^{0.9}}\right)\right)^2} = 0.0196$$

$B := \frac{f \cdot L \cdot G^2 \cdot R' \cdot T}{D \cdot MW} = 1.4462 \cdot 10^6\ \frac{kg\ Pa}{m\ s^2}$

$p2 := \sqrt{p1^2 - B} = 85311.3944\ Pa$ Final pressure at discharge

$dP := p1 - p2 = 8.4753\ Pa$

$dP = 0.0012\ psi$ Pressure loss in pipe

$inwc := 1 \cdot \frac{atm}{407} = 249\ Pa$

$dP = 0\ inwc$ Loss is acceptable, therefore, selected well diameter is appropriate

OBJECTIVE: Estimate pipe friction loss in SVE wells
Well Riser Southern Well

REFERENCE: Environmental Engineering Reference Manual. M. Linderburg. 2001
Section 17. Fluid Dynamics. Friction Losses for Steam and Gases

INPUT:

$p0 := 14.18\ psi$ Pressure at approximately 980 ft msl

$vac := \frac{50}{407} \cdot 1\ atm = 1.8\ psi$ Anticipated vacuum at the branch

$p1 := p0 - vac = 12.4\ psi$ SVE Applied Asolute Pressure

$L := 350\ ft$ Conveyance Pipe Length

$R' := \frac{0.08206\ atm\ L}{mol\ K}$ Universal Constant

$T := 60\ °F$ Soil vapor average temperature

$D := 3.768\ in$ Blank Internal Diameter - Assume 4" Schedule 80 PVC

$MW := 28.98\ \frac{g}{mol}$ Air

$Q := \frac{175\ ft^3}{min}$ Design volumetric flowrate - branch

$d := 1.293\ \frac{kg}{m^3}$ Density of air at 0 degrees Celcius

$mu := 1.709 \cdot 10^{-5}\ Pa\ s$ Absolute viscosity of air at 0 degrees Celcius

$e := 1.5 \cdot 10^{-6}\ m$ Specific Roughness for Plastic Pipe

CALCULATIONS:

$Area := \frac{3.14 \cdot D^2}{4} = 0.0774\ ft^2$ Area of pipe

$m := Q \cdot d \cdot \frac{p1}{1\ atm} \cdot \frac{32\ °F}{T} = 0.0851\ \frac{kg}{s}$ Mass flowrate

$G := \frac{m}{Area} = 11.8318\ \frac{kg}{m^2\ s}$ Mass flowrate per area

$Re := \frac{D \cdot G}{mu} = 66260$ Reynold's Number

$er := \frac{e}{D} = 1.5673 \cdot 10^{-5}$ Relative roughness

$$f := \frac{0.25}{\left(\log\left(\frac{er}{3.7} + \frac{5.74}{Re^{0.9}}\right)\right)^2} = 0.0196$$

$B := \frac{f \cdot L \cdot G^2 \cdot R' \cdot T}{D \cdot MW} = 2.5308 \cdot 10^8\ \frac{kg\ Pa}{m\ s^2}$

$p2 := \sqrt{p1^2 - B} = 83823.644\ Pa$ Final pressure at discharge

$dP := p1 - p2 = 1496.2257\ Pa$

$dP = 0.217\ psi$ Pressure loss in pipe

$inwc := 1 \cdot \frac{atm}{407} = 249\ Pa$

$dP = 6\ inwc$ Loss is acceptable, therefore, selected well diameter is appropriate

OBJECTIVE: Estimate pipe friction loss in SVE wells
Conveyence Piping Tee to Compound

REFERENCE: Environmental Engineering Reference Manual. M. Linderburg. 2001
Section 17. Fluid Dynamics. Friction Losses for Steam and Gases

INPUT:

$p0 := 14.18\ psi$ Pressure at approximately 980 ft msl

$vac := \frac{50}{407} \cdot 1\ atm = 1.8\ psi$ Anticipated vacuum at the branch

$p1 := p0 - vac = 12.4\ psi$ SVE Applied Asolute Pressure

$L := 552\ ft$ Conveyance Pipe Length

$R' := \frac{0.08206\ atm\ L}{mol\ K}$ Universal Constant

$T := 60\ °F$ Soil vapor average temperature

$D := 4.768\ in$ Blank Internal Diameter - Assume 5" Sch 80 PVC

$MW := 28.98\ \frac{g}{mol}$ Air

$Q := \frac{350\ ft^3}{min}$ Design volumetric flowrate - branch

$d := 1.293\ \frac{kg}{m^3}$ Density of air at 0 degrees Celcius

$mu := 1.709 \cdot 10^{-5}\ Pa\ s$ Absolute viscosity of air at 0 degrees Celcius

$e := 1.5 \cdot 10^{-6}\ m$ Specific Roughness for Plastic Pipe

CALCULATIONS:

$Area := \frac{3.14 \cdot D^2}{4} = 0.1239\ ft^2$ Area of pipe

$m := Q \cdot d \cdot \frac{p1}{1\ atm} \cdot \frac{32\ °F}{T} = 0.1702\ \frac{kg}{s}$ Mass flowrate

$G := \frac{m}{Area} = 14.7785\ \frac{kg}{m^2\ s}$ Mass flowrate per area

$Re := \frac{D \cdot G}{mu} = 1 \cdot 10^5$ Reynold's Number

$er := \frac{e}{D} = 1.2386 \cdot 10^{-5}$ Relative roughness

$$f := \frac{0.25}{\left(\log_{10}\left(\frac{er}{3.7} + \frac{5.74}{Re^{0.9}}\right)\right)^2} = 0.0178$$

$B := \frac{f \cdot L \cdot G^2 \cdot R' \cdot T}{D \cdot MW} = 4.4661 \cdot 10^8\ \frac{kg\ Pa}{m\ s^2}$

$p2 := \sqrt{p1^2 - B} = 82661.1962\ Pa$ Final pressure at discharge

$dP := p1 - p2 = 2658.6735\ Pa$

$dP = 0.3856\ psi$ Pressure loss in pipe

$inwc := 1 \cdot \frac{atm}{407} = 249\ Pa$

$dP = 10.7\ inwc$ Loss is acceptable, therefore, selected well diameter is appropriate

Appendix C

Product Cut Sheets

Please read and save this Repair Parts Manual. Read this manual and the General Operating Instructions carefully before attempting to assemble, install, operate or maintain the product described. Protect yourself and others by observing all safety information. The Safety Instructions are contained in the General Operating Instructions. Failure to comply with the safety instructions accompanying this product could result in personal injury and/or property damage! Retain instructions for future reference. AMT reserves the right to discontinue any model or change specifications at any time without incurring any obligation.

Periodic maintenance and inspection is required on all pumps to ensure proper operation. Unit must be clear of debris and sediment. Inspect for leaks and loose bolts. Failure to do so voids warranty.

High Head Centrifugal Pumps

Cast Iron, Bronze, and Stainless Steel Models

A Gorman-Rupp Company

Refer to pump manual 1808-634-00 for General Operating and Safety Instructions.

DESCRIPTION

These pumps are non-self-priming units designed for use where higher heads are needed to handle liquid transfer, heating and cooling application, where no suction lift is required. All models feature high efficiency closed impellers and continuous duty, 3450 RPM, 56J frame motors. The discharge port on all models can be rotated in 90º increments to accommodate specific applications. Casing working pressure to 150 psi (1034 kPa). These are manual units, no controls are supplied. Single phase units are capacitor start and have automatic thermal protection. Check motor wiring before putting unit into operation (see motor nameplate for specific wiring diagrams). All units are for use with nonflammable, non-abrasive liquids compatible with pump component materials.

CAST IRON UNITS

Pump construction is cast iron casing and adapter with a stainless steel impeller. Buna N type 21 mechanical shaft seal with carbon and ceramic wear faces. O-ring casing seal. Handles liquids from 40º to 180º F (4º to 82º C).

BRONZE UNITS

Pump construction is cast bronze casing and adapter with a stainless steel impeller. Viton type 21 mechanical shaft seal with carbon and ceramic wear faces. O-ring casing seal. Handles liquids from 40º to 200º F (4º to 93º C).

STAINLESS STEEL UNITS

Pump construction is cast 300 series stainless steel casing, adapter and impeller. Viton type 21 mechanical shaft seal with carbon and ceramic wear faces. O-ring casing seal. Handles liquids from 40º to 200º F (4º to 93º C).

MAINTENANCE

⚠WARNING

Make certain that the unit is disconnected from the power source before attempting to service or remove any components!

SHAFT SEAL REPLACEMENT

Refer to Figures 1 and 2.

REMOVAL OF OLD SEAL

IMPORTANT: Always replace both seal seat (Ref. No. 5) and seal head (Ref. No. 6) to ensure proper mating of components! Also, impeller seal (Ref. No. 9) should be replaced anytime impeller fastener (Ref. No. 10) has been removed.

1. Remove fasteners (Ref. No. 3) connecting casing (Ref. No. 12) to adapter (Ref. No. 4).
2. Remove casing.

⚠ CAUTION

Care should be taken not to pinch or "shave" casing seal (Ref. No. 11) between adapter and casing.

3. Use a box and/or socket wrench to remove impeller fastener. Remove impeller seal and impeller (Ref. No. 8).

NOTE: Motor shaft must be held in place to remove impeller. Back of the motor either has slot in shaft (use large screwdriver to hold) or has 2 flats on motor shaft (use 7/16 open end wrench to hold). Impeller and impeller fastener unscrew CCW (Counter Clockwise) when looking at the front of pump.

IMPORTANT: Care should be taken to be sure that the same number of thickness of shim washers (Ref. No. 7) are replaced behind the impeller as was removed. Shim washers are located directly behind impeller and become loose as impeller is removed.

4. The seal head can now be pulled from shaft.
5. Pry seal seat from adapter.

INSTALLATION OF NEW SEAL

⚠ CAUTION

The precision lapped faces on mechanical seal are easily damaged. Handle your repair seal carefully. Do not touch polished seal faces.

IMPORTANT: Be sure that shaft shoulder does not damage polished face (see figure 1).

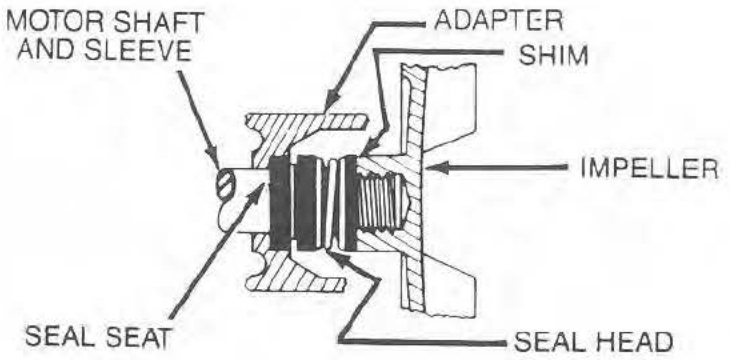

Figure 1 - Mechanical Seal Replacement

High Head Centrifugal Pumps

1. Thoroughly clean all surfaces of seal seat cavity in adapter.
2. Using a clean cloth, wipe shaft and shaft sleeve and make certain that they are perfectly clean.
3. Wet the rubber portion of new seal seat with a light coating of soapy water. While wearing clean gloves or using a clean light rag, press seal seat squarely into adapter recess. Use cardboard washer (usually supplied with new seal), place over polished surface and use a piece of pipe or dowel rod to press in firmly but gently. Avoid scratching polished face.
4. Dispose of cardboard washer. Check again to see that polished face is free of dirt and all other foreign particles and that it has not been scratched or damaged.
5. Wet the inside rubber portion of new seal head with a light coating of soapy water. Slide head onto motor shaft with sealing surface facing seal seat (see figure 2).

Note: A short "run in" period may be necessary to provide completely leak-free operation.

6. Screw impeller onto shaft. Use screwdriver slot at rear of motor shaft (opposite the threaded end) to tighten impeller.

NOTE: It may be necessary to remove plug in motor end cap to expose slot. If removed, be sure to reinstall plug AFTER pump is completely assembled.

7. Check if shaft turns freely by spinning impeller. If rubbing or binding is found, remove impeller and add a shim to shaft, then recheck. Repeat procedure until all rubbing is eliminated.
8. Slide impeller seal onto exposed shaft. Screw acorn nut onto shaft and tighten.
9. Place casing seal on adapter mounting flange. Attach casing using bolts being careful not to pinch or "shave" casing seal. As casing is being tightened, periodically spin impeller to check for interference with casing.

⚠ CAUTION

Seal will produce minor drag when spinning motor shaft, but rubbing anywhere else must be eliminated! Otherwise, damage to pump and/or motor may occur.

Circulator Pump

For Repair Parts contact dealer where pump was purchased.

Please provide following information:
-Model Number
-Serial Number (if any)

Part description and number as shown in parts list

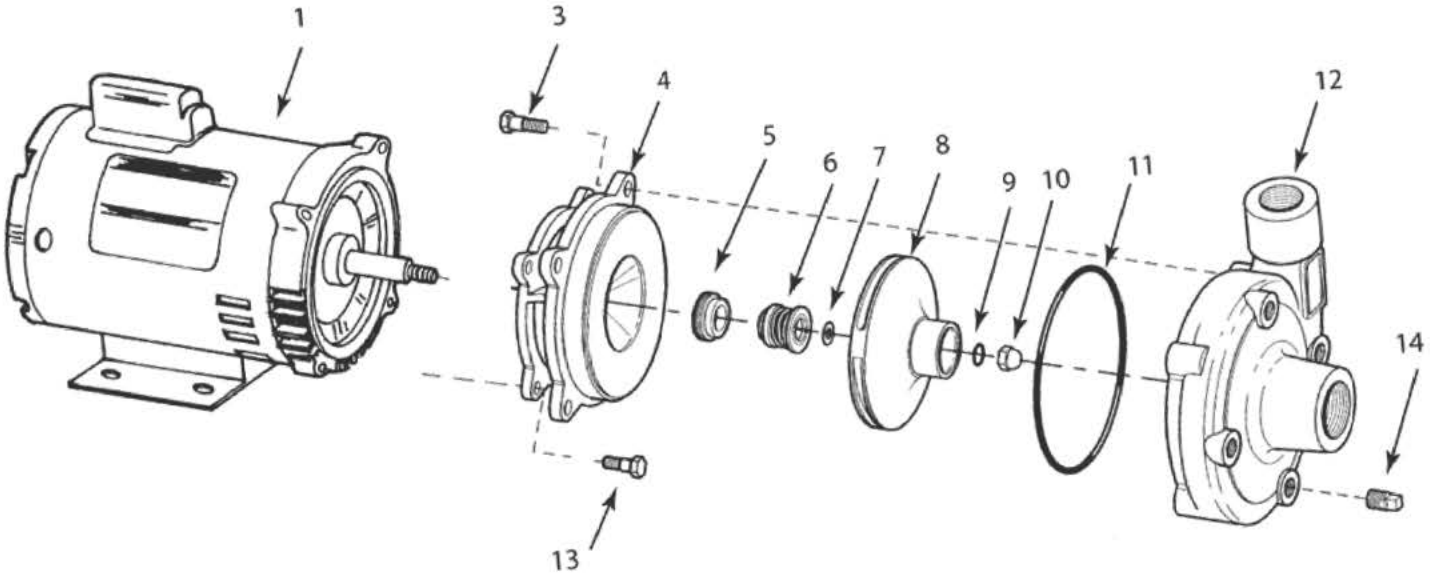

Figure 2 - Repair Parts Illustrations

Repair Parts List

Ref No.	Description	Part Number for Models: 4893 (1/2 HP) 4894 (1/2 HP) 489C (3/4 HP) 489D (3/4 HP)	4895 (3/4 HP) 4896 (3/4 HP) 489E (1 HP) 489F (1 HP)	4890 (1 HP) 4891 (1 HP) 489A (1½ HP) 489B (1½ HP)	4902 (1½ HP) 4903 (1½ HP) 490C (2 HP) 490D (2 HP)	4904 (2 HP) 4905 (2 HP) 490A (3 HP) 490B (3 HP)	4900 (3 HP) 4901 (3 HP) - -	Qty
1	Motor - 1 PH ODP	Discontinued	Discontinued	1626-011-00	1626-012-00	1626-024-00	1626-026-00	1
	Motor - 3 PH ODP	Discontinued	Discontinued	1626-015-00	1626-016-00	1626-025-00	1626-027-00	1
	Motor - 1 PH TEFC	1626-302-00	1626-303-00	1626-304-00	1626-305-00	1626-306-00	-	1
	Motor - 3 PH TEFC	1626-308-00	1626-309-00	1626-310-00	1626-311-00	1626-312-00	-	1
3	Fastener	*	*	*	*	*	*	4
4	Adapter - Cast Iron	4890-030-09	4890-030-09	4890-030-09	4900-030-09	4900-030-09	4900-030-09	1
	Adapter - Bronze	4890-030-97	4890-030-97	4890-030-97	4900-030-97	4900-030-97	4900-030-97	1
	Adapter - Stainless Steel	4890-030-98	4890-030-98	4890-030-98	4900-030-98	4900-030-98	4900-030-98	1
5&6	Shaft Seal Assembly - Buna N	1640-161-96	1640-161-96	1640-161-96	1640-161-96	1640-161-96	1640-161-96	1
	Shaft Seal Assembly - Viton	1640-161-97	1640-161-97	1640-161-97	1640-161-97	1640-161-97	1640-161-97	1
	Shaft Seal Assembly - EPDM/EPR	1642-421-00	1642-421-00	1642-421-00	1642-421-00	1642-421-00	1642-421-00	1
7	Impeller Shim Set	1806-044-90	1806-044-90	1806-044-90	1806-044-90	1806-044-90	1806-044-90	1
8	Impeller	4894-011-09	4896-011-09	4890-011-01	4903-011-09	4905-011-09	4900-011-01	1
9	Impeller Seal - Buna N	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	1
	Impeller Seal - Viton	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	1
	Impeller Seal - EPDM/EPR	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	1
10	Impeller Fastener	1784-001-00	1784-001-00	1784-001-00	1784-001-00	1784-001-00	1784-001-00	1
11	Casing Seal - Buna N	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	1
	Casing Seal - Viton	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	1
	Casing Seal - EPDM/EPR	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	Incl. w/Ref KIT	1
12	Casing - Cast Iron	4890-001-95	4890-001-95	4890-001-95	4900-001-95	4900-001-95	4900-001-95	1
	Casing - Bronze	4890-001-97	4890-001-97	4890-001-97	4900-001-97	4900-001-97	4900-001-97	1
	Casing - Stainless Steel	4890-001-98	4890-001-98	4890-001-98	4900-001-98	4900-001-98	4900-001-98	1
13	Fastener	*	*	*	*	*	*	4
14	3/8" NPT Pipe Plug	*	*	*	*	*	*	4
KIT	O-Ring Kit - Buna N	4890-300-90	4890-300-90	4890-300-90	4900-300-90	4900-300-90	4900-300-90	1
	O-Ring Kit - Viton	4890-301-90	4890-301-90	4890-301-90	4900-301-90	4900-301-90	4900-301-90	1
	O-Ring Kit - EPDM/EPR (includes Ref. Nos. 9 and 11)	4890-302-90	4890-302-90	4890-302-90	4900-302-90	4900-302-90	4900-302-90	1

(*) Standard hardware item, available locally.

NOTES:

NOTES:

A Gorman-Rupp Company

American Machine & Tool Co., Inc. of PA
(herein "AMT")
400 Spring Street
Royersford, PA 19468
Phone: (610) 948-3800
Fax: (610) 948-5300
www.amtpump.com

IPT PUMPS BY GORMAN-RUPP

General Information

SALES POLICY: AMT products are sold through our established Distributors. We do not sell direct to the consumer or organization not entitled to trade recognition. Therefore, possession of our catalogs and/or price list(s) does not infer an offer to sell.

MINIMUM ORDER: We appreciate your order, however, all orders are subject to a minimum $35.00 net invoice charge (excluding freight). This applies to all pump and parts purchase orders.

PRICES: Prices are subject to change without notice. All orders accepted are subject to prices in effect at time of shipment.

PAYMENT TERMS: Terms, upon establishment of credit, are Net 30 days. Past due accounts may be subject to a service charge of 1.5% per month. Domestic or assignable letter of credit is required for all export trade.

PAST DUE ACCOUNTS: AMT reserves the right to withhold open account shipments on any past due account. Invoices are considered past due after thirty (30) days. In the interest of sound business, all orders are subject to approval of the Credit Department.

SHIPPING INSTRUCTIONS: All shipments will be made F.O.B. the factory. Where instructions for shipment do not appear on the order, the shipment will be made according to our best judgment. Full risk of loss (including transportation delays and losses) shall pass to the customer upon delivery of the products to the carrier at the F.O.B. point. When loss or delay occurs, primary responsibility for tracing rests with the customer. When there is LOSS or APPARENT VISIBLE DAMAGE to a shipment, when tendered for delivery, *DO NOT* give the carrier a clear receipt. Note such damage on the carrier's delivery receipt and *HAVE THE DRIVER SIGN THE RECEIPT.*

PRODUCT REVISIONS: AMT reserves the right to discontinue, change or improve its products or any portions thereof without being obligated to provide such a change or improvement for units sold and/or shipped prior to such a change or improvement.

LEAD TIME: Products designated "Quick Ship Product", also referred to as "QSP" will normally be shipped within 24 hours of receipt of a non-cancellable purchase order. Only limited quantities of "QSP" pumps are available.

STANDARD LEAD TIME: Lead time is two weeks for all non "QSP" product. AMT reserves the right to revise lead times as required due to availability of materials and all other causes beyond our control.

VIP SHIPMENT: Select AMT and IPT branded pumps are available for next day shipment for non-QSP (Quick Ship Products) items and subjected to a specific model surcharge per unit noted in the respective price book. Requires calling for availability, confirmation and a non-cancellable purchase order or credit card payment prior to shipment. The expedited shipping charges are an additional cost added separately from the VIP charges per item. AMT reserves the right to revise lead times as required due to availability of materials and all other causes beyond our control. QSP quantities are limited as determined by AMT.

ALL purchase orders must be submitted via hard copy sent to AMT customer service department by fax, EDI or e-mail.

RETURN GOODS POLICY: Goods shall not be returned without a return goods authorization number (RGA) issued by AMT customer service. The RGA number must be listed on the packing list. Only current model and part numbers with a valid date code may be returned (within one year from date of purchase). **A 20% restocking and packaging charge will apply to all returns. All shipping charges must be pre-paid. No exceptions.**

ORDER CHANGES BY CUSTOMER: Orders in process may not be changed except with written consent and may be subject to special charges.

12 Month Limited Warranty

EXTENT AND DURATION OF LIMITED WARRANTY

Coverage: American Machine & Tool Company (herein "AMT") or IPT Pumps by Gorman-Rupp (herein "IPT") or Gorman-Rupp Industries Division of The Gorman-Rupp Company, Patterson, or the Gorman-Rupp Company (herein referred to as "G-R Unit") each individually warrants that its products and parts shall be free from defects in material ad workmanship for twelve (12) months from the date of purchase by the original end user when installation is made and maintenance is performed in accordance with G-R Unit's recommendations. Wear and tear resulting from use and items normally consumed in use are not covered.

EXCEPTIONS

(A) This Limited Warranty shall not apply to mechanical seals in AMT or IPT pumps and the following products and parts: engines, motors, trade accessories and all other products, components, parts and materials not manufactured by the G-R Units. These items may, however, be covered by the warranties of their respective manufacturers. (B) This warranty does not extend to or apply to any unit which has been repaired or altered at any place other than by a G-R Unit, or by persons not expressly approved by a G-R Unit to make repairs or alterations, nor to any unit the serial number, model number or identification of which has been removed, defaced or altered. (C) This warranty does not extend to any product manufactured by a G-R Unit, which has been subjected to mis-use, neglect, accident, improper installation, or use in violation of instructions furnished by a G-R Unit. (D) Pump Kits: This warranty does not extend to any product sold by a G-R Unit unassembled as a Pump Kit. Pump Kits are warranted against defects in material and workmanship for 60 days from the date of shipment from a G-R Unit. Any Pump Kit parts deemed defective by a G-R Unit will be replaced free of charge within 60 days of shipment. Pump Kits are not returnable for credit.

LIMITATIONS

THE G-R UNITS' SOLE AND EXCLUSIVE WARRANTY WITH RESPECT TO THEIR PRODUCTS AND PARTS IS THIS LIMITED WARRANTY. THIS LIMITED WARRANTY IS IN LIEU OF ALL OTHER EXPRESS AND/OR IMPLIED WARRANTIES, INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE.

EXCLUSIVE REMEDY AND DAMAGES

The sole and exclusive remedy for breach of this Warranty by a G-R Unit and the entire extent of its liability for such breach or for damages arising from the use of the products and parts covered under this Limited Warranty, shall be as follows:

1. **Repair or Replacement:** If inspection shows that any G-R Unit product or part covered under this Limited Warranty is defective in materials or workmanship, the G-R Unit shall repair or replace the defective or non-conforming product or part without charge, whichever the G-R Unit chooses. You must have properly maintained and used the product or part claimed to be defective in accordance with the maintenance schedule or manual, which comes with the product. No allowance will be made for labor, installation, removal, transportation or other charges incurred by you in connection with such repair or replacement.
2. To obtain the above remedy:
   - A. Immediately notify the G-R Unit upon discovery of the claimed defect in materials or workmanship and provide the serial number or date code of the product and/or part(s) or provide the G-R Unit with the invoice or bill of sale referencing the product by no later than the expiration date of the warranty period.
   - B. The G-R Unit will advise whether inspection will be necessary and how whether repair or replacement will be made. If inspection by the G-R Unit is necessary, the pump or defective part must be sent freight pre-paid to the G-R Unit. Return shipment will be F.O.B. the G-R Unit's plant.
   - C. **Return Goods Authorization Requirement:** No product will be accepted for return or replacement without the prior written authorization of the G-R Unit. Upon such authorization, and in accordance with instructions from the G-R Unit, the product will be returned to the G-R Unit, shipping charges prepaid by the Buyer.

3. **Damages:** The G-R Unit's liability for damages for breach of this Limited Warranty shall not exceed the amount of the purchase price of the product or part(s) in respect to which Such damages are claimed. **IN NO EVENT SHALL THE G-R UNITS BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES FOR BREACH OF THIS LIMITED WARRANTY.**

Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you. This Limited Warranty gives you specific legal rights, and you may also have other rights, which vary from state to state.

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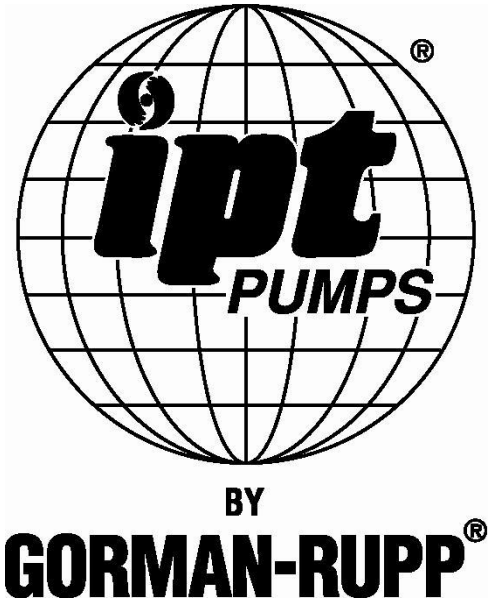


www.amtpump.com

High Head Straight Centrifugal Pumps

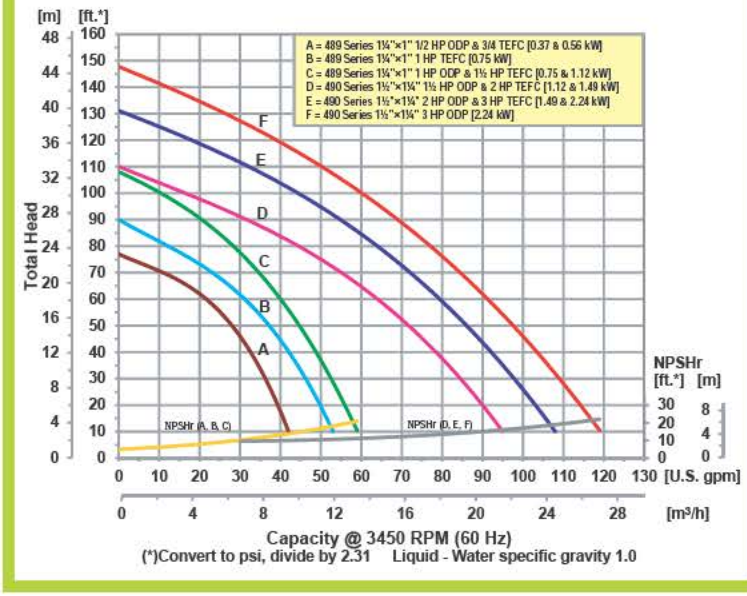
Model 490A-98
Stainless Steel

- **300 Series Investment Cast Stainless Steel, Cast Bronze and Cast Iron Construction with Stainless Steel Impeller**
- **Viton® Mechanical Seal and O-Ring with Stainless Steel and Bronze Models**
- **Buna-N Mechanical Seal and O-Ring with Cast Iron Models**
- **Optional Silicon Carbide Mechanical Seals Available**
- **Discharge Port Rotates in 90° Increments**
- **489 Series: 1-1/4˝ x 1˝ Ports**
- **490 Series: 1-1/2˝ x 1-1/4˝ Ports**
- **High Efficiency Closed Impeller**
- **Maximum Flow 118 GPM**
- **Maximum Head 149 Ft. (65 PSI)**

AMT High Head End Suction Centrifugal pumps are designed for continuous-duty OEM, Industrial/Commercial and processing applications including circulation, chemical processing, liquid transfer, heating and cooling, sprinkler/fire protection systems and pressure boosting.

These heavy duty high pressure pumps are available in a variety of construction and seal materials to meet your specification. Pull-from-rear design for easy servicing without disturbing any piping. High efficiency closed impeller maximizes performance. Pumps are close coupled to Totally Enclosed Fan Cooled (TEFC) or Open Drip Proof (ODP) motors. **Pumps are not self-priming and require flooded suction.**

Performance of High Head Straight Centrifugal Pumps



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AMT High Head Straight Centrifugal Pumps

A Gorman-Rupp Company

Pump Dimensional & Specification Data

Model ‡	Curve	HP	PH	ENC	Voltage @ 60 Hz +	Full Load Amps	SUC*	DIS*	A**	B**	C**	D	E	F	L**	W**	H	‡ Ship Wt. (Lbs.)
4893		1/2	1	ODP	115/230	10/5	1¼	1	N/A	5.1 [13.0]	7.4 [18.9]	0.2 [0.6]	2.1 [5.3]	3.3 [8.5]	14.0 [35.5]	8.2 [20.8]	8.6 [21.8]	43
489C	A	3/4	1	TEFC	115/230	9/5	1¼	1	5.4 [13.8]	5.1 [13.0]	7.4 [18.9]	0.2 [0.6]	2.1 [5.3]	3.3 [8.5]	14.7 [37.3]	10.0 [25.4]	8.6 [21.8]	51
489D		3/4	3	TEFC	230/460	3/2	1¼	1	5.4 [13.8]	N/A	7.4 [18.9]	0.2 [0.6]	2.1 [5.3]	3.3 [8.5]	14.2 [36.0]	10.0 [25.4]	8.6 [21.8]	43
489E	B	1	1	TEFC	115/230	12/6	1¼	1	5.4 [13.8]	5.1 [13.0]	7.4 [18.9]	0.2 [0.6]	2.1 [5.3]	3.3 [8.5]	14.9 [37.8]	10.0 [25.4]	8.6 [21.8]	57
489F		1	3	TEFC	208-230/460	3/2	1¼	1	5.4 [13.8]	N/A	7.4 [18.9]	0.2 [0.6]	2.1 [5.3]	3.3 [8.5]	13.5 [34.3]	10.0 [25.4]	8.6 [21.8]	47
4890		1	1	ODP	115/230	17/9	1¼	1	N/A	5.1 [13.0]	8.1 [20.6]	0.2 [0.6]	2.1 [5.3]	3.3 [8.5]	14.7 [37.3]	8.2 [20.8]	8.6 [21.8]	54
489A	C	1½	1	TEFC	115/230	19/9	1¼	1	5.4 [13.8]	5.1 [13.0]	7.4 [18.9]	0.2 [0.6]	2.1 [5.3]	3.3 [8.5]	15.4 [39.1]	10.0 [25.4]	8.6 [21.8]	61
489B		1½	3	TEFC	230/460	5/3	1¼	1	5.4 [13.8]	N/A	7.4 [18.9]	0.2 [0.6]	2.1 [5.3]	3.3 [8.5]	15.2 [38.6]	10.0 [25.4]	8.6 [21.8]	50
4902		1½	1	ODP	115/230	22/11	1½	1¼	N/A	5.1 [13.0]	8.7 [22.1]	0.5 [1.4]	3.0 [7.6]	3.4 [8.9]	15.8 [40.1]	8.7 [22.1]	9.0 [22.8]	58
490C	D	2	1	TEFC	115/230	22/11	1½	1¼	5.4 [13.8]	5.1 [13.0]	8.0 [20.4]	0.5 [1.4]	3.0 [7.6]	3.4 [8.9]	16.8 [42.6]	10.2 [25.9]	9.0 [22.8]	66
490D		2	3	TEFC	230/460	6/3	1½	1¼	5.4 [13.8]	N/A	8.0 [20.4]	0.5 [1.4]	3.0 [7.6]	3.4 [8.9]	16.3 [41.4]	10.2 [25.9]	9.0 [22.8]	59
4904		2	1	ODP	115/230	28/14	1½	1¼	N/A	5.1 [13.0]	8.7 [22.1]	0.5 [1.4]	3.0 [7.6]	3.4 [8.9]	15.8 [40.1]	8.7 [22.1]	9.0 [22.8]	66
490A	E	3	1	TEFC	230	16	1½	1¼	5.4 [13.8]	5.0 [12.7]	8.0 [20.4]	0.5 [1.4]	3.0 [7.6]	3.4 [8.9]	17.3 [43.9]	10.2 [25.9]	9.0 [22.8]	75
490B		3	3	TEFC	230/460	8/4	1½	1¼	5.4 [13.8]	N/A	8.0 [20.4]	0.5 [1.4]	3.0 [7.6]	3.4 [8.9]	16.8 [42.6]	10.2 [25.9]	9.0 [22.8]	63
4900	F	3	1	ODP	230	18	1½	1¼	N/A	5.0 [12.7]	8.7 [22.1]	0.5 [1.4]	3.0 [7.6]	3.4 [8.9]	17.1 [43.4]	8.7 [22.1]	9.0 [22.8]	73
4901		3	3	ODP	208-230/460	9/5	1½	1¼	N/A	N/A	8.0 [20.4]	0.5 [1.4]	3.0 [7.6]	3.4 [8.9]	16.8 [42.6]	8.7 [22.1]	9.0 [22.8]	73

(*) Standard NPT (Female) pipe thread.

Maximum Solids Handling Capacity: 1/8" Diameter

(**) This dimension may vary due to motor manufacturer's specifications.

(+) 3-Phase motors can also operate on 50 Hz. (This will change full load amps, service factor and RPM)

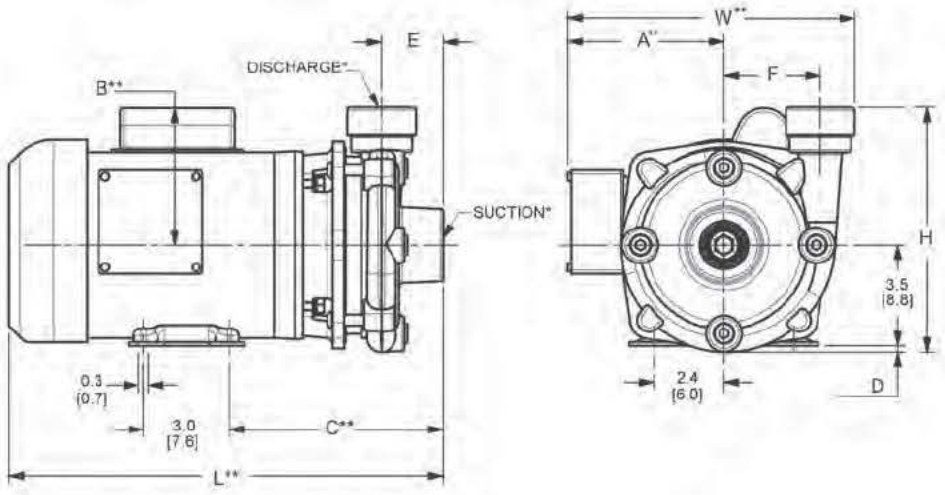
NOTE: Dimensions are in inches (centimeters) and have a tolerance of ± 1/4".

NOTE: Electric supply for **ALL** motors must be within ±10% of nameplate voltage rating (e.g. 230V ±10%= 207 to 253).

‡ When Ordering, Add the Correct (-9X) Suffix to Model Number Indicating Material Selection (Ex. 4893-95)

- XCI (-95) Cast Iron Construction with Buna-N Seals
- XB (-97) Cast Bronze Construction with Viton® Seals
- XSS (-98) Cast Stainless Steel Construction with Viton® Seals

(All Models Come Standard with Stainless Steel Impeller)



Standard Features

- Stainless Steel, Bronze and Cast Iron Construction
- Buna-N or Viton® Mechanical Seal and O-ring, Depending on Model
- Optional Silicon Carbide Mechanical Seals Available
- Stainless Steel Motor Shaft and Hardware
- NEMA TEFC Single or Three Phase 3450 RPM Motors, Optional ODP Motors Available
- NEMA Base Mounted Motor
- High Efficiency Closed Stainless Steel Impeller
- Discharge Rotates in 90° Increments
- Maximum Working Pressure 150 PSI
- Maximum Temperature
  - Viton® 200° F
  - Buna-N 180° F
- (4) Front Drain Plugs, Located 90° Apart
- QSP – Quick Ship Pump for Many Models

Hazardous Duty/Xplosion Proof motors available from stock ranging from 1 to 10 HP; *CALL FOR QUOTATION & LEAD TIME!*

AMT A Gorman-Rupp Company

Manufacturer of AMT & IPT Pumps

400 Spring Street • Royersford, PA 19468 USA

www.amtpump.com • 888-amt-pump (268-7867)

IPT PUMPS BY GORMAN-RUPP®

1212

Please read and save this Repair Parts Manual. Read this manual and the General Operating Instructions carefully before attempting to assemble, install, operate or maintain the product described. Protect yourself and others by observing all safety information. The Safety Instructions are contained in the General Operating Instructions. Failure to comply with the safety instructions accompanying this product could result in personal injury and/or property damage! Retain instructions for future reference. AMT reserves the right to discontinue any model or change specifications at any time without incurring any obligation.

Periodic maintenance and inspection is required on all pumps to ensure proper operation. Unit must be clear of debris and sediment. Inspect for leaks and loose bolts. Failure to do so voids warranty.

Electric Motor-Driven Pumps

Refer to Specific Information and Repair Parts Manual for product specific information.

SAFETY GUIDELINES

This manual contains information that is very important to know and understand. This information is provided for SAFETY and to PREVENT EQUIPMENT PROBLEMS. To help recognize this information, observe the following symbols:

⚠DANGER

Danger indicates an imminently hazardous situation which, if not avoided, WILL result in death or serious injury.

⚠WARNING

Warning indicates a potentially hazardous situation which, if not avoided, COULD result in death or serious injury.

⚠ CAUTION

Caution Indicates a potentially hazardous situation which, if not avoided, MAY result in minor or moderate injury.

NOTE: ***Indicates important information that, if not followed, may cause damage to equipment.***

UNPACKING

When unpacking the unit, inspect carefully for any damage that may have occurred during transit. Check for loose, missing or damaged parts. (See pump exploded view and Repair Parts List.) **Do not attempt to assemble or operate pump if any parts are missing or damaged. Determine that all parts are properly installed.**

GENERAL SAFETY INFORMATION

1. Know the pump application, limitations, and potential hazards. Read all manuals included with this product carefully. Be thoroughly familiar with the pump and the proper use of the equipment.

⚠WARNING

Pump should only be used with liquids compatible with pump component materials.

⚠DANGER

Do not use to pump flammable or explosive fluids such as gasoline, fuel oil, kerosene, etc. Do not use in flammable and/or explosive atmospheres.

When pumping hazardous or dangerous materials, use only in room or area designated for that purpose. For your protection, always wear proper clothing, eye protection, etc. in case of any malfunction. For proper handling techniques and cautions, contact your chemical supplier, insurance company and local agencies (fire dept., etc.). Failure to comply with this warning could result in personal injury and/or property damage.

2. Make certain that the power source (engine) conforms to the requirements of your equipment.
3. Provide adequate protection and guarding around moving parts.
4. Disconnect power before servicing. If the power disconnect is out of sight, lock in the open position and tag it to prevent unexpected application of power. Failure to do so could result in fatal electric shock!
5. Release all pressure within the system before servicing any component.
6. Drain all liquids from the system before servicing.
7. Secure the discharge line before starting the pump. An unsecured discharge line will whip, possibly causing personal injury and/or property damage.
8. Check hoses for weak or worn condition before each use, making certain that all connections are secure.
9. Periodically inspect pump and system components. Perform routine maintenance as required (See Maintenance section).
10. Provide a means of pressure relief for pumps whose discharge line can be shut-off or obstructed.
11. **Personal Safety:**
    a. Wear safety glasses at all times when working with pumps.
    b. Wear a face shield and proper apparel when pumping hazardous chemicals.
    c. Keep work area clean, uncluttered and properly lighted; replace all unused tools and equipment.
    d. Keep visitors at a safe distance from the work area.
    e. Make workshop childproof – with padlocks, master switches, and by removing starter keys.
12. This unit is not waterproof and is not intended to be used in showers, saunas or other potentially wet locations. The motor is designed to be used in a clean dry location with access to an adequate supply of cooling air. Ambient temperature around the motor should not exceed 104°F (40°C). For outdoor installations, motor must be protected by a cover that does not block airflow to and around the motor. This unit is not weatherproof nor is it able to be submersed in water.
13. When wiring an electrically driven pump, follow all electrical and safety codes, as well as the most recent United States National Electrical Code (NEC) and the Occupational Safety and Health Act (OSHA).

⚠WARNING

Risk of Electric shock!

Electric Motor-Driven Pumps

14. **THREE-PHASE MOTORS:** These units are for permanent installation using a power supply with a ground. To reduce the risk of electric shock, electric motor must have one of the following:
    a. Adequately grounded to a metal raceway system.
    b. Use of a separate grounding wire connected to bare metal on the motor frame or to the grounding screw located inside motor terminal box.
    c. By other suitable means.

    Refer to the most recent National Electrical Code (NEC) Article 250 (Grounding) for additional information. ALL WIRING SHOULD BE DONE BY A QUALIFIED ELECTRICIAN.

    On three-phase power, voltages on all three lines should be balanced within 1%. Unbalanced voltages cause motor overheating and poor performance.

⚠WARNING

Risk of Electric Shock! Never connect the green (or green and yellow) wire to a live terminal!

15. **SINGLE PHASE MOTORS:** These units can be wired for either portability with flexible 3-wire cord, or permanent installation using a supply with a ground. To reduce the risk of electric shock, the motor must be securely and adequately grounded! This can be accomplished by either (1) inserting plug (portable) directly into a properly installed and grounded 3-prong grounding type receptacle (as shown in Figure A for 110-120 volt, or Figure B for 220-240 volt) (2) permanently wiring the unit with a grounded, metal raceway system (3) using a separate ground wire connected to the bare metal of the motor frame or (4) other suitable means. The green (or green and yellow) conductor in the cord is the grounding wire.

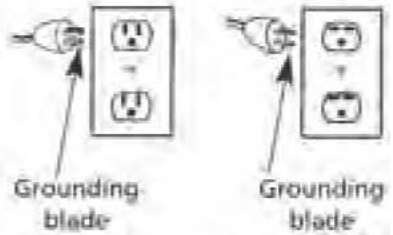


Figure 1 - Grounding Methods

    Where a 2-prong wall receptacle is encountered, it must be replaced with a properly grounded 3-prong receptacle installed in accordance with the National Electrical Code, local codes and ordinances. To ensure a proper ground, the grounding means must be tested by a qualified electrician.
16. Use only 3-wire extension cords that have 3-prong grounding type plugs and 3-pole receptacles that accept the equipment plug.
17. All wiring should be performed by a qualified electrician.
18. Protect electrical cord from sharp objects, hot surfaces, oil and chemicals. Avoid kinking the cord. Replace or repair damaged or worn cords immediately.
19. Keep fingers and foreign objects away from ventilation and other openings. Do not insert any objects into the motor.
20. Use wire of adequate size to minimize voltage drop at the motor.
21. Disconnect power before servicing a motor or its load. If the power disconnect is out of sight, lock it in the open position and tag it to prevent unexpected application of power.
22. Do not touch an operating motor. Modern motors are designed to operate at high temperatures.

⚠WARNING

Do not handle a pump or pump motor with wet hands, when standing on a wet or damp surface or in water.

⚠WARNING

Specific single phase pump motors are equipped with an automatic resetting thermal protector and may restart unexpectedly. Protector tripping is an indication of motor overloading as a result of operating the pump at low heads (low discharge restriction), excessively high or low voltage, inadequate wiring, incorrect motor connections or a defective motor or pump. A motor equiped with a automatic thermal protection will be inidicated on the motor nameplate

INSTALLATION

⚠WARNING

The pumps should not be used in flammable or explosive atmospheres. In order to safely use this product, familiarize yourself with this pump and also with the liquid (chemical, etc.) that is going to be pumped through the unit. This pump is not suitable for many liquids.

For installations where property damage might result from an inoperative or leaking pump due to power outages, discharge line blockage or any other reason, a backup system(s) should be used.
Failure to follow any warning can result in personal injury and/or property damage.

LOCATION

a. **Open Drip Proof Motor** - Clean dry locations with access to an adequate supply of cooling air.
b. **Totally Enclosed Motor** - Harsher environments where damp and dirty conditions may exist. Totally enclosed motors are not water proof.
c. Use only UL listed **Hazardous Location** motors for service in **Hazardous Locations** as defined in Article 500 of the NEC.
d. Temperature around the motor should not exceed 104°F (40°C). Minimum temperature is -20°F (29°C).
e. If the motor nameplate indicates "Air-Over, Cont. A.O.," etc., the motor must be mounted in the air stream of an air moving device.

1. Locate pump as close to the fluid source as possible, thus making the suction line short and direct as possible.

⚠ CAUTION

The unit should be placed where the motor and electrical components are protected from the weather and extremes of heat, cold and humidity.

2. Attach piping suction line to suction inlet and piping discharge line to discharge outlet. Avoid using looped section of pipe or fittings, which might permit air to ensure airtight pipe connections.

IMPORTANT: If plastic or fabric hose is used for the suction piping, it should be of a reinforced type so as not to collapse under suction. The suction piping should be one size larger than the discharge piping.

Electric Motor-Driven Pumps

3. Support the piping independently of the pump to avoid universal or excessive stresses on the pump casing, which would cause impeller misalignment and possible pump failure.
4. Install both a union and a gate valve (not furnished) on the discharge side of the pump for service convenience.

⚠ CAUTION

Do not use a globe or other restricting type of valve at the discharge. Globe valves seriously restrict the capacity of the pump; however, restricting the discharge of a centrifugal pump will not overload the drive motor.

5. **SELF-PRIMING PUMPS:** It is recommended that a foot valve be used on the suction line to assure quick priming and that a suitable suction strainer be attached to the suction line so that large pieces of foreign material are not drawn into the pump.
    a. Locate pump as close to the fluid source as possible making the suction line as short and direct as possible.

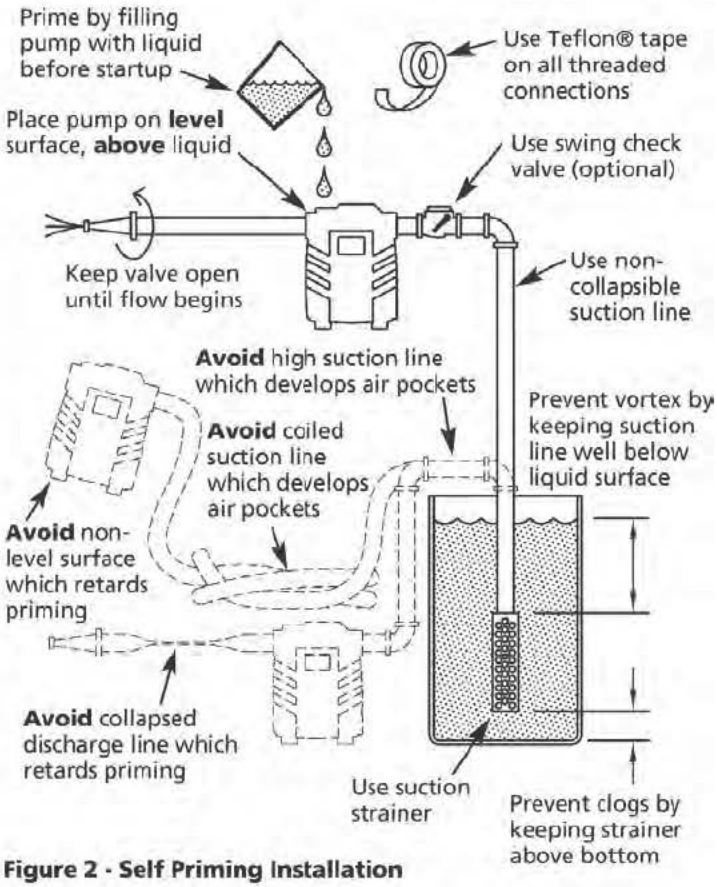


Figure 2 - Self Priming Installation

    b. The suction line should be positioned such that there is a continual upward slope from the fluid source to the pump. Avoid using loops or sections of pipe or fittings which might permit air to become trapped.
    c. Suction piping should be the same size as the discharge piping.

6. **WIRING:** For proper electrical connections, refer to the diagram located on the nameplate or inside the terminal of the motor. Make sure the connections are correct for the voltage being supplied to the motor. Connections should be made with flexible conduit to minimize vibration transmission.

Whenever possible, the pump should be powered from a separate branch circuit of adequate capacity to keep voltage drop to a minimum during starting and running.

Select the voltage to be used, either

    a. Single phase - 115V or 230V
    b. Three phase - 230V or 460V

Check motor wiring to verify which voltage the motor is currently wired for. If the wiring must be changed to conform to a specific voltage requirement, then the motor should be wired according to recommendations of wiring diagrams located on motor nameplate or wiring compartment cover. Make sure unit is properly grounded. A motor to be used with single phase power cannot be used with three phase power and vice versa. If unsure about the above information or the wiring diagrams, consult an electrician familiar with motor wiring.

⚠WARNING

A wrong connection can burn out the pump motor, cause an electrical short or produce an electrical shock. Failure to follow the above warning can result in property damage and/or personal injury. Always wire the motor with a three-wire system, ensuring that a ground wire runs to a good electrical ground such as a grounded water system or conduit. Also, ensure that a good electrical ground is provided at the supply end of the line. Connections should be made with flexible conduit to minimize vibration transmission.

7. Do not operate pump dry. Mechanical seal damage will result.
8. Install any auxiliary components (e.g. pressure switch, time).

OPERATION

SELF-PRIMING PUMPS

It is necessary to prime the pump before initial startup. Prime the pump by filling the casing with liquid through the top fill plug, the discharge port, or by installing a pipe tee at the discharge of the pump. (When installing a tee, use the horizontal leg of the tee as the pump discharge and place a pipe plug in the vertical leg. This procedure will help facilitate priming later.)

NON-PRIMING PUMPS

1. The casing and suction piping must be filled with liquid before the unit can begin pumping. In order to completely fill casing with liquid, entrapped air in casing must be vented. This is accomplished by momentarily loosening or removing the top drain plug located on the casing.

⚠ CAUTION

Do not run pump dry as permanent damage to the mechanical seal will result.

2. Activate the unit.

IMPORTANT: Proper Rotation- Power supply should be applied momentarily to the pump at first and the direction of rotation checked. When viewing the front of the pump, the motor shaft (impeller) should be rotating counterclockwise. If it is not, disconnect power and re-check wiring to motor. (See "Installation" section.) To change rotation on three phase models, interchange any two incoming line (power) leads. Other models, consult driver information that came with driver.

NOTE: Never shut off discharge or restrict suction flow while the pump is operating. It may take up to 5 minutes for a **SELF-PRIMING** pump to prime if

Electric Motor-Driven Pumps

long horizontal/ vertical lines are used. If pump has not picked up prime in 2 minutes, re-prime piping and casing after letting unit cool down for 5 minutes. Re-check all suction connections making sure pipe compound has sealed all connections. Initial priming may take 2 to 3 tries to prime successfully.

⚠ CAUTION

The proper Impeller (motor) rotation is CCW (counter clockwise) facing the front of the pump. Wrong rotation will give low performance, low head and could damage unit and/or injure personnel.

3. On initial start-up (after 15 minutes running time), check power consumption to be sure motor is not overloaded.
4. If motor is overloaded, install a valve on discharge to increase back pressure. Close the valve until pump motor is below full nameplate or within Service Factor (SF) amps.

MAINTENANCE

⚠WARNING

Make certain that the unit is disconnected from the power source before attempting to service or remove any components!

NOTE: Always flush pump thoroughly after use or if unit is not going to be used for any prolonged length of time to prevent crystallization and/or damage to seal and pump.

ROUTINE

1. Pump should be drained when subjected to freezing temperatures. A drain plug is provided on the pump casing.
2. Clean the suction line strainer at regular intervals.
3. Properly selected and installed electric motors are capable of operating for years with minimal maintenance. Periodically clean dirt accumulations from open-type motors, especially in and around vent openings, preferably by vacuuming (avoids imbedding dirt in windings).
4. Periodically check to see if electrical connections are tight.
5. Pump should be checked daily, weekly, monthly, etc. for proper operation. If anything has changed since unit was new, unit should be removed and repaired or replaced. Only qualified electricians or service personnel should attempt to repair this unit. Improper repair and/or assembly can cause an electrical shock hazard.

TROUBLESHOOTING CHART

Problem	Possible Cause(s)	Corrective Action
Motor will not start or run	1 Improperly wired.	1 Check wiring diagram on motor.
	2 Blown fuse or open circuit breaker.	2 Replace fuse or close circuit breaker after reason for overload has been determined and corrected.
	3 Loose or broken wiring.	3 Tighten connections, replace broken wiring.
	4 Stone or foreign object lodged in impeller.	4 Disassemble pump and remove foreign object.
	5 Motor shorted out.	5 Replace.
	6 Thermal overload has opened circuit.	6 Allow unit to cool. Restart after reason for overload has been determined.
	7 Voltage too low at motor terminals due to line drop.	7 Consult local power company. Increase wire size. Check for poor connections.
Motor runs slowly; will not get up to speed	1 Motor wired improperly.	1 Check and recheck wiring diagram on motor. Make internal wiring changes in wiring compartment.
	2 Capacitor burned out (single phase units only).	2 Replace capacitor.
	3 Voltage too low at motor terminals.	3 Increase wire size. Check for poor connections. Check for voltage unbalance (3 phase).
Motor overheats while running under load	1 Dirt blocking ventilation openings.	1 Clean Motor.
	2 Unbalanced supply voltage.	2 Check for faulty connections. Voltage on all three lines should be balanced within 1%. Excessive single phase loads.
	3 Faulty connection.	3 Clean, tighten, or replace.
	4 High or low voltage.	4 Check voltage at motor, should not be more than 10% above or below rated.
Pump will not prime	1 No priming water in casing.	1 Fill pump casing.
	2 Mechanical seal is leaking.	2 Replace (See Maintenance).
	3 Leak in suction line.	3 Use threaded sealant on piping, tighten, repair or replace.
	4 Discharge line is closed and priming air has nowhere to go.	4 Open.
	5 Suction line (or valve) is closed.	5 Open.
	6 Pipe union was used on suction side instead of discharge.	6 Remove union from suction side. Replace with single section of pipe.
	7 Pump is worn.	7 Replace worn parts.

TROUBLESHOOTING CHART (continued)

Problem	Possible Cause(s)	Corrective Action
Little or no discharge	1 Casing not filled with water.	1 Fill pump casing with liquid.
	2 Total head too high.	2 Shorten suction lift and/or discharge head.
	3 Suction head too high.	3 Lower suction head, install foot valve and prime.
	4 Impeller plugged.	4 Disassemble pump and clean impeller.
	5 Rotation incorrect.	5 Correct (See wiring diagram on motor)
	6 Hole or air leak in suction line.	6 Repair or replace suction line.
	7 Foot valve was too small.	7 Match foot valve to piping or install one size larger foot valve.
	8 Impeller damaged.	8 Replace.
	9 Foot valve or suction line not submerged deep enough in water.	9 Submerge lower in water.
	10 Suction piping too small.	10 Increase to pump inlet size or one size larger.
	11 Discharge piping too small.	11 Match to discharge outlet size on pump.
	12 Motor wired incorrectly.	12 Check wiring diagram.
	13 Casing gasket leaking.	13 Replace.
	14 Suction or discharge line valve closed.	14 Open.
	15 Single phase, new installation. Motor wired for 230V, etc. but supply is 115V, etc.	15 Check voltage of incoming power supply. Rewire as necessary.
	16 Mechanical seal is leaking.	16 Replace (See Maintenance).
Loss of suction	1 Air leak in suction line.	1 Use threaded sealant on piping, tighten, repair or replace.
	2 Suction lift too high.	2 Lower suction lift, install foot valve and prime.
	3 Clogged foot valve or strainer.	3 Clean.
Pump vibrates and/or makes excessive noise	1 Mounting plate or foundation not rigid enough.	1 Reinforce.
	2 Foreign material in pump.	2 Disassemble pump and clean.
	3 Impeller damaged.	3 Replace.
	4 Worn motor bearings.	4 Replace.
	5 Suction lift too high.	5 Decrease suction lift.
	6 Cavitation present.	6 Check suction line for proper size and be sure valve is open. Remove excessive lops in suction line. Install gate valve on discharge side of pump and reduce flow as necessary to match suction conditions available.
Pump leaks at shaft	1 Damaged or worn mechanical seal.	1 Replace (See Maintenance).
	2 Corrosion due to character of liquid pumped.	2 Discontinue pumping liquid and consult factory.
	3 Abrasive material in liquid causing an accumulation around the rotating assembly which results in faces opening up and allowing grit between them.	3 Pump not designed for abrasives. Discontinue use
	4 Liquid not compatible with seal.	4 Consult factory. Operational seal may be available.
	5 Temperature too high.	5 Lower liquid temperature below temperature rating of pump, See Specifications.
Pinholes in casting, drips around seal area	1 Cavitation caused by insufficient inlet pressure or suction head (NPSH).	1 Increase inlet pressure by adding a higher liquid level of fluid to source, increasing inlet pressure, or remove piping restrictions(valves, lops, etc.) in suction line.

A Gorman-Rupp Company

AMT Pump Company
(herein "AMT")
400 Spring Street
Royersford, PA 19468
Phone: (610) 948-3800
Fax: (610) 948-5300
www.amtpump.com

IPT PUMPS BY GORMAN-RUPP

General Information

SALES POLICY: AMT products are sold through our established Distributors. We do not sell direct to the consumer or organization not entitled to trade recognition. Therefore, possession of our catalogs and/or price list(s) does not infer an offer to sell.

MINIMUM ORDER: We appreciate your order, however, all orders are subject to a minimum $35.00 net invoice charge (excluding freight). This applies to all pump and parts purchase orders.

PRICES: Prices are subject to change without notice. All orders accepted are subject to prices in effect at time of shipment.

PAYMENT TERMS: Terms, upon establishment of credit, are Net 30 days. Past due accounts may be subject to a service charge of 1.5% per month. Domestic or assignable letter of credit is required for all export trade.

PAST DUE ACCOUNTS: AMT reserves the right to withhold open account shipments on any past due account. Invoices are considered past due after thirty (30) days. In the interest of sound business, all orders are subject to approval of the Credit Department.

SHIPPING INSTRUCTIONS: All shipments will be made F.O.B. the factory. Where instructions for shipment do not appear on the order, the shipment will be made according to our best judgment. Full risk of loss (including transportation delays and losses) shall pass to the customer upon delivery of the products to the carrier at the F.O.B. point. When loss or delay occurs, primary responsibility for tracing rests with the customer. When there is LOSS or APPARENT VISIBLE DAMAGE to a shipment, when tendered for delivery, *DO NOT* give the carrier a clear receipt. Note such damage on the carrier's delivery receipt and *HAVE THE DRIVER SIGN THE RECEIPT.*

PRODUCT REVISIONS: AMT reserves the right to discontinue, change or improve its products or any portions thereof without being obligated to provide such a change or improvement for units sold and/or shipped prior to such a change or improvement.

LEAD TIME: Products designated "Quick Ship Product", also referred to as "QSP" will normally be shipped within 24 hours of receipt of a non-cancellable purchase order. Only limited quantities of "QSP" pumps are available.

STANDARD LEAD TIME: Lead time is two weeks for all non "QSP" product. AMT reserves the right to revise lead times as required due to availability of materials and all other causes beyond our control.

VIP SHIPMENT: Select AMT and IPT branded pumps are available for next day shipment for non-QSP (Quick Ship Products) items and subjected to a specific model surcharge per unit noted in the respective price book. Requires calling for availability, confirmation and a non-cancellable purchase order or credit card payment prior to shipment. The expedited shipping charges are an additional cost added separately from the VIP charges per item. AMT reserves the right to revise lead times as required due to availability of materials and all other causes beyond our control. QSP quantities are limited as determined by AMT.

ALL purchase orders must be submitted via hard copy sent to AMT customer service department by fax, EDI or e-mail.

RETURN GOODS POLICY: Goods shall not be returned without a return goods authorization number (RGA) issued by AMT customer service. The RGA number must be listed on the packing list. Only current model and part numbers with a valid date code may be returned (within one year from date of purchase). **A 20% restocking and packaging charge will apply to all returns. All shipping charges must be pre-paid. No exceptions.**

ORDER CHANGES BY CUSTOMER: Orders in process may not be changed except with written consent and may be subject to special charges.

12 Month Limited Warranty

EXTENT AND DURATION OF LIMITED WARRANTY

Coverage: AMT Pump Company (herein "AMT") or IPT Pumps by Gorman-Rupp (herein "IPT") or Gorman-Rupp Industries Division of the The Gorman-Rupp Company, Patterson, or the Gorman-Rupp Company (herein referred to as "G-R Unit) each individually warrants that its products and parts shall be free from defects in material and workmanship for twelve (12) months from the date of purchase by the original end user when installation is made and maintenance is performed in accordance with G-R Unit's recommendations. Wear and tear resulting from use and items normally consumed in use are not covered.

EXCEPTIONS

(A) This Limited Warranty shall not apply to mechanical seals in AMT or IPT pumps and the following products and parts: engines, motors, trade accessories and all other products, components, parts and materials not manufactured by the G-R Units. These items may, however, be covered by the warranties of their respective manufacturers. (B) This warranty does not extend to or apply to any unit which has been repaired or altered at any place other than by a G-R Unit, or by persons not expressly approved by a G-R Unit to make repairs or alterations, nor to any unit the serial number, model number or identification of which has been removed, defaced or altered. (C) This warranty does not extend to any product manufactured by a G-R Unit, which has been subjected to mis-use, neglect, accident, improper installation, or use in violation of instructions furnished by a G-R Unit. (D) Pump Kits: This warranty does not extend to any product sold by a G-R Unit unassembled as a Pump Kit. Pump Kits are warranted against defects in material and workmanship for 60 days from the date of shipment from a G-R Unit. Any Pump Kit parts deemed defective by a G-R Unit will be replaced free of charge within 60 days of shipment. Pump Kits are not returnable for credit.

LIMITATIONS

THE G-R UNITS' SOLE AND EXCLUSIVE WARRANTY WITH RESPECT TO THEIR PRODUCTS AND PARTS IS THIS LIMITED WARRANTY. THIS LIMITED WARRANTY IS IN LIEU OF ALL OTHER EXPRESS AND/OR IMPLIED WARRANTIES, INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE.

EXCLUSIVE REMEDY AND DAMAGES

The sole and exclusive remedy for breach of this Warranty by a G-R Unit and the entire extent of its liability for such breach or for damages arising from the use of the products and parts covered under this Limited Warranty, shall be as follows:

1. **Repair or Replacement:** If inspection shows that any G-R Unit product or part covered under this Limited Warranty is defective in materials or workmanship, the G-R Unit shall repair or replace the defective or non-conforming product or part without charge, whichever the G-R Unit chooses. You must have properly maintained and used the product or part claimed to be defective in accordance with the maintenance schedule or manual, which comes with the product. No allowance will be made for labor, installation, removal, transportation or other charges incurred by you in connection with such repair or replacement.
2. To obtain the above remedy:
   - A. Immediately notify the G-R Unit upon discovery of the claimed defect in materials or workmanship and provide the serial number or date code of the product and/or part(s) or provide the G-R Unit with the invoice or bill of sale referencing the product by no later than the expiration date of the warranty period.
   - B. The G-R Unit will advise whether inspection will be necessary and how whether repair or replacement will be made. If inspection by the G-R Unit is necessary, the pump or defective part must be sent freight pre-paid to the G-R Unit. Return shipment will be F.O.B. the G-R Unit's plant.
   - C. **Return Goods Authorization Requirement:** No product will be accepted for return or replacement without the prior written authorization of the G-R Unit. Upon such authorization, and in accordance with instructions from the G-R Unit, the product will be returned to the G-R Unit, shipping charges prepaid by the Buyer.

3. **Damages:** The G-R Unit's liability for damages for breach of this Limited Warranty shall not exceed the amount of the purchase price of the product or part(s) in respect to which Such damages are claimed. **IN NO EVENT SHALL THE G-R UNITS BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES FOR BREACH OF THIS LIMITED WARRANTY.**

Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you. This Limited Warranty gives you specific legal rights, and you may also have other rights, which vary from state to state.

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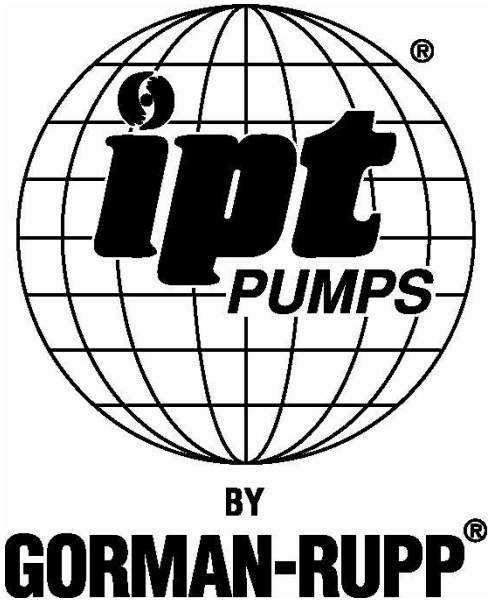


www.amtpump.com

SOLBERG®
Filtration • Separation • Silencing

Technical Data

Inlet Filter Silencers, Silencers

Applications & Equipment

- Industrial & Severe Duty
- Blowers - Side Channel & Roots (P.D.)
- Breathers
- Fuel Cells
- Piston Compressors
- Screw Compressors
- Centrifugal Compressors
- Hydraulic Breathers – fine filtration
- Engines
- Fans
- Vacuum Pumps & Systems
- Construction\Contractor Industry
- Medical
- Pneumatic Conveying
- Waste Water Aeration
- Sparging
- Factory Air
- Vacuum Vent Breathers
- Cement Processing
- Power Plants
- Centralized Air Intakes

Identification

Standard Solberg assemblies should have an identification label/nameplate that gives the following information:

- Assembly Model #
- Replacement Element #

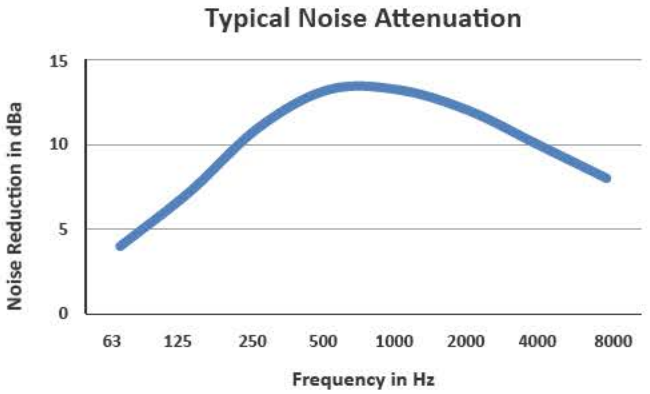
The part number designates the filter type, the element configuration and housing connection size. For example, the following part number identifies the filter as being an "FS" design filter with a "275™" element, "P" prefilter and 3" MPT connection size.

FS-275P-300

- 300 — Connection Size and Type
- 275P — Replacement Element Part Number
- FS — Filter Type

Typical Noise Attenuation

See chart for typical noise attenuation for filter silencers. It may vary due to the wide range of applications, installations, and machines.



Rev: US0621K

Choosing the Best Filter for Your Equipment

A. When the connection & airflow is known:

1. Select the appropriate connection style. (i.e.: MPT, Flange, NPSC, etc.)

a. Verify assembly SCFM (flow) rating. Compare with your required airflow.

(Note: Assembly flow ratings are based on 6,000 FPM or 30m/sec for a given connection size to achieve low pressure drop performance. When required flow exceeds assembly flow rating, the pressure drop through the outlet connection will increase. In such cases select by element SCFM (flow) rating.)

b. Verify that the flow rating matches connection size; skip to "C. Selecting Elements".

B. When the connection size is unknown, flexible, or the required flow rating exceeds assembly flow rating:

1. Match required flow rating with the element flow rating.
2. Choose related connection size.

C. Selecting Elements: The filter performance is influenced by the actual application duty and the equipment it is installed on. Regular maintenance checks and proper servicing is required.

Application Duty Descriptions:

Industrial Duty: clean workshop or clean outdoor environment - small element sizing is sufficient.

Severe Duty: dirty workshop, wastewater – medium to large element is recommended.

Extreme Duty: cement, steel making, plastics or dusty material conveying – largest element sizing is recommended.

1. Select media required by your application. Options include:

a. Standard media

1. Polyester: all purpose; withstands pulses, moisture, and oily air
2. Paper: mostly dry, smooth flow applications

b. Special Media: for a variety of micron levels and media types, see the "Filter Media Specifications" in the Replacement Element Section or contact Solberg.

2. Select element size by matching the element with the anticipated duty and upsize accordingly.

Filter Assembly Maintenance

Request the appropriate maintenance manual for more in-depth information from your Solberg representative or on our website: www.solbergmfg.com.

Element Maintenance

Solberg elements should be replaced once the pressure drop reaches 15-20" H_2O above the initial pressure drop of the installation. Cleaning the element is also an option.

Solberg recommends replacing dirty elements for optimal performance. Any damage which results from by-pass or additional pressure drop created by element cleaning is the sole responsibility of the operator.

Note: The overall performance of a filter element is altered once cleaned. The initial pressure drop after subsequent cleanings will be greater than the original, clean pressure drop of the element. After each cleaning, the pressure drop will continue to increase. Under all circumstances, the initial pressure drop of the element needs to be maintained at less than 15" H_2O.

If the pressure drop exceeds 20" H_2O at start-up; it should be replaced with a new element. With many types of equipment, the maximum pressure drop allowed will be dictated by the ability of the equipment to perform to its rated capacity. Under all circumstances, the operator should avoid exceeding the manufacturer's recommended maximum pressure drop for their specific equipment.

SOLBERG®
Filtration • Separation • Silencing

Stamped Steel Filter Silencers

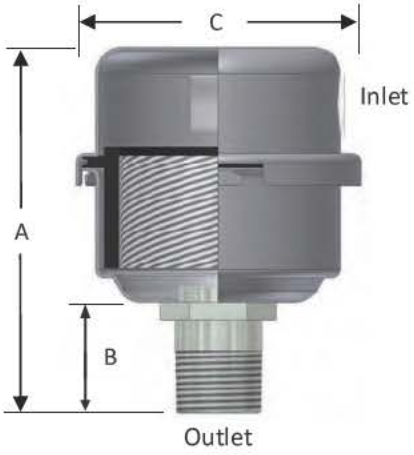
FS Series ¼" - 1"

Features

- High grade filter element with integrated gasket seal
- Fully drawn weatherhood
- Tubular silencing design: tube maximizes attenuation and air flow while minimizing pressure drop
- Corrosive resistant black powder coat carbon steel
- Ability to mount vertically and horizontally

Technical Specifications

- Temp (continuous): min -15°F (-26°C) max 220°F (104°C)
- Filter change out differential: 15-20" H_2O over initial ΔP
- Polyester: 99%+ removal efficiency standard to 10 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Pressure drop graphs available upon request



Options

- Various media for different environments
- Straight through configuration
- Various nonstandard finishes and connection styles

MPT Outlet	Assembly SCFM Rating	Assembly Part Number		Dimensions - inches			Suggested Service Ht. inches	No. of Silencing Tubes	Approx. Weight lbs	Replacement Element Part No.		Element SCFM Rating
		Polyester	Paper	A	B	C				Polyester	Paper	
¼"	4	FS-05-025	FS-04-025	2 ¾	11/16	2 ½	1	1	0.25	05™	04™	8
⅜"	8	FS-05-038	FS-04-038	2 ¾	11/16	2 ½	1	1	0.25	05™	04™	8
⅜"	8	FS-07-038	FS-06-038	3 9/16	11/16	3 ¼	2	1	0.50	07™	06™	12
½"	8	FS-05-050	FS-04-050	3	⅞	2 ½	1	1	0.25	05™	04™	8
½"	12	FS-07-050	FS-06-050	3 ¾	⅞	3 ¼	2	1	0.50	07™	06™	12
½"	12	FS-11-050	FS-10-050	4 3/16	⅞	4 ¼	2	1	1	11™	10™	35
¾"	12	FS-07-075	FS-06-075	4 ⅛	1 ¼	3 ¼	2	1	0.50	07™	06™	12
¾"	25	FS-11-075	FS-10-075	4 ½	1 ¼	4 3/16	2	1	1	11™	10™	35
1"	35	FS-11-100	FS-10-100	4 ½	1 ¼	4 3/16	2	1	1	11™	10™	35

See Filter Silencer Technical Data for sizing guidelines.

Rev: US0621K

SOLBERG®
Filtration • Separation • Silencing

Stamped Steel Filter Silencers

FS Series ½" - 6"

Features

- Fully drawn weatherhood
- Tubular silencing design - tubes are positioned to maximize attenuation and air flow while minimizing pressure drop
- Corrosive resistant gray powder coat carbon steel

Technical Specifications

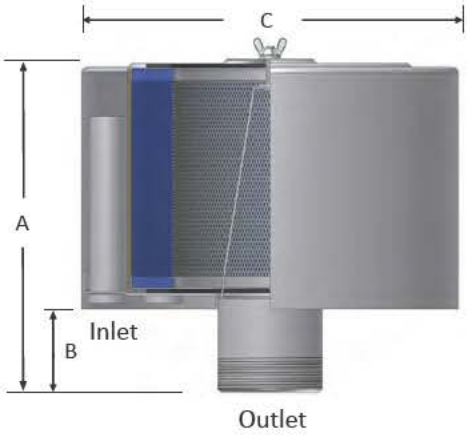
- Temp (continuous): min -15°F (-26°C) max 220°F (104°C)
- Filter change out differential: 15-20" H_2O over initial ΔP
- Pressure drop graphs available upon request
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron

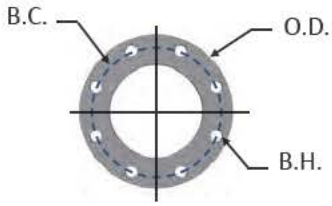
Options

ATEX Available

- Tap holes available
- Pressure drop indicator
- Various media for different environments
- Stainless steel construction
- Various nonstandard finishes and connection
- Side Access Silencer Filters (LQB Series) for s enclosures (select models)

Rev: US0621K





O.D.: Outside Diameter
B.C.: Bolt Circle
B.H.: Bolt Hole

125/150# Pattern Flange	Dimensions - inches			No. of Holes	Flange Thickness inches
	O.D.	B.C.	B.H.		
4"	9	7 ½	¾	8	0.5
5"	10	8 ½	⅞	8	0.5
6"	11	9 ½	⅞	8	0.5

MPT Outlet	Assembly SCFM Rating	Assembly Part Number		Dimensions - inches			Suggested Service ht. inches	No. of Silencing Tubes	Approx. Weight lbs.	Replacement Element Part No.		Element SCFM Rating
		Polyester	Paper	A	B	C				Polyester	Paper	
½"	10	FS-15-050	FS-14-050	3 7/16	1	6	3	1	2	15™	14™	35
¾"	25	FS-15-075	FS-14-075	4	1 ¼	6	3	2	2	15™	14™	35
1"	35	FS-15-100	FS-14-100	3 ¾	1 5/16	6	3	3	2	15™	14™	35
1"	55	FS-19P-100	FS-18P-100	6 ⅜	1 ¼	6	5	3	3	19P®	18P™	100
1 ¼"	70	FS-19P-125	FS-18P-125	6 ¾	1 ⅝	6	5	5	3	19P®	18P™	100
1 ½"	85	FS-19P-150	FS-18P-150	6 ¾	1 ⅝	6	5	5	4	19P®	18P™	100
2"	135	FS-31P-200	FS-30P-200	7 ½	2 ¼	10	5	5	8	31P™	30P™	195
2"	135	FS-231P-200	FS-230P-200	12	2 ⅜	10	10	5	14	231P™	230P™	300
2 ½"	195	FS-31P-250	FS-30P-250	7 ½	2 ½	10	5	5	8	31P™	30P™	195
2 ½"	195	FS-231P-250	FS-230P-250	12 ⅜	2 ⅝	10	10	9	15	231P™	230P™	300
3"	300	FS-231P-300	FS-230P-300	12 ¾	3 ⅛	10 ¼	10	9	15	231P™	230P™	300
3"	300	FS(12)-235P-300	FS(12)-234P-300	12 ⅞	2 11/16	12 ¼	10	3	29	235P™	234P™	570
3"	300	FS-275P-300	FS-274P-300	13	3	16	10	9	33	275P™	274P™	1100
4"	520	FS(12)-235P-400	FS(12)-234P-400	13 ⅞	3 11/16	12 ¼	10	6	29	235P™	234P™	570
4"	520	FS-275P-400	FS-274P-400	14	4	16	10	9	34	275P™	274P™	1100
5"	800	FS-245P-500	FS-244P-500	14	4	16	10	14	33	245P™	244P™	880
5"	800	FS-275P-500	FS-274P-500	14	4	16	10	14	36	275P™	274P™	1100
6"	1100	FS-275P-600	FS-274P-600	15	5 ⅛	16	10	18	38	275P™	274P™	1100

Flange Outlet	Assembly SCFM Rating	Assembly Part Number		Dimensions - inches			Suggested Service ht. inches	No. of Silencing Tubes	Approx. Weight lbs.	Replacement Element Part No.		Element SCFM Rating
		Polyester	Paper	A	B	C				Polyester	Paper	
4"	520	FS(12)-235P-400F	FS(12)-234P-400F	13 ⅞	3 11/16	12 ¼	10	6	32	235P™	234P™	570
4"	520	FS-275P-400F	FS-274P-400F	14	4	16	10	9	39	275P™	274P™	1100
5"	800	FS-245P-500F	FS-244P-500F	14	4	16	10	14	38	245P™	244P™	880
5"	800	FS-275P-500F	FS-274P-500F	14	4	16	10	14	41	275P™	274P™	1100
6"	1100	FS-275P-600F	FS-274P-600F	15	5 ⅛	16	10	18	42	275P™	274P™	1100

See Filter Silencer Technical Data for sizing guidelines.

Rev: US0621K

SOLBERG®
Filtration • Separation • Silencing

Big Boy Filter Silencers

FS Series 6" - 24"

Features

- Tubular silencing design - tubes are positioned to maximize attenuation and air flow while minimizing pressure drop
- Corrosive resistant gray powder coat carbon steel
- Low pressure drop center bracket & outlet pipe design

Technical Specifications

- Temp (continuous): min -15°F (-26°C) max 220°F (104°C)
- Filter change out differential: 15-20" H_2O over initial ΔP
- Pressure drop graphs available upon request
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron

Options

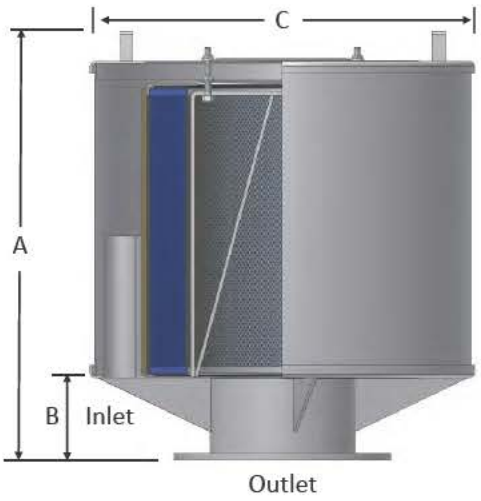
ATEX Available

- Tap holes available
- Pressure drop indicator
- Various media for different environments
- Stainless steel construction
- Various nonstandard finishes and connection styles
- Side Access Silencer Filters (LQB Series) for space restricted enclosures (select models)

Sumo Class Features

- Single barrel filter design allows for large airflows in space restricted work areas
- 16" to 24" flange connections available
- Designed for airflows up to 8000 SCFM

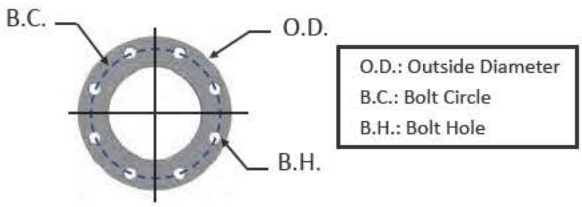
Rev: US0621K



Flange Outlet	Assembly SCFM Rating	Assembly Part Number		Dimensions - inches			Suggested Service ht. inches	No. of Silencing Tubes	Approx. Weight lbs	Replacement Element Part No.		Element SCFM Rating
		Polyester	Paper	A	B	C				Polyester	Paper	
6"	1100	FS-377P-600F	FS-376P-600F	22 11/16	5 1/4	21 7/8	15	6	95	377P™	376P™	1825
8"	1800	FS-377P-800F	FS-376P-800F	23 1/2	6	21 7/8	15	12	105	377P™	376P™	1825
8"	1800	FS-385P-800F	FS-384P-800F	24	6	28 5/16	15	12	125	385P™	384P™	3295
10"	3300	FS-385P-1000F	FS-384P-1000F	23 1/2	6	28 5/16	15	16	130	385P™	384P™	3295
10"	3300	FS-485P-1000F	FS-484P-1000F	31 1/2	6	28 5/16	22	16	143	485P™	484P™	4705
12"	4700	FS-485P-1200F	FS-484P-1200F	31 1/2	6	28 5/16	22	24	155	485P™	484P™	4705
12"	4700	FS-685P-1200F	FS-384P(2)-1200F	38 1/2	6	28 5/16	29	24	175	685P™	384P™(2)	6600
14"	6000	FS-485P(2)-1400F	FS-484P(2)-1400F	53 5/16	6	28 5/16	22	18	245	485P™(2)	484P™(2)	9410

Flange Outlet	Assembly SCFM Rating	Assembly Part Number		Dimensions - inches			Suggested Service ht. inches	Replacement Element Part No.	
		Polyester	Paper	A	B	C		Polyester	Paper
18"	5500	FS-391-1800F	FS-390-1800F	23 1/2	6	44	15	391	390
18"	8000	FS-491-1800F	FS-490-1800F	30 1/2	6	44	22	491	490
20"	8000	FS-491-2000F	FS-490-2000F	30 1/2	6	44	22	491	490
24"	8000	FS-491-2400F	FS-490-2400F	30 1/2	6	44	22	491	490

125/150# Pattern Flange	Dimensions - inches			No. of Holes	Flange Thickness inches
	O.D.	B.C.	B.H.		
6"	11	9 1/2	7/8	8	0.5
8"	13 1/2	11 3/4	7/8	8	0.5
10"	16	14 1/4	1	12	0.5
12"	19	17	1	12	0.5
14"	21	18 3/4	1 1/8	12	0.5
18"	25	22 3/4	1 1/4	16	0.5
20"	27 1/2	25	1 1/4	20	0.5
24"	32	29 1/2	1 3/8	20	1.18



See Filter Silencer Technical Data for sizing guidelines.

Rev: US0621K

Inlet Vacuum Filters

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.

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Maintenance Manual

Inlet Vacuum Filters

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**For Further Information Please Call:* *630-773-1363*

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Section A

INTRODUCTION

The purpose of this manual is instruction on the proper assembly and care of Solberg inlet vacuum filters.

WARNING

This manual must be read and thoroughly understood before using and caring for this vacuum 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 vacuum 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 vacuum 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 Vacuum Filters

All Solberg inlet vacuum 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 in Table 1.)

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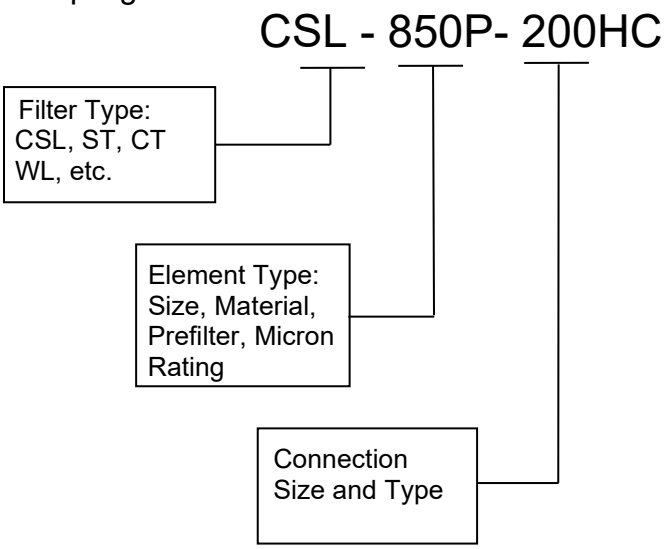
Fill in the actual nameplate data from your new Solberg inlet vacuum filter(s):

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 'CSL' design filter with an 850 element with prefilter and 2" NPSC half coupling connection:



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).

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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**	
Industrial Grade 2-micron **Paper**	Industrial Duty (clean, office/warehouse-like)	30 CFM/ft^2	(549m^3/h)/m^2
	Severe Duty (workshop, factory-like)	15 CFM/ft^2	(274.5m^3/h)/m^2
	Extreme Duty (Foundry, Construction-like)	10 CFM/ft^2	(183m^3/h)/m^2
Industrial Grade 5-micron **Polyester**	Industrial Duty (clean, office/warehouse-like)	65 CFM/ft^2	(1189.5m^3/h)/m^2
	Severe Duty (workshop, factory-like)	40 CFM/ft^2	(732m^3/h)/m^2
	Extreme Duty (Foundry, Construction-like)	25 CFM/ft^2	(457.5m^3/h)/m^2
Industrial Grade 1-micron **Polyester**	Severe Duty (Foundry, Construction-like)	25 CFM/ft^2	(457.5m^3/h)/m^2
Industrial Grade 0.3-micron **HEPA** Glass @ 99.97% Efficiency	Industrial Duty (Pre-filtered Applications)	9 CFM/ft^2	(164.7m^3/h)/m^2
	Severe Duty (workshop, factory-like)	7 CFM/ft^2	(128m^3/h)/m^2
	Extreme Duty (Foundry, Construction-like)	5 CFM/ft^2	(91.5m^3/h)/m^2

Table 2

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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_2O 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^3/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	
1/2"	10 CFM	17m^3/h	2 ½"	195 CFM	332m^3/h
3/4"	20 CFM	34m^3/h	3"	300 CFM	510m^3/h
1"	35 CFM	60m^3/h	4"	520 CFM	884m^3/h
1 ¼"	60 CFM	102m^3/h	5"	800 CFM	1360m^3/h
1 ½"	80 CFM	136m^3/h	6"	1,100 CFM	1870m^3/h
2"	135 CFM	230m^3/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_2O 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+% @ 10 micron

Table 4

Temperature Range: -15° to 385°F / -26° to 196°C
Filter Change-Out Differential**:** 10" to 15"/ 250-380mm H_2O Over Initial Delta P

Media	Micron Rating
"MX" & "MXD" Series – Nomex Cloth	99+% @ 10 micron

Table 5

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4. Element Cleaning - Inlet Filtration

Solberg elements should be cleaned or replaced, once the pressure drop reaches 10 to 15-inches water column (250 - 380mm WC) above the initial pressure drop of the installation.

The decision to clean the element rather than replace it is left to the discretion of the operator. Any damage which results from by-pass or additional pressure drop created by element cleaning is the sole responsibility of the operator.

WARNING

The overall performance of a filter element is altered once cleaned.

The initial pressure drop after cleaning will be greater than the original, clean pressure drop of the element.

After each subsequent cleaning, the initial pressure drop will continue to increase.

Under all circumstances, the initial pressure drop of the element needs to be maintained at less than 15-inches water column (380mm WC).

Cleaned elements that exceed 15-inches water column (380mm WC) at start-up should be replaced with new elements.

With many types of equipment, the maximum pressure drop allowed will be dictated by the ability of the equipment to perform to its rated capacity. Under all circumstances, the operator should avoid exceeding the manufacturer's recommended maximum pressure drop for their specific 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. The element should be replaced after a maximum of three cleanings.
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.

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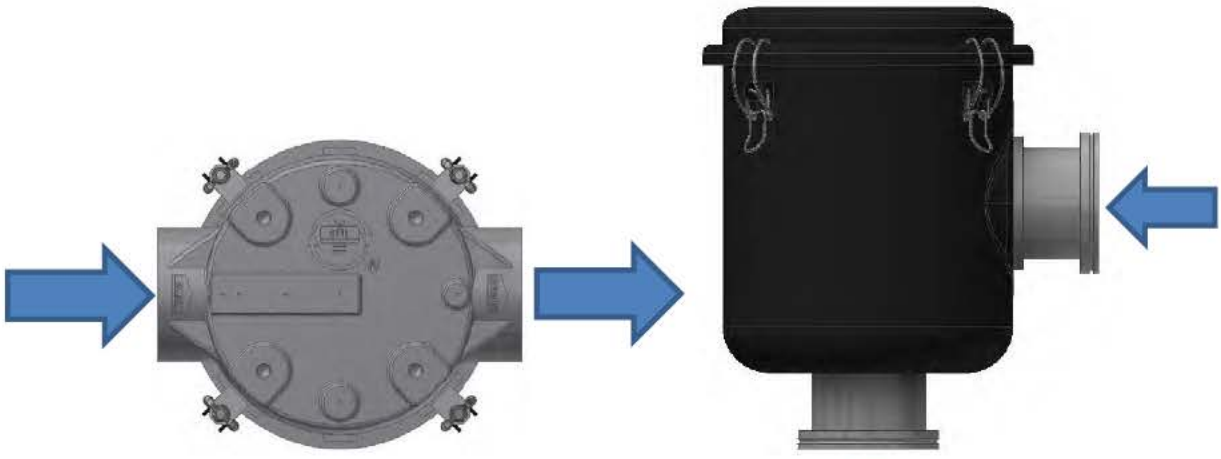
C. ***Polyurethane Prefilter***: The prefilter may be washed as a sponge or replaced to give the element a longer service life.
D. ***Epoxy Coated Wire Mesh and Stainless Steel Wire Mesh Elements***: Cleaning instructions similar to polyester, except mild solvents may be used.
E. ***Activated Carbon 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, wing nuts and washers can be supplied upon request.

5. Installation.

The drawing of the filter should be referenced before installation in order to ensure the unit is installed properly. The inlet and outlet should be identified on the unit as a label or as a physical design feature of the unit.



CT & ST Flow Direction

CSL & WL Flow Direction

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Section C

MAINTENANCE RECOMMENDATIONS

1. Pressure drop readings are recommended to have an effective vacuum 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_2O higher pressure drop above the initial reading.
2. Always check replacement cartridge gaskets to ensure they are adhered uniformly along the end caps during handling. If not, contact Solberg Manufacturing, Inc. immediately. Do not modify or change from Solberg specified parts!
3. Always check inlets/outlets, element base and its components when replacing element to ensure cleanliness. Wipe clean if necessary.
4. Operate only when a proper seal exists.

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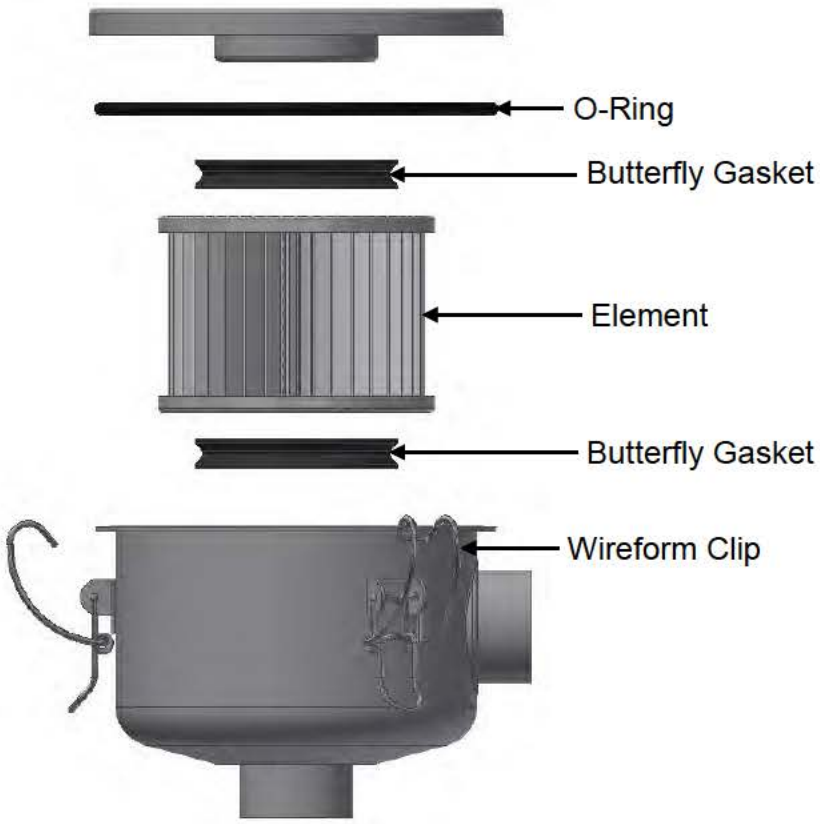
Section D

REPLACEMENT PARTS LIST

1. CSL Series



CSL Series 3/8" – 1 1/2" Compact "L" Style Vacuum Filter
Available Replacement Parts

Available Replacement Part by Product Number					
Product #	**Element****	**Prefilter**	**O-Ring**	**Butterfly Gasket**	**Wire-form Clip**
CSL-824-XXX	824	N/A	9240825	9110810	5080110+36
CSL-825-XXX	825	N/A	9240825	9110810	5080110+36
CSL-842-XXX	842	PF842	9241050	9110900	5080110+36
CSL-843-XXX	843	PF842	9241050	9110900	5080110+36
CSL-848-XXX	848	PF848	9241250	9111000	5080110+36
CSL-849-XXX	849	PF848	9241250	9111000	5080110+36

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

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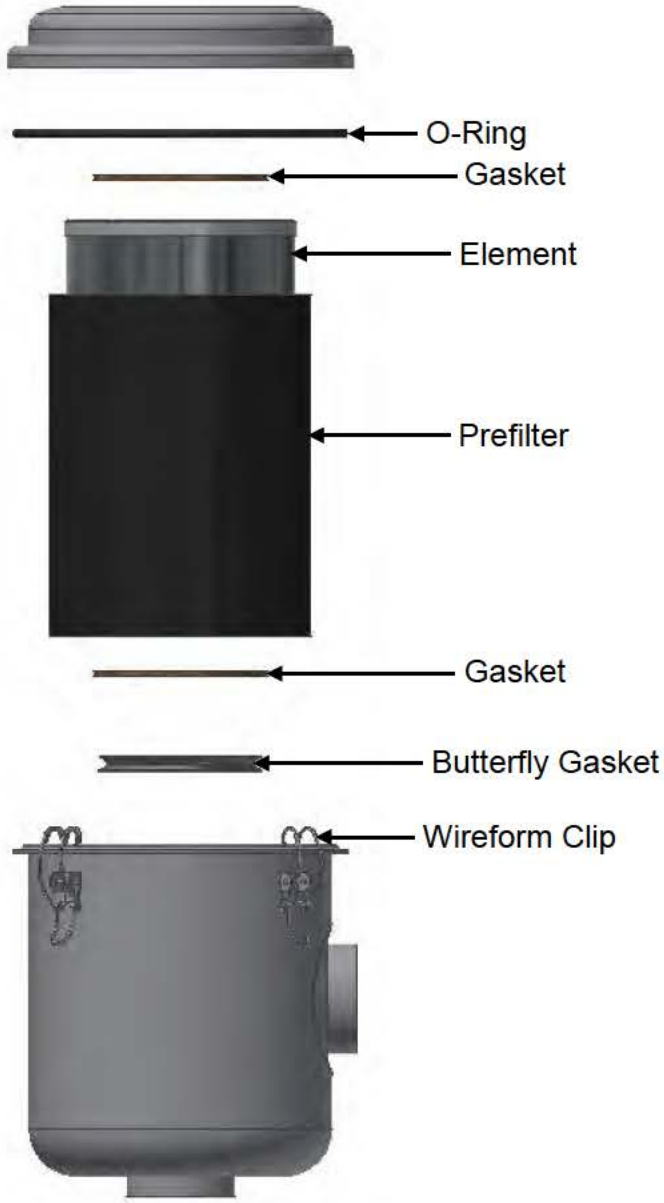

CSL Series 2" – 2 1/2" Compact "L" Style Vacuum Filter
Available Replacement Parts

Available Replacement Part by Product Number						
Product #	**Element****	**Prefilter**	**Gasket**	**O-Ring**	**Butterfly Gasket**	**Wire-form Clip**
CSL-850-XXX	850	PF850	9111200	9241400	9111100	5080110+36
CSL-851-XXX	851	PF850	9111200	9241400	9111100	5080110+36

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

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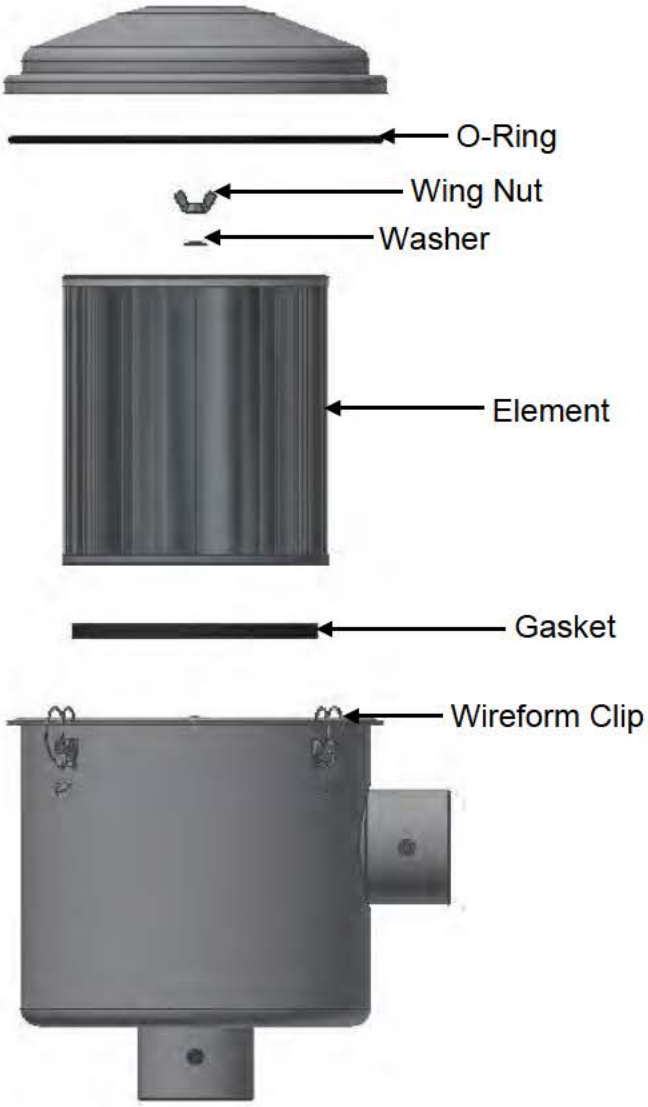

CSL Series 3" – 4" Compact "L" Style Vacuum Filter
Available Replacement Parts

Available Replacement Part by Product Number							
Product #	**Element****	**Prefilter**	**Gasket**	**Washer**	**Wing Nut**	**O-Ring**	**Wire-form Clip**
CSL-238-XXX	238	***	9110155	5020150	5030600	9241610	5080110+36
CSL-239-XXX	239	***	9110155	5020150	5030600	9241610	5080110+36

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*
***Consult Solberg Manufacturing regarding prefilter information for the 238 and 239 elements.*

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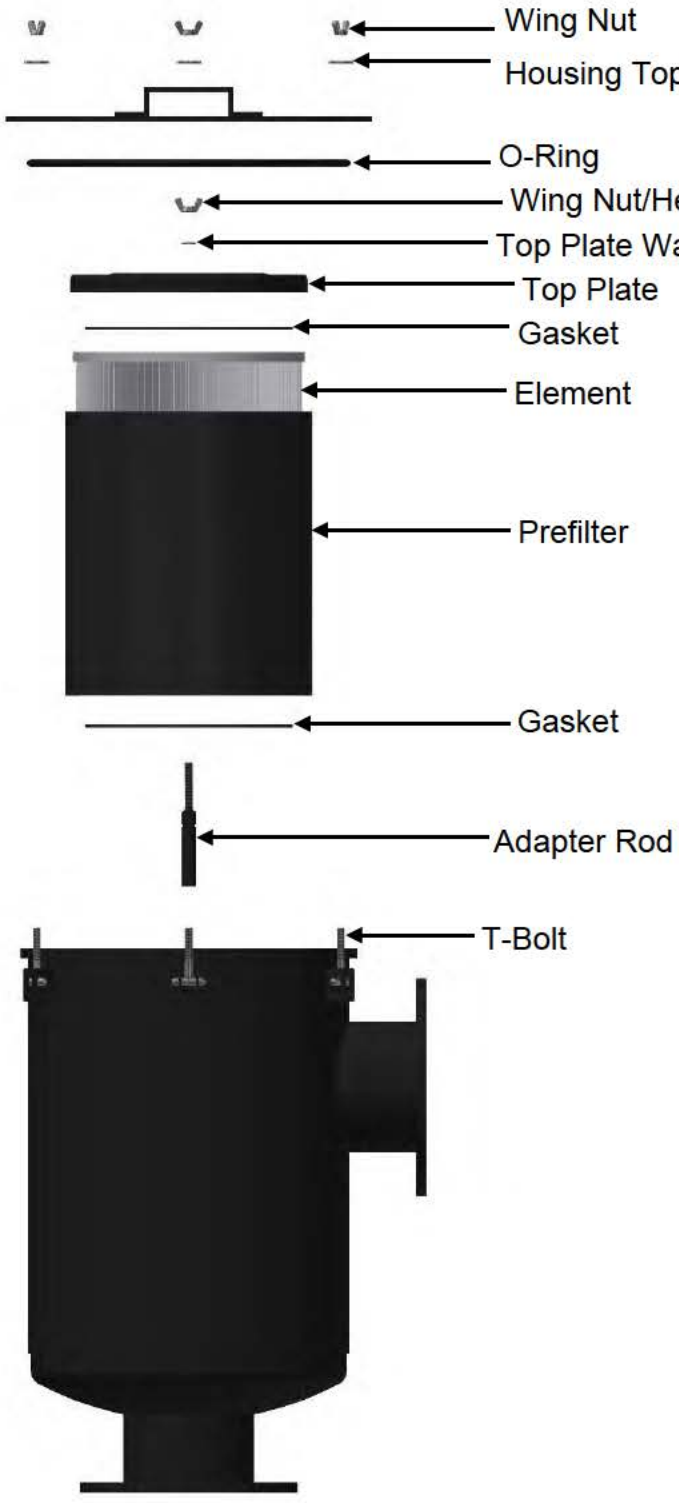

CSL Series "L" Style Vacuum Filter
Available Replacement Parts

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Available Replacement Part by Product Number					
Product #	**Element****	**Prefilter**	**Gasket**	**O-Ring**	**Top Plate**
CSL-234P-XXX	234	PF234	N/A	9241500	1030700+10
CSL-235P-XXX	235	PF234	N/A	9241500	1030700+10
CSL-334P-XXX	334	PF334	N/A	9241500	1030700+10
CSL-335P-XXX	335	PF334	N/A	9241500	1030700+10
CSL-244P-XXX	244	PF244	N/A	9241750	1030900+10
CSL-245P-XXX	245	PF244	9110100	9241750	1030900+10
CSL-274P-XXX	274	PF274	9110200	9241750	1031000+10
CSL-275P-XXX	275	PF274	9110200	9241750	1031000+10
CSL-374P-XXX	374	PF374	9110200	9241750	1031000+10
CSL-375P-XXX	375	PF374	9110200	9241750	1031000+10
CSL-376P-XXX	376	PF376	9110400	9241900	1031100+10
CSL-377P-XXX	377	PF376	9110400	9241900	1031100+10
CSL-384P(2)-XXX	384(2)	PF384	9110500	9242000	1031300+10
CSL-685P-XXX	685	PF684	9110500	9242000	1031300+10
CSL-484P(2)-XXX	484(2)	PF484	9110500	9242000	1031300+10
CSL-485P(2)-XXX	485(2)	PF484	9110500	9242000	1031300+10

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

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Available Replacement Part by Product Number Continued						
Product #	**Adapter Rod**	**Housing Top Washer**	**Top Plate Washer**	**Wing Nut**	**T-Bolt**	**Hex Nut**
CSL-234P-XXX	N/A	5040350	5020150	5030600	5011725	N/A
CSL-235P-XXX	N/A	5040350	5020150	5030600	5011725	N/A
CSL-334P-XXX	2511701+30	5040350	5020150	5030600	5011725	N/A
CSL-335P-XXX	2511701+30	5040350	5020150	5030600	5011725	N/A
CSL-244P-XXX	N/A	5040350	5020150	5030600	5011725	N/A
CSL-245P-XXX	N/A	5040350	5020150	5030600	5011725	N/A
CSL-274P-XXX	N/A	5040350	5020150	5030600	5011725	N/A
CSL-275P-XXX	N/A	5040350	5020150	5030600	5011725	N/A
CSL-374P-XXX	2511701+30	5040350	5020150	5030600	5011725	N/A
CSL-375P-XXX	2511701+30	5040350	5020150	5030600	5011725	N/A
CSL-376P-XXX	N/A	5040350	5020200	5030600	5011725	5011401
CSL-377P-XXX	N/A	5040350	5020200	5030600	5011725	5011401
CSL-384P(2)-XXX	N/A	5040350	5020200	5030600	5011725	5011401
CSL-685P-XXX	N/A	5040350	5020200	5030600	5011725	5011401
CSL-484P(2)-XXX	N/A	5040350	5020200	5030600	5011725	5011401
CSL-485P(2)-XXX	N/A	5040350	5020200	5030600	5011725	5011401

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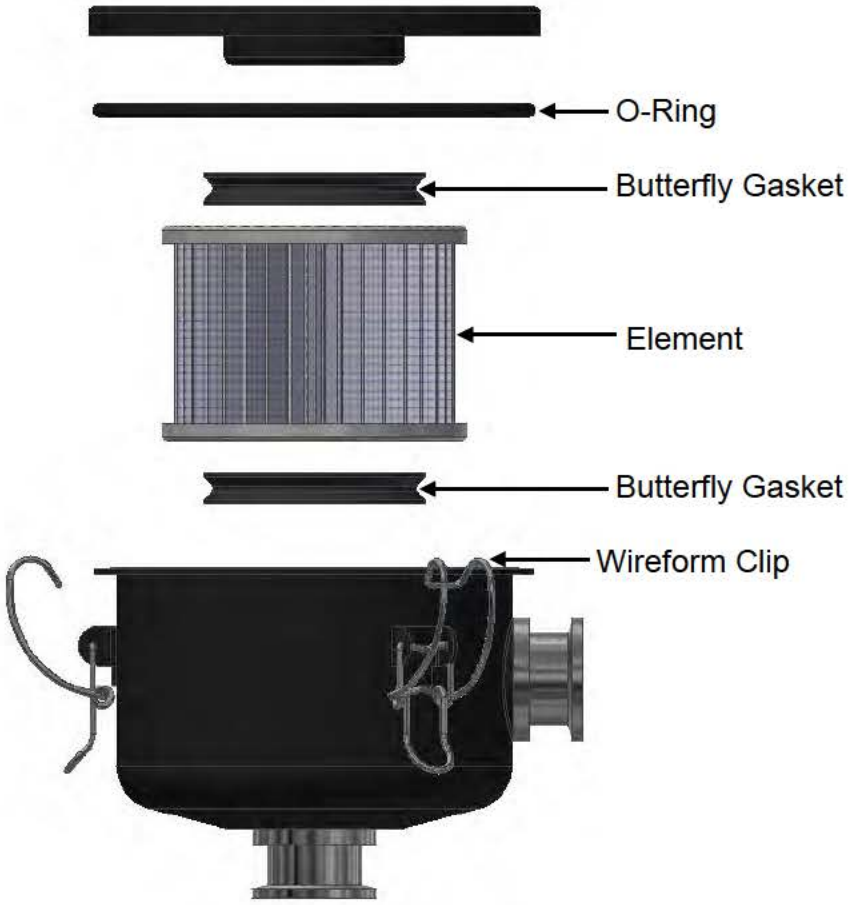
2. WL Series



WL Series 824, 825, 842, 843, 848, and 849 Compact "L" Style Vacuum Filter
Available Replacement Parts

Available Replacement Part by Product Number					
Product #	**Element****	**Prefilter**	**O-Ring**	**Butterfly Gasket**	**Wire-form Clip**
WL-824-XXX	824	N/A	9240825	9110810	5080110+36
WL-825-XXX	825	N/A	9240825	9110810	5080110+36
WL-842-XXX	842	PF842	9241050	9110900	5080110+36
WL-843-XXX	843	PF842	9241050	9110900	5080110+36
WL-848-XXX	848	PF848	9241250	9111000	5080110+36
WL-849-XXX	849	PF848	9241250	9111000	5080110+36

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

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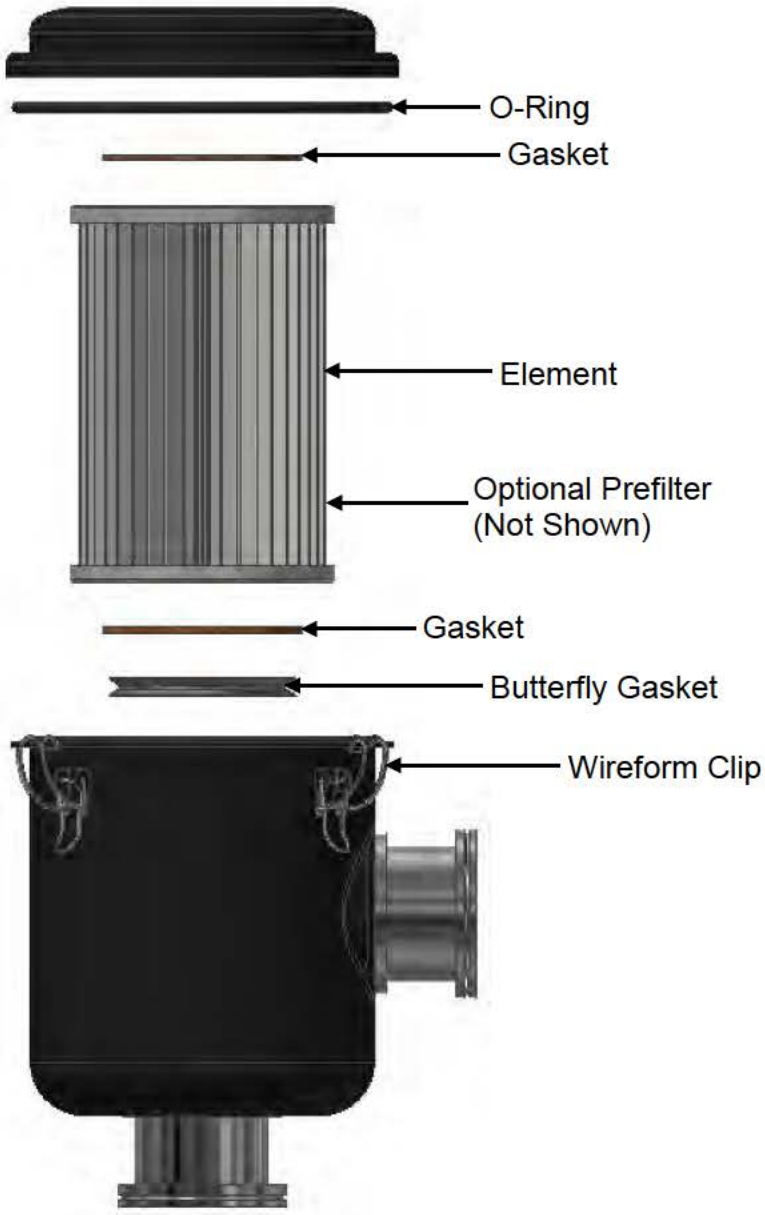

WL Series 850 & 851 Compact "L" Style Vacuum Filter
Available Replacement Parts

Available Replacement Part by Product Number						
Product #	**Element****	**Prefilter**	**Gasket**	**O-Ring**	**Butterfly Gasket**	**Wire-form Clip**
WL-850-XXX	850	PF850	9111200	9241400	9111100	5080110+36
WL-851-XXX	851	PF850	9111200	9241400	9111100	5080110+36

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

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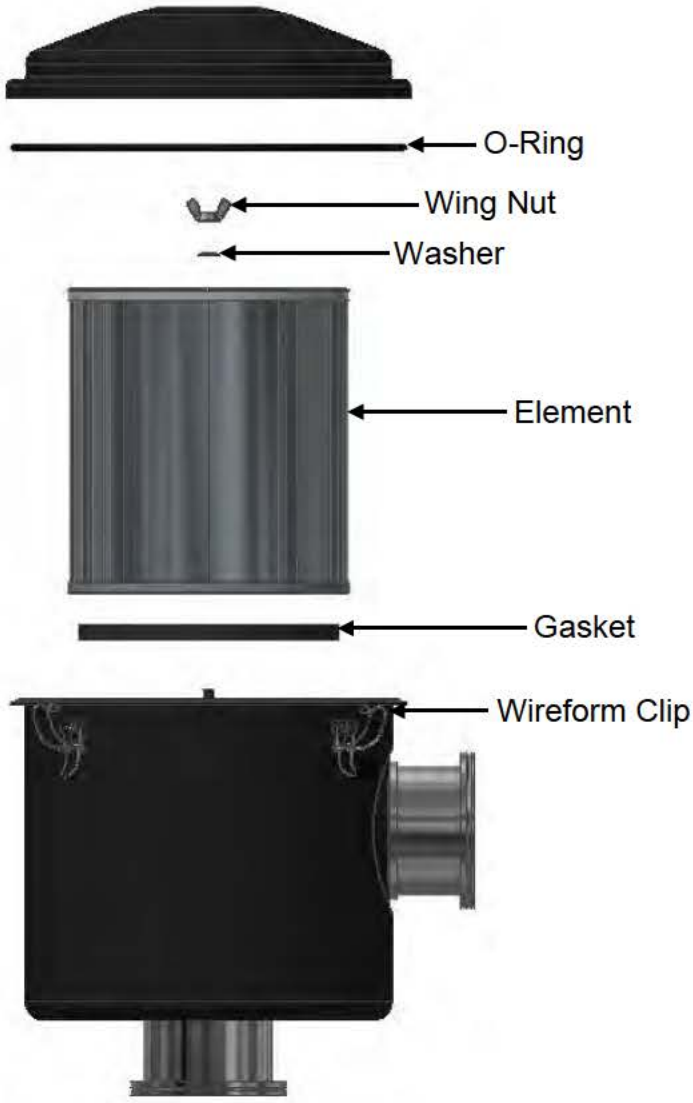

WL Series 238 & 239 Compact "L" Style Vacuum Filter
Available Replacement Parts

Available Replacement Part by Product Number							
Product #	**Element****	**Prefilter**	**Gasket**	**Washer**	**Wing Nut**	**O-Ring**	**Wire-form Clip**
WL-238-XXX	238	PF238	9110155	5020150	5030600	9241610	0003453+36
WL-239-XXX	239	PF238	9110155	5020150	5030600	9241610	0003453+36

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

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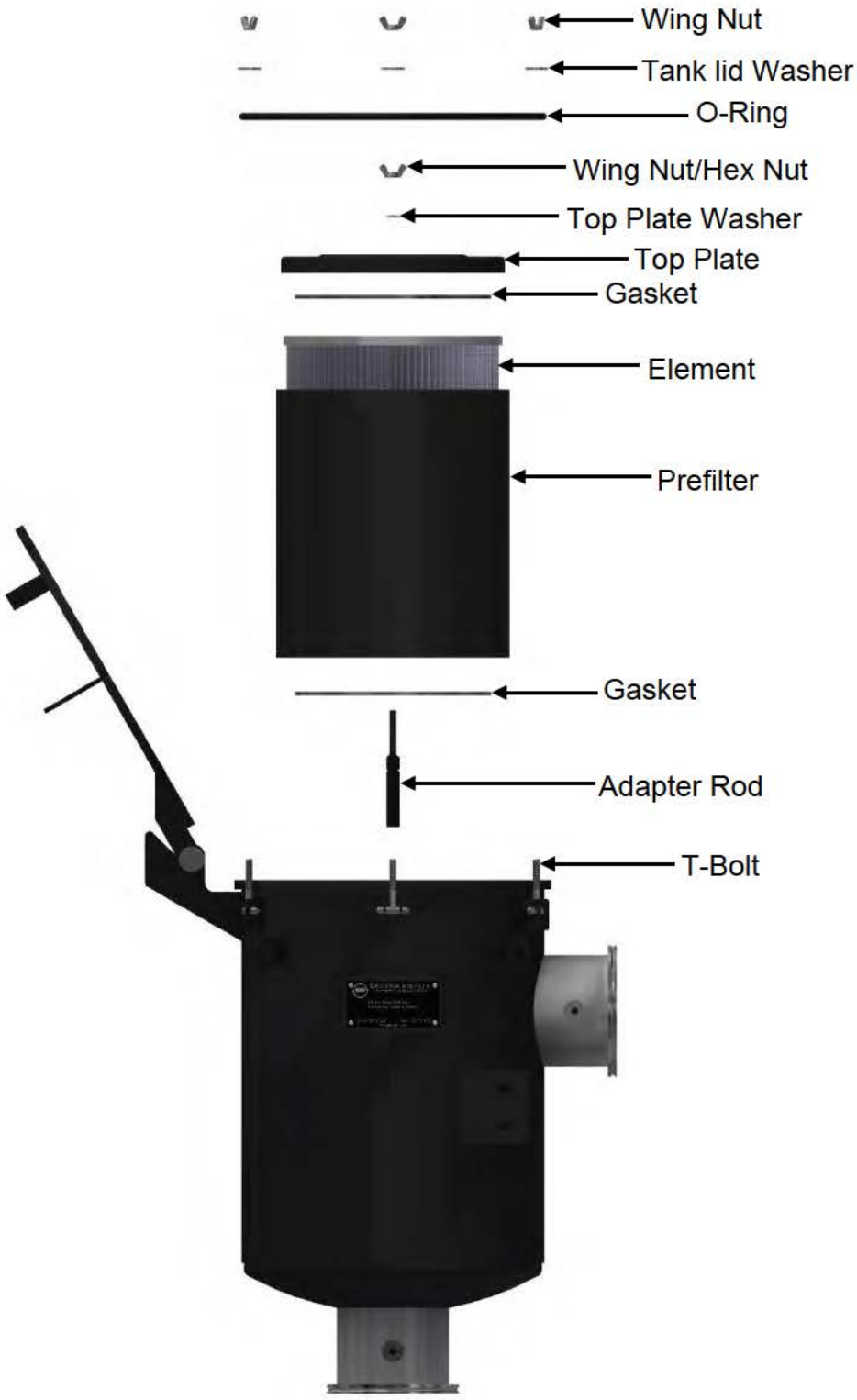

WL Series "L" Style Vacuum Filter
Available Replacement Parts

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Available Replacement Part by Product Number					
Product #	**Element****	**Prefilter**	**Gasket**	**O-Ring**	**Top Plate**
WL-274P-XXX	274	PF274	9110200	9241750	1031000+10
WL-275P-XXX	275	PF274	9110200	9241750	1031000+10
WL-374P-XXX	374	PF374	9110200	9241750	1031000+10
WL-375P-XXX	375	PF374	9110200	9241750	1031000+10
WL-376P-XXX	376	PF376	9110400	9241900	1031100+10
WL-377P-XXX	377	PF376	9110400	9241900	1031100+10
WL-384P-XXX	384	PF384	9110500	9242000	1031300+10
WL-385P-XXX	385	PF384	9110500	9242000	1031300+10

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

Available Replacement Part by Product Number Continued						
Product #	**Adapter Rod**	**Tank lid Washer**	**Top Plate Washer**	**Wing Nut**	**T-Bolt**	**Hex Nut**
WL-274P-XXX	N/A	5040350	5020150	5030600	5011725	N/A
WL-275P-XXX	N/A	5040350	5020150	5030600	5011725	N/A
WL-374P-XXX	2511701+30	5040350	5020150	5030600	5011725	N/A
WL-375P-XXX	2511701+30	5040350	5020150	5030600	5011725	N/A
WL-376P-XXX	N/A	5040350	5020200	5030600	5011702	5011401
WL-377P-XXX	N/A	5040350	5020200	5030600	5011702	5011401
WL-384P-XXX	N/A	5040350	5020200	5030600	5011725	5011401
WL-385P-XXX	N/A	5040350	5020200	5030600	5011725	5011401

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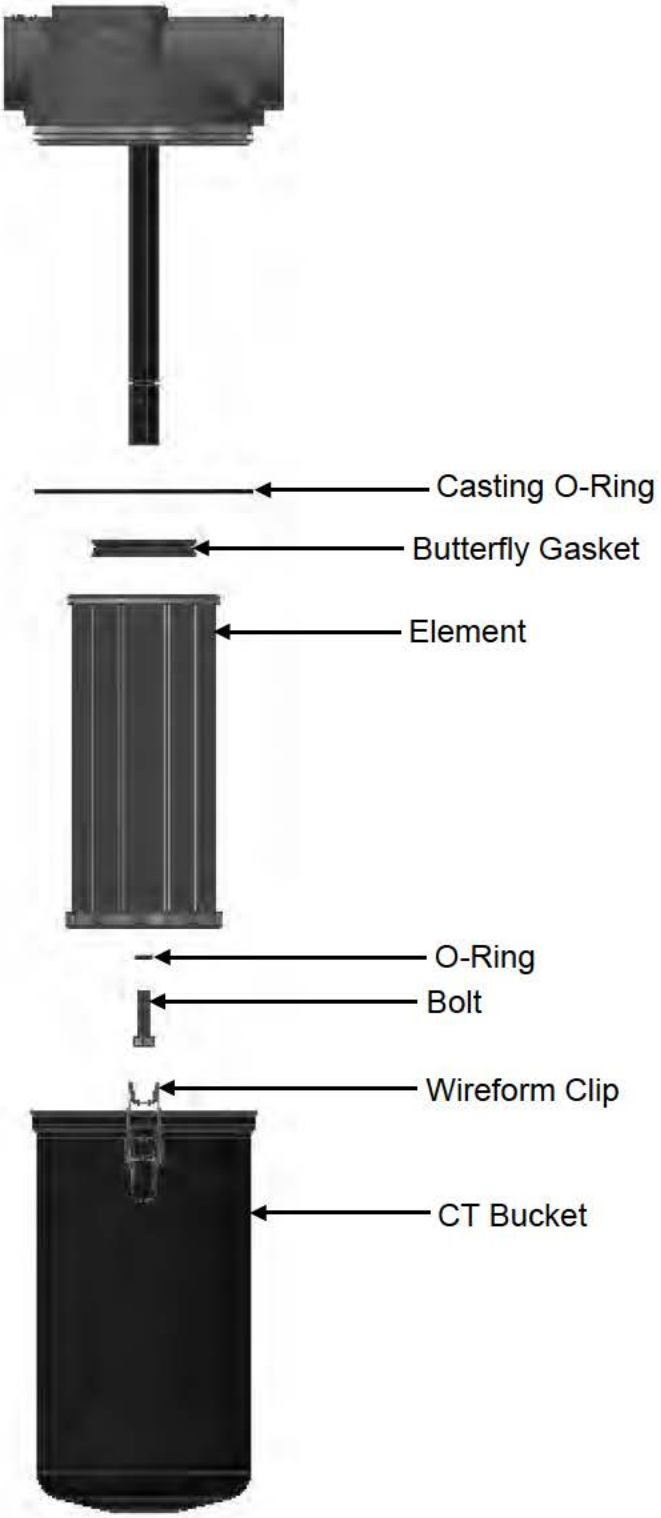
3. CT Series



CT Series 1" – 1 1/2" "T" Style Vacuum Filter
Available Replacement Parts

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Available Replacement Part by Product Number				
Product #	**Element****	**Butterfly Gasket**	**O-Ring**	**Bolt**
CT-896-XXX	896	9110900	9240030	5060250
CT-897-XXX	897	9110900	9240030	5060250

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

Available Replacement Part by Product Number			
Product #	**Casting O-Ring**	**CT Bucket**	**Wireform Clip**
CT-896-XXX	9262K375	300-1050241+10	5080110+36
CT-897-XXX	9262K375	300-1050241+10	5080110+36

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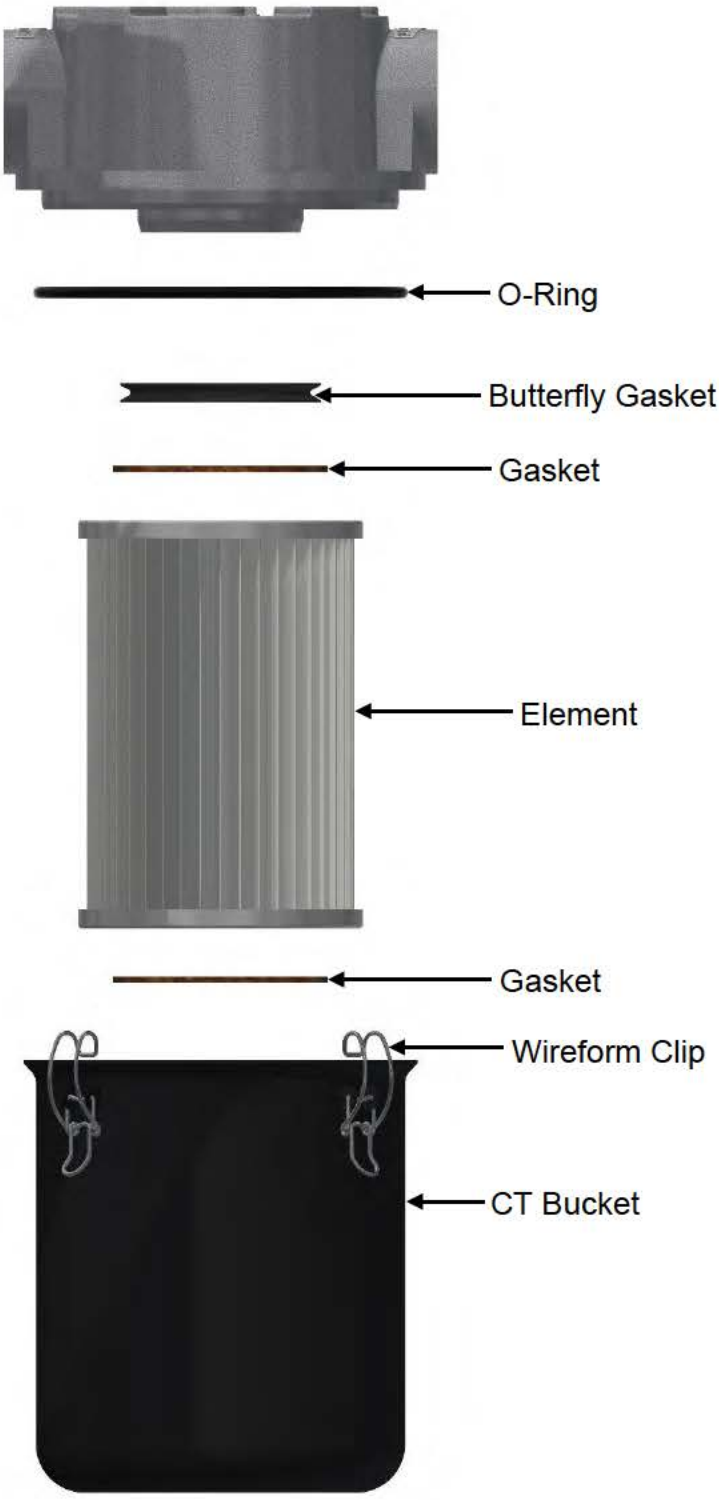

CT Series 2" – 2 1/2" "T" Style Vacuum Filter
Available Replacement Parts

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Available Replacement Part by Product Number			
Product #	**Element****	**Gasket**	**Butterfly Gasket**
CT-850-XXX	850	9111200	9111100
CT-851-XXX	851	9111200	9111100

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

Available Replacement Part by Product Number			
Product #	**Casting O-Ring**	**CT Bucket**	**Wireform Clip**
CT-850-XXX	9241260	200-1050800+10	5080110+36
CT-851-XXX	9241260	200-1050800+10	5080110+36

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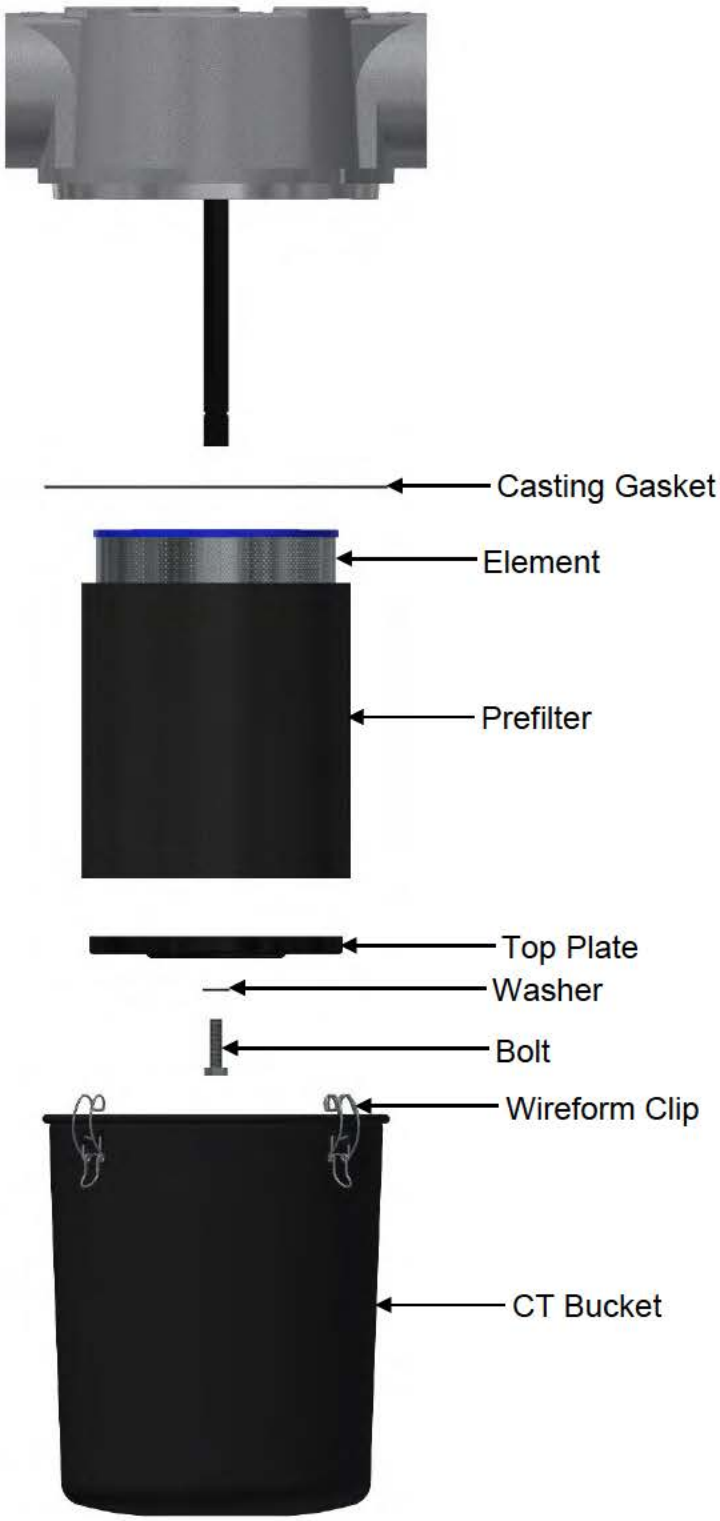

CT Series 3" – 4" "T" Style Vacuum Filter
Available Replacement Parts

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Available Replacement Part by Product Number				
Product #	**Element****	**Prefilter**	**Top Plate**	**Washer**
CT-234-XXX	234	PF234	1030700+10	5020150
CT-235-XXX	235	PF234	1030700+10	5020150

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

Available Replacement Part by Product Number				
Product #	**Bolt**	**Casting Gasket**	**CT Bucket**	**Wireform Clip**
CT-234-XXX	5011330	9112900	200-1051800+10	5080110+36
CT-235-XXX	5011330	9112900	200-1051800+10	5080110+36

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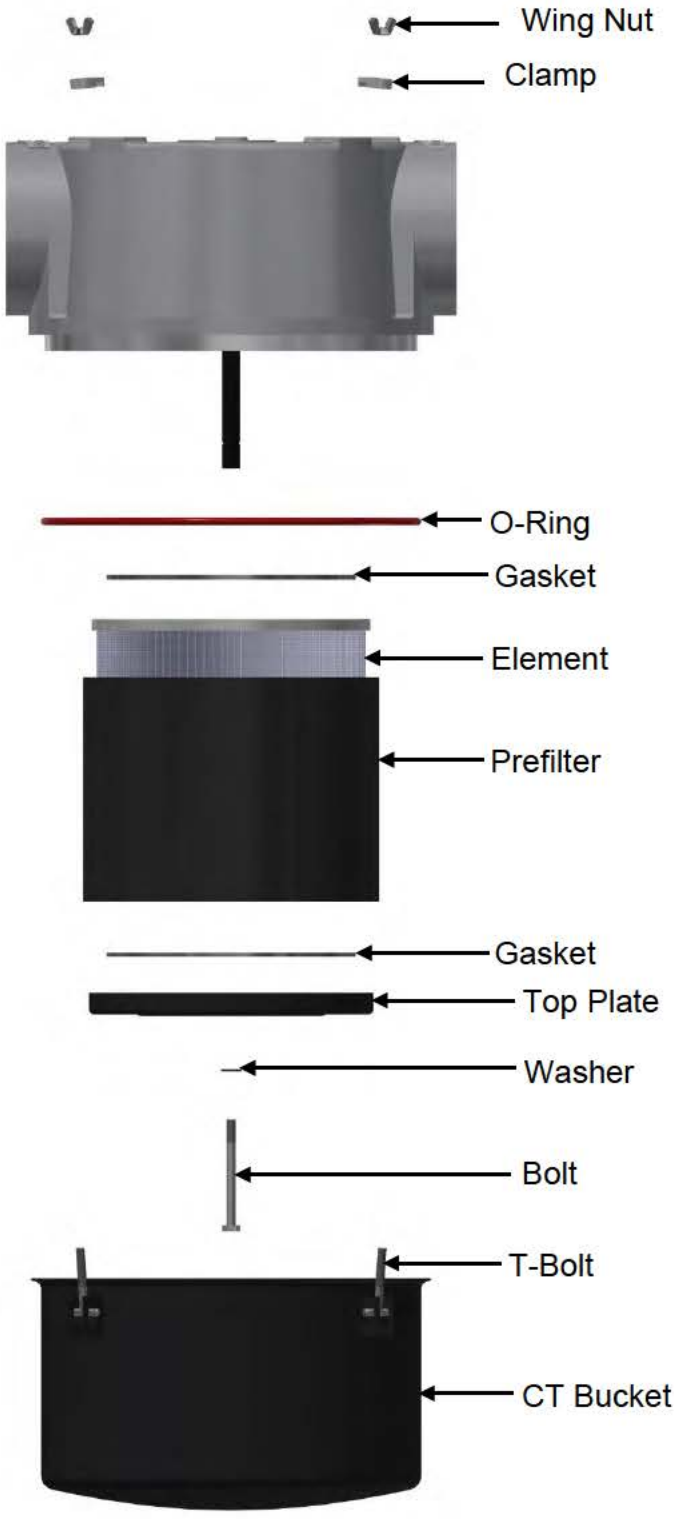

CT Series 6" "T" Style Vacuum Filter
Available Replacement Parts

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Available Replacement Part by Product Number						
Product #	**Element****	**Prefilter**	**Gasket**	**Top Plate**	**Washer**	**Bolt**
CT-274-XXX	274	PF274	9110200	1031000+10	5020150	5070285
CT-275-XXX	275	PF274	9110200	1031000+10	5020150	5070285

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

Available Replacement Part by Product Number					
Product #	**O-Ring**	**CT Bucket**	**T-Bolt**	**Clamp**	**Wing Nut**
CT-274-XXX	9241700	200-1071725-1+10	5011725	5081500	5030600
CT-275-XXX	9241700	200-1071725-1+10	5011725	5081500	5030600

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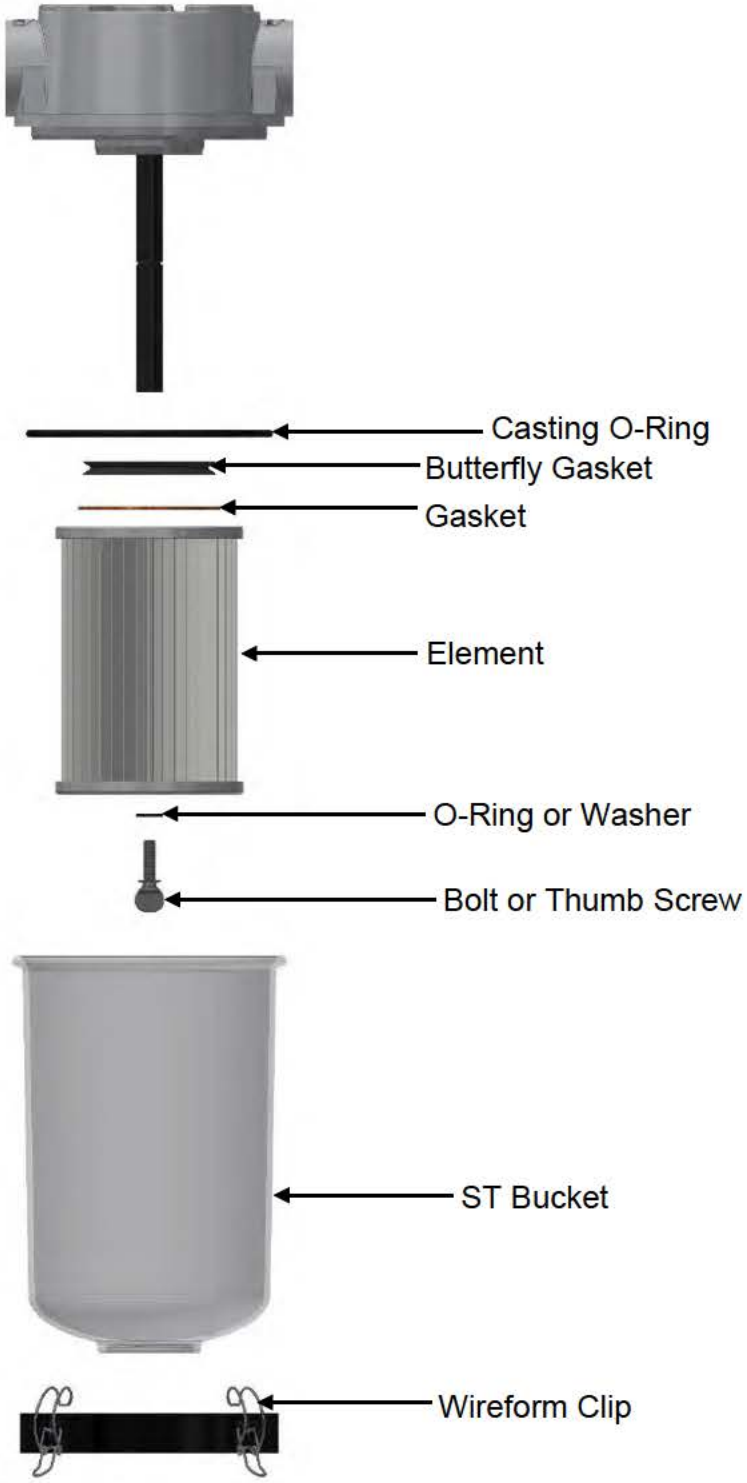
4. ST Series



ST Series 1" – 2 1/2" "T" Style Vacuum Filter
Available Replacement Parts

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Available Replacement Part by Product Number					
Product #	**Element****	**Prefilter**	**Butterfly Gasket**	**O-Ring or Washer**	**Bolt or Thumb Screw**
ST-896-XXX	896	PF896	9110900	9240030	5060250
ST-897-XXX	897	PF896	9110900	9240030	5060250
ST-850/1-XXX	850/1	PF850	9111100	5010445	5060300
ST-851/1-XXX	851/1	PF850	9111100	5010445	5060300

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

Available Replacement Part by Product Number				
Product #	**Gasket**	**Casting O-Ring**	**ST Bucket**	**Wireform Clip**
ST-896-XXX	N/A	9262K375	1050250	5080110+36
ST-897-XXX	N/A	9262K375	1050250	5080110+36
ST-850/1-XXX	9111200	9241260	1050810	5080110+36
ST-851/1-XXX	9111200	9241260	1050810	5080110+36

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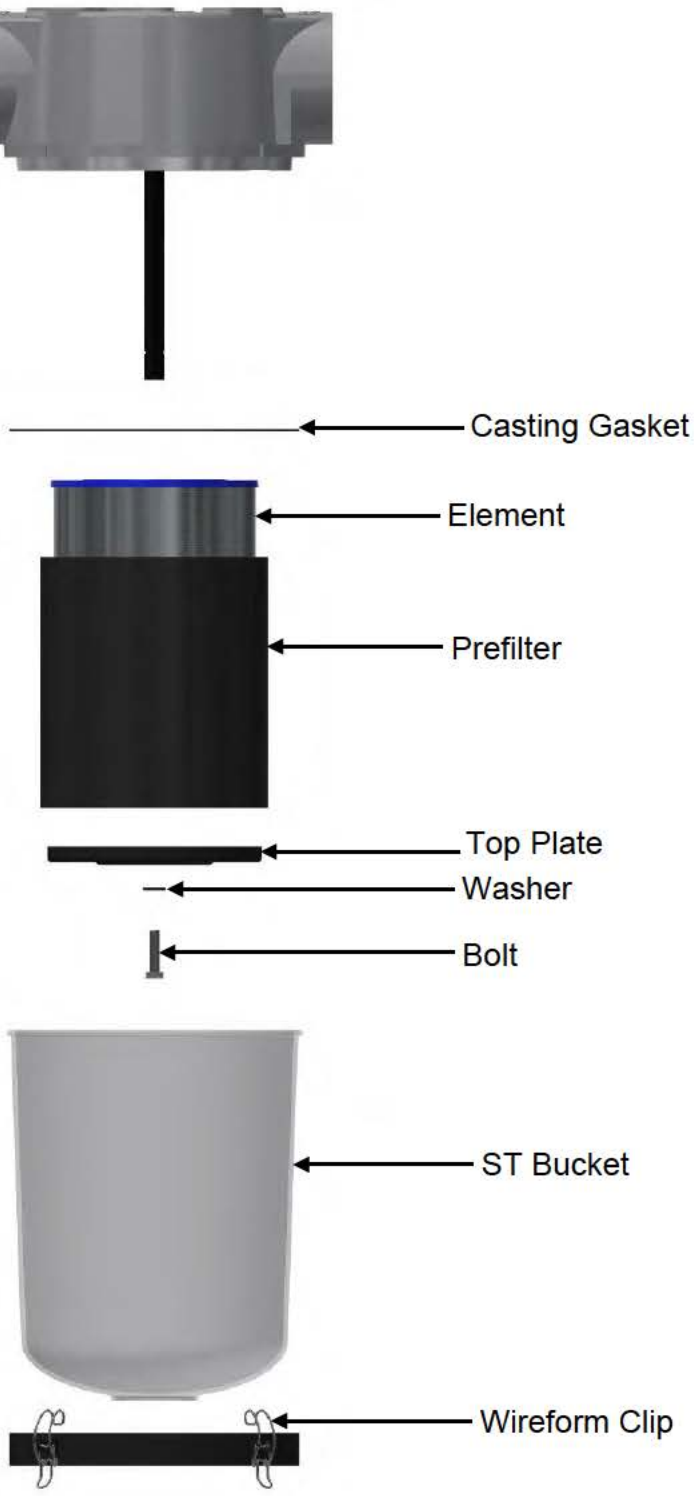

ST Series 3" – 4" "T" Style Vacuum Filter
Available Replacement Parts

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Available Replacement Part by Product Number				
Product #	**Element****	**Prefilter**	**Top Plate**	**Washer**
ST-234-XXX	234	PF234	1030700+10	5020150
ST-235-XXX	235	PF234	1030700+10	5020150

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

Available Replacement Part by Product Number				
Product #	**Bolt**	**Casting Gasket**	**ST Bucket**	**Wireform Clip**
ST-234-XXX	5011330	9112900	1051850	5080110+36
ST-235-XXX	5011330	9112900	1051850	5080110+36

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Intake Filters

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.

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Maintenance Manual

Intake Filters

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Section A

INTRODUCTION

The purpose of this manual is instruction on the proper assembly and care of Solberg intake 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 intake 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 intake 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 Intake Filters

All Solberg intake 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 in Table 1.)

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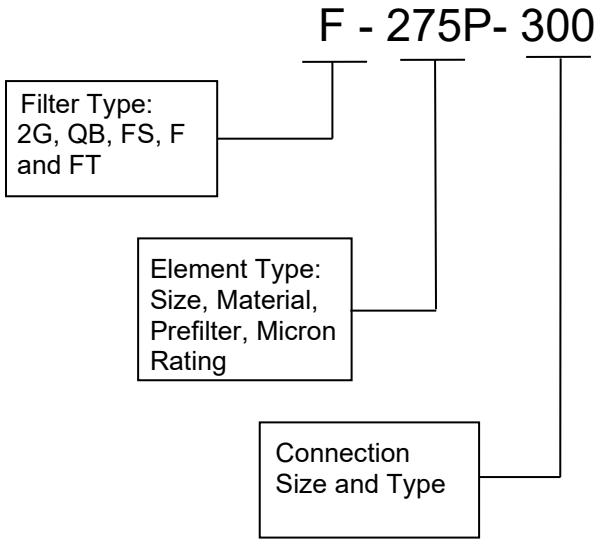
Fill in the actual nameplate data from your new Solberg intake filter(s):

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 'F' design filter with a 275 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).

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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**	
Industrial Grade 2-micron **Paper**	Industrial Duty (clean, office/warehouse-like)	30 CFM/ft^2	(549m^3/h)/m^2
	Severe Duty (workshop, factory-like)	15 CFM/ft^2	(274.5m^3/h)/m^2
	Extreme Duty (Foundry, Construction-like)	10 CFM/ft^2	(183m^3/h)/m^2
Industrial Grade 5-micron **Polyester**	Industrial Duty (clean, office/warehouse-like)	65 CFM/ft^2	(1189.5m^3/h)/m^2
	Severe Duty (workshop, factory-like)	40 CFM/ft^2	(732m^3/h)/m^2
	Extreme Duty (Foundry, Construction-like)	25 CFM/ft^2	(457.5m^3/h)/m^2
Industrial Grade 1-micron **Polyester**	Severe Duty (Foundry, Construction-like)	25 CFM/ft^2	(457.5m^3/h)/m^2
Industrial Grade 0.3-micron **HEPA** Glass @ 99.97% Efficiency	Industrial Duty (Pre-filtered Applications)	9 CFM/ft^2	(164.7m^3/h)/m^2
	Severe Duty (workshop, factory-like)	7 CFM/ft^2	(128m^3/h)/m^2
	Extreme Duty (Foundry, Construction-like)	5 CFM/ft^2	(91.5m^3/h)/m^2

Table 2

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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_2O 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^3/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	
1/2"	10 CFM	17m^3/h	4"	520 CFM	884m^3/h
3/4"	20 CFM	34m^3/h	5"	800 CFM	1360m^3/h
1"	35 CFM	60m^3/h	6"	1,100 CFM	1870m^3/h
1 ¼"	60 CFM	102m^3/h	8"	1,800 CFM	3060m^3/h
1 ½"	80 CFM	136m^3/h	10"	3,300 CFM	5610m^3/h
2"	135 CFM	230m^3/h	12"	4,700 CFM	7990m^3/h
2 ½"	195 CFM	332m^3/h	14"	6,000 CFM	10200m^3/h
3"	300 CFM	510m^3/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_2O 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+% @ 10 micron

Table 4

Temperature Range: -15° to 385°F / -26° to 196°C
Filter Change-Out Differential**:** 10” to 15”/ 250-380mm H_2O Over Initial Delta P

Media	Micron Rating
“MX” & “MXD” Series – Nomex Cloth	99+% @ 10 micron

Table 5

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4. Element Cleaning - Inlet Filtration

Solberg elements should be cleaned or replaced, once the pressure drop reaches 10 to 15-inches water column (250 - 380mm WC) above the initial pressure drop of the installation.

The decision to clean the element rather than replace it is left to the discretion of the operator. Any damage which results from by-pass or additional pressure drop created by element cleaning is the sole responsibility of the operator.

WARNING

The overall performance of a filter element is altered once cleaned.

The initial pressure drop after cleaning will be greater than the original, clean pressure drop of the element.

After each subsequent cleaning, the initial pressure drop will continue to increase.

Under all circumstances, the initial pressure drop of the element needs to be maintained at less than 15-inches water column (380mm WC).

Cleaned elements that exceed 15-inches water column (380mm WC) at start-up should be replaced with new elements.

With many types of equipment, the maximum pressure drop allowed will be dictated by the ability of the equipment to perform to its rated capacity. Under all circumstances, the operator should avoid exceeding the manufacturer's recommended maximum pressure drop for their specific 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. The element should be replaced after a maximum of three cleanings.
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.

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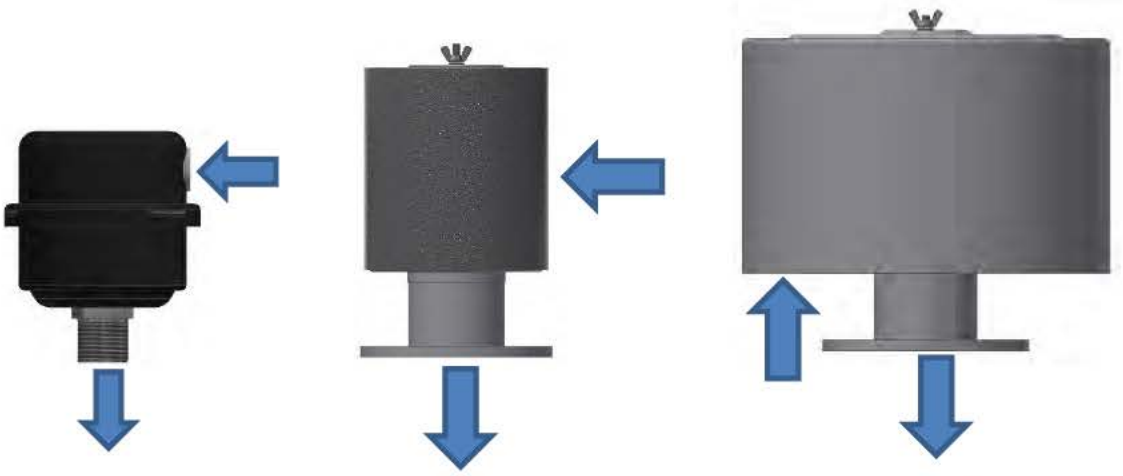
C. ***Polyurethane Prefilter***: The prefilter may be washed as a sponge or replaced to give the element a longer service life.
D. ***Epoxy Coated Wire Mesh and Stainless Steel Wire Mesh Elements***: Cleaning instructions similar to polyester, except mild solvents may be used.
E. ***Activated Carbon 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, wing nuts and washers can be supplied upon request.

5. Installation.

The drawing of the filter should be referenced before installation in order to ensure the unit is installed properly. The inlet and outlet should be identified on the unit as a label or as a physical design feature of the unit.



Mini FS Flow Direction FT Flow Direction F, FS, QB, & 2G Flow Direction

Section C

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_2O above drop above the initial reading. Refer to page 4 for initial values.
2. Always check inlets/outlets, element base and its components when replacing element to ensure cleanliness. Wipe clean if necessary.
3. Operate only when a proper seal exists.

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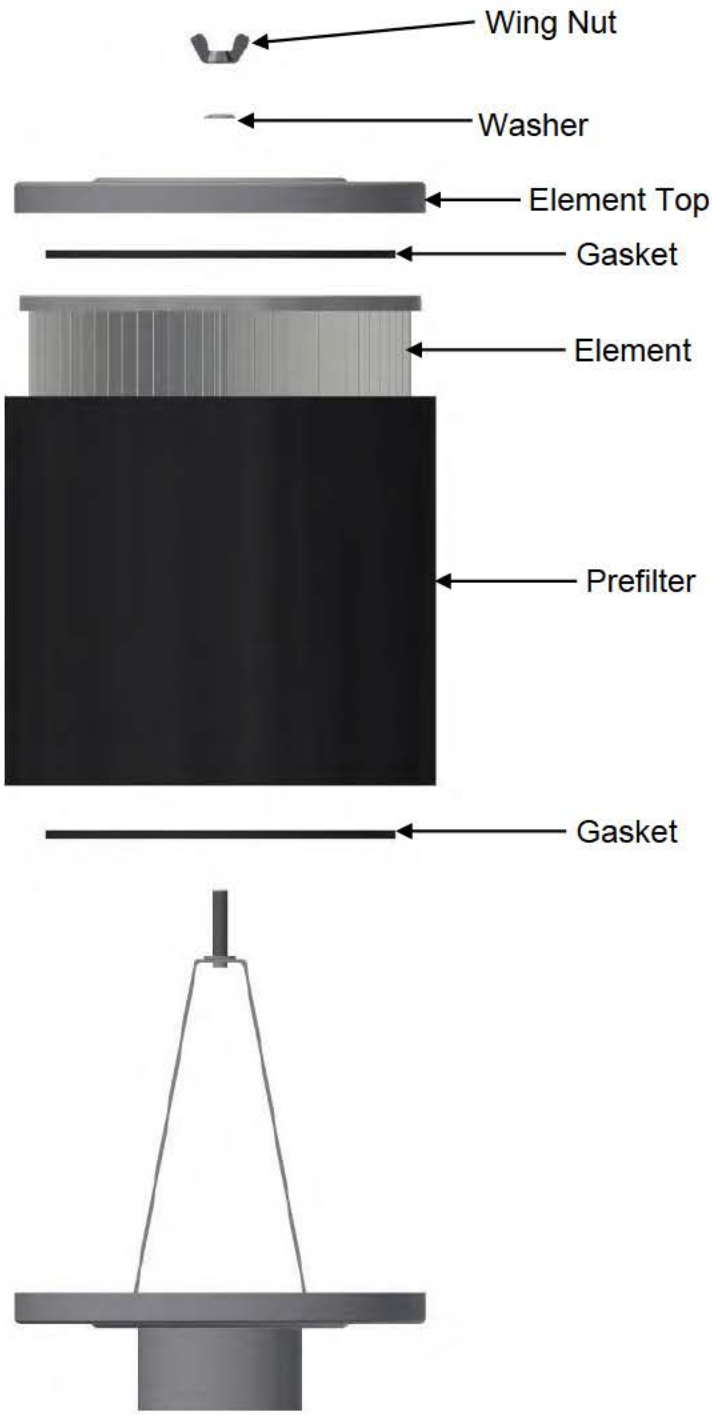
Section D

REPLACEMENT PARTS LIST

1. FT SERIES



FT Series Compact Exposed Inlet Filter
Available Replacement Parts

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

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Available Replacement Part by Product Number						
Product #	**Element****	**Prefilter**	**Gasket**	**Housing top**	**Washer**	**Wing Nut**
FT-14P-XXX	14	9010200	N/A	1030400+01	5040200	5030500
FT-15P-XXX	15	9010200	N/A	1030400+01	5040200	5030500
FT-18P-XXX	18	9010400	N/A	1030400+01	5040200	5030500
FT-19P-XXX	19	9010400	N/A	1030400+01	5040200	5030500
FT-30P-XXX	30	9010500	N/A	1030500+01	5040200	5030500
FT-31P-XXX	31	9010500	N/A	1030500+01	5040200	5030500
FT-230P-XXX	230	9010700	N/A	1030500+01	5020150	5030600
FT-231P-XXX	231	9010700	N/A	1030500+01	5020150	5030600
FT-234P-XXX	234	9010800	N/A	1030700+01	5020150	5030600
FT-235P-XXX	235	9010800	N/A	1030700+01	5020150	5030600
FT-244P-XXX	244	9010900	N/A	1030900+01	5020150	5030600
FT-245P-XXX	245	9010900	9110100	1030900+01	5020150	5030600
FT-274P-XXX	274	9011000	9110200	1031000+01	5020150	5030600
FT-275P-XXX	275	9011000	9110200	1031000+01	5020150	5030600

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

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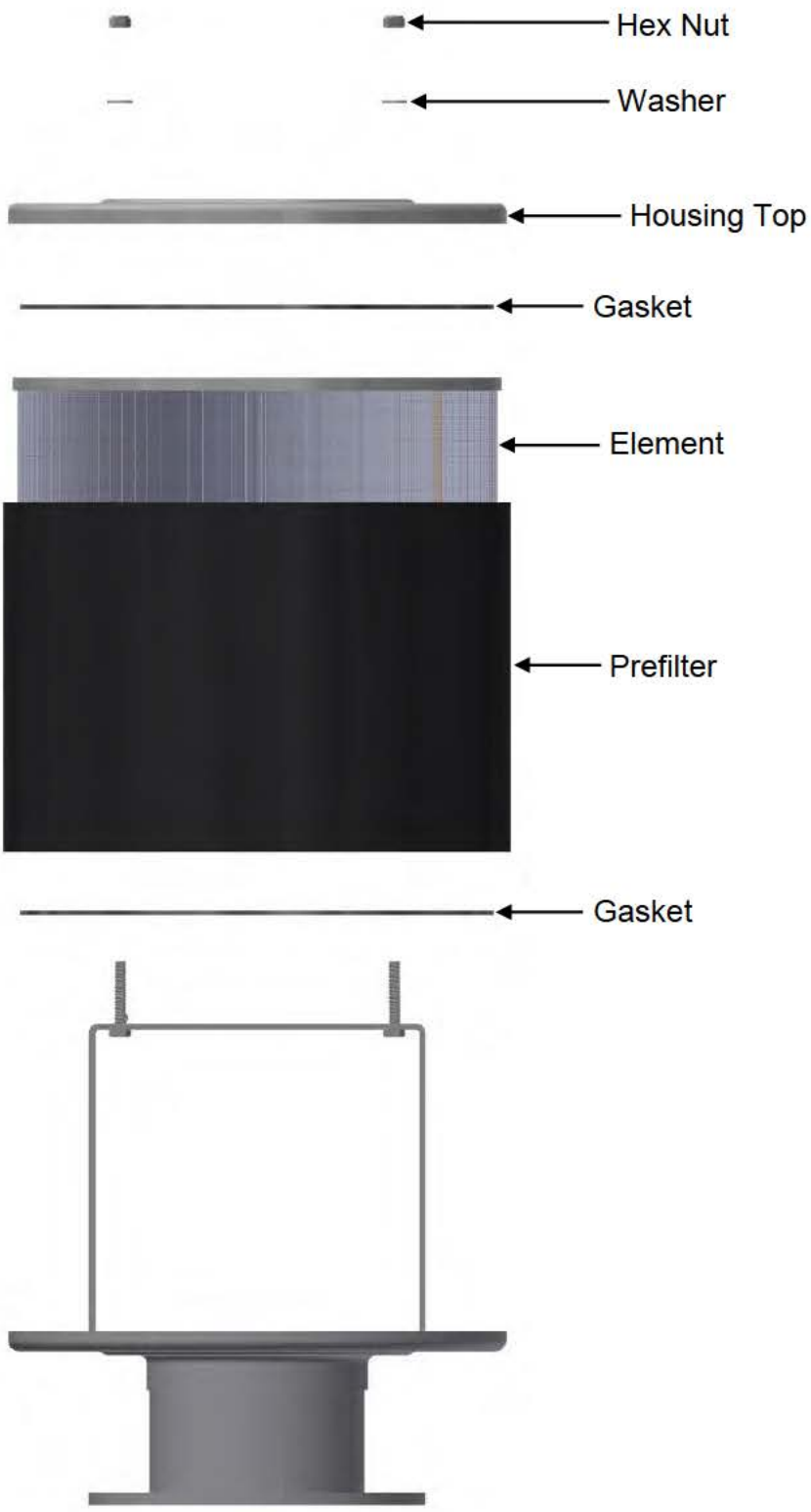

FT Series Big Boy Exposed Inlet Filter
Available Replacement Part

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Available Replacement Part by Product Number						
Product #	**Element****	**Prefilter**	**Gasket**	**Element Top**	**Washer**	**Hex Nut**
FT-376P-XXX	376	9011200	9110400	1031100+01	5020200	5011401
FT-377P-XXX	377	9011200	9110400	1031100+01	5020200	5011401
FT-384P-XXX	384	9011300	9110500	1031300+01	5020200	5011401
FT-385P-XXX	385	9011300	9110500	1031300+01	5020200	5011401
FT-484P-XXX	484	9011400	9110500	1031300+01	5020200	5011401
FT-485P-XXX	485	9011400	9110500	1031300+01	5020200	5011401
FT-384P(2)-XXX	384(2)	9011300	9110500	1031300+01	5020200	5011401
FT-685P-XXX	685	9011500	9110500	1031300+01	5020200	5011401

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

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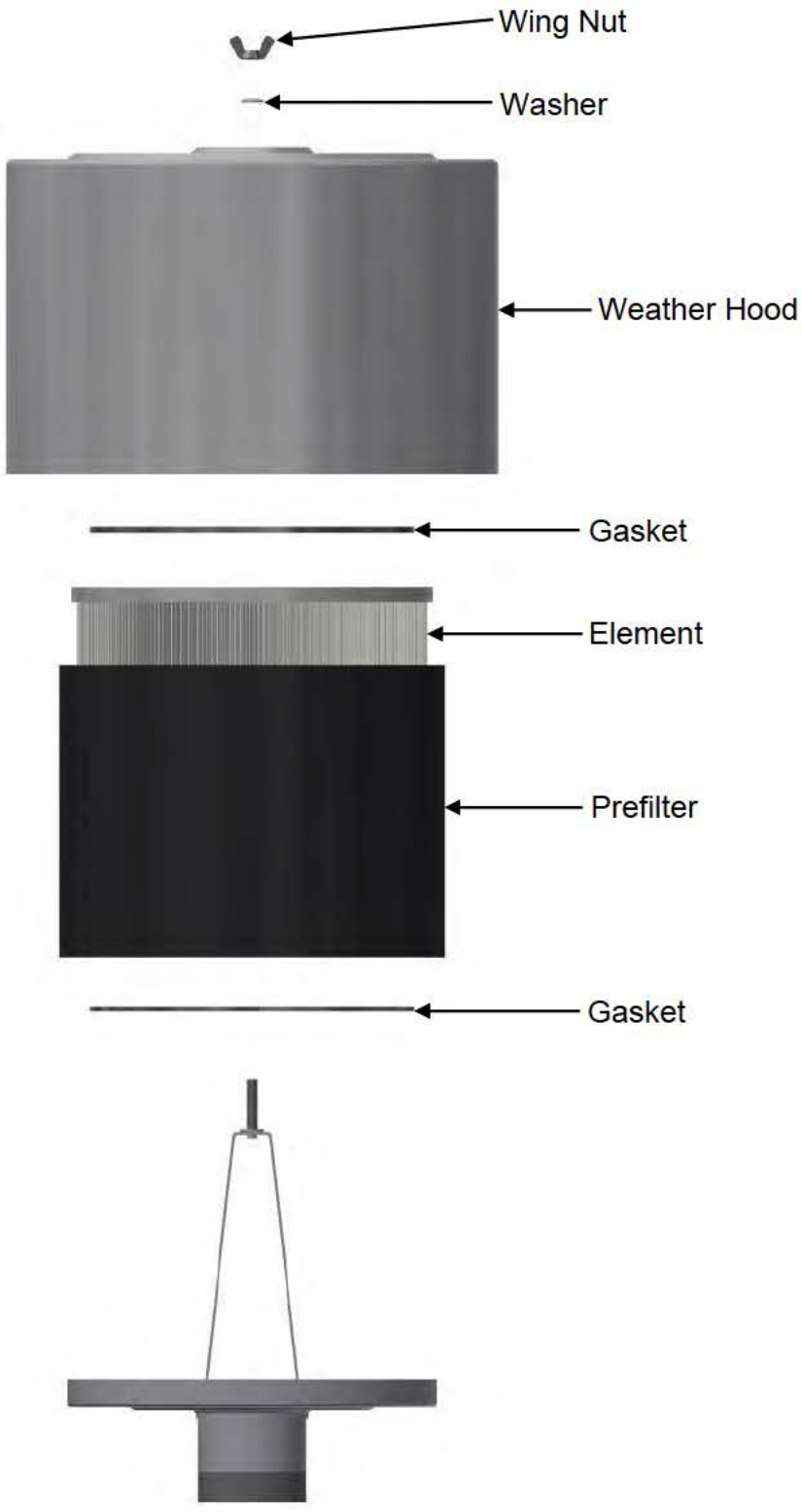
2. F SERIES



F Series Compact Inlet Filter
Available Replacement Parts

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Available Replacement Part by Product Number						
Product #	**Element****	**Prefilter**	**Gasket**	**Weather Hood**	**Washer**	**Wing Nut**
F-14P-XXX	14	9010200	N/A	1050300+01	5040200	5030500
F-15P-XXX	15	9010200	N/A	1050300+01	5040200	5030500
F-18P-XXX	18	9010400	N/A	1050500+01	5040200	5030500
F-19P-XXX	19	9010400	N/A	1050500+01	5040200	5030500
F-30P-XXX	30	9010500	N/A	1050700+01	5040200	5030500
F-31P-XXX	31	9010500	N/A	1050700+01	5040200	5030500
F-230P-XXX	230	9010700	N/A	1051000+01	5020150	5030600
F-231P-XXX	231	9010700	N/A	1051000+01	5020150	5030600
F-234P-XXX	234	9010800	N/A	1051000+01	5020150	5030600
F-235P-XXX	235	9010800	N/A	1051000+01	5020150	5030600
F-244P-XXX	244	9010900	N/A	0004822+01	5020150	5030600
F-245P-XXX	245	9010900	9110100	0004822+01	5020150	5030600
F-274P-XXX	274	9011000	9110200	1051200+01	5020150	5030600
F-275P-XXX	275	9011000	9110200	1051200+01	5020150	5030600

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

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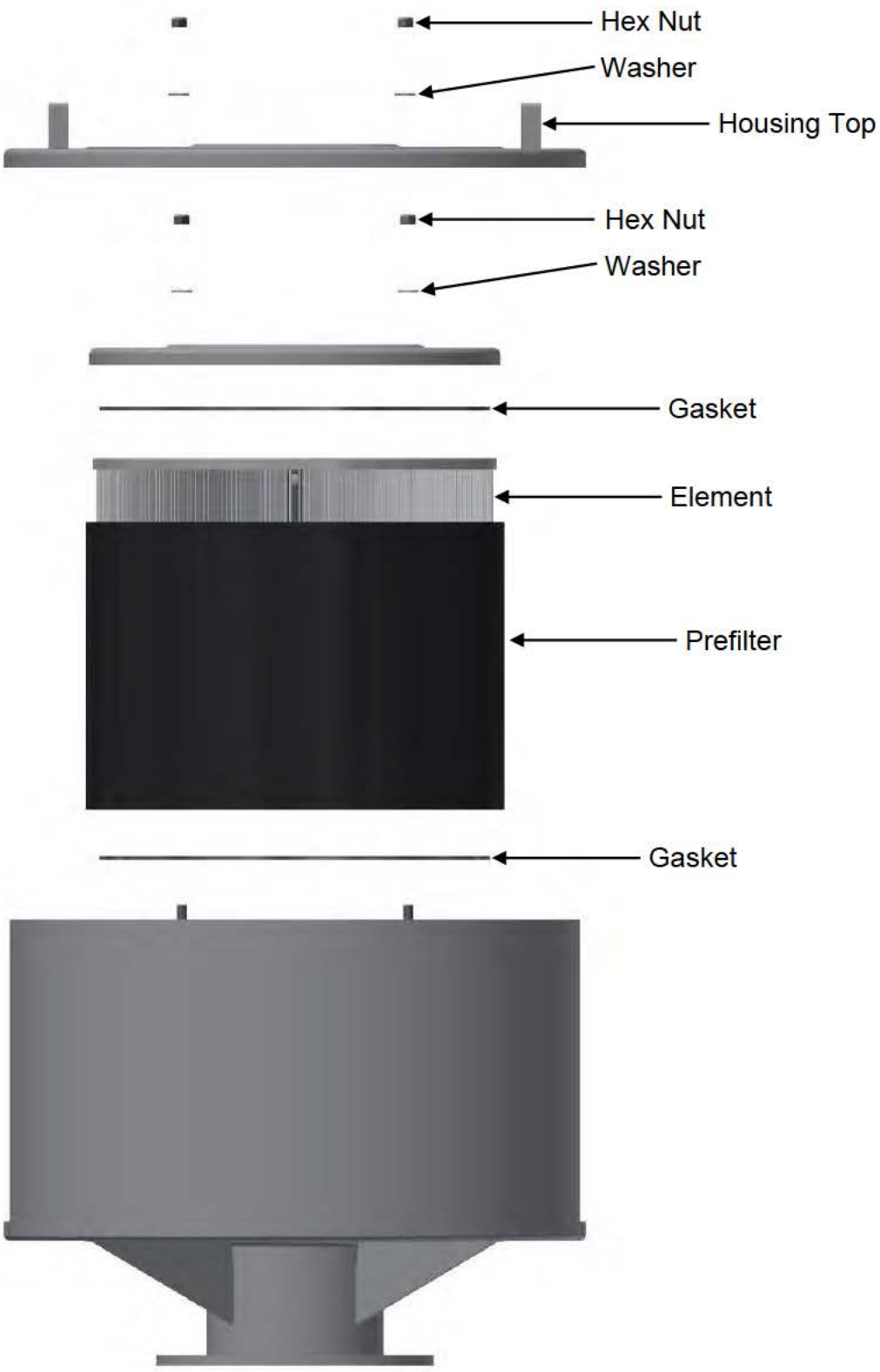

F Series Big Boy Inlet Filter
Available Replacement Parts

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Available Replacement Part by Product Number						
Product #	**Element****	**Prefilter**	**Gasket**	**Housing Top**	**Washer**	**Hex Nut**
F-376P-XXX	376	9011200	9110400	200-1031500+01	5020200	5011401
F-377P-XXX	377	9011200	9110400	200-1031500+01	5020200	5011401
F-384P-XXX	384	9011300	9110500	205-1031600+01	5020200	5011401
F-385P-XXX	385	9011300	9110500	205-1031600+01	5020200	5011401
F-484P-XXX	484	9011400	9110500	203-1031600+01	5020200	5011401
F-485P-XXX	485	9011400	9110500	203-1031600+01	5020200	5011401
F-384P(2)-XXX	384(2)	9011300	9110500	200-1031600+01	5020200	5011401
F-685P-XXX	685	9011500	9110500	200-1031600+01	5020200	5011401
F-484P(2)-XXX	484(2)	9011400	9110500	200-1031600+01	5020200	5011401
F-485P(2)-XXX	485(2)	9011400	9110500	200-1031600+01	5020200	5011401

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

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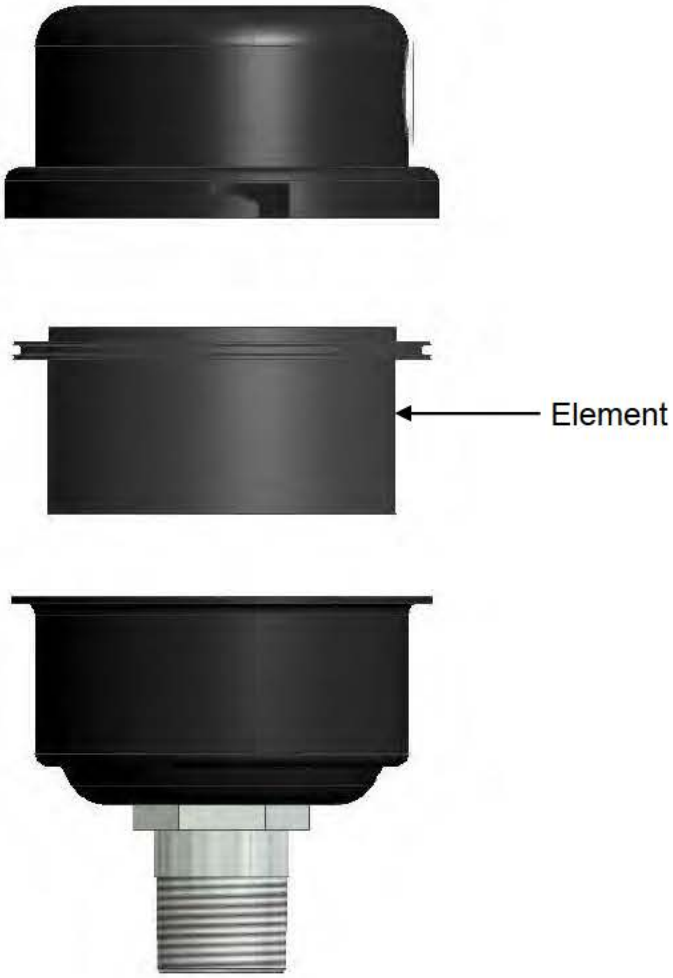
3. FS SERIES



FS Series Miniature Filter Silencer
Available Replacement Parts

Available Replacement Part by Product Number		
Product Number	**Element Type**	**Replacement Part Number**
FS-04-XXX	Paper	04
FS-05-XXX	Polyester	05
FS-06-XXX	Paper	06
FS-07-XXX	Polyester	07
FS-10-XXX	Paper	10
FS-11-XXX	Polyester	11

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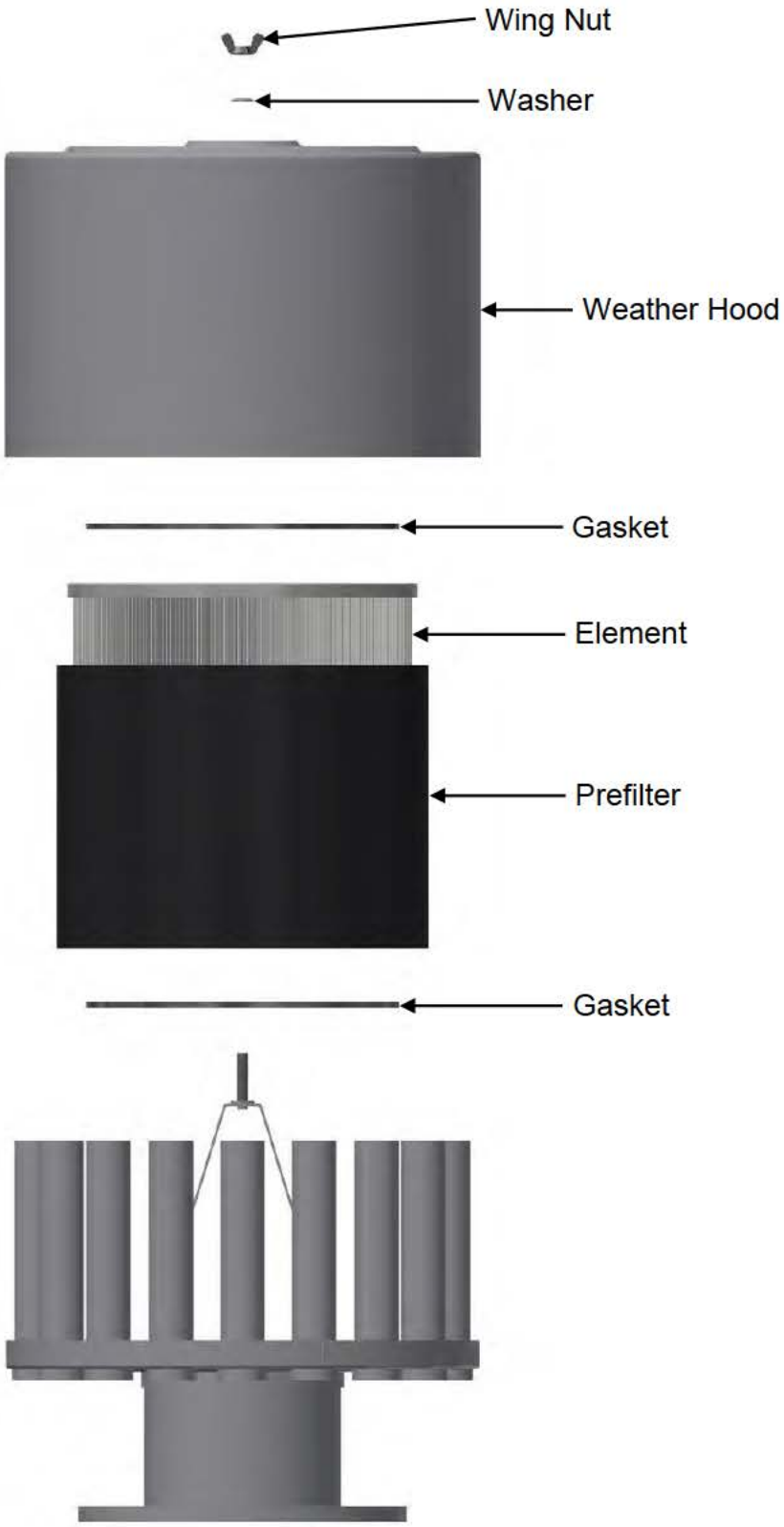

FS Series Compact Filter Silencer
Available Replacement Parts

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Available Replacement Part by Product Number						
Product #	**Element****	**Prefilter**	**Gasket**	**Weather Hood**	**Washer**	**Wing Nut**
FS-14P-XXX	14	9010200	N/A	1050300+01	5040200	5030500
FS-15P-XXX	15	9010200	N/A	1050300+01	5040200	5030500
FS-18P-XXX	18	9010400	N/A	1050500+01	5040200	5030500
FS-19P-XXX	19	9010400	N/A	1050500+01	5040200	5030500
FS-30P-XXX	30	9010500	N/A	1050900+01	5040200	5030500
FS-31P-XXX	31	9010500	N/A	1050900+01	5040200	5030500
FS-230P-XXX	230	9010700	N/A	1051000+01	5020150	5030600
FS-231P-XXX	231	9010700	N/A	1051000+01	5020150	5030600
FS-234P-XXX	234	9010800	N/A	1051200+01	5020150	5030600
FS-235P-XXX	235	9010800	N/A	1051200+01	5020150	5030600
FS-244P-XXX	244	9010900	N/A	1051200+01	5020150	5030600
FS-245P-XXX	245	9010900	9110100	1051200+01	5020150	5030600
FS-274P-XXX	274	9011000	9110200	1051200+01	5020150	5030600
FS-275P-XXX	275	9011000	9110200	1051200+01	5020150	5030600

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

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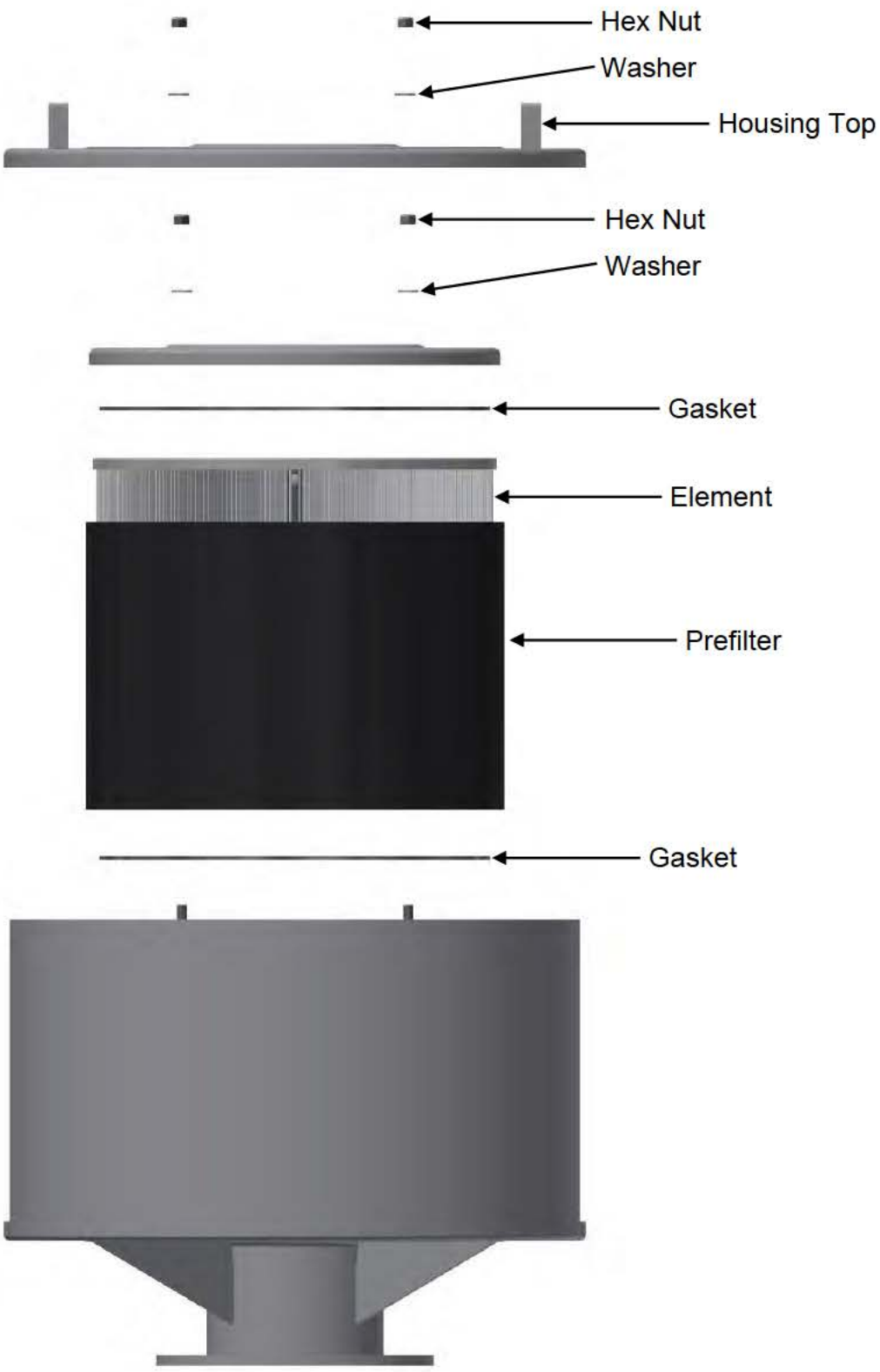

FS Series Big Boy Filter Silencer
Available Replacement Parts

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Available Replacement Part by Product Number							
Product #	**Element****	**Prefilter**	**Gasket**	**Housing Top**	**Washer**	**Hex Nut**	**Element Top**
FS-376P-XXX	376	9011200	9110400	201-1031500+01	5020200	5011401	1031100+01
FS-377P-XXX	377	9011200	9110400	201-1031500+01	5020200	5011401	1031100+01
FS-384P-XXX	384	9011300	9110500	200-1031600+01	5020200	5011401	1031300+01
FS-385P-XXX	385	9011300	9110500	200-1031600+01	5020200	5011401	1031300+01
FS-484P-XXX	484	9011400	9110500	200-1031600+01	5020200	5011401	1031300+01
FS-485P-XXX	485	9011400	9110500	200-1031600+01	5020200	5011401	1031300+01
FS-384P(2)-XXX	384(2)	9011300	9110500	200-1031600+01	5020200	5011401	1031300+01
FS-685P-XXX	685	9011500	9110500	200-1031600+01	5020200	5011401	1031300+01
FS-484P(2)-XXX	484(2)	9011400	9110500	200-1031600+01	5020200	5011401	1031300+01
FS-485P(2)-XXX	485 (2)	9011400	9110500	200-1031600+01	5020200	5011401	1031300+01

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

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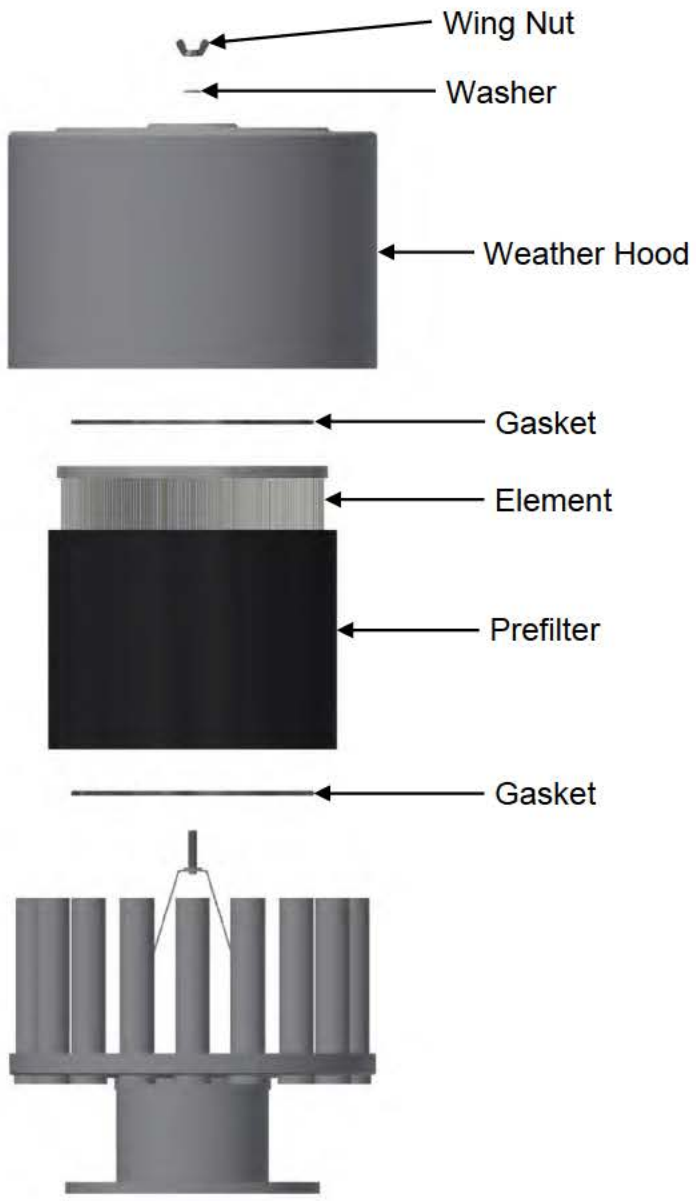
4. QB SERIES



QB Series Compact Filter Silencer
Available Replacement Parts

Available Replacement Part by Product Number						
Product #	**Element****	**Prefilter**	**Gasket**	**Weather Hood**	**Washer**	**Wing Nut**
QB-230P-XXX	230	9010700	N/A	1051000-1+01	5020150	5030600
QB-231P-XXX	231	9010700	N/A	1051000-1+01	5020150	5030600

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

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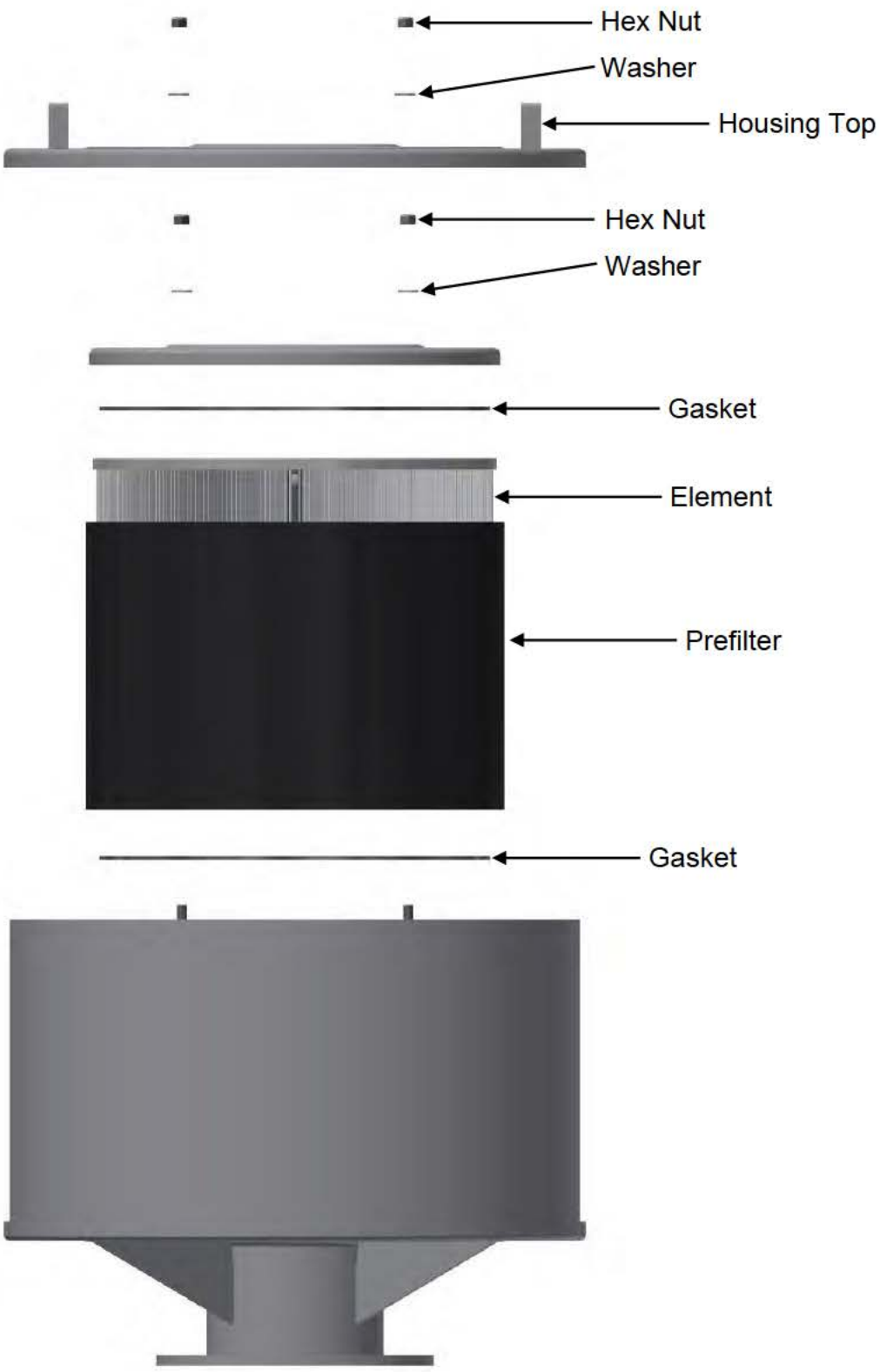

QB Series Big Boy Filter Silencer
Available Replacement Parts

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Available Replacement Part by Product Number							
Product #	**Element****	**Prefilter**	**Gasket**	**Housing Top**	**Washer**	**Hex Nut**	**Element Top**
QB-376P-XXX	376	9011200	9110400	201-1031500+01	5020200	5011401	1031100+01
QB-377P-XXX	377	9011200	9110400	201-1031500+01	5020200	5011401	1031100+01
QB-384P-XXX	384	9011300	9110500	200-1031600+01	5020200	5011401	1031300+01
QB-385P-XXX	385	9011300	9110500	200-1031600+01	5020200	5011401	1031300+01
QB-484P-XXX	484	9011400	9110500	200-1031600+01	5020200	5011401	1031300+01
QB-485P-XXX	485	9011400	9110500	200-1031600+01	5020200	5011401	1031300+01
QB-685P-XXX	685	9011500	9110500	200-1031600+01	5020200	5011401	1031300+01
QB-384P(2)-XXX	384(2)	9011300	9110500	200-1031600+01	5020200	5011401	1031300+01
QB-484P(2)-XXX	484(2)	9011400	9110500	200-1031600+01	5020200	5011401	1031300+01
QB-485P(2)-XXX	485(2)	9011400	9110500	200-1031600+01	5020200	5011401	1031300+01

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

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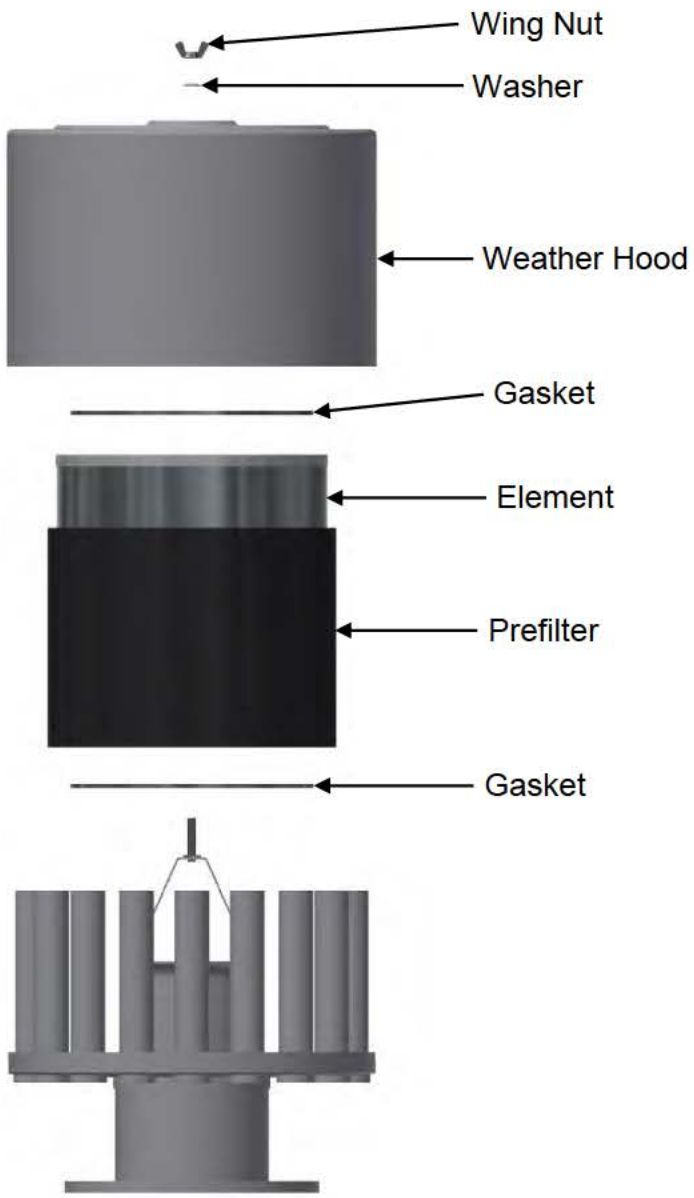
5. 2G SERIES



2G Series Compact Filter Silencer
Available Replacement Parts

Available Replacement Part by Product Number						
Product #	**Element****	**Prefilter**	**Gasket**	**Weather Hood**	**Washer**	**Wing Nut**
2G-274P-XXX	274	9011000	9110200	1051200-1+01	5020150	5030600
2G-275P-XXX	275	9011000	9110200	1051200-1+01	5020150	5030600

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

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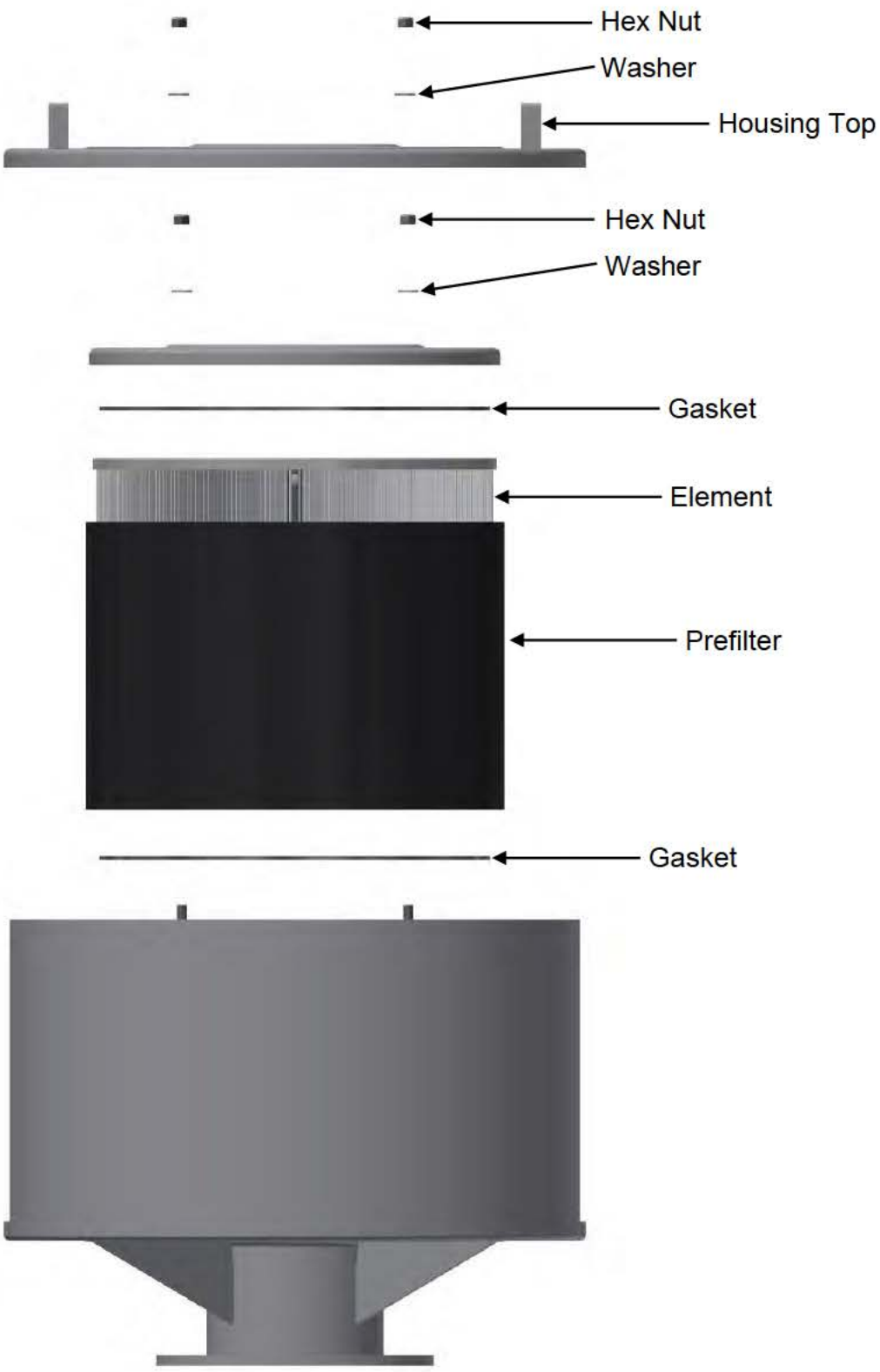

2G Series Big Boy Filter Silencer
Available Replacement Parts

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Available Replacement Part by Product Number							
Product #	**Element****	**Prefilter**	**Gasket**	**Housing Top**	**Washer**	**Hex Nut**	**Element Top**
2G-376P-XXX	376	9011200	9110400	201-1031500+01	5020200	5011401	1031100+01
2G-377P-XXX	377	9011200	9110400	201-1031500+01	5020200	5011401	1031100+01
2G-384P-XXX	384	9011300	9110500	200-1031600+01	5020200	5011401	1031300+01
2G-385P-XXX	385	9011300	9110500	200-1031600+01	5020200	5011401	1031300+01
2G-484P-XXX	484	9011400	9110500	200-1031600+01	5020200	5011401	1031300+01
2G-485P-XXX	485	9011400	9110500	200-1031600+01	5020200	5011401	1031300+01
2G-685P-XXX	685	9011500	9110500	200-1031600+01	5020200	5011401	1031300+01
2G-384P(2)-XXX	384(2)	9011300	9110500	200-1031600+01	5020200	5011401	1031300+01

**Note: *Even element numbers are Paper elements and odd element numbers are Polyester elements.*

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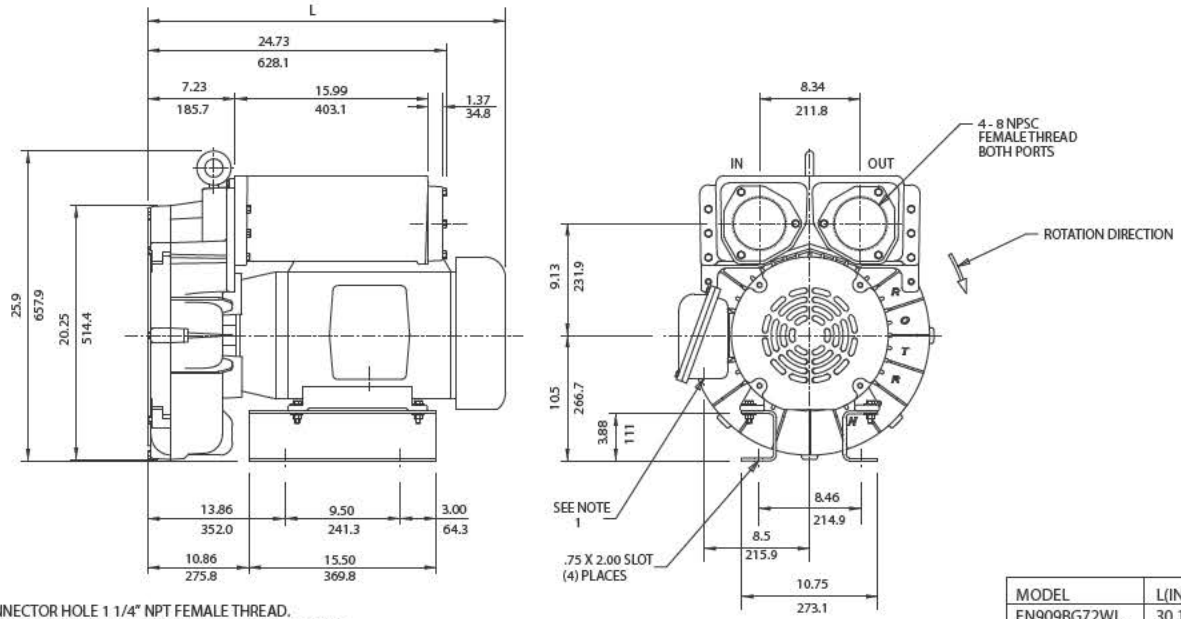
EN 909 & CP 909

ROTRON®

10.0 / 15.0 HP Sealed Regenerative w/Explosion-Proof Motor



NOTES
1 TERMINAL BOX CONNECTOR HOLE 1 1/4" NPT FEMALE THREAD.
2 DRAWING NOT TO SCALE, CONTACT FACTORY FOR SCALE CAD DRAWING.
3 CONTACT FACTORY FOR BLOWER MODEL LENGTHS NOT SHOWN.

MODEL	L(IN/MM)
EN909BG72WL	30.17/766.3
EN909DB72WL	23.66/601.0

		Part/Model Number			
		EN909BG72WL	EN909BG86WL	EN909BD72WL	CP909GA72WLR
Specification	Units	081741	081736	081743	038982
Motor Enclosure - Shaft Mtl.	-	15	15	10	15
Horsepower	-	Explosion-proof-CS	Explosion-proof-CS	Explosion-proof-CS	Chem XP-SS
Phase - Frequency	-	Three-60 hz	Three-60 hz	Three-60 hz	Three-60 hz
Voltage	AC	230/460	575	230/460	230/460
Motor Nameplate Amps	Amps (A)	36/18	14.4	24/12	36/18
Max. Blower Amps	Amps (A)	48/24	18	32/16	48/24
Locked Rotor Amps	Amps (A)	240/120	100	234/117	240/120
Service Factor	-	2/2	2	2/1	2/2
Starter Size	-	1.0	1.0	1.0	1.0
Thermal Protection	-	Class B - Pilot Duty	Class B - Pilot Duty	Class B - Pilot Duty	Class B - Pilot Duty
XP Motor Class - Group	-	I-D, II-F&G	I-D, II-F&G	I-D, II-F&G	I-D, II-F&G
Shipping Weight	Lbs	524	524	504	524
	Kg	237.7	237.7	228.6	237.7

Voltage - ROTRON motors are designed to handle a broad range of world voltages and power supply variations. Our dual voltage 3 phase motors are factory tested and certified to operate on both: **208-230/415-460 VAC-3 ph-60 Hz** and **190-208/380-415 VAC-3 ph-50 Hz**. Our dual voltage 1 phase motors are factory tested and certified to operate on both: **104-115/208-230 VAC-1 ph-60 Hz** and **100-110/200-220 VAC-1 ph-50 Hz**. All voltages above can handle a ±10% voltage fluctuation. Special wound motors can be ordered for voltages outside our certified range.

Operating Temperatures - Maximum operating temperature: Motor winding temperature (winding rise plus ambient) should not exceed 140°C for Class F rated motors or 120°C for Class B rated motors. Blower outlet air temperature should not exceed 140°C (air temperature rise plus inlet temperature). Performance curve maximum pressure and suction points are based on a 40°C inlet and ambient temperature. Consult factory for inlet or ambient temperatures above 40°C.

Maximum Blower Amps - Corresponds to the performance point at which the motor or blower temperature rise with a 40°C inlet and/or ambient temperature reaches the maximum operating temperature.

XP Motor Class - Group - See Explosive Atmosphere Classification Chart in Section I

AMETEK DYNAMIC FLUID SOLUTIONS
75 North Street, Saugerties, NY 12477
USA: +1 215-256-6601 - Europe: +49 7703 930909 - Asia: +86 21 5763 1258
Customer Service Fax: +1 215.256.1338
www.ametekdfs.com

EN 909 & CP 909

ROTRON®

10.0 / 15.0 HP Sealed Regenerative w/Explosion-Proof Motor

FEATURES

- Manufactured in the USA - ISO 9001 and NAFTA compliant
- Maximum flow: 615 SCFM
- Maximum pressure: 140 IWG
- Maximum vacuum: 112 IWG
- Standard motor: 15 HP, explosion-proof
- Cast aluminum blower housing, impeller , cover & manifold; cast iron flanges (threaded); teflon® lip seal
- UL & CSA approved motor with permanently sealed ball bearings for explosive gas atmospheres Class I Group D minimum
- Sealed blower assembly
- Quiet operation within OSHA standards

MOTOR OPTIONS

- International voltage & frequency (Hz)
- Chemical duty, high efficiency, inverter duty or industry-specific designs
- Various horsepowers for application-specific needs

BLOWER OPTIONS

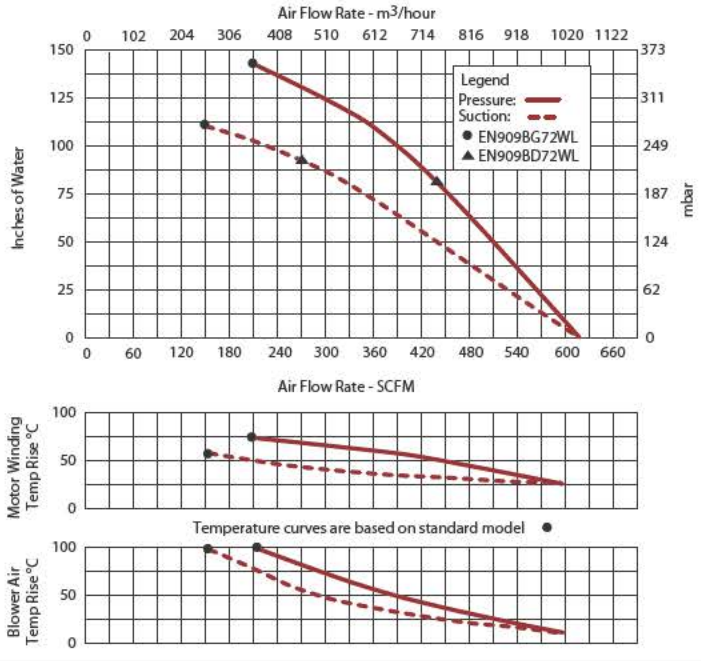
- Corrosion resistant surface treatments & sealing options
- Remote drive (motorless) models
- Slip-on or face flanges for application-specific needs

ACCESSORIES

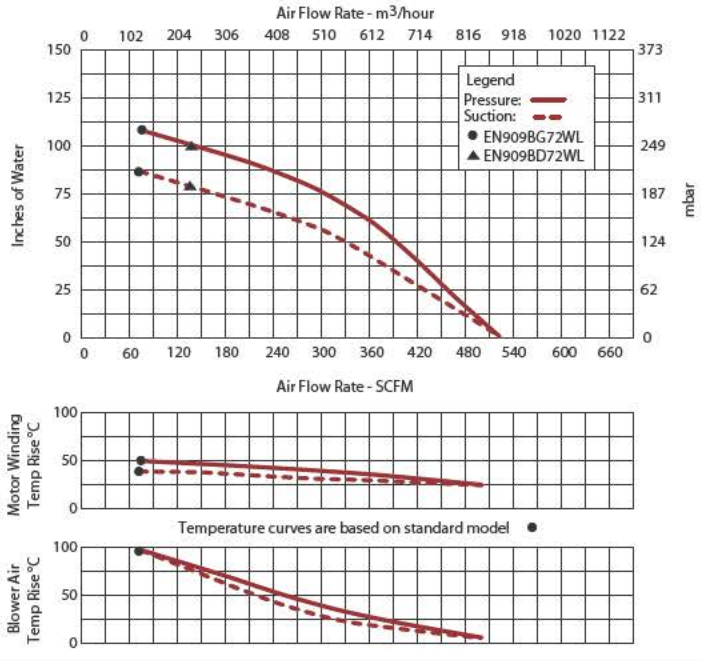
- Flowmeters reading in SCFM
- Filters & moisture separators
- Pressure gauges, vacuum gauges, & relief valves
- Switches - air flow, pressure, vacuum, or temperature
- External mufflers for additional silencing
- Air knives (used on blow-off applications)
- Variable frequency drive package

Blower Performance at Standard Conditions

60 Hz



50 Hz



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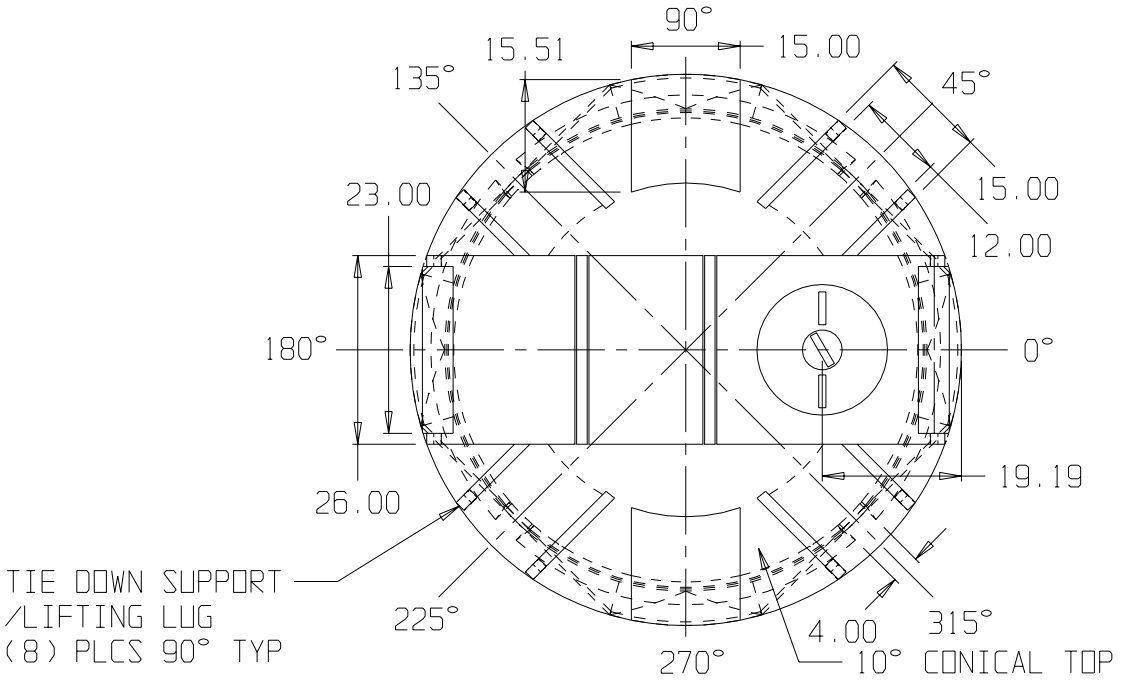
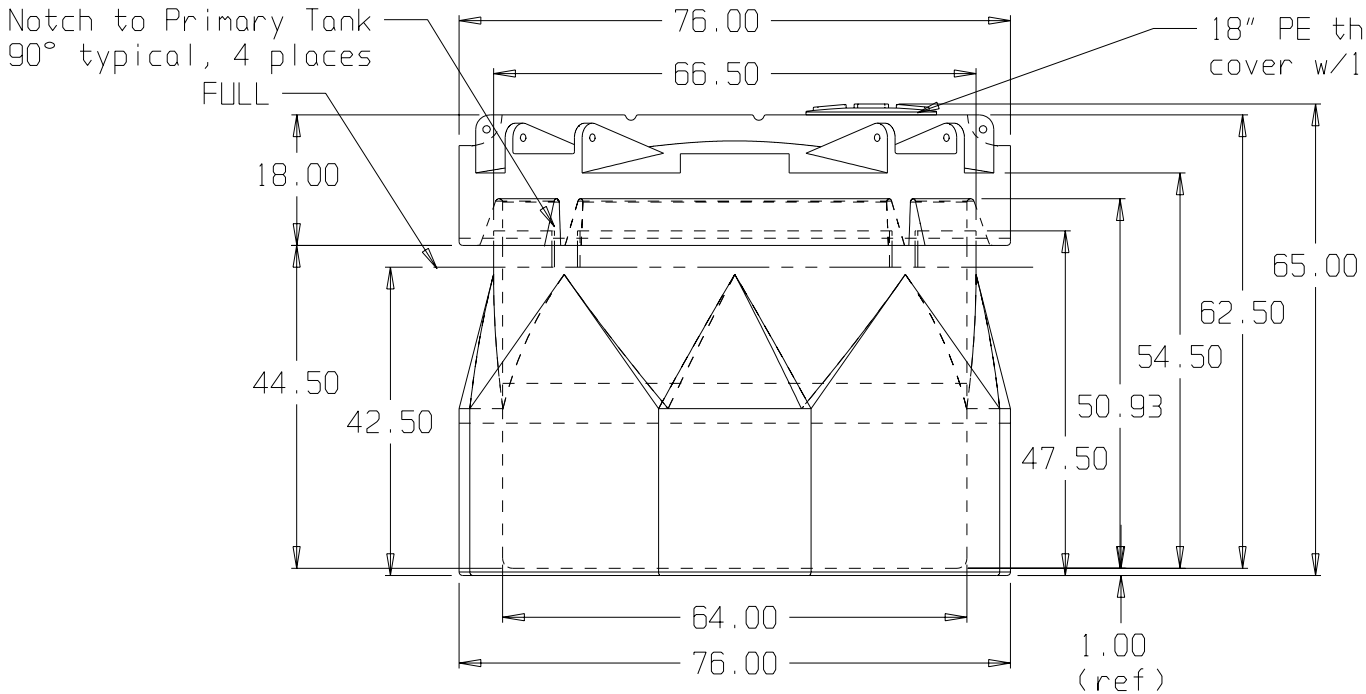




(all dimensions in inches)

BASE FITTINGS TO BE LEFT INSTALLED AT TIME OF SHIPMENT PER SII PROCEDURE

550 GALLON CAPTOR CONTAINMENT SYSTEM

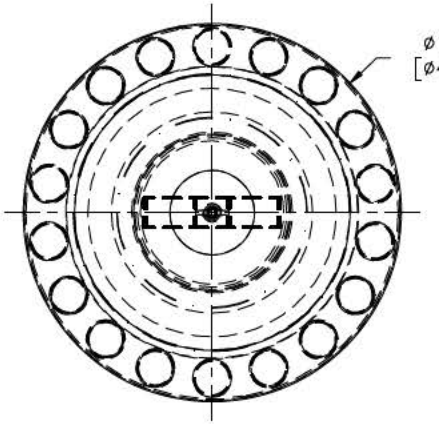
PART # PRIMARY: 504--

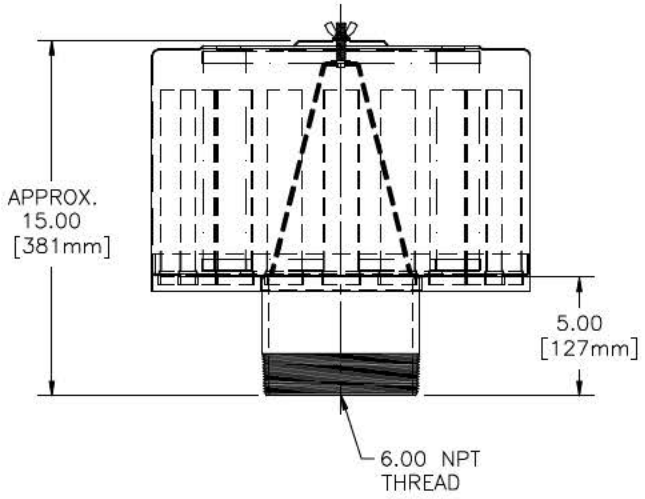
CONTAINMENT: 503--

REF#: 0000 01/23/03

SNYDER INDUSTRIES INC.

REVISIONS						
ZONE	REV	DESCRIPTION	ECN #	CHG BY	DATE	APP'D





REPLACEMENT ELEMENT# 275P	
MATERIAL	POLYESTER
CFM FLOW	1100
SURFACE AREA	19 SQ. FT.
I.D.	8.00
O.D.	11.75
HEIGHT	9.63

MODEL#	HOUSING MATERIAL	FINISH
FS-275P-600	CARBON STEEL	BAKED ENAMEL GREY

UNLESS OTHERWISE SPECIFIED:
-DIMENSIONS ARE IN INCHES
-REF: APPROXIMATE DIMENSIONS, NO TOLERANCES APPLY
-TOLERANCES ARE:
DECIMALS: .XX ±.25, .XXX ±.125
ANGLES ±2°

CUSTOMER APPROVAL:

SOLBERG MANUFACTURING INC.
1151 W. ARDMORE AVE.
ITASCA, IL 60143
630/773-1363

DESCRIPTION:
FS-275P-600

SALES REP.:

APPROVALS	DATE
DRAWN: ABL	07/17/07
APPROVED:	

SHEET: 1 of 1 | SHEET SIZE: C | SCALE: NTS

DRAWING NUMBER: SD12984 | REV: —

SOLBERG®
Filtration • Separation • Silencing

Technical Data

Inlet Vacuum Filters

Applications & Equipment

- Industrial & Severe Duty
- Vacuum Pumps & Systems: Roots, Rotary Vane, Screw, Piston
- Vacuum Packaging Equipment
- Vacuum Furnace
- Blowers: Side Channel & P.D.
- Vacuum Lifters
- Intake Suction Filters
- Food Industry
- Woodworking/Routers
- Ash Handling
- Printing Industry
- Medical/Hospital
- Sterilization
- Remote Installations for Piston & Screw Compressors
- Paper Processing
- Waste Water Aeration
- Cement Processing
- Bag House Systems
- Vacuum Vent Breathers
- Chemical Processing
- Factory Automation Equipment
- Leak Detection Systems
- Semiconductor / Solar

Identification

Standard Solberg assemblies should have an identification label/nameplate that gives the following information:

- Assembly Model #
- Replacement Element #

The part number designates the filter type, the element configuration and housing connection size. For example, the following part number identifies the filter as being a "CSL" design filter with a "235™" element, "P" prefilter and 4" flange connection size.

CSL-235P-400F

- Connection Size and Type
- Replacement Element Part Number
- Filter Type

Vacuum Service Rating Chart

Threaded vacuum filter connections must be free of defect and properly sealed to achieve deeper vacuum levels. Vacuum service levels are given for reference only and serve as a guideline for product selection. Product certification and alternative designs are available for applications requiring deeper vacuum levels and specific leak rates. Please contact factory for details.

Vacuum Level	Pressure (mbar)	Pressure (Torr)	Pressure (Pa)
Atmospheric Pressure	1013	760	$1.013 \times 10^{+5}$
Rough Vacuum	1013 to 33	760 to 25	$1 \times 10^{+5}$ to $3 \times 10^{+3}$
Medium Vacuum	33 to 1.3×10^{-3}	25 to 1×10^{-3}	$3 \times 10^{+3}$ to 1×10^{-1}
High Vacuum	1.3×10^{-3} to 1.3×10^{-9}	1×10^{-3} to 1×10^{-9}	1×10^{-1} to 1×10^{-7}

Rev: US0621K

Choosing the Best Filter for Your Equipment

A. When the connection & airflow is known:

1. Select the appropriate connection style. (i.e.: MPT, Flange, NPSC etc.)

a. Verify assembly SCFM (flow) rating. Compare with your required airflow. (Note: Assembly flow ratings are based on 6,000 FPM or 30m/sec for a given connection size to achieve low pressure drop performance. When required flow exceeds assembly flow rating, the pressure drop through the outlet connection will increase. In such cases select by element SCFM (flow) rating.)

b. Verify that the flow rating matches connection size; skip to "C. Selecting Elements".

B. When the connection size is unknown, flexible, or the required flow rating exceeds assembly flow rating:

1. Match required flow rating with the element flow rating.
2. Choose related connection size.

C. Selecting Elements: The filter performance is influenced by the actual application duty and the equipment it is installed on. Regular maintenance checks and proper servicing is required.

Application Duty Descriptions:

Industrial Duty: clean workshop or clean outdoor environment - small element sizing is sufficient.

Severe Duty: dirty workshop, wastewater – medium to large element is recommended.

Extreme Duty: cement, steel making, plastics or dusty material conveying – largest element sizing is recommended.

1. Select media required by your application. Options include:
   a. Standard media
      1. Polyester: all purpose; withstands pulses, moisture, and oily air
      2. Paper: mostly dry, smooth flow applications
   b. Special Media: for a variety of micron levels and media types, see the "Filter Media Specifications" in the Replacement Element Section or contact Solberg.
2. Select element size by matching the element with the anticipated duty and upsize accordingly.

Filter Assembly Maintenance

Request the appropriate maintenance manual for more in-depth information from your Solberg representative or on our website: www.solbergmfg.com.

Element Maintenance

Solberg elements should be replaced once the pressure drop reaches 15-20" H_2O above the initial pressure drop of the installation. Cleaning the element is also an option.

Solberg recommends replacing dirty elements for optimal performance. Any damage which results from by-pass or additional pressure drop created by element cleaning is the sole responsibility of the operator.

Note: The overall performance of a filter element is altered once cleaned. The initial pressure drop after subsequent cleanings will be greater than the original, clean pressure drop of the element. After each cleaning, the pressure drop will continue to increase. Under all circumstances, the initial pressure drop of the element needs to be maintained at less than 15" H_2O.

If the pressure drop exceeds 20" H_2O at start-up; it should be replaced with a new element. With many types of equipment, the maximum pressure drop allowed will be dictated by the ability of the equipment to perform to its rated capacity. Under all circumstances, the operator should avoid exceeding the manufacturer's recommended maximum pressure drop for their specific equipment.

Rev: US0621K

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Inline Straight Through Vacuum Filters

CT Series 3/4" - 6"

Features

- Compact design for space restrictions; min. service area
- Inlet above element for extended element life & maintenance intervals
- Corrosive resistant cast aluminum top with machined connections and integrated baffle design
- T-style design minimizes piping requirements
- Black powder coat carbon steel drop down bucket

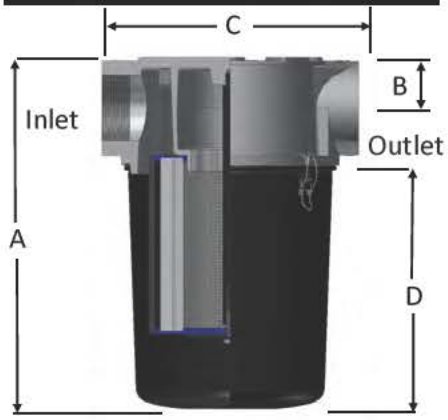
Technical Specifications

- Vacuum Rating: medium vacuum service*
- Temp (continuous): min -15°F (-26°C) max 220°F (104°C)
- Filter change out differential: 15-20" H_2O over initial ΔP
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron

Options

ATEX Available

- Swing bolts for heavy duty environments
- Drain ports
- Extended capacity (select models)
- Various nonstandard finishes
- Reverse pulse configuration
- See-through bucket (select models)
- Taps for gauges and mounting brackets



Inlet/Outlet Size	Type	Assembly SCFM Rating	Assembly Part Number Polyester	Paper	Dimensions - inches A	B	C	D	Suggested Service ht. inches	Approx. Weight lbs.	Replacement Element Part No. Polyester	Paper	Element SCFM Rating
¾"	NPSC	25	CT-8451-075C	CT-8450-075C	8 1/16	1	5	6 ½	5 ½	3.5	8451	8450	40
1"	NPSC	40	CT-897-100C	CT-896-100C	13 ⅛	1½	7	10 ⅛	9	12	897	896	80
1 ¼"	NPSC	60	CT-897-125C	CT-896-125C	13 ⅛	1½	7	10 ⅛	9	12	897	896	80
1 ½"	NPSC	80	CT-897-150C	CT-896-150C	13 ⅛	1½	7	10 ⅛	9	11	897	896	80
2"	NPSC	175	CT-851-200C	CT-850-200C	12 13/16	2	9	9	9	16	851	850	290
2 ½"	FPT	210	CT-851-250C	CT-850-250C	12 13/16	2	9	9	9	15	851	850	290
3"	FPT	300	CT-235P-300C	CT-234P-300C	18 ⅝	2¾	13 ½	13	9	30	235P™	234P™	570
4"	FPT	520	CT-235P-400C	CT-234P-400C	18 ⅝	2¾	13 ½	13	9	26	235P™	234P™	570
6"	FPT	1100	CT-275P-600C	CT-274P-600C	18 ¼	3⅜	19	9 13/16	10	45	275P™	274P™	1100

*See Vacuum Filter Technical Data for vacuum service data and sizing guidelines.
Note: CT 2" & 2 ½" models: element seals on the base of the housing.

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sales@solbergmfg.com

www.solbergmfg.com

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Inline See -Through Vacuum Filters

ST Series 3/4" - 4"

Overview

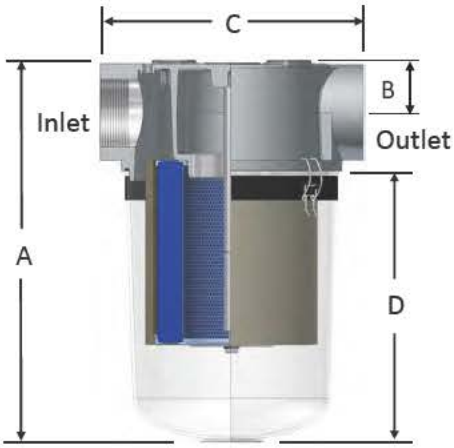
Solberg's ST Series is designed to offer exceptional performance across a broad range of vacuum applications. The transparent housing offers users the ability to inspect filter elements without disassembling the unit. Ideal for rough-medium vacuum service, this compact design offers a smaller service footprint, allowing for easy access and quick maintenance in tight spaces. Multiple filter element media options offer superior protection and longevity for the vacuum system.

Features

- Easy maintenance due to see-through bucket
- Compact design for space restrictions; min. service area
- Inlet above element for extended element life & maintenance intervals
- Corrosive resistant cast aluminum top with machined connections and integrated baffle design
- T-style design minimizes piping requirements
- Shatter-resistant polycarbonate drop down bucket

Technical Specifications

- Vacuum Rating: medium vacuum service*
- Temp (continuous): min -15°F (-26°C) max 220°F (104°C)
- Filter change out differential: 15-20" H_2O over initial ΔP
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron



Options

- Swing bolts for heavy duty environments
- Drain ports
- Extended capacity (select models)
- Reverse pulse configuration
- Taps for gauges and mounting brackets

Inlet/Outlet Size	Type	Assembly SCFM Rating	Assembly Part Number Polyester	Paper	Dimensions - inches A	B	C	D	Suggested Service Ht. inches	Approx. Weight lbs	Replacement Element Part No. Polyester	Paper	Element SCFM Rating
¾"	NPSC	25	ST-8451-075C	ST-8450-075C	8 ⅜	1	5	6 ⅛	5 ⅕	3	8451	8450	40
1"	NPSC	40	ST-897-100C	ST-896-100C	13 ⅜	1½	7	10 ⅜	9	11	897	896	80
1 ¼"	NPSC	60	ST-897-125C	ST-896-125C	13 ⅜	1½	7	10 ⅜	9	11	897	896	80
1 ½"	NPSC	80	ST-897-150C	ST-896-150C	13 ⅜	1½	7	10 ⅜	9	10	897	896	80
2"	NPSC	175	ST-851/1-200C	ST-850/1-200C	16 ¼	2	9	12 7/16	9	15	851/1	850/1	290
2 ½"	FPT	210	ST-851/1-250C	ST-850/1-250C	16 ¼	2	9	12 7/16	9	14	851/1	850/1	290
3"	FPT	300	ST-235P-300C	ST-234P-300C	19 ¾	2 11/16	13 ½	14	9	29	235P™	234P™	570
4"	FPT	520	ST-235P-400C	ST-234P-400C	19 ¾	2 11/16	13 ½	14	9	25	235P™	234P™	570

*See Vacuum Filter Technical Data for vacuum service data and sizing guidelines.

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www.solbergmfg.com

[redacted]

Features & Specifications

- All Welded Steel construction, ASTM A-36 sheet steel
- 17" Hg vacuum design rating (optional full vacuum design available)
- Polypropylene demister element covering entire separator cross section to minimizes vapor velocity & maximize water coalescing
- Tangential inlet utilizing centrifugal force for gross water/air separation (95%+ By Volume)
- 2" PVC site glass with unions for easy removal
- Steel baffle cover over water holding volume to prevent re-entrainment of water into air stream
- Stainless steel hermetically sealed float rod assembly (single or multiple floats)
- All zinc plated steel hardware
- Enamel external finish (optional internal & external finishes available)
- 99% + moisture removal of 10 micron and larger droplets (due to coalescing)
- Optional air filter with polyester element sized for specific blower, housed in separator (polyester element standard)
- 2" NPT half coupling for pump out or gravity drain, ¼" NPT gage port on inlet
- Neoprene full face top cover gasket

H2K Technologies, Inc.

Applications

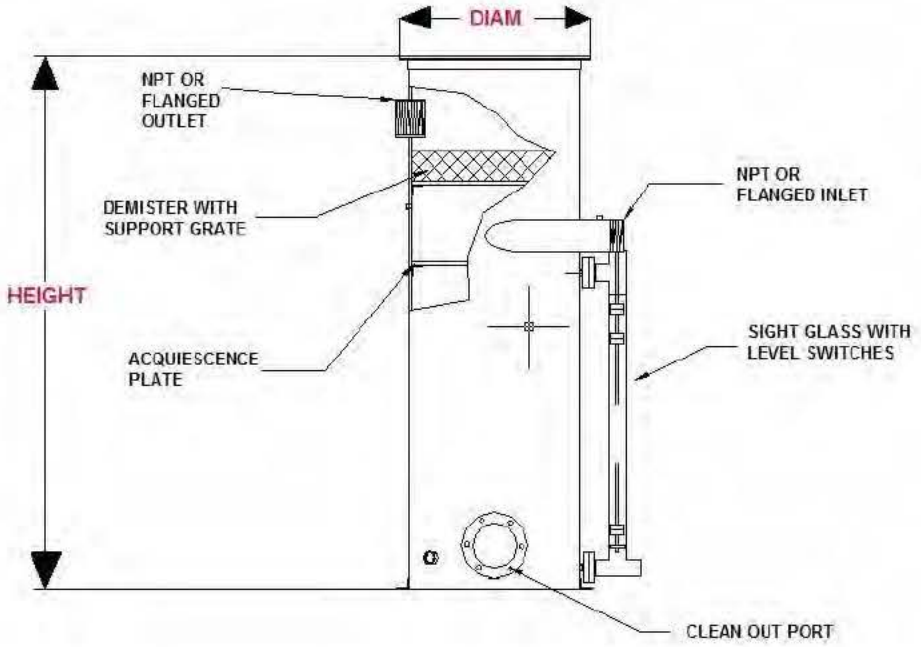
- Soil vapor extraction
- Dual phase extraction
- Liquid ring pump
- Vacuum or pressure
- Blowers-Side Channel/regenerative,

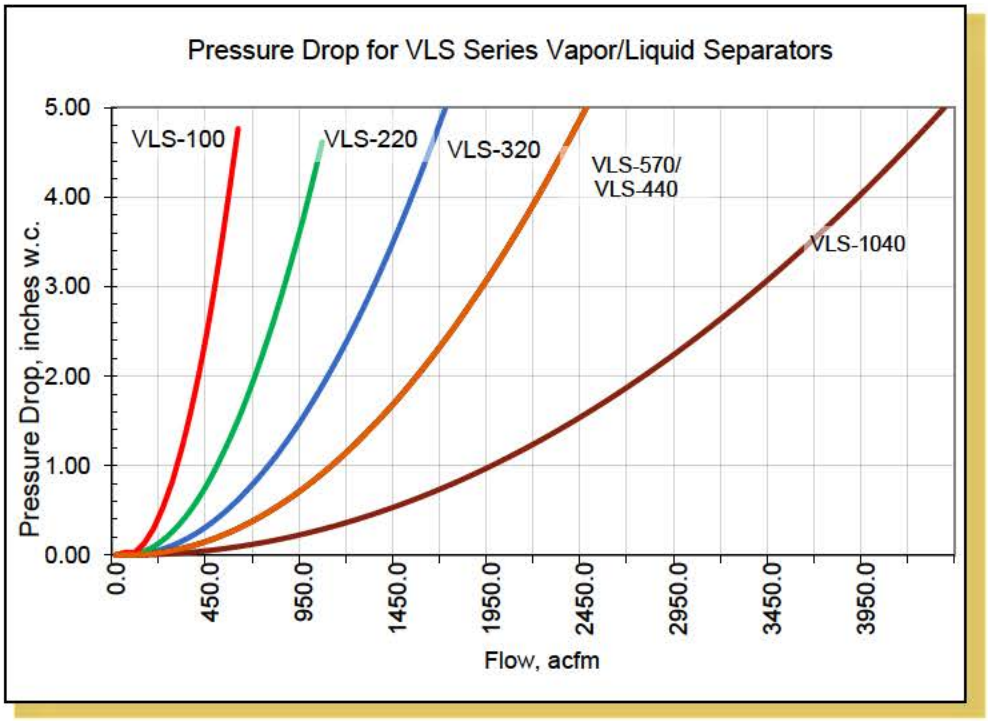
multi-stage regenerative, positive displacement, and centrifugal

- Industrial industry
- Remediation industry
- Vapor GAC
- Bio venting systems
- Excavation venting

H2K Technologies, Inc.
7550 Commerce St
Corcoran, MN 55340
Phone: 763.746.9900
Fax: 763.746.9903
www.H2KTECH.com
Sales@H2KTech.com

Model Number	Inlet/Outlet Connection	Height In.	Diam. In.	Rated Flow SCFM	Separator Total Volume Gallons	Liquid Holding Volume Gallons	Shipping Weight Lbs.	Operating Weight Lbs.	Vacuum/ Rating, "Hg/PSI
VLS-033	3" FPT	30	18	500	33	10	50	160	17"Hg/9psi
VLS-082	4" FPT	44	24	500	82	30	90	325	17"Hg/9psi
VLS-100	4"/6" FPT	50	22	650	100	40	140	480	30"Hg/9psi
VLS-220	8"/10" 150 lb flange	72	30	1440	220	75	350	1,020	30"Hg/9psi
VLS-320	10"/12" 150lb flange	72	36	2100	320	110	450	1,356	30"Hg/9psi
VLS-440	12" 150lb flange	74	42	2600	440	150	625	1,860	17"Hg/9psi
VLS-570	12" 150 lb flange	74	48	3600	570	195	860	2,465	17"Hg/9psi
VLS-1040	16" Duct flange	84	60	4500	1,040	200	1,250	2,978	10"Hg/5psi
VLS-1500	20" Duct flange	85	72	7000	1,500	440	1,525	5,325	10"Hg/5psi
VLS-3055	32" Duct flange	96	96	11,000	3,055	780	1,820	8,532	10"Hg/5psi

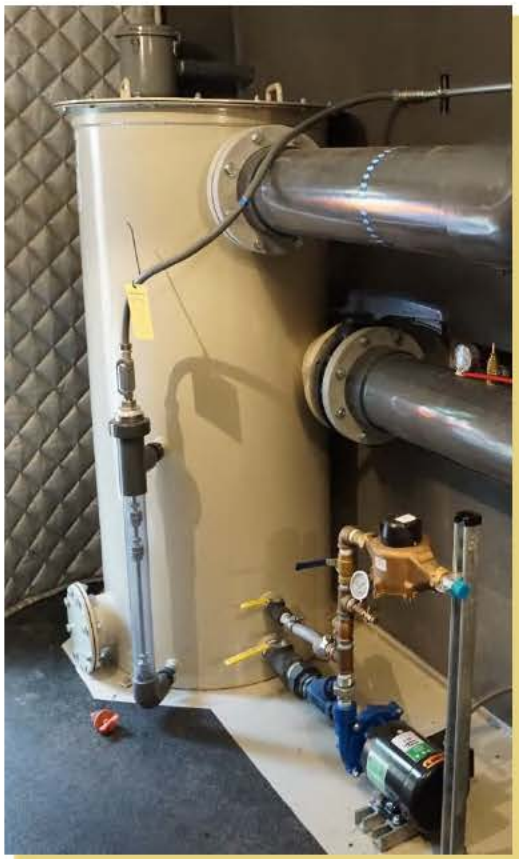




Options

- Stainless steel or Fiberglass re-enforced plastic construction (low pressure)
- Stainless steel coalescer media
- ASME designed & stamped for vacuum or pressure
- Full vacuum design
- Immersion heaters, NEMA 4 or NEMA 7 for freeze protection
- 1" recirculation port for pumping under high vacuum
- Air filter material and sizes
- Enamel internal finish, epoxy coatings or hot dipped galvanized finish
- Flanged or NPT inlet and outlet connections
- Flow, pressure, level & temperature gages or transmitters
- Heat trace for classified or non-classified electrical areas for freeze protection
- Clean out Ports
- Internal aeration diffuser for low level stripping or iron oxidation
- DP gage across filter, demister or both
- R-5 insulation with jacket, (steel or aluminum jacket)
- Vacuum relief valve

Additional Photos



Appendix D

Specifications

SECTION 01 10 00.01 - SUMMARY

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Contract description.

1.2 DEFINITIONS

A. Owner USEPA (United States Environmental Protection Agency)

B. Engineer: EA Engineering, Science, and Technology, Inc., PBC

C. Contractor: Soil Vapor Extraction (SVE) Vendor who has contracted with the Owner and is directly responsible for performance of the work referenced in the Statement of Work, specifications, and the drawings.

1.3 SCOPE DESCRIPTION

A. Work of the Project is the construction of a SVE System. Work will include, but is not limited to the following:

a. Prepare and submit SVE System design to the Engineer for approval

b. Acquire system enclosure, equipment, and materials

c. Fabricate and program SVE System

d. Deliver SVE System to the site

e. Provide onsite inspection, testing, startup, and training services after the SVE Unit System is installed.

f. Install horizontal wells, conveyance lines, moisture accumulation tank, and other appurtenances

PART 2 PRODUCTS - Not Used.

PART 3 EXECUTION - Not Used.

END OF SECTION

SECTION 01 25 00.01 - SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Quality assurance

B. Product options

C. Product substitution procedures.

1.2 QUALITY ASSURANCE

A. Contract is based on products and standards established in Contract Documents without consideration of proposed substitutions

B. Products specified define standard of quality, type, function, dimension, appearance, and performance required

C. Substitution proposals are permitted for specified products except where specified otherwise. Do not substitute products unless substitution has been accepted and approved in writing by Owner

1.3 PRODUCT OPTIONS

A. See Section 01 60 00.01 - Product Requirements.

1.4 PRODUCT SUBSTITUTION PROCEDURES

A. Submit requests for substitutions with the design submittal described in Section 02 62 16.01 – Soil Vapor Extraction System Fabrication, moisture accumulation tank, conveyance piping, and horizontal wells.

B. Substitutions may also be considered when a product becomes unavailable through no fault of the Contractor.

C. Document each request with complete data, substantiating compliance of proposed substitution with Contract Documents, including:

1. Manufacturer's name and address, product, trade name, model, catalog number (as applicable), performance and test data, and reference standards

2. Itemized point-by-point comparison of proposed substitution with specified product, listing variations in quality, performance, and other pertinent characteristics

3. Reference to Article and Paragraph numbers in Specification Section

4. Cost data comparing proposed substitution with specified product, and amount of net change to Contract Sum

5. Changes required in other Work

6. Availability of maintenance service and source of replacement parts as applicable

7. Certified test data to show compliance with performance characteristics specified

8. Samples when applicable or requested

9. Other information as necessary to assist Engineer's evaluation.

D. A request constitutes a representation that Contractor:

1. Has investigated proposed product and determined that it meets or exceeds quality level of specified product

2. Will provide same warranty for substitution as for specified product

3. Waives claims for additional costs or time extension that may subsequently become apparent

4. Will coordinate installation of the accepted substitute, making such changes as may be required for the Work to be complete

5. Will reimburse Engineer for review or redesign services associated with reapproval by authorities having jurisdiction

6. Will ensure that material is in compliance with Buy American Act provisions included in the contract by way of contract flow down clauses.

E. Substitutions will not be considered when they are indicated or implied on Shop Drawings or Product Data submittals without separate written request. The Engineer may choose not to consider substitutions when acceptance will require revision to Contract Documents.

F. Substitution Submittal Procedure:

1. Submit electronic files to the Engineer’s Project Manager. Limit each request to one proposed substitution.

2. Submit information required in Paragraph 1.4.C, above. Burden of proof is on Proposer.

3. Engineer will notify Contractor in writing of decision to accept or reject request.

PART 2 PRODUCTS - Not Used.

PART 3 EXECUTION - Not Used.

END OF SECTION

SECTION 01 40 00.01 - QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Quality control

B. Tolerances

C. References

D. Labeling

E. Testing and inspection services

F. Contractors' field services.

1.2 QUALITY CONTROL

A. Monitor quality control over suppliers, manufacturers, products, services, and workmanship, to produce Work of specified quality.

B. Comply with specified standards as the minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

C. Perform Work using persons qualified to produce required and specified quality.

D. Products, materials, and equipment may be subject to inspection by Engineer at place of manufacture or fabrication. Such inspections shall not relieve Contractor of complying with requirements of Contract Documents.

E. Supervise performance of Work in such manner and by such means to ensure that Work, whether completed or in progress, will not be subjected to harmful, dangerous, damaging, or otherwise deleterious exposure during fabrication period.

F. Remedial Action Contractor is responsible for quality control.

1.3 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' recommended tolerances and tolerance requirements in reference standards. When such tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.4 REFERENCES

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard except when more rigid requirements are specified or are required by applicable codes.

B. Conform to reference standard by date of issue current as of date of Contract Documents except where specific date is established by code.

C. Obtain copies of standards and maintain on Site when required by product Specification Sections.

D. When requirements of indicated reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

E. Neither contractual relationships, duties, or responsibilities of parties in Contract, nor those of Engineer, shall be altered from Contract Documents by mention or inference in reference documents.

1.5 LABELING

A. Attach label from agency approved by authorities having jurisdiction for products, assemblies, and systems required to be labeled by applicable code.

B. Label Information: Include manufacturer's or fabricator's identification, approved agency identification, and the following information, as applicable, on each label:

1. Model number
2. Serial number
3. Performance characteristics.

C. Manufacturer's Nameplates, Trademarks, Logos, and Other Identifying Marks on Products: Not allowed on surfaces exposed to view in public areas, interior, or exterior.

1.6 CONTRACTOR'S FIELD SERVICES

A. When specified in individual Specification Sections, provide qualified staff personnel to observe Site conditions, conditions of surfaces and installation, quality of workmanship, startup of equipment, testing, adjusting, balancing of equipment, commissioning as applicable, and to initiate instructions when necessary.

B. Report observations and Site decisions or instructions given to the Engineer or to Others.

C. Refer to Section 01 33 00.01 - Submittal Procedures, "Contractor's Field Reports" Article.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 33 00.01 - SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Definitions

B. Submittal procedures

C. Product data

D. Use of electronic CAD files of Project Drawings

E. Shop Drawings

F. Samples

G. Operation and maintenance data

H. Other submittals

I. Test reports

J. Certificates

K. Manufacturer's instructions

L. Contractor's field reports

M. Erection Drawings

N. Contractor review

O. Owner and Owner Representative review

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Owner and Owner's Representative’s responsive action.

B. Informational Submittals: Written and graphic information and physical Samples that do not require Owner and Owner's Representative’s responsive action.

1.3 SUBMITTAL PROCEDURES

A. Transmit each submittal electronically to the Engineer’s Project Manager and Resident Owner and Owner Representative

B. Identify: Project, Vendor, Subcontractor and supplier, pertinent Drawing and detail number, and Specification Section number appropriate to submittal.

C. Contractor shall certify that review, approval, verification of products required, verification of field dimensions, and coordination of information is according to requirements of the Work and Contract Documents.

D. Schedule submittals to expedite Project. Coordinate submission of related items.

E. For each submittal for review, allow 14 calendar days.

F. Identify product or system limitations that may be detrimental to successful performance of completed Work.

G. When a submittal is revised for resubmission, identify changes made since previous submission.

H. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.

I. Submittals not specified or requested may not be recognized or processed, at Engineer's discretion.

J. Incomplete Submittals: Owner and Owner's Representative's may opt to not review. Complete submittals for each item are required. Delays resulting from incomplete submittals are not the responsibility of Engineer.

1.4 PRODUCT DATA

A. Action Submittal: Submit to Owner and Owner's Representative's for review for assessing conformance with information given and design concept expressed in Contract Documents.

B. Send electronic submittals as portable document format (PDF) files to the Owner's and Owner's Representative's Project Manager.

C. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

D. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

E. After review, produce copies and distribute according to "Submittal Procedures" Article and for record documents described in Section 01 70 00.01 - Execution and Closeout Requirements.

1.5 ELECTRONIC CAD FILES OF PROJECT DRAWINGS

A. Electronic CAD Files of Project Drawings: May only be used to expedite production of Shop Drawings for the Project. Use for other Projects or purposes is not allowed.

B. Electronic CAD Files of Project Drawings: Distributed only under the following conditions:

1. Use of files is solely at receiver's risk. Owner and Owner's Representative's does not warrant accuracy of files. Receiving files in electronic form does not relieve receiver of responsibilities for measurements, dimensions, and quantities set forth in Contract Documents. In the event of ambiguity, discrepancy, or conflict between information on electronic media and that in Contract Documents, notify Engineer and use information in hard-copy Drawings and Specifications.

2. CAD files do not necessarily represent the latest Contract Documents, existing conditions, and as-built conditions. Receiver is responsible for determining and complying with these conditions and for incorporating addenda and modifications.

3. User is responsible for removing information not normally provided on Shop Drawings and removing references to Contract Documents.

4. Receiver shall neither hold Owner and Owner's Representative's responsible for data or file clean-up required to make files usable, nor for error or malfunction in translation, interpretation, or use of this electronic information.

5. Receiver shall understand that even though Owner and Owner's Representative's has computer virus scanning software to detect presence of computer viruses, there is no guarantee that computer viruses are not present in files or in electronic media.

6. Receiver shall not hold Owner and Owner's Representative's responsible for such viruses or their consequences, and shall hold Engineer harmless against costs, losses, or damage caused by presence of computer virus in files or media.

1.6 SHOP DRAWINGS

A. Action Submittal: Submit to Owner and Owner's Representative's for assessing conformance with information given and design concept expressed in Contract Documents.

B. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

C. When required by individual Specification Sections, provide Shop Drawings signed and sealed by a professional Engineer responsible for designing components shown on Shop Drawings.

1. Include signed and sealed calculations to support design

2. Submit Shop Drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction

3. Make revisions and provide additional information when required by authorities having jurisdiction.

D. Send electronic submittals as PDF files to the Owner's and Owner's Representative's Project Manager.

E. After review, produce copies and distribute according to "Submittal Procedures" Article and for record documents described in Section 01 70 00.01 - Execution and Closeout Requirements.

1.7 SAMPLES

A. Action Submittal: Submit to Owner and Owner's Representative's for assessing conformance with information given and design concept expressed in Contract Documents.

B. Samples for Selection as Specified in Product Sections:

1. Submit to Owner and Owner's Representative's for aesthetic, color, and finish selection
2. Submit Samples of finishes, textures, and patterns for Owner and Owner's Representative's selection.

C. Submit Samples to illustrate functional and aesthetic characteristics of products, with integral parts and attachment devices. Coordinate Sample submittals for interfacing work.

D. Include identification on each Sample, with full Project information.

E. Submit number of Samples specified in individual Specification Sections; Owner and Owner's Representative's will retain one Sample.

F. Reviewed Samples that may be used in the Work are indicated in individual Specification Sections.

G. Samples will not be used for testing purposes unless specifically stated in Specification Section.

H. After review, produce copies and distribute according to "Submittal Procedures" Article and for record documents described in Section 01 70 00.01 - Execution and Closeout Requirements.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit in PDF composite electronic indexed file.

B. Submit data bound in 8-1/2 x 11-inch (A4) text pages, binders with durable covers.

C. Prepare binder cover with printed title, "OPERATION AND MAINTENANCE INSTRUCTIONS," title of Project, and subject matter of binder when multiple binders are required.

D. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.

E. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

F. Contents: Prepare table of contents for each volume, with each product or system description identified, typed on white background, in three parts as follows:

1. Part 1: Directory, listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors, and major equipment suppliers

2. Part 2: Operation and maintenance instructions, arranged by system. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Include the following:

    a. Significant design criteria
    b. List of equipment
    c. Parts list for each component
    d. Operating instructions
    e. Maintenance instructions for equipment and systems
    f. Maintenance instructions for special finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents
    g. Safety precautions to be taken when operating and maintaining or working near equipment.
    h. Sampling and sample analysis

3. Part 3: Project documents and certificates, including the following:

    a. Shop Drawings and product data
    b. Air and water balance reports
    c. Certificates
    d. Originals of warranties and bonds.

1.9 OTHER SUBMITTALS

A. Closeout Submittals: Comply with Section 01 70 00.01 - Execution and Closeout Requirements.

B. Informational Submittal: Submit data for Owner’s and Owner's Representative’s knowledge.

C. Submit information for assessing conformance with information given and design concept expressed in Contract Documents.

1.10 TEST REPORTS

A. Informational Submittal: Submit reports for Owner’s and Owner's Representative’s knowledge.

B. Submit test reports for information for assessing conformance with information given and design concept expressed in Contract Documents.

1.11 CERTIFICATES

A. Informational Submittal: Submit certification by manufacturer, installation or application Subcontractor, or Contractor, to Owner and Owner's Representative.

B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or product but must be acceptable to Engineer.

1.12 MANUFACTURER'S INSTRUCTIONS

A. Informational Submittal: Submit manufacturer's installation instructions for Owner's and Owner's Representative's knowledge.

B. Submit printed instructions for delivery, storage, assembly, installation, startup, adjusting, and finishing, to Owner and Owner's Representative.

C. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.13 CONTRACTOR'S FIELD REPORTS

A. Informational Submittal: Submit reports for Owner and Owner's Representative's knowledge.

B. Submit report within 5 days of observation to Owner and Owner's Representative's Project Manager for information.

C. Submit reports for information for assessing conformance with information given and design concept expressed in Contract Documents.

1.14 ERECTION DRAWINGS

A. Informational Submittal: Submit Drawings for Owner and Owner's Representative's knowledge.

B. Submit Drawings for information assessing conformance with information given and design concept expressed in Contract Documents.

C. Submittals indicating inappropriate or unacceptable Work may be subject to action by Owner and Owner's Representative.

1.15 CONTRACTOR REVIEW

A. Review for compliance with Contract Documents and approve submittals before transmitting to Engineer.

B. Contractor shall be responsible for:

1. Determination and verification of materials including manufacturer's catalog numbers

2. Determination and verification of field measurements and field construction criteria

3. Checking and coordinating information in submittal with requirements of Work and of Contract Documents

4. Determination of accuracy and completeness of dimensions and quantities

5. Confirmation and coordination of dimensions and field conditions at Site

6. Construction means, techniques, sequences, and procedures

7. Safety precautions

8. Coordination and performance of Work of all trades.

C. Do not fabricate products or begin Work for which submittals are required until approved submittals have been received from Owner and Owner's Representative.

1.16 ENGINEER REVIEW

A. Do not make "mass submittals" to Owner and Owner's Representative. "Mass submittals" are defined as six or more submittals or items in one day or 15 or more submittals or items in one week. If "mass submittals" are received, Owner and Owner's Representative's review time stated above will be extended as necessary to perform proper review. Owner and Owner's Representative will review "mass submittals" based on priority determined by Owner and Owner's Representative after consultation with Contractor.

B. Informational submittals and other similar data are for Engineer's information, do not require Owner and Owner's Representative's responsive action, and may not be reviewed or returned with comment.

C. Submittals made by Contractor that are not required by Contract Documents may be returned without action.

D. Submittal approval does not authorize changes to Contract requirements unless accompanied by Contract Modification.

E. Contractor's submittals will be returned marked with one of the following classifications:

1. Code A (Approved) - No corrections, no marks

2. Code B (Approved as Noted) - A few minor corrections or notes to Contractor. Contractor shall complete work in accordance with corrections or notes. All items may be fabricated as marked without further resubmission.

3. Code C (Revise and Resubmit) - Minor corrections. Items not noted to be revised and corrected may be fabricated. Resubmit items as per original submissions with corrections noted.

4. Code X (Not Approved) - Requires correction or is otherwise not in accordance with contract documents. No items shall be fabricated.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 60 00.01 - PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Products

B. Product delivery requirements

C. Product storage and handling requirements

D. Product options

E. Equipment electrical characteristics and components.

1.2 PRODUCTS

A. At minimum, comply with specified requirements and reference standards.

B. Specified products define standard of quality, type, function, dimension, appearance, and performance required.

C. Furnish products of qualified manufacturers that are suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise. Confirm that manufacturer's production capacity can provide sufficient product, on time, to meet Project requirements.

1.3 PRODUCT DELIVERY REQUIREMENTS

A. Transport and handle products according to manufacturer's instructions.

B. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.

C. Provide equipment and personnel to handle products; use methods to prevent soiling, disfigurement, or damage.

1.4 PRODUCT STORAGE AND HANDLING REQUIREMENTS

A. Store and protect products according to manufacturer's instructions.

B. Store products with seals and labels intact and legible.

C. Store sensitive products in weathertight, climate-controlled enclosures in an environment suitable to product.

D. For exterior storage of fabricated products, place products on sloped supports aboveground.

E. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

1.5 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Products complying with specified reference standards or description.

B. Products Specified by Naming One or More Manufacturers: Products of one of manufacturers named and complying with Specifications; no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with Provision for Substitutions: Submit Request for Substitution for any manufacturer not named, according to Section 01 25 00.01 - Substitution Procedures.

PART 2 PRODUCTS

2.1 EQUIPMENT ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Include lugs for terminal box.

B. Cord and Plug: Furnish minimum 6-foot (2-m) long cord and plug including grounding connector for connection to electric wiring system. Cord of longer length may be specified in individual Specification Sections.

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 70 00.01 - EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Closeout procedures

B. Starting of systems

C. Demonstration and instructions

D. Project record documents

E. Spare parts and maintenance products

F. Product warranties and product bonds

G. Preparation

H. Execution

I. Cutting and patching

J. Final cleaning.

1.2 CLOSEOUT PROCEDURES

A. Prerequisites to Substantial Completion: Complete following items before requesting Certification of Substantial Completion, either for entire Work or for portions of Work:

1. Submit maintenance manuals, Project record documents, photographs, and other similar final record data in compliance with this Section.

2. Complete Soil Vapor Extraction Unit System startup, testing, adjusting, balancing of systems and equipment, demonstrations, and instructions to operating and maintenance personnel as specified in compliance with this Section.

3. Deliver tools, spare parts, extra stocks of material, and similar physical items.

1.3 STARTING OF SYSTEMS

A. Coordinate schedule for startup of various equipment and systems.

B. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.

C. Verify that tests, meter readings, and electrical characteristics agree with those required by equipment or system manufacturer.

D. Verify that wiring and support components for equipment are complete and tested.

E. Execute startup according to manufacturer's instructions.

1.4 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of products to Engineer’s personnel prior to date of final inspection.

B. Use operation and maintenance manuals as basis for instruction. Review contents of manual in detail to explain all aspects of operation and maintenance.

C. Demonstrate startup, operation, control, adjustment, troubleshooting, servicing, maintenance, and shutdown of each item of equipment, at equipment location.

D. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

E. Required instruction time for each item of equipment and system is specified in individual Specification Sections.

1.5 PROJECT RECORD DOCUMENTS

A. Maintain one set of the following record documents; record actual revisions to the Work:

1. Drawings
2. Specifications
3. Addenda
4. Change Orders and other modifications to the Contract
5. Reviewed Shop Drawings, product data, and Samples
6. Manufacturer's instruction for assembly, installation, and adjusting.
7. Survey data
8. Sample collection and analysis data

B. Ensure entries are complete and accurate, enabling future reference.

C. Specifications: Legibly mark and record, at each product Section, description of actual products installed, including the following:

1. Manufacturer's name and product model and number
2. Product substitutions or alternates used
3. Changes made by Addenda and modifications.

D. Record Drawings: Legibly mark each item to record actual fabrication as follows:

1. Include Contract modifications such as Addenda, supplementary instructions, change directives, field orders, minor changes in the Work, and change orders

2. Include locations of concealed elements of the Work

3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work

4. Field changes of dimension and detail

5. Details not on original Drawings.

E. Submit marked-up paper copy documents to Ownerwith claim for final Application for Payment.

F. Submit Portable Document Format (PDF) electronic files of marked-up documents to Owner with claim for final Application for Payment.

1.6 SPARE PARTS AND MAINTENANCE PRODUCTS

A. Furnish spare parts, maintenance, and extra products in quantities specified in individual Specification Sections.

B. Deliver to Project Site and place in location as directed by Owner.

1.7 PRODUCT WARRANTIES AND PRODUCT BONDS

A. Obtain warranties and bonds executed by responsible Subcontractors, suppliers, and manufacturers within ten days after completion of applicable item of Work.

B. Execute and assemble transferable warranty documents and bonds from Subcontractors, suppliers, and manufacturers.

C. Verify documents are in proper form, contain full information, and are notarized.

D. Co-execute submittals when required.

E. Include table of contents and assemble in binder with durable cover.

F. Submit prior to final Application for Payment.

G. Time of Submittals:

1. Make submittals within ten business days after date of Substantial Completion, prior to final Application for Payment.

2. For items of Work for which acceptance is delayed beyond Substantial Completion, submit within ten business days after acceptance, listing date of acceptance as beginning of warranty or bond period.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 EXECUTION

A. Comply with manufacturer's installation instructions, performing each step in sequence.

B. When manufacturer's installation instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Verify that measurements are as indicated on approved Shop Drawings or as instructed by manufacturer.

D. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1. Secure Work true to line and level and within specified tolerances, or if not specified, industry-recognized tolerances

2. Physically separate products in place, provide electrical insulation, or provide protective coatings to prevent galvanic action or corrosion between dissimilar metals

3. Exposed Joints: Provide uniform joint width and arrange to obtain best visual effect. Refer questionable visual-effect choices to Engineer for final decision.

E. Allow for expansion of materials and building movement.

F. Install each unit of Work under conditions to ensure best possible results in coordination with entire Project.

1. Isolate each unit of Work from incompatible Work as necessary to prevent deterioration

2. Coordinate enclosure of Work with required inspections and tests to minimize necessity of uncovering Work for those purposes.

G. Mounting Heights: Where not indicated, mount individual units of Work at industry recognized standard mounting heights for particular application indicated.

1. Refer questionable mounting heights choices to Engineer for final decision.
2. Elements Identified as Accessible to Handicapped: Comply with applicable codes and regulations.

H. Adjust operating products and equipment to ensure smooth and unhindered operation.

I. Clean and perform maintenance on installed Work as frequently as necessary through remainder of fabrication period. Lubricate operable components as recommended by manufacturer.

3.2 CUTTING AND PATCHING

A. Employ skilled and experienced installers to perform cutting and patching.

B. Execute cutting, fitting, and patching to complete Work and to:

1. Fit the several parts together, to integrate with other Work
2. Uncover Work to install or correct ill-timed Work
3. Remove and replace defective and nonconforming Work
4. Remove samples of installed Work for testing
5. Provide openings in elements of Work for penetrations of mechanical and electrical Work.

C. Execute Work by methods to avoid damage to other Work and to provide proper surfaces to receive patching and finishing.

D. Restore Work with new products according to requirements of Contract Documents.

E. Fit Work tight to pipes, sleeves, ducts, conduits, and other penetrations through surfaces.

F. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.

G. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for assembly, refinish entire unit.

END OF SECTION

SECTION 02 62 16 - SOIL VAPOR EXTRACTION UNIT SYSTEM FABRICATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. Soil vapor extraction (SVE) Unit System design, fabrication, delivery, and onsite startup and testing.

B. Related Sections:

1. Section 26 00 00 – Electrical General
2. Section 26 05 19 – Conductors and Cables
3. Section 26 05 26 – Electrical Grounding
4. Section 26 05 33.01 – Conduits and Raceway System
5. Section 26 05 53 – Identification for Electrical Systems
6. Section 26 09 00 – Instrumentation
7. Section 26 09 10 – Control Panels
8. Section 26 09 16.01 – Miscellaneous Electrical Controls
9. Section 26 21 01 – Incoming Services
10. Section 26 22 00 – Low Voltage Transformers
11. Section 26 27 16 – Enclosures
12. Section 26 27 26 – Wiring Devices
13. Section 26 28 00 – Panelboards and Circuit Protective Devices
14. Section 26 29 13 – Motor Controllers
15. Section 26 43 13 – Transient Voltage Surge Suppression
16. Section 26 50 00 – Lighting
17. Section 27 27 10 – Managed Connected Router Wireless Communications System
18. Section 40 05 13.74 – Plastic Process Piping
19. Section 40 05 23.01 – Common Work Results for Process Valves
20. Section 40 05 29.01 – Hangers and Supports for Process Piping and Equipment

1.2 DESCRIPTION OF WORK

A. This specification prescribes the requirements for the fabrication of an SVE Unit System. The Contractor shall provide labor, supervision, materials, equipment, tools, permits, and services that are required to fabricate, deliver, startup, and test the SVE Unit System as shown on the Drawings and as covered in this section. After delivery of the SVE Unit System to the site, Others will install and connect the system to the SVE line to a three-phase electrical service. Unless noted otherwise, all items described on the drawings shall be the responsibility of the Contractor. Specific items which are the responsibility of Others are labeled on the Drawings as work “By Others.”

B. The SVE Unit System shall consist of the unit’s control system; panelboards; motor starters; the system enclosure, which shall house the equipment listed at the end of this subsection; and the

moisture accumulation drum. The SVE Unit shall have external connections, as shown on the Drawings, to allow Others to connect the SVE Unit to the SVE wells and piping

C. Two horizontal extraction wells will each connect to a SVE conveyance line, through individual 4" Schedule 80 polyvinyl chloride (PVC) conveyance pipes. The SVE line will connect the two lines to the header pipe, and the header pipe will then connect to the SVE Unit System through an external connection, as shown in the Drawings.

The SVE Unit System shall extract approximately 350 standard cubic feet per minute (scfm) from each extraction well at a vacuum of 50 inches of water column (in. WC; at the inlet to the SVE Unit System).

The SVE Unit system shall include vapor analysis sample ports on the influent and effluent piping.

The SVE well line will have a 3/8" sampling port. Each sampling port will connect to its counterpart at the Vapor Analysis Manifold with a 3/8" Teflon™-lined polyethylene tubing line. The Contractor shall provide the tubing to allow Others to connect each extraction well to the Vapor Analysis Manifold. The tubing will enter the system enclosure through a casing pipe, shown on the drawings. The casing pipe shall have an external connection to the SVE Manifold, as shown on the drawings.

An explanation on how the SVE Unit System will control sampling and SVE well operations is provided in subsection 2.14 "Control System" of this section.

The SVE Unit System shall have the following remote monitoring and control capabilities:

- Remote monitoring of concentrations
- Remote monitoring of flow rates from each extraction well
- Ability to turn extraction wells on and off remotely.

D. The SVE Unit System Enclosure shall house the following components:

1. Vapor-Liquid Separator
2. Vapor-Liquid Separator Transfer Pump
3. Air Filter
4. Dilution Air Silencer
5. Soil Vapor Extraction Blower
6. Blower Discharge Silencer
7. Heat Exchanger
8. Moisture Accumulation Drum.

E. The Contractor shall provide piping, fittings, and electrical connections inside the SVE Unit System. The Contractor will be responsible for external piping, external electrical work, and for connecting the external piping and electrical work to the SVE Unit System.

1.3 REFERENCES

A. American Society of Testing and Material International (ASTM)

1. ASTM A-36/A36M-19 – Standard Specification for Carbon Structural Steel
2. ASTM D1785-21a – Standard Specification for PVC Plastic Pipe, Schedules 40, 80, and 120.

B. National Electrical Code (NEC)

1. National Electrical Code 2017.

1.4 SUBMITTALS

A. Contractor's Field Reports: Daily reports of all activities performed on site (i.e. delivery, start-up, and testing activities) shall be submitted to the Owner on a daily basis.

B. Operation and Maintenance Manual:

1. Operating instructions outlining the step-by-step procedures required for system startup, operation, and shutdown. Include in the instructions layout, wiring, and control diagrams of the system as installed. Include lasted approved shop drawings. Also include the manufacturer's name, model number, service manual, parts list, brief description of all equipment and their basic operational features, and operating instructions for each piece of equipment and bulletins, data sheets and descriptive data.

2. Maintenance instructions listing routine preventative maintenance procedures, possible breakdowns and repairs, and trouble-shooting guides

3. The Contractor shall provide any data requested by the Owner. Proprietary information or data shall be made available based on a non-disclosure agreement, if necessary.

C. As-Built Drawings:

1. Record actual locations of equipment, piping, valves and other appurtenances, connections, and centerline elevations.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00.01 - Execution and Closeout Requirements.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Tools: Furnish special tools, equipment, and other devices required to maintain system. Furnish compatible and appropriately labeled toolbox.

1.7 QUALITY ASSURANCE

A. Section 01 40 00.01 - Quality Requirements

B. The Contractor shall arrange and pay for all necessary official inspections and permits and shall install or modify the equipment as required as a result of the official inspection. All changes shall be documented by the Contractor and reported to the Owner to allow for construction options to be exercised.

1.8 QUALIFICATIONS

A. Manufacturers of the required equipment shall be companies specializing in manufacturing products specified in this section with a minimum of 10 years of experience in the manufacture of soil vapor extraction equipment.

B. Installer: Company specializing in performing Work of this Section, with minimum five years documented experience, shall be authorized for installation of the supplied equipment and shall have all required licenses and certifications for the Work performed on site.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00.01 - Product Requirements.

B. The Contractor shall be responsible for safe and timely transportation of the SVE Unit System, as described in subsection 1.2 of this section, to the site. The Contractor shall be responsible for any issues which are the result of equipment transportation.

C. Others will be responsible for providing any equipment required for system unloading and temporary storage.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

A. Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

B. Major equipment items such as the blower shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.2 VAPOR-LIQUID SEPARATOR

A. Manufacturers:

1. H2K Technologies Model VLS-100 or engineer approved equivalent
2. Substitutions: Section 01 25 00.01 – Substitution Procedures.

B. Product Description: Vapor-liquid separator.

1. Welded steel construction in accordance with ASTM A-36/A36M-19 for sheet steel
2. 30 inches (in.) of mercury vacuum rating

3. 100 gallon total capacity, 40 gallon liquid holding capacity
4. PVC sight glass with low/high/high-high float switch
5. 4 in. female pipe thread (FPT) inlet and 6 in. FPT outlet
6. Tangential inlet and demister for 99% + moisture removal
7. 6 inch cleanout port.

2.3 VAPOR-LIQUID SEPARATOR TRANSFER PUMP

A. Manufacturers:

1. AMT model 489 or engineer approved equivalent
2. Substitutions: Section 01 25 00.01 – Substitution Procedures.

B. Product Description: End suction centrifugal pump.

1. 10 gallons per minute (gpm) at 72’ total dynamic head (TDH)
2. Stainless steel volute and impeller
3. ¾ horsepower (HP), 208-230/460 VAC, 3-phase, TEFC motor.

2.4 AIR FILTER

A. Manufacturers:

1. Solberg CT-235P-400 Inlet Air Filter Assembly or engineer approved equivalent
2. Substitutions: Section 01 25 00.01 – Substitution Procedures.

B. Product Description: Inlet air filter assembly.

1. 2-micron, 99%+ removal efficiency
2. Carbon steel construction
3. 570 scfm flow rating
4. 4 in. flanged inlet and outlet.

2.5 DILUTION AIR SILENCER

A. Manufacturers:

1. Solberg Silencer FS-231P-200 or engineer approved equivalent
2. Substitutions: Section 01 25 00.01 – Substitution Procedures.

B. Product Description: Regenerative industrial/chemical processing blower.

1. 2” male pipe thread (MPT) outlet
2. 135 scfm flow rating.

2.6 SVE BLOWER

A. Manufacturers:

1. Rotron EN909BG72WL Regenerative Blower or engineer approved equivalent
2. Substitutions: Section 01 25 00.01 – Substitution Procedures.

B. Product Description: Regenerative industrial/chemical processing blower.

1. 15 HP, 230/460 VAC, 3-phase, totally enclosed, fan cooled (TEFC) Motor
2. Design flow: 374 scfm at 70 in. WC
3. Include vacuum switch on blower intake to trigger a low vacuum alarm.
4. Include a temperature switch at the outlet, upstream of the bypass to the atmosphere, to trigger a high temperature alarm when the blower discharge temperature exceeds 255 degrees Fahrenheit.

2.7 BLOWER DISCHARGE SILENCER

A. Manufacturers:

1. Solberg SLCR400 or engineer approved equivalent
2. Substitutions: Section 01 25 00.01 – Substitution Procedures.

B. Product Description: Blower Silencer.

1. 4 in. FPT inlet and outlet.

2.8 SYSTEM ENCLOSURE

A. Product Description: 10’ wide x 20’ long x 8.5’ high International Organization for Standardization Seabox system enclosure.

1. Corrosion resistant white steel exterior
2. 3/8” pressure treated flooring
3. Steel skid(s) appropriate for mounting of all equipment inside the enclosure
4. Insulated R20 walls and ceiling
5. Barn-style rear double doors with passive vents
6. One additional passive vent on the wall
7. Interior: incandescent light with vapor globe and wall switch
8. Interior: all electrical components and wiring shall be per NEC for a class 1, division 2 area inside of enclosure
9. Interior: ventilation fan with hand-off-auto (HOA) switch and hood
10. Exterior: NEMA 4-door in door control panel
11. Exterior: 480VAC Panelboard with service entrance rated circuit breaker
12. Exterior: 208/120VAC Panelboards
13. Exterior: 460V:208V/120V transformer.
14. Exterior: Combination motor starter (3 places).

2.9 MOISTURE ACCUMULATION TANK

A. Product Description: 250-gallon storage tank.

1. Volume capacity of 250-gallons

2. Load capacity of 500 pounds (minimum)
3. Water-tight lid or cover
4. Suitable for outdoor storage
5. Shall include a high-high float switch.

2.10 CONTROL SYSTEM

A. Product Description. Programmable logic controller (PLC) based control system with Operator Interface Terminal touchscreen to control the vapor-liquid separator transfer pump, SVE blower, Vapor Analyzer, solenoid valves, and vent fan.

B. Process Control Description. The Contractor shall develop a PLC program to control and sample the individual wells and operate them in a manner that maximizes concentrations in the extracted vapors. The PLC shall be programmed to operate the number of wells stated under subsection 1.2 of this section at any given time. Each well shall be controlled and made active by energizing the appropriate solenoid on the SVE line.

C. Graphical Displays on the Operator Interface Terminal (OIT). The OIT shall be programmed to display a graphical representation of the SVE System. This graphical representation shall consist of multiple screens logically organized to provide the user with an intuitive feel for navigating through these multiple screens. These multiple screens shall be organized around a main screen that shall depict an overview of the system. Additional screens shall depict an overview of each site or well in the SVE system. These additional screens shall be user selectable from the overview screen by choosing an appropriate icon. Additional screens depicting details pertinent to each site shall be available and user selectable from the site overview screens.

Information on each screen shall be arranged in a concise and orderly appearance, with options to select (or "drill down to") more detailed information that shall be provided on additional screens. The status of all input and output points at each well and site shall be depicted on either the site overview screen, or on one of the detail screens for that particular well or site. It shall be possible to determine the status of each input or output point by selection of the appropriate screen.

Appropriate symbols shall be chosen for each graphical element. Design of the graphical elements shall be done to maximize readability and minimize confusion. Graphical elements shall be designed to replicate an appropriate symbol for the item that is to be represented, to give a realistic appearance for the item to be represented, or to represent that item in a manner so that it cannot be misunderstood.

D. Use Factory Talk View Studio to develop screens and to program the OIT in support of the PLC program. Use Factory Talk ViewPoint to publish the screens developed to a website so that the status of the SVE equipment may be monitored remotely.

E. Remote Monitoring/Control. The PLC shall be able to serve as a remote terminal unit of the future SCADA system to allow user to monitor and control the SVE System off-site. Specific requirements for the remote monitoring and control capabilities are outlined in Specification Section 26 09 10 Control Panels.

F. Provide a desktop computer and provide support to allow monitoring and control of the SVE System remotely.

2.11 PIPE

A. The SVE inlet piping through the enclosure, all piping within the enclosure, the vapor-liquid separator drain piped through the enclosure, the piping from the vapor-liquid separator transfer pump to the moisture accumulation drum, and the blower air dilution inlet piping shall be schedule 80 PVC, or approved equivalent.

2.12 VALVES AND SAMPLE PORTS

A. The valve ends and size shall be compatible with adjacent piping.

B. All valves and sample ports shall be either schedule 80 PVC or Class 150.

2.13 INSTRUMENTATION

A. Pressure Gauges

1. Dial type with bottom connection
2. 3 ½-inch diameter dial
3. 0 to 75 psi reporting range
4. For use with -4 degrees F to 150 degrees F operational range
5. Within 2% accuracy
6. Steel case material

B. Pressure Gauge for Blower Discharge

1. Dial type with bottom connection
2. 2 ½-inch diameter dial
3. 0 to 125 psi reporting range
4. For use with -4 degrees F to 250 degrees F operational range
5. Within 2% accuracy
6. Type 304 stainless steel case material.

C. Vacuum Gauge - Low Vacuum Application

1. Dial type with bottom connection
2. 4-inch diameter dial
3. -150 to 0 inches of water reporting range
4. For use with -4 degrees F to 150 degrees F operational range
5. Within 2% accuracy
6. Type 304 stainless steel case material.

PART 3 EXECUTION

3.1 FABRICATION

A. Fabricate SVE Unit System based on the Engineer-approved design submittal.

3.2 POSTED FRAMED INSTRUCTIONS

A. Post installation instructions, sequences, and precautions, including tolerances for level, horizontal, and vertical alignment as specified. Submit for approval prior to posting: wiring and control diagrams; system layouts and isometrics; instructions and other sheets; operating instructions explaining preventive maintenance procedures; and checks to assure the system is operating normally and safely. Methods of checking the system for normal safe operation; procedures for operating the system; and procedures for safely starting and stopping the system shall be prepared in typed form, framed and posted beside the diagrams. Catalog cuts are not acceptable.

3.3 CONTRACTOR'S FIELD SERVICES

A. The Contractor shall coordinate the delivery of the SVE Unit System with the Engineer or Owner .

The Contractor shall provide the services of a field representative who is experienced in the installation, adjustment, testing, and operation of the equipment specified at the site. When installation of the SVE Unit System is complete, the system shall be inspected, tested, and adjusted by the Contractor's field representative and the Owner's representative to ensure that the system operates properly. All equipment shall be carefully inspected for defects in workmanship and material; debris and foreign matter shall be cleaned out of all equipment; all operating mechanisms shall be tested to check their proper functioning; and all nuts and bolts shall be checked for tightness. Valves and other equipment which do not operate easily or are otherwise defective shall be repaired or replaced. Tests shall assure that there is no abnormal vibration, or noise from any parts. If deficiencies are revealed during tests, such deficiencies shall be corrected and the tests shall be re-conducted. Results of the tests shall be used in determining the capacity and performance of the SVE Unit System.

The Contractor will be responsible for making changes to their installed work, as needed, based on the results of the Contractor's inspections and tests.

END OF SECTION

SECTION 03 20 00 - CONCRETE REINFORCING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Reinforcing bars.
   2. Reinforcement accessories.

1.2 RELATED SECTIONS

A. Section 03 30 00 – Cast-In-Place Concrete

1.3 REFERENCES

A. American Concrete Institute (ACI):
   1. ACI 301-16 - Specifications for Structural Concrete.
   2. ACI 318-19(22) - Building Code Requirements for Structural Concrete.
   3. ACI MNL-66(20) - ACI Detailing Manual.
   4. ACI TMS 402/602 – Building Code Requirements and Specification for Masonry Structures.

B. American Society for Testing and Materials (ASTM) International:
   1. ASTM A615/A615M-04 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

C. Concrete Reinforcing Steel Institute (CRSI):
   1. CRSI - Manual of Standard Practice.
   2. CRSI - Placing Reinforcing Bars.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate bar sizes, spacings, locations, and quantities of reinforcing steel, bending and cutting schedules, and supporting and spacing devices.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

D. Submit certified copies of mill test report of reinforcement materials analysis.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store rebar off ground in ventilated and protected manner to prevent deterioration from moisture.

1.6 COORDINATION

A. Coordinate with placement of formwork, formed openings and other Work.

PART 2 PRODUCTS

2.1 REINFORCEMENT

A. Reinforcing Steel: ASTM A615/A615M-04, 60 kilo-pounds per square inch (ksi) yield grade, deformed billet bars, uncoated finish.

2.2 ACCESSORY MATERIALS

A. Tie Wire: Minimum 16 gage annealed type.

B. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions

2.3 FABRICATION

A. Fabricate concrete reinforcement in accordance with ACI 318-19(22).

B. Form standard hooks for 90-degree bend.

C. Form reinforcement bends with minimum diameters in accordance with ACI 318-19(22).

D. Locate reinforcement splices at point of minimum stress. Review location of splices with Engineer.

PART 3 EXECUTION

3.1 PLACEMENT

A. Place, support and secure reinforcement against displacement. Do not deviate from required position beyond specified tolerance.

B. Accommodate placement of formed openings.

C. Space reinforcement bars with minimum clear spacing in accordance with ACI 318-19(22).
   1. Where bars are indicated in multiple layers, place upper bars directly above lower bars.

3.2 ERECTION TOLERANCES

A. Install reinforcement within the following tolerances for flexural members, walls, and compression members:

Reinforcement Depth Tolerance	Concrete Cover Tolerance
plus or minus 3/8 inch	minus 3/8 inch

B. Install reinforcement within the tolerances specified in ACI TMS 402/602 for foundation walls.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing and Inspection Services.

B. Perform field inspection in accordance with ACI 318-19(22).

C. Provide free access to Work and cooperate with Engineer.

END OF SECTION

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SUMMARY

A. Section includes cast-in-place concrete for the following:
   1. Footings.
   2. Concrete vaults.

1.2 RELATED SECTIONS

A. Section 03 20 00 – Concrete Reinforcing

1.3 REFERENCES

A. American Concrete Institute (ACI):
   1. ACI 117-10 - Standard Specifications for Tolerances for Concrete Construction and Materials.
   2. ACI 301-16 - Specifications for Structural Concrete.
   3. ACI 305R-20 - Hot Weather Concreting.
   4. ACI 306R-16 - Standard Specification for Cold Weather Concreting.
   5. ACI SPEC-308.1-23 – External Curing of Cast-in-Place Concrete.
   6. ACI 318-19(22) - Building Code Requirements for Structural Concrete.
   7. ACI PRC-347-14(21) - Guide to Formwork for Concrete.

B. American Society for Testing and Materials (ASTM) International:
   1. ASTM C33/C33M - Standard Specification for Concrete Aggregates.
   2. ASTM C94/C94M-22 - Standard Specification for Ready-Mixed Concrete.
   3. ASTM C150/C150M - Standard Specification for Portland Cement.
   4. ASTM C260/C260M-10a - Standard Specification for Air-Entraining Admixtures for Concrete.
   5. ASTM C494/C494M-17 - Standard Specification for Chemical Admixtures for Concrete.
   6. ASTM C618-22 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
   7. ASTM C1017/C1017M-13e1 - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
   8. ASTM D994/D994M-11(2022) - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
   9. ASTM C1582/C1582M-11(2017)e1 - Standard Specification for Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Submit certified concrete mix designs including proposed admixtures at least 14 days prior to commencing concrete operations.

C. Submit certified delivery tickets for concrete showing the following information:
   1. Water-Cement ratio (by weight)
   2. Mix proportions
   3. Source and type of cement
   4. Type and name of admixtures.

D. Testing results for concrete slump, air, temperature, and strength.

E. Submit written field quality control testing results.
   1. Submit records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
   2. Submit to Engineer 3 days following testing or sooner.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 301-16.

B. Conform to ACI 305R-20 when concreting during hot weather.

C. Conform to ACI 306R-16 when concreting during cold weather.

PART 2 PRODUCTS

2.1 CONCRETE MATERIALS

A. Cement: ASTM C150/C150M-22, Type I, IA, II, or IIA.

B. Fine and Coarse Aggregates: ASTM C33/C33M.

C. Water: Clean and not detrimental to concrete.

2.2 ADMIXTURES

A. Air Entrainment: ASTM C260/C260M-10a.

B. Chemical: ASTM C494/C494M-17
   1. Type A - Water Reducing
   2. Type B – Retarding
   3. Type D - Water Reducing and Retarding
   4. Type F - Water Reducing, High Range
   5. Type G - Water Reducing, High Range and Retarding

C. Corrosion Inhibitor: ASTM C1582/C1582M-11(2017)e1

2.3 ACCESSORIES

A. Corners: Chamfer, wood strip type, maximum possible lengths.

B. Sealant: The holes and exposed steel produced on all surfaces by the removal of form ties, cone-bolts, and she-bolts shall be cleaned, wetted, and filled with a dry-pack mortar as listed below.
   1. The mortar will consist of one part Portland cement, three parts sand that will pass a No. 16 sieve, and just sufficient water to produce a consistency such that the filling is at the point of becoming rubbery when the material is solidly packed.

C. Non-Shrink Grout: ASTM C1107/C1107M-20; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 pounds per square inch (psi) in 48 hours and 7,000 psi in 28 days.

D. Bonding Agent: Sikadur 32 Hi-Mod or W.R. Meadows Intralok #350 or Engineer approved equivalent.

2.4 SVE WELL PAD AND CONDENSATION COLLECTION POINT VAULT CONCRETE MIX

A. Mix concrete in accordance with ACI 301-16. Deliver concrete in accordance with ASTM C94/C94M-22.

B. Provide concrete to the following mix design:

Unit	Measurement
Compressive Strength (28 day)	3,000 psi
Water/Cement Ratio (maximum)	0.5 by weight (mass)
Entrained Air %	5-7%
Slump	5 inches max.

C. Admixtures: Include admixture types and quantities indicated in concrete mix designs approved through submittal process.
   1. Add air entraining agent to normal weight concrete mix for work exposed to exterior.
   2. Add water reducing admixture to reduce shrinkage.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify requirements for concrete cover over reinforcement.

B. Verify lines, levels, and centers before proceeding with formwork. Verify dimensions agree with Drawings.

C. When formwork is placed after reinforcement resulting in insufficient concrete cover over reinforcement before proceeding, request instructions from Engineer.

D. Verify anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with placing concrete.

3.2 PREPARATION

A. Clean previously placed concrete by bush-hammering. Apply bonding agent just before next concrete placement.

B. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.

C. Remove debris and ice from formwork, reinforcement, and concrete substrates.

D. Remove water from areas receiving concrete before concrete is placed.

E. Prepare the subgrade according to Section 31 23 23.

3.3 COLD AND HOT WEATHER REQUIREMENTS

A. Cold Weather: Except with authorization, do not place concrete when the ambient temperature is below 40 °F or when the concrete is likely to be subjected to freezing temperatures within 24 hours.

B. Hot Weather: the temperature of the concrete as placed shall not exceed 90 °F.

3.4 FORMWORK INSTALLATION

A. Earth Forms:
   1. Earth forms are not permitted.

B. Formwork - General:
   1. Construct forms to correct shape and dimensions, mortar-tight, braced, and of sufficient strength to maintain shape and position under imposed loads from construction operations.
   2. Carefully verify horizontal and vertical positions of forms. Correct misaligned or misplaced forms before placing concrete.
   3. Complete wedging and bracing 24 hours before placing concrete.

C. Framing, Studding and Bracing:
   1. Space studs at 16 inches on center maximum for nominal 2-inch boards and 12 inches on center maximum for plywood.
   2. Size framing, bracing, centering, and supporting members with sufficient strength to maintain shape and position under imposed loads from construction operations.
   3. Construct beam soffits of material minimum of 2 inches thick.
   4. Distribute bracing loads over base area on which bracing is erected.
   5. When formwork is placed on ground, protect against undermining, settlement or accidental impact.

D. Erect formwork, shoring, and bracing to achieve design requirements, in accordance with requirements of ACI 301-16.

E. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.

F. Obtain Engineer's approval before framing openings in structural members not indicated on Drawings.

G. Install chamfer strips on external corners of walls.

H. Do not reuse wood formwork more than 1 time for concrete surfaces to be exposed to view. Do not patch formwork.

I. Maximum variation (tolerance) from lines and grades shown in the Drawings: ½ inch.

3.5 FORMWORK INSTALLATION - INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Install formed openings for items to be embedded in or passing through concrete work.

B. Locate and set in place items required to be cast directly into concrete.

C. Coordinate with Work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.

D. Form Ties:
1. Use sufficient strength and sufficient quantity to prevent spreading of forms.
2. Leave inner rods in concrete when forms are stripped.
3. Space form ties equidistant, symmetrical and aligned vertically and horizontally unless otherwise shown on Drawings.

E. Arrangement: Arrange formwork to allow proper erection sequence and to permit form removal without damage to concrete.

F. Openings for Items Passing Through Concrete:
1. Frame openings in concrete where indicated on Drawings. Establish exact locations, sizes, and other conditions required for openings and attachment of work specified under other sections.
2. Coordinate work to avoid cutting and patching of concrete after placement.
3. Perform cutting and repairing of concrete required as result of failure to provide required openings.

3.6 CONVEYING

A. Concrete shall be delivered to the site and discharged into the forms within l½ hours after the introduction of the cement to the water and aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes.

B. The Engineer may allow a longer time, provided the setting time of the concrete is increased a corresponding amount by the addition of an approved set-retarding admixture. In any case, concrete shall be conveyed from the mixer to the forms as rapidly as practicable by methods that prevent segregation of the aggregates and assure no loss of mortar occurs.

3.7 PLACING CONCRETE

A. Place concrete in accordance with ACI 301-16.

B. Notify Engineer a minimum of 24 hours prior to commencement of concrete placement. Concrete shall not be placed until the subgrade, forms, steel reinforcement, and embedded items have been inspected and approved by the Engineer. No concrete shall be placed except in the presence of the Engineer. Deficiencies are to be corrected before concrete is delivered for placing. On arrival at the job site, no water will be added other than that required initially to adjust to the specified slump.

C. Ensure reinforcement, inserts, embedded parts, formed expansion and contraction joints are not disturbed during concrete placement.

D. The free drop of concrete shall not exceed 5 feet without the use of adjustable length pipes.

E. Extend joint filler from bottom of slab to within 1/2 inch of finished slab surface.

F. Deposit concrete at final position. Prevent segregation of mix.

G. Place concrete in continuous operation for each panel or section determined by predetermined expansion, control, and construction joints.

H. Consolidate concrete immediately after placement.

I. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

J. Do not interrupt successive placement; do not permit cold joints to occur.

3.8 CONCRETE FINISHING

A. Finish concrete floor surfaces in accordance with ACI 301-16.

B. Steel trowel surfaces which are indicated to be exposed.

C. In areas with sumps, maintain floor elevation at walls; pitch surfaces uniformly to drains as indicated on drawings.

D. Adding dry cement or water to the surface of the screeded concrete to expedite finishing is not allowed.

3.9 CURING AND PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
   1. Protect concrete footings from freezing for minimum 5 days.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

3.10 FORM REMOVAL

A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads, and until removal has been approved by Engineer.

B. Concrete shall reach 80% of its design strength before any loads are placed on it (erecting the building). 7-day cylinder test results may be submitted to the Engineer and for approval to expedite placement of loads on the concrete.

C. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

D. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

E. Leave forms in place for minimum number of days as specified in ACI PRC-347-14(21).

3.11 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing and Inspection Services.

B. Provide free access to Work and cooperate with Engineer.

C. Notify Engineer after placement of reinforcing steel in forms, but prior to placing concrete.

D. Schedule concrete placement to permit formwork and reinforcing steel inspection before placing concrete.

E. Strength Test Samples:
1. Sampling Procedures: ASTM C172/C172M-17.
2. Cylinder Molding and Curing Procedures: ASTM C31/C31M-23, cylinder specimens, standard cured.
3. Sample concrete and make one set of three cylinders for every 100 yd^3 or less of each class of concrete placed each day and for every 5,000 ft^2 of surface area for slabs and walls.

F. Field Testing:
1. Slump Test Method: ASTM C143/C143M-12.
2. Air Content Test Method: ASTM C173/C173M-16.
3. Temperature Test Method: ASTM C1064/C1064M-17.
4. Measure slump and temperature for each compressive strength concrete sample.
5. Measure air content in air entrained concrete for each compressive strength concrete sample.

3.12 PATCHING

A. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.

B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Engineer upon discovery.

C. Patch imperfections in accordance with ACI 318-19(22).

3.13 DEFECTIVE CONCRETE

A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.

B. Repair or replacement of defective concrete will be determined by Engineer.

C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.

END OF SECTION

SECTION 26 00 00 - ELECTRICAL GENERAL

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes general requirements for all electrical work. The Contractor shall furnish and install all materials, equipment, and appurtenances necessary for a complete and satisfactory installation of the electrical systems. The Contractor shall coordinate all electrical work required for the project. The Contractor shall provide the correct electrical service to each piece of electrical equipment whether or not shown on the drawings and check and coordinate electrical service and controls required with equipment provided under other specification sections.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers

B. National Fire Protection Association (NFPA)

C. Underwriters Laboratories, Inc. (UL)

D. National Electrical Manufacturers Association (NEMA)

E. American Society of Testing Materials (ASTM)

F. Association of Illuminating companies (AEIC)

G. Insulated Cable Engineers Association (ICEA)

1.3 SUBMITTALS

A. Submittals shall include the manufacturer's name, trade name, place of manufacture, catalog model number, complete part number, nameplate data, size, layout dimensions, capacity, project specification, and paragraph reference.

B. Shop Drawings: Submit shop drawings in accordance with the General Conditions, the Supplementary Conditions, Section 01 33 00 Submittals, and Section 26 00 00 Electrical General. Organize similar items into a single submittal that includes wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Shop drawings shall be specific for this project. Shop drawings which provide only generic information or are of a generic nature are not sufficient. Information within the shop drawings shall be clearly marked to identify components applicable for this project. Non-applicable information shall be noted, or neatly crossed out.

C. Manufacturer's Catalog Data: Shop drawings shall include manufacturer's catalog data for each manufactured item. Submittals for each manufactured item shall be current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog data sheets. Submittal shall include ratings, circuit diagrams, and dimensional data as a minimum.

D. Materials List: The Contractor shall submit, along with Shop Drawings, a materials list which shall include full information, including manufacturer's complete part number, regarding all components of the equipment. Materials of construction shall be presented in the listing by ASTM reference and grade.

E. Nameplate Information. Submit complete nameplate information for all industrial machinery. The nameplate shall include the following information:

1. Supply voltage, number of phases, frequency, and full-load current

2. Maximum ampere rating of the short-circuit and ground-fault protective device

3. Ampere rating of largest motor, from the motor nameplate, or load

4. Short-circuit current rating of the machine industrial control panel. Short-circuit current rating shall be based on the short-circuit current rating of a listed and labeled machine control enclosure or assembly. Or the short-circuit current rating shall be as established utilizing an approved method.

5. Electrical diagram number, or the number of the index to the manufacturer's electrical drawings.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Manual. Prepare operation and maintenance manuals. Submit one manual for review; then submit the remainder (quantity to be agreed between EPA or Engineer and contractor in advance.) Include one copy of the following:

1. Copy of all relevant, and previously reviewed shop drawings, with all comments addressed.

2. Record (as-built) drawings, incorporating all field changes and Engineer's comments.

3. Wiring diagrams incorporating all field changes and Engineer's comments.

4. Manufacturer's instructions on care, operation, and maintenance of equipment.

5. Narrative describing the procedures for equipment startup and operation.

6. Warranty certificates.

7. Spare parts list

8. Complete type written operating instructions, covering all systems descriptions and operation, emergency operating instructions, and precautions.

9. Copies and originals of all applicable software certificates showing proof of ownership by the Owner or Owner's Representative.

10. Name, address, and telephone number of supplier or representative of manufacturer for each item of equipment in Contract.

Bind all items (all unused, clean and legible) in common folder or heavy notebook covers and submit to Engineer before request for final acceptance.

B. Affidavit of Compliance. The manufacturer shall provide an affidavit stating compliance of their equipment with all applicable provisions of this specification.

C. Software. Submit two electronic copies of all final application software developed. Electronic copy shall be on flash drives, or other method mutually agreed upon between Engineer and Contractor. In addition to electronic copies, submit hard copy of all application software developed. For software applications of a graphical nature (such as Operator Interface Terminals or Human Machine Interfaces), hard copy submittal shall include copies of all screens.

D. Setup Parameters. Submit printed copy of all setup parameters used for all equipment in this project. This includes, but is not limited to, all setup parameters used for the programmable controller, and the operator interface terminal. Include the factory default value of each parameter in this list of setup parameters.

1.5 QUALITY ASSURANCE

A. Experience: All equipment furnished under Division 26 shall be furnished by manufacturers who have at least three (3) years' experience in the design, production, assembly, and field service of equipment of like type and size. Products shall have been in satisfactory commercial or industrial use for two years prior to bid opening. The two-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturer's catalogs, or brochures during the two-year period. Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6,000 hours, exclusive of the manufacturer's factory or laboratory tests, is furnished.

B. Uniformity: Unless otherwise specified, equipment or material of the same type of classification, used for the same purpose shall be the product of the same manufacturer. All material shall be new and of the current design of the manufacturer providing equipment or material.

C. Design: Equipment and accessories not specifically described or identified by manufacturer's catalog numbers shall be designed in conformity with NEMA, IEEE, or other applicable technical standards and shall have a neat and finished appearance.

D. Installation: Erect equipment in a neat and workmanlike manner; align, level, and adjust for satisfactory operation. Install equipment so that parts are easily accessible for inspection,

operation, maintenance, and repair. Minor deviations from the indicated arrangements may be made, but only after obtaining approval from the Engineer or Owner's Representative.

E. Electrical work shall meet or exceed the latest revisions for the following standards and codes except where more stringent requirements have been specified:

1. Local Building Codes
2. National Fire Protection Associations – NFPA
3. National Electrical Code – NEC
4. National Electrical Safety Code - NESC
5. Underwriters Laboratories, Inc. – UL
6. National Electrical Manufacturers Association – NEMA
7. Institute of Electrical and Electronic Engineers – IEEE
8. American Society of Testing Materials – ASTM
9. Insulated Power Cable Engineers Association – IPCEA
10. Association of Edison Illuminating Companies – AEIC
11. American National Standard Institute - ANSI

F. In general, all electrical equipment furnished shall be listed and labeled by Underwriters Laboratories, Inc. (UL), Factory Mutual (FM), Edison Testing Laboratories (ETL), or another nationally recognized testing laboratory acceptable to the Engineer or Owner's Representative. Submit name of organization that will label equipment if other than UL. Organization shall certify that the equipment meets applicable UL, ANSI, and NEMA standards.

1.6 INSPECTIONS

A. The Contractor shall have all electrical work inspected by the following agency and this work shall pass such inspection: Independent electrical inspection agency approved by the Engineer or Owner's Representative.

B. The Contractor shall furnish to the Engineer a certificate of compliance stating that the completed installation complies with the requirements of the NEC. This certificate shall be completed by the approved independent electrical inspection agency.

1.7 CONTRACT DRAWINGS

A. Locations Approximate. The locations of equipment shown on the Contract Drawings are approximate only. The Contractor shall determine the exact locations of the equipment, box-outs, sleeves, and of similar items required for the coordination of electrical work with the mechanical and other work.

B. Plan Drawings Diagrammatic. Power and Control Plans, and Lighting, Receptacle Circuit & Grounding Plans shown are diagrammatic and functional only and are not intended to show exact conduit layouts, number of fittings, or other installation details. The final determination as to routing, location, and termination shall be governed by structural conditions, obstructions, and job conditions. This shall not be construed to mean that the design of the system may be changed without written approval. The Contractor shall obtain shop drawings affecting all conduit locations before installation. The Contractor shall consult all drawings and specifications which may affect location of any outlet, piece of equipment, or conduit run to avoid interference with

other trades. The Contractor shall furnish all labor and materials necessary to install and place in satisfactory operation all power, control, and other electrical systems shown.

C. Elementary Circuit Drawings and Control Panel Drawings Diagrammatic. Circuit diagrams and elementaries shown are diagrammatic and functional only and are not intended to show exact wiring, circuitry, or to be considered a substitute for wiring diagrams. Control Panel drawings, including sub-panel layout drawings, are diagrammatic and functional only and are not intended to show exact parts and locations, or to be considered a substitute for assembly drawings. The Contractor shall submit shop drawings detailing exact part selection, placement, and wiring connections.

D. Parts lists and part numbers are included to convey design intent using actual manufactured parts. Every attempt has been made to provide a part number that may be used to order and purchase parts; but the Contractor shall be responsible for checking all part numbers to verify that all parts will perform the intended function correctly as part of an integrated system, and fit in the designated space.

1.8 INSTRUCTION OF ENGINEER'S REPRESENTATIVES

A. Before request for final acceptance of Work, furnish necessary skilled personnel to operate all systems. Instruct designated Engineer's representative in proper operation and care of systems and equipment. Repeat instructions as required.

1.9 PROTECTED WORK

A. Dry Locations. Dry locations are not normally subject to dampness or wetness. An area classified as dry may be temporarily subject to dampness or wetness.

B. Wet Locations. Wet locations are areas outside, underground, in concrete slabs or masonry in direct contact with the earth, and areas subject to saturation with water or other liquids, such as a vehicle washing area and unprotected areas exposed to weather.

C. Corrosive Areas. Corrosive areas are areas where the potential exists for corrosive gases or liquids to come in contact and corrode equipment and materials. Corrosive Areas shall include rooms housing chemical storage tanks or chemical feed equipment or pumps.

1.10 GROUNDING

A. Equipment and systems shall be bonded and grounded in accordance with Article 250 of the National Electrical Code, applicable local codes, the electrical utility provider, and the manufacturer's recommendations.

B. Ground raceways and noncurrent carrying parts of electrical equipment in accordance with NEC Article 250. Use the metallic conduit system for equipment and enclosure grounding. Grounding through the conduit system shall be in excess of any ground conductors shown on the Contract Drawings.

C. Circuits in nonmetallic conduit shall carry one equipment grounding conductor for equipment grounding.

PART 2 PRODUCTS

2.1 CONCRETE EQUIPMENT PADS (CEP)

A. Provide concrete equipment pads where shown on the Contract Drawings for equipment mounting racks, transformers, panelboards, control panels, and other floor and ground mounted equipment. Concrete shall be 4500 PSI, 28 day minimum. Refer to details on electrical drawings for outdoor concrete equipment pads.

2.2 EQUIPMENT MOUNTING RACKS (EMR)

A. Equipment mounting racks shall be provided as required to mount and support equipment and where specifically shown on the Contract Drawing details.

B. The details shown on the Contract Drawings provide minimum requirements for the equipment mounting racks. Equipment mounting racks shall be designed to support the required equipment. Equipment mounting racks shall be constructed to maintain a rigid installation minimizing movement and racking.

C. Materials

1. Tubing: 2” x 2” x ¼” Aluminum Alloy (6063-T52)

2. Backplate: ¼” thick aluminum plate (up to 24” x 24” maximum); 3/8” thick aluminum plate (for sizes larger than 24”x 24”)

3. Bottom Plate: 6” x 6” x ½” Aluminum Alloy

4. Hardware: 3/8” stainless steel locknuts, bolts, and washers.

5. Alternatively, Thomas & Betts Kindorf channel system, with stainless steel hardware, and non-corrosive parts.

D. Assembly

1. Corners and angles shall be ground smooth and shall be free of burrs.

2. Equipment mounting racks shall be constructed as required to accommodate field conditions such as handrails, mounting against walls, or other structures.

3. Equipment mounting racks installed in grass areas shall be provided with a concrete equipment pad. The concrete equipment pad shall extend a minimum of 6” around the perimeter of the equipment and an additional 30” (minimum) in front of the equipment to provide an area for operators to stand.

4. Equipment mounting racks shall be sized to facilitate access to the equipment controls. Controls shall be accessible in an area between 42” and 60” above finished grade.

5. Utilize 3/8” full welds as appropriate for the connection of the components.

E. Equipment Mounting Racks installed in rooms or areas designated as “Corrosive Areas” shall be constructed of non-metallic components. Hardware shall also be non-metallic, and resistive to corrosion.

2.3 PADLOCKS

A. Padlocks shall be suitable for outdoor, severe weather use and shall be provided with the following features:

1. Boron alloy-steel shackles which repel saws and bolt cutters

2. Dual locking shackles shall resist forcing or prying

3. Pick resistant spool pins

4. Durable thermo-plastic cover to protect lock body and key cylinder from dirt, dust, and other contaminants

5. Special drain channels to move water through the lock body

6. 2-1/8 inch wide steel case and five pin W6000 removable cylinder.

B. Padlocks shall be “keyed alike” for similar equipment, such that all locks can be opened via the same key number. Keys shall be punched with letters as specified. Pad locks shall be provided for the following areas:

1. Each Pad Mounted Transformer (Punched: “XMFR”)
2. Each Substation Area man-gate and vehicle gate. (Punched: “SUBST”)
3. 10 Spare Padlock & keys.

C. Manufacturers

1. Master – Pro-Series 6121
2. equal.

PART 3 EXECUTION

3.1 PAINTING OF EQUIPMENT

A. Factory Applied. Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test.

B. Field Applied. Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria.

3.2 NAMEPLATE MOUNTING

A. Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two stainless steel sheet-metal screws or two stainless steel rivets.

3.3 COORDINATION

A. The Contractor shall coordinate all electrical work involving existing circuits and operations with the Engineer for required shutdowns, conversions, and tie-ins.

END OF SECTION

SECTION 26 05 19 - CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section includes wires, cables, and accessories as shown, specified, or required for the complete power, lighting, control, and other systems in the Contract.

1.2 REFERENCES

A. NFPA 70 - National Electrical Code (NEC)

B. NFPA 262 – Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces

C. Insulated Cable Engineers Association (ICEA)

D. Underwriters Laboratories, Inc. (UL)

E. National Electrical Manufacturers Association (NEMA)

F. American Society of Testing Materials (ASTM)

G. Association of Edison Illuminating Companies (AEIC).

1.3 SYSTEM DESCRIPTION

A. Product Requirements. Provide products as follows:

1. Conductors for feeders and branch circuits 10 AWG and smaller shall be stranded
2. Control circuits shall utilize stranded conductors
3. Conductors for power and lighting circuits shall not be smaller than 12 AWG
4. Conductors for control circuits shall not be less than 16 AWG
5. Increase wire size in branch circuits to limit voltage drop to a maximum of 2.5%.

B. Wiring Methods. Provide the following wiring methods:

1. Concealed Dry Interior Locations: Use only building wire, type THHN/THWN, or XHHW insulation in raceway (rigid metal conduit, intermediate metal conduit, or electrical metallic tubing), or nonmetallic-sheathed cable or armored cable.

2. Exposed Dry Interior Locations: Use only building wire, type THHN/THWN, or XHHW insulation in rigid metal conduit.

3. Wet or Damp Interior Locations: Use only building wire, type THHN/THWN, or XHHW insulation using raceway (PVC coated rigid metal conduit or rigid metal conduit), direct burial cable, armored cable, or metal clad cable.

4. Exterior Locations: Use only building wire, type THHN/THWN, XHHW, or RHW-2 insulation using raceway (PVC coated rigid metal conduit or rigid metal conduit), direct burial cable, service-entrance cable, armored cable, or metal clad cable.

5. Underground Locations: Use only building wire, type THW, THHN/THWN, XHHW, or RHW-2 insulation using raceway (PVC coated rigid metal conduit or rigid metal conduit), direct burial cable, armored cable, or metal clad cable.

6. Conductors for electrical services shall be in accordance with the National Electrical Safety Code and recommended practices of Oncor Electric.

1.4 SUBMITTALS

A. Prior to obtaining any material in connection with this Section, detailed shop drawings on all material shall be submitted. Submittals shall conform to the requirements of Section 01 33 00 - Submittals.

B. Submittals shall contain a material list with manufacturer data describing the material and showing its compliance with the specification, associated standards, and test requirements.

C. Other Submittals

1. Samples of any material shall be submitted upon the Engineer's request
2. A list of all test equipment shall be submitted to the Engineer for review
3. Cable testing results.

1.5 CLOSEOUT SUBMITTALS

A. Provide project record documents which record actual locations of components and circuits.

1.6 QUALITY ASSURANCE

A. Material and installation shall be in accordance with the latest revisions of the following codes, standards, and specifications, except where more stringent requirements have been specified herein:

1. National Electrical Code (NEC)
2. National Electrical Safety Code (NESC)
3. Insulated Cable Engineers Association (ICEA)
4. Underwriters Laboratories, Inc. (UL)
5. National Electrical Manufacturers Association (NEMA)
6. American Society of Testing Materials (ASTM)
7. Association of Edison Illuminating Companies (AEIC)

B. Conductor Manufacturers. All wires and cables of like type shall be the product of one manufacturer.

C. Manufacturer Test Requirements. Certified test reports showing compliance with applicable ICEA and UL Standards for each type of conductor shall be provided upon request.

D. In general, all electrical equipment furnished shall be listed and labeled by UL or another acceptable organization to the EPA and the Engineer. Submit name of organization that will label equipment if other than Underwriters Laboratories. Organization shall certify that the equipment meets applicable UL, ANSI, and NEMA standards.

E. Verify that field measurements are as indicated on the drawings.

F. Coordination. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required.

PART 2 PRODUCT

2.1 GENERAL

A. Unless otherwise shown or specified, all conductors shall be stranded copper.

B. Material construction of copper conductor strands shall be coated or uncoated soft drawn or annealed copper.

2.2 LOW VOLTAGE CONDUCTORS

A. Low voltage conductors for 600 VAC service and below shall be rated a minimum of 600 volts. Conductors shall be constructed of uncoated Class B copper concentric-lay- stranded wires, rated for 90 degrees C (Dry), 75 degrees C (Wet), machine tool wire with thermoplastic (PVC) insulation and nylon jacket. Conductors shall be oil and gasoline resistant II. Conductors stranded in other than Class B may be used provided that all terminals, lugs, and connectors are listed and marked for use with that conductor stranding.

B. Conductors shall be of the following type, temperature rating, insulation, and/or jacket:

1. THHN/THWN/MTW: 600 Volt, 90ºC (Dry), 75ºC (Wet)
2. MTW/AWM: 600 Volt, 90ºC (Dry) with PVC insulation.

C. Control conductors shall be type MTW/ATM, 14 or 16 AWG. Control conductors for AC circuits within control panels shall be red. Control conductors energized from a source external to the control panel source shall be yellow.
   1. Control conductors may be 16 AWG copper provided all of the following conditions are met:
      a. Continuous load does not exceed 8 amperes.
      b. Overcurrent protection is provided by one of the following:
         i) Branch-circuit-rated circuit breakers listed and marked for use with 16 AWG copper wire

ii) Branch-circuit-rated fuses listed and marked for use with 16 AWG copper wire.
iii) Class CC, Class J, or Class T fuses.

2. Control conductors may be 18 AWG copper provided all of the following conditions are met:
   a. Continuous load does not exceed 8 amperes.
   b. Overcurrent protection is provided by one of the following:
      i) Branch-circuit-rated circuit breakers listed and marked for use with 18 AWG copper wire.
      ii) Branch-circuit-rated fuses listed and marked for use with 18 AWG copper wire.
      iii) Class CC, Class J, or Class T fuses.

D. Acceptable manufacturers: Royal, Deceron, Rome, GE, General Cable/BIC, Essex, or equal.

2.3 INSTRUMENTATION CABLES

A. Multi-conductor control cable shall consist of 600 volt, individual conductors, each constructed of a minimum of seven strands of No. 14 AWG (or as shown on the Contract Drawings) uncoated Class B copper concentric-lay-stranded wires. Each conductor shall have HMW-PE insulation and color coded PVC outer jacket. Additional overall PVC jacket shall be provided around individual conductors. Cables shall be Type 20-10 manufactured by Anaconda, Type CT-B as manufactured by Rome Cable Co. or equal.

B. Twisted Shielded Pair (TSP) Instrumentation conductors shall consist of two twisted strands of No. 16 AWG (or as shown on the Contract Drawings) tinned coated Class C copper concentric-lay-stranded wires with a braid or foil shield. Each conductor shall have polyethylene insulation and color coded (black/white) PVC outer jacket. With multi-conductor twisted pair assemblies, each pair shall include an individual shield and an overall shield shall be applied over the cable assembly with an additional overall PVC jacket around the conductors.

C. Acceptable manufacturers: Rome, Deceron, Belden, or equal.

2.4 GROUNDING SYSTEM CONDUCTORS

A. Grounding grid system conductors shall be constructed of tin coated copper concentrically lay-stranded wires in accordance Section 26 05 26 - Electrical Grounding.

2.5 NETWORKING CABLES

A. Category 5e Cables (CAT 5 enhanced)

1. The cable and patch cords shall consist of four (4) unshielded twisted pair of 24 AWG solid bare copper conductors and shall be FEP Teflon insulated. The conductor shall be color coded and the cable plenum jacketed.

2. The Unshielded Twisted Pair (UTP) wiring shall be able to accommodate data transmission speeds up to 1000 MPS (gigabit Ethernet) at 100 MHz.

3. Manufacturer: Belden or equal.

B. Category 6 Cables

1. The cable and patch cords shall consist of four (4) unshielded twisted pair of 24 AWG solid bare copper conductors and shall be FEP Teflon insulated. The conductor shall be color coded and the cable plenum jacketed.

2. The Unshielded Twisted Pair (UTP) wiring shall be able to accommodate data transmission speeds up to 10 gigabits at 250 MHz.

3. Manufacturer: Belden or equal.

C. Coaxial Cable

1. Cable shall be #20 AWG tinned stranded copper with tinned copper braid shielding, and a foam FEP Teflon insulation. Cable shall be rated for 120V, 75ºC. Cable shall support Ethernet and shall be plenum jacketed.

2. Video Cable (RG6)

a. The conductor shall be #18AWG, 0.037" diameter solid bare copper. The insulation shall be made of foam polyethylene and the core shall have a nominal outside diameter of 0.180 inches.

b. There shall be two (2) bare copper braids 98% shield coverage and the cable jacket shall be made of black PVC.

3. Manufacturer: Belden or equal.

2.6 TELEPHONE CABLES

A. Telephone cable shall be twisted shielded pairs, #24 AWG, and shall be solid copper. Cable shall consist of 4 pairs or 25 pairs as shown on the Contract Drawings. Cable shall be suitable for installation in cable tray, conduit, access floors, and above suspended ceilings.

B. The cable shall be provided with a FEP Teflon insulation and shall be plenum jacketed.

C. Manufacturer: Belden or equal.

2.7 FLEXIBLE CORD

A. Flexible cord for conductors 600 VAC and below shall be rated a minimum of 600 volts. Conductors shall be constructed of Class K flexible stranded conductors for sizes 18 AWG through 10 AWG, and soft-drawn rope lay conductors for sizes 8 AWG through 2 AWG, and heat and moisture resistant thermoplastic-elastomer (TPE) insulation, type SEOW.

2.8 COLOR CODING OF CONDUCTORS

A. Power conductors on systems 600 volts and less shall be color coded in accordance with the following:

1. 480/277 VAC, three phase, 4 wire, 60 Hz.

Phase A	Brown
Phase B	Orange
Phase C	Yellow
Neutral	White
Ground	Green

2. 240/120 VAC, single phase, 3 wire, 60 Hz.

Conductor 1	Black
Conductor 2	Red
Neutral	White
Ground	Green

3. 208/120 VAC, three phase, 4 wire, 60 Hz.

Phase A	Black
Phase B	Red
Phase C	Blue
Neutral	White
Ground	Green

B. For conductors larger than No. 6 AWG, colored tape may be used to color code the conductors at all terminations, splices or other places where they are visible.

C. Multi-conductor Instrumentation cables shall be color-coded according to ICEA/NEMA, latest edition, Method 1.

2.9 CONNECTORS AND TERMINALS

A. Connectors (for #10 AWG and smaller)

1. Solderless pressure connectors (wire nuts) for pigtail splicing all power conductors and cables #10 AWG and smaller shall be "Wing-nut" type made by Ideal.

Model No.	Wire Size
451	2 #18 min.; 3 #12 max.
452	2 #14 min.; 4 #12 max.
453	1 #10, and 1 #12 min.; 2 #8 and 1 #16 max.
455	3 #12 min.; 4 #10 max.

2. Connectors for (straight) splicing signal and control wires #10 AWG and smaller shall be solderless and compression type. Connectors shall be Burndy Hydent, Thomas and Betts Stakon, or equal.

B. Connectors (for #8 AWG and larger)

1. Connections of conductors to terminal posts or other conductors shall be made with UL approved compression type connectors. Wire nuts shall not be permitted.

2. Connections shall insure a thorough connection without damaging the conductor.

3. Connections shall be suitable for the conductor size used.

4. Typical compression type fittings shall be as specified below:

   a. Two way splices for large conductors size 1/0 and larger shall be uninsulated indenture type similar to Burndy "Hy-Link", Thomas and Betts Sta-kon, Burndy, or equal.

   b. Two way splices for small conductors, size l AWG and smaller shall be uninsulated indenture type similar to Burndy "Hy-Dent", Thomas and Betts "Sta-Kon" or equal.

   c. Fixture connections shall be two piece indenture type similar to Thomas and Betts "Sta-Kon" Series PT-66M, Ideal - Crimp Connector Sleeve No. 410 with wire cap insulated or equal.

C. Terminals

1. Terminals shall be 600 volt, indenture type, two or one hole lugs similar to Thomas and Betts "Sta-Kon", Burndy "Hylug" or equal.

2. Spade terminals shall be locking, vinyl self insulated similar to Thomas and Betts "Sta-Kon", Burndy or equal.

3. All accessories that use special tools for proper application as recommended by the manufacturer shall be installed only with those tools and in accordance with the established practices and recommendations of the manufacturers.

D. Terminal Blocks

1. Terminal blocks shall be suitable for a continuous rating of 600 VAC shall be manufactured in accordance with UL and NEMA standards for clearance between adjacent terminals.

2. Terminal blocks shall be sectional units of molded thermoplastic polyester and suitable for channel mounting.

   a. Sections shall have built-in marking areas.

   b. Center post in each section shall prevent over insertion of wires.

   c. Sections shall not be interlocked so that one section may be removed without disturbing the remainder of the assembly.

d. Terminals shall be tin plated, box lugs, having hardware recessed into the moulding, or flat terminal connectors.

E. Power Distribution Terminal Blocks

1. Power distribution blocks shall be constructed of copper. Blocks shall have a minimum of two line connections an one load connection per pole with lug wire range suitable for conductor size as indicated on the Contract Drawings.

2. Power terminal blocks shall be furnished with removable clear lexan cover plates to prevent accidental contact with live parts.

3. Power distribution blocks shall be manufactured by Allen-Bradley, Gould-Shawmut, or equal.

2.10 MISCELLANEOUS ACCESSORIES

A. Wire pulling lubricant shall be non-toxic and contain no solvents that degrade wire insulation, plastic tape, or conduits. Lubricant shall not leave residual material in conduit, shall be rust inhibited, and be non-combustible. Lubricant shall be as manufactured by Ideal, Tomic Electric, or equal.

B. Cable and wire supports shall be Kellem grips or cable supports wedges as manufactured by O. Z. Gedney, or equal.

C. Cable tags for coding of individual conductors shall be in accordance with Section 26 05 53 - Identification for Electrical Systems.

D. Plastic tape shall be all weather vinyl electrical tape having a high dielectric strength and resistant to sun, water, oil, acids and corrosive chemicals. Tape shall be 3M Type 88 or similar item as manufactured by Bishop Electric, General Electric, Okonite, or equal.

E. Electrical insulation putty shall be rubber based elastic putty in tape form. Putty shall be 3M Scotchfill or equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Unless otherwise shown or specified, all power, lighting, and control circuits shall be enclosed in conduit wireways.

B. All individual conductors shall be identified at all termination and splice points. Wire numbers or letter coding shall be by means of printed plastic tape, and shall be as scheduled on the Contract Drawings.

C. Each conductor’s insulation shall be a single color throughout its entire length.

D. Splices and connections shall be made with solderless pressure type connectors, and shall be taped and covered to provide an insulating value of the connection equal to the adjacent wire insulation.

E. Conductors installed in wireways shall be grouped and bundled as they exit each conduit run. In open areas, such as wireways, manholes, or other similar areas, wires and cables shall be tied every twelve (12) inches.

F. All conductors shall be carefully handled to avoid kinks or damage to its insulation.

1. Lubricant may be used to assist in pulling conductors through conduits.
2. Pulling strain shall not exceed the value recommended by the cable manufacturer.

G. Spare conductors shall be of sufficient length for future connections where spare terminals are provided; proper terminals shall be installed and connected.

H. Conductors shall be installed in junction boxes and pull boxes that are sized to meet the requirements of the NEC for wire bending and minimum radius.

3.2 SPLICES AND JOINTING

A. Cables and conductors installed in the underground distribution system and duct banks shall be routed continuously from termination point to termination point. No splices shall be made in underground manholes or handholes without written approval by the Engineer. Where underground or outdoor splices of 600 volt conductors are approved by the Engineer, they shall be installed utilizing an epoxy based cast splice kit. Splice kit shall be as manufactured by 3M or equal.

B. Splices shall be made in junction boxes and shall be taped to an insulating value at least equal to the insulating value of the conductors.

C. Application of taped joints shall be as follows:

1. For 480/277 VAC power circuits, connection shall be wrapped with plastic tape.

2. For lighting circuits, splice connections shall be wrapped with plastic electrical tape.

3. For motor circuit terminations, splice connections shall be wrapped with 3M Scotchfill tape and finished with plastic tape.

D. Copper to aluminum connections shall be made with UL approved aluminum-to-copper connectors and compound.

E. Solder joints, hinged connectors, and bolted terminal lugs will not be permitted. The exception of multi-bolted directed compression connectors in large wire and cable sizes will be permitted, if compression type fittings are not available.

F. Splices, taps, or terminations shall not be made when conductor ends have missing strands or when the ends are mutilated in any way.

G. Pump power and control cables shall be connected to conductors using power terminal blocks which shall be mounted inside local junction boxes as shown on the Contract Drawings. Terminal blocks shall be provided with insulation barriers so that there are no exposed live parts inside the junction box.

3.3 MULTI-CONDUCTOR CONTROL CABLE

A. Multi-conductor cable shall be provided where shown on the Contract Drawings. Multi-conductor control cable may be used where separate control circuits having a number of conductors greater than three are shown on the Contract Drawings. The Contractor shall be responsible for sizing the conduit required at no cost to the Engineer.

B. Termination of cable shall be as specified.

3.4 LOW VOLTAGE AND CONTROL CONDUCTORS

A. All power, control, and lighting conductors shall be type THHN-90C, THWN-75C/MTW unless otherwise noted.

3.5 CONNECTIONS TO EQUIPMENT

A. Connections and interconnections shall be made to all equipment in accordance with the Contract Drawings, and wiring diagrams furnished by manufacturers, and as specified by the Engineer.

B. The Contractor shall be responsible for the accuracy of the connected work made under this contract. Any damage resulting from erroneous connections shall be corrected by the Contractor at his own expense.

3.6 TESTING

A. General

1. When all wires and cables are in place but before the final connections have been made, they shall be tested.

2. Manufacturer’s data on testing resistance shall be submitted with tabulated test results.

3. Contractor shall furnish all necessary test equipment instruments.

4. All tests shall be performed in the presence of the Engineer, unless waived by the Engineer.

5. Contractor shall notify the Engineer three (3) working days in advance of any testing.

6. If damage is indicated during testing or upon review of the tabulated data, Contractor shall replace defective wires and cables and retest at no cost to the Engineer.

B. Direct Current High Potential Test

1. A direct current high potential test (Hi Pot Test) shall be performed as described below for the following conductors:

   a. All conductors operating over 600 volts.

   b. Any conductor, not otherwise required to be tested, but in the opinion of the Engineer has been subjected to possible damage.

2. The direct current high potential test shall be recorded at one minute intervals over a ten minute period for each conductor, and between each conductor and ground.

3. The ten minute period shall commence when the charging/leakage current stabilizes.

4. If leakage current stabilizes and decreases with time, the conductor being tested is acceptable.

5. Voltage levels for high potential test shall be as scheduled below.

Rated cable voltage	D.C. high potential test voltage
600	2000
Up to 5 kV	25 kV
Up to 8 kV	35 kV
Up to 15 kV	55 kV
Up to 25 kV	80 kV
Up to 28 kV	85 kV
Up to 35 kV	100 kV

6. The data recorded during high potential testing shall be tabulated by the Contractor and submitted to the Engineer in the typewritten form as indicated below:

High Potential Test Data

Circuit No.	Minute	Test Voltage		
		MF – 1/25 kV	P – 1/2 kV	P – 3/2 kV
PH A, B, C to Grd.	Init.			
	1			
	2			
	…			
	10			

Circuit No.	Minute	Test Voltage		
		MF – 1/25 kV	P – 1/2 kV	P – 3/2 kV
PH A to B, C	Init.			
	1			
	2			
	…			
	10			
PH C to A, B	Init.			
	1			
	2			
	…			
	10			

C. Megaohm Test

1. For all wires and cable #8 AWG and larger, a 1500 volt insulation resistance (Megohm) test shall be performed.

2. The Megohm test shall be performed on the following combination of conductors:

   a. Between all conductors in the same enclosure
   b. Between each conductor and ground.
   c. The resistance test shall be recorded at the end of one minute of sustained voltage.

D. Acceptance. After all final connections have been made, the equipment and controls shall be tested, by operation, to demonstrate performance.

END OF SECTION

SECTION 26 05 26 - ELECTRICAL GROUNDING

PART 1 GENERAL

1.1 SUMMARY

A. This section includes rod electrodes, active electrodes, equipment grounding conductors, grounding well components, mechanical connectors, exothermic connections, the grounding system, and the grounding grid where shown on the Contract Drawings.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers

1. IEEE 142 – Recommended Practice for Grounding of Industrial and Commercial Power Systems

2. IEEE 1100 – Recommended Practice for Powering and Grounding Electronic Equipment

B. International Electrical Testing Association

1. NETA ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

C. National Fire Protection Association

1. NFPA 70 – National Electrical Code

1.3 SYSTEM DESCRIPTION

A. The Grounding systems shall use the following elements as grounding electrodes:

1. Existing or new metal underground water pipe
2. Metal building frame
3. Concrete-encased electrode
4. Ground ring
5. Rod electrode
6. Plate electrode

B. All of these metal underground systems and structures shall be bonded together to form the grounding electrode system. Piping systems and underground tanks shall be included when present.

1.4 SUBMITTALS

A. Prior to obtaining any material in connection with this Section, detailed shop drawings on all material shall be submitted including but not limited to:

1. Ground Grid Conductors
2. Grid Connecting Conductors
3. Grid Compression Connectors (each type)
4. Compression Tools
5. Grounding Electrodes
6. Ground Bushings
7. Water Pipe Ground Connectors

B. Test Reports: Indicate overall resistance to ground and the resistance to ground at each electrode.

C. Submittals shall conform to the requirements of Section 01 33 00 - Submittals.

D. Submittals shall contain a material list with manufacturer data describing the material and showing its compliance with specifications, associated standards, and test requirements.

E. Prior to installation of any material, a detailed plan layout of the entire grounding system, including location and quantity of electrodes, connections, and cables shall be submitted to the Engineer for review.

F. Samples of any material shall be submitted upon Engineer's request.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of components and grounding electrodes.

1.6 QUALITY ASSURANCE

A. Materials and installation shall be in accordance with latest revisions of the following codes, standard, and specifications, except where more stringent requirements have been specified herein:

1. National Electrical Code (NEC)
2. Underwriters Laboratories, Inc. (UL).

B. These Specifications require that all grounding and grounding circuitry equal or exceed the requirements of the NEC Article 250, and in the event of a conflict or discrepancy between these Specifications, the Contract Documents, and NEC Article 250, the more stringent requirements shall apply.

1.7 COORDINATION

A. Complete grounding and bonding of building reinforcing steel prior to concrete placement.

PART 2 PRODUCT

2.1 GROUNDING GRID SYSTEM CONDUCTORS

A. Grid connecting conductors shall be minimum size 4/0 AWG bare stranded copper conductors in accordance with NEC Article 250.

2.2 GROUNDING ELECTRODES

A. Rods shall be 5/8 inch in diameter, minimum 8 feet long unless otherwise shown, steel core with copper molten welded or electrolytically bonded to exterior. Two section ground rods are acceptable. Rods shall be manufactured by Copperweld Steel Co., Thompson Lightning Protection, Inc. or equal.

B. Grounding plates shall be 24 inch by 24 inch, ¼ inch thick solid copper.

2.3 GRID CONDUCTOR CONNECTORS

A. Connections shall be made with compression type connectors specially made for buried grounding systems as manufactured by Thomas & Betts Co., Burndy Corp. or equal.

2.4 EQUIPMENT GROUND CONDUCTORS

A. Equipment ground conductors shall be in accordance with Section 26 05 19 – Conductors and Cables.

1. Ground conductor #8 and smaller shall be green in color.

2. For #6 and larger ground conductors, black wire may be used and identified where exposed in all junction boxes, disconnect switches, panels, etc. with green tape wrapped over its entire exposed length.

B. All exposed grounding conductors such as bars, straps, cables, flexible jumpers, braids, shunts, etc., shall be bare copper.

PART 3 EXECUTION

3.1 GENERAL

A. All grounding and bonding of electrical installations shall be in accordance with, or shall exceed, the requirements of Article 250 of the NEC. In the event of a conflict or a discrepancy between these Specifications, the Contract Document Drawings, and the NEC, the more stringent requirement shall apply.

3.2 INSTALLATION

A. Install in accordance with IEEE 142.

B. Install grounding rod electrodes at locations as indicated on the drawings. Install additional rod electrodes to achieve specified resistance to ground.

C. Install grounding and bonding conductors concealed from view.

D. Install grounding well pipe with cover at rod locations as indicated on the drawings. Install well pipe top flush with finished grade.

E. Equipment Grounding Conductor. Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

F. Permanently ground entire light and power system in accordance with the NEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, ground terminals, and ground bus at service panel.

G. Bare copper bars, cables, fittings, etc. shall not be installed in cinder fill nor shall be covered with soil containing cinders or other corrosive material.

H. Cables shall be installed with enough slack to prevent breaking stresses.

I. All grounding conductors subject to mechanical damage shall be protected by rigid steel conduit or other suitable guards and in all cases where so protected shall be permanently and effectively grounded to said enclosure at each end of its lengths with approved grounding connector and conduit fittings.

J. Where grounding conductors pass through floor slabs, walls, etc., and are not encased in metal conduit, they shall be sleeved in transite, fiber, or approved nonmetallic conduit.

K. Connections to water pipes, including water meter or other similar device bypass connections, shall be made only after the surface of the pipe at the point of connection has been thoroughly cleaned and brightened and immediately prior to actually making the connection the contact surfaces are to be coated with Vaseline or Oxidation Preventive Compound.

L. All equipment ground bus, ground pads, frames, enclosures, etc., shall have all surfaces at the point of connection thoroughly cleaned and brightened, to remove paint or non-conducting material, just prior to actually making the connection. Touch-up damaged pointed surfaces to match existing conditions.

M. Splices in wire or cable grounding conductors are prohibited.

3.3 GROUNDING GRID SYSTEM

A. Grounding Grid

1. Where shown on the Contract Drawings, a system of grounding conductors and driven electrodes, known as the grounding grid, shall be installed. The grounding grid shall interconnect all the various grounding systems.

2. The grounding grid conductors shall be embedded in a minimum of 36 inches below the finished grade and 36 inches from the foundation walls or footings in the backfill material around the structure(s).

3. Earthwork including trenching, excavation and backfill shall be in accordance with Section 31 23 16 – Excavation and Section 31 23 23 - Fill.

4. All underground conductors shall be laid slack.

5. Where shown on the Contract Drawings the Contractor shall locate the existing ground grid and make connections thereto.

6. Locations shown for the existing ground grid are approximate only and the exact location shall be determined in the field.

7. Care shall be taken in locating the existing grid to avoid damage to existing power and control conduits.

B. Grounding Electrodes

1. The grounding electrodes shall be driven as located on the Contract Drawings.

2. In areas where rock is encountered or hard ground makes the driving of grounding electrodes impractical, copper plates shall be installed in lieu of the grounding electrodes. The Contractor shall notify the Engineer in writing of his intention to substitute the copper plate in lieu of the electrodes. Section 01 25 00 – Substitution Procedures

3. Installation shall be a minimum of 36 inches below grade and 36 inches from footings.

C. Grid Connecting Conductors

1. In addition to the grounding requirements of the NEC, a grid connecting conductor shall be provided for, but not limited to, the following equipment:

   a. All transformer frames
   b. Neutral transformer taps
   c. Frames of electric motors 10 HP and larger
   d. Exposed structural steel
   e. Grounding of the conduit system
   f. Service entrance disconnects
   g. Motor control centers, including enclosure and ground bus
   h. Switchgear and switchboard including enclosures and ground bus
   i. Plant water system point of connection to each building or structure, if provided
   j. Engine generator sets

2. Where any equipment is shown or specified as "future," sufficient lengths of the grounding conductor, connected to the ground grid, shall be installed for future connections.

3. The ground grid connecting conductors shall be connected to the grounding grid, and all shall be buried in or below the floor slab with no conduit enclosures, unless exposed to mechanical injury.

3.4 GROUNDING SYSTEM CONNECTIONS

A. Exposed connections shall be made with pressure clamps. Connections between different metals shall be protected against corrosion and moisture with an insulating epoxy resin.

B. Buried connections shall be made with exothermic weld type connections. Exothermic welding equipment shall be selected and used in accordance with the equipment manufacturer's instructions. Equipment and molds shall be used to accommodate the wire size, the metallic structure's shape, the wire position of attachment, vertical or horizontal, and other criteria that may be specified. Before a mold is used, remove and clean slag, dirt, and other foreign matter from the mold. Use cartridge and charge size based on the manufacturer's recommendations for the specific application. Different charges are required for steel and ductile iron pipe.

1. Surface preparation

   a. Surfaces with little or no coating shall be cleaned to bare metal by grinding or filing an area approximately three inches square to produce a bright metal surface. Weld area shall be free of coating, dirt, mill scale, oxide, grease, moisture, and other foreign matter.

   b. Surfaces with a thick coating shall have a four inch square window cut through the coating and three inches square of surface cleaned to bright metal. Avoid damaging the surrounding coating.

2. Prior to welding, remove the wire insulation as required to fit the mold. Avoid damaging the exposed copper wire. If the wire is cut or nicked over halfway through its diameter, cut off and strip a new end. If the manufacturer requires the use of a copper sleeve, the sleeve shall be crimped securely to the wire and excess wire protruding from the end of the sleeve removed.

3. After the charge is set, remove the mold and slag from the weld area with a welder's hammer. Strike the top and sides of the weld with the hammer to test the secureness of the connection. If the weld does not hold, remove the scrap weld material clean and begin the weld process again.

4. After the weld is completed and prior to coating the clean and weld area, the Engineer may test the joint bond wire for electrical continuity.

5. Weld Caps

   a. After the weld passes the test for soundness, and electrical continuity, repair coating in the weld area with a cold-applied bituminous or coal-tar mastic and a weld cap placed over the weld. Mastic shall be applied to fill the weld cap and cover the exposed metal

of the structure and the wire to a minimum thickness of 1/4 inch. Damage to the coating around the weld area shall be repaired according to the coating manufacturer's recommendations.

b. If weld cap will not fit due to physical space limitations, coat bare metal and wire in weld area with a minimum 1/4 inch thickness of bituminous mastic.

C. In fixtures, enclosures, equipment, etc., ground terminals or lugs shall be provided.

1. Ground clips may be installed within device or switchboxes where terminals are not provided or are impracticable if used with solid ground wire.

2. Each panel, switchboard, or motor control center shall be provided with a ground bar of sufficient size for all ground conductors to be connected.

3.5 CONDUIT SYSTEM

A. Ground Conductor

1. All power and 120-volt control system conduits (feeders, branch circuits, lighting circuits, etc.) shall have an internal grounding conductor, which shall be sized in accordance with the requirements of the NEC. This grounding conductor shall be installed although it may not be shown or scheduled on the Contract Drawings.

2. The internal grounding conductor shall be bonded to each device box, pull-box, junction box, or wiring trough it passes through.

3. All conduits one inch and larger shall be provided with grounding bushings on each end and at all cabinets and pull, junction, or outlet boxes.

4. The Contractor shall exercise care to ensure good ground continuity, in particular, between the conduit system and equipment frames and enclosures.

3.6 SECONDARY ELECTRICAL SYSTEM

A. The neutral conductor of all low-voltage, single and/or polyphase distribution systems shall be solidly connected at one point only. This connection shall be as follows:

1. For Separately Derived System

a. Ground neutral at transformer neutral bushing. Connect to system ground and transformer enclosure in accordance with NEC Article 250. In addition, Transformer secondary neutral bushings are also to be bonded to nearest metallic water pipe, building steel, or ground rod.

b. Control power transformers must have their secondary (neutral) leg grounded at the transformer.

2. For Subfed Secondary Systems: Neutral shall be grounded only at one point of origin of secondary systems. Do not ground subfed panel neutral bars. Ground connection shall be in accordance with NEC Article 250.

3. For Service Supplied Systems

   a. The electric service shall be grounded at an accessible point in the main service disconnect in accordance with NEC Article 250.

   b. The grounding conductor shall be sized in accordance with NEC, Table 250-66 unless otherwise shown or specified.

3.7 TESTING

A. Acceptance

1. Unless otherwise specified, the installed grounding grid shall have a resistance to ground of 5 ohms or less.

2. The Contractor shall test all grounding conductors and grounding systems for continuity. Where continuity does not exist, jumpers shall be installed at no cost to the Engineer and the system retested.

3. All testing shall be performed in the presence of the Engineer.

B. Grounding Resistance

1. Grounding resistance of the existing facility ground grid shall be tested using the ratio method, or other similar method that is acceptable to the Engineer. Contractor shall submit test procedure and equipment to be used in the testing. If the grounding resistance of the existing facility ground grid is in excess of 5 ohms, additional grounding shall be provided. After instillation of additional grounding, ground resistance shall be retested to verify that the value does not exceed 5 ohms.

END OF SECTION

SECTION 26 05 33 - CONDUITS AND RACEWAY SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section includes the conduit system required, specified, or shown on Contract Drawings including conduits, fittings, boxes, hangers, and accessories.

1.2 REFERENCES

A. American National Standards Institute

1. ANSI C80.1 – Rigid Steel Conduit, Zinc Coated
2. ANSI C80.3 – Specification for Electrical Metallic Tubing, Zinc Coated
3. ANSI C80.5 – Aluminum Rigid Conduit – (ARC).

B. National Electrical Manufacturers Association

1. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

2. NEMA FN 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies

3. NEMA OS 1 – Sheet Steel Outlet Boxes, Device Boxes, covers, and Box Supports

4. NEMA OS 2- Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports

5. NEMA RN 1 – Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

6. NEMA TC 2 – Electrical Polyvinyl Chloride (PVC) Tubing and Conduit

7. NEMA TC 3 – PVC fittings for Use with Rigid PVC Conduit and Tubing.

1.3 SYSTEM DESCRIPTION

A. Raceways and boxes located as indicated on the drawings, and other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

B. In or Under Slab or Grade: Provide rigid metal conduit or PVC coated rigid metal conduit. Provide cast metal or nonmetallic boxes.

C. Outdoor Locations, Above Grade: Provide rigid metal conduit or PVC coated rigid metal conduit. Provide cast metal or nonmetallic outlet, pull, and junction boxes.

D. Wet and Damp Locations: Provide rigid metal conduit or PVC coated rigid metal conduit. Provide cast metal or nonmetallic outlet, junction, and pull boxes. Provide flush mounted outlet boxes in finished areas.

E. Concealed Dry Locations: Provide rigid metal conduit, PVC coated rigid metal conduit, or PVC conduit. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

F. Exposed Dry Locations: Provide rigid metal conduit, PVC coated rigid metal conduit, or PVC conduit. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

1.4 SUBMITTALS

A. Prior to obtaining any material in connection with this Section, detailed shop drawings on all material shall be submitted. Submittals shall conform to the requirements of section 01 33 00 - Submittals.

B. Submittals shall contain a material list with manufacturer's name and data describing the material and showing its compliance with specifications and associated standards.

C. Samples of any material shall be submitted upon Engineer's request.

D. Prior to installation of any material in a specific area, a detailed plan layout of the conduit system, including the routing of conduits, support systems, junction boxes, conduit fittings and condulets, and coordination of other work, shall be submitted to the Engineer for review. Existing conduits and enclosures to be reused shall be shown and indicated on the submittal.

1.5 CLOSEOUT SUBMITTALS

A. Provide project record documents which record actual locations of components and circuits.

1.6 QUALITY ASSURANCE

A. Material and installation shall be in accordance with the latest revisions of the following codes, standards, and specifications, except where more stringent requirements have been specified herein:

1. American National Standard Institute (ANSI)
2. National Electrical Code (NEC)
3. National Electrical Manufacturers Association (NEMA)
4. Underwriters Laboratories (UL)

B. Equipment furnished under this section shall be furnished by manufacturers who meet the industry standards for quality, workmanship, and experience.

PART 2 PRODUCT

2.1 CONDUIT

A. Rigid Metal Conduit (Type RMC)

1. RMC shall be galvanized steel, hot-dipped with zinc over the entire length, both exterior and interior including threads. Conduits shall have a coat of lacquer for sealing.

2. Each conduit shall have a coupling on one end and a thread protector on the other.

3. Conduit shall meet ANSI Standards C80.1 and C80.4 latest revisions. The conduit shall be manufactured by Allies Tube & Conduit Corporation, Pittsburgh Standard Conduit Company, Triangle PWC Co., or equal.

B. PVC Coated Rigid Metal Conduit

1. PVC coated RMC and fittings shall consist of a rigid metal conduit having a PVC coating not less than 40 mils thick. Rigid metal conduit shall be as specified above. PVC coating shall be bonded to the conduit and fittings such that the bonding shall be stronger than the tensile strength of the PVC.

2. PVC coated RMC shall be in accordance with NEMA Standard RN-1, latest revision, for Type A-40 PVC coated conduit and fittings. PVC coated conduit and fittings must comply to ASTM D870, D1151, D3359 and D1308.

3. The PVC coated conduit and general purpose fittings must be UL Listed for the PVC as supplying the primary corrosion protection.

4. Fittings and conduit bodies shall be accordance with NEMA FB1, steel fittings with external PVC coating to match conduit.

5. The conduit threads must be hot galvanized, not hot dipped, and have an additional coat of clear Urethane.

6. PVC coated rigid steel conduit, all conduit bodies, fittings, and female threads shall include a minimum of 2 mils urethane internal coating. Product shall be Robroy Plasti-Bond Red, Perma-Cote or engineered approved equal.

C. Non-Metallic Conduits (PVC)

1. Non-Metallic conduits and fittings shall be Schedule 40 or schedule 80, polyvinyl chloride. Materials shall be corrosion and fire retardant, and sunlight resistant.

2. Conduit and fittings shall be in accordance with the NEMA Standard TC-2 and TC-3, latest revisions, and UL-651 Schedule 40 and 80 PVC Conduit.

3. The conduit and fittings shall be manufactured by Carlon Electric Conduit Co., Triangle PWC Co., or equal.

D. Flexible Conduit

1. Flexible metallic conduit (Greenfield). Shall be hot dipped galvanized flexible steel or aluminum and shall comply with UL Standard No. 1, latest revisions. Conduit shall be manufactured by Anaconda Metal Hose Company, Triangle PWC Co., or equal. Fittings shall be PVC coated at each end of the liquid-tight conduit.

2. Liquid-tight flexible metal conduit (Seal-tight). Shall be constructed of flexible corrosion resistant zinc galvanized steel conduit with an extruded plastic jacket and built-in continuous copper ground strap under the jacket. Conduit shall be Type UA manufactured by Anaconda Metal Hose Company, Type LA manufactured by Electri-Flex Co., or equal. Fittings shall be PVC coated at each end of the liquid tight conduit.

3. Liquid-tight Flexible Non-metallic Conduit. Shall be constructed of corrugated flexible PVC. Fittings shall be identified for use with flexible non-metallic conduit. Flexible non-metallic conduit shall be Carflex as manufactured by Carlon, or equal.

2.2 JUNCTION, DEVICE AND PULL BOXES

A. Junction Boxes.

1. Junction boxes and pull-boxes shall be sized as required for the quantity and size of conductors to be installed within the box. Sizes shall comply with the requirements of the National Electrical Code for wire bending space radius.

2. Stamped Steel Junction Boxes installed in areas approved for use with EMT conduit may be constructed of code-gage galvanized steel.

   Cast Junction Boxes. Junction boxes for use with RMC or IMC shall be constructed of hot-dipped galvanized cast iron or copper free aluminum and shall be sized per NEC requirements. Boxes shall be manufactured by Crouse-Hinds Co., Killark Co., or equal.

3. PVC coated Junction Boxes. Junction boxes used with PVC coated rigid metal conduit shall be hot-dipped galvanized cast iron or copper free aluminum with a minimum of 40 mil factory applied PVC coating and a minimum of 2 mil of factory applied urethane interior coating. Thin or non-coated areas of the interior coating will be cause for rejection. Cover screws or bolts shall be stainless steel. Junction boxes and fittings are to be of the same manufacturer as the PVC coated conduit and must be UL listed with the PVC as a primary corrosion protection. Junction boxes installed in wet locations shall be suitable for such use.

B. Device Boxes for Outlets and Switches

1. Stamped Steel Device Boxes. In areas approved for use with EMT Conduit, device boxes may be constructed by code-gage galvanized steel with required knockouts. Boxes shall be manufactured by Steel City Co., or equal.

2. Cast Device Boxes. Cast device boxes shall be constructed of hot-dipped galvanized cast iron or copper free aluminum and sized in accordance with the requirements of the National

Electrical Code. Boxes shall be Series FD manufactured by Crouse-Hinds Co., Series FD manufactured by Killark Co., or equal.

3. Flush Device Boxes. Device boxes installed within concrete masonry units shall be constructed of code-gage galvanized steel and shall be of the type specifically approved for masonry use. Boxes shall be installed flush with finished surface and the mounting height shall be adjusted for masonry joints.

4. PVC Coated Device Boxes. Device boxes used with PVC coated rigid steel conduit shall be hot-dipped galvanized cast iron or copper free aluminum with a minimum of 40 mil factory applied PVC coating and a minimum of 2 mil urethane interior coating. Thin or non-coated areas in the interior will be cause for rejection. Cover screws shall be stainless steel. PVC coated device boxes and fittings are to be of the same manufacture as the PVC coated conduit and must be UL listed and the PVC coating shall provide the primary corrosion protection.

C. Pull Boxes:

1. Pull boxes shall be used in dry locations only for pulling. No splicing of conductors shall be allowed. The boxes shall be constructed of galvanized steel, 12-gauge sheet metal, angle and frame members with welded joints. The pull box cover shall be gasketed and attached with stainless steel screws. A ground lug shall be provided, sized in accordance with the National Electrical Code.

2.3 CONDUIT OUTLET BODIES, FITTINGS, COUPLINGS, EXPANSION COUPLINGS, CONDUIT SLEEVES, AND SUPPORTS

A. Conduit Outlet Bodies

1. Conduit outlet bodies shall be used where required to permit ready fishing and withdrawing of wires. Conduit bodies not located in areas classified as Hazardous shall be gasketed. Bodies shall be of cast iron or copper-free aluminum type. Bodies shall be Condulet series manufactured by Crouse-Hinds Co., Electrolet series manufactured by Killark Co., or equal.

2. Conduit bodies used with PVC coated rigid metal conduit shall be of the cast type as specified above with a factory applied 40-mil PVC coating. The conduit bodies, fittings, and couplings shall be provided with extruded PVC sleeves as required by NEMA Standards. Conduit bodies, for general service, (½" – 2") shall be equipped with a V-Seal gasket. All general-purpose fittings must be UL Listed for the PVC coating as supplying the primary corrosion protection, in accordance with the National Electrical Code. All screws shall be stainless steel with the screw heads encapsulated with PVC. Product shall be Robroy "Plasti-Bond Red", Perma-Cote, or engineer approved equal.

3. Conduit outlet bodies used with rigid PVC conduit shall be of the same material and schedule as rigid PVC conduit.

B. Fittings and Couplings

1. PVC Coated RMC - All couplings and fittings for PVC coated rigid metal conduits shall have factory coating similar to above PVC coated conduit bodies.

2. PVC - All couplings and fittings for PVC rigid conduit shall be of the same material and schedule as PVC rigid conduit.

C. Expansion Couplings

1. Expansion couplings shall be a watertight, corrosion retardant coupling with flexible neoprene outer jacket, stainless steel jacket clamp, flexible copper ground strap, and internal hub bushing.

2. Coupling shall compensate for the following movements:
   a. Axial expansion or contraction
   b. Angular misalignment
   c. Parallel misalignment

3. Coupling shall be Type XD as manufactured by Crouse-Hinds Company, Type DX as manufactured by O.Z. Gedney Co., or equal.

D. Conduit Sleeves

1. Where conduits pass through the walls or floors of structures, they shall be installed in suitable sleeves. Sleeves, installed in the outside walls of structures or elsewhere where watertightness is required, shall be cast iron and shall be equal to thru-wall and floor seal manufactured by O.Z. Gedney Manufacturing Company, Inc. Types No. FSK, WSK, FSC, or WSC as required, or Link-Seal as manufactured by Thunderline Corp. When Link-Seal is used, a wall sleeve, with water-stop, shall be installed. All other sleeves shall be galvanized steel pipe.

E. Conduit Hangers and Supports

1. Hangers and supports for conduits shall be adequate to support conduit systems with a minimum safety factor of 10.

2. All steel parts of the conduit support systems shall be galvanized, cadmium plated, or PVC coated.

3. Perforated strap hangars shall not be used.

4. Conduit supports shall be as manufactured by Steel Coty Co. (Kindorf), Unistrut Corp., Allied Tube & Conduit Corporation (Power-Strut) or equal.

5. One hole, malleable iron pipe clamps shall be hot-dipped galvanized. Pipe spacers shall be of malleable iron and have a hot-dip galvanized finish.

6. Hanger rods shall be continuous thread and galvanized not less than 3/8” inch in diameter.

7. All fasteners shall be stainless or silicon bronze.

8. All expansion anchors shall be self-drilling type.

F. Cable Terminator Fitting

1. Cable terminating fittings shall be provided complete with gland nut and neoprene bushing properly sized to provide a tight seal.

2. Cable terminator fittings shall be CGB or CGF series as manufactured by Crouse-Hinds, or equal.

2.4 MISCELLANEOUS ACCESSORIES

A. Warning Tape

1. Tape shall be red and have imprinted a minimum of 1-inch high letters "CAUTION BURIED ELECTRIC LINE BELOW" or appropriate warning approved by the Engineer.

2. Tape shall be 6 inches wide, 4.5 mils thick, and made of low-density polyethylene.

3. Warning tape shall be as manufactured by Allen Systems (Houston, Texas), Panduit, or equal.

B. Duct-bank Conduit Spacers

1. Underground Duct-bank conduit spacers shall provide stability and consistent separation on duct-banks. Spacers shall be sized for the conduits with which they are used. They shall provide both vertical and horizontal spacing with interlocking intermediate and base spacers.

2. Duct-bank conduit spacers shall be as manufactured by Carlon, or equal

2.5 SUPPORT GRIPS

A. Provide a flexible wire mesh holding device to fit around an electrical cable for support of motor cable as shown on the Contract Drawings. The support grip shall support vertical runs of up to 99 feet with loads up to 600 pounds. Provide a single eye for attaching support grip to steel rod. Support grips shall be Hubbel Kellems, or equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. General

1. All interior conduit work shall be installed exposed except areas in which there is a finished ceiling, or as indicated on the Contract Drawings, "Room Finish Schedule," a finished ceiling will be installed. These areas shall have all conduit work concealed.

2. No exterior conduits shall be run exposed on outside walls of buildings, or structures.

3. Minimum size shall be ¾ inch unless specifically shown otherwise.

4. Conduit shall be installed with a minimum number of joints. Conduits shall be continuous and shall be secured in such a manner that each system shall be electrically continuous. Terminations of conduits shall be furnished with locknuts at each fabricated panel using watertight conduit hubs. (Use PVC coated hubs in corrosive or chemical environments).

5. Terminations of metallic conduits shall be furnished with grounding bushings in accordance with Section 26 05 26 - Electrical Grounding.

6. Where exposed conduit requires clamping to the building structure, clamps shall consist of galvanized iron or stainless steel one-hole pipe straps and expansion shields.

7. All conduit fittings, connectors and couplings shall be properly tightened in such a manner so as not to be easily "backed off" in order that proper ground continuity is established.

8. The use of lubricating materials to aid in the installation of conductors is allowed. Where necessary, a powdered soapstone and "Y-ER-EAS" are acceptable.

9. Support outlets, pull-boxes, and junction boxes separately from building construction, not from conduit.

10. Where exposed conduit is permitted, install conduit parallel to or at right angles with lines of building in neat and organized configurations.

11. Coordinate all conduit installations with other trades in advance of installation.

12. Ream conduit ends before installation

13. Plug conduit openings until wires are installed.

14. Where spare conduits are shown to be installed, the conduit shall be capped at each end as provided with a nylon fish-wire.

15. Expansion couplings shall be installed in conduits crossing building expansion joints.

16. Plug conduit openings until wires are installed

17. Do not install conduit or boxes in structural columns unless detailed on Contract Documents.

18. Do not install adjacent to or on hot surfaces.

19. Do not install conduit in water or in areas saturated with moisture.

20. All conduit threads shall be given a coat of zinc dust in oil or other approved compound and shall be made watertight.

21. All conduits routed next to walls, columns, or ceilings shall have minimum ¼" separation between conduit and walls or ceiling.

22. Conduit reducers shall not be allowed unless otherwise specified or approved by the Engineer.

23. Conduits entering enclosures shall be provided with Myers hubs.

B. PVC Coated RMC Requirements

1. PVC coated RMC shall be installed using proper tools for threading and tightening conduit fittings.

2. Cutting back of coating for threading will not be allowed.

3. Minor touch up of coating shall be with manufacturer's recommended touch-up compound of applicable color.

4. Contractor must be trained and certified by the factory before installation of PVC coated products can begin.

5. Any coating and conduit considered by the Engineer damaged excessively shall be replaced at Contractor's expense.

6. Conduits shall be installed with a minimum number of joints. Conduits shall be continuous and shall be secured in such a manner that each system shall be electrically continuous. Terminations of conduits shall be furnished with locknuts at each fabricated panel or pull box using PVC coated hubs. Hubs shall be as manufactured by Myers.

7. Conduits entering enclosures shall be provided with PVC coated Myers hubs.

C. PVC Rigid Conduit Requirements

1. PVC rigid conduit shall be installed per manufacturer's recommendations.

2. Use proper tools for installing PVC conduits.

3. Fittings, boxes, and other accessories shall be PVC of the same schedule with all joints being the solvent cement type.

D. Conduit Supports and Hangers

1. Conduit supports shall be spaced at intervals of 8 feet or less as required to obtain rigid construction.

2. Single conduits shall be supported by pipe clamps with clamp backs to raise conduits at least 1 inch from the surface.

3. Multiple runs of conduits shall be supported on trapeze hangers with steel horizontal members and threaded hanger rods. Trapeze hangers shall be crossed braced to prevent spreading.

4. Conduit hangers shall be attached to structural steel by means of beam or channel clamps.

5. Supports located in corrosive areas and/or where shown shall be PVC coated.

E. Conduit Routing

1. The number of bends, offsets and crossovers shall be kept to a minimum.

2. The Contractor shall exercise the necessary precautions to prevent the lodging of dirt, plaster, or foreign matter, in conduits, boxes and fittings during instillations.

3. Runs shall be parallel to walls, beams, columns and horizontal planes and shall be neatly aligned.

   a. For bends made in the field, an approved conduit bending machine shall be used.

   b. Field bends shall be symmetrical and carefully made so as to prevent damage or deformation of conduit.

4. Conduit runs shall be slightly pitched to facilitate draining condensation or shall be otherwise installed to prevent trapping of condensation.

F. Underground Conduits

1. Conduits shall be buried to a minimum of 24 inches unless otherwise shown or specified.

2. All buried metallic conduits shall be individually tied to plant grounding grid at each electric manhole or handhole.

3. All buried conduits or groups on conduits 2 feet in width or less shall have an identifying tape buried 12 inches under finish grade and located directly over the centerline of the conduits. Groups of conduits over 2 feet wide shall have additional identifying tape per 2 feet or less of additional width. Where shown on the Contract drawings, additional tapes shall be provided for duct banks wider than thirty inches.

4. Underground conduit not encased in concrete shall be PVC coated rigid steel.

5. Underground conduit exiting and entering structures shall have expansion couplings as specified.

6. Where conduit is buried below structures, footing, slabs, etc., the electrical Subcontractor shall excavate, install, backfill, and compact buried conduit prior to final compaction by General Contractor.

7. Earthwork shall be in accordance with Section 31 23 16 – Excavation and Section 31 23 23 - Fill.

8. The transition from the underground conduit system to the building interior conduit system shall occur at the first junction box, device, or equipment enclosure within the building. Conduit seals shall be provided at this location. Such seals shall minimize the circulation of air between the underground conduit system and the indoor enclosures. Seals shall be composed of Duct Seal sealing compound or similar non-hardening removable sealant.

9. Conduit bends in underground conduits shall have a minimum centerline radius as follows:

Conduit Size	Radius (inches)
3 inch	36
4 inch	42
5 inch	48

10. Conduits spacers shall be used when installing two or more underground conduits. Conduit spacers shall be located at intervals of 8 ft or less.

G. Conduits in Concrete

1. All electrical conduit placed in concrete slabs shall be installed after and above the bottom reinforcing bars, but before and under the top reinforcing bars.

    a. Where conduit crossovers are necessary, they shall be located so that the reinforcing bars are not displaced from their positions.
    a. The minimum clearance between conduits shall be 2 times the diameter of the conduit.

b. No conduit greater than t/4 in diameter, where "t" is the thickness of the concrete slab, shall be placed in any structural slab.
c. If these conditions cannot be satisfied, the conduit shall be placed below the slabs.

2. Where electrical conduits in slabs cross a building expansion joint, an expansion coupling for each conduit shall be installed at the joint.

3. Conduits encased in concrete shall be type 40 heavy - wall polyvinyl chloride per NEMA standards and UL listed.

4. Where concrete encased conduits enter manholes, #4 dowels shall be installed between the duct bank and manhole, on 8 inch centers around the perimeter of the duct bank, to minimize the potential for conduit shearing at the ductbank/manhole interface.

5. Concrete encased conduits (underground ductbanks) where shown or scheduled shall be schedule 40 PVC. Where these conduits enter buildings or equipment, concrete encasement shall stop approximately 5 ft from the building or equipment. There shall be a transition from schedule 40 PVC to RMC or IMC approximately 10 ft. from the building or equipment, so that the transition occurs within the concrete encasement.

3.2 CONDUIT TYPES

A. Conduit types shall be in accordance with the following schedule unless specifically noted otherwise on the Contract Documents:

Area/Use Description	**RMC**	**PVC-coated RMC**	**PVC**	**Reference Notes**
Underground Ductbanks	x			
Conduit Encased in Concrete			x	
Exposed Conduit	x			
All conduits in "Corrosive" Areas		x		

B. Only RMC or Intermediate metal conduit, shall be provided, unless specifically noted otherwise on the Contract Drawings.

END OF SECTION

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section includes materials, procedures, practices, and requirements that shall be provided for identification of raceways, conductors, instruments, equipment, and devices.

1.2 QUALITY ASSURANCE

A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:

1. National Electrical Code (NEC)
2. Underwriters Laboratories, Inc. (UL)

1.3 SUBMITTALS

A. Prior to obtaining any materials in conjunction with this Section, detailed shop drawings on all material shall be submitted. Submittals shall conform to the requirements of Section 01 33 00 – Submittal Procedures.

B. Submittals include:

1. Complete list of all engraved nameplates. Failure to indicate all nameplates on this list shall not relieve the contractor of the requirement for their installation.

2. Sample of engraved nameplate, punch type label, marking tags, laminated instrument tags.

3. Catalog data sheets for engraved nameplates, marking tags, or other item used to identify equipment.

4. Duplicate set of all engraved nameplates.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Nameplates shall be engraved lamicoid.

B. All lettering shall be uppercase (condensed block type), unless otherwise noted.

C. Nameplate colors shall be black with white letters unless otherwise shown.

D. Nameplate numbering system, lettering style, and letter size shall be as shown on Contract Drawings, schedules, etc.

E. Plaques for building disconnecting means shall be provided on disconnecting means enclosures for each disconnecting means. For building with multiple power sources, each power source disconnecting means shall be provided with a plaque identifying it as a building disconnecting means, and the total quantity of building disconnecting means within the building. Plaques shall be of the same construction as the service entrance plaques specified in section entitled "Incoming Services".

2.2 MARKING TAGS (WIRE AND CABLE IDENTIFICATION)

A. Marking Tags shall be by means of preprinted plastic tape. Manufacturer: Brady, O.Z. Gedney, equal.

2.3 INSTRUMENT TAGS

A. Instrument tags shall be laminated vinyl tape, minimum 3 inches by 5 inches with preprinted insert and "write on" type laminate to provide calibration and servicing information. Each tag shall include a pre-punched hole for fastening to instrument with ty-raps.

B. Tags shall be Panduit No. PST-2 or equal with a preprinted (not handwritten) insert.

C. Each instrument tag shall include the following as appropriate:

SIDE1

FI – 212(*instrument tag number)*
FLOW INDICATOR *(instrument type)*

Manufacturer: xxxxx
Model No.: xxxxx
Serial No.: xxxxx
Calibrated Range: xxxxx
Power: 0-24 VDC *(if applicable)*
Installed by: xxxxx, Inc.
Any town, Any state, USA

SIDE 2 *(write-on laminate side)*

FI – 212 *(instrument tag number)*
FLOW INDICATOR *(instrument type)*

Calibrated Range: xxxx-xxxx GPM
Output: 4-20 mA
Alarms Set @ High: xxxxx
Low: xxxxx
Recommended Service Interval: xxx months
Last Serviced on: xxxxx

Last Serviced by: xxxxx

PART 3 EXECUTION

3.1 INSTALLATION

A. Follow the numbering systems specified, scheduled and/or shown on the Contract Documents.

B. Provide identification noted on panel schedules, one-line diagrams, etc. for all instruments, panelboards, contactors, transformers, disconnect switches, bus-ways, motor starters, devices, controllers, motor control centers, unit substation, fire alarm systems, sound systems, and all other electrical devices and enclosures. Indicate with engraved lamicoid nameplate, on cover of equipment and label with numbers and letters as shown.

3.2 FASTENING

A. Nameplates: Clean equipment surface and securely fasten each label with silicone adhesive.

B. Instrument Tags: Laminated instrument tags shall be fastened to instruments with cable ties.

3.3 DEVICES (RECEPTACLES AND LIGHT SWITCHES)

A. Label all receptacles and light switches on faceplate with 3/4-inch clear punched (Dymo) tape.

B. Provide the following information:

1. Panel Designations (per panelboard schedules)
2. Branch Breaker Number

3.4 WIRE CABLES

A. Tag all feeders, sub-feeders, special system wiring, and control wiring in each panelboard, pull-box and gutter space, denoting points of origin and termination of the wires.

B. Provide the following information:

1. Panel or source where the conductors originate
2. Circuit Number
3. Circuit Designation

3.5 SPECIAL PANELBOARD REQUIREMENTS

A. Nameplates: Identify in accordance with Panel Schedule

B. Directory:

1. Provide complete type written directory for each panel, with all locations, functions, etc., clearly identified for each individual branch circuit.

2. Handwritten directory shall be provided until all circuits are connected and balanced. Then, install permanent directory. Do not mark circuit identification on the front of enclosure of panels or on other electrical equipment.

3. Lighting panel locations shall be identified in the panel directory according to location.

4. Electrical sub-feed circuits from panels shall also be identified in the panel directories.

5. When branch circuits are relocated, the panel directory shall be updated to indicate new functions and locations.

6. When branch circuits are removed, the panel directory shall be updated to indicate a spare.

END OF SECTION

SECTION 26 09 00 - INSTRUMENTATION

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes requirements for the complete instrumentation system for this project as shown, specified and as scheduled. Detailed specifications for instrumentation equipment are included herein, on the Contract Drawings, and where specifically referenced elsewhere in the specifications. Unless otherwise noted, this section shall apply to all instrumentation furnished under this project, regardless of whether it is specifically identified in this section.

1.2 QUALITY ASSURANCE

A. Material and installation shall be in accordance with the latest revision of the following codes, standards, and specifications, except where more stringent requirements have been specified herein:

1. National Electrical Code (NEC)
2. National Electrical Manufacturers Association (NEMA)
3. Underwriters Laboratories (UL)
4. American National Standards Institute (ANSI)
5. The American Society of Mechanical Engineers (ASME)
6. The American Society for Testing Materials (ASTM)
7. Instrument Society of America (ISA).

B. Qualifications of manufacturer. Provide materials and equipment that are the products of manufacturers regularly engaged in the production of such products which are of equal material, design, and workmanship. Products shall have been in satisfactory commercial or industrial use for two (2) years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturer's catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer.

C. Uniformity: Unless otherwise specified, equipment or material of the same type of classification, used for the same purpose shall be the product of the same manufacturer. All material shall be new and of the current design of the manufacturer providing equipment or material.

D. Design: Equipment and accessories not specifically described or identified by manufacturer's catalog numbers shall be designed in conformity with ISA, ANSI, ASME, ASTM, and other applicable technical standards and shall have neat and finished appearance.

1.3 SUBMITTALS

A. Submittals shall conform to the requirements of Section 01 33 00 – Submittal Procedures, and to the requirements given in Section 26 00 00 - Electrical General. In addition, submittals shall include the manufacturer's name, trade name, place of manufacturer, catalog model or number,

nameplate data, size, layout dimensions, capacity, project specification, and technical paragraph reference.

B. Submittals shall contain a material list with manufacturer's name and data describing the material and showing its compliance with specifications, associated standards and test requirements.

C. Submittals for individual pieces of equipment such as indicators, flow meters, level meters, etc. shall include manufacturer's data describing the equipment and showing its compliance with their associated specification.

D. The Contractor, his supplier, system builder, or subcontractor shall prepare and submit a set of system coordination drawings which shall show all instrument connections and interconnections as well as the functional and connection relationship of the instrumentation equipment to the related equipment and devices.

E. Prior to obtaining any material in connection with this section, catalog data and detailed wiring connection diagrams shall be submitted. Submittals for each manufactured item shall be current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog data sheets. Submittal shall include ratings, circuit diagrams, and dimensional data, as a minimum. Drawings shall include elementary and interconnection diagrams showing connections to internal components, and indicate field termination points for power and control interface. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted.

F. Shop drawings shall present complete and accurate information relative to all working dimensions, equipment weights, assembly and section views, and all necessary details pertaining to coordinating the work of the Contract, lists of materials and finishes, parts list and the descriptions thereof, lists of spare parts and tools where such parts or tools are required, and any other information that is required to demonstrate compliance with the Contract Documents. Drawings for electrical equipment shall include elementary and interconnection diagrams showing connections to internal components, and indicating field termination points for power and control interface.

G. Submit factory calibration sheets for all instrumentation, and field calibration sheets for calibration under actual use conditions.

H. Manufacturer's standard wiring diagrams and specific modifications to the wiring of the equipment shall be submitted. All terminal points for field and interconnecting wiring shall be identified.

I. Samples of any material shall be submitted upon Engineer's request.

1.4 CLOSEOUT SUBMITTALS

A. Prepare four instruction and maintenance portfolios as specified hereinafter. Each shall include:

1. Index and tabbed section dividers

2. Reviewed submittals

3. Wiring diagrams

4. System coordination drawings

5. Field adjustable settings (e.g. setpoints, ranges, spans current alarm trips)

6. Manufacturer's instructions on care and operation of equipment.

7. Spare parts list

8. Complete typewritten operating instructions, covering all systems descriptions and operation, emergency operating instructions and precautions.

9. Name, address and telephone number of supplier and representative of manufacturer for each item of equipment in Contract.

B. Bind above items (all unused, clean, and legible) in three ring binders and submit to Engineer for review. Provide before request for final acceptance.

C. Provide project record documents which record actual locations of components and circuits.

D. Provide project record documents which record actual setup and calibration of each instrument.

PART 2 PRODUCT

2.1 GENERAL

A. Unless otherwise specified, each measurement system shall be accurate within one percent of full-scale reading over the specified range. This accuracy requirement shall apply to each overall system including any transmitters, retransmitters, receivers, etc. that are shown or required.

B. All instrumentation equipment and components shall be supplied by one contractor, subcontractor, supplier or other single entity who shall coordinate the equipment and its arrangements in the shop drawing, installation and start up stages of the work.

2.2 SIGNAL CARRIERS

A. Signal Carriers for instrumentation shall include the electric wires, cables and conduits as shown, specified and required for a complete transmission of signals between transmitters and receivers.

B. Electronic instrument signals (4-20mA) shall be carried over shielded twisted pairs of wires in accordance with Section 26 05 19 - Wires and Cables. All electric interconnections and terminations shall be in accordance with the requirements for control wiring specified. Signal conductors shall be separated from power and control conductors and routed in separate conduits, regardless of whether they are specifically scheduled or shown.

C. Shielded, coaxial, or special cables, where specified or required by the manufacturer, shall be supplied by the contractor regardless of whether they are specifically scheduled or shown.

D. Current isolators shall be provided and installed where required for proper operation of the equipment.

E. All instruments which utilize a 4-20 mA analog signal shall include surge/lightning transient protectors at the transmitter's power source. Transient surge protection device shall be Phoenix Contact PLT-SEC-T3-24-FM-UT 2907916.

F. All 4-20 mA analog control loops containing field mounted (i.e. remote from control panel) transmitters shall include surge/lightning transient protectors at the transmitter. Transient protectors shall be Phoenix Contact TTC-6P-1X2-24DC-PT-I 2906815, or equal.

2.3 MISCELLANEOUS EQUIPMENT

A. Enclosures for instruments shall be suitable for the location where mounted and or specified in Section 26 27 16 – Electrical Cabinets and Enclosures.

B. Isolators. Current to Current (I/I) or Current to Voltage (I/E) isolators shall be one of the following:

1. Current to current multi-channel 2-wire isolator; 4-20 mA input, 4-20 mA output – Acromag 600T Series.
2. Input Loop Powered, current to current; 4-20mA input, 4-20mA output- Acromag 270i Isolator or equal.

C. Signal Splitters. Current to current (I/I) or Voltage to current (E/I) signal splitters shall be one of the following:

1. 2 wire type, current to current; single 4-20 mA input, dual 4-20 mA outputs – Acromag 653T, or equal.
2. 2 wire type, process voltage to current; +/- 1VDC, +/- 5VDC, or +/- 10 VDC input, dual 4-20 mA outputs – Acromag SP237, or equal.
3. 2 wire type, thermocouple to current; thermocouple/millivolt input, dual 4-20 mA control signal outputs – Acromag SP233 or equal.
4. 2 wire type, high voltage to current; +/-15 VDC, +/- 75 VDC, or +/- 150 VDC input, dual 4-20 mA outputs – Acromag SP230 or equal.
5. 4 wire type, current to current, single 4-20 mA input, dual 4-20 mA output, AC/DC powered – Acromag 633T, or equal.

D. Power Supplies. DC power supplies shall be of sufficient size to power all connected equipment with an additional 50% reserve. DC power supplies shall be: Phoenix Contact UNO-PS/1AC/24DC/30W- 2902991, or equal.

E. Power Disconnection and Overcurrent Protection. Panel mounted instruments shall have integral or external fuse protection. Field instruments shall utilize terminal block mounted fuses.

F. Signal Conditioner

1. Provide a measurement, control, and regulation device which is capable of receiving a 4-20mA input signal and generating two 4-20mA output signals. Each output signal shall be identical to the input signal and isolated to the input signal and the other output signal.

2. Performance:

   Number of inputs: 1
   Current input signal: 4 - 20 mA
   Input burden: less than 3.0 V (150 ohms) at full scale
   Input overvoltage protection: bipolar transient voltage suppressors
   Input excitation: 24VDC +/- 10%, 22mA maximum each. Full isolated. Independent current limiting
   Output range: 4-20 mA (each channel0
   Output trim range: zero to full scale adjustment to +/- 4%
   Output limiting: limited to 27 mA
   Output load: 0 to 950 ohms
   Output load resistance effect: less than +/-0.01% of output span effect for a +/-100 ohm change in load resistance
   Output response time 9input step change): 25 mSec typical to achieve 98% of final value
   Accuracy: +/-0.05% of output span
   Temperature drift: > +/-50ppm/ ºC over the ambient temperature range
   Bandwidth: -3dB at 50Hz
   Common Mode Noise Rejection:
   Input resistance (current input): 50 ohms

3. Signal output data:
   Number of outputs: 2
   Voltage output signal: 0 (each identical to the input signal).

G. Digital Line Powered Meter

1. Provide a Digital Line Powered Meter for any and all instruments that require power from a 24 VDC source. The purpose of the digital Line Powered Meter is to provide a locally mounted power supply for the Level Indicating Transmitter, Pressure Indicating Transmitter, or temperature sensor.

2. Features

   a. NEMA 4X enclosure
   b. Powered using 115/230 VAC (Universal 85-265 VAC input power)
   c. 4-20mA retransmitted signal from instrument
   d. 2 (or 4) programmable relay outputs
   e. User configurable display
   f. Display: 6 digits 1”
   g. Provide mounting kit for Digital Line Powered Meter.

3. Manufacturer/Model

a. Helios PD2-6001-6H7
b. Precision Digital Model PD650, 655, or 656 (655-45)
c. Precision Digital Model PD6000
d. Magnetrol Model 009
e. equal.

2.4 FLOAT LEVEL SWITCH

A. Float level switches shall be designed for applications requiring accurate liquid level control, including wastewater environments. Float switch shall be capable of accurately signifying specific water levels, or for direct alarm actuation.

B. Float switches shall consist of a polypropylene or polyethylene body housing a mechanical type limit switch. Float switch shall be leak proof, shock proof, and impact resistant. Float switch shall also be suitable for use in wastewater applications and for use with intrinsically safe circuits.

C. Ratings.

Liquid temperature:	minimum 0°C (32°F), maximum 76°C (170°F)
Liquid density:	minimum 0.65 g/cm^3, maximum 1.5g/cm^3
Degree of Protection:	IP68, 20m (65ft)
Contact ratings:	AC resistive load, 250 volts 10 amperes
	AC inductive load, 250 volts 3 amperes
	DC load, 30 volts 5 amperes.

D. Switch Variations
1. Normally Open (N/O). Contacts are open in the hanging position. As the float rises (1" or 5°) above the horizontal position, the contacts shall close.

2. Normally Closed (N/C). Contacts are closed in the hanging position. As the float rises (1" or 5°) above the horizontal position, the contacts shall open.

3. Single Pole, double Throw (SPDT). Both normally open and normally closed contact (but not necessarily both) available.

E. Provide cord weight to facilitate proper operation of float switch.

2.5 LEVEL INDICATING TRANSMITTER

A. The level probe shall sense the liquid level as a function of the level of submersion. Level probe shall be a twin rod probe, Guided Wave Radar type, and operate based on the technology of TDR (Time Domain Reflectometry).

B. The level sensor shall consist of stainless steel, twin rod probe, and a solid state electronic unit (transmitter) housed in a NEMA 4X enclosure. Probe will operate in conjunction with a remotely mounted level transmitter (but within 3 feet of the tank) to provide level information, through a 4-20 mA analog signal, to a remote control panel. Probe shall provide a 4-20mA signal proportional to the liquid level in the tank.

C. Transmitter

1.	Signal output	4-20 mA
2.	Span	6 to 240 inches
3.	Resolution	Analog 0.01 mA, display 0.1 inch
4.	Power	11-28 VDC

(provide locally mounted Digital Line Powered Meter so unit may be powered using 115 VAC).

D. Performance Requirements

1.	Linearity	<0.1% of probe length
2.	Measured error	+/-0.1% probe length or 0.1 inch (3mm)
3.	Resolution	+/-0.1 inch (3mm)
4.	Repeatability	<0.1 inch (3mm)
5.	Response time	<1 second
6.	Operating temperature range	-40° to +175° F (-40° to +80° C)
7.	Process dielectric effect	<0.3 inch (8mm) of selected range
8.	Humidity	0-99%, non-condensing.

E. Manufacturer/Model

1. Magnetrol Model 705 Transmitter and Magnetrol Model 7EB probe
2. equal.

F. Schedule

Tag Number	Service	Notes
1) LIT-1	Influent Tank Level	1,2
2) LIT-2	Equalization Tank Level	1,2
3) LIT-3	Effluent Tank Level	1,2

Application Notes:

1. Calibration range shall be equal to tank maximum usable depth
2. Provide surge protection.

PART 3 EXECUTION

3.1 INSTALLATION

A. All electronic instruments and systems shall operate on the universal 4-20mA signal system unless otherwise noted and shall be installed in the instrument loop so that the failure or removal of any instrument from the loop, other than primary element or power supply, will not affect the remaining instruments on the loop or the overall integrity of the loop. This shall be accomplished through the use of bias resistors at each receiver.

B. All instruments shall be installed as shown, specified, directed and recommended by the manufacturers.

C. The instrument enclosures shall be solidly grounded with a ground conductor as specified in Section 26 05 26 - Electrical Grounding.

D. Instruments shall be factory calibrated to minimize field adjustments and insure proper operation.

E. Installation: Erect equipment in neat and workmanlike manner; align, level and adjust for satisfactory operation; install so that parts are easily accessible for inspection, operation, maintenance and repair. Minor deviations from indicated arrangements may be made, but only after obtaining approval from Engineer. All power and signal (4-20 mA / 1-5 VDC / other) cables shall be kept isolated and installed in separate conduit systems.

3.2 MISCELLANEOUS INSTRUMENTATION

A. The following items of materials and installation shall also be provided under this Section.

1. Instrument panels complete with all accessories and appurtenances as shown, specified and scheduled.

2. Furnish and install all mounting stands, supports structures, brackets and accessories as required or detailed for the installation of the instruments furnished. Unless otherwise specified or required, supports shall be galvanized steel. All mounting hardware shall be stainless steel. Equipment mounted on walls in contact with ground or water shall be mounted offset from the wall a minimum of ¼-inch.

3. Temporary storage of all instrumentation equipment shall be in a humidity-controlled environment heated to a minimum of 55°F, maximum of 85°F.

4. Isolation of each device on 4-20 mA loops as required to prevent ground loops, with current-to-current isolators.

5. Current to current isolators as required to provide rated outputs into total impedance of each loop.

6. Identification of instrumentation equipment by means of metal tags or durable printed symbols with information regarding manufacturer, serial number, catalog number and model number.

7. Cutting and drilling of existing panels for new instrumentation as shown, specified, or required, including repair and touch up painting of panel after installation.

3.3 STARTUP

A. Field Tests

1. After installation, instrumentation equipment shall be checked and the required adjustments shall be made by the representatives of the manufacturers.

2. Equipment shall be field tested in the presence of the Engineer and shall be demonstrated to operate satisfactorily over the specified ranges.

3. The Contractor shall provide the necessary test equipment and qualified test personnel.

4. In the event of failure of the field test, the Contractor shall perform the necessary corrections and retest, at his own cost and expense, the equipment as directed by the Engineer.

END OF SECTION

SECTION 26 09 10 - CONTROL PANELS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes requirements for the Control Panel. This Control Panel shall provide local control and it shall be capable of being operated remotely.

B. Equipment furnished under this Contract shall be installed in an industrial type environment and powered from an electrical source that may include harmonic distortion, surges, sags, and other electrical noise under normal operating conditions. The Contractor and his suppliers shall verify that all equipment furnished shall function correctly in this noisy electrical environment. If the equipment is found to be unable to operate in this environment, the Contractor and/or his suppliers shall furnish any replacement equipment, surge protection, power line conditioners, uninterruptible power supply, or other equipment required to correct this problem at no additional cost to the Engineer.

C. This section also contains Power Line Surge Protectors as shown on the drawings, specified herein, and otherwise required for appropriate equipment including but not limited to control panels, instrument cabinets, instruments, processors, and other equipment susceptible to damage.

1.2 QUALITY ASSURANCE

A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards, and specifications, except where more stringent requirements have been specified herein:

1. National Electrical Code (NEC)
2. Underwriters Laboratories, Inc. (UL)
3. National Electrical Manufacturers Association (NEMA)
4. JIC Standard EGP-1.

1.3 SUBMITTALS

A. Prior to obtaining any material in connection with this Section, detailed shop drawings on all material shall be submitted. Submittals shall conform to the requirements of Section 01 33 00 – Submittal Procedure.

B. Submittals shall include:

1. Bill of materials for all components in the panel
2. Catalog data sheets for all components
3. Elevation/layout of panel (front view)
4. Interior sub-panel layout drawings
5. Elementary wiring diagrams (including wire numbers and field connection points)
6. Nameplate list
7. Conduit penetrations

8. Installation and support details.

C. Submittal shall contain the NEMA type designation and manufacturer's data describing the enclosure and showing its compliance with specifications and associated standards.

D. Submit diagrams detailing the type, speed, setup parameters, and purpose of all communication ports on each piece of equipment in the control panel. Include a diagram detailing the cabling connections between equipment in the control panel and their ultimate destination or source.

E. Samples of any material shall be submitted upon Engineer’s request.

F. Submittal shall contain a narrative describing the Control Strategy that will be used as the basis of the PLC program.

G. Contractor shall furnish two copies of all development programming software packages that will be used to program the PLC and OIT. One copy of the software shall be submitted within 14 days after the shop drawings are approved. The second copy shall be submitted within 60 days of project closeout.

1.4 CLOSEOUT SUBMITTALS

A. Provide project record documents which record actual software and equipment configuration.

PART 2 PRODUCT

2.1 GENERAL

A. A programmable logic controller (PLC) based control system shall be provided to control equipment, generate alarms, collect and transmit data throughout the site, and provide remote monitoring and control capabilities.

B. The Contractor shall provide a coordinated system. The Contractor shall provide hardware, software, programming, cables, connectors, line drivers, interposing relays, fuses, terminal blocks, power supplies, surge arresters, printed circuit board and graphics drivers, and special controls required to integrate and implement a functional system as specified and shown on the Contract Drawings.

C. The Control Panel shall be furnished to house a programmable controller and all other related items to form a complete control system. The Control Panel shall include a programmable controller that shall serve as the local controller at the SVE compound. The PLC shall also be capable to serve as a remote terminal unit of a future SCADA system. The Control Panel shall also include any control relays, timers, power supplies, signal conditioners, surge suppressors, control operators, pilot lights, operator interface terminals, displays, or other equipment necessary to form a complete control system capable of interfacing with the instruments in the SVE System Enclosure.

D. Type 3 Surge Protection Device. Type 3 surge protection shall be provided for the 120VAC power at each control panel. The device shall provide the following Surge Protection Performance Requirements:

1. Ambient Conditions:

Degree of protection	IP20
Ambient temperature	-40°C to 80°C (-40°F to 176°F)
Altitude	<2000 m
Permissible humidity	5% through 95%
Shock (operation)	30g (half-sine / 11 ms / 3x +/-X, +/-Y, +/-Z)
Vibration (operation)	5g (10 – 500 Hz / 2.5 h / X, Y, Z)

2. General:

EN type	T2/T3
IEC Power Supply System	TN-S separate protective earth (PE) and neutral (N)
Mode of protection	L-N, L-PE, N-PE
Mounting type	DIN rail; 33 mm
Short-circuit current rating I_{SCCR}	0.25 kA DC(w/o additional backup fuse) 5 kA DC (for 20 A gG / B backup fuse)
Maximum continuous voltage U_C	150 V DC

3. Protective circuit:

Nominal voltage U_N	120 VAC (TN-S ot TT)
Nominal frequency f_N	50 Hz / 60 Hz
Maximum continuous voltage U_c (N-PE)	150 VAC
Rated load current I_L	26 A (at 30°C)
Residual current I_{PE}	< 5 uA
Nominal discharge current I_n (8/20) us	5 kA
Standby power consumption PC	<10.6 mVA (at U_{REF}), <13.5 mVA (at U_C)
Reference test voltage U_{REF}	132 VAC
Maximum discharge current I_{max} (8/20) us	10 kA
Combination Wave U_{OC} (8/20) us	6 kA
Voltage protection level U_p (L-N)	< 0.75 kV (at U_{OC}) and < 0.95 kV (at I_n)
Voltage protection level U_p (L-PE)	< 0.85
Voltage protection level U_p (N-PE)	< 0.85
TOV behavior U_T (L-N)	240 VAC (5 s / withstand mode), 240 VAC (120 min / withstand mode)
TOV behavior U_T (L-PE)	240 VAC (5 s / withstand mode), 240 VAC (120 mins / withstand mode), 1332 VAC (200 ms / safe failure mode)
TOV behavior U_T (N-PE)	1200 VAC (200 ms / safe failure mode)
Response time t_A (L-N)	<25 ns
Response time t_A (L-PE)	<100 ns
Response time t_A (N-PE)	<100 ns
Short-circuit current rating I_{SCCR}	10 kAC

4. UL Specifications

SPD Type 2 (Open-Type SPD)	
Maximum continuous operating voltage	MCOV (L-L) 150 VAC, 150 VDC
Nominal voltage	150 VDC
Rated load current I_L	20 A
Modes of protection	L-N, L-G, N-G, (DC+)-(DC-), (DC+)-G, (DC-)-G
Power distribution system	single phase
Nominal frequency	50/60 Hz
Voltage protection rating VPR (L-N)	700V
Voltage protection rating VPR (L-G)	700V
Voltage protection rating VPR (N-G)	900V
Nominal discharge current I_n	5 kA
Short-circuit current rating (SCCR)	10 kA AC, 5 kA DC

5. Standards and regulations: meets IEC 61643-11

6. Surge protection device for 120 VAC shall be Phoenix Contact Type 3 surge protection device – PLT-SEC-T3-120-FM-UT 2907918.

E. Surge protection device for 2-wire floating signal circuit. Two wire surge protection shall be provided for sensors which utilize a 4-20 mA current loop. The device shall provide the following Surge Protection Performance Requirements:

1. Ambient Conditions:

Degree of Protection	IP20
Ambient temperature	-40°C to 85°C (-40°F to 185°F)
Permissible humidity	5% through 95%
Altitude	<4000 m
Degree of protection	IP20

2. General:

Housing Material	PBT
Mounting type	DIN rail: TH 35-7.5mm, two-section divisible module
Direction of action	Line-Line & Line-Signal Ground/Shield

3. Protective Circuit:

IEC test classification	C1, C2, C3, D1	
Nominal voltage U_N	24 VDC	
Max. continuous voltage U_C	30 VDC, 21 VAC	
Rated current	600mA (56°C)	
Operating effective current I_c at U_c	< 5uA	
Residual current I_{PE}	<1uA	
Nominal discharge current I_n (8/20) us (line-line)		5kA
Nominal discharge current I_n (8/20) us (line-earth)		5kA
Pulse discharge current I_{imp} (10/350) us (line-line)		0.5kA
Pulse discharge current I_{imp} (10/350) us (line-earth)		0.5kA

Total discharge current I_{total} (8/20) us	10kA
Voltage protection level U_p (line-line)	<200V (C1 – 1 kV/500A), <320 V (C2 – 10kV / 5kA) <50 V (C3 – 25A) <55 V (C3 – 100A

4. UL Specifications:

SPD Type 2 (Open-Type SPD)	
Maximum continuous operating voltage	MCOV (L-L) 150 VAC, 150 VDC
Nominal voltage	150 VDC
Rated load current I_L	20 A
Modes of protection	L-N, L-G, N-G, (DC+)-(DC-), (DC+)-G, (DC-)-G
Power distribution system	single phase
Nominal frequency	50/60 Hz
Voltage protection rating VPR (L-N)	700V
Voltage protection rating VPR (L-G)	700V
Voltage protection rating VPR (N-G)	900V
Nominal discharge current I_n	5 kA
Short-circuit current rating (SCCR)	10 kA AC, 5 kA DC

5. Standards and Regulations: meets IEC 61643-21 2000.

6. Surge protection device for 4-20mA devices shall be Phoenix Contact surge protection device – TTC-6P-1X2-M-24DC-PT-I 2906750.

2.2 ENCLOSURE

A. Enclosure shall be NEMA 4X. NEMA 4X enclosures shall be water-tight and dust-tight suitable for outdoor installation, protecting enclosed equipment against splashing water, seepage of water, falling or hose-directed water, and severe external condensation. Enclosure shall also be corrosion resistant. NEMA 4X enclosures located outdoors shall be stainless steel or painted fiberglass for enhanced UV protection.

B. Enclosure Construction

1. Enclosure shall be constructed of a minimum of 12 gauge steel.

2. Seams shall be continuously welded and ground smooth, with no holes or knockouts.

3. Exterior hardware shall be stainless steel.

4. Enclosure shall be provided with gray prime finish over phosphatized surface inside and out with a white enamel interior unless otherwise specified.

C. Enclosure Door

1. Enclosure shall be provided with front access single door, as required for the enclosure size. Door shall be provided with three point latches operated by a key locking handle. Latch rods shall have rollers to facilitate door closing.

2. Door shall be mounted with continuous piano hinges. A rolled lip around minimum three sides of door shall be provided to prevent dirt and liquid from dropping into the panel when door is open.

3. Door shall be fitted with a neoprene gasket applied with oil resistant adhesive and held in place with stainless steel retaining strips.

4. Provide an interior door swing-out panel. Swing-out panel shall be by the same manufacturer as the enclosure and shall be specifically designed by the manufacturer for this application. Swing-out panel shall provide an area to mount devices (instead of mounting these devices on the exterior door) so that these devices will be afforded a degree of protection from outdoor weather.

D. Interior Subpanels

1. Interior subpanels shall be constructed of minimum 12 gauge steel finished in white enamel paint. Fasteners, screws, and equipment mounting racks shall be stainless steel.

E. Internal Wiring

1. Terminal blocks for external connections shall be suitable for No. 12 AWG wire, fabricated complete with marking strip, covers, and pressure connectors. Terminal blocks shall be rated for 30A at 600 VAC unless noted otherwise. An additional 25 percent spare terminals shall be provided.

2. Terminals shall be labeled to agree with identification shown on supplier's submittal drawings. A terminal shall be provided for each conductor of external circuits, plus one ground for each shielded cable. Wires shall be numbered using wire markers. Wire numbers shall agree with terminal numbers, associated with remote equipment wiring designations, as indicated on the submittal drawings.

3. Wiring shall be grouped or cabled and firmly supported in the panel. Plastic wireway, Panduit or equal, shall be used to route wire within the panel. Wireway shall be run in continuous length with snap on covers.

F. Circuit Identification

1. Each circuit shall be identified by a typewritten directory with transparent sealed plastic cover, fastened to the inside surface of the door of the enclosure.

2. Devices mounted on or within the enclosures shall be permanently identified. The device and terminal identifications shall agree with those shown on the Contract Drawings

2.3 PROGRAMMABLE CONTROLLER

A. General

1. The PLC processor and related equipment shall be the product of one manufacturer and the components shall be completely compatible.

2. The PLC processor shall be designed and tested to operate in an industrial, high electrical noise environment. The system shall be provided with RFI protected shields and barriers to prevent interference with other electrical systems.

B. PLC Processor

1. The PLC shall be a 16 bit microprocessor-based stand-alone device. It shall be a process and logic controller designed for industrial environments. It shall be capable of a mix of logic, timing, counting, and computation functions. It shall also include a library of preprogrammed subroutines, and PID loop control capabilities.

2. The PLC shall come complete with central processors, memory, communication ports, uninterruptible power supply, interconnecting cables, and discrete and analog I/O interfaces.

3. The PLC and associated hardware shall have the following ratings (minimum):

Operating Temperature:	0 Deg. C to 60 Deg. C (32 Deg. F to 140 Deg. F)
Storage Temperature:	-40 Deg. C to 85 Deg. C (-40 Deg. F to 185 Deg. F)
Humidity:	5% to 95% relative (non-condensing)
Vibration:	5g @ 10-500 Hz
Shock	20g
Emissions	CISPR 11 Group 1, Class A
ESD immunity	IEC 61000-4-2 6kV contact discharge, 8kV air discharge
Radiated RF immunity	IEC 61000-4-3 10V/m with 1 kHz sine-wave 80% AM from 80-2000 MHz 10V/m with 200 Hz 50% 100% AM from 900 MHz 10V/m with 200 Hz 50% 100% AM from 1890 MHz 3V/m with 1 kHz sine-wave 80% AM from 2000-2700 MHz
EFT/B immunity	IEC 61000-4-4 +/- 3kV at 5kHz on power ports and communications ports
Surge Transient Immunity	IEC 61000-4-5 +/- 2kV line-earth (CM) on communication ports

Controller Tasks:	continuous	32 tasks
	Periodic	100 programs/task
	Event Tasks	all event triggers
Memory Size and Type	2 MB	
Number of I/O modules	30	
Current draw	500mA @ 5VDC, 225mA @ 24VDC	
Power dissipation	4.5W	
Isolation voltage	30V	
Communication Ports	Dual 256 Ethernet/IP 120 TCP	
	Universal Serial Bus.	

4. The PLC shall monitor the internal operation of the PLC system for failures. If a failure is detected, the system shall shut down and freeze all inputs and outputs in their last states until the error is cleared. As a minimum, the following failures shall cause the PLC to shut down:

   a. Memory Failure
   b. Memory parity failure
   c. I/O cycle failure
   d. Operating system failure

5. PLC memory shall be read/write RAM, with an EEPROM or Flash module provided. The RAM shall be battery-backed and shall retain a program for a minimum of six months if there is a loss of external power.

6. PLC Processor shall be Allen-Bradley Modular Compact1769.

C. Isolated Analog Input Module

1. Where indicated on the Contract Drawings, the PLC system shall include an Isolated Analog Input Module. The Analog Input Module shall be capable of reading 4-20mA signals for the instruments indicated.

2. The Analog Input Module shall have the following ratings:
   a. 8 channel voltage or current analog input
   b. Resolution 16 bits (unipolar) or 15 bits plus sign (bipolar)
   c. Input range +/-10VDC, 0-10 VDC, 0-5 VDC, 1-5 VDC, 0-20mA, or 4-20mA
   d. Input Impedance 220kohms (voltage) and 250 ohms (current)
   e. Accuracy +/- 0.2% full scale (voltage) and +/- 0.35% full scale (current)
   f. Normal Mode Rejection -50 dB @50/60 Hz

3. Analog Input Module shall be Allen-Bradley Model 1769-IF8.

D. Digital Input Module

1. Where indicated on the Contract Drawings, the PLC system shall include a Digital Intput Module. The Digital Input Module shall be capable of reading 16 discrete 120 VAC input points.

2. The Digital Input Module shall have the following ratings:

   a. Number of digital inputs: 16 120VAC
   b. Operating Voltage Range 79-132 VAC, 47-63 Hz
   c. Input delay 20msec
   d. Input Current: 5mA typical
   e. Input Impedance 10 kilo-ohms
   f. Response Time: Off to On 7msec, On to Off 24msec typical
   g. Isolation: 1517VAC for 1 sec or 2145VDC for 1 sec
   h. Power Requirements: 5V @ 115mA.

3. Digital Input Module shall be Allen-Bradley Model 1769-IA16.

E. Relay Contact Output Module

1. Where indicated on the Contract Drawings, the PLC system shall include an AC/DC relay contact Output Module. The Digital Input Module shall be capable of reading 16 discrete relay outputs rated for 120VAC.

2. The Relay Contact Output Module shall have the following ratings:
   a. Number of relay outputs: 16 normally open (8 points/group)
   b. Delay 10msec
   c. Current per point: 2.5 A
   d. Response Time: 10 msec
   e. Isolation: 1800VAC
   f. Power Requirements: 205mA @ 5V and 180mA at 24V.

3. Relay Contact Output Module shall be Allen-Bradley Model 1769-OW16.

F. PLC Programming Software – Use manufacturer's recommended development software to program PLC. Provide licenses and copies of PLC Development software to EPA and EA Engineering. PLC Development software shall be RSLogix 5000 (Full Edition).

G. Operator Interface

1. Contractor shall provide an Operator Interface Terminal (OIT) to display status and fault messages, and to receive inputs from the operator.

2. The OIT display shall be a touch screen interface for programmable controllers to display pictorial information, data, and messages that are preloaded into it. The touch screen area shall be programmed to perform various functions to receive inputs from the operator. The OIT display shall receive messages from the PLC processor via an Ethernet or RS-232 communication link. Section 2.13 of Specification Section 26 09 10 outlines graphical display requirements on the OIT.

3. The display shall have a display area of 246mm wide (9.7") by 184mm high (7.2") with a pixel resolution of 800(W) x 600(H) 18-bit color graphics.

4. The Operator Interface display shall have the following ratings:

Input Power	18-32 VDC 2.9A at 24VDC
UL	UL Listed Industrial Control Equipment
CE	EN61000-6-2 Industrial Immunity EN61000-6-4 Industrial Emissions
EMI	Complies with FCC Class A
Vibration endurance	10 to 25 Hz (X Y Z direction 2G 30 minutes)
Environmental	NEMA 4X / IP65 front panel with high bright panel
Operating Environment:	0°C to 55°C (32°F to 131°F)
Operation Humidity	5 to 95% relative humidity, non-condensing
LCD Display	5.7" STN 256 color
Contrast Ratio	30:1
Brightness	High Bright Panel for use in direct sunlight
Touch Panel	8 wire analog resistive. Actuation 1 million presses. Operating force 10-110g
Touch Granularity	2mm grid
Touch Feedback	Beeper and graphic indicator
Surface Hardness	4H
Operating System	Microsoft Windows CE 6.0 R3
Processor	x86 – 1.0 GHz
Memory	512 MB nonvolatile flash and 512 MB RAM
Development Software	FactoryTalk View Studio ME 9701-VWSTMENE.

5. Operator Interface shall be Allen-Bradley PanelView Plus 6 Logic Module with PanelView Plus display Touch Screen High Bright Display.

6. Operator Interface Programming Software. Use manufacturer's recommended software to develop screens for the Operator Interface Terminal. Provide licenses and copies of OIT Development software to EPA and EA Engineering. OIT Development software shall be FactoryTalk View Studio ME software 9701-VWSTMENE.

H. The Contractor shall provide all discrete input modules, discrete output modules, analog input modules, and analog output modules required for interfacing to the instruments located at each pumping station.

I. The Contractor shall provide any modem, communications module, antenna, telephone interface, cables, or other equipment to establish communications with a central computer located at EA Engineering, PBC, located at 405 S. Highway 121, Lewisville, Texas 75067. The programmable controller shall be programmed to accept commands from the central computer and transmit the status of any device or the measured value of any instrument in the SVE Compound.

J. The programmable controller shall be programmed to provide seamless and coordinated operation of all devices in the treatment compound, SVE site, or the wells.

2.4 POWER SUPPLIES

A. DC power supplies shall be of sufficient size to power all connected equipment with an additional 20% reserve.

B. Performance Requirements

1. Nominal Input Voltage: 100-240VAC (wide range input)
2. Input Voltage Range: 85-264 VAC (0.82–0.33A, 1.4A for 120VAC input) 45-65 Hz, 90-350 VDC
3. Inrush current limiting: < 35A
4. Switch-on time: < 1 sec
5. Built in Transient Surge Protection Device: Varistor
6. Nominal Output Voltage: 24VDC +/- 1%
7. Output Voltage Range Setting: 22.5-28.5 VDC
8. Nominal Output Current: 2A
9. Startup of capacitive Loads: Unlimited
10. Derating: from 60oC (140oF), 5% per Kelvin
11. Internal Surge Protection: limited to approximately 33VDC
12. Maximum Power Loss (no load/nominal load): 2W/10W
13. Connection in parallel to increase redundancy and power.

C. General Requirements

1. Isolation Voltage (input/output): 4kV/3kV
2. Enclosure Package Degree of Protection: IP 20
3. MTBF: greater than 500,000 hours
4. Ambient Temperature (Operation): -25oC to +70oC (-13oF to +158oF)
5. Storage Temperature: -40oC to +85oC (-40oF to +185oF)
6. Humidity: up to 95% at 25oC (77oF), no condensation
7. Conformance to the EMC Directive 89/336/EEC and the Low Voltage Directive 72/23/EEC.

D. DC Power Supplies shall be one of the following: Phoenix Contact MINI-PS-100, or equal

2.5 ELECTRIC HEATERS

A. Provide electric heaters for outdoor control panels. Electric heaters shall be sized to protect sensitive mechanical, electrical, and electronic equipment from the harmful effects of condensation, corrosion, and low temperatures.

B. Electric heaters shall be thermostatically controlled, fan driven units that can maintain a stable temperature within the control panel. Thermostat shall be adjustable from 0^{o}F to 100^{o}F (-18^{o}C to 38^{o}C).

C. Electric heaters shall be Hoffman model DAH or equal.

PART 3 EXECUTION

3.1 GENERAL

A. Enclosures shall be provided with wiring, schematic, layout, connection, and control diagrams.

3.2 INSTALLATION

A. Enclosure wiring shall be installed by the manufacturer and shall be brought out to identified terminal blocks. Interwiring between sections shall be from terminal blocks to terminal blocks. Terminal blocks for wiring shall be correlated with those for the electrical equipment by the enclosure manufacturer. Each terminal block shall contain no more than two wires on each side. Additional terminal blocks shall be provided when connection of more than two wires are required.

B. Wiring for panel enclosures shall be neatly arranged in bunches taped or tied together at six inch intervals and shall be securely attached to the interior of the panel unless continued within plastic wireways. Identification of panel component and wiring shall be as shown on the submittals. Wiring to door mounted components shall be bundled and enclosed in flexible spiral wrap to provide protection to the wiring.

C. Panels shall be grounded, and equipment and circuits included in the panels, as shown or required to be grounded, shall be connected to the grounding conductors.

D. Equipment shown or specified to be furnished with the panels shall be mounted by the panel manufacturer. Panel mounted controls and components shall be mounted a minimum of 30" above finished floor and a maximum of 72" above finished floor. The panels shall be furnished as completely assembled units, requiring only field connections of power and control wiring.

E. Pole or wall mounted panels shall be provided with brackets designed for pole or wall mounting.

F. Where multiple power sources enter a single enclosure, a nameplate shall be provided indicating: "CAUTION: MULTIPLE POWER SOURCES" or similar warning.

G. Not less than eight inches of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space.

H. AC and DC wiring shall be run in separate plastic wireways.

I. Where different voltages are present within the enclosure, provide nameplates indicating the voltage levels applicable to terminals. Terminals for 480 VAC and 120 VAC shall be separated by a minimum of six inches. If the enclosure contains low voltage instrumentation wiring and terminals, the wiring and terminal blocks shall be separated from the 120 VAC and 480 VAC wiring by a minimum of six inches. The terminal blocks for low voltage instrumentation wiring shall be enclosed in a separate steel enclosure inside the terminal cabinet for shielding.

J. Power terminal blocks shall be provided with clear Lexan shields removable without removing the power terminal blocks.

3.3 PROGRAMMING

A. Use RSLogix 5000 to program the PLC to operate the SVE System as described in the Process Control Description in Section 02 62 16 SVE System.

B. Use Factory Talk View Studio to develop screens and to program the Operator Interface Terminal (OIT) in support of the PLC program. Use Factory Talk ViewPoint to publish the screens developed to a website so that the status of the SVE equipment may be monitored remotely.

C. The OIT shall be programmed to display a graphical representation of the SVE System. This graphical representation shall consist of multiple screens logically organized to provide the user with an intuitive feel for navigating through these multiple screens. These multiple screens shall be organized around a main screen that shall depict an overview of the system. Additional screens shall depict an overview of the site. Additional screens depicting details pertinent to the SVE site shall be available and user selectable from the site overview screen.

D. Information on each screen shall be arranged in a concise and orderly appearance, with options to select (or "drill down to") more detailed information that shall be provided on additional screens. The status of all input and output points at the site shall be depicted on either the overview screen, or on one of the detail screens. It shall be possible to determine the status of each input or output point, and status information for all other instruments, by selection of the appropriate screen.

E. All screens shall be designed to provide a consistent appearance and feel for the operator, and shall be maximized to the greatest extent possible and practicable. The additional screens depicting the details at each site should also present a consistent appearance and feel.

F. The OIT screens shall be designed so that the system may be easily expanded. Expansion should be possible by creating additional screens for the new SCADA site by adding a new site overview screen and relevant site detail screens.

G. Appropriate symbols shall be chosen for each graphical element. Design of the graphical elements shall be done to maximize readability and minimize confusion. Graphical elements shall be designed to replicate an appropriate symbol for the item that is to be represented, to give a realistic appearance for the item to be represented, or to represent that item in a manner so that it cannot be misunderstood.

H. Furnish and install Factory View Station operating on a laptop computer to allow the SVE System to be monitored and controlled remotely. Configure Factory View Station to allow laptop computer to remotely monitor and control the SVE System.

I. Provide support and configure application programs to allow remote monitoring using Engineer's laptop computer.

3.4 FIELD TESTS

A. The panel shall be checked and necessary adjustments shall be made in the field after installation, by representatives of the manufacturers of the equipment included in the panel.

B. The panel shall be functionally tested by simulating the inputs. Tests shall be in the presence of the Engineer.

END OF SECTION

SECTION 26 09 16 - MISCELLANEOUS ELECTRICAL CONTROLS

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section includes miscellaneous controls, electric indicating instruments, instrument transformers, elapsed time meters, pressure and limit switches, control stations, pushbuttons, selector switches, and indicators and all appurtenances necessary for a complete installation.

1.2 QUALITY ASSURANCE

A. Material and installation shall be in accordance with the latest revisions of the following codes, standards, and specifications, except where more stringent requirements have been specified herein:

1. National Electric Code (NEC)
2. National Electrical Manufacturers Association (NEMA)
3. Underwriters Laboratories, Inc. (UL)
4. International Electrotechnical Commission (IEC).

B. Uniformity: Unless otherwise specified, equipment or material of the same type of classification, used for the same purpose shall be the product of the same manufacturer. All material shall be new and of the current design of the manufacturer providing equipment or material.

1.3 SUBMITTALS

A. Submittals shall conform to the requirements of Section 01 33 00 – Submittal Procedures, and to the requirements given in Section 26 00 00 - Electrical General. In addition, submittals shall include the manufacturer's name, trade name, place of manufacturer, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification, and technical paragraph reference.

B. Submittals shall contain a material list with manufacturer's name and data describing the material and showing its compliance with specifications, associated standards and test requirements.

C. Prior to obtaining any material in connection with this section, catalog data and detailed wiring connection diagrams shall be submitted. Submittals for each manufactured item shall be current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog data sheets. Submittal shall include ratings, circuit diagrams, and dimensional data, as a minimum. Drawings shall include elementary and interconnection diagrams showing connections to internal components, and indicate field termination points for power and control interface. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted.

D. Shop drawings shall present complete and accurate information relative to all working dimensions, equipment weights, assembly and section views, and all necessary details pertaining to coordinating the work of the Contract, lists of materials and finishes, parts list and the descriptions thereof, lists of spare parts and tools where such parts or tools are required, and any other information that is required to demonstrate compliance with the Contract Documents.

Drawings for electrical equipment shall include elementary and interconnection diagrams showing connections to internal components, and indicating field termination points for power and control interface.

E. Submittal shall contain manufacturer's descriptive data including ratings, circuit diagrams, and dimensional data.

F. Samples of any material shall be submitted upon Engineer's request.

1.4 CLOSE OUT SUBMITTALS

A. Provide project record documents which record actual locations of components and circuits.

PART 2 PRODUCTS

2.1 CONTROL RELAYS AND CONTACTORS

A. Plug-In Control Relays (Control Panel Applications)

1. General purpose control relays shall be provided where control functions require remote indicating functions, use of interposing relays, or for other control functions where installed in control panels, annunciator panels, and display panel applications.

2. Control panel relays shall be plug-in type. Provide 120 voltage alternating current (VAC) coil relays with pin-type construction for alternating current (AC) control wiring and 24 voltage direct current (VDC) coil relays for direct current (DC) control wiring. AC coil relays shall be pin type construction and DC coil relays shall be blade-type construction. Provide 8 or 11 pin-type or blade-type sockets as required for mounting relays.

3. Control panel relays shall be provided with a pushbutton for testing the operation of the relay and other control functions.

4. Control relays shall be provided with an integral indicating light to show the state of the relay coil (energized or de-energized) and contacts.

5. Contacts for use with analog circuits shall be Silver Cadmium Oxide type rated for 10 amperes at 240 VAC.

6. Control relays shall be as manufactured by:

a. Allen-Bradley 700
b. Automation Direct 728
c. Square D – Class 8501 type K
d. Idec – RR Series
e. Potter & Brumfield
f. Equal.

B. Solid State Timing Relays

1. Solid state timing relays shall have adjustable time settings within adjustable time ranges.

2. Timing ranges shall be adjustable from 0.5 seconds to 24 hours, unless noted otherwise.

3. Timing relays shall have four selectable modes: on-delay, off-delay, one-shot, and repeat cycle.

4. Solid state timing relays shall be as manufactured by Square D Class 9050 type JCK, or equal.

2.2 PUSHBUTTONS, SELECTOR SWITCHES, INDICATOR LIGHTS

A. All field mounted devices shall be heavy duty, oiltight, with die cast operator bodies, and molded modular type contact blocks.

B. Unless noted otherwise, pushbuttons, selector switches, and indicator lights mounted on the front of control panels shall be the 30mm, heavy duty, industrial style.

C. Pushbuttons, selector switches, and indicating lights shall be configured as shown on the Contract Drawings, specified, or detailed. (e.g. momentary contacts, maintained contacts, 2-position, lockout type, spring return to center, or other control functions).

D. Pushbuttons

1. Pushbuttons shall have color button operator with guards, engraved legend plates, and contact blocks as required.

2. Stop pushbuttons shall be of the mushroom head type.

3. Emergency stop pushbuttons shall be of the maintained contact type, push to stop, pull to release, with the extra large mushroom style knob, legend plate, and color appropriate for an emergency stop function.

4. Lockout stop pushbuttons shall be designed to accommodate a padlock in the stop position

E. Selector Switches

1. Selector switches shall have glove hand type operators, engraved legend plates, and contact blocks as required.

2. Selector switches for use with analog circuits shall be provided with gold plated contacts

F. Indicating Lights

1. Indicating lights shall be wired for "push-to-test" operation when specified, shown, or required.

2. Indicating lights shall be 120 volt transformer type unless otherwise noted.

3. Indicating lights shall be provided with interchangeable color caps.

4. Indicating lights shall be provided with engraved legend plates stating the intended control function and purpose.

G. Pushbutton and Indicator Light Colors

1. Unless otherwise noted, pilot light and pushbutton colors shall be in accordance with NFPA-79 Industrial Machinery, modified below to provide additional definition.

2. Indicator Lights Colors

a. Red – On/Open/Danger/Alarm
b. Green – Off/Closed/Ready
c. Yellow or Amber – Caution/Attention
d. White – Power On/Energized
e. Blue – Miscellaneous.

3. Pushbutton Colors

a. Red – Stop/Off/Emergency Stop
b. Green – Start/On
c. Yellow or Amber – Intervention/Return
d. Black – No specific function.

H. Manufacturers

1. Square D Class 9001 Type K
2. Allen-Bradley Bulletin 800T
3. General Electric CR2940
4. equal.

2.3 MISCELLANEOUS CONTROLS FUNCTIONS

A. Power Conditioner

1. Power conditioners shall be furnished to provide power protection against sags, surges, swells, spikes, and electrical noise. The power protection unit shall provide noise suppression and fast microcomputer-controlled voltage regulation.

2. Power conditioners shall be rated for 10 kVA with a 208 VAC, 3 phase input power rating and a 208/120 VAC, 3 phase power output rating. Unit shall be hardwired to a 208/120 VAC, 3 phase lighting panelboard.

3. Power conditioners shall be Model 62610-Line 2 as manufactured by Square D Company, or equal.

B. Limit Switches

1. Mechanical limit switches shall have a heavy duty, snap action mechanism that prevents false contact opening. Limit switches shall be the lever arm with hardened roller configuration.

2. Limit switch enclosure shall be metal and rated NEMA 4. Limited switch shall use a booted shaft design to prevent penetration of foreign materials.

3. Provide 1 N.O. and 1 N.C. set of contacts, rated for 20 amperes. Wire insulation shall be rated for 600VAC and DC.

4. Limit switch shall meet the following requirements:

a.	Temperature range:	0^{o}F to 200^{o}F (-17^{o}C to 93^{o}C)
b.	Vibration resistance:	30G max (10-55 hz)
c.	Repeatability:	0.03^{o}.

PART 3 EXECUTION

3.1 INSTALLATION

A. General

1. All controls unless shown otherwise shall operate at 120 VAC.

2. All electrical control components shall be installed as shown and specified in the Contract Documents, as directed by the County and as recommended by the manufacturers.

3. The enclosures containing electrical components shall be solidly grounded with a ground conductor as specified in Section 26 05 26 – Electrical Grounding.

4. Where existing controls are shown to be utilized for new functions, a new, permanent tag shall be provided to identify the new control function.

B. Field Tests

1. After installation, all controls shall be checked and the required adjustments shall be made.

2. Each control function on each piece of equipment shall be field tested and certified to be functioning by the Contractor. Equipment shall be field tested in the presence of the Engineer and shall be demonstrated to operate satisfactorily.

3. In the event of failure of the field test, the Contractor shall retest the equipment, at his own cost and expense, as directed by the Engineer.

END OF SECTION

SECTION 26 22 00 - LOW VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes dry type distribution transformers, enclosures, and accessories. Electrical ratings shall be as shown on the contract drawings.

1.2 QUALITY ASSURANCE

A. Material and installation shall be in accordance with the latest revision of the following codes, standards, and specifications, except where more stringent requirements have been specified herein:

1. National Electrical Code (NEC)
2. National Electrical Manufacturers Association (NEMA)
3. Underwriters Laboratories (UL)
4. American National Standard Institute (ANSI).

B. Qualifications of manufacturer. Provide materials and equipment that are the products of manufacturers regularly engaged in the production of such products which are of equal material, design, and workmanship. Products shall have been in satisfactory commercial or industrial use for two (2) years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturer's catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer.

C. Uniformity: Unless otherwise specified, equipment or material of the same type of classification, used for the same purpose shall be the product of the same manufacturer. All material shall be new and of the current design of the manufacturer providing equipment or material.

1.3 SUBMITTALS

A. Submittals shall conform to the requirements of Section 01 33 00 – Submittal Procedures, and to the requirements given in Section 26 00 00 - Electrical General. In addition, submittals shall include the manufacturer's name, trade name, place of manufacturer, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification, and technical paragraph reference.

B. Submittals shall contain a material list with manufacturer's name and data describing the material and showing its compliance with specifications, associated standards and test requirements.

C. Prior to obtaining any material in connection with this section, catalog data and detailed wiring connection diagrams shall be submitted. Submittals for each manufactured item shall be current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog data sheets. Submittal shall include ratings,

circuit diagrams, and dimensional data, as a minimum. Drawings shall indicate field termination points. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted.

D. Shop drawings shall present complete and accurate information relative to all working dimensions, equipment weights, assembly and section views, and all necessary details pertaining to coordinating the work of the Contract.

E. Submittal shall contain manufacturer's descriptive data including ratings, circuit diagrams, dimensional data, conduit entry restrictions, and heat dissipation to ambient. Submittals shall also contain manufacturer's part number for the equipment.

F. Manufacturer's standard wiring diagrams and specific modifications to the wiring of the equipment shall be submitted. All terminal points for field and interconnecting wiring shall be identified.

1.4 CLOSEOUT SUBMITTALS

A. Provide project record documents which record actual locations of components and circuits.

PART 2 PRODUCT

2.1 TRANSFORMERS

A. Dry Type Transformer – General

1. Three phase transformers shall be 480 volt delta primary and 208Y/120 secondary unless otherwise noted.

2. Transformers shall be 115^{o}C temperature rise above 40^{o}C ambient. All insulating materials to be in accordance with NEMA ST20-1972 standards for a 220^{o}C UL component recognized insulation system.

3. Transformer coils shall be of the continuous wound and copper construction.

4. Cores shall be constructed of high grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point. The core laminations shall be clamped together with structural steel angles. The completed core and coil shall then be bolted to the base of the enclosure but isolated therefrom by means of rubber, vibration-absorbing mounts. There shall be not metal-to-metal contact between the core, coil, and the enclosure.

5. The entire transformer enclosure shall be primed, and finished with a gray, baked enamel topcoat.

6. The maximum temperature of the top of the enclosure shall not exceed 50°C rise above a 40°C ambient.

7. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable NEMA, IEEE, and ANSI standards.

8. Dry type transformers shall be “Sorgel” as manufactured by Square D Company; types QB, ML, QMS or QL as manufactured by General Electric Company; or equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Transformers shall be installed as shown, specified and recommended by the manufacturer.

END OF SECTION

SECTION 26 27 16
ENCLOSURES

PART 1 GENERAL

1.1 DESCRIPTION

This Section includes enclosures of the type suitable for their locations to protect all electrical equipment and controls.

1.2 QUALITY ASSURANCE

A. Material and installation shall be in accordance with the latest revisions of the following:

1. National Electrical Code (NEC)
2. Underwriters Laboratories, Inc. (UL)
3. National Electrical Manufacturers Association (NEMA)
4. International Electrotechnical Commission (IEC)

B. Qualifications of manufacturer: All equipment furnished under this Section shall be furnished by manufacturers who meet the industry standards for quality, workmanship, and experience.

C. In general, all electrical equipment furnished shall be listed and labeled by Underwriters Laboratories, Inc. (UL) or another acceptable organization to the Engineer and owner. Submit name of organization that will label equipment if other than Underwriters Laboratories. Organization shall certify that the equipment meets applicable UL, ANSI, and NEMA standards.

D. Control panels shall be constructed and UL Labeled by a UL certified panel shop.

1.3 SUBMITTALS

A. Prior to obtaining any material in connection with this Section, detailed shop drawings on all material shall be submitted. Submittals shall conform to the requirements of Section 01 33 00 Submittals.

B. Enclosures shall be submitted with each piece of equipment they are protecting.

C. Submittals shall contain the NEMA or IEC type designation and manufacturer data describing the enclosure and showing its compliance with specifications and associated standards.

D. A list of nameplate titles shall be submitted for each annunciator panel or enclosure as part of the shop drawing submittals.

E. Samples of any material shall be submitted upon Engineer’s request.

1.4 CLOSEOUT SUBMITTALS

Provide project record documents which record actual locations of components and circuits.

PART 2 PRODUCT

2.1 GENERAL

A. Enclosures for Protected Work

1. The enclosures for electrical equipment shall be NEMA Type 1 – Gasketed or IEC-IP42 except as modified below.

2. In areas designated as Hazardous Locations, all work shall meet the requirements of the National Electrical Code for Class I Division 1 locations. All electrical equipment and enclosures shall be NEMA Type 7, approved for Class 1, Division I, Group D atmosphere.

3. In Outdoor areas, or areas designated as a Wet Location, all work shall meet the requirements of the National Electrical Code for Wet Locations. All electrical equipment and enclosures shall be NEMA Type 4 (or Type 4X), or IEC-IP66.

4. In areas designated as a Corrosive Location, all electrical equipment and enclosures shall be NEMA Type 4X, or IEC-IP66.

B. Where electrical equipment is installed in motor control centers, panels, panelboards, or other control assemblies, no additional enclosures are required except where specifically specified or shown.

C. Lighting fixtures shall be of the type specified in Section 26 50 00 Lighting Equipment.

D. Device, junction, pull-boxes, and other conduit system accessories shall be as specified in Section 26 05 33 Conduits and Raceway Systems.

2.2 ENCLOSURES

A. NEMA 3R Enclosures

NEMA 3R enclosures shall provide protection from falling rain, formation of ice, windblown dust, and other weather hazards. NEMA 3R enclosures shall be suitable for outdoor installation.

B. NEMA 4 Enclosures

NEMA 4 Enclosures shall be water-tight and dust-tight suitable for outdoor installation, protecting enclosed equipment against splashing water, seepage of water, falling or hose-directed water, severe external condensation. NEMA 4X enclosures, in addition to the requirements for NEMA 4, shall be corrosion resistant. NEMA 4X enclosures located outdoors shall be stainless steel.

C. Enclosure Construction

1. Enclosures shall be constructed of a minimum of 12 gauge steel.

2. Seams shall be continuously welded and ground smooth, with no holes or knockouts.

3. Exterior hardware shall be stainless steel.

4. Enclosures shall be provided with gray prime finish over phosphatized surface inside and out with a white enamel interior unless otherwise specified.

5. Dimensions of enclosures shown on the Contract Drawings are approximate and represent the minimum size required. Contractor shall size each enclosure as required to house the electrical equipment shown or specified and coordinate space availability.

2.3 ENCLOSURE IDENTIFICATION

A. All enclosures shall have nameplates on the exterior of each enclosure identifying the application function of the equipment enclosed such as "SLUDGE PUMP NO. 1."

B. For Control Stations, a factory installed legend plate shall be provided to indicate the function each station performs, such as "ON" or "OFF."

C. Identification Tags

1. Identification nameplates shall be engraved ¼ -inch high letters on a 1/8-inch thick plastic black nameplate mechanically attached to the enclosure.

2. Legend plates shall be metal with black lettering mechanically attached to control station.

3. Nameplates and circuit identification shall be as specified in Section 16095 Electrical Systems Identification.

D. Devices mounted on or within the enclosures shall be permanently identified. All control functions shall be identified. The device and terminal identifications shall agree with those shown on the Contract Drawings.

E. Each circuit shall be identified by a typewritten directory with transparent sealed plastic cover, fastened to the inside surface of the door of the enclosure.

2.4 ENCLOSURE DOORS

A. Enclosures shall be provided with front access single door or double doors as required for the enclosure size. For large enclosures requiring double doors, doors shall be provided with three point latches operated by a key locking handle. Latch rods shall have rollers to facilitate door closing.

B. Doors shall be mounted with continuous piano hinges. A rolled lip around minimum three sides of door shall be provided to prevent dirt and liquid from dropping into the panel when door is open.

C. Doors shall be fitted with a neoprene gasket applied with oil resistant adhesive and held in place with stainless steel retaining strips.

D. Enclosure doors shall be provided with stainless steel door strips to hold the doors in the open position. The open position shall be field adjustable. The doors shall be capable of being opened at a minimum of 90° angle from their closed positions.

E. Provide interior door swing-out panel for outdoor mounted control panels. Swing-out panel shall be by the same manufacturer as the enclosure and shall be specifically designed by the

manufacturer for this application. Swing-out panel shall provide an area to mount devices (instead of mounting these devices on the exterior door) so that these devices will be afforded a degree of protection from outdoor weather elements.

2.5 INTERIOR SUBPANELS

Interior subpanels shall be constructed of minimum 12 gauge steel finished in white enamel paint. Fasteners, screws, and equipment mounting racks shall be stainless steel.

2.6 INTERNAL WIRING

A. Terminal blocks for external connections shall be suitable for No. 12 AWG wire, fabricated complete with marking strip, covers, and pressure connectors. Terminal blocks shall be rated for 30A at 600 VAC unless noted otherwise. Not less than 25 percent spare terminals shall be provided.

B. Terminals shall be labeled to agree with identification shown on supplier's submittal drawings. A terminal shall be provided for each conductor of external circuits, plus one ground for each shielded cable. Wires shall be numbered using wire markers. Wire numbers shall agree with terminal numbers, associated with remote equipment wiring designations, as indicated on the submittal drawings.

C. Wiring shall be grouped or cabled and firmly supported in the panel. Plastic wireway, Panduit, or equal, shall be used to route wire within the panel. Wireway shall be run in continuous length with snap on covers.

2.7 CONTROL PANEL ENCLOSURE AND CONDUIT SYSTEM ACCESSORIES

A. Conduit system accessories shall be as specified in Section 26 05 33 Conduits and Raceway Systems.

B. A large print pocket shall be provided on the interior face of the enclosure door.

C. For enclosures housing a programmable controller, provide a folding shelf or equivalent accessory to accommodate a laptop computer or other programming tools for servicing and programming the programmable controller. Provide a 115 VAC, 15 A utility receptacle for use with laptop computer or other programming tools.

D. Provide a fluorescent light in floor mounted, or freestanding enclosures.

E. For floor mounted, or freestanding enclosures housing a programmable controller, provide a window on the enclosure door so the status of the programmable controller processor and input/output modules may be monitored without opening the enclosure door.

2.8 ABOVE GROUND ENCLOSURES

Above ground enclosures shall be weatherproof, clamshell design, and provide drip-proof edges which assure the flow of rainwater away from the enclosure. Material of construction shall be fiberglass suitable for outdoor installation. Provide corrosion resistant hardware, including hinges, restraining

line (to limit the opening of the cover), handle, and locking hasp. Above ground enclosure shall permit access to the interior contents. Above ground enclosure to be as manufactured by Diffused Gas Technologies, Inc., or equal.

PART 3 EXECUTION

3.1 GENERAL

Enclosures shall be provided with wiring, schematic, layout, connection, and control diagrams. These diagrams shall be placed in the print pocket contained on the inside of the enclosure door.

3.2 INSTALLATION

A. Enclosure wiring shall be brought out to identifying terminal blocks. Interwiring between units or sections shall be from terminal block to terminal block. Terminal blocks for wiring shall be correlated with those for the electrical equipment by the Systems Integrator. Each terminal block shall contain no more than two wires on each side. Additional terminal blocks shall be provided when a connection of more than two wires are required. Use the full complement of wiring accessories available to provide a neat and organized appearance.

B. Wiring for panel enclosures shall be neatly arranged in bunches taped or tied together at six inch intervals and shall be securely attached to the interior of the panel unless contained within plastic wireways. Identification of panel component and wiring shall be as shown on the Contract Drawings. Wiring to door mounted components shall be bundled and enclosed in flexible spiral wrap to provide protection to the wiring.

C. Panels shall be grounded, and equipment and circuits included in the panels, as shown or required to be grounded, shall be connected to the equipment grounding conductors.

D. The panel manufacturer shall mount equipment shown or specified to be furnished with the panels. Panel mounted controls and components shall be mounted a minimum of 30” above finished floor and a maximum of 72” above finished floor. The panels shall be furnished as completely assembled units, requiring only field connections of power and control wiring.

E. Where multiple power sources enter a single enclosure, a nameplate shall be provided indicating: “CAUTION: MULTIPLE POWER SOURCES” or similar warning. Nameplates shall be as specified in Section 16095.

F. Not less than eight inches of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space.

G. AC and DC wiring shall be routed in separate plastic wireways.

H. Where different voltages are present within the enclosure, provide nameplates indicating the voltage levels applicable to terminals. Terminals for 480 VAC and 120 VAC shall be separated a minimum of six inches. If the enclosure contains low voltage instrumentation wiring and terminals, the wiring and terminal blocks shall be separated from the 120 VAC and the 480 VAC wiring by a minimum of six inches. The terminal blocks for low voltage instrumentation wiring shall be enclosed in a separate steel enclosure inside the solid state motor controller cabinet for shielding.

I. Component mounting and panel layout shall meet the requirements of NEMA and U.L. for location, type of mounting, separation of components for proper ventilation and air circulation to prevent heat build-up and accessibility for maintenance.

3.3 FIELD TESTS

A. The panel shall be checked and necessary adjustments shall be made in the field after installation, by representatives of the manufacturers of the equipment included in the panel.

B. The panel shall be functionally tested by simulating the inputs. Tests shall be in the presence of the Engineer.

C. In the event of failure of the field test, the Contractor shall retest, at his own cost and expense, the equipment as directed by the Engineer.

** End of Section **

SECTION 26 27 26 - WIRING DEVICES

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section includes switches, receptacles, and accessories required for a complete installation as shown and specified.

1.2 QUALITY ASSURANCE

A. Material and installation shall be in accordance with the latest revisions of the following codes, standards, and specifications, except where more stringent requirements have been specified herein:

1. American National Standard Institute (ANSI)
2. National Electrical Code (NEC)
3. National Electrical Manufacturers Association (NEMA)
4. Underwriters Laboratories (UL)
5. Association of Edison Illumination Companies (AEIC)
6. Insulated cable Engineers Association (ICEA)
7. American Society of Testing Materials (ASTM).

B. Qualifications of manufacturer: All equipment furnished under this Section shall be furnished by manufacturers who meet the industry standards for quality, workmanship, and experience.

C. All electrical materials and equipment falling within the scope of the Underwriters' standards shall bear the UL Label.

1.3 SUBMITTALS

A. Submittals and samples shall be submitted in accordance with the provisions set forth in the General Conditions, Section 01 33 00 – Submittal Procedures, and Section 26 00 00 - Electrical General.

B. Submit product information for each type of wiring device.

C. Prior to obtaining any material in connection with this Section, detailed shop drawings on all material shall be submitted. Submittals shall contain manufacturer data describing the material and showing its compliance with specifications, associated with standards and test requirements.

D. Samples are not required for specified manufacturers and part numbers. If "equal" products are proposed, samples of both the "equal" and the specified product shall be submitted for comparison purposes. Equal products will not be considered unless samples are submitted.

PART 2 PRODUCT

2.1 GENERAL

A. Provide industrial grade heavy-duty wiring devices, in types, characteristics, grades, colors, and electrical ratings for applications indicated, which are UL listed and which comply with NEMA WD 1 and other applicable UL, Federal, and NEMA standards.

B. Provide ivory color devices except as otherwise indicated.

C. Model or series numbers, where indicated, refer only to the specified manufacturer. Identical numbers by other manufacturer are not considered equal.

2.2 SWITCHES AND RECEPTACLES

A. Receptacles (Wall Plug): Wall plug receptacles shall be NEMA 5-20R rated 15 amperes at 120 VAC of the two-pole, three-wire type. They shall be suitable for use with a three-wire polarized plug having two parallel blades and shall have the third leg grounded. They shall meet the requirements of Federal Specifications WC596.

B. All duplex receptacles shall be:

1. Hubbell 5262 Series heavy-duty industrial grade.
2. Leviton 5262 Series heavy-duty industrial grade.
3. Arrow Hart 5262 Series heavy-duty industrial grade
4. Daniel Woodhead 5262 Series heavy-duty industrial grade.
5. Equal (samples of any proposed equal products shall be submitted as noted above).

C. Ground-fault circuit interrupter (GFCI) Receptacles: Receptacles marked as GFI shall be of the ground fault interrupter type. They shall be UL rated Class A, Group 1. They shall be Hubbell Series GF5262 or equal.

1. Single GFCI receptacles providing “downstream” protection are not acceptable unless specifically shown.

2. GFCI circuit breakers used with conventional receptacles are not acceptable where GFCI receptacles are indicated.

3. GFCI receptacles shall be installed for all wet locations, including service receptacle on roof for HVAC unit, and all analytical instruments, unless otherwise noted.

4. All GFCI receptacles shall have plastic rainshield covers installed, unless otherwise noted.

D. Receptacles (other): Other receptacles shall be industrial grade heavy duty of the type specified on the drawings, or as required to feed the corresponding equipment. Device boxes for the receptacles shall be of the type appropriate for each location.

E. Switches: Lighting switches shall be rated 20 amperes at 277 VAC, toggle operated, plastic enclosed, single pole, three-way, or four-way as shown or required. They shall meet Federal

Specification WS896. Switches shall be: Hubbell 1221 Series heavy-duty industrial grade, Leviton 1221 Series heavy-duty industrial grade, Arrow Hart 1221 Series heavy-duty industrial, or equal. Samples of any proposed equal products shall be submitted as noted above.

1. Dimming switches shall be used with fluorescent dimming ballasts. The dimming switches shall be coordinated to work with the ballasts as recommended by the manufacturer. The dimming switches shall be paddle switch type, single pole or three-way as required, and shall include selected light level slider and an On/Off at selected level.

2. Switches shall have silver cadmium oxide alloy contacts and provisions for side and back wiring.

3. Device boxes for switches shall be of the type appropriate for each location. Switches in hazardous locations shall be suitable for installation in Class I, Group D, Division1 Hazardous Locations.

F. Corrosion Resistant Devices. Devices used in area noted as corrosive, wet, or classified (hazardous) shall be "corrosion resistant." Devices shall be industrial grade heavy-duty constructed with additional protection from corrosive environments including additional nickel plating on metallic parts, melamine bodies, and weatherproof boots. Devices shall be Hubbell Series CM, Leviton Series CM, Arrow Hart Series CR, or equal.

G. Plates. Unless otherwise specified, flush plates for devices shall be smooth stainless steel type 302. Plates in unfinished areas shall be galvanized steel, unless otherwise noted. Plates in wet, corrosive, or outdoor areas shall be of the corrosive resistant weatherproof design. Plates shall be Hubbell S1 Series, Leviton S Series, Arrow Hart S1 Series, or equal.

H. Weatherproof Outlet Covers. Weatherproof outlet enclosures shall be provided for receptacles and switches installed in Wet Locations. Covers shall protect electrical devices while the device is in use (cord is plugged in). Covers shall be constructed of a UV protected clear Lexan material. Covers shall be provided with provisions for pad-locking the cover in the closed position. Covers shall be provided for installation for single gang and multi-gang device boxes, and GFCI type receptacles where required. Weatherproof covers shall be as manufactured by Carlon Electrical Products, Mulberry Metal Products (Weathersafe Outlet Enclosures), or equal.

2.3 POWER PLUGS AND RECEPTACLES FOR PROCESS EQUIPMENT

A. Power plugs and receptacle shall be provided for connection of submersible mixer motor equipment and sample pumps where shown on the Contract Drawings. Power plugs and receptacle shall be designed for use with highly inductive and resistive loads. The power plugs and receptacles shall be UL listed as a combination disconnect switch, plug and receptacle per UL Standard 98 and 508.

B. Plug and receptacle assembly shall be watertight, suitable for installation in Wet Locations. When not in use, the receptacle shall be shielded by a protective lid. Receptacle shall be provided with an angle adapter and junction box suitable for wall or backboard mounting. Parts shall be provided with a corrosion protective finish.

C. Power plug and receptacle shall be a 3 pole, 4 wire, 480 VAC, 30 amperes and rated for 10 horsepower minimum. Units shall have a UL 10,000 ampere short circuit rating. Plugs and receptacles shall be provided with 2 sets of integral pilot contacts (total of 4 contacts) which shall allow connection of 2 closed loop auxiliary control signals.

D. Power plugs and receptacles shall be Type DSM3 as manufactured by Meltric Corporation or equal, with accessories as specified.

PART 3 EXECUTION

3.1 INSTALLATION

A. Wall receptacles shall be mounted 18 inches above floor unless otherwise noted or required by the NEC.

B. Switches shall be mounted 48 inches above floor on knob side of doors unless otherwise noted or required by the NEC. Coordinate switch locations with cabinets, temperature controls, and other devices to avoid conflicts.

C. Install wiring devices and accessories as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.

D. Coordinate with Work, including painting, electrical boxes, and wiring installations, as necessary to interface installation of wiring devices with other Work.

E. Install wiring devices only in electrical boxes, which are clean, free from building materials, dirt, and debris.

F. Install wiring devices after wiring work is completed.

G. Install wall plates after painting work is completed.

H. All metallic raceways shall be electrically continuous and bounded in accordance with the NEC for proper grounding.

END OF SECTION

SECTION 26 28 00 - PANELBOARDS AND CIRCUIT PROTECTIVE DEVICES

PART 1 GENERAL

1.1 DESCRIPTION

A. This section includes low voltage panelboards, circuit breakers, disconnect switches, fuses, and other circuit protective devices for service at 600 voltage in alternating current (VAC) or less.

1.2 QUALITY ASSURANCE

A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards, and specifications, except where more stringent requirements have been specified herein:

1. National Electrical Code (NEC)
2. National Electrical Manufacturers Association (NEMA)
3. Underwriters Laboratories, Inc. (UL) 1449
4. American National Standards Institute (ANSI).

B. Qualifications of manufacturer. Provide materials and equipment that are the products of manufacturers regularly engaged in the production of such products which are of equal material, design, and workmanship. Products shall have been in satisfactory commercial or industrial use for two (2) years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturer's catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer.

C. Uniformity. Unless otherwise specified, equipment or material of the same type of classification, used for the same purpose shall be the product of the same manufacturer. All material shall be new and of the current design of the manufacturer providing equipment or material.

1.3 SUBMITTALS

A. Submittals shall conform to the requirements of Section 01 33 00 – Submittal Procedures, and to the requirements given in Section 26 00 00 - Electrical General. In addition, submittals shall include the manufacturer's name, trade name, place of manufacturer, catalog model, layout dimensions, project specification, and technical paragraph reference.

B. Submittals shall contain a material list with manufacturer's name and data describing the material and showing its compliance with specifications, associated standards and test requirements.

C. Prior to obtaining any material in connection with this section, detailed shop drawings on all material shall be submitted. Submittals for each manufactured item shall be current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog data sheets. Submittal shall include ratings, circuit diagrams, and dimensional data, as a minimum. Drawings shall include elementary and

interconnection diagrams showing connections to internal components, and indicate field termination points for power and control interface. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted.

D. Submittals shall also contain descriptive data and time-current characteristic trip curves for each type of circuit breaker or fuse. These curves shall be submitted on full size manufacturer's drawings.

E. Samples of any material shall be submitted upon Engineer's request.

1.4 CLOSEOUT SUBMITTALS

A. Provide project record documents which record actual circuit directories, as well as actual locations of components and circuits.

PART 2 PRODUCT

2.1 PANELBOARDS

A. Panelboards

1. Panelboards shall meet Federal Specification W-P-115B, Type 1, Class 1, and shall conform to UL50 UL67, and NEMA PB-1.

2. Loadcenters (Federal Specification W-P115C Type 1 Class 2) shall not be substituted for panelboards unless specifically indicated.

3. Panelboards shall be circuit breaker type as shown on the drawings with neutral bar, ground bar, and main and branch circuit breakers as scheduled.

a. Unless otherwise shown, scheduled or specified, bus bars, ground bar, and neutral bar shall be copper or tin plated aluminum

b. Panelboards shall be furnished and installed in accordance with the panelboard schedules as shown

c. Subject to Engineer's review, such schedules may be revised to obtain more convenient grouping and better balance of the actual connected load.

4. Panelboards shall be provided with ample wiring gutters and shall have a single door with spring door hinges, lock, keys, and cardholder on the side of the door. Circuit identification cards shall be typewritten with circuits identified as actually installed.

5. Panelboards shall have single, double, or triple pole bolt-on branch circuit breakers as scheduled.

a. Branch circuit breakers shall be in accordance with subsection headed "Molded Case Circuit Breakers"

b. Unless otherwise shown, circuit breakers shall be rated at 20 amperes

c. Circuit breakers shall be provided for all spares shown on the schedule.

6. Short circuit current requirements shall be obtained only from the schedules, specifications, or the Contract Drawings.

a. If this information is not shown, the Engineer shall be consulted.

b. Under no circumstances shall any short circuit requirements be assumed by the Contractor

c. Integrally rated panelboards utilizing branch breakers with reduced short circuit ratings are acceptable.

7. Panelboards with main circuit breakers serving as building disconnecting means shall be service entrance rated, and shall be provided with a plaque designating the circuit breaker as a building disconnecting means.

8. Provide surge suppression for panelboards. Devices for surge suppression may be an integral part of the panelboard.

9. Panelboard enclosures shall be provided with key-locked doors. Provide a minimum of two keys for each lock.

10. Manufacturers

a. 120/208 VAC and 120/240 VAC, 3 Phase Panelboards. Unless otherwise indicated, four wire 120/208 VAC and 120/240 VAC panelboards shall be: bolt-on AQ Series manufactured by General Electric Co., Type NQOD manufactured by Square D Company, or equal

b. 277/480 VAC, 3 Phase Panelboards. Unless otherwise indicated, four wire 277/480 VAC panelboards shall be: bolt-on AE Series manufactured by General Electric Co., Type NF as manufactured by Square D Company, or equal.

B. Panelboard Circuit Breakers

1. Circuit breakers, where included as part of panelboards, shall be mechanically and electrically similar to molded case circuit breakers.

2. Single pole breakers shall have a minimum interrupting rating of 10,000 amperes RMS symmetrical at 240 VAC or 14,000 amperes at 480 VAC unless otherwise shown or specified.

3. Except where otherwise shown, trip ratings shall be 20 amperes.

4. 120/208 VAC circuit breakers shall be Q Line manufactured by General Electric Co., Type QOB manufactured by Square D Company, or equal.

5. 277/480 VAC circuit breakers shall be TEY Line manufactured by General Electric Company, Type ED/EG/EJ manufactured by Square D Company or equal.

6. GFCI circuit breakers shall be provided where scheduled on the Contract.

2.2 CIRCUIT BREAKERS

A. Molded Case Circuit Breakers

1. Except as modified below, the material and construction of molded case circuit breakers shall be in accordance with NEMA AB-1 and UL 489 standards for breakers.

2. Circuit breakers shall be of the air-break type.

3. Circuit breaker mechanisms shall be so designed that an overload or a fault on any one pole shall trip all poles simultaneously.

4. All poles shall be effectively barriered from one another.

5. Circuit breaker handles shall be trip-free. Circuit breakers in motor control centers or individual enclosures shall be interlocked with the door latching mechanism so that the door of the circuit breaker enclosure or motor control center compartment cannot be opened unless the circuit breaker contained is in the open position.

6. Number of poles and trip ratings of circuit breakers shall be as shown, specified, or required.

7. Motor control center main and tie circuit breakers shall be provided with auxiliary contacts for remote monitoring of the circuit breaker status.

B. Individual Circuit Breakers

1. Circuit breakers shall have a minimum of 14,000 amperes RMS symmetrical interrupting rating at 480 VAC or 10,000 amperes at 240 VAC except where different ratings are shown on the Contract Drawings, or unless otherwise specified.

2. Circuit breakers, 225 ampere frame and above, shall have interchangeable thermal and adjustable magnetic tripping elements.

3. Circuit breaker enclosures of the type shown on the drawings shall be provided.

C. Motor Circuit Protectors

1. Motor Circuit Protectors (MCP) shall have a quick make, quick break, switching mechanism, mechanically trip free from the handle, enclosed in a molded case.

2. The Contractor shall field verify actual motor starting and running currents in sizing the MCPs. Any replacement of MCPs due to this verification not being performed shall be done at no additional cost to the Contract.

3. MCPs shall have provisions for adjusting the instantaneous magnetic trip element.

4. Each pole shall provide instantaneous short circuit protection and all poles shall be constructed to open, close, and trip simultaneously.

5. Where higher short circuit protection is required, MCPs shall be provided with current limiters with trip indicators that are fully coordinated with the motor circuit protector so all three phases open if the current limiter is operated. Current limiters shall be constructed so replacement can only be made with an identical limiter having the same interrupting capacity. The minimum interrupting short circuit ratings of the MCP shall be known as shown on the Contract Drawings (integral rating).

6. MCPs shall be Type MCP manufactured by Cutler-Hammer Co., type Mag-Break manufactured by General Electric Co., or equal.

D. Service Entrance Circuit Breakers

1. Where shown or required, a service entrance breaker shall be provided to disconnect all conductors in a building or structure from the service-entrance conductors.

2. The service entrance breaker shall be UL listed, service entrance rated.

3. Where a 480 Volt System 1,000 ampere breaker or larger is shown or required, ground fault protection shall be provided in accordance with NEC 230-95.

4. The service entrance breaker shall be provided with an appropriate enclosure labeled as "Service Disconnect," and the enclosure shall be connected to the grounding grid in accordance with Section 26 05 26 - Electrical Grounding and the NEC.

2.3 SWITCHES

A. Disconnect Switches

1. Disconnect switches as indicated on the plans and specifications shall be NEMA Heavy Duty Type HD, Underwriter's Laboratories listed. The switches shall be fusible type unless otherwise indicated on the Contract Drawings.

2. Switch Interior. All switches shall have switchblades that are fully visible in the OFF position when the door is open. Switches shall have removable arc suppressors, where necessary, to permit easy access to line-side lugs. Lugs shall be UL listed for aluminum and/or copper cables and front removable. All current carrying parts shall be plated.

3. Switch Mechanism. Switches shall have a quick-make, quick-break, operating handle and mechanism, which shall be an integral part of the box, not the cover. Switches shall have interlock to prevent unauthorized opening of the switch door in the ON position or closing of

switch mechanism with the door open. Handle position shall indicate if switch is ON or OFF. Switch shall be lockable in the OFF position.

4. Enclosures. Switches shall be furnished in NEMA 1 general-purpose enclosures unless specified as NEMA 3R (rainproof), NEMA 4 (stainless steel), or NEMA 7 (Class1, Div 1) on the Contract Drawings. Covers on NEMA 1 enclosures shall be attached with pin type hinges.

5. Ratings. Switches shall be rated as indicated on the Contract Drawings. The switch must have a UL listed rejection feature to reject all fuses except Class R. UL listed short circuit ratings, when equipped with Class J or Class R fuses, shall be 200,000 amperes RMS symmetrical.

B. Molded Case Switches

1. Molded case switches shall be provided where shown on the Contract Drawings. Molded cases switches shall be automatic type designed to open instantaneously at a factory preset magnetic trip point. Molded case switches shall be designed for 600 VAC, 3 pole, with a minimum withstand rating of 25,000 amperes.

2. Molded case switches shall be as manufactured by Square D, or equal.

2.4 FUSES

A. Low Voltage (less than 600 volts) cartridge fuses shall be of the voltage and amperage rating listed on the drawings. Fuses shall be selected to provide overcurrent , short circuit, and blackout protection. They shall be of the type listed below unless otherwise indicated.

1. Main service and feeder protection (above 600 amps) – Current limiting UL Class L above 600 amperes (current UL standards do not rate Class L fuses at 600 amperes or below).

2. Main service and feeder protection at 600 amps and below – Current limiting UL Class J.

3. Motor branch circuit, transformer, inductive loads protection (such as MCCs, starters, etc.) – UL Class J current limiting, time delay for motor inrush and short circuit protection.

B. Manufacturers

1. Bussman
2. Littlefuse
3. Eagle
4. equal.

2.5 ENCLOSURES

A. Enclosures for Circuit Protective Devices shall be of the type appropriate for each location as specified under Section 26 27 16 - Enclosures.

PART 3 EXECUTION

3.1 INSTALLATION

A. Electrical Contractor shall refer to all pertinent Sections of these Specifications for installation details of other equipment associated with panelboards and individual circuit breakers.

B. Provide all miscellaneous bolts, washers, nuts, clips, Belleville washers, lockwashers, small hardware, etc., of corrosion resistant material to make installation complete.

C. Provide minimum working clearance, as described in the NEC Article 110.26, for all electrical equipment.

D. Verify the location of each piece of equipment at the site before installing enclosures or conduits.

E. Mount all cabinets level and plumb, flush or surface as scheduled.

F. Install recessed cabinet flush with finished wall.

G. Be sure wall thickness will accept panel enclosures before ordering equipment.

H. Paint all scratches, mars, and other imperfections in the finish, resulting from installation. Use matching paint.

I. Provide complete and professional installation for all items of equipment included in this Section, and in accordance with the NEC.

3.2 INSTALLATION OF PANELBOARDS

A. Mount panelboards 6’-6” minimum to centerline to top circuit breakers; 3’-0” to bottom of cabinet where possible, unless noted otherwise.

B. Properly align panel in cabinet.

C. Provide for empty 1-inch conduits from panel to ceiling space for all flush mounted panels. Arrange for future continuation of work.

3.3 FUSES

A. Install fuses in fusible devices as shown. Arrange fuses such that fuse ratings may be read without removing the fuse.

B. Install spare fuse cabinet with spare fuses in location shown (or adjacent to distribution switchgear).

C. Spare Fuses. Furnish quantity equal to 20 percent of each type and six installed, but not less than one set of three of each type and size.

END OF SECTION

SECTION 26 29 13 - MOTOR CONTROLLERS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes motor controllers for the three-phase and single-phase motors operating at voltages not in excess of 600 voltage in alternating current (VAC).

1.2 QUALITY ASSURANCE

A. Material and installation shall be in accordance with the latest revision of the following codes, standards, and specifications, except where more stringent requirements have been specified herein:

1. National Electrical Code (NEC)
2. National Electrical Manufacturers Association (NEMA)
3. Underwriters Laboratories (UL)
4. International Electrotechnical Commission (IEC).

B. Qualifications of manufacturer. Provide materials and equipment that are the products of manufacturers regularly engaged in the production of such products which are of equal material, design, and workmanship. Products shall have been in satisfactory commercial or industrial use for two (2) years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturer's catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer.

C. Uniformity: Unless otherwise specified, equipment or material of the same type of classification, used for the same purpose shall be the product of the same manufacturer. All material shall be new and of the current design of the manufacturer providing equipment or material. Solid state motor controllers, AC magnetic contactors, NEMA rated overloads, and molded case circuit breakers for motor circuit shall be of the same manufacturer.

1.3 SUBMITTALS

A. Submittals shall conform to the requirements of Section 01 33 00 – Submittal Procedures, and to the requirements given in Section 26 00 00 - Electrical General. In addition, submittals shall include the manufacturer's name, trade name, place of manufacturer, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification, and technical paragraph reference.

B. Submittals shall contain a material list with manufacturer's name and data describing the material and showing its compliance with specifications, associated standards and test requirements.

C. Prior to obtaining any material in connection with this section, catalog data and detailed wiring connection diagrams shall be submitted. Submittals for each manufactured item shall be current

manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog data sheets. Submittal shall include ratings, circuit diagrams, and dimensional data, as a minimum. Drawings shall include elementary and interconnection diagrams showing connections to internal components, and indicate field termination points for power and control interface. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted.

D. Shop drawings shall present complete and accurate information relative to all working dimensions, equipment weights, assembly and section views, and all necessary details pertaining to coordinating the work of the Contract, lists of materials and finishes, parts list and the descriptions thereof, lists of spare parts and tools where such parts or tools are required, and any other information that is required to demonstrate compliance with the Contract Documents. Drawings for electrical equipment shall include elementary and interconnection diagrams showing connections to internal components, and indicating field termination points for power and control interface. Solid State Motor Controller Equipment supplier shall submit manufacturer's catalog data and diagrams, output cable lug sizes and ratings, and elevation view of Solid State Motor Controller with the door removed. Project specific wiring diagrams shall be provided.

E. Submittal shall contain manufacturer's descriptive data including ratings, circuit diagrams, dimensional data, conduit entry restrictions, and heat dissipation to ambient. Submittals shall also contain manufacturer's part number for the equipment.

F. Manufacturer's standard wiring diagrams and specific modifications to the wiring of the equipment shall be submitted. All terminal points for field and interconnecting wiring shall be identified.

G. Submittals shall include a list of the setup parameters for the solid state motor controller.

H. Samples of any material shall be submitted upon Engineer's request.

1.4 CLOSEOUT SUBMITTALS

A. Provide project record documents which record actual locations of components and circuits.

PART 2 PRODUCT

2.1 NEMA MAGNETIC MOTOR CONTROLLERS

A. NEMA Magnetic Motor Starters

1. Magnetic motor starters shall be 3-pole, 60 cycle magnetic starters, and shall be of the NEMA size appropriate for the motor horsepower and voltage shown but not be less than NEMA Size 1.

2. Unless otherwise specifically shown or specified, all magnetic motor starters shall be provided with:

    a. Vertical lift operation
    b. A replaceable type, encapsulated operating coil rated at 120 VAC
    c. Overload relays
    d. Starter coils and contacts shall be easily replaceable without removing contactor from the enclosure.

3. Magnetic motor starters shall be rated to meet minimum number of load/life operations (contact electrical life under load) when motor starter is used for starting of squirrel cage motors and switching motor off only after the motor is up to speed, as follows:

NEMA Size	# of Operations	Operational Current
1	2 million	27 amperes
2	2 million	45 amperes
3	1.5 million	90 amperes
4	1.5 million	135 amperes
5	2 million	270 amperes

4. Individual magnetic motor starters shall be provided with the required accessories to perform the control circuit as shown on Contract Drawings or specified. These accessories shall include but shall not be limited to the following:

    a. Single-phase control transformers of rating suitable for the load of the control circuit as actually installed, with fused secondary rated for 120 VAC

    b. Pushbutton stations or selector switches with legend plates or engraved nameplates as specified in Section 26 09 16 - Miscellaneous Electrical Controls

    c. Hand-Off-Auto selector switch, unless otherwise noted.

    d. Push-to-test indicating lights with interchangeable covers as specified in Section 26 09 16 - Miscellaneous Electrical Controls

    e. Control circuit fuse where a separate control circuit is shown

    f. Two electrically convertible contact interlocks.

5. Each magnetic motor starter shall be of a type suitable to perform the control function shown and be in accordance with one of the following:

    a. Constant Speed, Full Voltage, Non-Reversing Starters (FVNR) shall provide basic contactors for forward control.

    b. Constant Speed, Full Voltage Reversing Starters (FVR) shall provide basic contactors for the forward and reverse speed. Mechanical and electrical interlocks shall be provided to preclude the possibility of both contactors being closed at the same time.

    c. Constant Speed, Reduced Voltage Starters (RV) shall be of the closed transition, auto-transformer type and shall include the required 3 pole and 5 pole contactors, auto-transformers, timing relays and appurtenances.

    d. Multi-Speed Motor Starters shall provide the basic contactors for each speed, suitable interlocked. Where shown, sequence-compelling relays shall be provided.

6. Magnetic motor starter manufacturers:

    a. Allen-Bradley Bulletin 500, 505 Series
    b. General Electric CR-306, CR-309 Series
    c. Sq D Class 8536, 8702 Series
    d. Cutler-Hammer A-200 Series, A-210 Series
    e. equal (Samples of equal products shall be submitted in accordance with Part I).

B. NEMA Combination Motor Starter with Circuit Breaker (MCP) Disconnect

1. Combination magnetic motor starters shall be the combination type consisting of a motor circuit protector (MCP) and NEMA magnetic motor starter assembled and wired into a self-contained unit.

2. The magnetic motor starter shall be designed to coordinate with the circuit protective device to withstand a minimum short circuit current of 22,000 AIC or as shown on the Contract Drawings.

3. MCP and magnetic motor starter shall be packaged by one manufacturer. Combination motor starters shall be:

    a. Allen-Bradley Bulletin 513, 507 Series
    b. General Electric Type CR387, CR390 Series
    c. Sq D Class 8539, 8739 Series
    d. Cutler-Hammer Class A206, A216 Series
    e. equal (Samples of equal products shall be submitted in accordance with Part I).

C. NEMA Combination Magnetic Motor Starter with Fused Switch Disconnect

1. Combination magnetic motor starters shall be the combination type consisting of a fused switch and NEMA magnetic motor starter assembled and wired into a self-contained unit.

2. The magnetic motor starter shall be designed to coordinate with the fused switch to withstand a minimum short circuit current of 100,000 AIC or as shown on the Contract drawings.

3. Fused switches shall be provided with Class R fuse clips.

4. Fused type combination starter shall be provided certified Type 2 coordination in accordance with IEC 947-4-1.

5. Fused switch and magnetic motor starter shall be packaged by one manufacturer. Combination motor starters shall be:

    a. Allen-Bradley Bulletin 512, 506 Series
    b. General Electric Type CR308, CR311 Series
    c. Sq D Class 8538, 8738 Series
    d. Cutler-Hammer Class A204, A214 Series
    e. equal (Samples of equal products shall be submitted in accordance with Part I).

D. NEMA Manual Motor Starting Switches

1. Manual motor starting switches shall be provided for the control and protection of all single-phase motors which do not require control from a remote location.

2. Manual motor starting switches shall provide thermal overload protection, including trip-free operation, and a manual reset overload.

3. Integral start-stop pushbuttons or on-off toggle switches shall be provided as shown on the Contract Drawings.

4. Manual motor starting switch manufacturers:

    a. Allen-Bradley Bulletin 600 Series
    b. General Electric CR101, CR1062
    c. Sq D Class 2510, 2511, 2512
    d. equal (Samples of equal products shall be submitted in accordance with part I).

E. NEMA Overloads

1. The Contractor shall verify the ratings of overloads and install overloads suitable for the actual motors installed, and based on the actual nameplate information and other supplemental information furnished with the installed motors. Any replacement of motor overloads due to this verification not being performed shall be done at no additional cost to Engineer.

2. Overload relays shall be class 20, manual reset, eutectic alloy, thermal type overload device with visual trip indication, unless shown or specified otherwise. Overload relays shall be current transformer operated if required for coordination.

3. Three spare overload relay thermal elements shall be provided for each type of element installed.

4. Overload relay manufacturers:

    a. Allen-Bradley Bulletin 592
    b. General Electric CR324
    c. Square D Class 9065
    d. equal (Samples of equal products shall be submitted in accordance with part I).

PART 3 EXECUTION

3.1 INSTALLATION

A. Overload relays shall be installed in each leg of the starter.

1. Overload relay characteristics shall be closely parallel the motor thermal characteristics.

2. Ambient compensated overload relay thermal elements shall be installed where motor and overload are in different locations.

B. Enclosures for motor controllers shall be of the type appropriate for each location, as specified in Section 26 27 16 –Enclosures.

END OF SECTION

SECTION 26 43 13 - TRANSIENT VOLTAGE SURGE SUPPRESSION

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section describes the materials and installation requirements for transient voltage surge suppressors (TVSS) for the protection of AC electrical circuits from the effects of lightning induced currents, substations switching transients and internally generated transients resulting from inductive and capacitive load switching. This section is applicable for transient voltage surge suppressors for protection of electrical equipment and electronic systems at 600 volts and below, and communication equipment from the effects of line and electromagnetic induced transient voltage surges and coupled lightning discharged transients.

1.2 QUALITY ASSURANCE

A. Materials and installation shall be in accordance with the latest revision of the following codes, standards, and specifications, except where more stringent requirements have been specified herein:

1. National Electric Manufacturers Association (NEMA) LS-1, Specification Format for Low Voltage AC Surge Protective Devices (1000 volts or less)

2. Underwriters Laboratories, Inc. (UL) 1449 – Standard for Safety for Transient Voltage Surge Suppressors

3. National Electrical Code (NEC)

4. The Institute of Electrical and Electronic Engineers (IEEE) ANSI/IEEE C62.41, Recommended Practice for Surge Voltages in Low Voltage AC Power Circuits

5. The Institute of Electrical and Electronic Engineers (IEEE) ANSI/IEEE c62.1, standard for surge Arrestors for AC power circuits

6. The Institute of Electrical and Electronic Engineers (IEEE) ANSI/IEEE c62.33, standard for Test Specifications for Varistor Surge Protection Devices.

B. This specification requires that all grounding and grounding circuitry be equal to or exceed the requirements of NEC Article 250. In the event of a conflict or discrepancy between these Specifications, the Contract Documents, and NEC Article 250, the more stringent requirement shall apply.

C. Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products, which are of equal material, design, and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or

more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

D. Uniformity. Unless otherwise specified, equipment of same type of classification shall be a product of same manufacturer. All equipment shall be new and of the latest design of manufacturer providing equipment or material.

1.3 SUBMITTALS

A. Submittals shall conform to the requirements of Section 01 33 00 – Submittal Procedures, and to the following additional requirements. Submittals shall include the manufacturer's name, trade name, place of manufacture, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification, and technical paragraph reference.

B. Prior to obtaining any material in connection with this section, catalog data and detailed wiring connection diagrams for each type of equipment shall be submitted. Submittals for each manufactured item shall be current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog data sheets. Submittal shall include ratings, circuit diagrams, and dimensional data, as a minimum. Handwritten and typed modifications and other notations not part of the manufacturer's preprinted data will result in the rejection of the submittal. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified for certificates of compliance.

C. Submittals shall contain a material list with manufacturer data describing the material and showing its compliance with the specifications, associated standards, and test requirements.

D. UL Standard 1449 Listing, Standard for Safety, Transient Voltage Surge Suppressors, documentation.

E. UL Standard 1283 Listing, Electromagnetic Interference Filters, documentation.

F. IEEE C62.41-1991 Category C3 (20kV-1.2/50, 10kA-8/20useec waveform) let through voltage test results.

G. Spectrum analysis of TVSS based on MIL-STD-220A test procedures between 50kHz and 200kHz verifying noise attenuation exceeds 50dB at 100kHz.

H. Independent third party test results verifying single impulse current rating capabilities.

I. Conductor size, rating, and type for connection of surge protection.

J. Submit manufacturer’s installation instructions and testing requirements for each type of surge suppressor utilized.

K. Submit Operations and Maintenance Manual for each type of unit.

1.4 CLOSEOUT SUBMITTALS

A. Provide project record documents which record actual locations of components and circuits.

PART 2 PRODUCT

2.1 GENERAL

A. Surge protective devices (SPD) furnished for use on this project are to incorporate protective elements in all applicable modes. Hardwired and direct plug-in type units are to incorporate line to neutral (L-N), line to ground (L-G), and neutral to ground (N-G) protective elements, unless otherwise noted. TVSS shall be UL Listed.

B. SPD shall be housed in an enclosure that is compatible with the system being protected.

C. Voltage class and type of unit shall be compatible with system voltage being protected.

2.2 480 VAC SYSTEM SURGE PROTECTIVE DEVICE

A. Minimum surge current capacity shall be 240 kA per phase at service entrance and panelboard applications.

B. SPD shall be designed withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.

C. Pulse life test: Capable of protecting against and surviving 5000 ANSI/IEEE C62.41 Category C3 transients without failure or degradation of UL 1449 suppression voltage ratings by more than 10%.

D. The UL 1489 suppression voltage ratings (based on IEEE Category C3 Combination Wave):

Voltage	L-G	L-N	N-G
480 V	900V	900V	900V

E. SPD shall be made of solid-state components and operate bidirectionally.

F. SPD shall have a response time no greater than one nanosecond for any of the individual protection modes.

G. Visual indication of proper SPD connection and operation shall be provided. Visual indication shall be by means of solid state status indicator lights on the front of the SPD.

H. SPD shall have an integral disconnect switch to disconnect all phases simultaneously.

I. Surge counter to monitor the occurrence of transients entering the facility through the suppressor.

J. Dry contacts to monitor each phase and provide a summary alarm.

K. Approved Manufacturer:

1. Advanced Protection Technologies Inc., TE/XGA Series
2. Equal.

2.3 120/208 VAC System Surge Protective Device and 120/240 Surge Protective Device

A. Minimum surge current capacity shall be 80kA per phase.

B. SPD shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.

C. Pulse life test: Capable of protecting against and surviving 2000 ANSI/IEEE C62.41 Category C3 transients without failure or degradation of UL 1449 suppression voltage ratings by more than 10%.

D. The UL 1449 suppression voltage ratings (based on IEEE Category C3 Combination Wave):

Voltage	L-G	L-N	N-G
480 V	900V	900V	900V

E. SPD shall be made of solid-state and operate bidirectionally.

F. SPD shall have a response time no greater than one nanosecond for any of the individual protection modes.

G. Visible indication of proper SPD connection and operation shall be provided. Visual indication shall be by means of solid state status indicator lights on the front of the SPD.

H. SPD shall have an integral disconnect switch to disconnect all phases simultaneously.

I. Dry contacts to monitor each phase and provide a summary alarm.

J. Approved Manufacturer:

1. Advanced Protection Technologies Inc., TE/HPS Series
2. Equal

2.4 PANELBOARD SUPPRESSORS

A. Panelboard surge suppression devices shall be modular design with field-replaceable modules and the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity

2. Fabrication using bolted compression lugs for internal wiring

3. Integral disconnect switch

4. Redundant suppression circuits

5. Redundant replaceable modules

6. Arrangement with copper busbars and for bolted connections to phase bus, and ground bus

7. Arrangement with wire connections to phase buses, neutral bus, and ground bus

8. Red and green LED indicator lights for power and protection status

9. Audible alarm, with silencing switch, to indicate when protection has failed

10. One set of dry contacts rated at 5-a and 250-V ac, for remote monitoring of protection status

11. Coordinate with building power monitoring and control system

12. Surge event operations counter

13. Peak Single-Impulse Surge Current Ratings: 80 kA per phase

14. Protection modes and UL 1449 clamping voltage for grounded wye circuits on 3-phase, 4-wire circuits, shall be as follows:

    a. Line to Neutral:

        1) 800 V for 480Y/277VAC
        2) 400 V for 208Y/120VAC.

    b. Line to Ground:

        1) 800 V for 480Y/277VAC
        2) 400 V for 208Y/120VAC.

    c. Neutral to Ground:

        1) 800 V for 480Y/277VAC
        2) 400 V for 480Y/277VAC.

15. Protection modes and UL 1449 clamping voltage for 240/120 VAC, single-phase, single-phase, 3-wire circuits, shall be as follows:

    a. Line to Neutral: 400V
    b. Line to Ground: 400V
    c. Neutral to Ground: 400V.

16. Protection modes and UL 1449 clamping voltage for 240/120 VAC, 3-phase, 4-wire circuits, with high leg shall be as follows:

    a. Line to Neutral: 400V, 800V from high leg
    b. Line to Ground: 400V
    c. Neutral to Ground: 400V.

17. Protection modes and UL 1449 clamping voltage for voltages of 240, 480, or 600; 3-phase, 3-wire, delta circuits shall be as follows:

    a. Line to Line:

        1) 2000 V for 480 VAC
        2) 1000 V for 240 VAC.

    b. Line to Ground:

        1) 1500 V for 480VAC
        2) 800 V for 240 VAC.

2.5 PLUG-IN SURGE SUPRESSORS

A. Non-modular, plug-in suppressors shall have at least four 15-ampere, 120 VAC, NEMA WD 6, with configuration for 15-15R receptacles, suitable to plug into a NEMA WD 6, Configuration 15-15R receptacle. Plug-in suppressors shall have the following features and accessories:

1. LED indicator lights for power and protection status

2. LED indicator lights for reverse polarity and open outlet ground

3. Circuit breaker and thermal fusing. When protection is lost, circuit shall open and cannot be reset

4. Circuit breaker and thermal fusing. Unit shall continue to supply power if protection is lost

5. Cord connected with nominal 15-foot line cord

6. Rocker-type on-off switch, illuminated when in on position

7. One RJ11/12C telephone line protector, suitable for modem connection. Maximum clamping voltage 220-volt peak on pins Nos. 3 and 4.

B. Peak Single-Impulse Surge Current Rating shall be 33kA per phase.

C. Protection modes and UL 1449 clamping voltage shall be as follows:

1. Line to Neutral: 475 V
2. Line to Ground: 475 V
3. Neutral to Ground: 475 V.

2.6 CONTROL AND DATA TERMINALS

A. Protection for copper control, data, antenna, and telephone conductors entering the building form the outside shall be as recommended by manufacturer for the type of line being protected and selected by Engineer based on application.

PART 3 EXECUTION

3.1 INSTALLATION OF SURGE PROTECTIVE DEVICES

A. Install surge protective devices as indicated on the drawings, as specified, and according to manufacturer's recommendations.

B. Locate suppressor on load side of main disconnect device, as close as possible to the phase conductors and ground/neutral bar.

C. Hardwired suppressors shall be close-nippled to the device being protected. The mounting position of the suppressor shall permit a straight and short lead length connection between the suppressor and the point of connection.

D. Securely mount surge suppressor to wall, or panel with stainless steel hardware.

E. Conductors for connection of surge suppression shall be as recommended by the manufacturer for this application, and shall be wrapped together the full length of the conductor.

F. Neutral and ground shall not be bonded together at panelboard locations.

G. Minimum conductor size for hardwire connection of SPD to phase, neutral, and grounding connection points shall be as follows:

1. For 480 VAC system applications where surge capacity is 160 kA/phase or greater, #1 AWG shall be used

2. For 240 VAC (or 208 VAC) system applications where the surge capacity is below 160 kA, #6 AWG shall be used.

H. Exposed ground conductors shall be installed in conduit.

I. Install devices at service entrance suppressors on load of the service entrance disconnecting, with ground lead bonded to service entrance grounded conductor bus.

J. Provide multi-pole circuit breakers as a dedicated disconnect for the suppressor, unless otherwise indicated.

3.2 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing surge protective devices, but before electrical circuitry has been energized, test for compliance with requirements

2. Complete startup checks according to manufacturer's written instructions

3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.19. Certify compliance with test parameters.

B. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

END OF SECTION

SECTION 26 51 00 - LIGHTING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes fixtures, lamps, and accessories required for a complete installation as shown and specified.

1.2 QUALITY ASSURANCE

A. Material and installation shall be in accordance with the latest revision of the following codes, standards, and specifications, except where more stringent requirements have been specified herein:

1. National Electrical Code (NEC)
2. National Electrical Manufacturers Association (NEMA)
3. Underwriters Laboratories (UL)
4. American National Standard Institute (ANSI)

B. Qualifications of manufacturer. Provide materials and equipment that are the products of manufacturers regularly engaged in the production of such products which are of equal material, design, and workmanship. Products shall have been in satisfactory commercial or industrial use for two (2) years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturer's catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer.

C. Uniformity: Unless otherwise specified, equipment or material of the same type of classification, used for the same purpose shall be the product of the same manufacturer. All material shall be new and of the current design of the manufacturer providing equipment or material.

1.3 SUBMITTALS

A. Submittals shall conform to the requirements of Section 01 33 00 – Submittal Procedures, and to the requirements given in Section 26 00 00 - Electrical General. In addition, submittals shall include the manufacturer's name, trade name, place of manufacturer, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification, and technical paragraph reference.

B. Prior to obtaining any material in connection with this Section, detailed shop drawings on all material shall be submitted.

C. Submittals shall contain a material list with manufacturer's name and data describing the material and showing its compliance with specifications, associated standards and test requirements.

D. Prior to obtaining any material in connection with this section, catalog data and detailed wiring connection diagrams shall be submitted. Submittals for each manufactured item shall be current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog data sheets. Submittal shall include ratings, circuit diagrams, and dimensional data, as a minimum. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted.

E. Shop drawings shall present complete and accurate information relative to all working dimensions, equipment weights, assembly and section views, and all necessary details pertaining to coordinating the work of the Contract, lists of materials and finishes, parts list and the descriptions thereof.

F. Photometric data for fixtures shall be submitted upon Engineer's request.

G. Samples of any material shall be submitted upon Engineer's request.

1.4 CLOSEOUT SUBMITTALS

A. Provide project record documents which record actual circuit directories, as well as actual locations of components and circuits.

PART 2 PRODUCTS

2.1 GENERAL

A. Unless otherwise shown or specified, all conductors shall be stranded copper.

B. Lighting fixtures shall be provided with required hangers, mounting brackets, and hardware for installation in the location shown on the Contract Drawings.

C. Provide low-temperature ballasts with minimum starting temperature of 0°F for all fixtures to be mounted outdoors. Energy-Saving Magnetic Ballasts: Full-light-output type, compatible with energy-saving lamps specified.

D. Light fixtures shall be furnished as shown.

E. Reflectors, reflector cones and visible trim of all lighting fixtures shall not be installed until completion of plastering, ceiling tile work, painting and general cleanup. They shall be carefully handled to avoid scratching or fingerprinting and shall be, at time of acceptance by Engineer, completely clean.

F. Adjustable fixtures shall be capable of being locked in position.

G. Unpainted fixture parts shall be either anodized aluminum, non-corrosive grade stainless steel or an acceptable equivalent of non-corrosive material.

H. Lamps shall be provided for all fixtures specified. The Contractor shall be responsible for all lamps broken or removed up to the date of acceptance of work.

2.2 FIXTURES

A. Building Wall Mounted Wall-Pack (Type W1 and W2)

1. General: For general exterior perimeter illumination for building facades, office complexes, parks, residential areas, campuses, walkways, outdoor storage areas, warehouses, factories, loading docks, and similar locations.

2. Light source: High Pressure Sodium 150W lamp, 250W lamp, or 400W lamp

3. Voltage: 120 voltage in alternating current (VAC), 208VAC, 240VAC, 277VAC, 347VAC, or 480VAC, 60Hz, single phase

4. Housing: Rugged, weather and corrosion resistant, die-cast aluminum

5. Finish: Dark bronze polyester powder, electrostatically applied and oven cured

6. Optical System: Specular anodized aluminum reflector and prismatic, borosilicate glass. Lens shall be sealed and gasketed to inhibit entrance of outside contaminants

7. Listings: UL listed for 25^{o}C ambient and suitable for use in wet locations

8. Mounting: Wall mounted, 8’ to 25’ above optical plane

9. Manufacturer: Hollophane Wallpack, or equal.

B. Building Wall Mounted Wall-Pack (Type W3)

1. General: For general exterior area illumination in outdoor storage areas, warehouse and factory perimeters, loading docks, and similar locations.

2. Light source: High Pressure Sodium 150W lamp, 250W lamp, or 400W lamp

3. Voltage: 120VAC, 208VAC, 240VAC, 277VAC, 347VAC, or 480VAC, 60Hz, single phase

4. Housing: Rugged, weather and corrosion resistant, die-cast aluminum.

5. Finish: Dark bronze polyester powder, electrostatically applied and oven cured

6. Optical System: Specular anodized aluminum reflector and prismatic, borosilicate glass. Lens shall be sealed and gasketed to inhibit entrance of outside contaminants

7. Ballast: Copper-wound ballast, high reactance or high power factor with constant wattage autotransformer as appropriate for the application

8. Listings: UL listed for 25oC ambient and suitable for use in wet locations

9. Mounting: Wall mounted, 8’ to 25’ above optical plane.

10. Fixture Options: Fixtures shall be provided with a quartz restrike system where indicated on the fixture schedule

11. Manufacturer: Lithonia TWH, Holophane Wallpack, or equal.

C. Area Lighting (Type A1)

1. General: Pole mounted light fixture for general exterior area illumination in parking areas, equipment areas, or similar locations

2. Light Source: High Pressure Sodium 70W lamp, 100W lamp, or 150W lamp

3. Voltage: 120VAC, 208VAC, 240VAC, 277VAC, 347VAC, or 480VAC, 60Hz, single phase

4. Housing: Rugged, heavy-gauge (.12" thick), aluminum housing. Square shape, seam-welded and internally sealed watertight. Anodized, extruded aluminum door frame sealed to housing by silicone closed-cell gasket and secured with quarter turn screws

5. Finish: Dark bronze polyester powder, electrostatically applied and oven cured

6. Optical System: Rotatable and interchangeable, anodized reflectors. 0.125" thick, impack-resistant, tempered glass lens

7. Ballast: High reactance, high power factor, copper wound ballast

8. Listings: UL Listed for use in wet locations

9. Mounting: Pole mounted. Provide all pole fitters, hardware, brackets, for mounting light fixture on the light pole.

10. 1Mounting: Wall mounted. Provide all slip fitters, hardware, brackets, for mounting light fixture on the wall

11. Manufacturer: Lithonia KSE1, or equal.

D. High Pressure Sodium (Types P2 and P3)

1. General: For interior or exterior area illumination in installations where moisture, dirt, dust, vibration, corrosion, and rough usage are problems. Also, for applications requiring light fixtures suitable for Class I Division 2 Hazardous (Classified) Locations

2. Light Source: High Pressure Sodium 50W – 250W lamp

3. Voltage: 120VAC, or 480VAC, 60Hz, single phase

4. Temperature: -40^{o}C to 40^{o}C ambient temperature

5. Housing: Cast aluminum housing. Hinged ballast housing for ease of installation and maintenance. Gasketing seals between the mounting module, housing, and optical assembly

6. Finish: Epoxy powder coat (housing, and high reflectance white (reflector)

7. Optical System: Krydon fiberglass-reinforced polyester reflector, with heat and impact resistant internally fluted glass globe

8. Ballast: Copper-wound ballast, high power factor with constant wattage autotransformer

9. Listings: UL listed for use in wet locations. UL listed for use in Class I, Division 2 Hazardous (Classified) Locations where designated on the contract drawings

10. 1Mounting: Pendant mount, flexible pendant mount, ceiling mount, wall bracket mount, or stanchion mount. Mounting shall be as designated on the contract drawings.

11. Fixture Options: Quartz restrike system to enable a hot high pressure sodium lamp to immediately restrike after a momentary loss of arc due to voltage fluctuation or power outage. Fixtures shall be provided with a quartz restrike system where indicated on the fixture schedule.

12. Manufacturer: Hubbell MH, or equal.

E. Fluorescent Fixture (Type P1)

1. General: For low to medium mounting heights where dust, dirt, humidity, moisture, cold ambient spaces, or corrosive elements are present. Application shall be for areas similar to wastewater treatment plants and pumping stations, water treatment plants, refrigerated areas, food processing, and similar non-hazardous environments

2. Light source: 1 or 2 high output fluorescent, high output lamps, 4’ or 8’ lengths

3. Voltage: 120VAC, or 277VAC, 60Hz, single phase

4. Housing: Impact resistant, UV stabilized, fiberglass reinforced polyester with cold-rolled steel enclosed wireway, and gasket seal between housing and diffuser. Captive, corrosion-resistant cam-action latches to seal the diffuser

5. Finish: Baked white enamel, or other color as approved by the Engineer

6. Optical System: High impact, acrylic diffuser with a stippled interior surface designed to spread lamp image

7. Lamps: Lamps shall be four or eight foot T8 type. Initial lumen output shall be 3150 lumens and each lamp shall have a minimum life of 9,000 hours.

8. Listings: UL listed and suitable for use in damp or wet locations

9. Mounting: Surface (ceiling or wall) mounted, or suspended mounting

10. Manufacturer: Lithonia type DM (damp locations), DMW (wet locations) or equal.

F. Emergency Lighting Unit/Exit Sign combination unit (Type E1)

1. General: Emergency lighting unit and exit sign combination unit for use in industrial and wet environments

2. Light Source: Green direct view LEDs for the exit sign illumination, and two halogen sealed beam lamps for the emergency lighting

3. Voltage: 120/277 VAC dual voltage

4. Housing: Fiberglass reinforced polyester enclosure with a clear polycarbonate lens cover. Lens shall provide a watertight fit and be impact resistant. Housing shall be rated for use in NEMA 3, NEMA 3R, NEMA 4, NEMA 4x, NEMA 12, and NEMA 13 areas

5. Batteries: Maintenance free sealed nickel cadmium to provide 90 minutes of operation, 10 years expected operating life.

6. Charger: Unit shall utilize a constant current charging system. The charging system shall maintain the battery at full capacity

7. Listings: UL listed for use in wet locations

8. Manufacturer: Holophane LNM – DeLeon, or equal

2.3 SUPPORT SYSTEMS

A. Support systems shall be provided with clamping nuts, square washers, splice plates, and hardware to assemble the system.

B. Hangers. Lighting fixtures shall be provided with required hangers and mounting brackets for installation in the locations shown on the Contract Drawings. Mounting brackets and supports shall be heavy duty channel constructed or strip steel with a hot dipped finish per ASTM A-123. Support system shall be designed to carry the required lighting fixture load with a safety factor of 10. Provide extra steel for supports to achieve this safety factor. Hangers and accessories shall be as manufactured by: Grinnell – Powerstrut, Globe Strut – Metal Framing Systems, or equal.

C. Poles

1. Poles shall be compatible for outdoor use. Factory templates shall be provided with units to assure proper anchoring bolts setting. Provide screws, nuts, and bolts; screws nuts and bolts shall be made of ANSI 300 series stainless steel.

2. Shape:
   a. The pole shall bear a square, non-tapered shaft.
   b. Mounting height: 20 feet
   c. Width: 5 inches
   d. Shaft thickness: 0.188 inches.

3. Mounting: The pole's anchor base shall be cast from 356 aluminum alloy (ASTM b-108), with the anchor bolt holes recessed and covered by aluminum caps. The anchor bolts shall have 12" galvanized tops per ASTM A-153, and shall be made of ¾" or 1" diameter steel rod with minimum yield strength of 50,000 psi.

4. Finishes: Weatherproof, dark bronze polyester powder finish, with high strength plastic cap on top.

5. Wire access: Each pole shall have a rectangular reinforced handhole having nominal dimensions of 2 1/8" x 5 1/8" on the shaft. A rain-tied handhole cover plate shall be provided.

6. Option: 10' poles shall be provided where specified.

7. Poles shall be as manufactured by Lithonia T20 SSA, or equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Mounting height for fixtures shall be as shown on the Contract Drawings. Where no mounting height is shown, fixtures shall be mounted so as to give the minimum of shading from pipes, beams and other obstructions, but in no case less than approximately 10'-0" above the finished floor unless a lower ceiling height is specified. Where pendent type fixtures are required, they shall be suspended by means of 3/4-inch, galvanized conduit stems and ball hangers from outlet boxes or as detailed on the drawings. Check and verify field conditions to insure against mechanical or structural interference. Provide nighttime adjustment of all adjustable lighting units and floodlighting, as required, to satisfaction of Engineer.

B. The contractor shall be responsible for coordinating the final location of fixtures and fixture supports with other work, such as duct work, building steel, overhead cranes and hoists, and mechanical piping and equipment.

END OF SECTION

SECTION 27 27 10
MANAGED CONNECTED ROUTER WIRELESS COMMUNICATIONS SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes requirements for a Managed Connected Router Wireless Communications System. This communications system shall consist of a Managed Connected Router, which utilizes a 900 Megahertz (MHz) Unlicensed Spread Spectrum Radio, Cellular Modem, and associated Antennas. The Spread Spectrum Radio and Cellular Modem shall be packaged in single system. Radio, cellular modem, and antennas shall operate as a complete communications system.
The spread spectrum radios and antennas shall comply with Federal Communications Commission (FCC) rules for unlicensed radio operation in the 902-928 MHz band. Cellular modem shall be compatible with the 3G and 4G (third generation and fourth generation) mobile telecommunications technology and the public cellular infrastructure.

B. Equipment furnished under this Contract shall be installed in an industrial type environment and powered from an electrical source that may include harmonic distortion, surges, sags, and other electrical noise under normal operating conditions. The Contractor and his suppliers shall verify that all equipment furnished shall function correctly in this noisy electrical environment. If the equipment is found to be unable to operate in this environment, the Contractor and/or his suppliers shall furnish any replacement equipment, surge protection, power line conditioners, uninterruptible power supply, or other equipment required to correct this problem at no additional cost to the Engineer.

C. This section also contains Surge Protectors for the antenna and radio, as shown on the drawings.

1.2 QUALITY ASSURANCE

A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:

1. National Electrical Code (NEC)
2. Underwrites Laboratories, Inc. (UL)
3. Federal Communications Commission (FCC).

1.3 SUBMITTALS

A. Prior to obtaining any material in connection with this Section, detailed shop drawings on all material shall be submitted. Submittals shall conform to the requirements of Section 01 33 00, Submittals.

B. Submittals shall include:

1. Bill of materials for all components
2. Catalog cuts for all components
3. Wiring diagrams (including wire numbers and field connection points)
4. Radio installation details

5. Antenna installation details
6. Grounding details for the antenna, antenna cable, and antenna mounting brackets.

C. Samples of any material shall be submitted upon Engineer's request.

D. Submit test plan for the radio and antenna system.

E. Perform a radio site survey between all new sites and the master radio site (on the Worcester County SCADA Communications network), or another site designated by the Engineer. Submit radio site survey report.

1.4 CLOSEOUT SUBMITTALS

Provide project record documents which record actual locations of components and circuits.

PART 2 PRODUCT

2.1 MANAGED CONNECTED ROUTER

A. The Managed Connected Router shall be capable of providing Industrial Protocol (IP)/Ethernet, serial, and machine-to-machine wireless communication and integrated 4G LTE wireless technology and connectivity for Ethernet and serial devices.

B. Managed Connected Router platform shall allow the option of communications using 900 MHz Industrial, Scientific, and Medical (ISM); Cellular 3G; Cellular 4G; and WiFi.

C. 900 MHz ISM Radio

Technology	Point-multipoint
Operating Modes	Access Point, Remote, Store & Forward
Data Rates/Sensitivity	125 kbps / -105Decibel-milliwatts (dBm)
(1x 10-6 BER)	250 kbps / -103dBm
	500 kbps / -99dBm
	1 Mbps / -95dBm
	1.25 Mbps / -95dBm
Average latency	<10 msec one-way
Output Impedance	50 ohms
Spreading Method	FHSS, DTS
Occupied Bandwidth	152 to 1320 kHz
Modulation	2, 4-level GFSK
Dwell Time	10-300 msec
Number of channels	up to 80
Carrier Power	100mW – 1W
Range	up to 30 miles
Max SAF Hops	Up to 8 hops.

D. Cellular 3G

Protocol/Frequency	GSM, GPRS, EDGE, HPSA+ 850/900/1800/1900 MHz 1700/1900/2100 MHz
Region/Carrier	Global PTCRB, GCF certification Regional carrier certifications
Max Throughput	21 Mbps downlink, 5 Mbps uplink
Typical Throughput	5.5 Mbps downlink, 0.3 Mbps uplink.

E. Cellular 4G

Protocol/Frequency	LTE Release 8 700 MHz CDMA Band class 0 (850 MHz) Band class 1 (1900 MHz)
Region/Carrier	U.S. Verizon
Max Throughput	50 Mbps downlink, 25 Mbps uplink
Typical Throughput	21 Mbps downlink, 10 Mbps uplink.

F. WiFi

Standard IEEE	802.11 b/g/n
Operating Modes	Access Point, Station
AP Networking	Dual SSID with VLAN mapping
Security	WPA/WPA2 PSK, Enterprise SSID hding
Carrier Power	20dBm.

G. Protocol

Networking	Layer 2 bridging Layer 3 routing, QoS
Ethernet	IEEE 802.3, Spanning Tree (Bridging), VLAN, IGMP TCP/IP DHCP, ICMP, UDP, TCP ARP, NTP, FTP, SFTP, TFTP, DNS
Serial	TCP server, TCP client UDP Unicast and Multicast Terminal Server for any asynchronous serial protocol Modbus TCP to remote terminal unit (RTU) conversion.

H. Physical Interfaces

Ethernet	10/100BaseT, RJ-45 Integrated Switch
Serial	RS-232/RS-485, RJ-45
USB	2.0 Management Port

Antenna Ports	900 ISM: TNC WiFi: RP-SMA Cellular: SMA.

I. Electrical

Input Voltage	10-60 VDC

Power Consumption (MCR 900, nominal output power 1W)

AP (idle)	4W
AP (50% duty)	5.3W
Remote (idle)	3.2W
Remote (50% Duty)	5.0W

Power Consumption (MCR 3G, nominal)

Connected (idle)	2.5W
Connected (typical download)	3.2W

Power Consumption (MCR 4G, nominal)

Connected (idle)	4.0W
Connected (typical download)	4.3W.

J. Mechanical

Case	Die Cast Aluminum
Dimensions	4.4cm H x 20.3cm W x 12.2cm D (1.75” x 8.0” x 4.8”)
Weight	2 pounds
Mounting Options	Integrated Din Rail Mount or standard mounting bracket.

K. Environmental

Temperature	-40°C to 70°C (-40°F to 158°F)
Humidity	95% at 60° C (140°F) non-condensing.

L. Management

HTTP, HTTPS, SSH, NETCONF, local console
SNMP v1/v2/v3, MIB-II, Enterprise MIB
Syslog and Syslog-over-TLS
MDS PulseNET compatible.

M. Agency Approvals

FCC Part 15
IC
ETSI/CE (3G and WiFi medels)
CSA Class 1, Div2, UL508, UL 1604
IEEE 1613.

2.2 RADIO

A. Spread spectrum radios shall meet FCC rules for unlicensed radio operation in the 902-928 MHz frequency band.

B. All radios shall be capable of operating as a stand alone Multiple Address System (MAS), as a stand alone point-to-point link, or as a "Tail End" or "Last Mile" link from an existing Multiple Address radio system.

C. The spread spectrum radio shall use the spread spectrum frequency hopping technique for data communications. In addition, the radio shall utilize narrow band filtering techniques to reject noise and interference. A 10^{-6} Bit Error Rate (minimum) shall be achieved for signal strengths of –110 dBm or stronger.

D. Radio shall be certified under FCC rules Part 15.247. No license will be required to operate radios under this contract.

E. Radios must be capable of transmitting user's data at standard rates between 1,200 and 115,200 bits per second. The radio must be capable of operation with RTS/CTS flow control and the data interface shall be selectable between RS-232 or RS-485.

F. Communications between the central master radio site and all remote sites must be 100% transparent communications for all standard asynchronous protocols. The radio must transmit data in the same format as used by the data system, seamlessly and without interruptions. Radio overhead or latency must average 6 to 10 milliseconds, and shall not exceed 30 milliseconds for communications from master to remote, or from remote to master.

G. It shall not be acceptable to require that the user's protocol be modified in any way for compatibility with radio communications nor will it be acceptable to require a special protocol driver in the radio.

H. It shall not be acceptable to require a front-end controller to convert protocols or reorder data packets.

I. It shall not be acceptable to transmit data in a non-deterministic manner such that the data would be received longer than 30milliseconds after transmission.

J. The master and remote radios shall be interchangeable such that all radios are identical. The user shall be able to select master, remote, or repeater operation using a software command.

K. Radios shall be designed to minimize interference from noise and other radios operating in this band. Transmission power shall be adjustable from 0.1 watt to the FCC maximum of 1.0 watt. The radio must be capable of hopping over 128 separate frequencies from 902 to 928 MHz. To ensure the ability to operate multiple radio systems in one area and to avoid possible interference that may be in this band, the 128 frequencies must be divided into 8 non-overlapping zones. The radio must be able to operate in all 8 zones, or any combination of 4 to 7 zones. Zone selection shall be initiated by a command from the master radio that is broadcast to all radios in the system. In addition, the radio must have a minimum of 65,000 separate system addresses. Assignment of a unique address (which sets the hop pattern) ensures that multiple radio systems can operate in the same area with minimal interference.

L. Radios shall utilize Cyclic-Redundant Checksum error checking and automatic retransmission in order to minimize the effects of in band interfering signals.

M. The radio system must utilize Digital Signal Processing (DSP) to automatically optimize communication performance and eliminate the requirements for internal tuning adjustments.

N. Software and firmware configurable operating parameters must be available to ensure maximum radio system performance and that throughput is available for a wide variety of system conditions and configurations. As a minimum, the data rate shall be adjustable from 1200 to 115,200 bps. It must also have two different hop times in order to optimize for best throughput or least delay. It must be possible to operate the system in a mode that buffers data or in a mode that transmits data as it is received by the radio.

O. All system configuration parameters shall be capable of being set by the user using a terminal or PC directly connected to the radio. Parameters for remote radios must be selectable over the air from the master radio.

P. Radio shall support automatic store and forward such that data can be transmitted through an unlimited number of repeaters. The repeaters must also be able to act as RTU radios. Using Store and Forward techniques, the radios must be able to perform alternate routing in the event of a repeater failure and to implement both a primary route scheme or a "use any equally" route scheme.

Q. The radio system shall provide integral diagnostic capability to allow the user to verify communications reliability between the master and remote radios. Diagnostic data must be continuously acquired by the master radio without interrupting the user's data communications. Diagnostic communication must be usable from any radio in the network.

R. Provide a separate diagnostic port to enable the remote RTU/PLC/Terminal to access all radio diagnostics directly from the radio and enable radio diagnostic data to be incorporated into the SCADA system database.

S. Other requirements:

General	
Frequency range	902-928 MHz, FCC Part 15 Spread Spectrum Band
Frequency Stability	+/- 0.00015% (1.5 PPM), -30°C to 60°C (-22°F to 140°F)
Frequency Hopping Range	128 channels/frequencies
Hop dwell times	7 milliseconds, 28 milliseconds, user selectable
Frequency Zones	8 zones
Unit Addresses	0-65000
System Addresses	0-65000.

Data Characteristics	
User Interface	RS-232 and RS-485
Data Latency	7 milliseconds (typical)
Byte Length	7 msec (typical)
Data Interface Baud Rate	1200-115,200 bps
Data Rate over the RF channel	115kps

Modulation Type	Binary CPFSK
Output Impedance	50 ohms.

Transmitter

Power Output	0.1 to 1.0 Watts (+20 to _30 dBm), user selectable
Duty Cycle	Continuous
Spurious Emissions	60 dBc
Harmonic Emissions	70 dBc
Transmitter Keying	Data activated
VSWR	Unlimited no damage
Modulation Type	Binary CPFSK
Output Impedance	50 ohms.

Receiver

Receiver Type	Double conversion superheterodyne
Bit Error Rate	$< 10^{-6}$ (-110dBm)
Intermodulation	59 dB minimum (EIA)
Desensitization	75 dB
Spurious	70 dB minimum
RSSI Range	-40 dBm to –120 dBm.

Primary Power

Voltage	13.8 VDC nominal (6-30 VDC Operating Range)
TX Supply Current	500mA @ 13.8 VDC
RX Supply Current	125mA @ 13.8 VDC
Sleep Mode Current	8mA @ 13.8 VDC
Reverse Polarity Protection	Included.

Environmental

Humidity	95% at 40°C (104°F) non-condensing
Temperature Range	-40° to +70° C (-22° to 140° F).

T. Managed Connected Router shall be model MDS Orbit MCR 900 MHz radio and 4G Cellular Modem, as manufactured by GE.

2.3 LTE MULTI BAND EXTERNAL VEHICLE OR ENCLOSURE DIRECT MOUNT ANTENNA

A. Direct mount antenna for cellular modem and 802.11n Applications.

B. Antenna Specifications

Frequency	698-906/1710-2500/2400-2700 MHz
Nominal Impedance	50 ohms
Nominal Gain	4.5 / 5.6 / 4 dBd
VSWR	3.0:1 / 2.0:1
Polarization	Vertical
Horizontal Plane	Omni
Power Rating	10 W.

C. Environmental Specifications

Operating Temperature	-40°C to 85°C
Storage Temperature	-40°C to 85°C
Relative Humidity	100%

D. Mechanical

Material	PC + ABS Plastic
Color	Black
Ingress Protection	IP-67
Weight	4.6oz / 130.4 g
Connector	N Female.

E. Provide antenna cable for connecting to cellular modem.

F. Antenna shall be Model SLPT698/2170DMN as manufactured by Pulse/Larsen.

2.4 DIRECTIONAL ANTENNA

A. Directional antenna shall provide directional coverage in the 890-960 MHz frequency band. Antenna base shall be constructed of 6061-T6 anodized Aluminum.

B. Directional Antenna Specifications

Bottom Operating Frequency	890 MHz
Top Operating Frequency	960 MHz
Nominal Gain	10.0 dBd
Horizontal Beamwidth	56 degrees (+/- 3dB)
Vertical Beamwidth	46 degrees (+/- 3dB)
Front to Back Ratio	20 dB
Power Rating	200 Watts
Length	24 inches
Width	2.4 inches
Height	6.8 inches
Weight	2 pounds
Cross Sectional Area	.24 ft^2
Lateral Thrust at 100 mph	5.9 pounds
Rated Wind Velocity	125 miles/hour.

C. Provide antenna with integral LMR400 antenna cable.

D. Antenna shall be Model Marathon BMY890K, as manufactured by Bluewave.

2.5 SURGE PROTECTION

A. Provide surge protection for input to radio. Surge protection shall conform to the following requirements:

Current	3 ADC
Insertion loss	<= 1dB

Frequency Range	300-2500MHz
Mounting	Flange
Operating Voltage	+/-24 Volts
Polarity	+/-
Protected Side Connector	F Female 75 ohms
RF Power	50 Watts
Surge Side Connector	F Female 75 ohms
Throughput Energy	<= 1000uJ for 3kA @ 8/20usec waveform
Throughput Voltage	<= 2 x operating voltage max Vpk
Turn-On voltage	+/-33 volts
Unit Impedance	75 ohms
Voltage Standing Wave Ratio	1.42:1
Weatherized	Bellcore #TA-NWT-000487 Procedure 4.11, Wind Driven (120 h) Rain Intrusion.

B. Surge protection device shall be Polyphaser IS-B50LN-C2 or equal.

PART 3 EXECUTION

3.1 GENERAL

A. Antennas and radio equipment shall be provided with wiring, schematic, layout, connection and control diagrams.

B. Configure the antenna and cellular modem equipment so that it equipment may be monitored remotely. Configure the antenna and radio modem equipment so that it may operate as a slave in the future SCADA communications network.

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3.2 INSTALLATION

A. Mount antennas as shown on the contract drawings and in accordance with all manufacturer's installation recommendations.

B. Keep antenna and antenna mast clear of all transmission lines. Antenna shall not be erected in any position such that the feedline, the antenna, or the antenna mast, or any part thereof crosses over or under a power line or pole transformer.

C. Tune antenna to the desired frequency.

D. Provide separate radio frequency signal ground for the transmitted signal. Ensure that the antenna is solidly grounded; do not rely on feed cable for ground return. Secure feed-line and transmission line to tower or building.

E. Weatherproof all cable connections.

F. Orient the antenna so that the received signal strength is maximized.

3.3 FIELD TESTS

A. The panel shall be checked and necessary adjustments shall be made in the field after installation.

B. Ensure that the antenna has been securely fixed, and that the antenna is oriented correctly.

C. Test radio system operation using simulated inputs and messages. Tests shall be performed in the presence of the Engineer.

End of Section

SECTION 31 23 17 - TRENCHING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavating trenches for utilities from outside building to utility service.
   2. Excavating trenches for soil vapor extraction (SVE) pipelines from well locations to the treatment system, including excavation for the condensation collection vault.
   3. Compacted fill from top of utility bedding to subgrade elevations.
   4. Bedding from bottom of excavated trenches to the top of the pipe bedding, as described in this section, for utility and SVE pipelines.

B. Related Sections:
   1. Section 03 30 00 – Cast-In-Place Concrete.
   2. Section 31 23 16 – Excavation.
   3. Section 31 23 23 – Fill.
   4. Section 40 05 13.73 – Plastic Process Piping.

1.2 REFERENCES

A. ASTM International:
   1. American Society for Testing and Materials (ASTM) C136-06 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
   2. ASTM D2488-17e1 - Standard Practice for Description and Identification of Soils.

1.3 DEFINITIONS

A. Utility: Any buried pipe, duct, conduit, or cable.

B. Trench Zone: The trench zone includes the portion of the trench from the top of the pipe zone to the existing surface in unpaved areas.

C. Pipe Zone: The pipe zone shall include the full width of trench from the bottom of the pipe or conduit to a horizontal level 12 inches above the top of the pipe. Where multiple pipes or conduits are placed in the same trench, the pipe zone shall extend from the bottom of the lowest pipes to a horizontal level 12 inches above the top of the highest or topmost pipe.

D. Pipe Bedding: The pipe bedding shall be defined as a layer of material immediately below the bottom of the pipe or conduit and extending over the full trench width in which the pipe is bedded. Thickness of pipe bedding shall be shown on the drawings or as described in these specifications for the particular type of pipe installed.

E. Excess Excavated Material
   1. The Contractor shall make the necessary arrangements for and shall remove and dispose of all excess excavated material at a landfill. Excess excavated material shall be weighed at the landfill and weight ticket shall be submitted to the Engineer. Excess excavated material may not be spread on site unless written permission from the Engineer is secured by the Contractor.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures.

B. Materials Source: Submit name of fill materials suppliers.

C. Material test results

1.5 QUALITY CONTROL

A. Perform Work according to appropriate local, state and federal standards and in accordance with International Building Code 2018.

1.6 FIELD MEASUREMENTS

A. Verify field measurements prior to construction activity.

B. Verify existing buried utilities and requirements prior to construction activity.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. Native earth backfill, acceptable for use, shall be free from large roots, debris, and rocks.

   1. Whenever the excavated material is not suitable for backfill, the Contractor shall arrange for and furnish suitable imported backfill material that is capable of being compacted per subsection 3.6 “Compaction” of this section.

   2. The Contractor shall dispose of the excess trench excavation as specified in the preceding section. Backfilling with imported material shall be done in accordance with the methods described in this section.

B. Sand Pipe Bedding:
   1. Gradation per ASTM C136-06

SIEVE SIZE	PASSING SIEVE BY % WEIGHT
3/8"	100
#4	90-100
#50	10-40
#100	3-15
#200	0-7

2. Shall not contain angular material as described in ASTM D2488-17e1
3. Free from ice, clay, organic matter, and rocks.

C. Topsoil:
1. Excavated and reused material.
2. Graded.
3. Free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds and foreign matter.

PART 3 EXECUTION

3.1 LINES AND GRADES

A. Lay pipes to lines and grades indicated on Drawings.
1. The Engineer reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.

B. Use laser-beam instrument with qualified operator to establish lines and grades.

3.2 PREPARATION

A. Call Local Utility Line Information service not less than one week before performing Work.
1. Request underground utilities to be located and marked within and surrounding construction areas.

B. Maintain and protect above and below grade utilities not indicated to be removed.

C. The surface and subsurface area within the drip line of protected trees shall not be disturbed.

D. Protect plant life, lawns, and other features remaining as portion of final landscaping.

E. Identify required lines, levels, contours, and datum locations.

F. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

3.3 TRENCHING

A. Excavation for pipe, fittings, and appurtenances shall be open trench to the depth and direction necessary for the proper installation of the facilities as shown on the Drawings.

B. Trench Banks shall be kept as near to vertical as possible.

C. When trenches remain open at the end of the workday, construction fencing shall line any open trenches to prevent injury.

D. The trench bottom shall be graded to provide a smooth, firm, and stable foundation that is free from rocks and other obstructions and shall be at a reasonably uniform grade, before placing any sand pipe bedding.

E. Cut trenches sufficiently wide to enable installation and allow inspection. Remove water or materials that interfere with Work.

F. Excavate bottom of trenches maximum 2 feet wider than outside diameter of pipe.

G. When subsurface materials at bottom of trench are loose or soft, excavate to greater depth as directed by Engineer until suitable material is encountered.

H. Correct over excavated areas with compacted backfill as specified for authorized excavation or replace with crushed rock or gravel as approved by the Engineer.

I. Cut out soft areas of subgrade not capable of compaction in place. Backfill and compact to density equal to or greater than requirements for subsequent backfill material.

J. Trim excavation. Remove loose matter.

K. Remove excess subsoil not intended for reuse from site.

3.4 SHEETING AND SHORING

A. Contractor shall comply with the OSHA Trenching and Excavation Standards 29 CFR 1926.651 and 1926.652.

3.1 BACKFILLING

A. Backfill trenches to contours and elevations with unfrozen fill materials.

B. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

C. Placing pipe bedding:

1. Place at least six inches of pipe bedding material over the full width of trench

2. Grade the top of the pipe bedding ahead of pipe to provide firm, uniform support along the full length of pipe.

D. Backfill within pipe zone:

1. After pipe has been installed in the trench, place pipe zone material simultaneously on both sides of the pipe, keeping the level of backfill uniform

2. Voids and uncompacted areas shall not be left beneath pipe

3. Trench shall be backfilled to prevent lateral movement of the pipe.

4. Place tracer wire on top of each pipe installed

E. Backfill within Trench Zone

1. Do not permit free fall of the material

2. Trench shall be backfilled in horizontal layers of not greater than 12 inches in depth

3. Contractor shall repair or replace any utility pipe, fittings, or structures as directed by the Engineer

3.2 COMPACTION

A. Compaction on conveyance pipe trenches shall be a minimum of 3 passes with a trench roller or one of the following attachments on an excavator: a sheepsfoot roller or a vibrating plate attachment.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements

B. No compaction tests are required for conveyance pipe.

3.4 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements.

B. Reshape and re-compact fills subjected to vehicular traffic during construction.

END OF SECTION

SECTION 32 31 13 - CHAIN-LINK FENCES AND GATES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fence framework, fabric, and accessories.
   2. Excavation for post bases.
   3. Concrete foundation for posts and center drop for gates.
   4. Manual gates and related hardware.

1.2 REFERENCES

A. ASTM International:
   1. ASTM A123/A123M-15 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. ASTM A153/A153M-16a - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. ASTM A392-11a - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
   4. ASTM F567-14a - Standard Practice for Installation of Chain-Link Fence.
   5. ASTM F900-11(2017) - Standard Specification for Industrial and Commercial Swing Gates.

B. Chain-Link Fence Manufacturers Institute:
   1. CLFMI - Product Manual.

1.3 SUBMITTALS

A. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.

B. Product Data: Submit data on fabric, posts, accessories, fittings and hardware.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Accurately record actual locations of fencing.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum 3 years documented experience.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver fence fabric and accessories in packed cartons or firmly tied rolls.

B. Identify each package with manufacturer’s name.

C. Store fence fabric and accessories in secure and dry place.

PART 2 PRODUCTS

2.1 MATERIALS AND COMPONENTS

A. Materials shall be new.

B. Materials and Components: Conform to CLFMI Product Manual.

C. Fabric:
1. Size: 2-inch mesh, 9 gauge.
2. Material: Zinc-Coated Steel Fabric: ASTM A392-11a hot dipped galvanized (1.2 oz/sqft) before or after weaving.
3. Privacy Insert: White Privacy Wing Slat. 90% privacy and 25-year pro-rated warranty.

D. Steel Fence Framework
1. Round steel pipe and rail: ASTM F1043-18(2022) Group IA Table 3 Heavy Industrial Fence Framework, regular grade, schedule 40 galvanized pipe per ASTM F1083-18. Exterior zinc coating Type A, interior zinc coating Type A.
   a. Line post: 2-inch diameter
   b. End, Corner, Pull post: 3-inch diameter
   c. Top, brace, bottom and intermediate rails, 2-inch diameter

E. Tension Wire
1. Metallic Coated Steel Marcelled Tension Wire: 7 gauge marcelled wire complying with ASTM A824-01(2017). ASTM A392-11a hot dipped galvanized (1.2 oz/ ft²).

F. Barbed Wire
1. Metallic Coated Steel Barbed Wire: Comply with ASTM A121-22, Design Number 12-4-5-14R, double 12-½ gauge twisted strand wire, with 4 point 14 gauge round barbs spaced 5 inches on center. ASTM A392-11a hot dipped galvanized (1.2 oz/ ft²).

2.2 FITTINGS

A. Tension and Brace Bands: Galvanized pressed steel complying with ASTM F626-14(2019), minimum steel thickness of 12 gauge, minimum width of ¾ in. and minimum zinc coating of 1.20 oz/ft².

B. Terminal Post Caps, Line Post Loop Tops, Rail and Brace Ends, Boulevard Clamps, Rail Sleeves: In compliance to ASTM F626-14(2019), pressed steel galvanized after fabrication having a minimum zinc coating of 1.20 oz/ft².

C. Truss Rod Assembly: In compliance with ASTM F626-14(2019), 3/8 in. diameter steel truss rod with a pressed steel tightener, minimum zinc coating of 1.2 oz/ft², assembly capable of withstanding a tension of 2,000 lbs.

D. Tension Bars: In compliance with ASTM F626-14(2019). Galvanized steel one-piece length 2 in. less than the fabric height. Minimum zinc coating 1.2 oz/ft².

1. Bars shall have a cross section of 1/4 in. by 3/8 in.

E. Barbed Wire Arms: In compliance with ASTM F626-14(2019), pressed steel galvanized after fabrication, minimum zinc coating of 1.20 oz. /ft², capable of supporting a vertical 250-lb load. Type I – three strand 45-degree arm.

2.3 TIE WIRE and HOG RINGS

A. Tie Wire and Hog Rings: Galvanized minimum zinc coating 1.20 oz/ft² 11-gauge steel wire in compliance with ASTM F626-14(2019).

2.4 SWING GATES

A. Swing Gates: double opening. Galvanized steel welded fabrication in compliance with ASTM F900-11(2017). Gate frame members 3 in. OD. Welded joints protected by applying zinc-rich paint in accordance with ASTM Practice A780/A780M-20. ASTM F1043-18(2022) Group IA F1083-18 Schedule 40 pipe. Positive locking gate latch fabricated of 5/16 in. thick by 1¾" pressed steel galvanized after fabrication. Galvanized malleable iron or heavy gauge pressed steel post and frame hinges. Match gate fabric to that of the fence system. Gateposts 3 in. OD.

B. Factory-assembled gates.

C. Design gates for operation by one person.

D. Fabricate gates to permit 180-degree swing, or the maximum swing allowable by the adjacent fencing.

E. Gates Construction: ASTM F900-11(2017) with welded corners. Use of corner fittings is not permitted.

2.5 ACCESSORIES

A. Accessories shall be new.

B. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.

C. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; galvanized steel.

D. Extension Arms: Cast steel galvanized, to accommodate three strands of barbed wire, single arm, sloped to 45 degrees.

E. Gate Hardware: Center gate stop and drop rod and hardware for padlock.

2.6 CONCRETE

A. Concrete for post footings shall have a minimum 28-day compressive strength of 2,500 psi. (17.2 MPa).

PART 3 EXECUTION

3.1 SURVEY

A. Construction layout of fence location as shown on the Drawings.

3.2 INSTALLATION

A. Center and align posts. Place concrete around posts, and vibrate or tamp for consolidation. Verify vertical and top alignment of posts and make necessary corrections.

B. Install framework, fabric, accessories and gates in accordance with ASTM F567-14a.

C. Set intermediate, terminal, gate and corner posts plumb, in concrete footings with top of footing level with finish grade.

D. Brace each gate and corner post to adjacent line post with horizontal center brace rail. Install brace rail one bay from end and gate posts.

E. Install top rail through line post tops and splice with six long rail sleeves.

F. Install center and bottom brace rail on corner gate leaves.

G. Place fabric on outside of posts and rails, away from the treatment building site.

H. Do not stretch fabric until concrete foundation has cured 7 calendar days.

I. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.

J. Position bottom of fabric 2 inches above finished grade.

K. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.

L. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.

M. Install bottom tension wire stretched taut between terminal posts.

N. Install support arms sloped outward and attach barbed wire; tension and secure.

O. Support gates from gate posts.

P. Install gate with fabric and barbed wire overhang to match fence. Install three hinges on each gate leaf, latch, catches, retainer and locking clamp.

Q. Provide concrete center drop to footing depth and drop rod receivers at center of double gate openings.

R. Install posts with 4 inches maximum clear opening from end posts to buildings, fences and other structures.

3.3 ERECTION TOLERANCES

A. Maximum Variation from Plumb: ¼ inch.

B. Minimum distance from property line: 6 inches.

END OF SECTION

SECTION 33 05 24 - UTILITY HORIZONTAL DIRECTIONAL DRILLING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavation for approach trenches and pits.
   2. Horizontal directional drilling.
   3. Pipe.

B. Related Requirements:
   1. Section 31 23 17 - Trenching.
   2. Section 40 05 13.73 – Plastic Process Piping
   3. Section 33 23 16 - SVE Well Installation

1.2 REFERENCE STANDARD

A. ASTM International:
   1. ASTM F1962 - Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings.

B. National Utility Contractors Association:
   1. NUCA - HDD Installation Guidelines.

1.3 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Coordinate work with trenching and SVE conveyance pipe installation.

1.4 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:
   1. Identify source of water used for drilling.
   2. Submit copy of approvals and permits for use of water source.

C. Shop Drawings:

1. Submit technical data for equipment, method of installation, and proposed sequence of construction.
2. Include information pertaining to equipment size and capacity, equipment capabilities including installing pipe on radius, type of drill bit, drilling fluid, method of monitoring line and grade and detection of surface movement, name plate data for drilling equipment and mobile spoils removal unit.

D. Qualification Statement:
1. Submit installer history of previous work completed of equivalent nature and scope. Include qualification and experience of key personnel.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of pipe and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

D. Record actual depth of pipe at 25-foot intervals.

E. Record actual horizontal location of installed pipe.

F. Show depth and location of abandoned bores.

G. Record depth and location of drill bits and drill stems not removed from bore.

1.7 QUALITY ASSURANCE

A. Perform work in accordance with the following:
1. NUCA HDD Installation Guidelines.
2. ASTM F1962.

1.8 QUALIFICATIONS

A. Installer: Company specializing in performing work of this section with minimum 2 years documented experience.
1. Work Experience: Include projects of similar scope and conditions.
2. Furnish list of references upon request.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Provide temporary end caps and closures on piping and fittings until pipe is installed.

C. Protect pipe from entry of foreign materials and water by temporary covers, completing sections of work, and isolating parts of completed system.

D. Accept products on site in manufacturer's original containers or configuration. Inspect for damage.

E. Use shipping braces between layers of stacked pipe. Stack piping lengths no more than 3 layers high.

F. Store field joint materials indoors in dry area in original shipping containers. Maintain storage temperature of 60 to 85 degrees F.

G. Support pipes with nylon slings during handling.

1.10 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Ambient conditions control facilities for product storage and installation.

B. Conduct operations so as not to interfere with, interrupt, damage, destroy, or endanger integrity of surface or subsurface structures or utilities, and landscape in immediate or adjacent areas.

1.11 EXISTING CONDITIONS

A. Maintain access to existing facilities and protect structures indicated to remain.

PART 2 PRODUCTS

2.1 HORIZONTAL DIRECTIONAL DRILLING

A. Performance / Design Criteria:
   1. Drilling Steering System: Remote with continuous electronic monitoring of boring depth and location.

   2. Ratio of Reaming Diameter to Pipe Outside Diameter:
      a. Submit recommended ratio and reaming procedures for review.

2.2 DRILLING FLUID

A. Drilling Fluid: Liquid bentonite clay slurry; biodegradable, totally inert with no environmental risk.

2.3 CASING PIPE

A. HDPE Pipe

B. Polyethylene Pipe, Manufacturers:
   1. Carlon.

2. Charter Plastics, Inc.
3. JM Eagle.
4. Substitutions: Section 01 60 00 - Product Requirements.

2.4 CARRIER PIPE

A. Provided by Others.

2.5 WATER SOURCE

A. Shall be provided by Contractor.

2.6 FLOWABLE FILL

A. Fill and seal around pipe ends with flowable fill.
   1. Mix: One part Portland cement, 6 parts mortar sand, sufficient water to make sufficiently flowable for sealing.

2.7 UNDERGROUND PIPE MARKERS

A. Trace Wire: Electronic detection materials for non-conductive piping products.
   1. Unshielded 10 AWG THWN insulated copper wire.
   2. Conductive tape.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify entry and exit locations and invert elevations are in accordance with Drawings.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Call Local Utility Line Information service at 811 not less than three working days before performing Work.
   1. Request underground utilities to be located and marked within and surrounding construction areas.

C. Locate, identify, and protect utilities indicated to remain from damage.

D. Notify Engineer of potential interference with private utilities.

E. Identify required lines, levels, contours, and datum locations.

F. Protect survey control points, existing structures, fences, sidewalks, and paving from excavating equipment and vehicular traffic.

G. Establish pipe elevations with not less than 1.5 feet of cover.

3.3 DEWATERING

A. Intercept and divert surface drainage, precipitation, and groundwater away from excavation through use of dikes, curb walls, ditches, pipes, sumps or other means.

B. Develop and maintain substantially dry subgrade during drilling and pipe installation.

C. Comply with applicable requirements for discharging water and erosion and sediment control.

3.4 EXCAVATION

A. Excavate subsoil as specified in Section 31 23 16.

B. Excavate approach trenches and pits in accordance with shop drawings and as site conditions require. Minimize number of access pits.

C. Provide sump areas to contain drilling fluids.

D. Restore areas after completion of drilling and carrier pipe installation.

3.5 DRILLING

A. Drill pilot bore with vertical and horizontal alignment as indicated on Drawings.

B. Guide drill remotely from ground surface to maintain alignment by monitoring signals transmitted from drill bit.
   1. Monitor depth, pitch, and position.
   2. Adjust drill head orientation to maintain correct alignment.

C. Inject drilling fluid into bore to stabilize hole, remove cuttings, and lubricate drill bit and pipe.

D. Continuously monitor drilling fluid pumping rate, pressure, viscosity, and density while drilling pilot bore, back reaming, and installing pipe to ensure adequate removal of soil cuttings and stabilization of bore.
   1. Provide relief holes when required to relieve excess pressure.
   2. Minimize heaving during pullback.

E. Calibrate and verify electronic monitor accuracy during first 50 feet of bore in presence of Engineer before proceeding with other drilling. When required accuracy is not met, adjust equipment or provide new equipment capable of meeting required accuracy.

F. After completing pilot bore, remove drill bit.

3.6 DRILLING OBSTRUCTIONS

A. When obstructions are encountered during drilling, notify Engineer immediately. Do not proceed around obstruction without Engineer's approval.

B. For conditions requiring more than 3 feet deviation in horizontal alignment, submit new shop drawings to Engineer for approval before resuming work.

C. Maintain adjusted bore alignment within private property.

3.7 PIPE INSTALLATION

A. After completing pilot bore, remove drill bit. Install reamer and pipe pulling head.
   1. Select reamer with minimum bore diameter required for pipe installation.

B. Attach pipe to pipe pulling head. Pull reamer and pipe to entry pit along pilot bore.

C. Inject drilling fluid through reamer to stabilize bore and lubricate pipe.

D. Install piping with horizontal and vertical alignment as shown on Drawings.

E. Protect and support pipe being pulled into bore so pipe moves freely and is not damaged during installation.

F. Do not exceed pipe manufacturer’s recommended pullback forces.

G. Install trace wire continuous with each bore. Splice trace wire only at intermediate bore pits. Tape or insulate trace wire to prevent corrosion and maintain integrity of pipe detection.
   1. Terminate trace wire for each pipe run at structures along pipe system.
   2. Provide extra length of trace wire at each structure, so trace wire can be pulled 3 feet out top of structure for connection to detection equipment.
   3. Test trace wire for continuity for each bore before acceptance.

H. Terminate pipe in such a way that carrier pipes can be freely installed without significant bending or fittings requirements.

I. Seal around pipe ends with flowable fill.

J. Mark location and depth of bore with spray paint on paved surfaces, and wooden stakes on non-paved surfaces at 25 foot intervals.

3.8 SLURRY REMOVAL AND DISPOSAL

A. Contain excess drilling fluids at entry and exit points until recycled or removed from site. Provide recovery system to remove drilling spoils from access pits.

B. Remove, transport and legally dispose of drilling spoils.
   1. Do not discharge drilling spoils in sanitary sewers, storm sewers, or other drainage systems.

2. When drilling in suspected contaminated soil, test drilling fluid for contamination before disposal.
3. Drilling spoils will be analyzed by the Toxic Characteristic Leaching Procedure prior to proper waste disposal at an approved landfill under manifest.

C. When drilling fluid leaks to surface, immediately contain leak and barricade area from vehicular and pedestrian travel before resuming drilling operations.

D. Complete cleanup of drilling fluid at end of each work day.

3.9 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

B. Maximum Variation From Horizontal Position: 12 inches.

C. Maximum Variation From Vertical Elevation: 6 inches.

D. Minimum Horizontal and Vertical Clearance From Other Utilities: 12 inches.

E. When pipe installation deviates beyond specified tolerances, abandon bore, remove installed pipe, re-bore, and reinstall pipe in correct alignment.

3.10 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting, testing.

3.11 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Upon completion of drilling and pipe installation, remove drilling spoils, debris, and unacceptable material from approach trenches and pits. Clean up excess slurry from ground.

C. Restore approach trenches and pits to original condition.

D. Remove temporary facilities for drilling operations in accordance with Section 01 50 00 - Temporary Facilities and Controls.

END OF SECTION

SECTION 33 23 16 - SOIL VAPOR EXTRACTION WELL INSTALLATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Soil vapor extraction (SVE) well drilling.
   2. SVE well installation
   3. SVE well surface completion

B. Related Sections:
   1. Section 40 05 13.74 - Plastic Process Piping

1.2 DESCRIPTION OF WORK

A. Section has been prepared to detail the material and equipment requirements necessary for the construction of 3 horizontal soil vapor extraction (SVE) wells to depths of approximately 55 feet below ground surface (bgs). The locations of the proposed new SVE wells are shown in the Drawings.

B. The Contractor shall provide all tools, equipment, materials, design documents, and labor to install the SVE wells.

C. The Contractor shall familiarize himself with the local conditions of the project sites. Failure to do so shall in no way relieve Contractor of the responsibility for performing any of the work or operations required as a part of this contract.

1.3 REFERENCES

A. Code of Federal Regulations
   1. 29 CFR 1910.120, OSHA Regulations, Hazardous Waste Operations and Emergency Response

B. Texas Water Code
   1. Texas Water Code, Title 2, Water Administration, Subtitle D, Water Quality Control, Chapter 32, Water Well Drillers
   2. Texas Water Code, Title 2, Water Administration, Subtitle D, Water Quality Control, Chapter 33, Water Well Pump Installers

C. Texas Administrative Code
   1. 16 TAC 76, Texas Department of Licensing and Regulation, Water Well Drillers and Water Well Pump Installers

1.4 PROTECTION OF SITE

A. Except as otherwise provided herein, the Contractor shall protect all existing fences, structures, walks, utilities, etc. During the progress of the work the Contractor shall remove all debris and unused materials and shall, upon completion of the work, restore the site as nearly as possible to its original condition to the satisfaction of the Engineer. The restoration shall include the replacement, at the Contractor's expense, of any facility or landscaping that has been destroyed or damaged beyond restoration.

1.5 UTILTIES

A. Unless otherwise indicated in this section, the Contractor shall arrange for and provide any required utilities. This includes, but is not limited to, water for drilling, power for operating the drill rig or equipment (including testing equipment), and personnel sanitation facilities. It shall be the Contractor's responsibility to notify all utility companies involved whenever activities are to occur that have the potential to cut, tap, move, or in any way disturb a utility line from its original placement. Sufficient notice shall be provided to the utility company so that its users can be informed of any disruption of service. Such notice shall be given no less than 96 hours in advance, excluding weekends.

1.6 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. The following submittals shall be provided by the Contractor prior to mobilization:
   1. Copy of the Texas Water Well Contractor registration

C. The Contractor shall submit Daily Drilling Log as detailed as Section 3.2 within 7 days of well installation.

D. The Contractor shall register well records with TCEQ. Copies of the registration shall be provided to the Engineer.

E. The Contractor shall furnish the Engineer with a copy of the daily drilling log. The log shall accurately describe the following:
   1. Material
   2. Time
   3. Depth
   4. Problems encountered by the driller
   5. Well diameter
   6. Length of casing
   7. Screen installation

   The log shall be kept up to date with the progress of drilling. A copy of the drill log shall be maintained at the site at all times. The Contractor shall prepare and submit a final log in accordance with this Specification.

1.7 UNIT PRICE - MEASUREMENT AND PAYMENT

A. SVE Well:

1. Basis of Measurement: By vertical length of borehole and well in feet.
2. Basis of Payment: Includes drilling, casing, screen, bentonite pellet seal, bentonite grout, centralizers, and filter pack.

PART 2 PRODUCTS

2.1 DRILLING EQUIPMENT

A. The targeted depth for the SVE wells is 52feet bgs. The Contractor shall drill the soil borings using a horizontal well drill rig capable of successful installation of wells as shown on design drawings. The Contractor shall propose the necessary equipment to advance soil borings with a nominal diameter of not less than 6 inches, and install a well casing and well screen of 4-inch diameter schedule 80 PVC to the targeted depths and alignment shown on the Drawings.

2.2 WELL CASING

A. Well materials shall consist of new, unused 4-inch diameter schedule 80 PVC with welded joints.

2.3 WELL SCREENS

A. Well screen shall be constructed of new, unused 4-inch diameter schedule 80 PVC with four 2-inch x 0.020-inch openings per foot. Engineer may provide additional specification for graduated well screen at the time of proposal request.

2.4 DRILLING FLUIDS

A. Drilling fluids shall be fully biodegradable.

2.5 ENTRANCE SLOPE

A. Entrance slope shall be 5H:1V or steeper.

2.6 BENTONITE (CHIP) PELLET SEAL

A. Provide powdered, granular, pelletized, or chipped sodium or calcium montmorillonite in sealed containers from a commercial source, free of impurities. Diameter of pellets shall be less than one-fifth (1/5) the diameter of the borehole annular space to prevent bridging.

PART 3 EXECUTION

3.1 MOBILIZATION AND DEMOBILIZATION

A. The Contractor shall execute the trenching and associated piping activities; as described in Section 31 23 17 Trenching, Section 40 05 13.73 Plastic Process Piping, and the Drawings; before executing the work described in this section.

B. Before drilling activities begin, the Contractor shall be responsible for obtaining the necessary permits and underground utility clearances. Engineer will not be responsible for damage to underground or overhead utilities.

C. The Contractor shall mobilize and demobilize all equipment, tools, and personnel required to install the wells.

D. The Contractor shall avoid contaminating other project areas and shall not dump waste oil, fuels, rubbish, or other hazardous materials on the ground.

E. Drill rods and other downhole drilling equipment shall be decontaminated before each well is initiated.

F. Upon completion of well installation, the Contractor shall remove from the site the drilling rig and all associated equipment, unused materials, debris, and other miscellaneous items resulting from or used during the operation.

3.2 DRILLING

A. The Contractor shall notify the Engineer one (1) week before drilling.

B. The Contractor shall provide, at all times, a licensed State of Texas driller and two helpers who shall be present during all drilling operations at the site.

C. The Contractor shall drill the holes at the locations designated by the Engineer on the drawings.

D. The Contractor shall allow time for the Engineer to collect soil samples at multiple depths and shall provide assistance as needed.

E. The Contractor shall drill each borehole to permit the installation of well casing and screen assembly in a plumb and true line.

3.3 DRILL CUTTINGS AND WELL DEVELOPMENT AND DECONTAMINATION FLUIDS

A. The Contractor shall manage and containerize all drill cuttings and fluids generated during well installation, development, and site cleanup. At the time of bidding, the Contractor shall provide a written description of drill cutting and well fluids management, estimated total volume, and propose disposal options.

3.4 DECONTAMINATION

A. Drilling equipment shall be decontaminated (1) before the beginning of field activities, (2) between individual borings, and (3) prior to demobilization. The Contractor shall provide personnel, material, and equipment such as pressure washers, steamers, electric generator, hand tools, pumps, and any other necessary equipment needed to decontaminate drilling equipment. The Contractor shall establish temporary decontamination areas, as needed, to be used for decontamination. The Contractor shall be responsible for maintaining the decontamination system equipment and for providing all consumables for the decontamination system. Decontamination shall consist of a combination of high

pressure, hot water or steam cleaning; water rinse; and repeated water rinse. Soap, phosphates, and other surfactants shall not be used to decontaminate equipment. Decontamination shall be conducted in accordance with the site-specific Health and Safety Plan. The Contractor shall collect and containerize the decontamination water. The containerized decontamination water shall be placed in a location onsite as designated by the Engineer.

3.5 WELL CONSTRUCTION

A. The wells will be constructed in accordance with Drawings. Actual construction details may be modified by the Engineer based on field conditions.

3.6 CASING AND SCREEN ASSEMBLY

A. Well screens shall be located as indicated on the Drawings or as revised by the Engineer based on field conditions.

B. The Contractor shall install the well screen and casing assembly in accordance with the design drawings alignment and depth.

C. Casing or screen that fails, collapses shall be removed from the hole, and a new hole shall be drilled at the Contractor's sole expense.

3.7 WELL SEAL

A. The Contractor shall install bentonite pellets near the surface to prevent infiltration of surface water into the borehole. The bentonite shall be installed in 1-foot lifts, with a minimum of 5 gallons of potable water placed on top of each lift to aid in the hydration of the pellets. Pellets shall be given a minimum of 1 hour to hydrate before grouting. Grout shall be extended to 3 feet below ground surface.

3.8 SURFACE COMPLETION

A. Another contractor shall install the well vault. After well installation and development, the drilling contractor shall cap the well and backfill the cavity with clean sand and cover with a steel plate.

3.9 WELL ABANDONMENT

A. In the event the well is not accepted for completion because of poor alignment, loss of tools, or for any other cause, the Contractor shall, as directed by the Engineer, fill the abandoned hole with expansive clay or clay and concrete. In the event a constructed well is not usable and is abandoned for the above reasons, the Contractor may be required to move to another location in the area and drill an additional. Well abandonment and re-drilling described in this section shall be at the Contractor's expense.

END OF SECTION

SECTION 40 05 13.74 - PLASTIC PROCESS PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. PVC pipe and fittings
2. Accessories for plastic piping and fittings.

B. Related Requirements:

1. Section 02 62 16 – Soil Vapor Extraction System
2. Section 40 05 23.01 - Common Work Results for Process Valves
3. Section 40 05 29.01 - Hangers and Supports for Process Piping and Equipment.

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form)
2. ASME B1.20.1 - Pipe Threads, General Purpose (Inch)
3. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800
4. ASME B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys
5. ASME B16.20 - Metallic Gaskets for Pipe Flanges
6. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges
7. ASME B31.3 - Process Piping Guide.

B. ASTM International:

1. ASTM D1784-20 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

2. ASTM D1785-21a - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

3. ASTM D2241-20 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

4. ASTM D2321-20 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

5. ASTM D2464-15 - Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

6. ASTM D2467-20 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

7. ASTM D2564-20 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems

8. ASTM D2737-21 - Standard Specification for Polyethylene (PE) Plastic Tubing

9. ASTM D2837-22 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products

10. ASTM D2855-20 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings

11. ASTM D3139-19 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

12. ASTM F477-14(2021) - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

13. ASTM F656-21 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

1.3 SUBMITTALS

A. Section 01 33 00.01 - Submittal Procedures

B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Perform Work according to appropriate local, state and federal standards and in accordance with International Building Code 2018.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years documented experience.

PART 2 PRODUCTS

2.1 PVC PIPE, TUBE, AND FITTINGS

A. Manufacturer List:

1. Charlotte Pipe and Foundry Company
2. Georg Fischer Harvel, LLC
3. Texas United Pipe, Inc

4. Substitutions: Section 01 25 00.01 – Substitution Procedures.

B. PVC Pipe and Fittings:

1. Pipe: ASTM D1785-21a, Schedule 80

2. Fittings: ASTM D2467-20, Schedule 80

3. Joints: Socket, solvent-welded, ASTM D2855-20; threaded or flanged if later removal is required

4. Materials: ASTM D1784-20, minimum cell classification 12545-C.

2.2 ACCESSORIES

A. PVC Piping:

1. PVC Unions for Piping to other fittings

2. PVC Flanges for Piping to Equipment

3. Flange Bolting: Stainless steel, ASTM A193 Grade hex head bolts and ASTM A194 Grade hex head nuts

4. Flange Gaskets: Full faced, red rubber, according to ASME B16.21

5. Solvent Cement: ASTM D2564-20; primers according to ASTM F656-21.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00.01 - Quality Requirements

B. Certificate of Compliance: When fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify equipment is installed in final locations and ready for piping

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Thoroughly clean pipe and fittings before installation.

C. Surface Preparation:
   1. Clean surfaces to remove foreign substances.

3.3 INSTALLATION

A. Below Ground Piping

1. Run piping straight with minimum number of joints.

2. Install piping and components according to ASME B31.3

3. Fittings:

   a. Clean gasket seats thoroughly, and wipe gaskets clean prior to installation

   b. Install fittings according to manufacturer's instructions

   c. All valves and fittings shall be accessible.

4. Install piping with sufficient slopes for venting or drainage of liquids and condensate to low points

5. Buried piping in trenches in accordance with ASTM D2321-20

6. Field Cuts: According to pipe manufacturer's recommendations.

7. Joining:

   a. Primers and Cleaners: ASTM F402-18.
   b. PVC Solvent-Cemented Joints: ASTM D2855-20.

B. Above Ground Piping

1. Run piping straight with minimum number of joints.

2. Install piping and components according to ASME B31.3

3. Fittings:

   a. Clean gasket seats thoroughly, and wipe gaskets clean prior to installation

   b. Install fittings according to manufacturer's instructions

   c. Tighten bolts progressively, drawing up bolts on opposite sides until bolts are uniformly tight; use torque wrench to tighten bolts to manufacturer's recommendations

   d. All valves and fittings shall be accessible.

4. Install piping with sufficient slopes for venting or drainage of liquids and condensate to low points

5. Support piping as specified in Section 40 05 29.01 - Hangers and Supports for Process Piping and Equipment

6. Provide pipe guides as specified in Section 40 05 29.01 - Hangers and Supports for Process Piping and Equipment to compensate for pipe expansion due to temperature differences

7. Field Cuts: According to pipe manufacturer's recommendations.

8. Joining:

    a. Primers and Cleaners: ASTM F402-18.
    b. PVC Solvent-Cemented Joints: ASTM D2855-20.

TOLERANCES

C. Section 01 40 00.01 - Quality Requirements.

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00.01 - Quality Requirements

B. Inspect for damage to pipe lining or coating, or other defects that may be detrimental as determined by the Engineer. Repair damaged piping, or provide new, undamaged pipe

C. After installation, inspect for proper supports and interferences.

3.5 CLEANING

A. Keep pipe interior clean as installation progresses

B. Clean pipe interior of soil, grit, shavings, and other debris after pipe installation.

END OF SECTION

SECTION 40 05 23.01 - COMMON WORK RESULTS FOR PROCESS VALVES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball valves
2. Check valves
3. Flow adjustment valves
4. Gate valves
5. Solenoid valves
6. Vacuum relief valves.

B. Related Requirements:

1. Section 02 62 16 – Soil Vapor Extraction System
2. Section 40 05 13.74 – Plastic Process Piping
3. Section 40 05 29.01 – Hangers and Supports for Process Piping.

1.2 REFERENCE STANDARDS

A. ASTM International:

1. ASTM A307-21 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

2. ASTM A563/A563M-21ae1 - Standard Specification for Carbon and Alloy Steel Nuts

3. ASTM D1785-21a – Standard Specification for Rigid (PolyVinyl) Chloride (PVC) Compounds and CPVC Compounds

4. ASTM F436/F436M-19 - Standard Specification for Hardened Steel Washers.

B. American Water Works Association:

1. AWWA C550-13 - Protective Interior Coatings for Valves and Hydrants.

C. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP-122-2017 – Plastic Industrial Ball Valves.

D. NSF International:

1. NSF/ANSI Standard 61 - Drinking Water System Components - Health Effects
2. NSF/ANSI Standard 14 - Plastic Piping System Components and Related Materials.

1.3 COORDINATION

A. Coordinate Work of this Section with piping and appurtenances.

1.4 SUBMITTALS

A. Section 01 33 00.01 - Submittal Procedures

B. Product Data: Submit manufacturer’s catalog information with valve data ratings for each service

C. Valve-Labeling Schedule: Indicate valve locations and nametag text

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements

E. Manufacturers' Instructions: Submit installation instructions and special requirements.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00.01 - Execution and Closeout Requirements.

1.6 QUALITY ASSURANCE

A. Perform Work according to federal, state, and local standards and in accordance with International Building Code 2018.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

PART 2 PRODUCTS

2.1 Ball Valves

A. Manufacturers:

1. Hayward
2. Spears
3. Substitutions: Section 01 25 00.01 – Substitution Procedures.

B. Schedule 80 PVC, slip ends.

2.2 Spring Loaded Check Valves

A. Manufacturers:
1. Spears
2. Hayward
3. Substitutions: Section 01 25 00.01 – Substitution Procedures.

B. Schedule 80 PVC, slip ends, stainless steel spring, silent closing, integral seat.

2.3 Flow Adjustment Valves

A. Manufacturers:

1. Parker
2. ARO
3. Substitutions: Section 01 25 00.01 – Substitution Procedures.

B. Flow rate range: 0 to 1 liter per minute, vacuum service.

2.4 Gate Valves

A. Manufacturers:

1. Spears
2. Valterra
3. Substitutions: Section 01 25 00.01 – Substitution Procedures.

B. Schedule 80 PVC, slip ends, knob handle.

2.5 Solenoid Valves

A. Manufacturers:

1. ASCO
2. Substitutions: Section 01 25 00.01 – Substitution Procedures.

B. 2-way, vacuum service, operating temperature: 0 to 125 degrees Fahrenheit, operating pressure differential: 0 to 200 inches of water column, 120VAC.

2.6 Vacuum Relief Valves

A. Manufacturers:

1. Rotron
2. Substitutions: Section 01 25 00.01 – Substitution Procedures.

B. Range 20-190 inches of water column.

2.7 VALVES

A. Provide valves, operator, handwheel, lever handle, extension stem, operating nut, chain, wrench, and other accessories as required.

B. Valve Ends: Compatible with adjacent piping system.

C. Operation: Open by turning counterclockwise; close by turning clockwise. Cast opening/closing directional arrow on valve or actuator with OPEN and CLOSE cast on valve in appropriate location.

D. Valve Marking and Labeling:

1. Marking: According to MSS SP-25-2018
2. Labeling: As specified in Section 40 05 13.74 – Plastic Process Piping.

E. Valve Construction:

1. Bodies: Rated for maximum temperature and pressure to which valve will be subjected; as specified in particular valve Section.

2. Bonnets: Clamped, screwed, or flanged to body and of same material and pressure rating as body; provide glands, packing nuts, or yokes as specified in valve Sections.

3. Stems and Stem Guides:
   a. Of materials and with seals as specified in valve Sections
   b. Space stem guides 5 ft o.c.
   c. Submerged Stem Guides: Type 304 stainless steel.

4. Nuts, Bolts, and Washers:
   a. Nuts: ASTM A563/A563M-21ae1 heavy hex type or Engineer approved equivalent
   b. Bolts: ASTM A307-21; Grade A or B
   c. Washers: ASTM F436/F436M-19; Type 1.

2.8 FINISHES

A. Do not coat flange faces of valves unless otherwise specified.

2.9 SOURCE QUALITY CONTROL

A. Section 01 40 00.01 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Testing:

1. Test valves according to manufacturer's standard testing protocol, including hydrostatic, seal, and performance testing.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping system is ready for valve installation.

3.2 INSTALLATION

A. Install valves and accessories according to manufacturer's instructions

B. Firmly support valves to avoid undue stresses on piping

C. Coat studs, bolts, and nuts with anti-seizing lubricant

D. Clean field welds to remove slag and splatter to provide a smooth surface

E. Install valves with stems upright or horizontal, not inverted

F. Install valves with clearance for installation of insulation and allowing access

G. Provide access where valves and fittings are not accessible

H. Comply with Section 40 05 29.01 - Hangers and Supports for Process Piping and Equipment for pipe hangers and supports

I. Comply with Section 40 05 13.74 - Plastic Process Piping, for piping materials applying to various system types

J. Valve Applications:

1. Install shutoff valves at locations as indicated on Drawings, according to this Section

2. Install shutoff and isolation valves; isolate equipment, part of systems, or vertical risers, as indicated on Drawings

3. Install valves for throttling, bypass, or manual flow control services, as indicated on Drawings.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00.01 - Quality Requirements: Requirements for inspecting and testing.

B. Valve Field Testing:

1. Test for proper alignment

2. Where specified by individual specification Section, field test equipment to demonstrate operation without undue noise, vibration, or overheating

3. Engineer will witness field testing.

3.4 ATTACHMENTS

VALVE SCHEDULE						
Valve Number	**Location**	**Description**	**Valve Type**	**Media**	**Size**	**Operator**
GV-1001	Treatment Facility	Transfer Pump Effluent	Gate	Liquid	1"	Manual
BV-1001	Treatment Facility	Inlet from SVE Line	Ball	Soil Vapor	4"	Manual
VRV-1001	Treatment Facility	Vapor-Liquid Separator	Vacuum Relief	Soil Vapor	--	Manual
CV-1001	Treatment Facility	Transfer Pump Effluent	Check	Liquid	1"	Manual
FAV-1001	Treatment Facility	Inlet from SVE line	Flow Adjustment	Soil Vapor	1/2"	Manual

END OF SECTION

SECTION 40 05 29.01 - HANGERS AND SUPPORTS FOR PROCESS PIPING AND EQUIPMENT

1.1 SUMMARY

A. Section Includes:

1. Pipe supports.

B. Related Requirements:

1. Section 02 62 16 – Soil Vapor Extraction System
2. Section 40 05 13.74 - Plastic Process Piping
3. Section 40 05 23.01 - Common Work Results for Process Valves.

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME B31.1 - Power Piping
2. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM A36/A36M-19 - Standard Specification for Carbon Structural Steel

2. ASTM A47/A47M-99(2022)e1 - Standard Specification for Ferritic Malleable Iron Castings

3. ASTM A181/A181M-22 - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping

4. ASTM A576-17 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.

C. American Welding Society:

1. AWS D1.1 - Structural Welding Code Steel - Reference Manual.

D. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP-58-2018 - Pipe Hangers and Supports - Materials, Design, Manufacturer, Selection, Application, and Installation.

1.3 COORDINATION

A. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

1.4 SUBMITTALS

A. Section 01 33 00.01 - Submittal Procedures

B. Product Data: Submit manufacturer's catalog data including load capacity.

1.5 QUALITY ASSURANCE

A. Perform Work according to federal, state, and local standards and in accordance with International Building Code 2018.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum five years experience.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturer List:

1. Haydon Corporation
2. PHD Manufacturing, Inc.
3. PHS Industries, Inc.
4. Substitutions: Section 01 60 00.01 - Product Requirements.

B. Description:

1. Conform to MSS SP58
2. Provide means of vertical adjustment after erection
3. Pipe Sizes 1 to 1-1/2 in: ASTM A36/A36M-19, steel, adjustable swivel, split ring
4. Pipe Sizes 2 in (50 mm) and Larger: ASTM A36/A36M-19, steel, adjustable, clevis
5. Vertical Support: Riser clamp
6. Floor Supports: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.

C. Performance and Design Criteria:

1. Pipe Hangers:

a. Allow for expansion and contraction of piping while eliminating undue stress on piping appurtenances and equipment

b. Provide linkage to permit lateral or axial movement where anticipated

c. Where horizontal pipe movement is greater than 1/2 in, or where hanger rod deflection from the vertical is greater than 4 degrees from cold to hot position of pipe, hanger rod and structural attachment shall be offset to maintain rod vertical in hot position.

2. Riser Supports: Support risers on each floor with riser clamps and lugs, independent of connected horizontal piping.

3. Point Loads:

a. Support plastic piping containing meters, valves, appurtenances, and other point loads on both sides

b. Avoid point loads on plastic piping by providing extra wide pipe saddles or galvanized steel shields.

2.2 HANGER RODS

A. Hanger Rods:

1. ASTM A576-17, steel
2. Threaded both ends
3. Diameter: ASME B31.1; as indicated on Drawings.

2.3 STRUCTURAL ATTACHMENTS

A. Manufacturer List:
1. Anvil International
2. Cooper B-Line, Inc.
3. Globe Pipe Hanger Products Incorporated
4. Haydon Corporation
5. PHD Manufacturing, Inc.
6. PHS Industries, Inc.
7. Unitron Product, Inc./US Strut
8. Substitutions: Section 01 60 00.01 - Product Requirements.

B. Mounting Brackets: ASTM A36/A36M-19, welded steel.

C. Beam Clamps:

1. Manufacturer List:
a. Haydon Corporation
b. PHD Manufacturing, Inc
c. PHS Industries, Inc
d. Substitutions: Section 01 60 00.01 - Product Requirements.

2. ASTM A36/A36M-19; MSS SP-58-2018

3. Clamp Size: Based on load to be supported and load configuration

4. Anchoring: Locknuts and cup-point set screws

5. Reversible top or bottom flange.

D. Offset Clamps:

1. Manufacturer List:
   a. Anvil International
   b. PHS Industries, Inc.
   c. Substitutions: Section 01 60 00.01 - Product Requirements.

2. Double leg, two-piece.

2.4 PIPE GUIDES

A. Intermediate Guides:

1. Pipe clamp with oversize pipe sleeve.

B. Alignment Guides:

1. Pipes 8 in and Smaller: Sleeve type.

PART 3 EXECUTION

3.1 INSTALLATION

A. Obtain permission from Engineer before using powder-actuated anchors.

B. Pipe Hangers and Supports:

1. Install according to: MSS SP-58-2018

2. Install hangers with minimum 1/2 in space between finished covering and adjacent Work

3. Place hangers within 12 in of each horizontal elbow

4. Use hangers with 1-1/2 in minimum vertical adjustment

5. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers

6. Support riser piping independently of connected horizontal piping

7. Design hangers for pipe movement without disengagement of supported pipe

8. Support piping independently so that equipment is not stressed by piping weight or expansion in piping system

9. Provide welded steel brackets where piping is to be run adjacent to building walls or columns

10. Use beam clamps where piping is to be suspended from building steel

11. Use offset clamps where pipes are indicated as offset from wall surfaces.

C. Equipment Bases and Supports:

1. Provide rigid anchors for pipes after vibration isolation components are installed. Comply with Section 40 05 13.74 – Plastic Process Piping.

END OF SECTION

Appendix E

Cost Estimate

Project:	Circle Court Ground Water Plume Superfund Site Final Remedial Design Cost Estimate	Project No.	15785-40-0156-CP		
Subject:	Cost Summary - SVE System	Sheet No.	1	of	3
		Dwg No.	NA		
Computed by:	AM	Date:	Jun-24	Checked by:	BL Date: Aug-24

Estimated Remediation Time for Soil Vapor Extraction and Treatment System = (b) (4)

Discount Rate =

Capital Cost	Operations and Maintenance Cost (Present Value)	**Total Cost (Present Value)**
$ (b) (4)		

NOTE:

All values are rounded to three significant figures

Total Cost Estimated (-20% and +30%)

Project:	Circle Court Ground Water Plume Superfund Site		Project No.	15785-40-0156-CP	
	Final Remedial Design Cost Estimate		Sheet No.	2	of 3
Subject:	Capital Costs - SVE System		Dwg No.	NA	
Computed by:	AM	Date: Jun-24	Checked by:	BL	Date: Aug-24

Soil Vapor Extraction System

Item	Description	Unit Cost	Units	Quantity	Total	Source/Notes
1	**Soil Vapor Extraction System and Compound**	(b) (4)				
2	Update Site-specific Plans					Engineer's estimate for prior SVE system, adjusted for inflation
3	Equipment Freight, Loading, and Installation					Engineer's estimate for prior SVE system, adjusted for inflation
4	Site Clearance and Utility Clearance					Engineer's estimate for prior SVE system, adjusted for inflation
5	Ground Preparation and Base Course					Engineer's estimate for prior SVE system, adjusted for inflation
6	Differential Pressure Transmitters and Installation					Engineer's estimate for prior SVE system, adjusted for inflation
7	Power Drop and Electrical Hookup					Engineer's estimate for prior SVE system, adjusted for inflation
8	Trenching 2'x4', includes backfill, bedding and compaction					Means 31 23 16.13 0062, Means 31 23 16.13 3020, Means 31 23 23.23 7000, Means 31 23 23 16.0200, Means 31 23 23 16.0500
9	Trailer, Equipment, and Furnishings (with delivery & pickup)					Engineer's estimate for prior SVE system, adjusted for inflation
10	Portable Toilets (with delivery and pickup)					Engineer's estimate for prior SVE system, adjusted for inflation
11	Storage Trailer (with delivery and pickup)					Engineer's estimate for prior SVE system, adjusted for inflation
12	Start-up and Travel Labor (2 staff members)					Engineer's estimate for prior SVE system, adjusted for inflation
13	Start-up Flight and Vehicle Rental (2 staff members)					Engineer's estimate for prior SVE system, adjusted for inflation
14	Start-up Per Diem and Lodging (2 staff members)					Engineer's estimate for prior SVE system, adjusted for inflation
15	Start-up Truck Usage					Engineer's estimate for prior SVE system, adjusted for inflation
16	Vendor Start-up and Operator Training					Engineer's estimate for prior SVE system, adjusted for inflation
17	Start-up Analytical					Engineer's estimate for prior SVE system, adjusted for inflation
18	Operation and Maintenance Manual					Engineer's estimate for prior SVE system, adjusted for inflation
19	Completion Report					Engineer's estimate for prior SVE system, adjusted for inflation
20	Site Restoration					Engineer's estimate for prior SVE system, adjusted for inflation
21	**Wells**					
22	Mobilization/Demobilization					Engineer's estimate for prior SVE system, adjusted for inflation
23	Horizontal Well Installation and Development (2 wells)					Engineer's estimate for prior SVE system, adjusted for inflation
24	Disposal of IDW Fluids and Solids					Engineer's estimate for prior SVE system, adjusted for inflation
25	Well Vault Installation and Plumbing					Engineer's estimate for prior SVE system, adjusted for inflation
26	Truck and Gasoline					Engineer's estimate for prior SVE system, adjusted for inflation
27	**Surveying**					
28	Surveying					Engineer's estimate for prior SVE system, adjusted for inflation
29	**Oversight**					
30	On-site Oversight and Travel Labor (1 staff member)					Engineer's estimate for prior SVE system, adjusted for inflation
31	Oversight Flight and Vehicle Rental (1 staff member)					Engineer's estimate for prior SVE system, adjusted for inflation
32	Oversight Per Diem and Lodging (1 staff member)					Engineer's estimate for prior SVE system, adjusted for inflation
33	Oversight Truck and Gasoline					Engineer's estimate for prior SVE system, adjusted for inflation
34	On-site Oversight and Travel Labor (1 staff member)					Engineer's estimate for prior SVE system, adjusted for inflation
35	Flight and Vehicle Rental (1 staff member)					Engineer's estimate for prior SVE system, adjusted for inflation
36	Per Diem and Lodging (1 staff member)					Engineer's estimate for prior SVE system, adjusted for inflation
37	**Piping and System Installation**					
38	2-inch Solenoid Valves (for Main Header) and Installation					Engineer's estimate for prior SVE system, adjusted for inflation
39	**Subtotal**					
40	Bonding					
41	Contingency					
42	Project Management					
43	**Total**					(a)

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Notes:

(a) Total was rounded to three significant figures

IDW = Investigation-derived waste

LF = Linear feet

LS = Lump sum

RT = Round trip

SVE = Soil vapor extraction

SY = Square yard

Project:	Circle Court Ground Water Plume Superfund Site Final Remedial Design Cost	Project No.	15785-40-0156-CP		
		Sheet No.	3	of	3
Subject:	O&M Costs - SVE System	Dwg No.	NA		
Computed by:	AM	Date:	Jun-24	Checked by: BL	Date: Aug-24

Present Value Analysis (Annual): **Discount Rate:** (b) (4)

YEAR	SVE System Op	Well	Discount
1	$	(b) (4)	
2	$		
3	$		
Totals	$		[a]

NOTE:
(a) Total was rounded to three significant figures

Item	Description	Unit Cost[a]	Units	Quantity	Total	Source/Notes
1	**Annual SVE System Operation - Year 1**	(b) (4)				
2	Field Labor					Rate from a Previous Project in Region 6, adjusted for inflation - 1 employee; 8 hours/day; 1 day/week
3	Quarterly Reports					3 Quarterly Reports and 1 Annual Report
4	Vehicle Usage (Includes daily rate, mileage, & gasoline)					Rate from a Previous Project in Region 6, adjusted for inflation - 1 trip to the site per week
5	Equipment Costs					Engineer's estimate for prior SVE system, adjusted for inflation
6	Electrical Usage (assuming 95% uptime)					Rate from prior SVE system, adjusted for inflation
7	Emission Sample Analysis, Influent and Effluent					Rate from prior SVE system, adjusted for inflation. Assume weekly sampling first month, then monthly, for 15 sampling events, five samples per event
8	Contingency					
9	Project Management					
10	**Total**					
11	**Annual SVE System Operation - Year 2**					
12	Field Labor					Rate from a Previous Project in Region 6, adjusted for inflation - 1 employee; 8 hours/day; 1 day/week
13	Quarterly Reports					3 Quarterly Reports and 1 Annual Report
14	Vehicle Usage (Includes daily rate, mileage, & gasoline)					Rate from a Previous Project in Region 6, adjusted for inflation - 1 trip to the site per week
15	Equipment Costs					Engineer's estimate for prior SVE system, adjusted for inflation
16	Electrical Usage (assuming 95% uptime)					Rate from prior SVE system, adjusted for inflation
17	Emission Sample Analysis, Influent and Effluent					Rate from prior SVE system, adjusted for inflation. Monthly sampling, five samples per event
18	Contingency					
19	Project Management					
20	**Total**					
21	**Annual SVE System Operation - Year 3**					
22	Field Labor					Rate from a Previous Project in Region 6, adjusted for inflation - 1 employee; 8 hours/day; 1 day/week
23	Quarterly Reports					3 Quarterly Reports and 1 Annual Report
24	Vehicle Usage (Includes daily rate, mileage, & gasoline)					Rate from a Previous Project in Region 6, adjusted for inflation - 1 trip to the site per week
25	Equipment Costs					Engineer's estimate for prior SVE system, adjusted for inflation
26	Electrical Usage (assuming 95% uptime)					Rate from prior SVE system, adjusted for inflation
27	Emission Sample Analysis, Influent and Effluent					Rate from prior SVE system, adjusted for inflation. Monthly sampling, five samples per event
28	Contingency					
29	Project Management					
30	**Total**					
31	**Periodic Costs**					
32	Well Abandonment - Horizontal Wells (2)					Bid from Previous Remedial Action in Region 6, adjusted for inflation
	Total					

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Notes:
(a) Includes Prime Contractor and Subcontractor Markups, as appropriate
KWh = Kilowatt-hour
LF = Linear feet
LS = Lump sum
O&M = Operation and maintenance
SVE = Soil vapor extraction