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February 24, 2020 **VIA PRIVATE CARRIER**

Brian Dietz
Land Restoration Program
Land and Materials Administration
Maryland Department of the Environment
1800 Washington Boulevard, Suite 625
Baltimore, Maryland 21230

Subject: Transmittal of the Operation Maintenance and Monitoring Plan for
Blocks E/F Groundwater Remedy
Lockheed Martin Corporation – Middle River Complex
2323 Eastern Boulevard, Middle River, Baltimore County, Maryland

Dear Mr. Dietz,

For your review please find enclosed two hard copies with a CD of the above-referenced document. This operations, maintenance, and monitoring (OMM) plan describes the method of operation, maintenance and monitoring for the planned groundwater remedy located in the Blocks E and F of Lockheed Martin Middle River Complex in Middle River, Maryland.

If possible, we respectfully request to receive MDE's document review comments by April 20, 2020.

Please let me know if you have any questions. My office phone is (301) 548-2209.

Sincerely,

Thomas D. Blackman
Project Lead, Environmental Remediation

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OPERATION MAINTENANCE AND MONITORING PLAN FOR BLOCKS E/F GROUNDWATER REMEDY AT LOCKHEED MARTIN MIDDLE RIVER COMPLEX, 2323 EASTERN BOULEVARD MIDDLE RIVER, MARYLAND

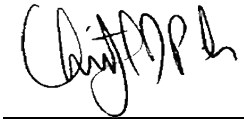
Prepared for:
Lockheed Martin Corporation

Prepared by:
Tetra Tech, Inc.

February 2020

Revision: _____

Michael Martin, P.G.
Regional Manager



Christopher Pike
Project Manager

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ACRONYMS

ARD	anaerobic-reductive dechlorination
cis-1,2 DCE	*cis*-1,2-dichloroethene
DHC	*dehalococcoides*
DOP	detailed operating procedure
GAC	granular activated carbon
gpm	gallons per minute
HDPE	high-density polyethylene
HMI	human-machine interphase
in. WC	inches water column
LGAC	liquid-phase granular activated carbon
L/min	liters per minute
LMC	Lockheed Martin Corporation
MDE	Maryland Department of the Environment
µg/L	microgram per liter
µg/m^3	microgram(s) per cubic meter
mg/L	milligram per liter
MRC	Middle River Complex
OMM	operation, maintenance, and monitoring
PID	photoionization detector
PLC	programmable logic controller
PRB	permeable reactive membrane
RTO	Remediation Technical Operations
SOP	standard operating procedure
TCE	trichloroethene
Tetra Tech	Tetra Tech, Inc.
VFD	variable frequency drive
VGAC	vapor-phase granular activated carbon

VOC	volatile organic compound

SECTION 1
INTRODUCTION

This operations, maintenance, and monitoring (OMM) plan describes the method of operation, maintenance and monitoring for the groundwater remedy located in the Blocks E and F of Lockheed Martin Middle River Complex (MRC) in Middle River, Maryland. Tetra Tech, Inc., (Tetra Tech) has prepared this document for Lockheed Martin Corporation (Lockheed Martin).

1.1 SITE LOCATION AND BACKGROUND

The Middle River Complex site, located at 2323 Eastern Boulevard in Middle River, Maryland, consists of multiple parcels of land designated as tax blocks (referred to as blocks herein), all owned by Lockheed Martin (Appendix A, Drawing C-1). Block I contains currently operating facilities; surrounding Block I are the external Blocks A, B, D, E, F, G, and H. Some of these external blocks are used by Lockheed Martin Corporation for offices and parking or are leased by others for parking or operations.

The groundwater response action in the Blocks E and F of the Middle River Complex site is described in the *Groundwater Response Action Addendum Number 4 - Blocks E and F* (Tetra Tech, 2018a) and in *Groundwater Remedy Blocks E/F Design Report* (Tetra Tech, 2019).

The groundwater response action in the Blocks E and F of the Middle River Complex site involves the implementation of hydraulic containment and a permeable reactive barrier (PRB) in Block F and operation of the existing anaerobic-reductive dechlorination (ARD) system in Block E. The operation of the ARD system is by others and is included in this plan for information purposes only.

1.2 PURPOSE AND ORGANIZATION

This manual describes the operation, maintenance, and monitoring requirements for the Blocks E and F groundwater response system. It is intended to assist the operator of the system, and to describe the function of the remediation equipment and components. It is also intended to

provide operational procedures, maintenance requirements, equipment and instrument specifications, safety requirements, and system performance monitoring requirements.

Tetra Tech will perform the start-up, operation, maintenance, and monitoring activities for the Blocks E/F Groundwater Extraction and Treatment System; Standard Operating Procedures (SOPs), Detailed Operating Procedures (DOPs), check lists, and other required documentation are attached.

This operation, maintenance and monitoring plan is organized as a single document addressing the following topics:

Section 1 Introduction—This section presents the background information, objectives, and organization of the operation, maintenance, and monitoring manual.

Section 2 Blocks E/F Groundwater Extraction and Treatment System—This section describes start-up and operation of the Blocks E/F groundwater extraction and treatment system.

Section 3 Block F Permeable Reactive Barrier—This section describes performance monitoring activities related to PRB operation in Block F.

Section 4 Block E ARD System Injection Event—This section describes include activities related to Block E ARD system start-up and operation.

Section 5 Reporting— This section describes reporting procedures.

Section 6 References— This section lists the references used to compile this manual.

SECTION 2
BLOCKS E/F GROUNDWATER EXTRACTION AND TREATMENT SYSTEM

This section describes start-up and operation of the Blocks E/F groundwater extraction and treatment system. The following sub-sections present a system overview, start-up procedures, and routine operations and maintenance activities.

2.1 PROCESS SUMMARY

The details of the Blocks E/F groundwater extraction and treatment system can be found in the *Groundwater Remedy Blocks E/F Design Report* (Tetra Tech, 2019). The Blocks E/F groundwater extraction and treatment system consists of the following components:

- Installation of submersible pumps with associated controls in existing Block F extraction wells EW-1 and EW-2 (Drawings C-2 and C-4, Appendix A).
- Construction of groundwater treatment building and the treatment process equipment in Block E (Drawing C-2).
- Installation of piping and conduits between the extraction wells in Block F and the groundwater treatment building at Block E (Drawing C-2 and M-3).
- Installation of electric power to the treatment system building from the nearby pump house (with a separate meter) and from the treatment system building to the extraction well pumps and heat trace system in the vault for sanitary sewer tie-in. Final connection logistics are being discussed with the appropriate facility personnel.
- Installation of treated groundwater discharge line between the groundwater treatment building at Block E and the sanitary sewer piping in Block I (Drawing C-3).
- Extraction of groundwater from EW-1 and EW-2; treatment of the extracted groundwater using air stripping, filtration, and liquid-phase granular activated carbon (LGAC); and vapor treatment of the air stripper exhaust using vapor-phase granular activated carbon vessels (VGAC).
- Discharge of the treated groundwater to the Baltimore County sanitary sewer via piping in Block I.

2.2 SYSTEM START-UP PHASE

This section describes the commissioning, start-up procedures, and operations, maintenance, and monitoring activities during system start-up.

2.2.1 Commissioning

The objectives for commissioning are to confirm that the system has been installed as designed, and that the system operates as specified, to facilitate any additional modifications in the system, and to gather and evaluate initial operational data. A system commissioning check list (SOP-1) to determine if the system is ready for operation is included in Appendix B. The following describes the procedures associated with the commissioning of the system.

The commissioning testing process is composed of three primary activities:

- pre-commissioning check
- functional performance tests of individual components
- pre-startup functional performance system test of the combined components using potable water (via a temporary line from the nearby pump house) as described in the project specifications.

The inspection will be performed as detailed in a system commissioning check list (SOP-1) and will verify that all the components of the system have been properly installed.

The system process and instrumentation diagram (Drawing M-2) and mechanical layouts (M-3 through M-5) will be used to verify that all equipment and piping are installed as designed. As-built drawings will also be created and updated as necessary. Electrical systems will be checked to verify that wiring has been completed correctly and according to the applicable code(s). The electrical one-line diagrams and wiring diagrams will be used to verify electrical and instrumentation systems.

All equipment and instrumentation will be inspected to verify proper installation and lubrication. Inspections of equipment lockouts, safety valves and/or other pressure relief devices will also be completed. Any deficiencies will be corrected to meet operational requirements.

Checks and individual component testing will be performed to verify integrity before operation. Equipment functional performance tests will only start after all pre-commissioning checks have successfully been performed. The functional performance tests will be carried out in a manner that duplicates the vendor's recommended procedures. If no vendor procedures are provided, performance test methods will be developed to provide the information specified in the checklist. Any deficiencies with the system must be corrected and performance checks successfully completed before the system can be accepted.

After equipment and electrical systems are tested and certified ready for operation, electrical systems can be energized in preparation for testing equipment and control systems. As part of the startup process, the operating range and proper operation of each controller will be demonstrated. Controls will be electrically tested with signal generators to verify operating ranges. Where controls provide ON/OFF signals, switches will be manually tripped to test control loops. Testing of control systems will proceed from this point to verify operability. If there are safety shutdown sequences in the control systems, they will be tested to ensure proper functionality. Motors that can be started with hand switches will be bump-tested to test equipment rotation. All interlocks and motor starters controlled by interlocks or the programmable logic controller (PLC) and any other relationships between equipment will be tested to determine if the responses are consistent with the design logic. Proper functioning of the local touch-screen human-machine interface (HMI) and the cellular gateway's (cellular transmission) ability to enable remote parameter monitoring and control will be verified. All system interlocks including callout and uninterruptible power supply system functioning will be tested as described in SOP-2 (Appendix B). At this point, systems will be considered ready for actual startup operating tests.

2.2.2 System Start-up

Upon completion of the commissioning step, the system will be operated. The strategy for startup is to conduct these activities sequentially, comparing observations and test data to design and performance criteria. If necessary, adjustments will be made to the design parameters based on the actual operational values. Operation of all mechanical equipment and controllers will be demonstrated in the presence of the designated system operator. Refer to a system start-up check list in SOP-3 (Appendix B). The startup check-out will demonstrate operation of the following:

- Electric submersible pumps – achieve design flow rate and pressures for all locations (SP-101 and SP-201, Drawing M-2).
- Air stripper discharge pump (TP-1, Drawing M-2).
- Air stripper blower (B-1, Drawing M-2).
- All valves, gauges, sensors, and controllers.

Startup will proceed slowly with sequenced events. All related health, safety, and emergency response procedures will be in place and reviewed before this phase of operation. Before process systems are started, a final check on the alignments and positioning of all motor drives, valves, and control set points will be made.

The general startup sequence for normal operation of the system is as follows:

- ✓ Ensure that all valves are in the proper positions as indicated in the commissioning/startup check list.
- ✓ Ensure that the electrical disconnects are in the energized positions.
- ✓ Ensure that all alarm conditions are cleared.
- ✓ Turn air stripper blower B-1 selector switch on HMI panel to the AUTO position (Drawing E-2).
- ✓ Turn air stripper discharge pump TP-1 on HMI panel selector switch to the AUTO position (Drawing E-2).
- ✓ Adjust the set-point for variable frequency drive VFD-101 as needed to obtain maximum yield from the extraction well EW-1. This is accomplished by dewatering the well as much as practically possible (approximately 1 foot above the submersible pressure transducer SPT-101). Therefore, the set-point for VFD-101 will be set to 1 foot of water column.
- ✓ Turn the selector switch for extraction well pump SP-101 on the HMI panel to the AUTO position (Drawing E-2). This should start the well pump SP-101 in EW-1.
- ✓ Monitor the water levels (SPT-101) and flow rates (FM-101) in extraction well EW-1 using the HMI display. The well pump will slow down as necessary when the set-point is approached. Once the set point is reached the water level in the well (SPT-101) should remain close to a set point (1 foot) and the flow rate (FM-101) will stabilize at approximately 0.5 gpm based on the July 2017 pump test.
- ✓ Adjust the set-point for variable frequency drive VFD-201 as needed to obtain maximum yield from the extraction well EW-2. This is accomplished by dewatering the well as

much as practically possible (approximately 1 foot above the submersible pressure transducer SPT-201). Therefore, the set-point for VFD-201 will be set to 1 foot of water column.

- ✓ Turn the selector switch for extraction well pump SP-201 on the HMI panel to the AUTO position (Drawing E-2). This should start the well pump SP-201 in EW-2.
- ✓ Monitor the water levels (SPT-201) and flow rates (FM-201) in extraction well EW-2 using the HMI display. The well pump will slow down as necessary when the set-point is approached. Once the set point is reached the water level in the well (SPT-201) will remain close to a set point (1 foot) and the flow rate (FM-201) should stabilize at approximately 4 gpm based on the July 2017 pump test.
- ✓ Compare combined flow measured by electronic flowmeters FM-101 and FM-201 and the total flow measured by electronic flowmeter FM-1 and the mechanical flow totalizer MFT-1 (Drawing M-2).

The system is now in automatic operation, and the ON/OFF and START/STOP functions of the system are controlled by control system. Refer to a Detailed Operating Procedure (DOP) in Appendix B (SOP-008) for routine system start-up/shut down procedures.

The start-up activities terminate when the design and equipment performance is documented to comply with specifications, and the system is then ready for transition into the routine operation and maintenance phase.

Level switches will be re-checked in the air stripper and extraction wells to ensure proper operation, cycling, and shut down of all pumps. Pressure readings between liquid-phase carbon vessels LGAC-1 and LGAC-2 will be taken, and totalizer readings will be documented.

Exhaust from the air stripper and vapor-phase carbon vessels VGAC-1 and VGAC-2 will be checked to confirm that the units are operating properly. Observations, sampling, and other performance testing will be performed during startup to ensure that the system is operating as expected.

After steady-state operation is achieved, operational efficiency data will be collected. Steady-state operation will occur when all systems are running without shutdowns, the treatment system is functioning, and the flow rates have stabilized.

After the initial data set is evaluated, system adjustments will be made until the system reaches a steady-state condition wherein all design criteria are satisfied. At that point, startup and commissioning of the system is complete.

The first batch of the treated groundwater will be collected in a 5,000-gallon holding tank and then the groundwater treatment system will be shut down pending the results of the holding tank analytical sampling. The contents of the holding tank will be sampled and when it is confirmed that the treated effluent meets the sanitary sewer discharge criteria, the groundwater treatment system will be restarted and the discharge to the sanitary sewer will be initiated, starting with the water collected in the holding tank (collected water will be treated twice). If the water does not meet the required standards, it will be re-treated until all standards are met and the system will be adjusted to provide adequate treatment.

During the first week of system operation and testing, the engineer and equipment vendor representatives will be on-call if troubleshooting is required. In addition to field activities, system operations will be monitored remotely throughout the project duration to verify and ensure appropriate system operations.

2.2.3 Operations, Maintenance, and Monitoring

Operations and maintenance during the start-up phase will be performed to maintain compliance and proper system operation. The system start-up phase will occur during the first four weeks (28 days) of system operation. During the startup phase, operation and maintenance will be conducted daily for the first week, and then twice per week for the remainder of the first month of operation, to ensure that the system is operating as designed. Post-startup operation and maintenance will be conducted as described in Section 2.3.1.

All operation and maintenance will be documented on site-specific data daily logs and in the field logbook. Refer to a daily log in DOP-1 (Appendix B)). Routine operation and maintenance will be conducted as described in Section 2.3.1. Routine system start-up and shut-down will be conducted as described in SOP-3 (Appendix B).

After the system is running within the expected operating conditions, the entire system will be checked. Readings for flows and pressure at each extraction well, and operation flows, pressures,

and temperatures at all monitoring points in the system will be recorded. Operating data will be compared to equipment performance data and evaluated for discrepancies. The expected operating parameters, acceptable operating ranges, and criteria for adjustment are summarized in Table I2-1. Individual pieces of equipment will be inspected for proper mechanical operation.

Groundwater samples will be collected from the following locations:

- Each extraction well (EW-1 and EW-2)
- Air stripper influent
- Air stripper effluent (LGAC-1 influent)
- LGAC-2 influent
- LGAC-2 effluent (treated discharge)
- Vapor-phase samples for VOCs will be collected from the following locations:
- Air stripper effluent (VGAC-1 influent)
- VGAC-2 influent
- VGAC-2 effluent (treated discharge)

Refer to Table I2-2 for a summary of analytical parameters and sampling frequency. Refer to an SOP-4 in Appendix B for analytical sampling procedures.

Each vapor sampling location will be screened with a photoionization detector (PID) during each System Operator visit. The screening results will be used as a basis for vapor-phase treatment performance evaluation.

Levels of pH will be measured at each aqueous sampling location with a pH meter during each System Operator visit.

If VOCs are detected in the air stripper aqueous effluent samples at concentrations exceeding design criteria, the system will be shut down, and system evaluation will be conducted until VOC concentrations in the effluent are less than the design criteria. If exceedances cannot be addressed, the system will be deactivated until a detailed evaluation is performed.

2.3 LONG-TERM OPERATIONS AND MAINTENANCE

Following startup, the groundwater extraction and treatment system is anticipated to operate as a stand-alone system and only require routine operation and maintenance visits. Water level readings will be viewed on the VFD-101 keypad. All operation and maintenance will be documented in the daily logs (DOP-1, Appendix B) and in the site log book that will be kept in the treatment system building. Routine operation and maintenance will be conducted as described below, and according to the operation, maintenance, and monitoring (OMM) manual and equipment manufacturer recommendations. A sign-in sheet for all personnel entering the building will be kept on site.

2.3.1 System Maintenance and Operation

This section describes the routine system maintenance and operation. Maintenance will be executed in a manner that prevents emergencies or unscheduled shutdowns. Regular site visits will occur weekly for the first 12 weeks following the start-up phase and bi-weekly thereafter. Daily reports will be submitted to RTO/LMC each time the system operator visits the system. However, the system operator will visit the system if an alarm shutdown occurred to evaluate and alleviate the cause of shutdown and restart the system. Refer to SOP-5 in Appendix B) for alarm response procedures. LMC and the RTO will be notified within 24 hours when a plant shutdown occurs.

Drawings showing each unit, piping, valves, and electrical schematics will be available on site for reference. The manufacturer's maintenance recommendations for each component will be followed because the manufacturer has developed the maintenance program to protect its equipment and extend the operating performance and life of the equipment.

Spare parts for several key instruments and equipment items will be maintained and kept in the treatment system building on the shelves provided for this purpose. Refer to Table I2-6 for the spare parts lists.

The following subsections summarize the general routine maintenance activities and schedules for each of the major process components of the system. If electrical power maintenance is

performed on any energized unit, the electrical disconnect located at the local distribution panel will be tagged and locked out.

Extraction Wells. The extraction wells may require maintenance when excessive solids have accumulated within the wells or when yields have diminished. If either of these situations occur, well rehabilitation may be necessary. Typical issues may be caused by sediment infiltration, chemical scaling, biomass growth, or physical damage. Well maintenance activities will be scheduled based on the results of flow monitoring at the wells. The determination of required maintenance will be on a case-by-case basis, and appropriate actions may include chemical treatment and/or physical surging.

Extraction Well Submersible Pumps. Extraction well pump maintenance generally includes pulling the pump from the extraction well, removing the pump casing, and inspecting for wear, blockages, and damage. Indications that well pump maintenance is required may include reduced water flow, excessive motor noise, and/or excessive power consumption. Each pump can be shut down by turning its selector switch to the OFF position.

Close the shutoff valve and bleed water pressure from the sample valve into an appropriate vessel before performing pump or wellhead maintenance. Pump removal is necessary when a pump fails or groundwater yield decreases. Refer to SOP-6 in Appendix B for extraction well pump removal procedures. Lockout/tagout procedures (SOP-7 in Appendix B) shall also be followed during pump removal.

Pump and motor wear occur over time. Wear of the pump impellers may be accelerated due to abrasion from fine sediment particles or buildup of organic biomass or mineral deposits. The wetted surfaces of both the pump and motor are composed of stainless steel, and maintenance of these components should be limited to cleaning as needed.

Mechanical seals, although designed to be chemically resistant, may wear or deteriorate over time and may require replacement when an inspection of the seals indicates significant impact.

Air Stripper. With normal operation of the air stripper (in induced draft configuration), the blower inlet vacuum typically increases over time. This typically indicates that the air stripper trays are becoming fouled and need to be cleaned as described in DOP-2 (Appendix B).

Air Stripper Blower. Routine maintenance of the air stripper blower will be conducted in accordance with the manufacturer's recommendations. Inspection of the blower will be conducted and recorded at least monthly. At a minimum, the following inspection activities are to be performed quarterly:

- Inspect all blower and foundation hardware for tightness
- Inspect blower for excessive vibration
- Inspect inlet filter for particulate fouling
- Inspect blower oil level and lubrication
- Inspect moisture separator and drain any accumulated liquids.

Inlet filters are to be replaced as needed. Routine lubrication is performed per manufacturer's recommendations. A lubrication schedule will be finalized in the OMM manual. If excessive vibration or heat is encountered, troubleshooting per manufacturer recommendations will be performed.

Air Stripper Discharge Pump. Routine maintenance of the air stripper discharge pump will be conducted in accordance with the manufacturer's recommendations. An inspection of the pump internals will be conducted and recorded at least quarterly. At a minimum, the pump and pump motor will be routinely checked while in operation for excessive heat, leakage, or unusual noises. Each pump stator and mechanical seal will be inspected and cleaned quarterly or as necessitated by pump performance. Routine lubrication is performed per manufacturer's recommendations. A lubrication schedule will be established in the final OMM plan.

Vapor-Phase GAC vessels. Exterior surfaces of the VGAC tanks will be inspected monthly for corrosion and damage. When vapor samples indicate breakthrough in the lead VGAC tank the VGAC replacement will be scheduled. See Table I2-4 for frequency of sampling.

The VGAC replacement schedule will be based on the timing of breakthrough in the lead VGAC vessel. A VGAC replacement will be scheduled in approximately 75% of the time that is has taken for a breakthrough to occur. A breakthrough is defined as a point when the VGAC removal efficiency for total VOCs becomes less than 90%. For example, if breakthrough in the lead VGAC occurred after 4 months of system operation, a VGAC changeout would be scheduled

after 3 additional months of system operation and the VGAC will be replaced in both lead and lag vessels. Before the change-out, arrangements will be made with the VGAC supplier to provide replacement VGAC and to verify haul/re-activation services. The spent carbon in both VGAC vessels will be vacuumed out and placed in the spent carbon container ("super sack bag") and the VGAC vessels will be filled with fresh carbon using a vacuum system. Refer to SOP-8 in Appendix B for VGAC vessel carbon replacement procedures. As indicated in the above description, under normal conditions a lead/lag vessels swap would not be necessary. However, if necessary, a lead/lag vessel swap could still be performed as described in SOP-8. To perform the VGAC vessels lead/lag swap, the VGAC vessels will be disconnected from piping. The flanged connections provided for this purpose will be used to disconnect the piping. The VGAC vessels will then be swapped using a fork-lift dolly and placed in the same position to re-connect the piping. The process piping will be then be re-connected using the flanged connections.

Liquid-Phase GAC vessels. Exterior surfaces of the LGAC tanks will be inspected monthly for corrosion and damage. The air stripper is expected to remove the VOCs from the effluent liquid stream to levels below 2 micrograms per liter (µg/L) and thus the LGAC vessels contaminant loading is expected to be minimal and the LGAC replacement to be rare. See Table I2-4 for frequency of sampling.

The approach to LGAC replacement will be similar to VGAC replacement described above. The LGAC replacement schedule will be based on timing of a breakthrough in the lead LGAC vessel. LGAC replacement will be scheduled in approximately 25% of the time that is has taken for a breakthrough to occur. A breakthrough is defined as a point when the LGAC removal efficiency for total VOCs becomes less than 95%. For example, if breakthrough in the lead LGAC occurred after 8 months of system operation, a LGAC changeout would be scheduled after additional 2 months of system operation and the LGAC will be replaced in both lead and lag vessels. Before a change-out, arrangements will be made with the LGAC supplier to provide replacement LGAC and to verify haul/re-activation services. The LGAC vessels will be completely drained and carbon in both LGAC vessels will be vacuumed out and placed in the spent carbon container ("super sack bag" or roll-off box). The LGAC vessels will be filled with fresh carbon using a vacuum system. Refer to SOP-9 in Appendix B for LGAC vessel carbon replacement procedures. As indicated in the above description, under normal conditions a lead/lag vessel

swap would not be necessary. However, if necessary, a lead/lag vessels swap could still be performed as described in SOP-9. To perform LGAC vessel lead/lag swap, the LGAC vessels will be disconnected from piping. The pipe union connections provided for this purpose will be used to disconnect the piping. The LGAC vessels will then be swapped using a fork-lift dolly and placed in the same position to re-connect the piping. The process piping will be then be re-connected using the pipe union connections.

2.3.2 Interlock Testing

The groundwater extraction and treatment system interlocks will be tested quarterly to ensure proper functioning by simulating an operating condition (e.g., high liquid level, high/low pressure, etc.). If warranted, sensors and switches will be cleaned after testing is performed and before the system components are returned to working condition. The interlocks testing procedure will be performed at system commissioning and then quarterly. The interlock testing procedure is summarized in Table I2-3. Refer to SOP-2 in Appendix B for interlock testing procedures.

2.3.3 Lock-Out/Tag-Out Procedure

Personnel are to follow lock out/tag out procedures before any equipment repair. Refer to SOP in Appendix B (SOP-7) for lock-out/tag out procedures. The locations of both electrical and mechanical lock-out points are listed below:

Equipment/device	Electrical lockout
System power connection	LMC service panel inside Block E pump shed
Primary transformer	Disconnect before transformer
Secondary transformer	Disconnect after transformer
Control panel with HMI	Disconnect on breaker panel
EW-1 well pump SP-101	Disconnect inside control panel with HMI
EW-2 well pump SP-201	Disconnect inside control panel with HMI
Emergency heater #1	Disconnect on breaker panel
Emergency heater #2	Disconnect on breaker panel
Exhaust fan	Disconnect on breaker panel
Valve box heat trace	Disconnect on breaker panel
Sump pump receptacle	Disconnect on breaker panel
Interior lights	Disconnect on breaker panel
Interior receptacles	Disconnect on breaker panel
Exterior lights	Disconnect on breaker panel

Emergency lights	Disconnect on breaker panel

2.3.4 Air Stripper Cleaning

General Information

A shallow tray air stripper (QED EZ 2.6P model) will be used to remove volatile organic compounds (VOCs) such as trichloroethene (TCE) from groundwater. Refer to Appendix A of the design report for the general design information and to SOP-2 in Appendix B for cleaning procedures. Refer to "Air Stripper Manufacturer Manual" for the air stripper operation and maintenance details,

During operation, the trays of shallow tray air strippers can be fouled by suspended solids and by solids such as iron that precipitate due to oxidation. Air stripper performance can be reduced by solids precipitation and fouling to a point when tray cleaning is required.

Cleaning Criteria

During the system startup, a baseline pressure drop for the air stripper will be established. This can be done by reading the vacuum level at the air stripper outlet. This baseline vacuum should be approximately 20 inches water column (in. WC). Air stripper cleaning will be considered when this baseline pressure drop increases by approximately 6 in. WC (or 1 in. WC per tray).

Refer to DOP-2 in Appendix B for air stripper cleaning procedures. All liquid and/or solid wastes generated during air stripper cleaning would be handled as described in SOP-10 in Appendix B.).

2.3.5 Performance Monitoring

Performance monitoring for the Blocks E and F groundwater extraction and treatment system will include three components:

- process parameter monitoring and adjustment
- treatment system efficiency evaluation
- monitoring of hydraulic capture and contaminant distribution in Block F

Process parameter monitoring and adjustment will consist of monitoring and adjustment of the process parameters, including: readings for flows and pressures at each extraction well and operation flows, pressures, and temperatures at all monitoring points in the system. Operating data will be compared to system performance goals, equipment performance criteria, and other benchmarks and evaluated for discrepancies. The expected operating parameters, acceptable operating ranges, and criteria for adjustment are summarized in Table I2-1.

The treatment system efficiency evaluation will be based on the results of the influent and effluent sampling and will determine the efficiency of the treatment process and contaminant mass removal. Specifically, the treatment efficiency of the air stripper and VGAC vessels will be determined. The LGAC vessels are not expected to receive any measurable VOC loading and thus treatment efficiency of the LGAC units may not be quantifiable. Refer to Table I2-4 for sampling locations, parameters to be collected and laboratory analytical methods. In addition, each air sampling location will be screened with a PID during site visits. The screening results will be used as a basis for vapor-phase treatment performance evaluation.

The sanitary sewer discharge permit for the treatment has not been received yet. However, based on the sanitary sewer discharge permit requirements for the multi-phase extraction (MPE) system that operated at this location in 2015 the following discharge monitoring will be required:

Total flow discharged (totalizer meter reading)	-	monthly
Average daily flow (calculated from total flow)	-	monthly
Effluent VOCs (grab sample; 2130 ug/L maximum)	-	monthly
Effluent pH (grab sample; range 6 to 10 units	-	monthly

Monitoring of hydraulic capture achieved by the groundwater extraction system will consist of monthly elevation measurements of groundwater table in selected Block F observation wells and piezometers (Table I2-5), followed by a calculation of the drawdown achieved by pumping in those locations, and a comparison of the measured drawdown values with the values that are necessary to achieve a hydraulic capture of the TCE plume as predicted by the groundwater model. If a hydraulic capture of the TCE plume in Block F cannot be achieved even when

extraction wells EW-1 and EW-2 are fully stressed (i.e., at maximum pumping rates with water level near the pumps' intake), the groundwater extraction system design will be evaluated, and additional extraction wells may be added to achieve complete hydraulic capture of the TCE plume. The piping and treatment system design includes such accommodation, such as two spare one-inch-diameter high-density polyethylene (HDPE) lines for two additional extraction wells and additional treatment capacity (up to 20 gallons per minute [gpm]).

It is possible that due to fouling of the extraction well screens, the pumping rate from the Block F extraction wells will decrease to a degree that achieving the design capture zone to intercept the TCE plume in Block F becomes impossible. In this case, the extraction wells may need to be re-developed and the screens cleaned using high velocity nozzles. Such well development and cleaning procedures have been successfully implemented during ARD system operation in Blocks G and I. Groundwater extraction in Block F is expected to reduce TCE concentrations and other VOC concentrations in Block F. The baseline groundwater samples for VOCs and other geochemical parameters will be collected from Block F monitoring wells before system startup. Sampling at these locations will be continued during the system operation.

It should be noted that a mass discharge study is currently being performed by Lockheed Martin in the Block E and F area. In January 2019, fourteen (14) mass discharge study monitoring wells were installed in Block F near the Dark Head Cove as shown on Drawings C-2 and C-5. These wells will be monitored and sampled under the mass discharge study scope of work. If necessary, the data collected from these wells could be used as additional information to determine if the TCE plume in Block F is being intercepted by the groundwater treatment system.

Another element of the groundwater remedy in Block F that is expected to reduce the concentrations of TCE and other VOCs is the permeable reactive barrier (PRB) to be installed in Block F (see Section 3). After the PRB is installed, monitoring of the combined effects of groundwater extraction and PRB operation will continue. Groundwater extraction and PRB operation will be conducted simultaneously, and both remedies will use the same monitoring wells for performance monitoring sampling, so sampling will be performed jointly. Refer to Tables I3-1 and I3-2 for sampling locations, sampling parameters to be collected, and laboratory analytical methods.

SECTION 3
BLOCK F PERMEABLE REACTIVE BARRIER

This section describes the activities related to the operations, maintenance and monitoring (OMM) of the permeable reactive barrier (PRB) in Block F. As described in the *Groundwater Remedy Blocks E/F Design Report* (Tetra Tech, 2019), the PRB in Block F will be installed by injection of reactive media into the subsurface using temporary injection points and a direct-push drilling method. Therefore, no infrastructure will need to be maintained and operated after the PRB is installed. Performance monitoring is the only operation, maintenance, and monitoring (OMM) activity that will be performed during the operation of PRB and is described in this section.

3.1 PILOT PRB MONITORING

As described in the *Groundwater Remedy Blocks E/F Design Report* (Tetra Tech, 2019), a pilot test of the PRB will include a small-scale installation, and its performance will be evaluated before the full-scale PRB installation. Based on the performance of the pilot PRB, the full-scale PRB design will be modified (if necessary). To install the pilot PRB, the selected reactive media (AquaZVI™ supplied by Regenesis or equivalent) will be injected into four locations (designated as RB-1 through RB-4 on Drawing C-5).

The pilot PRB will be installed approximately ten feet upgradient of new performance monitoring wells SEMW-10S/I and approximately ten feet downgradient of existing performance monitoring well SEMW-7I. An additional new performance monitoring well cluster (SEMW-11S/I) will be installed within the PRB. This monitoring layout allows for a rapid and direct comparison between the conditions both upgradient, downgradient, and within the pilot PRB.

As indicated in Section 3.4 of the *Groundwater Remedy Blocks E/F Design Report* (Tetra Tech, 2019), six DPT borings will be advanced in the locations indicated on Drawing C-5 and soil

samples collected before the PRB pilot test installation. The sampling of these borings is detailed in the design report.

Soil samples from the vicinity of each of these six DPT borings will be collected immediately after the PRB pilot test injection is completed to determine the radius of influence of ZVI injection. A comparison of the soil iron content before and after ZVI injections will allow for a direct evaluation of the ROI achieved by the ZVI injections. Soil samples will be sent to an analytical laboratory to determine total iron content using US EPA analytical method 6010C.

The pilot PRB will be installed before the groundwater treatment system operation begins. The performance monitoring of the pilot PRB will include the determination of the effectiveness of TCE removal by the PRB, potential production of vinyl chloride and *cis*-1,2-dichloroethene (*cis*-1,2 DCE), iron particle migration, changes in dissolved and total iron concentrations, and other parameters. These parameters will be determined by comparing the subsurface conditions immediately upgradient and downgradient of the PRB. This will include water levels and groundwater samples for volatile organic compounds (VOCs), iron, dissolved oxygen, oxidation reduction potential, pH, conductivity, nitrate, sulfate, sulfide, and other biochemical parameters will be collected in monitoring wells SEMW-7I, SEMW-10S/I and SEMW-11S/I.

It is anticipated that the pilot PRB monitoring duration will last between three and six months, with the actual pilot duration depending on the performance results. If the conditions downstream of the pilot PRB stabilize quickly and change little over time, then the pilot test duration could be reduced. Performance monitoring samples will be collected more frequently at the beginning of the test and less frequently thereafter. Refer to Table I3-1 for a summary of sampling parameters to be collected during the pilot PRB operation, and the frequency of sampling.

3.2 FULL SCALE PRB MONITORING

As described in the *Groundwater Remedy Blocks E/F Design Report* (Tetra Tech, 2019), the full scale PRB will be essentially an extension of the pilot PRB shown on Drawing C-5; thus, performance monitoring of the full scale PRB will be similar to pilot PRB monitoring (described in Section 3.1 above).

As indicated in Section 3.5 of the *Groundwater Remedy Blocks E/F Design Report* (Tetra Tech, 2019), a soil sampling program similar to the PRB pilot test soil sampling (described in Section 3.1 above) will be performed for the full-scale PRB. The main purpose of this soil sampling program is to perform a direct evaluation of the radius of influence achieved by ZVI injections.

Before the full scale PRB installation, three DPT borings will be advanced approximately 25 feet to the east of the PRB center line (SEMW-11S/I) and another three DPT borings will be advanced approximately 25 feet to the west of the PRB center line (SEMW-11S/I). Locations of these DPT borings are shown on Drawing C-5 as small green crosses. Sampling of these locations is detailed in the design report.

Soil samples from the vicinity of each of these six DPT borings will be collected immediately after the full scale ZVI injection is completed to confirm the radius of influence of ZVI injection. Post ZVI-injection soil sampling intervals will be the same as the pre-injection background sampling (5 soil samples per DPT boring location). A comparison of the soil iron content before and after ZVI injections will allow for an evaluation of the ROI achieved by the ZVI injections.

The performance of the full-scale PRB will be evaluated by comparing the subsurface conditions immediately upgradient and downgradient of the PRB, using monitoring wells SEMW-7I, SEMW-10S/I and SEMW-11S/I (Drawing C-5). Extraction wells EW-1 and EW-2 will also be used for the PRB performance monitoring. However, because the full-scale PRB could influence a wider area, additional monitoring wells will also be used. Although piezometers PZ-1 and PZ-2 are outside the known TCE plume, they will be used to determine changes in total iron and other biochemical parameters downgradient of the PRB. Monitoring well MW-37B will be used to determine if VOCs migrate around the PRB during operation. Monitoring wells SEMW-8S/I and SEMW-9S/I (Drawing C-5) will also be included, as indicated on Table I3-2. As described in Section 2.3.5, the results of the wells sampling in Block F will be used for performance monitoring of both the groundwater extraction system and the PRB.

During the PRB installation, Tetra Tech will perform visual monitoring of surface water bodies for the presence of the injected fluids. If any changes in the surface water bodies are observed, the PRB installation will be discontinued and Lockheed Martin personnel will be immediately notified.

It should be noted that a mass discharge study is currently being performed by Lockheed Martin in the Block E and F area. In January 2019, fourteen (14) mass discharge study monitoring wells were installed in Block F near Dark Head Cove as shown on Drawings C-2 and C-5. These wells will be monitored and sampled under the mass discharge study scope of work. If required, the analytical sampling results from these wells could be used as additional information for the PRB performance evaluation.

SECTION 4
BLOCK E ARD SYSTEM INJECTION EVENT

ARD activities described in this section will not start until after the Block E soil remedy is completed in late 2021/early 2022.

The groundwater response action at the Middle River Complex (MRC) site is described in the *Groundwater Response Action Plan* (Tetra Tech, Inc. [Tetra Tech] 2012) and in the *Groundwater Response Action Design Report* (Tetra Tech, 2013). This groundwater response action employs enhanced anaerobic reductive dechlorination (ARD) technology in three areas with elevated groundwater concentrations of trichloroethene (TCE): the southeastern trichloroethene area (Block E), the southwestern trichloroethene area (Block G), and the northern trichloroethene area (Block I). ARD technology has already been implemented in Blocks G and I, and the results and recommendations for these areas were presented in the following reports: *First Injection Event Completion Report* (Tetra Tech, 2015a), *Second Injection-Event Completion Report, Blocks G and I* (Tetra Tech, 2016a), *Third Injection-Event Completion Report, Block I* (Tetra Tech, 2018b).

The methods for monitoring, operating, and maintaining the ARD-based groundwater remedy at the MRC site are presented in the *Operations and Maintenance Plan for Groundwater Remediation System at the Lockheed Martin Middle River Complex* (Tetra Tech, 2014). However, the implementation of ARD in Block E was delayed by the need to address the TCE source related to the underground storage tank that was discovered in the injection area during the ARD system construction. Currently, the ARD operation is planned for 2021 after the soil remediation in Block E is finished. The current operations and maintenance plan (Tetra Tech, 2014) does not contain a section that describes the injection event specifics for Block E, so this section provides general approach for future ARD implementation in Block E. It should be noted that details such as injection processes, injection equipment modules description, operating procedures, troubleshooting, lock-out-tag-out procedures are not presented here. Refer to the former operations and maintenance plan (Tetra Tech, 2014) for these details.

In 2016, a tracer study was performed in Block E to develop specific information for ARD implementation. The tracer study results and recommendations were presented in the *Block E Tracer Study Report* (Tetra Tech, 2016b). The details of the ARD injection described in this section are based on those tracer study results, and on the recommendations and experience accumulated during the ARD implementation in Blocks G and I between 2013 and 2017.

4.1 GENERAL METHODOLOGY

The injection event in Block E will be performed to achieve more rapid and complete TCE reduction by injecting the biological amendments (substrate, pH buffer and *dehalococcoides* [DHC] cultures) in the areas with elevated TCE concentrations, thus avoiding downgradient spread of TCE and its degradation products. At the same time, the injection program is down-scaled in the upgradient area of Block E where the TCE concentrations are very low. Logistically, the first full-scale injection event will consist of two injection phases with a relatively short monitoring phase between the injections. The sequence of the first Block E injection is presented below:

- Perform the injection event in a phased approach.
    - Phase A injection— Inject substrate and pH buffer solution to create favorable conditions for bio-augmentation.
    - Monitoring phase— Determine if conditions favorable for bio-augmentation are achieved.
    - Phase B injection— Perform bio-augmentation with DHC cultures as part of the first injection, using the approach developed for Block G. Based on its success in Block G, DHC injection is expected to accelerate the TCE degradation process in Block E. Injection sequencing is covered in Section 4.3.
- The sodium lactate substrate dosage should be increased from the design values documented in the remedial design report (Tetra Tech 2013), because current aerobic conditions must be overcome quickly to create favorable conditions for bioaugmentation.
- The sodium bicarbonate dosage should likewise be increased as compared to that in the remedial design report (Tetra Tech 2013), because current pH levels are lower than the levels favorable for DHC cultures, and our experience at Block G suggests that the calculations in the remedial design report (Tetra Tech, 2013) underestimate the actual buffer volumes needed.

- Deliver sodium bicarbonate buffer directly to the injection wells. The experience at Blocks G and I suggest that carbonate-scale precipitate severely impacts injection-manifold instrumentation and prevents increased buffer delivery. Direct placement of sodium bicarbonate was successful at Blocks G and I and did not have any negative impact.

- The injections will be performed on a rotating basis: substrate and buffer will be injected in one group of wells for a specific period, then the injection will be switched to another group of wells.

To minimize groundwater mounding and reduce the risk of injectate release to the surface, the injection pressures will be monitored and kept at levels below 5 pounds per square inch (psi). The system interlocks will be adjusted such that an injection well will be turned off if its injection pressure exceeds 5 psi. The importance of injection pressure monitoring will be stressed in the system operator training.

Water levels in the Block E monitoring wells will be measured every site visit during the initial 2 weeks of the injection and then bi-weekly. The measured water levels will be used to evaluate groundwater mounding. The injection rates will be reduced if excessive groundwater mounding is observed (water levels less than 1 foot below grade surface).

The system operators will also visually examine utilities, outfalls, and channels for the presence of the injected solution. If the injected solution is detected, corrective actions such as a reduction in the injection flows and pressures and shutting down the injection wells in the problem areas will be undertaken.

4.2 INJECTION VOLUMES AND AMENDMENT DOSAGES

The modified injection volumes and amendment dosages are based on the revised 1,000 microgram per liter (µg/L) TCE contour shown on Drawing C-2. The area within the revised 1,000 µg/L TCE contour is approximately 20,000 square feet, approximately 40% smaller than the original design value. (Refer to Table 3-2 in the groundwater response action 100% design document [Tetra Tech, 2013] for the original design values.) The target lactate concentration in pore volume is increased from the original design value (see Table 3-4 in Tetra Tech, 2013) of 400 milligram per liter (mg/L) to 1,000 mg/L. Note that for the area outside the revised 1,000 µg/L TCE contour (approximately 15,000 square feet, see Table I4-1) the modified target pore volume lactate concentration is 50% less (500 mg/L). Table I4-1 contains calculation

details. A general comparison between the original design values and the modified design is on Table I4-2.

The target pore volume concentration for sodium bicarbonate is increased from the original design value of 80 mg/L (Table 3-7 in Tetra Tech, 2013) to 200 mg/L for the area within the revised 1,000 µg/L TCE contour. Note that the modified sodium bicarbonate concentration is 50% less (100 mg/L) for the area outside the revised contour (approximately 15,000 square feet, Table I4-1). Refer to Table I4-1 for calculation details. A general comparison between the original design values and the modified design is on Table I4-2.

The remaining parameters (formation porosity, injection interval, and injection volume to pore volume ratio) are retained the same as in the original design (Table 3-2 in the original design document). The modified injection volumes and amendment dosages for Block E are summarized in Table I4-1, and Table I4-2 includes a comparison of original design values to modified values.

4.3 INJECTION SEQUENCE

The first injection is phased to include the steps necessary to establish suitable conditions for bioaugmentation. These conditions (to be achieved for 50-75% of the treatment area) are defined as follows:

- total organic carbon > 100 mg/L
- oxidation-reduction potential < -50 milliVolts
- dissolved oxygen < 0.5 mg/L
- 8.0 > pH > 6.5

The following phased approach is used to configure the injection sequence for Block E:

- Phase A— Inject sodium lactate substrate and sodium bicarbonate buffer solution into all 28 injection wells. A full design volume with the revised amendment dosages (Table I4-1) will be injected. Refer to Table I4-3 for the solution volumes, injection rates, and amendments dosages. The expected duration of Phase A is approximately six to eight weeks. The injections will be performed in three groups of wells (Group #1 [10 wells], Group #2 [10 wells], and Group #3 [eight wells]).

- Monitoring phase— Perform monitoring and determine if the conditions suitable for bio-augmentation are achieved within 1,000 µg/L TCE contour. The following monitoring wells will be sampled for total organic carbon and field parameters: SEMW-1I, SEMW-2I, SEMW-3I, SEMW-4I, SEMW-5I, SEMW-6I, SEMW-7I, SEMW-8I, IW-E, MW-72B, and MW-74B. Monitoring wells SEMW-6I, SEMW-7I, and SEMW-8I will also be sampled for VOCs. Go to next step if proper conditions suitable for bio-augmentation are achieved. Otherwise, certain modifications to the injection sequence will be considered, such as a longer pause before implementing Phase B; additional substrate and/or pH buffer injections; changes in the injection volumes, rates, and amendments dosages. The expected duration of monitoring phase is approximately four to six weeks.

- Phase B— Perform bioaugmentation for the wells within the revised 1,000 µg/L TCE contour. Inject 50% of the full design volume and amendments (as shown in Table I4-3). The injections will be performed in two groups of wells (Group #1 [10 wells] and Group #2 [8 wells]). The expected duration of Phase B is approximately two to three weeks. Bioaugmentation for the areas outside the revised 1,000 µg/L TCE contour is not planned.

This general injection sequence is presented in a more detail on Table I4-3. Introducing DHC cultures (KB-1) for bioaugmentation and preparing the solution will be conducted in the same manner as for Block G (water prepared in frac tank; oxygen-free environment in frac tank maintained by argon).

It should be noted that fouling of the injection manifold and injection lines was experienced during the earlier injection events in Blocks G and I and extensive experience was obtained to prevent fouling. It was determined that direct placement of sodium bicarbonate in the injection wells eliminates fouling of the process lines. Sodium bicarbonate will be placed in the injection wells in small increment batches (10 pounds batch per each well) until the design dosage per well is reached. Each 10-pound load of sodium bicarbonate will be carried individually to reduce injury potential due to heavy load lifting to the operators.

If fouling of the injection manifold and/or the individual lines to the injection wells does occur, the system operators will isolate the affected portion of the piping and flush the affected piping using treated potable water.

It is possible that due to fouling of the injection well screens, the flows to some injection wells will decrease and injection pressures increase to a degree that achieving the design injection volumes becomes impossible. In this case the selected injection wells may need to be re-developed and screens cleaned using high velocity nozzles. Such well development and cleaning

procedures have been successfully implemented during ARD system operation in Blocks G and I. However, due to higher formation permeability in Block E and the 2016 tracer test experience, it is anticipated that the overall needs for injection well re-development and cleaning in Block E will be less compared to Blocks G and I.

Sodium lactate drums will be unloaded from a freight truck by the delivery company workers and then the sodium lactate will be transferred directly from the drums to the lactate dosing tank using drum transfer pumps. There will be no need to move or handle the full drums of sodium lactate. However, the system operators will be trained in safe drum handling techniques and proper drum handling equipment such as drum lifting dollies will be available.

4.4 PERFORMANCE MONITORING

Performance monitoring in Block E after Phase B of the first injection will be conducted similar to how performance monitoring was conducted in Blocks G and I. The evaluation methodology and criteria, monitoring parameters, sampling procedures and other details are described in Appendix B of the *Operation and Maintenance Plan for Groundwater Remediation System at Lockheed Martin Middle River Complex* (Tetra Tech, 2014) and not included in this document to avoid redundancy.

Performance-monitoring sampling for Block E will include the baseline monitoring event and four follow-up monitoring rounds. Baseline monitoring will include collecting samples from several injection wells and analysis for VOCs. Additional data from the injection wells in Block E together will be used together with data from the Block E monitoring wells to determine the pre-injection TCE plume in Block E, and to evaluate whether any changes in the TCE plume configuration occurred after the last comprehensive sampling event performed in 2016.

During the ARD injection start-up a Site Operator will perform the visual monitoring of surface water bodies for a presence of the injected fluids. In case if any changes in the surface water bodies are observed the injections will be shut down and the LMC personnel will be immediately notified.

Follow-up monitoring events will be conducted after Phase B of the first injection is complete, at one, three, six, and 12 months. A summary of performance monitoring sampling including sampling locations, analytical parameters, and frequency is included in Table I4-4.

It should be noted that a mass discharge study is currently being performed by Lockheed Martin in the Block E and F area. In January 2019, nine (9) mass discharge study monitoring wells were installed in Block E as shown on Drawing C-2. These wells will be monitored and sampled under the mass discharge study scope of work. If necessary, the data collected from these wells could be used as additional information for ARD system performance evaluation.

Note that all selected sampling locations are in Block E. However, groundwater sampling results associated with performance monitoring of the groundwater extraction system and the Block F PRB (described in Section 3.0) will also be used to evaluate the effects that the first Block E injection has on conditions in Block F.

Following completion of the ARD and groundwater extraction system operation, Lockheed Martin will develop a plan for sampling of site soil to determine if there is residual soil contamination above industrial standards in the treatment area. If present, a plan for addressing this soil contamination will be developed at that time.

SECTION 5
REPORTING

Three different types of reports will be prepared during the groundwater remedy operation at Blocks E and F: Groundwater Extraction and Treatment System (GWETS) Progress Report, Sanitary Sewer Discharge Report, and Permeable Reactive Barrier (PRB) Performance Monitoring Report. The description of these reports is presented in the following sections.

5.1 GWETS PROGRESS REPORT

GWETS progress reports will be prepared quarterly and submitted to Remedial Technical Operations (RTO) and Lockheed Martin Corporation (Lockheed Martin) for review and approval. The final reports will be submitted to Maryland Department of the Environment (MDE). These reports will include:

- extracted groundwater volumes for the monitoring period (total and per extraction well)
- treated groundwater volumes for the monitoring period
- efficiency evaluation for treatment system influent, process, and effluent data
- summary of activities performed during the reporting period
- field notes/daily activity logs
- system down time durations and reasons
- results from laboratory analytical samples
- recommendations for continued operation

5.2 SANITARY SEWER DISCHARGE REPORT

Sanitary Sewer Discharge Reports will be prepared quarterly and submitted to RTO and Lockheed Martin for review and approval. The final reports will be submitted to Baltimore

County Department of Public Works (Bureau of Utilities, Engineering & Regulation Division). These reports will include:

- Total discharged groundwater volumes for the monitoring period
- Calculated daily discharge volume
- Analytical data for the treated discharge

5.3 PRB PERFORMANCE MONITORING REPORT

PRB performance monitoring reports will be prepared quarterly and submitted to RTO and Lockheed Martin for review and approval. The final reports will be submitted to MDE. These reports will include:

- summary of activities performed during the reporting period
- results from laboratory analytical samples
- field notes
- efficiency evaluation for PRB for the reporting period

SECTION 6
REFERENCES

Tetra Tech, Inc. (Tetra Tech), 2012. *Groundwater Response Action Plan, Lockheed Martin Middle River Complex*. Report prepared by Tetra Tech, Inc., Germantown, Maryland for Lockheed Martin Corporation, Bethesda, Maryland. August.

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TABLES

Table I2-1

Process Parameters Operating Ranges
OMM Manual for Blocks E/F Groundwater Remedy
Lockheed Martin Middle River Complex, Middle River, Maryland

Description	Measurement device	Expected range	Units	Operational Criteria and Rationale
Flow from EW-1	FM-101	0.25 to 1	gpm	EW-1 is low yield well. Maximum flow was 0.65 gpm during pump test.
Flow from EW-2	FM-201	3 to 5	gpm	EW-2 is high yield well. Maximum flow was 4.3 gpm during pump test.
Filter inlet pressure	PG-301, PG-303	2 to 25	psig	Filter inlet pressure is expected to be low (2 to 5 psig) after filter element replacement and rise gradually as the filter element accumulates particles. Filter element will be replaced when inlet pressure reaches 25 psig (20 psig warning set point value). A different set-point value could be utilized if required based on operational experience. At this point an automatic notification is sent to system operator operator (set point reached and sensed by PT-1).
Filter outlet pressure	PG-302, PG-304	2 to 5	psig	Filter outlet pressure is expected to be low (2 to 5 psig) during the majority of the operation because the LGAC vessels will have negligible pressure losses at the design flow and the discharge line to the sewer will have low friction losses (2 to 3 psi) at the design flow.
LGAC-1 inlet pressure	PG-401	2 to 5	psig	Should be the same as filter outlet pressure measured by PG-302/PG-304. LGAC vessels are oversized for the design flow and will not have measurable back pressure under normal operation conditions. However, if LGAC vessel becomes clogged by precipitation or biological fouling the inlet pressure may increase. If this happens a media changeout shall be considered.
LGAC-2 inlet pressure	PG-402	2 to 5	psig	Pressure differential across LGAC-1 (differential between PG-401 and PG-402 readings) should be negligible under normal conditions. An increase in pressure differential across LGAC-1 would signal LGAC-1 a clogging or fouling.
LGAC-2 outlet pressure	PG-403	2 to 5	psig	Pressure differential across LGAC-2 (between PG-402 and PG-403 readings) should be negligible under normal conditions. An increase in pressure differential across LGAC-1 would signal LGAC-1 is clogging or fouling. LGAC-2 outlet pressure is determined by pressure losses in the discharge plumbing and flow measurement devices (1-2 psi at design flow) and the pressure losses in the line to the sewer (2 to 3 psi at the design flow). An increase in the LGAC-2 outlet pressure would signal a blockage of the discharge line.
Discharge flow (electronic flow meter)	FM-1	3 to 5	gpm	Flow rate and total flow should be close to the sum of FM-101 and FM-201 readings at steady state conditions
Discharge flow (mechanical flow totalizer)	MFT-1	3 to 5	gpm	Total flow should be close to the sum of FM-101 and FM-201 readings at steady state conditions. Flow rate could be calculated by using timer.
AS-1 outlet vacuum	PT-2	20 to 30	in.w.c.	Vacuum at the air stripper effluent. Expected to be approximately 20 in.w.c. when the trays are clean. Air stripper cleaning shall be considered when vacuum increases 4 to 6 in.w.c above the value recorded with clean trays. Air stripper trays must be cleaned when vacuum reaches 26 in. w.c. (warning set point value). A different set-point value could be utilized if required based on operational experience. At this point an automatic notification is sent to system operator operator (set point reached and sensed by PT-2).
MS-1 outlet vacuum	LPG-1	20 to 30	in.w.c.	Vacuum at the moisture separator effluent. Expected to be slighly higher (1-2 in.w.c.) than the air stripper effluent vacuum. Increase in a vacuum differential across moisture separator is indicative of moisture separator demister fouling/clogging.
VGAC-1 inlet pressure	LPG-2	4 to 6	in.w.c.	Pressure at the VGAC vessels inlet. Determined by pressure drop across VGAC vessels and friction losses in the ducting. Increase in LPG-2 is indicative of VGAC vessels fouling/clogging.
VGAC-1 inlet temperature	TG-1	90 to 110	deg.F	Temperature at the VGAC vessels inlet. Determined by temperature rise across the blower and heat losses in the ducting. Air temperature increase above manufacturer's information is indicative of blower malfunction.
VGAC-2 inlet pressure	LPG-3	2 to 3	in.w.c.	Pressure at the VGAC-2 inlet. Determined by pressure drop across VGAC-2 and friction losses in the ducting. Increase in LPG-3 is indicative of VGAC-2 fouling/clogging.
VGAC-2 inlet temperature	TG-2	85 to 105	deg.F	Temperature at the VGAC-2 vessel inlet. Determined by temperature rise across the blower and heat losses in VGAC-1 and in the ducting.
VGAC-2 outlet temperature	TG-3	80 to 100	deg.F	Temperature at the VGAC-2 vessel outlet. Determined by temperature rise across the blower and heat losses in VGAC-1, VGAC-2 and in the ducting.
Effluent air flow	AFT-1	130 to 150	SCFM	Should remain at around 140 SCFM to allow specified VOC removal efficiency in air stripper. Decreases from this value are indicative of air stripper tray fouling, excessive pressure/vacuum losses in the system, and/or blower B-1 malfunction. Causes of the flow rate decrease should be corrected.

in.w.c.	inches of water column (pressure or vacuum)
deg.F	degrees Fahrenheit
SCFM	standard cubic feet per minute
gpm	gallons per minute
LGAC	Liquid-phase granular activated carbon
VGAC	Vapor-phase granular activated carbon

Table I2-2

Start-Up GWETS Sampling Summary
OMM Manual for Blocks E/F Groundwater Remedy
Lockheed Martin Middle River Complex, Middle River, Maryland

Sampling Stream	Sampling Port ID	Analytical Parameter	Purpose	Frequency of samping					
				Day 1	Day 3	Day 7	Day 14	Day 21	Day 28
Air stripper inlet (aqueous)	SPL-1	VOCs	Performance evaluation	1	1	1	1	1	1
Air stripper inlet (aqueous)	SPL-1	metals (total and dissolved)	Performance evaluation	1		1			1
Air stripper inlet (aqueous)	SPL-1	general chemistry	Performance evaluation	1		1			1
Air stripper effluent (aqueous)	SPL-2	VOCs	Performance evaluation	1		1			1
Air stripper effluent (aqueous)	SPL-2	metals (total and dissolved)	Performance evaluation	1		1			1
Air stripper effluent (aqueous)	SPL-2	general chemistry	Performance evaluation	1		1			1
Treatment system effluent (aqueous)	SPL-5	VOCs	SS discharge permit	1	1	1	1	1	1
Treatment system effluent (aqueous)	SPL-5	pH	SS discharge permit	1	1	1	1	1	1
EW-1 discharge (aqueous)	SPL-101	VOCs	Performance evaluation	1		1			1
EW-1 discharge (aqueous)	SPL-101	metals (total and dissolved)	Performance evaluation	1		1			1
EW-1 discharge (aqueous)	SPL-101	general chemistry	Performance evaluation	1		1			1
EW-2 discharge (aqueous)	SPL-101	VOCs	Performance evaluation	1		1			1
EW-2 discharge (aqueous)	SPL-101	metals (total and dissolved)	Performance evaluation	1		1			1
EW-2 discharge (aqueous)	SPL-101	general chemistry	Performance evaluation	1		1			1
Air stripper effluent (vapor-phase)	SPV-1	VOCs	Performance evaluation	1		1			1
VGAC- 2 influent (vapor-phase)	SPV-2	VOCs	Performance evaluation	1		1			1
VGAC- 2 effluent (vapor-phase)	SPV-3	VOCs	Performance evaluation	1		1			1

Metals	Cadmium, Chromium, Copper, Cyanide, Iron (total and dissolved), Lead, Manganese, Mercury, Nickel, Silver, Zinc
General chemistry	total dissolved solids, hardness, alkalinity, sulfates, nitratres, bromide, salinity, pH

Totals for start-up	
aqueous VOCs (USEPA 8260B)	27
vapor-phase VOCs	9
Metals	12
General chemistry	12
pH	6

Analytical methods

Aqueous VOCs	US EPA 8260B
Vapor VOCs	US EPA TO-15
Metals (Ca,Cd, Cr, Cu, Fe, Pb, Mg, Mn, Ni, Ag & Zn)	US EPA 6010C
Metals (Mercury)	US EPA 7470A
Metals (Cyanide)	US EPA 9012B
Total Dissolved Solids (TDS)	US EPA 2540 C-2011
Hardness, alkalinity	US EPA 2340B-2011
Sulfates, nitratres, bromide	US EPA 300.0
Salinity	US EPA SM 2520B
pH	US EPA 9040C

Table I2-3

Interlock Testing Procedure
OMM Manual for Blocks E/F Groundwater Remedy
Lockheed Martin Middle River Complex, Middle River, Maryland

No.	Alarm or Interlock	P&ID Symbol	Alarm Type	Testing procedure	Design outcome
1	Air stripper sump high level switch	HLA-1	Critical	Triggered by manually lifting the float	System shutdown, operator notification via phone, email and text
2	Air stripper sump high level switch (redundant)	HLA-1	Critical	Triggered by removing the conductivity probe and submerging the probe in a container of water to activate alarm.	System shutdown, operator notification via phone, email and text
3	Moisture separator high liquid level	HLA-2	Critical	Triggered by manually lifting the float	System shutdown, operator notification via phone, email and text
4	Moisture separator high liquid level (redundant)	HLA-2	Critical	Triggered by removing the conductivity probe and submerging the probe in a container of water to activate alarm.	System shutdown, operator notification via phone, email and text
5	Liquid level switch in building floor sump	HLA-3	Critical	Triggered by manually lifting the float	System shutdown, operator notification via phone, email and text
6	Liquid level switch in building floor sump (redundant)	HLA-3	Critical	Triggered by removing the conductivity probe and submerging the probe in a container of water to activate alarm.	System shutdown, operator notification via phone, email and text
7	Air stripper blower low vacuum	LVA-1	Critical	Triggered by disconnecting the switch PS-1 tubing from the process piping to simulate vacuum loss.	System shutdown, operator notification via phone, email and text
8	Air stripper blower low vacuum (redundunt)	LVA-1	Critical	Triggered by disconnecting the transmitter PT-2 from the process piping to simulate vacuum loss.	System shutdown, operator notification via phone, email and text
9	High air stripper vacuum	HVA-1	Non-critical	Triggered by restricting air inlet on AS-1 and allow vacuum to increase above set-point. Default high vacuum alarm set point is 30“wc.	Operator notification via email and text
10	High filter inlet pressure	HPA-1	Non-critical	Triggered by closing valves V-301 and V-304. Use valve V-302 downstream of PT-1 to increase pressure above set point. Default high pressure alarm set point is 30 psig.	Operator notification via phone, email and text
11	Low building temperature	LTA-1	Non-critical	Triggered by increasing set point to above current transmitter reading.	Operator notification via phone, email and text
12	High building temperature	HTA-1	Non-critical	Triggered by lowering set point to below current transmitter reading.	Operator notification via phone, email and text
13	Valve box heat trace failure	TRA-1	Non-critical	Triggered by temporarily disconnecting heat cable in valve box	Operator notification via phone, email and text

Table I2-4

GWETS 1st Year of Operation Treatment Efficiency Sampling Summary
OMM Manual for Blocks E/F Groundwater Remedy
Lockheed Martin Middle River Complex, Middle River, Maryland

Sampling Stream	Sampling Port ID	Analytical Parameter	Purpose	Frequency of samping	
				Monthly	Quarterly
Air stripper inlet (aqueous)	SPL-1	VOCs	Performance evaluation	1	
Air stripper inlet (aqueous)	SPL-1	metals	Performance evaluation		1
Air stripper inlet (aqueous)	SPL-1	general chemistry	Performance evaluation		1
Air stripper effluent (aqueous)	SPL-2	VOCs	Performance evaluation	1	
Air stripper effluent (aqueous)	SPL-2	metals	Performance evaluation		1
Air stripper effluent (aqueous)	SPL-2	general chemistry	Performance evaluation		1
LGAC-2 influent (aqueous)	SPL-3	VOCs	Performance evaluation		1
LGAC-2 influent (aqueous)	SPL-3	metals	Performance evaluation		1
LGAC-2 influent (aqueous)	SPL-3	general chemistry	Performance evaluation		1
Treatment system effluent (aqueous)	SPL-5	VOCs	SS discharge permit	1	
Treatment system effluent (aqueous)	SPL-5	pH	SS discharge permit	1	
EW-1 discharge (aqueous)	SPL-101	VOCs	Performance evaluation		1
EW-1 discharge (aqueous)	SPL-101	metals	Performance evaluation		1
EW-1 discharge (aqueous)	SPL-101	general chemistry	Performance evaluation		1
EW-2 discharge (aqueous)	SPL-101	VOCs	Performance evaluation		1
EW-2 discharge (aqueous)	SPL-101	metals	Performance evaluation		1
EW-2 discharge (aqueous)	SPL-101	general chemistry	Performance evaluation		1
Air stripper effluent (VGAC-1 influent) (vapor-phase)	SPV-1	VOCs	Performance evaluation	1	
VGAC- 2 influent (vapor-phase)	SPV-2	VOCs	Performance evaluation	1	
VGAC- 2 effluent (vapor-phase)	SPV-3	VOCs	Performance evaluation	1	

VOCs	Volatile organic compounds
Metals (total and dissolved)	Cadmium, Chromium, Copper, Cyanide, Iron, Lead, Manganese, Mercury, Nickel, Silver, Zinc
General chemistry	total dissolved solids, hardness, calcium, alkalinity, sulfates, nitratres, bromide, salinity,

Totals for start-up	
aqueous VOCs	45
vapor-phase VOCs	36
Metals	16
General chemistry	16
pH	11

Analytical methods

Aqueous VOCs	US EPA 8260B
Vapor VOCs	US EPA TO-15
Metals (Ca,Cd, Cr, Cu, Fe, Pb, Mg, Mn, Ni, Ag & Zn)	US EPA 6010C
Metals (Mercury)	US EPA 7470A
Metals (Cyanide)	US EPA 9012B
Total Dissolved Solids (TDS)	US EPA 2540 C-2011
Hardness, alkalinity	US EPA 2340B-2011
Sulfates, nitratres, bromide	US EPA 300.0
Salinity	US EPA SM 2520B
pH	US EPA 9040C

Table I2-5

Block F Groundwater Table Monitoring Locations
OMM Manual for Blocks E/F Groundwater Remedy
Lockheed Martin Middle River Complex, Middle River, Maryland

Location ID	Frequency of measurement	
	Monthly	Quarterly
SEMW-6I		1
SEMW-7I	1	
SEMW-10S	1	
SEMW-10I	1	
SEMW-11S	1	
SEMW-11I	1	
SEMW-8S	1	
SEMW-8I	1	
SEMW-9S		1
SEMW-9I		1
PZ-1		1
PZ-2		1
MS-37B		1
MS-37C		1

Table I2-6

GWETS Spare Parts List
OMM Manual for Blocks E/F Groundwater Remedy
Lockheed Martin Middle River Complex, Middle River, Maryland

Item	Descriptioin	Manufacturer and Model	Spare part Quantity
Air stripper transfer pump	1.5hp, 208- 230/460V, 3-phase, 22.5 gpm @ 44 psig, wetted parts: 316SS, Viton, 1.25-inch inlet, 1-inch outlet	Goulds NPE series	1
Air stripper blower	3hp, 208- 230/460V, 3-phase, 140 SCFM	Rotron DR656	1
Submersible well pump	4-inch size, 1" discharge, 1/2hp, 230 VAC, 3-phase, pollution recovery series motor, teflon pump leads	Grundfos environmental pollution series model 5E5	1
Variable frequency drive	DURAPULSE GS3 series, 2 hp 7 AMP 230V 3-PHASE, installed with DURAPULSE line reactor	DURAPULSE GS3 series	1
Submersible pressure transmitter	316SS material, 0.63-inch dia, 4-20mA output, 40-foot Tefzel cable, 0 to 30 feet water column pressure	Dwyer MBLT-S-IVEF-30-50	1
Low pressure transducer	Wetted materials: 318 Duplex SS, 0 to 100 inches water column pressure tange, 1/4-inch MNPT process connection	Dwyer series 672 model 672-5-A	1
Electronic flow meter	Padle-type electronic flow sensor, transmitter with totalizer function (0.3 to 20 fps or 0.25 to 15 gpm for 1/2-inch sch 80); 1/2-inch PVC sch 80 fitting, field-mounted transmitter	Georg Fischer Signet Sensor: 3-8512-P0 Transmitter: 3-8550-1	1
Mechanical flow totalizer	Bronze multi-jet water meter, ½-inch union couplings, 145 psi max, 0.125 to 20 gpm range	Dwyer WM-A-C-01	1
Pressure transmitter	Pressure transmitter (0 to 30 psig), 316SS body, current and voltage output, 1/4-inch male thread process connection	Dwyer 626-08-GH-P1-E5-S1	1
Cellular modem	4G Wireless modem/gateway	Sierra Wireless ES450/AL-1102383	1
Air stripper gaskets	Set of gaskets	QED	1
Low pressure (vacuum) transmitter	SERIES 605 Magnehelic® Indicating Transmitter, 4-20mA output, range 0-50 inches of feet water column	Dwyer 605-50	1

MNPT - male national pipe thread
PI&D - piping and instrumentation diagram
psi - pound(s) per square inch
psig - pound(s) per square inch gauge
rpm - revolutions per minute
SCFM - standard cubic feet per minute
VAC - volts alternating current
VGAC - vapor-phase GAC

Table I3-1

Block F PRB Pilot Test Performance Monitoring Frequency and Analytical Parameters
OMM Manual for Blocks E/F Groundwater Remedy
Lockheed Martin Middle River Complex, Middle River, Maryland

Aqueous Samples

Sampling event	Baseline				2 Weeks after PRB Installation				2 Months after PRB Installation				5 Months after PRB Installation			
Monitoring Well	VOCs	TOC	Chem	Field	VOCs	TOC	Chem	Field	VOCs	TOC	Chem	Field	VOCs	TOC	Chem	Field
SEMW-7I	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SEMW-10I	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SEMW-10S	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SEMW-11I	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SEMW-11S	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
DHC			1	1			1	1			1				1	1
Totals	5	5	6	6	5	5	6	6	5	5	6	5	5	5	6	6

Sample Quantities

VOCs	20
TOC	20
Chem	24
field	23

Chem - sulfates, alkalinity, total dissolved solids, total and dissolved iron, total and dissolved manganese

Field - pH, oxidation-reduction potential, dissolved oxygen, specific conductance

TOC - total organic carbon

VOCs - volatile organic compounds

DHC - Dark Head Cove surface water sample

Soil Samples

Sampling event	Pre-PRB pilot installation		Post-PRB pilot installation	
Parameter	VOCs	Iron	VOCs	Iron
Quantities	30	30	30	30

Table I3-2

Block F 1st Year Performance Monitoring Frequency and Analytical Parameters
OMM Manual for Blocks E/F Groundwater Remedy
Lockheed Martin Middle River Complex, Middle River, Maryland

Aqueous Samples

Sampling event	1st quarter after PRB installation				2nd quarter after PRB installation				3rd quarter after PRB installation				4th quarter after PRB installation			
Monitoring Well	VOCs	TOC	Chem	Field	VOCs	TOC	Chem	Field	VOCs	TOC	Chem	Field	VOCs	TOC	Chem	Field
SEMW-8I	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SEMW-8S	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SEMW-9I	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SEMW-9S	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PZ-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PZ-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SEMW-7I	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SEMW-10I	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SEMW-10S	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SEMW-11I	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SEMW-11S	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
MW-37B	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
DHC			1	1			1	1			1	1			1	1
Totals	12	12	13	13	12	12	13	13	12	12	13	13	12	12	13	13

Sample Quantities

VOCs: 48 TOC: 48 Chem 52 Field 52

Chem - sulfates, alkalinity, total dissolved solids, total and dissolved iron, total and dissolved manganese
Field - pH, oxidation-reduction potential, dissolved oxygen, specific conductance
TOC - total organic carbon
VOCs - volatile organic compounds
DHC - Dark Head Cove surface water sample

Soil Samples

Sampling event	Pre-PRB pilot installation		Post-PRB pilot installation	
Parameter	VOCs	Iron	VOCs	Iron
Quantities	30	30	30	30

Table I4-1

Injection Volumes and Amendment Dosages for Block E 1st Injection Event
OMM Manual for Blocks E/F Groundwater Remedy
Lockheed Martin Middle River Complex, Middle River, Maryland

Injection wells to address revised 1,000 µg/L contour (17 wells): IWE-8, IWE-9, IWE-10, IWE-11, IWE-25, IWE-26, IWE-27, IWE-28, IWE-14, IWE-15, IWE-16, IWE-19, IWE-20, IWE-21, IWE-22, IWE-23, IWE-24

Injection volumes for Block E wells to address revised 1,000 ug/L contour

Revised 1,000 µg/L TCE contour area (square feet)	Formation porosity	Injection interval thickness (feet)	Calculated pore volume within 1,000 µg/l TCE contour (gal)	Injection volume to pore volume ratio	Injection volume (gallons)	Number of injection wells	Injection volume per well (gallons)
20000	25%	20	748,000	10.2%	76,300	17	4,500

Substrate quantities for Block E wells to address revised 1,000 µg/L contour

Target pore volume sodium lactate concentration (mg/L)	Sodium lactate active ingredients content	Sodium lactate total as 60% product (pounds)	Sodium lactate total as 60% (gallons)	Sodium lactate concentration as injected	Sodium lactate per wel (gallons)	Sodium lactate # of drums
1,000	60%	10,400	940	1.0%	55	19

Sodium bicarbonate buffer quantities for Block E wells to address revised 1,000 µg/L contour

Target pore volume bicarbonate alcalinity increase (mg/L)	Sodium bicarbonate quantity (pounds)	Sodium bicarbonate per well (pounds)
200	1750	103

µg/L - micrograms per liter
mg/L- milligrams per liter
TCE - trichloroethene

Injection wells to address areas outside revised 1,000 µg/L contour (11 wells): IWE-1, IWE-2, IWE-3, IWE-4, IWE-5, IWE-6, IWE-7, IWE-12, IWE-13, IWE-17, IWE-18

Injection volumes for Block E wells outside revised 1,000 µg/L contour

Area outside 1,000 µg/L TCE contour (square feet)	Formation porosity	Injection interval thickness (feet)	Calculated pore volume within 1,000 µg/l TCE contour (gallons)	Injection volume to pore volume ratio	Injection volume (gallons)	Number of injection wells	Injection volume per well (gallons)
15000	25%	20	561,000	10.2%	57,300	11	5,300

Substrate quantities for Block E wells outside revised 1,000 µg/L contour

Target pore volume sodium lactate concentration (mg/L)	Sodium lactate active ingredients content	Sodium lactate total as 60% product (pounds)	Sodium lactate total as 60% (gallons)	Sodium lactate active ingredients in injected solution	Sodium lactate per well as 60% (gallons)	Sodium lactate # of drums as 60%
500	60%	3,900	360	0.5%	33	7

Sodium bicarbonate buffer quantities for Block E wells outside revised 1,000 µg/L contour

Target pore volume bicarbonate alcalinity increase (mg/L)	Sodium bicarbonate quantity (pounds)	Sodium bicarbonate per well (pounds)
100	660	60

TCE - trichloroethene

µg/L - micrograms per liter
mg/L- milligrams per liter

Table I4-2

Comparison of Original and Revised Parameters for Block E Phase A Injection Event
OMM Manual for Blocks E/F Groundwater Remedy
Lockheed Martin Middle River Complex, Middle River, Maryland

Parameter	Original Design Value	Revised Design Value
Total injection volume (gallons)	126,100	134,000
Number of injection wells	24	28
Number of injection wells	24	28
Substrate quantity (pounds)	5,150 (LactOil)	14,300 (Lactate)
Sodium bicarbonate quantity (pounds)	1,130	2,400
KB-1 cultures quantity (liters)	0	160

Table I4-3

1st Injection Event for Block E Remedy
OMM Manual for Blocks E/F Groundwater Remedy
Lockheed Martin Middle River Complex, Middle River, Maryland

Step No.	Activity Description	Number of wells	Injection volume per well (gallons)	Injection volume per event (gallons)	Sodium lactate conc. (%)	Sodium lactate per well (gallons)	Sodium lactate per event (gallons)	Sodium bicarb per well (lbs)	Sodium bicarb per event (lbs)	DHC cultures (liters)	Injection rate per well (gpm)	Event duration (days)	Cumulative duration (days)
Phase A Injection Event													
1	Injection into 1st group of wells (within 1,000 µg/L contour): IWE-8, 9, 25, 26, 27, 28, 15, 19, 20, 21. Inject full design volume (as revised).	10	4500	45000	1.0%	55	553	103	1029	0	0.2 to 0.3	16 to 10	16 to 10
2	Injection into 2nd group of wells (all are within 1,000 µg/L contour except IWE-18): IWE-10, 11, 14, 16, 22, 23, 24, 18. Inject full design volume.	8	4500	36000	1.0%	55	442	103	721	0	0.2 to 0.3	16 to 10	31 to 21
3	Injection into 3rd group of wells (outside 1,000 µg/L contour): IWE-1, 2, 3, 4, 5, 6, 7, 12, 13, 17. Inject full design volume.	10	5300	53000	0.5%	33	327	60	600	0	0.2 to 0.3	18 to 12	50 to 33
Monitoring Phase													
4	Monitor the conditions (TOC, field parameters, and selected wells VOCs) and determine if proper conditions suitable for bio-augmentation are achieved.Go to next step if proper conditions suitable for bio-augmentation are achieved. If conditions for bio-augmentation are not achieved then certain modifications to the injection sequence will be necessary. Some of these potential changes are longer pause before Phase B implementation; additional substrate and/or pH buffer injections; changes in the injection volumes, rates, and amendments dosages.										0 to 0	35 to 28	85 to 61
Phase B Injection Event													
5	Prepare anaerobic solution for bio-augmentaiotn in frac tank. Injection into 1st group of wells (within 1,000 µg/L contour): IWE-8, 9, 25, 26, 27, 28, 15, 19, 20, 21. Inject 50% of design volume. Perform bioaugmentaiton with KB-1 cultures.	10	2250	22500	1.0%	28	276	51	515	90	0.2 to 0.3	8 to 5	92 to 66
6	Injection into 2nd group of wells (all are within 1,000 µg/L contour except IWE-18): IWE-10, 11, 14, 16, 22, 23, 24, 18. Inject 50% of design volume. Perform bio-augmentation.	8	2250	18000	1.0%	28	221	51	412	70	0.2 to 0.3	8 to 5	100 to 72

Injection Parameters Summary For Injection Event

Parameter	Phase A	Phase B	Totals for Event
Injection volume (gallons)	134000	40500	174500
Sodium lactate as 60% product (gallons)	1330	500	1830
Sodium lactate as 60% product (lbs)	14300	5400	19700
Sodium bicarbonate (lbs)	2400	930	3330
KB-1 cultures (liters)	0	160	160

DHC - *dehalococcoides*
µg/L- micrograms per liter
gal - gallons
gpm - gallons per minute
lbs - pounds

Table I4-4

Block E 1st Injection Event Performance Monitoring Frequency and Analytical Parameters
OMM Manual for Blocks E/F Groundwater Remedy
Lockheed Martin Middle River Complex, Middle River, Maryland

Sampling event	Baseline						1 Month after 1st Event						3 Months after 1st Event						6 Months after 1st Event						12 Months after 1st Event					
Monitoring Well	VOCs	TOC	Chem	MEE	DHC	Field	VOCs	TOC	Chem	MEE	DHC	Field	VOCs	TOC	Chem	MEE	DHC	Field	VOCs	TOC	Chem	MEE	DHC	Field	VOCs	TOC	Chem	MEE	DHC	Field
IWE-1	1																								1					
IWE-3	1																								1					
IWE-6	1																								1					
IWE-8	1																								1					
IWE-9	1																								1					
IWE-14	1																								1					
IWE-17	1																								1					
IWE-14	1																								1					
IWE-15	1																								1					
IWE-17	1																								1					
IWE-18	1																								1					
IWE-21	1																								1					
IWE-22	1																								1					
IWE-24	1																								1					
IWE-25	1																								1					
IWE-26	1																								1					
IWE-27	1																								1					
IWE-28	1																								1					
SEMW-5S	1	1	1	1		1	1	1	1	1		1	1	1	1	1		1	1	1	1	1		1	1	1	1	1		1
SEMW-5I	1	1	1	1		1	1	1	1	1		1	1	1	1	1		1	1	1	1	1		1	1	1	1	1		1
SEMW-6I	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
MW-72B	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
MW-74B	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
IL-3	1	1					1	1					1	1					1	1					1	1				
IL-2		1						1						1						1						1				
IL-1	1	1					1	1					1	1					1	1					1	1				
Outfall 8	1	1					1	1					1	1					1	1					1	1				
Totals	26	9	5	5	3	5	8	9	5	5	3	5	8	9	5	5	3	5	8	9	5	5	3	5	26	9	5	5	3	5

Sample Quantities

VOCs	76
TOC	33
Chem	25
MEE	25
DHC	15
field	25

Chem - sulfates, alkalinity, total dissolved solids, total iron, total manganese
DHC and functional genes - dehalococcoides, trichloroethene (TCE) reductase, vinyl chloride (VC) reductase
Field - pH, oxidation-reduction potential, dissolved oxygen, specific conductance, temperature
MEE - gases (methane, ethane, ethene)
TOC - total organic carbon
VOCs - volatile organic compounds

APPENDICES

Appendix A—Design Drawings

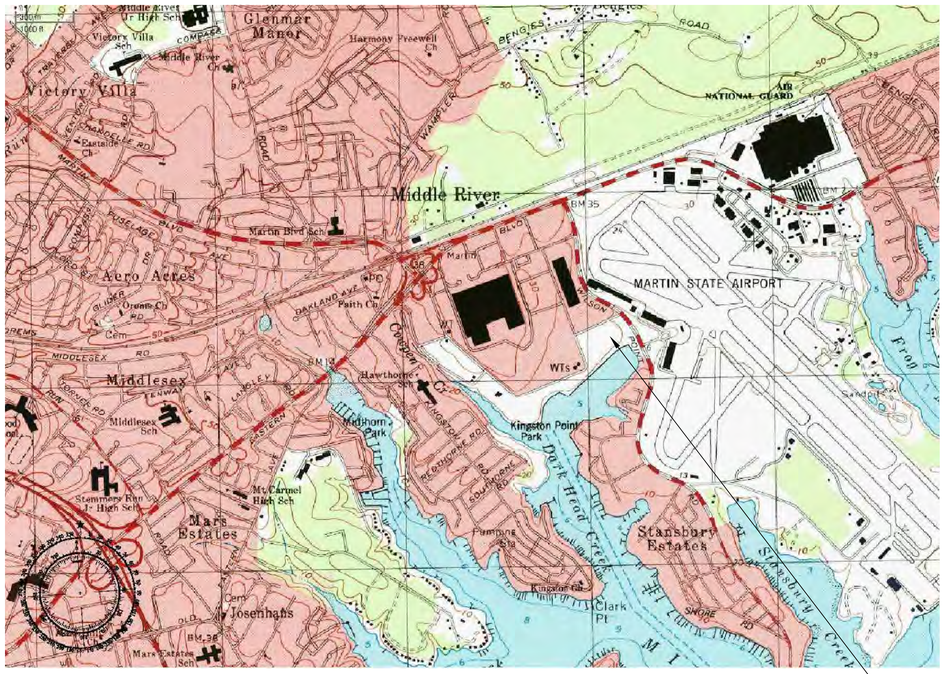
Appendix B—Standard and Detailed Operating Procedures (SOPs and DOPs)

APPENDIX A—DESIGN DRAWINGS

GROUNDWATER REMEDY BLOCKS E/F DESIGN DRAWINGS
100% COMPLETION SUBMITTAL
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
2323 EASTERN BOULEVARD, MIDDLE RIVER MARYLAND

SITE VICINITY MAP

ID #	DRAWING TITLE
T-1	TITLE SHEET
C-1	EXISTING CONDITIONS PLAN
C-2	REMEDY LAYOUT PLAN
C-3	SANITARY SEWER DISCHARGE PIPING ROUTING
C-4	EXTRACTION WELLS DESIGN AND TRENCH SECTIONS
C-5	PRB LAYOUT
C-6	REMEDIATION SYSTEM CLOSEOUT PLAN
E-1	ELECTRICAL NOTES AND LEGEND
E-2	SINGLE LINE DIAGRAM
E-3	GROUNDING/LIGHTING PLAN
E-4	CONTROL PANEL LAYOUT
E-5	HMI SCREENS LAYOUT
M-1	PROCESS FLOW DIAGRAM
M-2	PROCESS & INSTRUMENTATION DIAGRAM
M-3	EQUIPMENT ARRANGEMENT PLAN
M-4	LGAC UNITS AND MANIFOLD LAYOUT
M-5	LAYOUT OF VGAC UNITS AND FLOW MEASUREMENT ENCLOSURE



SITE AREA TOPOGRAPHIC MAP

TETRA TECH
www.tetratech.com

MARK	DATE	DESCRIPTION	BY
	12/23/19	Revision 1	C.P.

TITLE PAGE
GROUNDWATER REMEDY BLOCKS E/F DESIGN

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

DATE:	2/20/19
PROJECT NO.:	112IC03835
DRAWING SIZE:	ARCH D
DRAWN BY:	BD
CHECKED BY:	CP

DRAWING T-1

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\BLOCK F DESIGN\ACAD DRAWINGS\T-1.DWG DWM 2/20/19

IWE-1
IWE-2
IWE-3
IWE-4
IWE-5
IWE-6
7.5'
SEMW-1I
SEMW-2I
SEMW-3I
40'x8' INJECTION EQUIPMENT MODULE
GATE DOOR
CONCRETE (FORMER D-BUILDING BASEMENT)
FIRE WATER LINE
18" RCP
HISTORICAL FIRE PUMP LOCATION
CONCRETE
CONCRETE
IWE-7
IWE-8
IWE-25
IWE-9
IWE-26
IWE-10
IWE-11
IWE-12
UG COMMUNICATION LINE
(ABANDONED)
15" RCP
9.78
MH-10/IL-3
INV.5.20
FORMER UST 2 (TCE PLUME SOURCE)
MW-72B
NEW COMMUNICATION LINE
IWE-27
1,000mg/L
HISTORIC WATER LINES
UG COMMUNICATION LINE
IWE-13
IWE-14
IWE-28
IWE-15
IWE-16
IWE-17
MW-156A
MW-157A
MW-158A
MW-159A
CONCRETE SLAB
GRASS AREA
SEMW-4I/MPE-1S
500,000-GALLON WATER TANK ABOVE-GROUND
FIRE WATER LINE
ROAD CURB
SEMW-5S/I
MW-74C
MW-74A
MW-74B
IWE-18
IWE-19
IWE-20
IWE-21
PUMP HOUSE
10'
18" RCP
INV.1.56
6' CHAIN-LINK FENCE
CONCRETE SLAB
CONCRETE SLAB
1,000 ug/L TCE CONTOUR
1,000 ug/L
10'
IWE-22
IWE-24
IWE-23
MW-152B
MW-151A
MW-153A
MW-154A
MW-155A
SEMW-6I
8'
8'
INV.3.92
18" RCP
Chesapeake Park Plaza Drive
grass median
INV.2.75
24" CMP
6' CHAIN-LINK FENCE
8'
HISTORIC WATER LINE
SEMW-7I
MW-37B
MW-37C
24" RCP
EW-1
PZ-1
MW-112A
OUTFALL 06
-0.85
-0.85
OUT-06
SEMW-8S
EW-2
SEMW-8I
PZ-2
-1.68
OUT-08
MW-149B
MW-150B
MW-148A
MW-146B
MW-147B
MW-145A
SEMW-9S/I
4'
OUTFALL 08
-1.68
MW-144B
MW-143A
MW-141B
MW-142B
MW-140A
MW-139B
MW-138B
MW-137A
BULKHEAD WATER EDGE
DARK HEAD COVE

LEGEND

- PROPERTY LINE
- CONCRETE
- TREELINE
- BULKHEAD (DARK HEAD COVE WATER EDGE)

EXISTING UTILITIES

- CHAIN LINK FENCE W/ GATE
- UNDERGROUND ELECTRIC
- FIRE WATER
- FORMER FUEL OIL LINE
- STORM PIPE W/ INLET & MANHOLE
- COMMUNICATION LINE W/ BOX
- POTABLE WATER LINE W/ VALVE & HYDRANT
- UNKNOWN UTILITIES- GEOPHYSICAL SURVEY
- HISTORICAL UTILITIES OR STRUCTURES (LINETYPES VARY)
- SURFACE CONTOUR LINE (2 FEET CONTOUR INTERVAL)

EXISTING ARD SYSTEM FEATURES

- 1,000 ug/L TCE CONTOUR
- EXISTING BLOCK E ARD SYSTEM UTILITIES
- EXISTING BLOCK E INJECTION WELL
- EXISTING BLOCK E INJECTION WELL WITH ELECTRICAL CONDUIT
- EXISTING GROUNDWATER MONITORING WELL
- EXISTING PERFORMANCE MONITORING WELL (S- SHALLOW, I - INTERMEDIATE)

NEW GROUNDWATER REMEDY FEATURES

- EXISTING WELL (TO BE RETROFITTED TO EXTRACTION WELL)
- EXISTING MASS DISCHARGE STUDY WELL (INSTALLED JANUARY 2019)
- EXISTING PIEZOMETER

GRAPHIC SCALE
0' 25' 50'

REFERENCE PLANS & DATA:

1. UTILITY CROSS CONNECTION SURVEY PERFORMED BY TETRA TECH CREW: RAB & AN, DATED 10/6,10/10 & 10/11/2011
2. SURVEYED LOCATIONS OF UNDERGROUND ELECTRIC, WATER, COMMUNICATION LINES, ARE BASED ON GEOPHYSICAL SURVEYS CONDUCTED BY ENVIROSCAN, INC. LANCASTER, PA, AND UNKNOWN FEATURES.
3. SEWER PIPE CCTV REPORTS PREPARED BY VIDEO PIPE SERVICES, INC. DATED 9/26 & 10/12/2011
4. BLOCK G TOPOGRAPHIC SURVEY UPDATE PREPARED BY TETRA TECH CREW: RAB & AN. DATED: 06/07 & 06/08/2011
5. PRE-CONSTRUCTION SURVEY OF STORM DRAIN LINES FOR BLOCK E PREPARED BY TETRA TECH CREW: RAB & AN. DATED 08/15 & 08/16/ 2011.
6. BACKGROUND BASEMAP AND PROPERTY LINES ARE FROM CHESAPEAKE PARK SITE PLAN - LMC PROPERTIES, INC PREPARED BY TAI CONSULTING ENGINEERS, DATED 4/15/01. BACKGROUND DATA IS NOT FIELD VERIFIED AND FOR REFERENCE ONLY.

TETRA TECH
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MARK	DATE	DESCRIPTION	BY

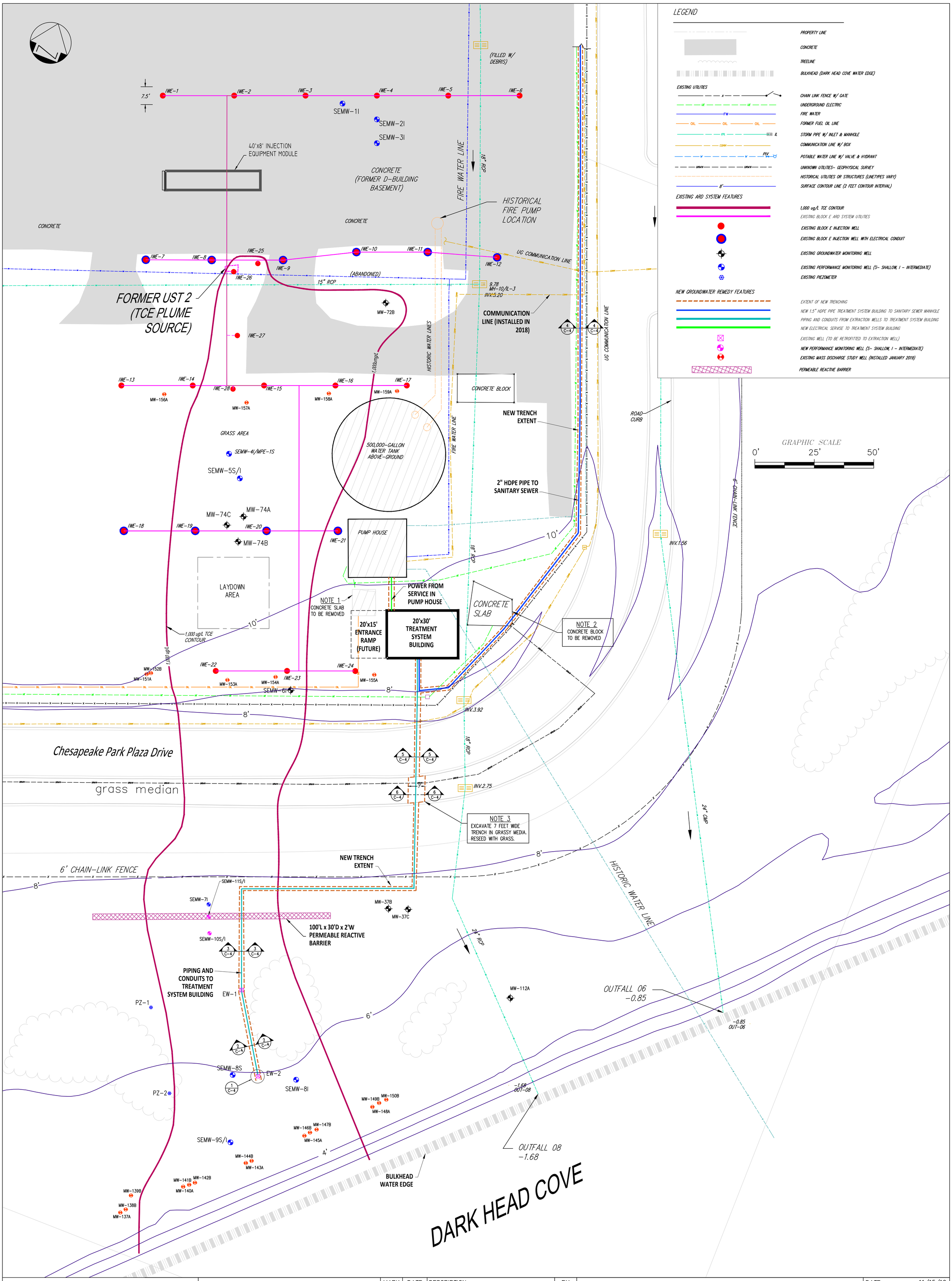
EXISTING CONDITIONS
GROUNDWATER REMEDY BLOCKS E/F DESIGN

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

DATE:	4/17/19
PROJECT NO.:	112IC03835
DRAWING SIZE:	ARCH C
DRAWN BY:	DWM
CHECKED BY:	BD

DRAWING C-1

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\BLOCK F DESIGN\ACAD DRAWINGS\EXISTING CONDITIONS C-1_V2.DWG DWM 4/17/19



REFERENCE PLANS & DATA:

1. UTILITY CROSS CONNECTION SURVEY PERFORMED BY TETRA TECH CREW: RAB & AN, DATED 10/6,10/10 & 10/11/2011
2. SURVEYED LOCATIONS OF UNDERGROUND ELECTRIC, WATER, COMMUNICATION LINES, ARE BASED ON GEOPHYSICAL SURVEYS CONDUCTED BY ENVIROSCAN, INC. LANCASTER, PA, AND UNKNOWN FEATURES.
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4. BLOCK G TOPOGRAPHIC SURVEY UPDATE PREPARED BY TETRA TECH CREW: RAB & AN, DATED 09/07 & 06/08/2011
5. PRE-CONSTRUCTION SURVEY OF STORM DRAIN LINES FOR BLOCK E PREPARED BY TETRA TECH CREW: RAB & AN, DATED 08/15 & 08/16/ 2011.
6. BACKGROUND BASEMAP AND PROPERTY LINES ARE FROM CHESAPEAKE PARK SITE PLAN - LMC PROPERTIES, INC PREPARED BY TAI CONSULTING ENGINEERS, DATED 4/15/01. BACKGROUND DATA IS NOT FIELD VERIFIED AND FOR REFERENCE ONLY.

TETRA TECH

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MARK	DATE	DESCRIPTION	BY

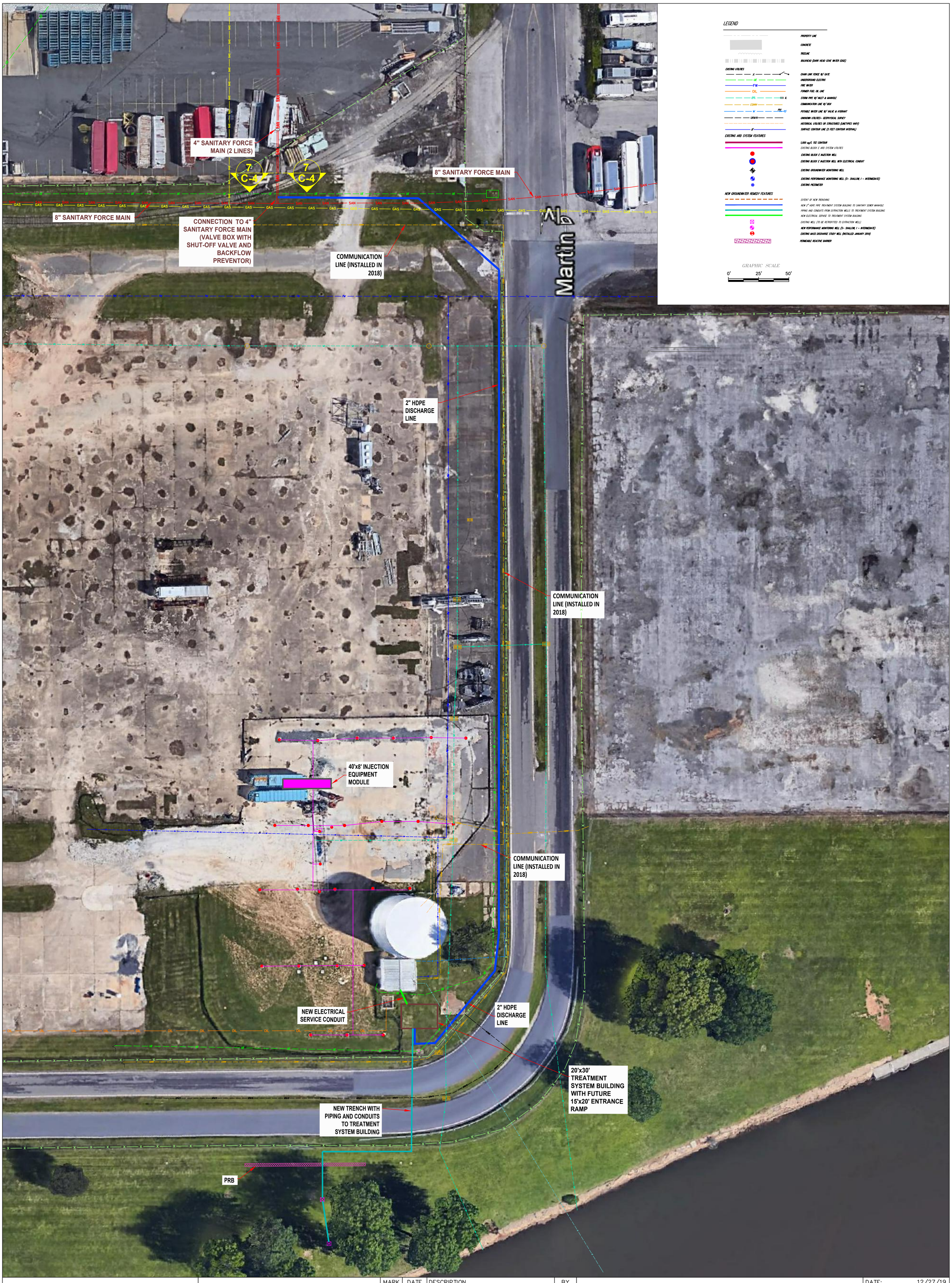
REMEDY LAYOUT PLAN
GROUNDWATER REMEDY BLOCKS E/F DESIGN

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

DATE:	11/15/19
PROJECT NO.:	112IC03835
DRAWING SIZE:	ARCH C
DRAWN BY:	DWM
CHECKED BY:	BD

DRAWING C-2

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\BLOCK F DESIGN\NEW DESIGN CHANGES\ACAD FILES\LAYOUTS C-2 AND C-3 NEW SS ROUTING.DWG DWM 11/15/19



NOTES:

1. THIS DRAWING IS INTENDED AS GENERAL REFERENCE AND SHOULD NOT BE RELIED UPON TO LOCATE UNDERGROUND UTILITIES FOR CONSTRUCTION BY INSTALLATION CONTRACTOR.
2. UNDERGROUND UTILITIES ROUTES AS SHOWN ON THE DRAWING ARE APPROXIMATE AND CAN BE DIFFERENT FROM ACTUAL ROUTES.
3. INSTALLATION CONTRACTOR SHALL ASSUME THAT UNKNOWN UNDERGROUND UTILITIES ARE PRESENT WITHIN THE NEW TRENCH ROUTING AND MAKE PROPER ARRANGEMENTS TO AVOID DAMAGE TO THE EXISTING UTILITIES.

TETRA TECH

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MARK	DATE	DESCRIPTION	BY

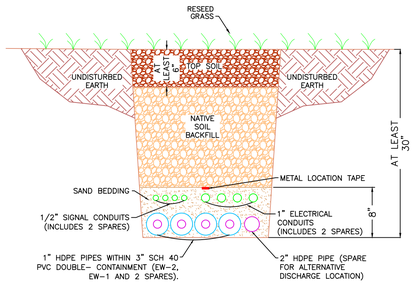
SANITARY SEWER DISCHARGE PIPING ROUTING
GROUNDWATER REMEDY BLOCKS E/F DESIGN

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

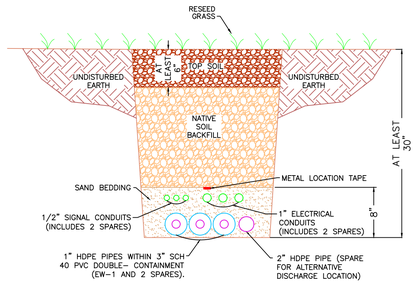
DATE:	12/27/19
PROJECT NO.:	112IC03835
DRAWING SIZE:	ARCH C
DRAWN BY:	DWM
CHECKED BY:	BD

DRAWING C-3

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\BLOCK F DESIGN\NEW DESIGN CHANGES\ACAD FILES\LAYOUTS C-2 AND C-3 NEW SS ROUTING.DWG DWM 12/27/19

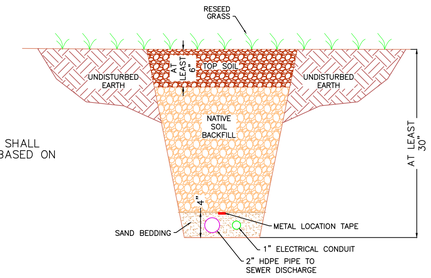


2 C–2 TRENCH SECTION DETAIL

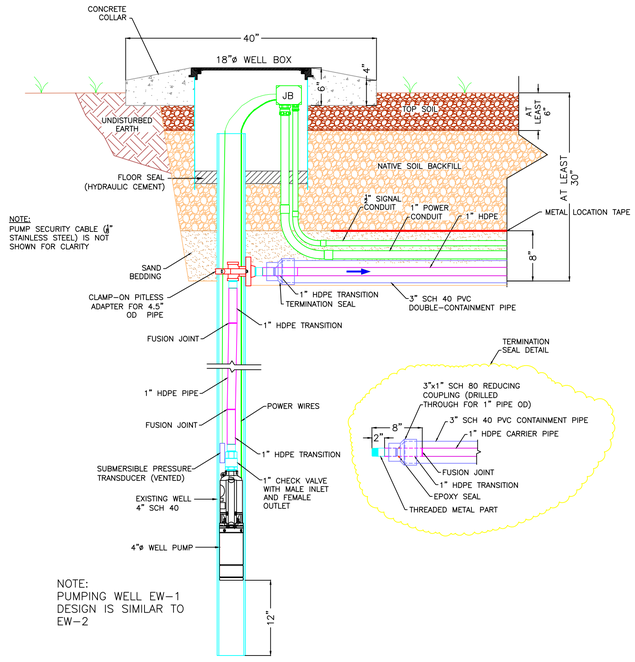


3 C–2 TRENCH SECTION DETAIL

NOTE:
TRENCH WIDTH SHALL BE MINIMIZED BASED ON CONDITIONS.



4 C–2 TRENCH SECTION DETAIL



NOTE:
PUMPING WELL EW–1 DESIGN IS SIMILAR TO EW–2

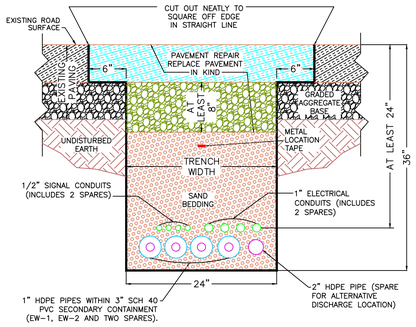
1 C–2 PUMPING WELL EW–2 SECTION DETAIL

DRAWING SCALE

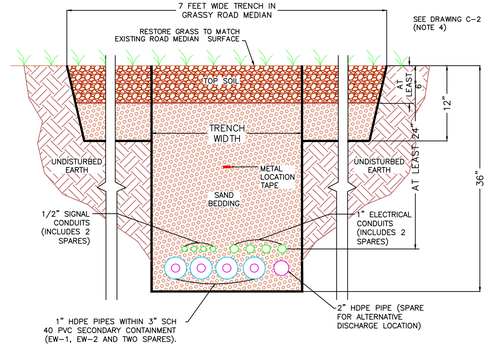
0" 12" 24" 12" 0"

NOTES:

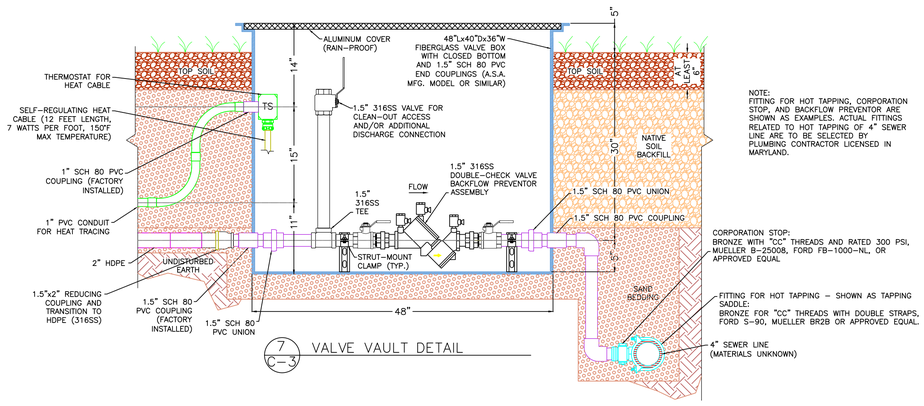
1. ALL PAVEMENT CUTS SHALL BE REPAIRED WITHIN A MAXIMUM OF THREE (3) DAYS FROM THE DATE THE CUT IS MADE. IF CONDITIONS DO NOT PERMIT A PERMANENT REPAIR WITHIN THE GIVEN TIME LIMIT, PERMISSION TO MAKE A TEMPORARY REPAIR MUST BE OBTAINED FROM THE COUNTY ENGINEER.
2. CONCRETE TRENCH CAP ON ASPHALT ROADS SHALL BE USED ONLY DURING INCLEMENT WEATHER WHEN ASPHALT PLANTS ARE NOT OPERATING.
3. IN ALL OPEN TRENCHES, BACKFILL SHALL BE COMPACTED TO 95% MAXIMUM DRY DENSITY. THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING COMPACTION REQUIREMENTS BY SOILS TESTING CERTIFIED BY A LICENSED PROFESSIONAL GEOTECHNICAL ENGINEER.
4. STRUCTURAL FILL SHALL BE GRANULAR MATERIAL OR FLOWABLE FILL TO PREVENT SETTLEMENT.
5. BACKFILL WITH A HIGH CLAY CONTENT, HIGH SHRINK–SWELL POTENTIAL, OR HIGH MOISTURE CONTENT THAT CANNOT MEET COMPACTION REQUIREMENTS SHALL BE DEEMED UNSUITABLE AND SHALL BE REPLACED WITH SUITABLE BACKFILL MATERIAL.
6. ALL PAVEMENT PATCHES SHALL PROVIDE A UNIFORM AND SMOOTH DRIVING SURFACE.
7. DEPTH OF PERMANENT REPAIR TO MATCH DEPTH OF EXISTING PAVING. HOT MIX ASPHALT BASE TO BE PLACED IN COURSES NO TO EXCEED 4". SURFACE COURSE SHALL BE 1 ½".
8. MINIMUM ALLOWABLE SECTION = 3" HOT MIX ASPHALT / 11" GRADED AGGREGATE BASE.
9. PERMANENT HOT MIX ASPHALT SHALL BE 9.5mm (LEVEL 1) (PG 64–22).



5 C–2 TRENCH SECTION DETAIL

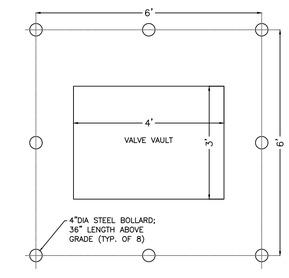


6 C–2 TRENCH SECTION DETAIL



NOTE:
FITTING FOR HOT TAPPING, CORPORATION STOP, AND BACKFLOW PREVENTOR ARE SHOWN AS EXAMPLES. ACTUAL FITTINGS RELATED TO HOT TAPPING OF 4" SEWER LINE ARE TO BE SELECTED BY PLUMBING CONTRACTOR LICENSED IN MARYLAND.

7 C–3 VALVE VAULT DETAIL



VALVE VAULT SAFETY BOLLARDS PATTERN

TETRA TECH
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MARK	DATE	DESCRIPTION	BY

EXTRACTION WELLS DESIGN AND TRENCH SECTIONS
GROUNDWATER REMEDY BLOCKS E/F DESIGN
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

DATE:	1/3/20
PROJECT NO.:	112IC03835
DRAWING SIZE:	ARCH D
DRAWN BY:	BD
CHECKED BY:	CP

DRAWING C-4

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\BLOCK F DESIGN\NEW DESIGN CHANGES\ACAD FILES\EQUIPMENT LAYOUTS M–3 TO M–5 AND C–4_GAC_ASB CHANGES.DWG DWM 1/3/20

6' CHAIN-LINK FENCE

NEW TRENCH EXTENT

PERMEABLE REACTIVE BARRIER
100'L x 30'D

SEMW-7I

SEMW-11S/I

ROI

RB-1 RB-2 RB-3 RB-4

PILOT TEST AREA

SEMW-10S/I

MW-37B

MW-37C

PIPING AND CONDUITS TO TREATMENT SYSTEM BUILDING

EW-1

PZ-1

6'

SEMW-8S

EW-2

SEMW-8I

PZ-2

MW-149B MW-150B

MW-148A

MW-146B MW-147B

MW-145A

SEMW-9S/I

4'

MW-144B

MW-143A

MW-141B MW-142B

MW-140A

MW-139B

MW-138B

MW-137A

DARK HEAD COVE

LEGEND

- CHAIN LINK FENCE W/ GATE
- EXTENT OF NEW TRENCHING
- PIPING AND CONDUITS FROM EXTRACTION WELLS TO TREATMENT SYSTEM BUILDING
- 1,000 ug/L TCE CONTOUR
- 6' SURFACE CONTOUR LINE (2 FEET CONTOUR INTERVAL)
- TREELINE
- BULKHEAD (DARK HEAD COVE WATER EDGE)
- PILOT TEST PRB INJECTION POINT WITH 3.3 FEET RADIUS OF INFLUENCE
- FULL SCALE PRB INJECTION POINT
- PRB PILOT TEST SOIL SAMPLING LOCATION
- FULL SCALE PRB TEST SOIL SAMPLING LOCATION
- EXISTING MASS DISCHARGE STUDY WELL (INSTALLED JANUARY 2019)
- EXISTING GROUNDWATER MONITORING WELL
- EXISTING PERFORMANCE MONITORING WELL (S- SHALLOW, I - INTERMEDIATE)
- NEW PERFORMANCE MONITORING WELL (S- SHALLOW, I - INTERMEDIATE)
- EXISTING PIEZOMETER

GRAPHIC SCALE

0' 25'

TETRA TECH

www.tetratech.com

MARK	DATE	DESCRIPTION	BY

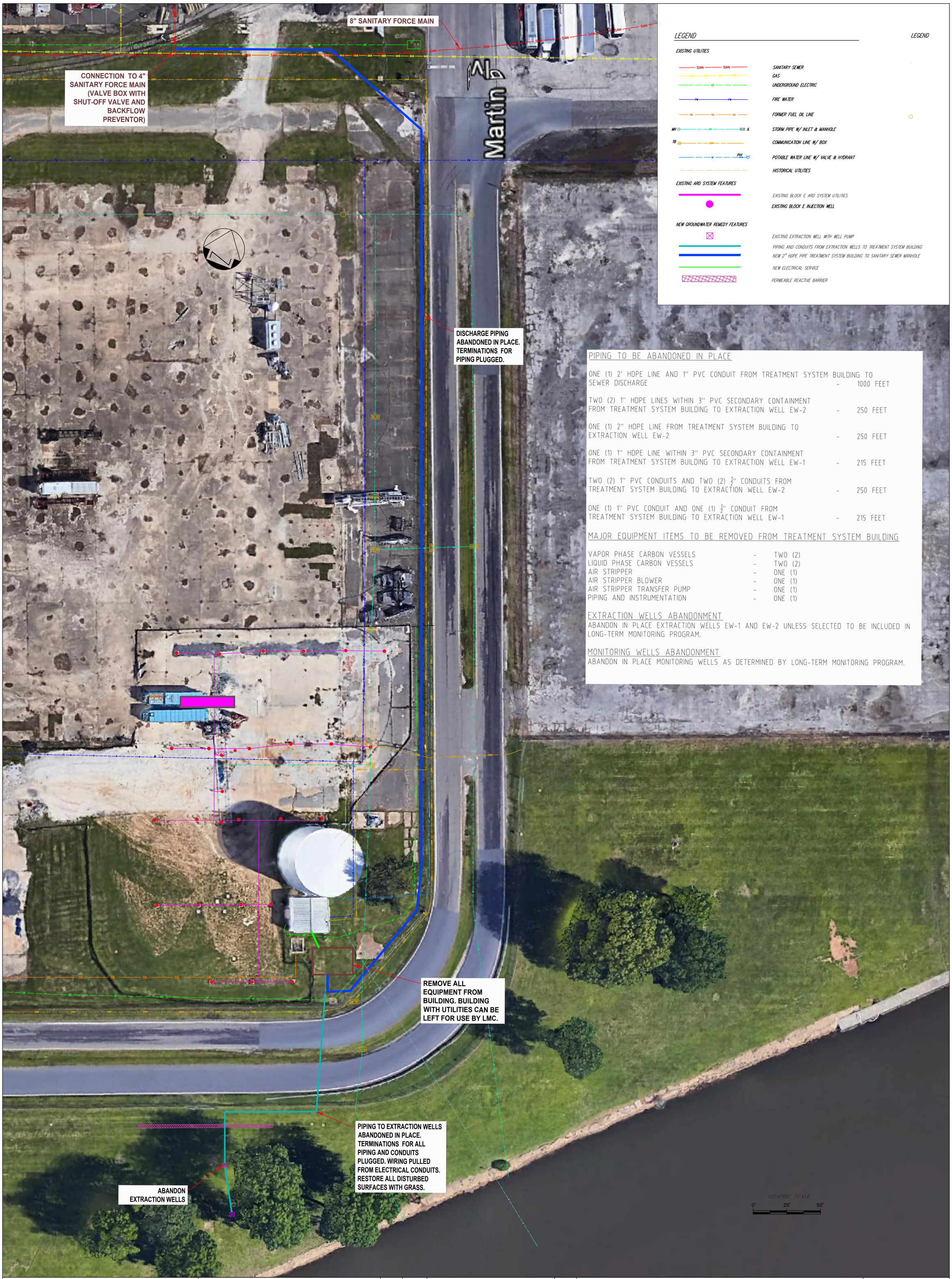
PRB LAYOUT
GROUNDWATER REMEDY BLOCKS E/F DESIGN

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

DATE:	11/21/19
PROJECT NO.:	112IC03835
DRAWING SIZE:	ARCH D
DRAWN BY:	DWM
CHECKED BY:	BD

DRAWING C-5

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\BLOCK F DESIGN\NEW DESIGN CHANGES\ACAD FILES\PRB LAYOUT C-5_V4.DWG DWM 11/21/19



LEGEND

EXISTING UTILITIES

- SANITARY SEWER
- GAS
- UNDERGROUND ELECTRIC
- FIRE WATER
- FORMER FUEL OIL LINE
- STORM PIPE W/ INLET & MANHOLE
- COMMUNICATION LINE W/ BOX
- POTABLE WATER LINE W/ VALVE & HYDRANT
- HISTORICAL UTILITIES

EXISTING ARD SYSTEM FEATURES

- EXISTING BLOCK E ARD SYSTEM UTILITIES
- EXISTING BLOCK E INJECTION WELL

NEW GROUNDWATER REMEDY FEATURES

- EXISTING EXTRACTION WELL WITH WELL PUMP
- PIPING AND CONDUITS FROM EXTRACTION WELLS TO TREATMENT SYSTEM BUILDING
- NEW 2" HDPE PIPE TREATMENT SYSTEM BUILDING TO SANITARY SEWER MANHOLE
- NEW ELECTRICAL SERVICE
- PERMEABLE REACTIVE BARRIER

LEGEND

PIPING TO BE ABANDONED IN PLACE

ONE (1) 2" HDPE LINE AND 1" PVC CONDUIT FROM TREATMENT SYSTEM BUILDING TO SEWER DISCHARGE	-	1000 FEET
TWO (2) 1" HDPE LINES WITHIN 3" PVC SECONDARY CONTAINMENT FROM TREATMENT SYSTEM BUILDING TO EXTRACTION WELL EW-2	-	250 FEET
ONE (1) 2" HDPE LINE FROM TREATMENT SYSTEM BUILDING TO EXTRACTION WELL EW-2	-	250 FEET
ONE (1) 1" HDPE LINE WITHIN 3" PVC SECONDARY CONTAINMENT FROM TREATMENT SYSTEM BUILDING TO EXTRACTION WELL EW-1	-	215 FEET
TWO (2) 1" PVC CONDUITS AND TWO (2) ½" CONDUITS FROM TREATMENT SYSTEM BUILDING TO EXTRACTION WELL EW-2	-	250 FEET
ONE (1) 1" PVC CONDUIT AND ONE (1) ½" CONDUIT FROM TREATMENT SYSTEM BUILDING TO EXTRACTION WELL EW-1	-	215 FEET

MAJOR EQUIPMENT ITEMS TO BE REMOVED FROM TREATMENT SYSTEM BUILDING

VAPOR PHASE CARBON VESSELS	-	TWO (2)
LIQUID PHASE CARBON VESSELS	-	TWO (2)
AIR STRIPPER	-	ONE (1)
AIR STRIPPER BLOWER	-	ONE (1)
AIR STRIPPER TRANSFER PUMP	-	ONE (1)
PIPING AND INSTRUMENTATION	-	ONE (1)

EXTRACTION WELLS ABANDONMENT

ABANDON IN PLACE EXTRACTION WELLS EW-1 AND EW-2 UNLESS SELECTED TO BE INCLUDED IN LONG-TERM MONITORING PROGRAM.

MONITORING WELLS ABANDONMENT

ABANDON IN PLACE MONITORING WELLS AS DETERMINED BY LONG-TERM MONITORING PROGRAM.

NOTES:

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TETRA TECH

www.tetratech.com

MARK	DATE	DESCRIPTION	BY

REMEDIATION SYSTEM CLOSEOUT PLAN
GROUNDWATER REMEDY BLOCKS E/F DESIGN

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

DATE:	12/27/19
PROJECT NO.:	112IC03835
DRAWING SIZE:	ARCH C
DRAWN BY:	DWM
CHECKED BY:	BD

DRAWING C-6

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\BLOCK F DESIGN\NEW DESIGN CHANGES\ACAD FILES\CLOSEOUT C-6_V5.DWG DWM 12/27/19

GENERAL ELECTRICAL NOTES

1. INSTALLATION OF ALL ELECTRICAL WORK SHALL CONFORM TO THE LATEST EDITION OF THE NATIONAL ELECTRICAL CODE (NFPA 70), AND ALL APPLICABLE LOCAL CODES.
2. CONDUIT RUNS ARE SHOWN DIAGRAMMATICALLY ONLY AND SHALL BE INSTALLED IN A MANNER TO PREVENT CONFLICTS WITH EQUIPMENT AND STRUCTURAL CONDITIONS. EXPOSED CONDUITS ABOVE SUSPENDED CEILING AND INFURRED WALLS SHALL BE INSTALLED PARALLEL TO THE BEAMS AND WALLS.
3. PROVIDE ALL REQUIRED PULL BOXES AND JUNCTION BOXES FOR INSTALLATION OF THE WIRING IN ACCORDANCE WITH THE CONTRACT SPECIFICATIONS THOUGH THE BOXES MAY NOT BE INDICATED ON THE DRAWINGS.
4. THE WIRING DIAGRAMS, QUANTITY AND SIZE OF WIRES AND CONDUITS ARE BASED UPON SELECTED STANDARD COMPONENTS OF ELECTRICAL EQUIPMENT. MODIFICATIONS, APPROVED BY THE ENGINEER, MAY BE MADE BY THE CONTRACTOR AT HIS EXPENSE TO ACCOMMODATE EQUIPMENT ACTUALLY PURCHASED.
5. PROVIDE ALL NECESSARY COMPONENTS REQUIRED FOR MAKING FINAL CONNECTION OF ALL EQUIPMENT INSTALLED AS PART OF THIS CONTRACT.
6. ALL JUNCTION, PULL BOXES AND WIREWAY SHALL BE LABELED WITH THEIR VOLTAGE AND USAGE.
7. DRAWINGS ARE DIAGRAMMATIC. ACTUAL LOCATION OF EQUIPMENT TO BE DETERMINED IN THE FIELD. NEW EQUIPMENT SHALL FIT INTO AVAILABLE SPACE. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROVIDE EQUIPMENT WHICH MEETS THE SPACE REQUIREMENT.
8. COORDINATE WORK SCHEDULE WITH OWNER. WORK WILL BE ALLOWED IN CERTAIN AREAS AND GOVERNED BY EXISTING SECURITY REGULATIONS AT THE FACILITY. WORK SHALL ALLOW FOR DAILY OPERATION OF THE FACILITY WITHOUT INTERRUPTION.
9. CONTRACTOR SHALL SUBMIT A LIST OF ALL MAJOR EQUIPMENT AND FIXTURES TO THE ENGINEER FOR REVIEW AND APPROVAL. NO SUBSTITUTIONS WILL BE ALLOWED WITHOUT THE PERMISSION OF THE ENGINEER IN WRITING. ALL EQUIPMENT SHALL BE NEW AND BEAR THE MANUFACTURER'S NAME AND TRADE NAME. ALL EQUIPMENT SHALL BE UL LISTED.
10. THE CIRCUIT NUMBERS ARE FOR IDENTIFICATION PURPOSE ONLY. THE CONTRACTOR IS RESPONSIBLE FOR BALANCING LOADS AND CORRECTLY PHASING THE CIRCUITS IN PANELBOARDS.
11. ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT ARE BASED ON EQUIPMENT SPECIFIED. COORDINATE EXACT REQUIREMENTS WITH MECHANICAL SHOP DRAWINGS PRIOR TO ORDERING AND INSTALLING EQUIPMENT.
12. ALL 120 VOLT RECEPTACLE BRANCH CIRCUITS LONGER THAN 100 FEET FROM PANELBOARD TO LAST OUTLET SHALL UTILIZE #10AWG OR LARGER WIRES.
13. WHERE ELECTRICAL INSTALLATIONS DEPEND UPON WORK OF OTHER TRADES, THE ELECTRICAL CONTRACTOR SHALL ENSURE THAT NECESSARY INSTRUCTIONS, TEMPLATES, MATERIALS, ETC. ARE PROVIDED AND SUPERVISE THE WORK OF THE OTHER TRADES FOR QUALITY AND CODE COMPLIANCE.
14. CONTRACTOR SHALL VISIT THE JOB SITE AND EXAMINE THE EXISTING CONDITIONS THAT MAY AFFECT HIS WORK.
15. DO NOT INSTALL MORE THAN THREE 120V CIRCUITS IN ONE HOMERUN UON.
16. ALL WORK SHOWN ON THE DRAWINGS SHALL BE NEW UNLESS OTHERWISE NOTED.
17. ALL 120V CIRCUITS SHALL HAVE SEPARATE NEUTRALS.
18. MINIMUM CONDUIT SIZE SHALL BE ¾" FOR POWER AND ½" FOR SIGNAL
19. MINIMUM WIRE SIZE SHALL BE #12 AWG FOR POWER AND #24 AWG FOR SIGNAL.
20. PROVIDE SYSTEM GROUNDING CONDUCTORS AND EQUIPMENT GROUNDING CONDUCTORS IN ACCORDANCE WITH NEC-250, UON.
21. ALL SINGLE PHASE BRANCH CIRCUITS SHALL BE 2 #12, 1 #12GND IN 3/4" CONDUIT UON.
22. ALL WIRE INSTALLED UNDER THIS CONTRACT SHALL BE COPPER:
    22.1 SINGLE CONDUCTOR SHALL BE STRANDED THHN/TFFN 600VAC INSULATION.
23. ALL EQUIPMENT SHALL BE INSTALLED IN ACCORDANCE WITH LOCAL CODES AND REGULATIONS.
24. REFERENCE THE CIVIL SHEETS FOR ALL BUILDING LOCATIONS AND DISTANCES; REFERENCE THE MECHANICAL SHEETS FOR EQUIPMENT LOCATIONS AND DISTANCES.
25. CONDUITS:
    25.1 ALL EXPOSED CONDUIT THREADS SHALL BE COATED WITH CORROSION RESISTANT PAINT.
    25.2 BELOW GRADE CONDUIT SHALL BE SCHEDULE 40 PVC.
    25.3 ABOVE GRADE/EXPOSED CONDUIT SHALL BE GALVANIZED RIGID STEEL.
26. ALL EQUIPMENT SHOWN IS NEW UNLESS SPECIFICALLY NOTED OTHERWISE (ie. EXISTING, EX., ETC.)
27. IF ELECTRICAL INFORMATION DEPICTED IN THIS PLAN SET DEVIATE FROM ACTUAL CONDITIONS, INFORM CONTRACTING OFFICER IMMEDIATELY.
28. CONTRACTOR TO COORDINATE ANY REQUIRED POWER OUTAGES WITH LOCKHEED MARTIN CORPORATION.
29. SUBMERSIBLE TRANSMITTER CABLE SHALL BE SHIELDED, 600 VOLTS, THREE 20-GAUGE WIRES, BARE COPPER STRANDED WIRES, INSULATION MATERIAL: PVC.
30. CIRCUIT BREAKERS FOR WELL PUMPS IN CONTROL PANEL WITH HMI SHALL HAVE PADLOCKABLE HANDLES.
31. CIRCUIT BREAKER FOR MAIN POWER IN MINI-POWER ZONE MODULE SHALL HAVE BE PADLOCKABLE.
32. AIR STRIPPER CONTROL PANEL SHALL HAVE ELECTRICAL FAN PROPERLY SIZED FOR VARIABLE FREQUENCY DRIVE COOLING.
33. CONTROL PANEL WITH HMI SHALL HAVE ELECTRICAL FAN PROPERLY SIZED FOR VARIABLE FREQUENCY DRIVES COOLING.

ABBREVIATION LEGEND

A	AMPS
AFF	ABOVE FINISHED FLOOR
AG	ABOVE GRADE
ANEC	A&N ELECTRIC COOPERATIVE
AWG	AMERICAN WIRE GAUGE
BCSD	BARE COPPER SOFT DRAWN
C	CONDUIT
GND	GROUND
HMI	HUMAN MACHINE INTERFACE
KW	KILOWATT
VFD	VARIABLE FREQUENCY DRIVE
PH	PHASE
UON	UNLESS OTHERWISE NOTED
VAC	VOLTAGE ALTERNATING CURRENT
W	WIRE
WP	WEATHER PROOF

LIGHTING LEGEND

(SEE DRAWING E-3)

- LIGHTING FIXTURE
- EMERGENCY BATTERY POWERED LIGHTING UNIT
- EXIT/EMERGENCY COMBO UNIT W/REMOTE HEAD
- S — SWITCH, 1-POLE, 20A, 120-277V
- FULL CUTOFF WALL PACK
- DUPLEX CONVENIENCE OUTLET, 20A, 125 VAC
- WP — WATER-PROOF ENCLOSURE

DENOTES LIGHTING PANEL — LP-10 — DENOTES CIRCUIT NUMBER

ELECTRICAL LEGEND

(SEE DRAWING E-2)

- TRANSFORMER SIZE AS NOTED ON DRAWING

GROUNDING LEGEND

(SEE DRAWING E-3)

- ---------- BELOW GRADE GROUND CABLE
- ———— EXPOSED GROUND CABLE

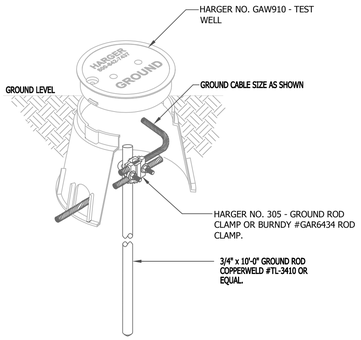
GENERAL GROUNDING NOTES:

(SEE DRAWING E-3)

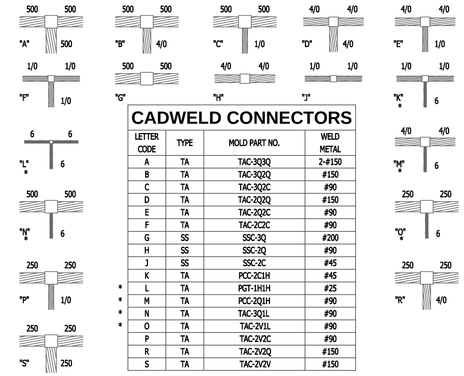
1. A COMPLETE GROUND SYSTEM SHALL BE INSTALLED IN STRICT COMPLIANCE WITH ARTICLE 250 OF THE NATIONAL ELECTRIC CODE AND THE FOLLOWING. THE CONTRACTOR IS RESPONSIBLE FOR MEETING ALL GROUNDING REQUIREMENTS, WHETHER OR NOT THEY ARE SPECIFICALLY INDICATED ON THE DRAWINGS.
2. GROUNDING CIRCUITS SHALL EMPLOY A SOFT DRAWN BARE COPPER STRANDED CONDUCTOR.
3. SIZE OF THE GROUND CIRCUIT EMPLOYED SHALL BE REGULATED BY THE FOLLOWING:
   #6 - CONTROL STATIONS AND EQUIPMENT UNDER 75 HP
   #1/0 - EQUIPMENT 75 HP THRU 250 HP
   #4/0 - EQUIPMENT OVER 250 HP AND MOTOR CONTROL CENTERS
   #4/0 - UNDERGROUND LOOP UNLESS NOTED OTHERWISE.
4. ALL GROUND CABLE TO BE A MINIMUM OF 2'-6" BELOW FINISHED GRADE AND COVERED WITH A NON-CORROSIZE FILL.
5. GROUND BED RESISTANCE TO EARTH SHALL BE TESTED UNDER DRY SOIL CONDITIONS. ADDITIONAL GROUND RODS SHALL BE INSTALLED AS REQUIRED TO ACHIEVE THE MAXIMUM RESISTANCE OF 3 OHMS OR LESS TESTING SHALL BE BY THE THREE-POINT FALL OF POTENTIAL METHOD USING A BIDDLE "MEGGER" EARTH RESISTANCE TESTER (OR EQUIVALENT) IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS.
6. SURFACES WHERE GROUNDING CONNECTIONS ARE TO BE MADE SHALL BE CLEAN AND DRY.
7. STEEL SURFACES SHALL BE GROUND OR FILED TO REMOVE ALL SCALE, RUST AND DIRT.
8. COPPER AND GALVANIZED STEEL SHALL BE CLEANED WITH EMERY CLOTH TO REMOVE OXIDE BEFORE MAKING JUNCTIONS.
9. THE COMPLETE CONDUIT/TRAY SYSTEM, INCLUDING JUNCTION BOXES AND PULL BOXES WILL FORM A CONTINUOUS CONDUCTIVE PATH TO GROUND.

GROUNDING SPECIFIC NOTES:

1. PART NUMBERS LISTED ON THIS SHEET ARE AS SPECIFIED OR EQUAL.



DETAIL NO. 1 [1]
GROUND ROD - IN WELL

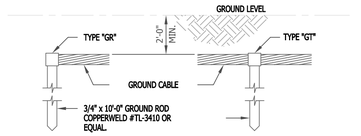


CADWELD CONNECTORS

LETTER CODE	TYPE	MOLD PART NO.	WELD METAL
A	TA	TAC-3Q3Q	2-#150
B	TA	TAC-3Q2Q	#150
C	TA	TAC-3Q2C	#90
D	TA	TAC-2Q2Q	#150
E	TA	TAC-2Q2C	#90
F	TA	TAC-2C2C	#90
G	SS	SSC-3Q	#200
H	SS	SSC-2Q	#90
J	SS	SSC-2C	#45
K	TA	PCC-2C1H	#45
* L	TA	PGT-1H1H	#25
* M	TA	PCC-2Q1H	#90
* N	TA	TAC-3Q1L	#90
* O	TA	TAC-2V1L	#90
P	TA	TAC-2V2C	#90
R	TA	TAC-2V2Q	#150
S	TA	TAC-2V2V	#150

* REQUIRES WRAP SLEEVE #8140A.

DETAIL NO. 2 [1]
CABLE TO CABLE CONNECTION - WELDED



CADWELD CONNECTORS

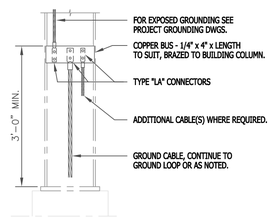
CABLE SIZE	TYPE	MOLD PART NO.	WELD METAL
500	GR	GRC-183Q	#150
4/0	GR	GRC-182Q	#90
1/0	GR	GRC-182C	#90
500	GT	GTC-183Q	#250
4/0	GT	GTC-182Q	#115
1/0	GT	GTC-182C	#115

DETAIL NO. 3 [1]
BURIED GROUND ROD - WELDED

CADWELD CONNECTORS

CABLE SIZE	TYPE	CABLE SIZE	TYPE	MOLD PART NO.	WELD METAL	LUG SIZE	LUG PART NO.	2 BOLTS SIZE
500	LA	500	LA	LAC-3QEG	#200	1/4 x 1 1/2	B-102-EG-OL	1/2 x 1 1/4
4/0	LA	4/0	LA	LAC-3QEE	#90	1/4 x 1	B-102-EE-OL	1/2 x 1 1/4
1/0	LA	1/0	LA	LAC-2CEE	#65	1/4 x 1	B-102-EE-OL	1/2 x 1 1/4
4	LA	4	LA	LAC-1LCE	#45	1/8 x 1	B-102-CE-OL	1/2 x 1 1/4
6 *	LA	6 *	LA	LAC-1LCE	#45	1/8 x 1	B-102-CE-OL	1/2 x 1 1/4

* REQUIRES WRAP SLEEVE #8140A.

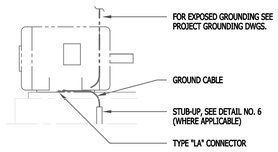


DETAIL NO. 4 [1]
STRUCTURAL - WELDED

CADWELD CONNECTORS

MOTOR HP	CABLE SIZE	TYPE	MOLD PART NO.	WELD METAL	LUG SIZE	LUG PART NO.	BOLT SIZE
< 75	6 *	LA	LAC-1LCE	#45	1/8 x 1	B-101-CE-OL	3/8 x 1
75-250	1/0	LA	LAC-2CEE	#65	1/4 x 1	B-101-EE-OL	1/2 x 1 1/4
> 250	4/0	LA	LAC-2QEE	#90	1/4 x 1	B-101-EE-OL	1/2 x 1 1/4

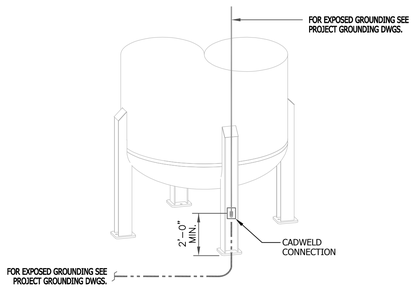
* REQUIRES WRAP SLEEVE #8140A.



DETAIL NO. 5
MOTOR GROUNDING - WELDED

CADWELD CONNECTORS

CABLE SIZE	TYPE	MOLD PART NO.	WELD METAL
1/0	VS	VSC-2C	#90
2/0	VS	VSC-2G	#90
3/0	VS	VSC-2L	#115
4/0	VS	VSC-2Q	#115



DETAIL NO. 6 [1]
TANK - WELDED

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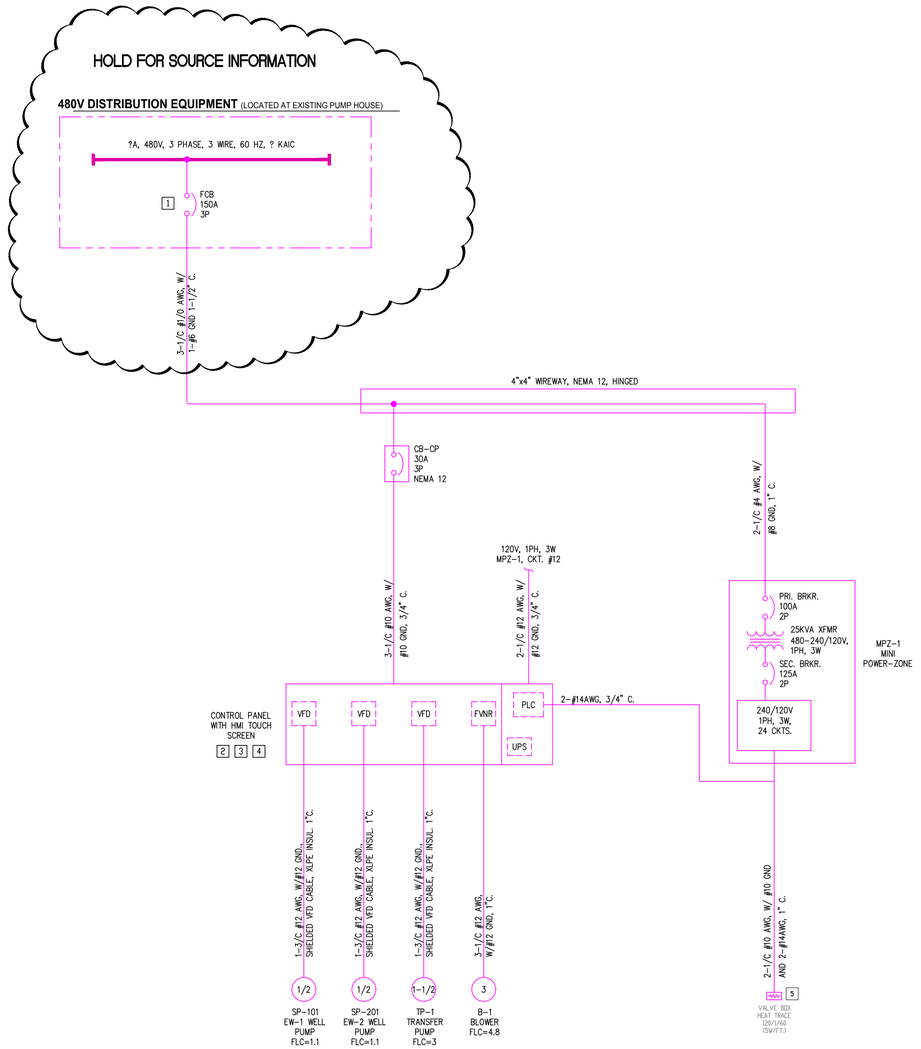
MARK	DATE	DESCRIPTION	BY

ELECTRICAL NOTES & LEGEND
GROUNDWATER REMEDY BLOCKS E/F DESIGN
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

DATE:	4/23/19
PROJECT NO.:	112IC03835
DRAWING SIZE:	ARCH E
DRAWN BY:	KH
CHECKED BY:	WS

DRAWING E-1

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\BLOCK F DESIGN\ACAD DRAWINGS\ELECTRICAL DRAWINGS\E-1.DWG DWM 4/23/19



GENERAL NOTES:

1) SEE DRAWING E-1 FOR NOTES AND LEGEND.

2) SEE DRAWING E-3 FOR LIGHTING AND GROUNDING PLAN.

SPECIFIC NOTES:

1 CONTRACTOR TO INSTALL NEW 150A, 3-POLE FEEDER BREAKER AT EXISTING PUMP HOUSE DISTRIBUTION EQUIPMENT. CONTRACTOR SHALL FIELD DETERMINE EXACT MOUNTING LOCATION AND PROVIDE ALL NECESSARY COMPONENTS REQUIRED FOR PROPER INSTALLATION OF CIRCUIT BREAKER. CONTRACTOR SHALL PROVIDE AS PART OF RECORD DRAWINGS ALL EQUIPMENT RATINGS FOR EXISTING DISTRIBUTION EQUIPMENT.

2 PANEL FABRICATOR SHALL PROVIDE A CONTROL PANEL WITH AN UNINTERRUPTIBLE POWER SUPPLY (UPS) CAPABLE OF PROVIDING A MINIMUM BATTERY RUNTIME OF 120 MINUTES.

3 PANEL FABRICATOR SHALL PROVIDE MULTIPLE POWER SOURCE WARNING LABEL ON DOOR OF CONTROL PANEL.

4 PANEL FABRICATOR SHALL PROVIDE ALL CIRCUIT BREAKERS, FUSES, WIRING, TERMINALS, ETC. AS REQUIRED FOR A COMPLETE CONTROL PANEL.

5 CONTRACTOR SHALL PROVIDE AND INSTALL CHROMALOX SELF-REGULATING HEAT TRACE CABLE SERIES "SRL" AND DIGITAL THERMOSTAT "DTS-HAZ" OR EQUAL. DIGITAL THERMOSTAT SHALL PROVIDE REMOTE ALARM STATUS INDICATION, INCLUDING LOSS OF POWER, HIGH OR LOW TEMPERATURE ALARM AND RTD FAILURE.

6 PROVIDE HUBBELL SWITCHED SAFETY ENCLOSURE WITH MECHANICALLY INTERLOCKED RECEPTACLE (NEMA L5-30R) AND MATCHING PLUG (NEMA L5-30P), 120VAC, 2-POLE, 3-WIRE OR EQUAL.

TREATMENT SYSTEM BUILDING – MINI POWER ZONE (MPZ-1)

KVA: 25
VOLTAGE: 120/240V
PHASES: 1PH, 3W
KAIC: 25
MAINS: 100A MCB (PRI)
125A MCB (SEC)

BUS RATING: 100A
NEUTRAL BUS RATING: 100A
MOUNTING: SURFACE MOUNT
FED FROM: EXISTING PUMPHOUSE

NEMA ENCLOSURE TYPE: 3R
LOCATION: TREATMENT SYSTEM BLDG.
ACCESSORIES: –
ACCESSORIES: –

KVA	BREAKER POLE	BREAKER TRIP	LOAD DESCRIPTION	CKT NO	CKT NO	LOAD DESCRIPTION	BREAKER POLE	BREAKER TRIP	KVA
–	2	30	EUH-1	1	2	EUH-2	2	30	–
–			ELECTRIC UNIT HEATER #1	3	4	ELECTRIC UNIT HEATER #2			–
–	1	20	EXTERIOR LIGHTS	5	6	EMERGENCY LIGHTS	1	20	–
–	1	30*	SUMP PUMP RECEPTACLE	7	8	INTERIOR RECEPTACLES	1	20*	–
–	1	20*	INTERIOR RECEPTACLES	9	10	EXHAUST FAN (1/4HP)	1	20	–
–	1	20	INTERIOR LIGHTS	11	12	CONTROL PANEL W/HMI	1	20	–
–	1	30**	VALVE VAULT HEAT TRACE	13	14	SPARE	1	20	–
–	–	–	–	15	16	–	–	–	–
–	–	–	–	17	18	–	–	–	–
–	–	–	–	19	20	–	–	–	–
–	–	–	–	21	22	–	–	–	–
–	–	–	–	23	24	–	–	–	–

6

NOTE: "*" INDICATES GFCI TYPE CIRCUIT BREAKER.
"**" INDICATES GFEP TYPE CIRCUIT BREAKER.

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MARK	DATE	DESCRIPTION	BY

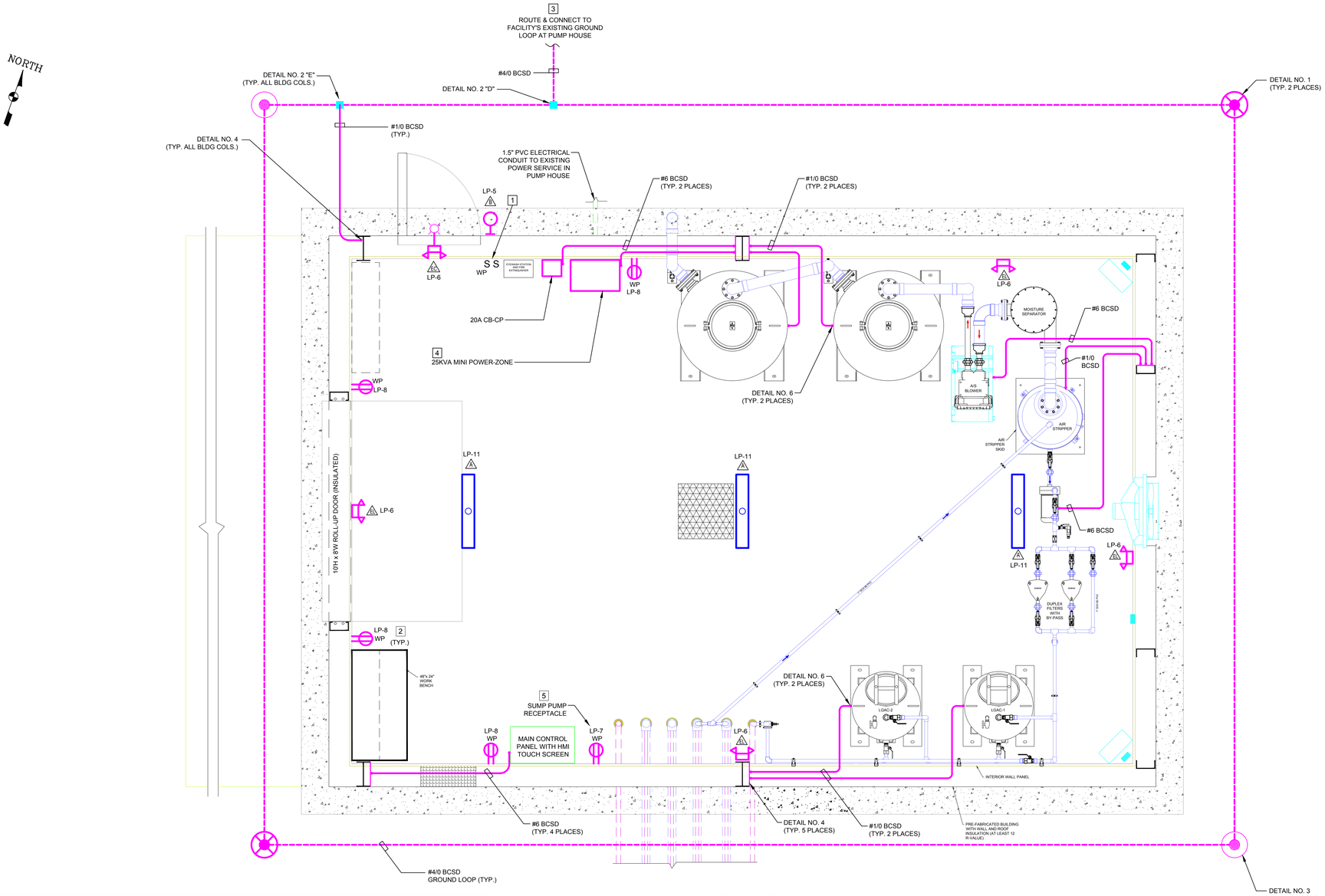
SINGLE LINE DIAGRAM
GROUNDWATER REMEDY BLOCKS E/F DESIGN

MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

DATE: 12/31/19
PROJECT NO.: 112IC03835
DRAWING SIZE: ARCH E
DRAWN BY: KH
CHECKED BY: WS

DRAWING E-2

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\BLOCK F DESIGN\NEW DESIGN CHANGES\ACAD FILES\E-2.DWG DWM 1/7/20



GENERAL NOTES:

1. SEE DRAWING E-1 FOR NOTES, LEGEND AND GROUNDING DETAILS.
2. SEE DRAWING E-2 FOR SINGLE LINE DIAGRAM.
3. SEE LIGHTING FIXTURE SCHEDULE BELOW LEFT FOR FIXTURE TYPES AND MOUNTING HEIGHTS.
4. SIZE ALL JUNCTION BOXES, PULL BOXES AND WIREWAY PER NEC.
5. GROUND CABLE ROUTINGS ARE SHOWN IN A SCHEMATIC FORMAT.
6. ROUTE EXPOSED GROUNDING TAPS OVERHEAD. CLAMP CABLE TO STRUCTURAL STEEL WITH APPLETON "K-CLAMPS" OR EQUAL AT 3-FOOT INTERVALS. ROUTE VERTICAL DROPS ALONG PIPE, CONDUIT OR SUPPORT STEEL.
7. EXPOSED GROUNDING CONDUIT SHALL BE GREEN COLOR "XHHW" INSULATED, SIZE AS NOTED.
8. MOUNT ALL RECEPTACLES 30" AFF TO BOTTOM OF BOX, UNLESS OTHERWISE NOTED.
9. THE ELECTRICAL CONTRACTOR IS RESPONSIBLE FOR AVOIDING ALL OBSTRUCTIONS IN DETERMINING THE ACTUAL ROUTINGS.
10. ALL CONDUIT CONNECTIONS TO BE MADE TIGHT TO FORM A CONTINUOUS PATH FOR GROUND CURRENTS TO EARTH.
11. ALL FIXTURES TO BE GROUNDED.
12. ALL LIGHTING CIRCUITS SHALL BE 2-1/2 #12 AWG, W/#12 GND UNLESS OTHERWISE SPECIFIED. ALL RECEPTACLES SHALL BE 2-1/C #12 AWG, W/#12 GND UNLESS OTHERWISE SPECIFIED.
13. ALL LIGHTING CONDUITS TO BE A MINIMUM OF 3/4" RIGID METAL CONDUIT, UNLESS OTHERWISE NOTED.
14. ALL ELECTRICAL WORK IS TO BE PERFORMED IN STRICT CONFORMANCE WITH THE NATIONAL ELECTRICAL CODE AND ALL APPLICABLE LOCAL CODES.
15. THE ELECTRICAL CLASSIFICATION OF THE TREATMENT BUILDING IS NON-HAZARDOUS.

SPECIFIC NOTES:

1. MOUNT LIGHT SWITCH AT 4'-6" ABOVE FINISHED FLOOR. EACH LIGHT SWITCH SHALL BE MARKED WITH THE NAME AND CIRCUIT NUMBER OF ITS FEED.
2. EACH RECEPTACLE SHALL BE MARKED WITH THE NAME AND CIRCUIT NUMBER OF ITS FEED.
3. CONTRACTOR SHALL FIELD DETERMINE CONNECTION TYPE REQUIRED AT EXISTING GROUND LOOP AND APPLY APPROPRIATE CONNECTOR.
4. PROVIDE UNISTRUT MOUNTING SUPPORT FOR ELECTRICAL EQUIPMENT AS REQUIRED
5. PROVIDE HUBBELL SWITCHED SAFETY ENCLOSURE WITH MECHANICALLY INTERLOCKED RECEPTACLE (NEMA L5-30R) AND MATCHING PLUG (NEMA L5-30P), 120VAC, 2-POLE, 3-WIRE OR EQUAL.

LIGHTING FIXTURE SCHEDULE

FIXTURE TYPE	DESCRIPTION	MOUNTING	LAMPS			MANUFACTURER AND CATALOG NUMBER	VOLTS	REMARKS
			NO.	WATTS	TYPE			
A	8" x 48" LED FIXTURE, GASKETED, CORROSION RESISTANT, SEALED FIXTURE WITH STAINLESS STEEL LENS CLIPS.	SUSPENDED 10'-0" AFF	3	99	LED	LITHONIA VAP12000LM-PCL-MD-MVOLT GZ10-40K-80CRI-VAPPMPK-LSC OR EQUAL	MVOLT	ADJUST LOCATIONS IN FIELD TO AVOID OBSTRUCTION AND PROVIDE EVEN LEVEL OF LIGHT THROUGHOUT THE SPACE.
B	LED WALL PACK, FULL CUTOFF FIXTURE, WEATHER-RESISTANT ALUMINUM HOUSING, DARK BRONZE FINISH, 3020 LUMENS AT 5000K, PHOTOCELL INCLUDED	WALL 9'-6" AG	1	31	LED	LITHONIA OLW 23 OR EQUAL	MVOLT	-
EL	EMERGENCY LIGHTING FIXTURE, WET LOCATION, GREY THERMOPLASTIC, IMPACT, SCRATCH AND CORROSION RESISTANT, LED LAMP HEADS W/GLASS LENS, 90 MINUTES NI-CAD BATTERY, TEST SWITCH, STATUS INDICATOR.	WALL 9'-6" AFF	4	2.7	LED	LITHONIA WLTU LED OR EQUAL	120/277	-
ELC	EXIT/EMERGENCY COMBO UNIT, WHITE THERMOPLASTIC, IMPACT RESISTANT, SCRATCH RESISTANT AND CORROSION PROOF HOUSING, LED LAMP HEADS WITH POLYCARBONATE LENS, 90 MINUTES NI-CAD BATTERY, HIGH OUTPUT, SELF DIAGNOSTIC TESTING	WALL 9'-6" AFF	1	4.3	LED	LITHONIA LHQM LED G HO SD	120	PROVIDE ONE (1) WEATHER-PROOF REMOTE HEAD, GRAY, SELF-DIAGNOSTICS MODEL ELA QWP L0309 SD

LIGHTING & GROUNDING PLAN

0" 12" 24" 12" 0"

DRAWING SCALE

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MARK	DATE	DESCRIPTION	BY

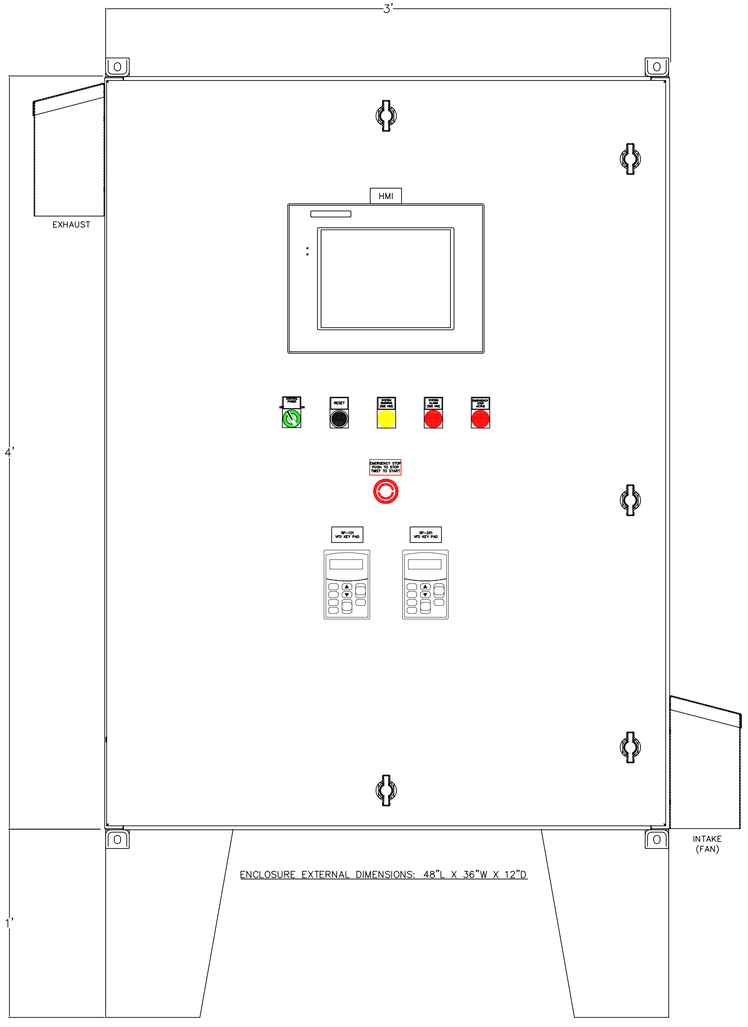
GROUNDING/LIGHTING PLAN
GROUNDWATER REMEDY BLOCKS E/F DESIGN

MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

DATE:	1/7/20
PROJECT NO.:	112IC03835
DRAWING SIZE:	ARCH E
DRAWN BY:	KH
CHECKED BY:	WS

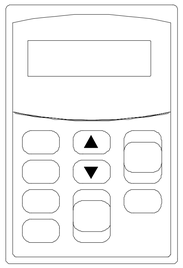
DRAWING E-3

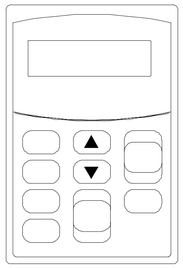
C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\BLOCK F DESIGN\NEW DESIGN CHANGES\ACAD FILES\E-3.DWG DWM 1/7/20

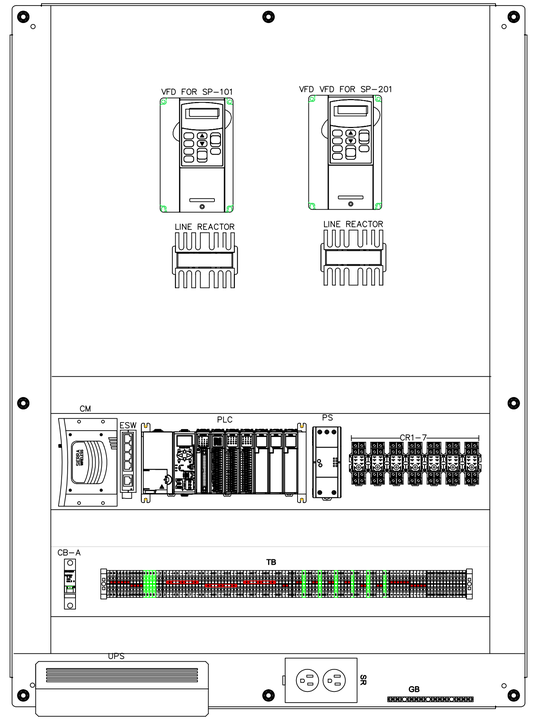


PANEL EXTERIOR
SCALE: 1 1/2" = 1'-0"

OPERATOR DETAILS







PANEL INTERIOR
SCALE: 1 1/2" = 1'-0"

1. SEE DRAWING E-1 FOR NOTES AND LEGEND
2. SEE DRAWING M-2 FOR PROCESS & INSTRUMENTATION DIAGRAM SYMBOLS

TETRA TECH
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MARK	DATE	DESCRIPTION	BY

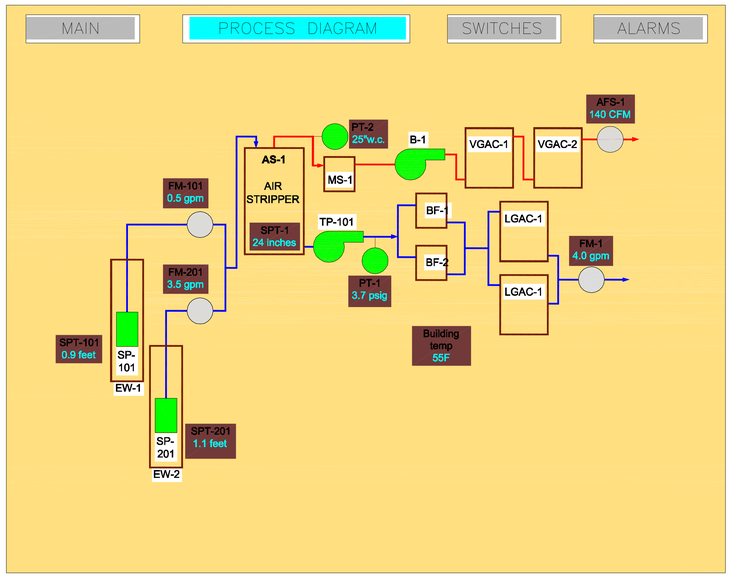
CONTROL PANEL LAYOUT
GROUNDWATER REMEDY DESIGN BLOCKS E/FL

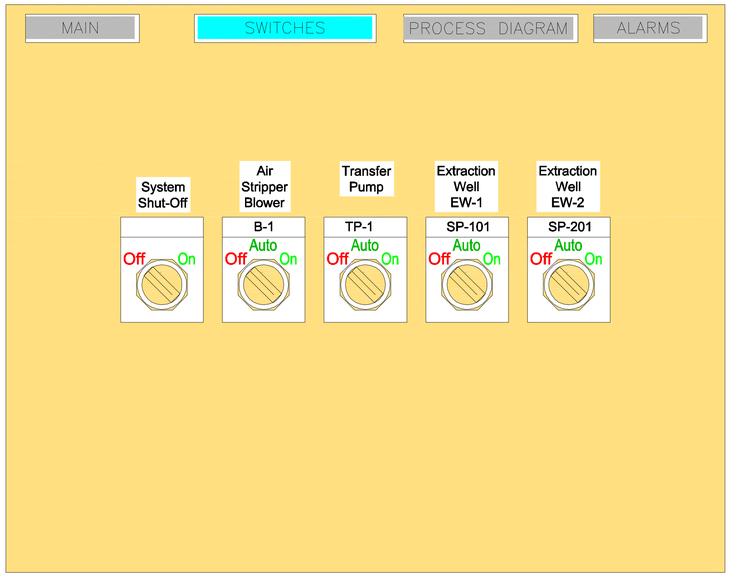
LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

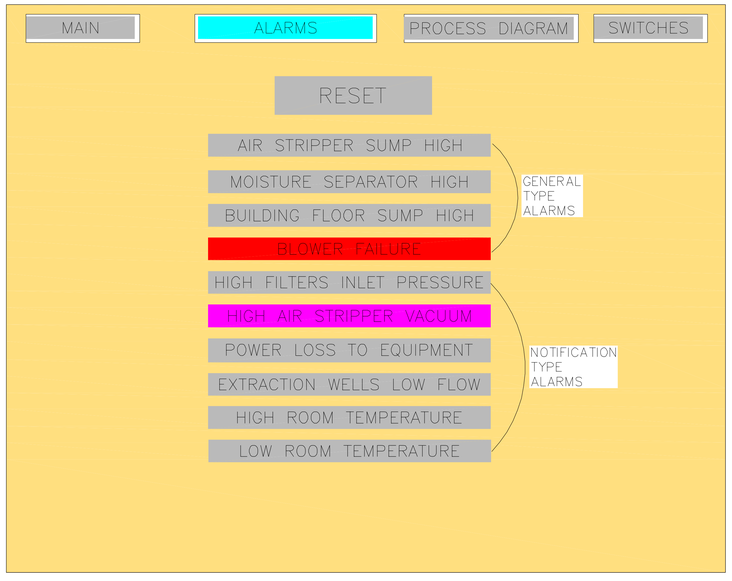
DATE:	2/20/19
PROJECT NO.:	112IC03835
DWG. SIZE:	ARCH D
DRAWN BY:	BD
CHECKED BY:	CP

E-4

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\BLOCK F DESIGN\ACAD DRAWINGS\E-1 PANEL.DWG DWM 2/20/19







1. SEE DRAWING E–1 FOR NOTES AND LEGEND
2. SEE DRAWING M–2 FOR PROCESS & INSTRUMENTATION DIAGRAM SYMBOLS

TETRA TECH
www.tetratech.com

MARK	DATE	DESCRIPTION	BY

HMI SCREENS LAYOUT
GROUNDWATER REMEDY BLOCKS E/F DESIGN

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

DATE:	3/31/19
PROJECT NO.:	112C03835
DRAWING SIZE:	ARCH D
DRAWN BY:	BD
CHECKED BY:	CP

DRAWING E-5

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\BLOCK F DESIGN\ACAD DRAWINGS\E-5 PLC SCREENS.DWG DWM 3/31/19

EQUIPMENT AND INSTRUMENTS ABBREVIATIONS

AS	AIR STRIPPER
B	BLOWER
TP	TRANSFER PUMP
SP	SUBMERSIBLE PUMP
MS	MOISTURE SEPARATOR
V	PROCESS VALVE
CV	CHECK VALVE
VGAC	VAPOR PHASE GRANULAR ACTIVATED CARBON
LGAC	LIQUID PHASE GRANULAR ACTIVATED CARBON
FM	FLOW METER
AFT	AIR FLOW TRANSMITTER
DPG	DIFFERENTIAL PRESSURE GAUGE
VFD	VARIABLE FREQUENCY DRIVE
LSHH	LEVEL SWITCH HIGH
HPA	HIGH PRESSURE ALARM
LVA	LOW VACUUM ALARM
LFA	LOW VACUUM ALARM
SPL	SAMPLING PORT (LIQUID)
SPV	SAMPLING PORT (VAPORS)
MFT	MECHANICAL FLOW TOTALIZER
PG	PRESSURE GAUGE
LPG	LOW PRESSURE GAUGE
TG	TEMPERATURE GAUGE
PT	PRESSURE TRANSMITTER
SPT	SUBMERSIBLE PRESSURE TRANSMITTER
HOA	HAND OFF AUTO SELECTOR SWITC

GENERAL INSTRUMENT SYMBOLS

- LOCALLY MOUNTED
- PANEL MOUNTED
- REAR-OF-PANEL MOUNTED
- INTERLOCK
- PROGRAMMABLE LOGIC CONTROLLER FUNCTION (ANALOG)
- PROGRAMMABLE LOGIC CONTROLLER FUNCTION (DISCRETE)
- PERSONAL COMPUTER SOFT SWITCH
- PERSONAL COMPUTER HUMAN MACHINE INTERFACE
- PERSONAL COMPUTER
- ALARM

LINE SYMBOLS

- PROCESS PIPES (LIQUID)
- PROCESS PIPES (VAPOR)
- ELECTRICAL OR SIGNAL
- BUILDING OR EQUIPMENT PACKAGE

VALVE AND PIPING SYMBOLS

- BALL VALVE
- NEEDLE VALVE
- CHECK VALVE
- GATE VALVE
- Y-STRAINER
- NO NORMALLY OPEN
- NC NORMALLY CLOSED
- SP SAMPLE PORT
- FLEXIBLE HOSE
- EXHAUST TO ATMOSPHERE (INSIDE)
- EXHAUST TO ATMOSPHERE (OUTSIDE)
- REDUCER
- FLANGE
- UNION
- QUICK DISCONNECT COUPLING
- REMOVABLE CAP
- M MOTOR, ELECTRIC

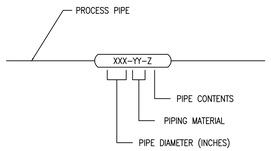
PROCESS LINE ABBREVIATIONS

AIR	AIR, ATMOSPHERIC PRESSURE
CF	CHEMICAL FEED
CGW	CONTAMINATED GROUNDWATER
D	DRAIN
EFF	EFFLUENT
EXH	EXHAUST
GW	GROUNDWATER
PW	POTABLE WATER
S	SANITARY
TGW	TREATED GROUNDWATER
V	VENT
VAP	VAPOR

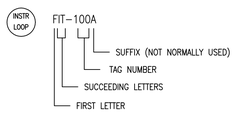
PIPING MATERIAL ABBREVIATIONS

AL	ALUMINUM
CPVC	CHLORINATED POLYVINYL CHLORIDE
CS	CARBON STEEL
COP	COPPER
FLEX	FLEXIBLE PIPE/DUCT/TUBING
GALV	GALVANIZED STEEL
HDPE	HIGH DENSITY POLYETHYLENE
PE	POLYETHYLENE
PP	POLYPROPYLENE
PVC	POLYVINYL CHLORIDE
RUB	RUBBER HOSE
SS304	304 STAINLESS STEEL PIPE/TUBING

PROCESS PIPING IDENTIFICATION



INSTRUMENT IDENTIFICATION

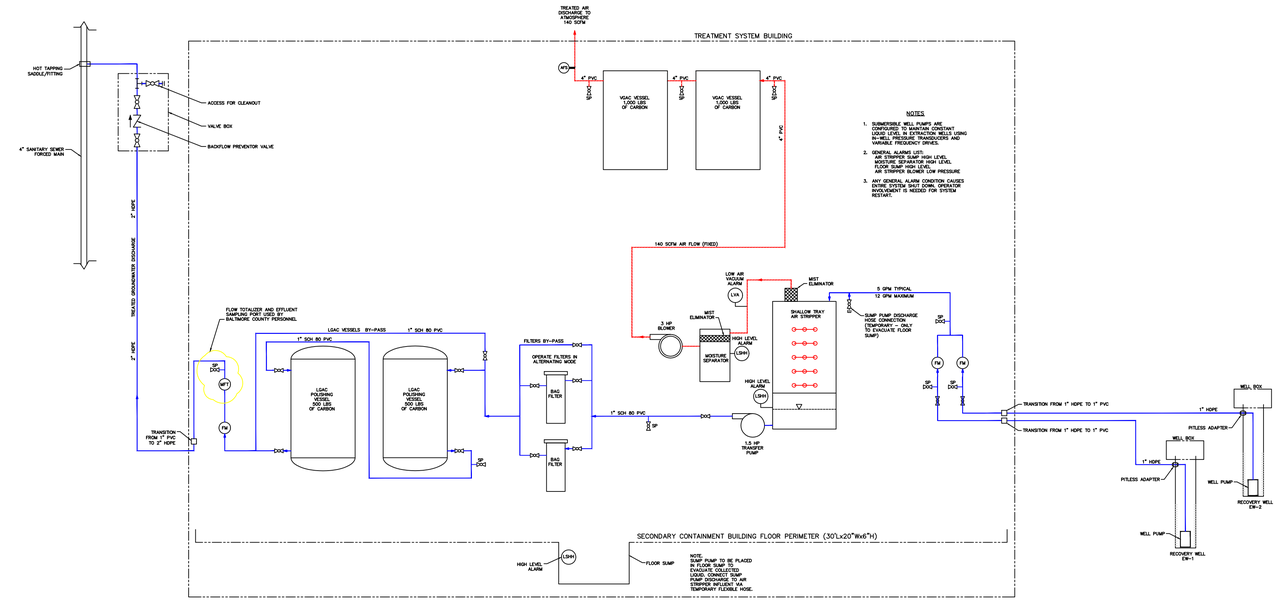


FUNCTION ABBREVIATIONS

FC	FAIL CLOSED
FL	FAIL LOCKED
FO	FAIL OPEN
HOA	HAND-OFF-AUTOMATIC
I/I	CURRENT-TO-CURRENT
LCP	LOCAL CONTROL PANEL
LR	LOCAL-REMOTE
MI	MOTOR RUN INDICATION
OC	OPEN-CLOSE
OO	ON-OFF (MAINTAINED)
OSC	OPEN-STOP-CLOSE (MOMENTARY)
SI	MOTOR SPEED INDICATION
SS	START-STOP (MOMENTARY)
↑	HIGH SELECT
↓	LOW SELECT
√	SQUARE ROOT
Σ	ADD OR TOTALIZE

EQUIPMENT SYMBOLS

- AIR VELOCITY TRANSMITTER
- VFD VARIABLE FREQUENCY DRIVE
- TOTALIZING FLOWMETER
- SUBMERSIBLE WELL PUMP
- TURBINE OR PROPELLER TYPE FLOW METER
- M ELECTROMAGNETIC TYPE FLOW METER
- BLOWER
- TRANSFER PUMP



TETRA TECH
www.tetratech.com

MARK	DATE	DESCRIPTION	BY

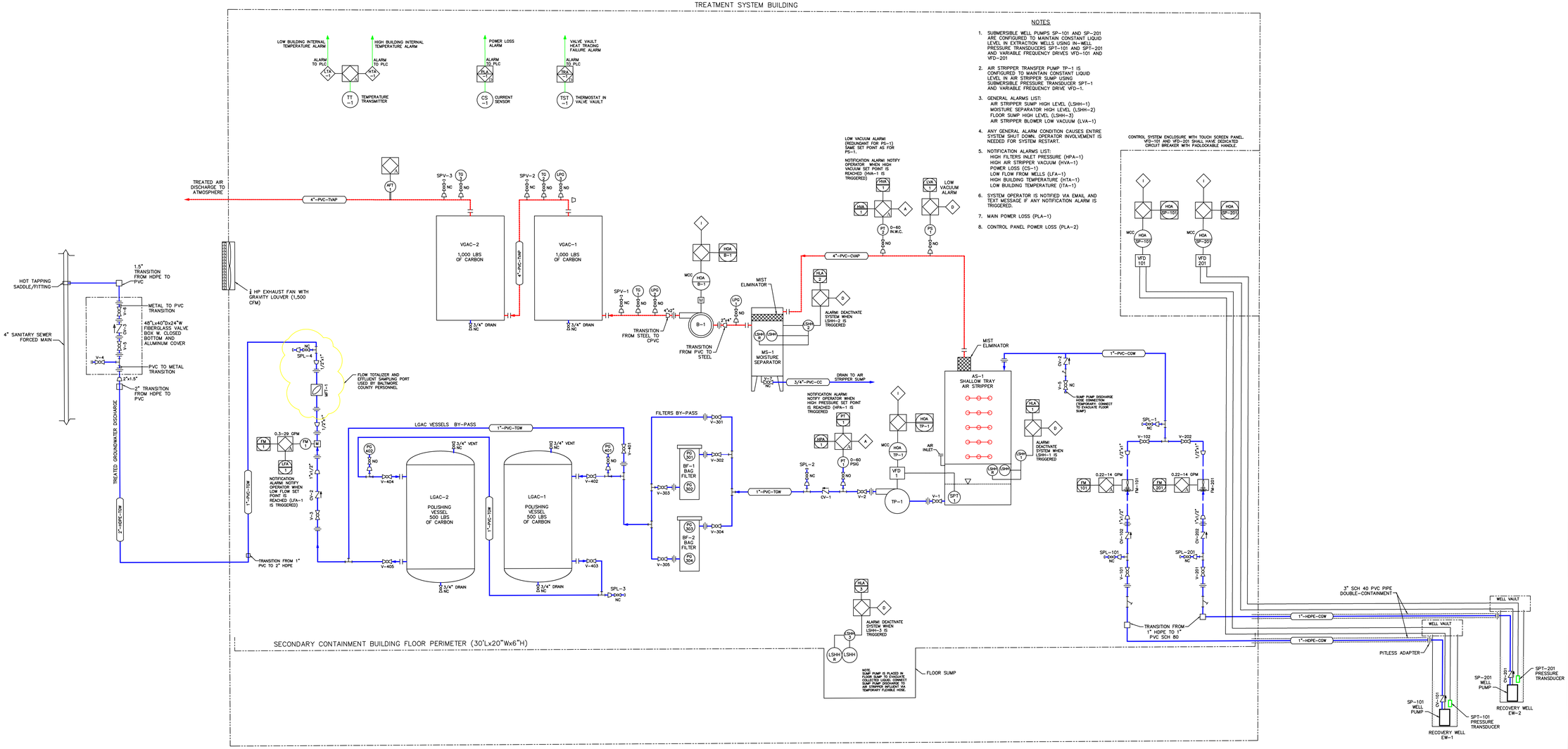
GROUNDWATER TREATMENT SYSTEM PROCESS FLOW DIAGRAM
GROUNDWATER REMEDY BLOCKS E/F DESIGN

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

DATE:	10/22/19
PROJECT NO.:	112IC03835
DWG. SIZE:	ARCH D
DRAWN BY:	BD
CHECKED BY:	CP

DRAWING M-1

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\BLOCK F DESIGN\NEW DESIGN CHANGES\ACAD FILES\PFD AND P&ID M-1 AND M-2_NEW CDM CHANGES.DWG DWM 10/22/19



TETRA TECH
www.tetratech.com

MARK	DATE	DESCRIPTION	BY

GROUNDWATER TREATMENT SYSTEM PROCESS & INSTRUMENTATION DIAGRAM
GROUNDWATER REMEDY BLOCKS E/F DESIGN

LOCKHEED MARTIN CORPORATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

DATE:	1/8/20
PROJECT NO.:	112IC03835
DWG. SIZE:	ARCH D
DRAWN BY:	BD
CHECKED BY:	CP

DRAWING M-2

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\BLOCK F DESIGN\NEW DESIGN CHANGES\ACAD FILES\PFD AND P&ID M-1 AND M-2_NEW CDM CHANGES.DWG DWM 1/8/20

NORTH

30'

PERSONNEL ENTRANCE DOOR
DOOR BOTTOM LEVEL WITH 6"
PERIMETER CONTAINMENT LIP

1.5" PVC ELECTRICAL
CONDUIT TO EXISTING
POWER SERVICE IN
PUMP HOUSE

4" PVC TREATED AIR DISCHARGE

15-FEET
ENTRANCE RAMP TO BE ERECTED LATER)

1'-3"

I-BEAM BUILDING SUPPORT COLUMN

EYEWASH STATION AND FIRE EXTINGUISHER

CIRCUIT BREAKER

15 KVA TRANSFORMER

I-BEAM BUILDING SUPPORT COLUMN

INTERIOR WALL PANEL

ANCHOR BOLTS

C-CHANNEL SUPPORT COLUMN

4" SCH 80 CPVC

MOISTURE SEPARATOR

5 KW ELECTRIC UNIT HEATER, INSTALL 8 FEET ABOVE FINISHED FLOOR.

WALL-MOUNTED THERMOSTAT CONTROLS UNIT HEATER. INSTALL 4 FEET ABOVE FINISHED FLOOR.

48"x12" SHELVES FOR SPARE PARTS (FOUR STEEL SHELVES)

4" SCH 80 PVC

2" STEEL

A/S BLOWER

C-CHANNEL SUPPORT COLUMN

4'

NOTE:
BUILDING SUPPORT COLUMNS AND ANCHOR BOLT POSITIONS ARE SHOWN APPROXIMATELY AND WILL BE ADJUSTED AS NEEDED BASED ON FINAL ANCHOR BOLTS PLAN PROVIDED BY BUILDING MANUFACTURER.

SHELF FOR A/S BLOWER

AIR INTAKE WITH INSECT-PROOF MESH

AIR STRIPPER

6" HIGH PERIMETER CONTAINMENT LIP (CONCRETE)

AIR STRIPPER SKID

1,500 CFM EXHAUST FAN WITH 30"x30" GRAVITY LOUVER

NOTE:
20'x15' ENTRANCE RAMP (SHOWN AS LIGHT GREEN) WILL BE ERECTED LATER.

10'H x 8'W ROLL-UP DOOR (INSULATED)

8'

24" SQUARE x 18" DEPTH FLOOR SUMP WITH REMOVABLE GRATING (FIBERGLASS). 2% SLOPE (¼" PER FOOT) FOR BUILDING FLOOR TOWARDS SUMP

TRANSFER PUMP

1" SCH 80 PVC

DUPLEX FILTERS WITH BY-PASS

1" SCH 80 PVC

WALL-MOUNTED THERMOSTAT CONTROLS EXHAUST FAN. INSTALL 4 FEET ABOVE FINISHED FLOOR.

20'

8' x 4" ENTRANCE RUMP

C-CHANNEL SUPPORT COLUMN

48"x 24" WORK BENCH

48"x12" SHELVES FOR SPARE PARTS (THREE STEEL SHELVES)

THREADED-ROD PIPE HANGER CLAMP FOR 1" PIPE ATTACHED TO ROOF PURLINS. MINIMUM 48 INCHES SPACING (TYP.)

LINK SEALS (TYP.):
4" BOREHOLE FOR 2" PIPES AND
5" BOREHOLE FOR 3" PIPES

LGAC-2

LGAC-1

WALL-MOUNTED THERMOSTAT CONTROLS UNIT HEATER. INSTALL 4 FEET ABOVE FINISHED FLOOR.

6" HIGH PERIMETER CONTAINMENT LIP (CONCRETE)

MAIN CONTROL PANEL WITH HMI TOUCH SCREEN

SP-1

C-CHANNEL SUPPORT COLUMN

I-BEAM BUILDING SUPPORT COLUMN

I-BEAM BUILDING SUPPORT COLUMN

STRUT-CHANNELPIPE CLAMP ATTACHED TO WALL EVERY 3' (TYP.)

3'

INTERIOR WALL PANEL

1'-3"

40"

NOTE:
EXTEND BUILDING FOUNDATION 1 FOOT FROM EXTERIOR WALLS

24"x 24" GRAVITY LOUVER. INSTALL 24 INCHES FROM FLOOR. INCLUDES INSECT-PROOF MESH.

2" HDPE PIPE (SPARE FOR FOR ALTERNATIVE DISCHARGE LOCATION)

1" HDPE PIPES WITHIN 3" SCH 40 PVC DOUBLE-CONTAINMENT (EW-1, EW-2 AND 2 SPARES)

2" HDPE DISCHARGE TO SANITARY SEWER

PRE-FABRICATED BUILDING WITH WALL AND ROOF INSULATION (AT LEAST 12 R-VALUE)

NOTE:
EXTEND BUILDING FOUNDATION 1 FOOT FROM EXTERIOR WALLS

GENERAL EQUIPMENT PLAN VIEW

DRAWING SCALE
0" 12" 24" 12" 0"

TETRA TECH
www.tetratech.com

MARK	DATE	DESCRIPTION	BY

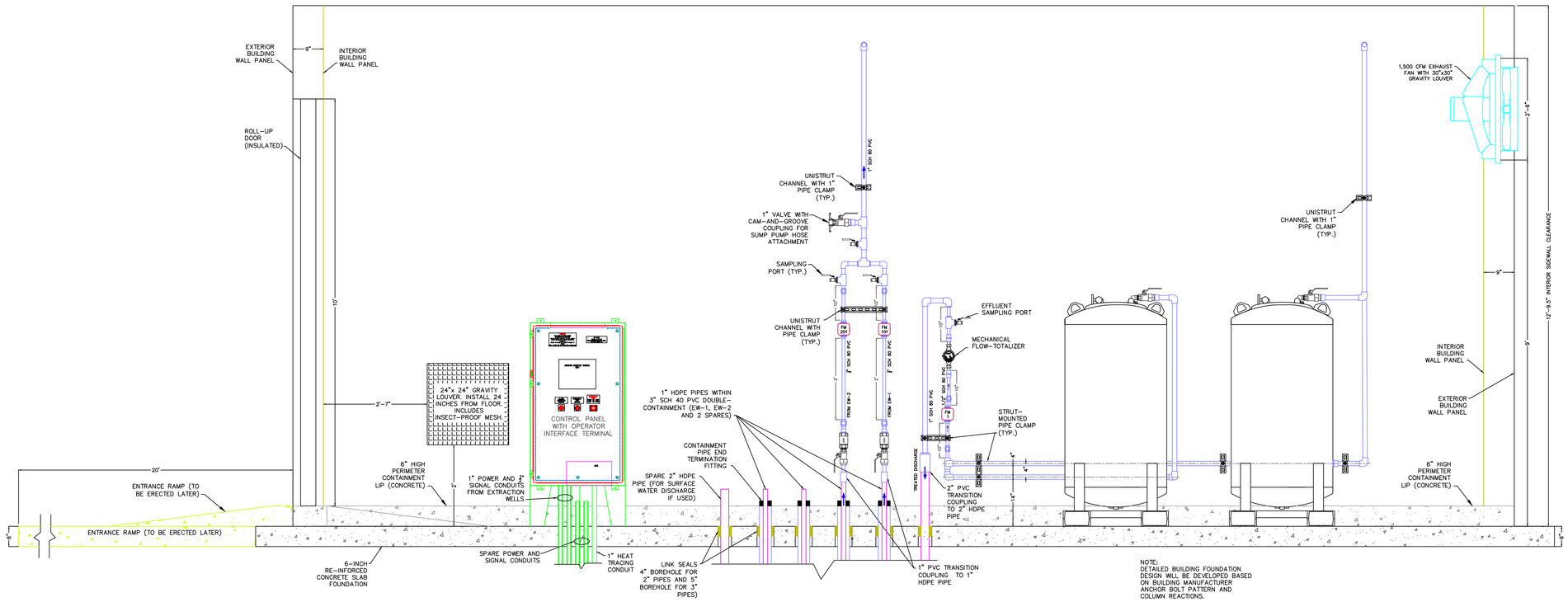
EQUIPMENT ARRANGEMENT PLAN
GROUNDWATER REMEDY BLOCKS E/F DESIGN

MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

DATE:	12/20/19
PROJECT NO.:	112IC03835
DRAWING SIZE:	ARCH E
DRAWN BY:	BD
CHECKED BY:	CP

DRAWING M-3

C:\USERS\BORIS.DYNKIN\DOCUMENTS\LMC MRC\BLOCK F DESIGN\NEW DESIGN CHANGES\ACAD FILES\EQUIPMENT LAYOUTS M-3 TO M-5 AND C-4_GAC_ASB CHANGES.DWG DWM 12/20/19



VIEW A-A (M-3)

DRAWING SCALE

0" 12" 24" 12" 0"

TETRA TECH
www.tetratech.com

MARK	DATE	DESCRIPTION	BY

LGAC UNITS AND MANIFOLD LAYOUT
GROUNDWATER REMEDY BLOCKS E/F DESIGN

MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

DATE:	12/30/19
PROJECT NO.:	112IC03835
DRAWING SIZE:	ARCH E
DRAWN BY:	BD
CHECKED BY:	CP

DRAWING M-4

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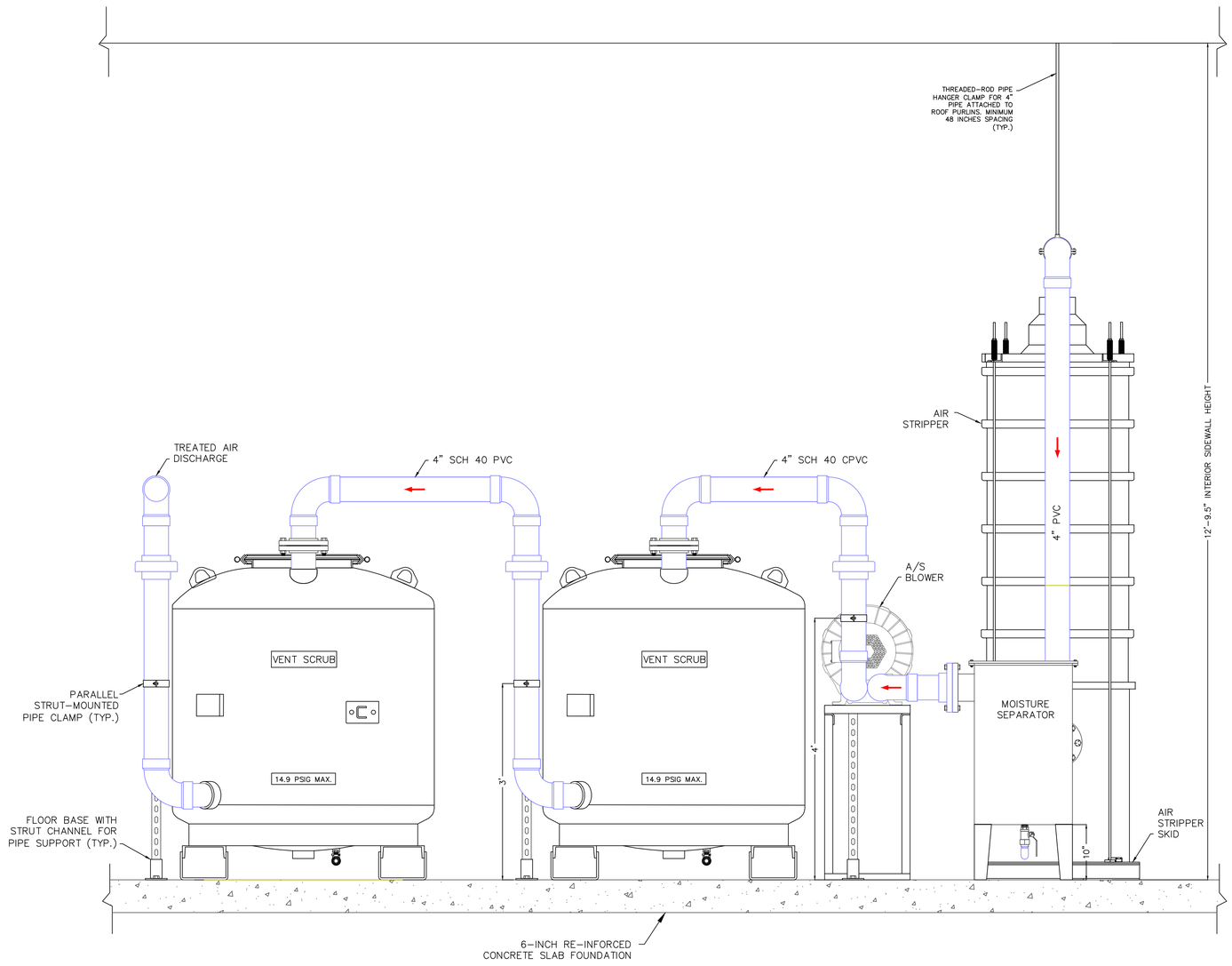

DRAWING SCALE

0" 12" 24" 12" 0"

VIEW B-B (M-3)

TETRA TECH
www.tetratech.com

MARK	DATE	DESCRIPTION	BY

LAYOUT OF VGAC VESSELS AND FLOW MEASUREMENT ENCLOSURE
GROUNDWATER REMEDY BLOCKS E/F DESIGN

MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

DATE:	12/27/19
PROJECT NO.:	112CO3835
DRAWING SIZE:	ARCH E
DRAWN BY:	BD
CHECKED BY:	CP

DRAWING M-5

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APPENDIX B—STANDARD AND DETAILED OPERATING PROCEDURES (SOPs AND DOPs)

SYSTEM COMISSIONING	Identifier: SOP-001 Revision: 0 Effective Date: TBD	Page: 1 of 4

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	1/9/2020	All	New Procedure

RESPONSIBLE PERSONNEL	
LO:	Lead Operator
OM:	Operations Manager

1. INTRODUCTION

1.1 Purpose

This Standard Operating Procedure (SDOP) provides instructions for verifying that all elements of the Lockheed Martin groundwater extraction and treatment system (GWETS) at the Middle River Complex in Middle River, Maryland are completed and ready for start up.

1.2 Scope and Applicability

This SOP is executed to determine that the GWETS is ready for the initial system start up.

2. PREREQUISITES

2.1 Field Preparations

2.1.1 LO: Obtain most current "Design Drawings".

2.1.2 LO: ***Verify that no emergency stops are in effect (e.g., hurricane, flood). If in effect, exit this procedure***.

2.2 Planning and Coordination

2.2.1 LO: IF any of the following events occur**,**

THEN exit this procedure

AND go to identified procedure:

A. ***A hurricane event requiring a treatment system shutdown; refer to applicable sections of the Site Specific Health and Safety Plan***.

B. A flooding event requiring a treatment system shutdown; refer to applicable sections of the Site Specific Health and Safety Plan

3. SYSTEM COMMISIONING CHECK LIST

Check if Okay. Enter N/A if not applicable. Enter Note number if deficient.

SYSTEM COMMISSIONING CHECK LIST

General Requirements				
Item	**P&ID Symbol**	**Requirement**	**Check**	**Notes**
SS Discharge Permit	NA	Obtained and copy kept in GWETS building		
GWETS Design Drawings	NA	Obtained and copy kept in GWETS building		
OMM Manual	NA	Obtained and copy kept in GWETS building		
Building Design Drawings	NA	Obtained and copy kept in GWETS building		
Leak Testing	NA	Reports obtained and reviewed		
Operators training certificates	NA	Obtained and copy kept in GWETS building		
Eyewash Station	NA	Filled and checked		
First Aid Kit	NA	Filled and checked		
Fire extinguisher	NA	Mounted as designated		
Fire extinguisher	NA	Note Expiration date		
Building Envelope				
Roofing - insulation, flashing, downspouts	NA	Installed per building design drawings		
Exterior - metal panels, concrete work	NA	Installed per building design drawings		
Walls - insulation, interior panels, support columns	NA	Installed per building design drawings		
Doors - mechanical operation, hardware, locks, sills, flashings	NA	Installed per building design drawings		
Special design features - perimeter containment lip	NA	Installed per building design drawings		
Electrical and HVAC				
Service switchgear	NA	Energized when switched on		
Interior lighting	NA	on/off switch and circuit breaker		
Exterior lighting	NA	on/off switch and circuit breaker		
Emergency lighting	NA	Activate when main power is off		
Interior receptacles	NA	Energized when circuit breaker is on		
Sump pump receptacle	NA	Energized when circuit breaker is on		

Item	P&ID Symbol	Requirement	Check	Notes
Valve vault heat trace	NA	Energized when circuit breaker is on		
Control panel with HMI	NA	Energized when circuit breaker is on		
Control panel UPS	NA	HMI energized when main power is off		
Exhaust fan	NA	Energized when circuit breaker is on. Run fan by adjusting thermostat.		
Electric heater #1	NA	Energized when circuit breaker is on. Run heater by adjusting thermostat.		
Electric heater #2	NA	Energized when circuit breaker is on. Run heater by adjusting thermostat.		
Process Equipment				
Bump EW-1 well pump	SP-101	Activates from HMI screen		
Check EW-1 well pump rotation	SP-101	Monitor flow to check. To reverse switch power leads to VFD.		
Bump EW-2 well pump	SP-201	Activates from HMI screen		
Check EW-2 well pump rotation	SP-201	Monitor flow to check. To reverse switch power leads to VFD.		
Bump air stripper blower	B-1	Activates from HMI screen		
Check air stripper blower rotation	B-1	Monitor rotation visually. To reverse switch power leads to VFD.		
Bump air stripper transfer pump	TP-1	Monitor rotation visually. To reverse switch power leads to VFD.		
Check air stripper transfer pump rotation	TP-1	Monitor rotation visually. To reverse switch power leads to VFD.		
Interlocks Testing				
Interlocks testing	NA	Perform interlocks testing as described in SOP-9. Check as complete only if all interlocks are tested positively.		
EOR/Owner Inspection				
EOR/Owner Inspection	NA	Check as complete only after EOR/Owner inspection approval		

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	11/26/19	All	New Procedure
1	01/09/20	All	RTO comments response

RESPONSIBLE PERSONNEL	
LO:	Lead Operator
OM:	Operations Manager

1. INTRODUCTION

1.1 Purpose

This Standard Operating Procedure (SOP) presents procedures for performing interlocks testing. Interlocks testing will be performed every four months.

1.2 Scope and Applicability

This SOP applies to the testing of interlocks alarms installed on the Lockheed Martin groundwater extraction and treatment system at the Middle River Complex in Middle River, Maryland.

Interlocks

Interlocks are outlined in Table 2-4 of the Remedial Design and on Drawing M-2.

Interlocks:

- HLA-1 (critical alarm, call out, system shut down) **Level** – Indicates a high water level in AS-1 sump that could indicate transfer pump failure, or other flooding. System is shut down until the cause can be determined by an operator.

- HLA-2 (critical alarm, call out, system shut down) **Level** - Indicates a high water level in MS-1 that could indicate water carryover from AS-1. System is shut down until the cause can be determined by an operator.

- HLA-3 (critical alarm, call out, system shut down) **Level** – Indicates a high water level in floor sump that could indicate water leakage or other flooding. System is shut down until the cause can be determined by an operator.

- LVA-1 (critical alarm, call out, system shut down) **Pressure** – Indicates low vacuum in the air stripper indicating blower failure or other reasons to lose air flow requiring an operator to determine the cause.

- HVA-1 (call out, operator warning) **Pressure** – Indicates high vacuum set point in the air stripper indicating AS-1 clogging or other reasons to restrict air flow requiring an operator to determine the cause.

- HPA-1 (call out, operator warning) **Pressure** – Indicates high pressure set point in bag filters inlet indicating clogging or other reasons to restrict water flow requiring an operator to determine the cause.

- LFA-1 (call out, operator warning) **Flow** – Indicates low effluent flow set point indicating clogging or other reasons to restrict water flow requiring an operator to determine the cause.

- LTA-1 (call out, operator warning) **Temp** - Indicates a low building temperature indicating possible heater(s) failure requiring an operator to determine the cause.

- HTA-1 (call out, operator warning) **Temp** - Indicates a high building temperature indicating possible exhaust fan failure requiring an operator to determine the cause.

- PLA-1 (call out, power loss, plant shut down) – Indicates system power loss. This shuts the system down requiring an operator to determine the cause before the plant can be restarted.

- TRA-1 (valve box heat trace failure) – Indicates loss of power to heat trace. This shuts the system down requiring an operator to determine the cause before the plant can be restarted.

2. PREREQUISITES

2.1 Field Preparations

2.1.1 LO: Obtain current working edition of "Operations Log."

2.1.2 LO: Refer to "Daily Logs" to ensure that there are no operational issues reported/recorded that would prevent a normal system start up or the testing of critical alarms. If issues are noted, then exit this procedure until resolution is obtained**.**

2.1.3 LO: Verify that no emergency stops are in effect (e.g. hurricane, flood). If in effect, exit this procedure.

2.2 Planning and Coordination

2.2.1 LO: IF any of the following events occur,
THEN exit this procedure
AND go to identified procedure**:**

A. ***A hurricane event requiring a treatment system shutdown; refer to the applicable sections of the Site Specific Safety and Health Plan***.

B. ***A flooding event requiring a treatment system shutdown, refer to the applicable sections in the Site Specific Safety and Health Plan***.

2.3 Approvals and Notifications

2.3.1 Approval to perform this procedure shall be obtained from the OM.

3. STEP-BY-STEP INSTRUCTIONS

3.1 Interlocks Testing

All instruments should be calibrated prior to interlocks testing if applicable. Set points adjusted for a test must be returned to the original set point immediately after the test. Note in the field copy of this DOP if the interlock worked correctly. If any interlock does not operate correctly, note it as nonoperational in the field copy of this SOP, and complete interlocks testing. Notify the OM at the completion of testing regardless of results.

LEVEL – Float

These alarms will be triggered by manually lifting the floats. When this alarm is triggered, the system should shut off and operator's notification should be sent.

3.1.1 LO: Keep the system running

3.1.2 LO: Locate the float in the sump or the tank and remove float.

3.1.3 LO: Manually lift the float and rotate it.. This alarm should shut down the system and notify the operator by phone, text and email.

3.1.4 LO: Re-install the float back into the port.

HLA-1
HLA-2
HLA-3

LEVEL – Conductivity probes
(redundant)

These alarms will be triggered by removing the conductivity probe and submerging the probe in a container of water to activate alarm. When this alarm is triggered, the system should shut off and operator's notification should be sent.

3.1.5 LO: Keep the system running.

3.1.6 LO: Locate the conductivity probe in the sump or the tank

3.1.7 LO: Place the in a small container with potable water and document the alarm functioning. This alarm should shut down the system and notify the operator by phone, text and email.

3.1.8 LO: Re-install the probe back into the port.

HLA-1
HLA-2
HLA-3

LOW VACUUM – Switch

This alarm is tested with system running but with extraction well pumps disabled. This alarm is triggered by disconnecting the switch PS-1 tubing from the process piping to simulate vacuum loss. When this alarm is triggered, the system should shut off and operator's notification should be sent by phone, text and email. This testing procedure should be used for the following alarm: LVA-1.

LOW VACUUM – Transmitter (redundant)

This alarm is tested with system running but with extraction well pumps disabled. This alarm is triggered by disconnecting the transmitter PT-2 tubing from the process piping to simulate vacuum loss. When this alarm is triggered, the system should shut off and operator's notification should be sent by phone, text and email. This testing procedure should be used for the following alarm: LVA-1.

HIGH VACUUM – Transmitter

This alarm is tested with system running but with extraction well pumps disabled. This alarm is triggered by restricting air inlet on AS-1 and allow vacuum to increase above set-point for

the transmitter PT-2 to simulate increased pressure losses across air stripper. When this alarm is triggered, the system should continue to operate, and operator's notification should be sent by phone, text and email. This testing procedure should be used for the following alarm: HVA-1.

HIGH PRESSURE – Transmitter

This alarm is tested with system running. This alarm is triggered by slowly restricting water flow at the bag filters inlet (valve V-302) and allow pressure to increase above set-point for the transmitter PT-1. When this alarm is triggered, the system should continue to operate, and operator's notification should be sent by phone, text and email. This testing procedure should be used for the following alarm: HVA-1.

LOW/HIGH BUILDING TEMPERATURE – Transmitter

These alarms are tested with system running. Low temperature alarm (LTA-1) is triggered by increasing a set point of TT-1 to above current transmitter reading. High temperature alarm (HTA-1) is triggered by lowering a set point of TT-1 to below current transmitter reading. When this alarm is triggered, the system should continue to operate, and operator's notification should be sent by phone, text and email. This testing procedure should be used for the following alarms:

LTA-1
HTA-1

VALVE BOX HEAT TRACE FAILURE – Thermostat in valve box

This alarm is tested by temporarily disconnecting heat cable in valve box. When this alarm is triggered, the system should continue to operate, and operator's notification should be sent by phone, text and email. This testing procedure should be used for the following alarms:

TRA-1

4. REFERENCES

- SOP-1 "System Commissioning"
- SOP-003 "Routine system start-up/shut down procedures"
- DOP-2 "Daily Logs"

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	11/26/19	All	New Procedure
1	01/09/20	All	RTO comments response

RESPONSIBLE PERSONNEL	
LO:	Lead Operator
OM:	Operations Manager

1. INTRODUCTION

1.1 Purpose

This Standard Operating Procedure (SOP) provides instructions for routine treatment system startup following shutdown.

1.2 Scope and Applicability

This procedure applies to routine startup and shutdown of the Lockheed Martin groundwater extraction and treatment system in Middle River, Maryland.

2. PREREQUISITES

2.1 Field Preparations

2.1.1 LO: Refer to current "Daily Logs" to ensure that there are no operational issues reported/recorded that would prevent a normal system start up or startup of individual components. If such issues are noted, exit this procedure until resolution is obtained.

2.1.2 LO: Verify that no emergency stops are in effect (e.g., hurricane, flood). If in effect, exit this procedure.

2.1.3 LO: Ensure that plant utilities (lights, emergency eye washes, and exhaust system) are operational.

2.1.4 LO: Confirm that all piping connections such as flanges and unions are secured and connected and that three are no leaks in the piping.

2.1.5 LO: Confirm that all process valves are in proper positions for normal operation as shown in DOP-1 "System Start Up Check List".

2.1.6 LO: Confirm on human-machine interface (HMI) screen that Air Stripper Transfer Pump TP-1 and Blower B-1 are set to automatic

2.1.7 LO: Confirm on HMI screen that well pumps SP-101 and SP-201 are set to automatic.

2.1.8 LO: Confirm that thermostat for exhaust fan is set to 75deg F.

2.1.9 LO: Confirm that thermostats for emergency heaters are set to 40degF.

2.2 Planning and Coordination

2.2.1 SO: IF any of the following events occur,
THEN exit this procedure
AND go to identified procedure.

A. ***A hurricane event requiring a treatment system shutdown; refer to applicable section of the Site Specific Health and Safety Plan***.

B. ***A flooding event requiring a treatment system shutdown; refer to applicable section of the Site Specific Health and Safety Plan***.

3. STEP-BY-STEP INSTRUCTIONS

3.9 LO: Treatment plant will be started from the HMI screen.

3.10 LO: Confirm that no alarm conditions exist on the HMI screen.

3.11 LO: Start the system using on/off switch on the HMI screen (switches page).

3.12 LO: Treatment plant will be shut down from the HMI screen.

3.13 LO: Shut down the system using on/off switch on the HMI screen (switches page). The well pumps SP-101 and SP-201 will be shut down immediately and the air stripper blower will shut down after a pre-programmed delay of approximately 10 minutes.

3.14 Fill out daily logs to document start-up event.

3.15

4 SYSTEM MANUAL VALVES CHECKS PRIOR TO ROUTINE TREATMENT SYSTEM STARTUP

4.1 LO: Inspect manual valve configurations to verify they are in the positions presented in the following table and bring virtual switches on HMI panel to the positions presented in the following table.

Description	P&ID/HMI Symbol	Position	Check	Comments
HMI screen "Switches"	System Off/On	On		
HMI screen "Switches"	Air Stripper Blower B-1 Off/Auto/On	Auto		
HMI screen "Switches"	Transfer Pump TP-1 Off/Auto/On	Auto		
HMI screen "Switches"	Extraction Well EW-1 SP-101 Off/Auto/On	Auto		
HMI screen "Switches"	Extraction Well EW-2 SP-201 Off/Auto/On	Auto		
Thermostat for exhaust fan	NA	75 deg F		
Thermostat for building heater	NA	40 deg F		
Process Valve	V-101	open		EW-1 building influent
Process Valve	V-102	open		EW-1 building influent
Process Valve	V-201	open		EW-2 building influent
Process Valve	V-202	open		EW-2 building influent
Process Valve	V-1	open		Stripper effluent
Process Valve	V-2	open		TP-1 effluent
Process Valve	V-301	closed		Filters by-pass
Process Valve	V-302	open		Configured for BF-1 in operation and BF-2 in standby. Reverse valves position if BF-2 in operation and BF-1 in standby.
Process Valve	V-303	open		
Process Valve	V-304	closed		
Process Valve	V-305	closed		
Process Valve	V-401	closed		LGACs by-pass
Process Valve	V-402	open		LGAC-1 influent
Process Valve	V-403	open		LGAC-1 effluent
Process Valve	V-404	open		LGAC-2 influent
Process Valve	V-405	open		LGAC-2 effluent
Process Valve	V-3	open		Prior to effluent flow meter
Process Valve	V-4	closed		Cleanout in effluent vault
Process Valve	V-5	Opne		Effluent valve in vault
Process Valve	V-6	open		Effluent valve in vault
Process Valve	V-7	closed		Moisture separator drain

5 REFERENCES

- Engineering Drawings, M-2 through M-5

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	11/26/19	All	New Procedure
1	01/09/20	All	RTO comments response

RESPONSIBLE PERSONNEL	
LO:	Lead Operator
OM:	Operations Manager

1. INTRODUCTION

1.1 Purpose

This Standard Operating Procedure (SOP) identifies the activities to be followed when sampling extraction wells or other process locations by way of sample ports within the treatment system building. This SOP presents the procedures to be followed when sampling inside the treatment system building.

1.2 Scope and Applicability

This SOP applies to sampling various sample ports located inside the Lockheed Martin groundwater extraction and treatment system at the Middle River Complex in Middle River, Maryland.

2. PRECAUTIONS AND LIMITATIONS

The extraction wells remove contaminated groundwater from the subsurface; therefore, operators should minimize contact with the groundwater.

3. PREREQUISITES

3.1 Field Preparations

3.1.1 LO: Verify that no emergency stops are in effect (e.g., hurricane, flood). If in effect, exit this procedure.

3.1.2 LO: Verify using Daily Logs that there are no current problems with the treatment system. If problems exist, discuss with OM on whether to continue with the sampling.

3.1.3 LO: Verify that there is a cooler with ice available to store samples.

3.1.4 LO: Gather all of the necessary equipment (listed below) and locate near the manifold on the northeast wall of the treatment building.

3.1.5 LO: Contact the designated analytical laboratory (s) to convey the timing of upcoming sampling activities.

3.2 Equipment

The following equipment can be found in the treatment building: 5-gallon container labeled "Purge Water" that has no holes or fractures (except for the main opening), proper lid to seal the 5-gallon container, ***proper personal protective equipment (PPE; steel-toed boots, nitrile gloves, safety glasses or goggles), spill containment kit***, designated bucket or trash bag for temporary storage of used PPE and anything else that has contacted groundwater, sample containers, laboratory bottleware, cooler, ice, ziplock bubble bags, trash bags, and labeling supplies.

3.3 Planning and Coordination

3.3.1 SO: IF any of the following events occur,
THEN exit this procedure,
AND go to identified procedure.

A. ***A hurricane event requiring a treatment system shutdown; refer to the applicable sections of the Site Specific Health and Safety Plan***.

B. ***A flooding event requiring a treatment system shutdown; refer to the applicable sections of the Site Specific Health and Safety Plan***.

3.4 Approvals and Notifications

3.4.1 Approval to perform this procedure shall be obtained from the OM.

4. SAMPLING VIA RESPECTIVE SAMPLE PORTS

4.1 LO: Keep a record of the sampling event in the Log Book. At minimum, record the start and end time when the sampling of each sample port occurred, plus any observations.

4.2 LO: Complete the chain of custody (COC).

4.3 LO: Label sample bottles with indelible marker with sample points, analysis required, sampler initials, correct sampling times as per the completed COC, and any other requirement listed on the label. Where sample preservation is required, check that the preservative in the bottle is the correct one needed for the sample analysis.

4.4 LO: Line cooler with a heavy-duty garbage bag and place ice inside the garbage bag. Close the cooler between placement of sample containers.

4.5 LO: ***Don nitrile gloves. Do not handle other materials between donning gloves and sampling to avoid cross contamination.***

4.6 LO: Place the 5-gallon container directly under the sample port to be sampled. If the 5 gallon container cannot be positioned so that the water will flow directly into it, add a section of polyethylene tubing.

4.7 LO: Slowly open the sample port to allow water to flow through the valve and into the 5-gallon container.

4.8 LO: Purge approximately 1 liter of water into the 5-gallon container.

4.9 LO: To reduce aeration and volatilization of VOCs, reduce flow rates to a minimum when sampling. Allow the water to flow gently down the inside of the bottle so as not to trap air. Fill just to the level required to create a positive miniscus (slight overfill) in these sample containers. Screw lids back into place immediately after collecting each sample, ensuring no air is trapped in the container. Excess water should spill down the sides of the container when replacing the lid. Turn the bottle over several times gently to look for air bubbles. If air bubbles are found, resample the location.

4.10 LO: For remaining samples, fill the appropriate laboratory containers with water from the appropriate sample port. Fill to within one (1) to two (2) inches of the top. Cap immediately upon fill to avoid spills. Verify samples are collected from the correct ports.

4.11 LO: After all samples have been collected from the first sample port, close the sample port.

4.12 LO: Double-check the COC for each cooler against the sample bottles intended for that cooler, including sample IDs and number of bottles.

4.13 LO: Place sample bottles in ziplock bubble bags, provided by the laboratory, and place upright in the iced trash bag inside the cooler. When the cooler is full, place more ice on top of the sample bottles and securely tie the trash bag, keeping knot on the top of the samples.

4.14 LO: Place the COC in a ziplock bag, close the bag, and securely attach it to the underside of the cooler lid. Close the cooler lid and use packing tape to wrap the cooler completely, at least twice.

4.15 LO: Verify that the sample port is completely closed prior to advancing to the next sample port location.

4.16 LO: **Gloves must be changed after completing sample collection activities at a port location and before beginning sampling activities at the next port location. Remove gloves in the following manner**:

- ***Using one gloved hand (hand "A"), grip the outer surface of the other glove (the glove on hand "B") near the wrist cuff (avoid contacting skin).***
- ***Remove the glove from hand "B" by pulling toward the fingertips. Peel it down and let it become inside-out. Now hand B has no glove. Hand A is wearing a glove and is holding the other used glove.***
- ***With hand B, grip the inside surface of the glove that is on hand A near the wrist cuff. Pull toward the fingertips; peel it down and let it become inside-out.***
- ***Dispose of used gloves in "Used PPE" bucket or bag. This used PPE will be disposed of in a drum labeled "Used PPE".***

4.17 LO: ***Don a new, clean pair of disposable nitrile gloves***.

4.18 LO: Repeat Steps 4.4 through 4.15 for each sample port.

4.19 LO: Use peristaltic pump to transfer the contents of 5-gallon bucket into the air stripper inlet using valve V-5 connection.

1

4.20 LO: Dispose of tubing and used PPE in a drum labeled "Used PPE".

4.21 LO: Load the sample coolers and transport to the transfer location by lab courier or via FedEx.

4.22 SO: Equipment should be returned to its proper storage location.

5. REFERENCES

- Site Specific Health and Safety Plan
- SOP-011 "Trash Procedures"

SYSTEM ALARM RESPONSE	Identifier: SOP-005 Revision: Effective Date: Page: 1 of 6

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	11/26/19	All	New Procedure
1	01/09/20	All	RTO comments response

RESPONSIBLE PERSONNEL	
LO:	Lead Operator
OM:	Operations Manager

1. INTRODUCTION

1.1 Purpose

This Standard Operating Procedure (SOP) is to be followed when responding to the various alarms of the treatment system. This SOP presents possible alarm causes and troubleshooting assistance. Due to the complex nature of the treatment system and its various components, this document will not always present the correct solution and professional judgment must be used. A critical alarm will automatically shut down treatment system equipment. If the critical alarm fails to shut down the system, the system must be manually shut down immediately, and the Operations Manager must be notified of the alarm malfunction. Refer to SOP-003, "Routine Startup/Shutdown" to shut down the system.

1.2 Scope and Applicability

This procedure applies to alarm response at the Lockheed Martin groundwater extraction and treatment system at the Middle River Complex in Middle River, Maryland.

2. PREREQUISITES

2.1 Field Preparations

2.1.1 LO: Obtain current "Daily Logs."

2.1.2 LO: Verify that no emergency stops are in effect (e.g., hurricane, flood). If in effect, exit this procedure.

2.2 Planning and coordination

2.2.1 LO: IF any of the following events occur, THEN exit this procedure AND go to identified procedure:

A. ***A hurricane event requiring a treatment system shutdown, refer to applicable sections of the Site Safety and Health Plan***.
B. ***A flooding event requiring a treatment system shutdown, refer to applicable sections of the Site Safety and Health Plan***.

2.3 Equipment Required

Nitrile gloves, work gloves, safety glasses, hard hat, and safety boots.

3. CRITICAL ALARMS

Refer to SOP-003 Interlocks Testing and the Process and Instrumentation Diagram.

4. STEP BY STEP INSTRUCTIONS

4.1 LO/OM: If a critical alarm occurs during off hours, the LO and OM will determine if a site visit is necessary, or if a remote shut down is appropriate.

4.2 LO: If a critical alarm occurs, verify that the treatment system and extraction wells have automatically shut down as described below. If the critical alarm fails to shut down the system and wells, the system and wells must be manually shut down within 8 hours. In an emergency, use the E-Stop on the control system panel. Never assume that the condition is a false alarm.

4.3 LO: Record the alarm condition and time of the alarm in the operations log book.

4.4 LO: Notify the Operations Manager immediately if the alarm condition is valid, and if it has caused equipment damage or has resulted in a release of any kind. The Operations Manager can be contacted by phone. Notification numbers are located on the bulletin board in the treatment system building.

4.5 Lockheed Martin and the RTO should be notified within 24 hours of any unplanned system shutdown.

4.6 Notifications:

1. Record system shutdowns or operational interruptions and document the efforts employed to return the system to full operation as soon as possible. In all cases, a summary memorandum (or email) shall be prepared and distributed to Lockheed Martin and the RTO within 24 hours after the incident occurred to document the issue. A subsequent email shall be prepared and distributed to Lockheed Martin and the RTO to document the root cause, and to identify steps taken or planned to remedy the problem. If unanticipated activities are required, the Contractor shall prepare a new budget estimate and submit the estimate to Lockheed Martin for written approval before proceeding with the work. Unanticipated activities necessary to prevent injury or release to the environment do not require pre-authorization. The Contractor shall prepare and distribute an email to Lockheed Martin and the RTO prior to taking groundwater treatment and extraction system offline for any reason, and a follow-up email when the system is returned to operation.

2. Report all accidents, environmental releases, spills, and other emergencies immediately to Lockheed Martin and as specified in the Site Crisis and Emergency Plan (Tetra Tech, 2018).

4.7 In the event of a release, Lockheed Martin and the RTO shall be immediately notified

and the Draft Contingency Plan and Emergency Procedures will be followed. Also, The Emergency Coordinator will be notified immediately.

4.8 LO: Determine the cause of the alarm. Take appropriate measures to address the cause. The following list offers possible causes that may be related to triggering the alarm. NOTE: Start with the assumption that the alarm was triggered for the purpose it was intended. Do not assume that it is a FALSE alarm. NEVER override any alarm function. Do not restart the system if the condition that triggered the alarm cannot be determined or rectified.

4.9 LO: If the treatment system must be manually shut down, the extraction wells should be shut down (via HMI screen or remotely) prior to disabling the entire treatment system (via HMI screen or remotely).

4.10 LO: Make the appropriate repairs by following the specific SOP or implementthe appropriate solutions/notifications.

5. ALARMS AND POSSIBLE CAUSES

5.1 LEVEL

The purpose of these alarms is to alert the operator when the water level reaches a high-level set point. If the water level appears to drastically and quickly change, there may be a problem with the sensor. Verify the high-level set point is set correctly. If the set point is correct and the water level continues to rise, shut down the system and notify the operations manager immediately. Triggering of any alarms listed below requires a restart from the GWETS HMI screen in the building - remote restart is not allowed. Water level may rise for several minutes after shut down due to gravity draining of piping. The high-level alarms are as follows:

- High level in air stripper sump (HLA-1) – If this alarm is tripped, the system will be automatically shut down. Investigate the cause and rectify the problem. The operator will visit the system on the next business day.. This may be anindication of a transfer pump TP-1 failure or bag filters clogging. When the cause of the alarm is determined, and the situation rectified the system can be restarted. Before the system re-start, operate the air stripper transfer pump in manual mode to remove water from the sump and clear high level alarm condition. Follow SOP-003 to initiate system restart.

  High level in moisture separator (HLA-2) – If this alarm is tripped, the system will be automatically shut down. Investigate the cause and rectify the problem. The operator will visit the system on the next business day.. This may be anindication of a water carryover from air stripper AS-1. This may also be anindication of a transfer pump TP-1 failure or bag filters clogging. When the cause of the alarm is determined, and the situation rectified the system can be restarted. Before the system re-start, drain liquid from moisture separator (by gravity, open V-7) to the air stripper sump and clear high-level alarm condition in MS-1. Follow SOP-003 to initiate system

restart.

- High level in building floor sump (HLA-3) – If this alarm is tripped the system will be automatically shut down. Investigate the cause within 24 hours. This may be an indication of a piping leak or rain water entering the building. When the cause of the alarm is determined, and the situation rectified the system can be restarted. Before starting the extraction wells, start the air stripper blower B-1 in "Hand" mode and place the air stripper transfer pump TP-1 in automatic mode. Remove the floor sump grate, place the utility sump pump in the floor sump and connect the sump pump discharge hose to the air stripper inlet. Activate the sump pump and pump out the liquid collected in the floor sump through the treatment system. This should clear high-level alarm condition in the floor sump.

5.2 FLOW

The purpose of flow alarms is to alert the operator of a low flow condition and perform necessary steps to rectify a problem. Note that a low flow condition should not cause the system shut down.

- Low system effluent flow (LFA-1) – If this alarm is activated the operator will be notified and the system will continue to operate. The operator must investigate the cause via remote system and rectify the problem during the next scheduled site visit. If it is determined that the alarm could lead to a system upset or equipment damage, the operator will visit the system on the next business day. Some of the causes of low flow condition could be decreased formation yield, well(s) clogging, well pump(s) clogging, bag filter(s) clogging, well transducers malfunction, well control VFD(s) malfunction.

5.3 TEMPERATURE

The purpose of temperature alarms is to alert the operator and perform necessary steps to rectify a problem. Note that a low/high temperature condition should not cause the system shut down.

- Low Building Temperature (LTA-1) - If this alarm is triggered, the temperature of the building interior reaches the programmed low limit. This may be caused by possible heater(s) failure. The operator must investigate the cause via remote system and rectify the problem during the next scheduled site visit. If it is determined that the alarm could lead to a system upset or equipment damage, the operator will visit the system on the next business day.

- High Building Temperature (HTA-1) - If this alarm is triggered, the temperature of the building interior reaches the programmed high limit. This may be caused by possible exhaust fan failure. The operator must investigate the cause via remote system and rectify the problem during the next scheduled site visit. If it is determined that the alarm could lead to a system upset or equipment damage, the operator will visit the system on the next business day

5.4 PRESSURE/VACUUM

The purpose of these alarms is to alert the operator and/or shut down the system in the event of a high- or low-pressure condition.

- Low vacuum condition in the air stripper (LVA-1) – This alarm is triggered by low vacuum at the air stripper outlet. Most often, this is caused by an air stripper blower failure. If this alarm is tripped, the system will be automatically shut down. Investigate the cause and rectify the problem. The operator will visit the system on the next business day. Air stripper blower or the blower's motor may need to be replaced.

- High vacuum condition in the air stripper (HVA-1) – This alarm is triggered by high vacuum at the air stripper outlet. Most often, this is caused by air stripper trays clogging, indicating that air stripper cleaning is needed. If this alarm is tripped, the operator will receive a warning message, but the system will continue to operate. The operator must investigate the cause via remote system and rectify the problem during the next scheduled site visit. If it is determined that the alarm could lead to a system upset or equipment damage, the operator will visit the system on the next business day Air stripper cleaning could be required if excessive pressure losses across the air stripper are confirmed. Refer to DOP-001 for the air stripper cleaning procedures.

- High filter inlet pressure (HPA-1) – If triggered, this alarm indicates an obstruction in the bag filter inlet likely indicating that a filter bag is clogged and needs to be replaced. If this alarm is tripped, the operator will receive a warning message, but the system will continue to operate. The operator must investigate the cause via remote system and rectify the problem during the next scheduled site visit. If it is determined that the alarm could lead to a system upset or equipment damage, the operator will visit the system on the next business day. Upon arriving to the site, the operator shall switch the valves on the bag filters to put on-line the stand-by filter with a fresh filter bag. Replace the clogged filter bag by a fresh bag and leave the filter in a stand-by position for future use. Use plastic sheeting to keep the building floor clean. The spent filter bag shall be placed in a waste collection drum (properly maintained and labeled). Disposal of the spent filter bags shall be handled as described in SOP-010. Dispose of trash and used PPE per SOP-011 "Trash Procedures".

5.5 POWER LOSS

The purpose of this alarm is to alert the operator to the power loss events.

- System power loss (PLA-1) – This alarm is triggered by a loss of power. If this alarm is

tripped, the system will be automatically shut down. Investigate the cause and rectify the problem. The operator will visit the system on the next business day.

6. REFERENCES

- SOP-002 “Interlock Testing”
- DOP-002 “Air Stripper Cleaning”
- “Air Stripper Manufacturer Manual”
- SOP-003 “Routine Start-up/Shut-down”
- SOP-010 “Waste Disposal”
- SOP-011 “Trash Procedures”

EXTRACTION WELL PUMP	Identifier: SOP-006 Revision: 0 Effective Date: TBD	Page: 1 of 4

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	11/26/19	All	New Procedure
1	01/09/20	All	RTO comments response

RESPONSIBLE PERSONNEL	
LO:	Lead Operator
OM:	Operations Manager

1. INTRODUCTION

1.1 Purpose

This Standard Operating Procedure (SOP) provides instructions for pulling an extraction well pump out of an extraction well.

1.2 Scope and Applicability

This SOP applies to extraction well pump pulling at the Lockheed Martin groundwater extraction and treatment system at the Middle River Complex in Middle River in Middle River, Maryland. This is a two-person operation. ***Well vaults have been classified as a non-permit required confined space because the electrical and hydraulic hazards can be eliminated through LOTO of disconnects and valves.***

2. PREREQUISITES

2.1 Field Preparations

2.1.1 LO: Refer to the "Daily Logs" to ensure that there are no operational issues reported/recorded that would prevent daily logs. If issues are noted, then exit this procedure until resolution is obtained.

2.1.1 LO: Verify that no emergency stops are in effect (e.g., hurricane, flood). If in effect, exit this procedure.

2.1.2 LO: Verify that a condition indicating pump fouling, malfunction or failure has occurred or a visual inspection necessitates pulling the pump for servicing.

2.2 Planning and Coordination

2.2.1 SO: IF any of the following events occur,
THEN exit this procedure
AND go to identified procedure.

A. A hurricane event requiring a treatment system shutdown; refer to applicable section of the Site Specific Health and Safety Plan.

B. ***A flooding event requiring a treatment system shutdown; refer to applicable section of the Site Specific Health and Safety Plan***.

C.

2.3 Equipment Required

Nitrile gloves, work gloves, safety glasses, hard hat, and safety boots, large plastic container, plastic sheeting, screwdriver, wrenches, vault lock key, water level meter spray bottle with water for cleaning.

3. STEP-BY-STEP PROCEDURES

2.2 LO: Gather supplies listed under the equipment section of this SOP and stage them by the well vault.

2.3 LO: Shut down the extraction well at the appropriate well control panel in the field or call the office and instruct operator to do so for the pump being pulled.

2.4 LO: De-energize the well pump in accordance with SOP-007 "Lockout/ Tagout.

2.5 LO: Close the appropriate isolation valve inside the treatment system building (V-101 or V-201).

2.6 LO: ***Don leather work gloves for pulling the pump and wear nitrile gloves under the leather gloves.***

2.7 LO: Using the vault key unlock the lock.

3.8 LO: Lift vault lid from the front holding the lid on the way up.

3.9 LO: Lift the lid up until it is standing vertically and verify that the lid locking device is enabled and secured.

3.10 LO: Set up plastic sheeting around the well vault and place a large plastic container on top of the sheeting.

3.11 LO: Slowly raise the transducer by pulling on the cable. Remove transducer with cable from well and place on plastic sheeting.

3.12 LO: Verify that there is no power. Disconnect power leads from the pump at the junction box in the well vault.

3.13 LO: Thread the lifting tool (t-rod) into the pitless adapter thread and pull the pump from the pitless adapter. With assistance from 2nd person, lift the pump with discharge hose from the well and place on plastic sheeting.

3.14 LO: Service the pump/motor in accordance with identified defect. Inspect the discharge hose and check valve for fouling. Clean if needed.

3.15 LO: Replace the repaired or replaced pump/motor by lowering the pump and discharge hose slowly and carefully into the well. This should be performed by two operators using the discharge hose for support. Reattach the pitless adapter to the sliding base in the well.

3.16 LO: Lower transducer back into well taking care to ensure that the transducer is placed to its original depth using a mark on the transducer cable. In order to reestablish accurate placement of the level transducer, using a water level meter, measure the static depth to water from the top of casing to cross-verify depth of the transducer, always measure on the north rim of the well casing.

3.17 LO: Perform final inspection of work site and remove any trash and debris from the vault. Dispose of trash and used PPE per SOP-014 "Trash Procedures".

3.18 LO: Open the appropriate isolation valve inside the treatment system building (V-101 or V-201).

3.19 LO: ***Return power to the pump at the control panel and/or local disconnect. Follow appropriate LOTO procedure to restore power. Refer to SOP-007 "Lockout and Tagout".***

3.20 LO: Restart the extraction well at the appropriate local well control panel.

3.21 LO: Visually inspect the fittings for leaks.

3.22 LO: If there are no leaks, close and lock the vault lid. If leaks are present, repair the leaks before returning the extraction well to service.

4. REFERENCES

- SOP-007 "Lockouts and Tagouts"
- SOP-011 "Trash Procedures"
- Engineering Drawings

LOCKOUTS AND TAGOUTS	Identifier: SOP-007 Revision: 0 Effective Date: TBD	Page: 1 of 11

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	11/26/19	All	New Procedure
1	01/09/20	All	RTO comments response

REVIEW LOG

Rev.	Date	Review Summary

RESPONSIBLE PERSONNEL	
LO:	Lead Operator
OM:	Operations Manager

1. PURPOSE

This *Lockout/Tagout Procedure* (LO/TO) implements the requirements of 29 CFR 1910.147, "The Control of Hazardous Energy (Lockout/Tagout);" 29 CFR 1910.333, "Selection and Use of Work Practices;" and NFPA 70E, "Standard for Electrical Safety in the Workplace," 2015 Edition; and provides a consistent method to protect employees from injury using *lockout* (see Step 7, Definitions) and *tagout* (see Step 7, Definitions).

2. SCOPE

This Lockout/Tagout Procedure provides instruction for planning, placement, verification and removal of lockout and/or tagout (LO/TO). This LO/TO applies only to the control of energy during operations, servicing and/or maintenance of equipment and is applicable to LO/TO performed on fixed permanently installed equipment, temporarily installed equipment and portable equipment at the Lockheed Martin groundwater extraction and treatment system at the Middle River Complex in Middle River, Maryland.

This LO/TO Procedure discusses servicing and maintenance of equipment in which the unexpected energization or startup of the equipment or release of stored energy could cause injury to personnel.

This LO/TO Procedure covers servicing and/or maintenance that takes place during construction and *normal operation* (see Step 7, Definitions) **only under the following conditions**:

☐ An employee is required to remove or bypass a guard or other safety device.

☐ An employee is required to place any part of his or her body into an area of a piece of equipment where work is actually performed upon the material being processed (point of operation) or where an associated danger zone exists during an equipment operating cycle.

This LO/TO Procedure **does not** cover the following activities:

☐ Work on cord- and plug-connected electric equipment for which exposure to the hazards of unexpected energization or start-up of the equipment is controlled by unplugging the equipment from the *energy source* (see Step 7, Definitions) and by the plug being under the *exclusive control* (see Step 7, Definitions) of the employee performing the *servicing or maintenance* (see Step 7, Definitions).

☐ Hot tap operations involving transmission and distribution systems for substances such as gas, steam, water or petroleum products when they are performed on pressurized pipelines, provided that the following are demonstrated:

- Continuity of service is essential.
- Shutdown of the system is impractical.
- Documented procedures are followed and special equipment is used that will provide proven effective protection for employees.

☐ Minor tool changes and adjustments and other minor servicing activities are not covered by this LO/TO Procedure if they are routine, repetitive and integral to the use of the equipment for production, provided that the work is performed using alternative measures that provide effective personnel protection.

☐ Situations that have been evaluated and found not to involve a hazard or to situations for which hazards are mitigated by approved methods (e.g., job safety analysis, safe work permit or independent hazard review).

3. RESPONSIBILITIES/PREREQUISITES

3.1 Responsibilities

Performer	Responsibilities
Tetra Tech HSPO (or designee)	Review the LO/TO program at least annually, and implement corrective actions for identified deficiencies.
Operations Manager (OM)	Review and approve LO/TO as applicable. Resolve problems/concerns regarding the LO/TO process. Verify that equipment has been placed in a condition to support application of LO/TO. The OM exercises overall responsibility for adequacy of LO/TOs and adherence to the specified requirements.
Authorized Employee (AE; see Step 7, Definitions)	Perform LO/TO activities as applicable.
Qualified Person (see Step 7, Definitions)	Operate equipment, systems or *isolation devices* (see Step 7, Definitions) as required for LO/TO. Perform zero-energy verifications as qualifications allow.
All Employees	Comply with the restrictions and limitations imposed during the use of LO/TO.

3.2 Prerequisites

3.2.1 Personnel assigned to prepare LO/TO will be knowledgeable on the equipment and systems for which they are preparing an LO/TO.

4. REQUIREMENTS

4.1 General Requirements Controlling LO/TO

4.1.1 Equipment that has been locked out and/or tagged out **WILL NOT BE OPERATED** by any person.

4.1.2 **All employees** are required to comply with the restrictions and limitations imposed upon them during the use of LO/TO.

4.1.3 Each authorized employee working under the protection of LO/TO will be protected by a *personal lock* (see Step 7, Definitions) and *personal "Do Not Operate" tag* (see Step 7, Definitions) under the exclusive control of that employee.

4.2 Lockout Devices

4.2.1 If an isolation device is *capable of being locked out* (see Step 7, Definitions), then a lockout device will be used to prevent operation of the device and will be affixed in a manner that will hold the energy-isolating device in a "safe" or "off" position.

4.2.2 Isolations will be protected by locks and *lockout devices* (see Step 7, Definitions) to the maximum extent possible. Locks used for LO/TO will meet the following requirements:

4.2.2.1 All locking devices will be approved by the Qualified Person (QP) and meet the requirements defined in OSHA 29 CFR 1910.147. Locking devices shall be used for controlling energy and shall not be used for other purposes. Locking device shall indicate the identity of the employee applying the device.

4.3 Tags and *Tagout Devices* (see Step 7, Definitions)

4.3.1 Tags used for LO/TO will meet the following requirements:

4.3.1.1 *"Do Not Operate" tags* (see Step 7, Definitions) are essentially warning devices affixed to energy-isolating devices and do not provide the physical restraint on those devices that is provided by a lock.

4.3.1.2 When a "Do Not Operate" tag is attached to an energy-isolating device, it will not be removed without authorization of the authorized employee responsible for it, and will not be bypassed, ignored or otherwise defeated.

4.3.1.3 "Do Not Operate" tags must be legible and understandable by all qualified employees and all other employees whose work operations are or may be in the area. Personnel will use only "Do Not Operate" tags approved by the QP for LO/TO.

4.3.1.4 "Do Not Operate" tags and their means of attachment must be made of materials that will withstand the environmental conditions encountered in the workplace.

4.3.1.5 "Do Not Operate" tags may evoke a false sense of security, and their meaning must be understood as part of the overall energy control program. "Do Not Operate" tags are reserved for LO/TO use and will not be used for any other purpose. NOTE: "Out of Service" tags will not be substituted for "Do Not Operate" tags.

4.3.1.6 "Do Not Operate" tags will be securely attached to energy-isolating devices so that they cannot be inadvertently or accidentally detached during use, and so they clearly indicate that operation or movement of the isolation device from the "safe" or "off" position is prohibited.

4.4 Isolation Practices for LO/TO

4.4.1 Electrical Systems

4.4.1.1 Isolation must be provided for any electrical energy equal to or greater than 50 volts (V; ac or dc) unless it can be demonstrated that de-energizing introduces additional or increased hazards, or is infeasible due to equipment design or operational limitations or for performing approved troubleshooting, calibrations or other work activity that requires a system to remain *energized* (see Step 7, Definitions) to perform the activity. If the electrical circuit(s) cannot be de-energized, an approved work control document must be used to specify applicable safety precautions/instructions and required safety equipment to address hazards from both electrical shock and arc flash.

4.4.1.2 Grounding requirements must be considered as part of the isolation for any electrical circuit. The grounds must be tagged to ensure that they remain installed until the work is complete and removed prior to re-energizing the equipment or system.

4.4.1.3 Control circuit devices (e.g., pushbuttons, selector switches and interlocks) may not be used as the sole means for de-energizing circuits or equipment. Interlocks for electrical equipment may not be used as a substitute for LO/TO.

4.4.1.4 When using lifted leads as an isolation point, the "Danger" tag used to identify the required condition of the leads should not be placed inside a junction box, as this could be a fire hazard. The "Do Not Operate" tag should be placed on the junction box cover or other appropriate location.

5. INSTRUCTIONS

5.1 Simple LO/TO

NOTE: *Documentation of the steps followed for simple LO/TO is not required.*

5.1.1 A simple LO/TO may be performed if ALL of the following conditions exist:

A. The equipment has no potential for stored or residual energy, or reaccumulation of stored energy after shutdown that could endanger employees.

B. The equipment has a single energy source that can be readily identified and isolated.

C. The isolation and locking out of the single energy source will completely de-energize and deactivate the equipment. All capacitors will be drained of their stored energy if present.

D. The equipment is isolated from the single energy source and locked out during servicing or maintenance.

E. A single lockout device will achieve a locked-out condition.

F. The lockout device is under the exclusive control of the AE performing the servicing or maintenance.

G. The servicing or maintenance does not create hazards for other employees.

H. The facility has not experienced any unexpected activation or re-energization of the equipment during servicing or maintenance.

5.1.2 If all the criteria listed in 5.1.1 A through 5.1.1 H are **not** satisfied,then the servicing or maintenance **cannot** be performed using a simple LO/TO.

5.1.3 AE/: Notify all *affected employees* (see Step 7, Definitions) that servicing or maintenance is required on the equipment and that the equipment must be shut down and locked out to perform the servicing or maintenance.

5.1.4 AE/: Identify the type(s) and magnitude(s) of energy associated with performing the servicing or maintenance on the equipment, using up-to-date diagrammatic drawing representations and/or documents and physical walk-down, and identify the isolation device required to de-energize and isolate the equipment from the energy source.

5.1.5 AE/: Obtain permission from the equipment owner to shut down and perform the LO/TO and the servicing or maintenance.

5.1.6 Qualified Person: If the equipment is operating, shut it down in accordance with approved procedures or other instructions as applicable, ensuring that all operating controls are placed in the neutral, off or other appropriate position.

5.1.7 Qualified Person: Position, as necessary, the isolation device neededto isolate the equipment from the energy source.

5.1.8 AE: Lock out the energy-isolating device, using Personal Lock and Personal "Do Not Operate" tag.

5.1.9 Qualified Person: Ensure that the equipment is completely de-energized by performing zero-energy verification(s).

5.1.9.1 For electrical energy sources, use approved methods to verify the absence of electrical energy(voltage).

5.1.9.2 Perform zero-energy verification(s) for other energysources as identified in Step 5.1.4.

5.1.10 AE: Perform the servicing or maintenance on the equipment.

5.1.10.1 If it is necessary to leave the job prior to completing the work, other than for lunch or for a break, then perform the following step:

5.1.10.1.1 Turn over the job to an oncoming personnel by having the oncoming AE install his or her Personal Lock and Personal "Do Not Operate"

tag in place of your Personal Lock and Personal "Do Not Operate" tag. This should be done prior to the removal of the departing employee's lock and tag. Departing employee should also notify the arriving employee of the status of the equipment and the work in progress; inform the arriving employee of any problems or concerns regarding the work in progress; and notify the Qualified Person of all locked out energy sources.

5.1.11 AE: When servicing or maintenance is complete, perform the following activities:

5.1.11.1 Check the equipment and the immediate area around the equipment to ensure that nonessential items have been removed and that the equipment components are operationally intact.

5.1.11.2 Check the work area to ensure that all employees have been safely positioned or removed from the area.

5.1.11.3 Verify that the equipment controls are in the neutral, off or other appropriate position.

5.1.11.4 Remove your personal lock, *personal "Do Not Operate" tag* (see Step 7, Definitions), and lockout device, as applicable, from the isolation device.

5.1.11.5 Notify all affected employees that the servicing or maintenance on the equipment has been completed and that the equipment may be placed back into operation.

5.1.11.6 Perform tests and visual inspections per NFPA 70E Article 120.2.(F)(2)(m).

6. ADDITIONAL INSTRUCTIONS

6.1 Documentation of Lock Out/Tag Outs

6.1.1 For each lock out /tag out procedure performed, the Qualified Person shall complete a Lockout/Tagout Log Sheet (Appendix A) to verify that all energy isolation devices have been identified and located. Special instructions associated with application of lockout/tagout of a piece of equipment are also documented on this form.

7. DEFINITIONS

All employees/affected employees. Their job requires them to operate or use equipment on which servicing/maintenance is being performed under lockout/tagout or whose job requires him/her to work in an area in which such servicing or maintenance is being performed. An affected employee may NOT perform work under the protection of a LO/TO. They must comply with the restrictions and limitations imposed during the use of LO/TO.

Authorized employee (AE). An individual trained on all aspects of this procedure who prepares, installs, verifies, performs work under and/or removes LOs/TOs.

Capable of being locked out. Refers to an isolation device that has a means to attach a lock or into which a locking mechanism is built.

"Do Not Operate" tag. A numbered tag, red and white with black lettering, used to prohibit operation of equipment or components.

Energized. Connected to an energy source or containing residual or stored energy.

Energy source. Any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal or other energy.

Exclusive control. Exclusive control means that the employee has physical possession of the key to his/her personal lock and tag, which is attached to the isolation device. For cord- and plug-control equipment, the plug is considered to be under the exclusive control of the employee if it is physically in his/her possession, or within arm's reach and in line of sight of the employee, or if the employee has affixed an LO/TO device to the plug.

Site supervisor (SS). A general term used to identify the supervisor directly and officially in charge of a facility/area or systems/equipment operation and who has been trained in all aspects of this procedure. The SS can be the equipment owner. For areas that do not have an operating organization, the SS is the maintenance supervisor under whose direction the work will be performed (all references to the SS include the designated alternate).

Isolation device. A mechanical device that physically prevents the transmission or release of energy. Examples include a manually operated electrical circuit breaker, fuse block, fuse, disconnect switch, line valve (not a check valve), slip blind, wood or metal block, Halon system control head solenoid or squib/initiator cable connector removal, or any similar device used to block or isolate energy. Push buttons, selector switches and other control circuit type of devices are not isolation devices.

Lockout. Placing a lockout device on an isolation device according to the LO/TO procedure, ensuring that the isolating device and the equipment being controlled cannot be operated until the lockout device is removed.

Lockout device. A device that uses a positive means, such as a padlock, to hold an isolation device in the desired position. Included are blank flanges and bolted slip blinds.

Normal operation. The use of equipment to perform its intended operating function.

Personal "Do Not Operate" tag. A tag placed by an AE on a lockbox/isolation device that clearly indicates his/her name and organization.

Personal lock. A lock, under the exclusive control of the AE who placed it (except where specifically addressed in this procedure), used to ensure the continuity of energy isolation while work is being performed by the AE.

Qualified person. A person, familiar with the construction and operation of the equipment and the hazards involved, trained and competent in the applicable LOTO procedures and assigned authority for the coordination and overseeing of Authorized Employee(s) implementation of LOTO protection. A Qualified Person may be referred to by a different term depending upon jurisdiction (e.g. Requesting Authority, Lockout Authority, Person in Charge, etc.).

Servicing or maintenance. Workplace activities such as constructing, installing, setting up, adjusting, inspecting, modifying and maintaining and/or servicing equipment. These activities include lubrication, cleaning or clearing jamming of equipment, and making adjustments or tool changes, where the employee may be exposed to the unexpected energization or startup of the equipment or release of hazardous energy.

Tagout. Placing a tag on an isolation device, in accordance with the LO/TO procedure, to indicate that the isolation device and the equipment being controlled cannot be operated until the tag is removed.

Tagout device. A tag and its means of attachment, that can be securely fastened to an isolation device in accordance with the LO/TO procedure, to indicate that the isolation device and the equipment being controlled cannot be operated until the tagout device is removed. The tagout device will meet Article 120.2 (E)(4).

8. REFERENCES

29 CFR 1910.147, "The Control of Hazardous Energy

(Lockout/Tagout)" 29 CFR 1910.333, "Selection and Use of

Work Practices"

NFPA 70E, "Standard for Electrical Safety in the Workplace," 2015 Edition

9. APPENDICES

Lockheed Martin MRC Blocks E/F GWETS
LOCKOUT/TAGOUT LOG SHEET
Page Number:

Lock/Tag Number	Equipment being locked out (Description, P&ID designation)	Name	Phone	Date Applied	Released	
					Date	Initial

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	11/26/19	All	New Procedure
1	01/09/20	All	RTO comments response

RESPONSIBLE PERSONNEL	
LO:	Lead Operator
OM:	Operations Manager
SC:	Subcontractor

1. INTRODUCTION

1.1 Purpose

This Standard Operating Procedure (SOP) provides instructions for removing and replacing the granular activated carbon (GAC) in the vessels.

1.2 Scope and Applicability

This SOP applies to the operation and maintenance of the VGAC treatment system located at the Lockheed Martin groundwater extraction and treatment system at the Middle River Complex in Middle River. A carbon change-out will be performed by contractor personnel and would occur as required for the treatment system. Under normal circumstances, VGAC media in both lead and lag vessels would be replaced as this approach is more efficient for small VGAC vessels. However, if necessary, a lead/lag vessels swap can be performed as described in Section 4.0.

2. PREREQUISITES

2.1 Field Preparations

2.1.1 LO: ***Review the Safety Data Sheet (SDS) for the vapor-phase carbon prior to arrival at the facility site***.

2.1.2 LO: ***Conduct on-site Health & Safety meeting with responsible personnel prior to carbon arrival and change-out. No suspended loads are allowed.***

2.1.3 SC: Stage equipment listed in the "equipment required" step next to the treatment system building.

2.1.4 LO: Obtain the current working edition of "Daily Logs".

2.1.5 LO: Refer to the "Daily Logs" to ensure that there are no operational issues reported/recorded that would prevent a normal system shut down or startup. If issues are noted, then exit this procedure until resolution is obtained.

2.1.6 LO: Inspect the GAC material to ensure that it is dry and free flowing.

2.1.7 LO: Shut down the system.

2.1.8 LO: Verify that no emergency stops are in effect (e.g., hurricane, flood). If in effect, exit this procedure. Verify that weather is such that carbon will not be blown around during wind gusts or rain.

2.2 Planning and Coordination

2.2.1 LO: IF any of the following events occur,

THEN exit this procedure

AND go to identified procedure:

A. ***A hurricane event requiring a treatment system shutdown; refer to the applicable sections of the Site Specific Health and Safety Plan***.

B. ***A flooding event requiring a treatment system shutdown; refer to applicable sections of the Site Specific Health and Safety Plan***.

2.3 Equipment Required

Wrenches, nitrile gloves, neoprene apron, hearing protection with a minimum Noise Reduction Rating of 25 (when vacuum truck is used for carbon loading/unloading), hard hat, safety glasses, and respirator fitted with P100 particulate filter cartridges.

3. VGAC VESSELS CARBON CHANGEOUT

Loading vapor phase granular activated carbon is referred to as dry loading. In the process of dry loading an activated carbon bed, attention must be paid to prevent formation of the air pockets that lead to channeling. Channeling is the absence of even flow distribution in the carbon bed, therefore reducing the efficiency and capacity of the bed. Under normal circumstances, VGAC media in both lead and lag vessels would be replaced.

3.1 Dry Removal of Spent GAC

In this procedure, the GAC will be removed through the top manway by contractor personnel using a vacuum truck or some other means of vacuum collection.

3.1.1 LO/SC: ***Don PPE***.

3.1.2 LO: ***Make sure that all system process equipment (blower, transfer pump, and well pumps) is locked out in accordance with SOP 007 "Lockouts and Tagouts".***

3.1.3 SC: ***The manway at the top is to be opened by contractor personnel. Use of portable ladders to access the top of the unit is in accordance with HASP***.

3.1.4 SC: By means of vacuum system, start removing spent carbon through top manway. If spent carbon is classified as hazardous waste a supersack or other container rated for hazardous waste must be used. ***Personnel working near the vacuum system will be provided with hearing protection (with a minimum Noise Reduction Rating of 25). The building exhaust fans shall be turned on during spent carbon removal.***

3.1.5 All Lockheed Martin procedures regarding proper waste transportation and disposal will be followed to transport and dispose of the spent carbon. The Contractor will discuss the carbon disposal characterization, manifesting, and disposal locations for the carbon with Lockheed Martin and the on an annual basis to ensure conformance with proper disposal protocols.

3.2 Dry Loading Procedure

3.2.1 LO: Visually inspect the VGAC vessel for damage including all fittings and seals. Record conditions in the Daily Logs. If any damage is noted, use the digital camera and photograph the inside of the empty VGAC vessel. If repairs are needed, make arrangements to make the necessary repairs. Once repairs are made, return to this procedure for completion.

3.2.2 SC: Open the top access port of the VGAC as instructed above.

3.2.3 SC: No suspended loads are allowed. Carbon sacks must be supported by an appropriate enclosed stand.

3.2.4 SC: Fill up vessel with fresh carbon using the equipment for vacuuming the carbon in reverse.

3.2.5 SO: Monitor for any excessive carbon dust emissions during loading operations. If excessive emissions are noted, discontinue loading operations and take corrective measures such as reducing the load rate to reduce dust.

3.2.6 SC: Close the access port securely once the carbon is installed and the bed is leveled.

3.2.7 SC: Clean the access cover and flange surface making sure that the gasket sealing-surface is free of any foreign material(s). Remove trash and clean up any carbon material in the work area.

3.2.8 LO: Thoroughly clean the exterior of the VGAC vessel and sweep the surrounding area.

3.2.9 LO: Dispose of trash and used PPE per SOP-014 “Trash Procedures”.

4. VGAC VESSELS LEAD/LAG SWAP

4.1 LO/OM: Confirm that lead/lag VGAC vessels swap is required (consult Daily Logs). Lead/lag VGAC vessels swap is performed when only VGAC-1 carbon is replaced by fresh carbon as described in 3.1. No lead/lag swap is required if carbon is replaced in both VGAC-1 and VGAC-2.

4.2 LO: disconnect inlet and outlet connections (4-inch PVC flanges) to the vessel units VGAC-1 and VGAC-2.

4.3 LO: Utilize forklift dolly to swap vessels VGAC-1 and VGAC-2 positions. Position the VGAC vessels precisely to align process piping.

4.4 LO: Re-establish inlet and outlet connections (4-inch PVC flanges) to the vessel units with the previous lag position vessel serving as the lead vessel and the new vessel serving as the lag vessel.

4.5 LO: Thoroughly clean and sweep the surrounding area.

5. REFERENCES

- DOP-002 “Daily Logs”
- SOP-007 “Lock-out/Tag-out”
- SOP-010”Waste Disposal”
- SOP-011 “Trash Procedures”
- Engineering Drawings

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	11/26/19	All	New Procedure
1	01/09/20	All	RTO comments response

RESPONSIBLE PERSONNEL	
LO:	Lead Operator
OM:	Operations Manager
SC:	Subcontractor

1. INTRODUCTION

1.1 Purpose

This Standard Operating Procedure (SOP) provides instructions for removing and replacing the granular activated carbon (GAC) in the liquid-phase vessels (LGAC).

1.2 Scope and Applicability

This SOP applies to the operation and maintenance of the LGAC treatment system located at the Lockheed Martin groundwater extraction and treatment system at the Middle River Complex in Middle River, Maryland. The carbon change-out will be performed by contractor personnel and would occur as required for the treatment system. Under normal circumstances, LGAC media in both lead and lug vessels would be replaced as this approach is more efficient for small LGAC vessels. However, if necessary, a lead/lag vessels swap can be performed as described in Section 4.0.

2. PREREQUISITES

2.1 Field Preparations

2.1.1 LO: ***Review the Safety Data Sheet (SDS) for the liquid-phase carbon prior to arrival at the facility site***.

2.1.2 LO: ***Conduct on-site Health & Safety meeting with responsible personnel prior to carbon arrival and change-out***. ***No suspended loads are allowed.***

2.1.3

2.1.4 SC: Stage equipment listed in the "equipment required" step next to the treatment system building.

2.1.5 LO: Obtain the current working edition of "Daily Logs".

2.1.6 LO: Refer to the "Daily Logs" to ensure that there are no operational issues reported/recorded that would prevent a normal system startup. If issues are noted, then exit this procedure until resolution is obtained.

2.1.7 LO: Inspect the GAC material to ensure that it is dry and free flowing.

2.1.8 LO: Shut down the system.

2.1.9 LO: Verify that no emergency stops are in effect (e.g., hurricane, flood). If in effect, exit this procedure. Verify that weather is such that carbon will not be blown around during wind gusts or rain.

2.2 Planning and Coordination

2.2.1 LO: IF any of the following events occur,

THEN exit this procedure

AND go to identified procedure:

A. ***A hurricane event requiring a treatment system shutdown; refer to the applicable sections of the Site Specific Health and Safety Plan***.

B. ***A flooding event requiring a treatment system shutdown; refer to applicable sections of the Site Specific Health and Safety Plan***.

2.3 EQUIPMENT REQUIRED

Wrenches, nitrile gloves, neoprene apron, hearing protection with a minimum Noise Reduction Rating of 25 (when vacuum truck is used for carbon loading/unloading), hard hat, safety glasses, and respirator fitted with P100 particulate filter cartridges, portable air compressor with regulator and flexible air hose.

3. LGAC VESSELS CARBON CHANGEOUT

Loading liquid phase granular activated carbon is referred to as dry loading. In the process of dry loading an activated carbon bed, attention must be paid to prevent formation of the air pockets that lead to channeling. Channeling is the absence of even flow distribution in the carbon bed, therefore reducing the efficiency and capacity of the bed. Under normal circumstances, LGAC media in both lead and lag vessels would be replaced.

3.1 Draining of LGAC Vessel

In this procedure, water from the LGAC vessels (LGAC-1 and LGAC-2) will be drained by using compressed air to displace water from the vessel.

3.1.1 LO: ***Don PPE***.

3.1.2 LO: ***Shut down the system and make sure that all system process equipment (blower, transfer pump, and well pumps) is locked out in accordance with SOP 007 "Lockouts and Tagouts".***

3.1.3 LO: Close valves V-303 and V-305 to isolate LGAC-1 and LGAC-2 from upstream equipment.

3.1.4 LO: Connect compressed air hose from a source of compressed air (portable air compressor) to a ¾" vent valve located on top of LGAC-1.

3.1.5 LO: Start air compressor and apply slight air pressure (approximately 5 psig) to LGAC-1. Monitor pressure in LGAC-1 using PG-401 and effluent flow using flow meter FM-1.

3.1.6 LO: Maintain air pressure in LGAC-1 to obtain the effluent flow between 2 to 5 gallons per minute. Do not exceed 5 pounds per square inch gauge (psig) pressure during water displacement.

3.1.7 LO: Monitor sampling port SPL-4 effluent. When air is detected in SPL-4, close ¾" vent valve located on top of LGAC-1 and stop compressed air flow to LGAC-1. At this point LGAC-1 and LGAC-2 are drained.

3.1.8 LO: Disconnect compressed air hose from ¾" vent valve located on top of LGAC-1and carefully de-pressurize LGAC-1 and LGAC-2 using a ¾" vent valve located on top of LGAC vessels.

3.2 Dry Removal of Spent GAC

In this procedure, the GAC will be removed through the top manway by contractor personnel using a vacuum truck or some other means of vacuum collection.

3.2.1 LO/SC: ***Don PPE***.

3.2.2 LO: ***Shut down the system and make sure that all system process equipment (blower, transfer pump, and well pumps) is locked out in accordance with SOP 007 "Lockouts and Tagouts".***

3.2.3 SC: ***The manway at the top is to be opened by contractor personnel. Use of portable ladders to access the top of the unit is in accordance with HASP***.

3.1.5 SC: By means of vacuum system, start removing spent carbon through top manway. If spent carbon is classified as hazardous waste a supersack or other container rated for hazardous waste must be used. ***Personnel working near the vacuum system will be provided with hearing protection (with a minimum Noise Reduction Rating of 25). The building exhaust fan shall be turned on during spent carbon removal***.

3.1.5 All Lockheed Martin procedures regarding proper waste transportation and disposal will be followed to transport and dispose of the spent carbon .

3.3 Dry Loading Procedure

3.3.1 LO: Visually inspect the LGAC vessel for damage including all fittings and seals. Record conditions in the Daily Logs. If any damage

is noted, use the digital camera and photograph the inside of the empty LGAC vessel. If repairs are needed, make arrangements to make the necessary repairs. Once repairs are made, return to this procedure for completion.

3.3.2 SC: Open the top access port of the LGAC.

3.3.3 SC: No suspended loads is allowed. At no time shall any personnel reach under a suspended sack of carbon. Carbon sacks must be supported by an appropriate enclosed stand.

3.3.4 SC: Fill up vessel with fresh carbon using the equipment for vacuuming the carbon in reverse.

3.3.5 SO: Monitor for any excessive carbon dust emissions during loading operations. If excessive emissions are noted, discontinue loading operations and take corrective measures such as reducing the load rate to reduce dust.

3.3.6 SC: Close the access port securely once the carbon is installed and the bed is leveled.

3.3.7 SC: Clean the access cover and flange surface making sure that the gasket sealing-surface is free of any foreign material(s). Remove trash and clean up any carbon material in the work area.

3.3.8 SO: Re-start the system to fill up the LGAC vessels with water. Vent air using ¾" vent valves at the top of the LGAC vessels. Shut down the system, wait 24 hours to wet the carbon and restart the system.

3.3.9 LO: Return any tools used during this procedure to the tool cabinet.

3.3.10 LO: Thoroughly clean the exterior of the LGAC vessel and sweep the surrounding area.

3.3.11 LO: Dispose of trash and used PPE per SOP-014 "Trash Procedures".

4. LGAC VESSELS LEAD/LAG SWAP

4.1 LO/OM: Confirm that lead/lag LGAC vessels swap is required (consult Daily Logs). Lead/lag LGAC vessel swap is performed when only LGAC-1 carbon is replaced by fresh carbon as described in 3.3. No lead/lag swap is required if carbon is replaced in both LGAC-1 and LGAC-2.

4.2 LO: disconnect inlet and outlet connections (1-inch PVC pipe unions) to the vessel units LGAC-1 and LGAC-2.

4.3 LO: Utilize forklift dolly to swap vessels LGAC-1 and LGAC-2 positions. Position the LGAC vessels precisely to align process piping.

4.4 LO: Re-establish inlet and outlet connections (1-inch PVC pipe unions) to the vessel units with the previous lag position vessel serving as the lead vessel and the new vessel serving as the lag vessel.

4.5 LO: Thoroughly clean and sweep the surrounding area.

5. REFERENCES

- DOP-002 “Daily Logs”
- SOP-007 “Lock-out/Tag-out”
- SOP-011 “Waste Disposal”
- SOP-011 “Trash Procedures”
- Engineering Drawings

WASTE TRANSPORTATION, DISPOSAL AND STORAGE	Identifier:	SOP-010	
	Revision:	0	
	Effective Date:	TBD	Page: 1 of 4

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	11/26/19	All	New Procedure
1	01/09/20	All	RTO comments response

RESPONSIBLE PERSONNEL	
LO	Lead Operator
OM	Operations Manager

1. INTRODUCTION

1.1 Purpose

This Standard Operating Procedure (SOP) is to be followed when transporting liquid and solid wastes generated during the system operation.

1.2 Scope and Applicability

This SOP is to be used when storing, transporting, and disposing of liquids generated during air stripper cleaning, spent filter bags, and other wastes associated with the operation of Lockheed Martin groundwater extraction and treatment system at the Middle River Complex in Middle River, Maryland.

2. PRECAUTIONS AND LIMITATIONS

Wastes may be contaminated with volatile organic compounds, metals, and acids. Therefore, it is extremely important that the operator use care to avoid inhalation or direct contact with any wastes thereof.

3. PREREQUISITES

3.1 Field Preparations

3.1.1 Gather and stage all needed equipment (listed below).

3.2 Planning and Coordination

3.2.1 FO/ FT: IF any of the following events occur,
THEN exit this procedure
AND go to identified procedure:

A. ***A hurricane event; refer to applicable sections of the Site Specific Health and Safety Plan***.

B. ***A flooding event; refer to applicable sections of the Site Specific Health and Safety Plan***.

3.3 Equipment

The following items are located in the Treatment Building unless otherwise stated:

- Spill containment kit including flat shovels
- Labeling supplies

- ***Proper personal protective equipment (PPE; e.g., steel-toed boots, nitrile gloves, safety glasses or goggles, hard hat, traffic vest)***

- Drum and drum pallet - Any trash items that have been in contact with groundwater – or that may have been in contact with groundwater – must be discarded with used PPE and other groundwater-contaminated items. These may be temporarily gathered in a bucket or garbage bag and transferred to a suitable 55-gallon drum. This drum must be labeled with the date that the initial waste was placed in it and labeled as F-listed TCE waste. The drum should be placed on a drum pallet and stored in the treatment building as it is filled. When full, the drum shall be disposed of per Lockheed Martin procedures and all applicable regulations. Handling these items requires appropriate personal protective equipment (PPE; e.g., safety glasses and chemical protective gloves, such as nitrile gloves).

4. STEP-BY-STEP PROCEDURE

4.1 General waste categories:

Vapor-phase activated carbon – Not a listed waste; must be sampled prior to change-out to determine if it is a characteristic hazardous waste. Based on operation of the multi-phase extraction system in this area, this material is expected to be hazardous. These wastes should be removed from site immediately after they are generated. Any change to this must be coordinated with Lockheed Martin and the RTO; therefore, there are no storage requirements.

Liquid-phase activated carbon – If sampling shows that the water entering the liquid-phase carbon has a TCE concentration below 5 µg/L, the carbon is not considered a listed waste. The carbon must be sampled prior to change-out to determine if it is a characteristic hazardous waste. Based on operation of the multi-phase extraction system in this area, this material is not expected to be hazardous. These wastes should be removed from site immediately after they are generated. Any change to this must be coordinated with Lockheed Martin and the RTO; therefore, there are no storage requirements.

Water from extraction wells and prior to treatment in the air stripper – this groundwater, and any solids in contact with it are to be considered F-listed wastes and shall be handled accordingly. The water may be treated through the air stripper; if treatment within a reasonable time period is not possible, the water should be transferred to an appropriately-labeled drum on a drum pallet within the building awaiting treatment or proper disposal.

Solid wastes may be temporarily gathered in a bucket or garbage bag and immediately transferred to a suitable 55-gallon drum. This drum must be labeled with the date that the initial waste was placed in it and labeled as F-listed TCE waste. The drum should be placed on a drum pallet and stored in the

treatment building as it is filled. When full, the drum shall be disposed of per Lockheed Martin procedures and all applicable regulations. Handling these items requires appropriate personal protective equipment (PPE; e.g., safety glasses and chemical protective gloves, such as nitrile gloves).

4.2 OM: Ensure that all profile and manifests are reviewed by Lockheed Martin and the RTO, and signed by Lockheed Martin Corporation. Ensure that disposal facility and transporter (if necessary) are approved by Lockheed Martin Corporation.

4.3 OM: Work with Lockheed Martin Corporation to determine which waste from the site is considered Listed Waste.

4.4 OM: Follow all site-specific and Lockheed Martin Corporation requirements as provided in the references below.

4.5 LO/OM: Coordinate pick up and replacement of the drum containing F-listed waste when it approaches capacity with designated hauling company. Oversee pick-up.

4.6 LO: Dispose of trash and used PPE per SOP-014 “Trash Procedures”.

5. REFERENCES

- SOP-011 “Trash Procedures”
- Tetra Tech, 2019. Soil Management Plan for Blocks A, B, D, D Panhandle, F, G and H, Lockheed Martin Middle River Complex, 2323 Eastern Boulevard, Middle River, Maryland. April.
- Tetra Tech, 2019. Soil Management Plan for Blocks E and I, Lockheed Martin Middle River Complex, 2323 Eastern Boulevard, Middle River, Maryland. April.
- Tetra Tech, Inc., 2019. 2019 Waste Management Plan, Lockheed Martin Middle River Complex, 2323 Eastern Boulevard Middle River, Maryland. August.
- Lockheed Martin Corporation (Lockheed Martin), 2008. Enterprise Operations (EO)-28 and Lockheed Martin Minimum Requirements for Intrusive Fieldwork Work Plans.
- Lockheed Martin Corporation (Lockheed Martin), 2009. Energy, Environment, Safety, and Health (EESH) Remediation Waste Management Procedure No: EROP-03, Revision 4 (effective April 17, 2009).
- Lockheed Martin Corporation (Lockheed Martin), 2016. Remediation Contractor’s ESH Handbook, Revision 2, effective May 1.

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	11/26/19	All	New Procedure
1	01/09/20	All	RTO comments response

1. INTRODUCTION

1.1 Purpose

This Standard Operating Procedure (SOP) provides instructions for discarding items.

1.2 Scope and Applicability

This SOP applies to trash procedures at the Lockheed Martin groundwater extraction and treatment system at the Middle River Complex in Middle River, Maryland.

2. STEP BY STEP INSTRUCTIONS

2.1 Any trash items that have been in contact with groundwater – or that may have been in contact with groundwater – must be discarded with used PPE and other groundwater-contaminated items. These may be temporarily gathered in a bucket or garbage bag and transferred to a suitable 55-gallon drum. This drum must be labeled with the date that the initial waste was placed in it and labeled as F-listed TCE waste. The drum should be placed on a drum palate and stored in the treatment building as it is filled. When full, the drum shall be disposed of per Lockheed Martin procedures and all applicable regulations. Handling these items requires appropriate personal protective equipment (PPE; e.g., safety glasses and chemical protective gloves, such as nitrile gloves).

2.2 All other garbage must be deposited into a garbage can located in the treatment system building. Larger items may be placed in the designated dumpster. Closed bags of garbage may also be placed in the designated dumpster.

DAILY LOGS	Identifier: DOP-001 Revision: 0 Effective Date: TBD	Page: 1 of 5

CHANGE REQUEST REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	11/26/19	ALL	New Procedure
1	01/09/20	ALL	RTO comments response

RESPONSIBLE PERSONNEL	
LO:	Lead Operator
OM:	Operations Manager

1. INTRODUCTION

1.1 Purpose

This Detailed Operating Procedure (DOP) provides instructions for completing the Daily Logs. Select data within the Daily Log will be entered manually by the Lead Operator and select data will be automatically collected from the HMI every 24 hours. This procedure will be performed once during the final hour of each site visit.

1.2 Scope and Applicability

This DOP applies to Daily Logs for the Lockheed Martin groundwater extraction and treatment system at the Middle River Complex in Middle River, Maryland.

2. PREREQUISITES

2.1 Field Preparations

2.1.1 LO: Obtain current "Daily Logs"

2.1.2 LO: If the system is not running, verify that the time and reason preventing normal operations have been noted in Daily Logs.

2.1.3 LO: Verify that no emergency stops are in effect (e.g., hurricane, flood).

2.2 Planning and Coordination

2.2.1 OM: IF any of the following events occur,
THEN exit this procedure
AND go to identified procedure:

A. ***A hurricane event requiring a treatment system shutdown; refer to the applicable sections of the Site Safety and Health Plan***.

B. ***A flooding event requiring a treatment system shutdown; refer to the applicable sections of the Site Safety and Health Plan***.

2.3 Equipment Required

Daily Logs

3. DAILY LOGS STEP-BY-STEP INSTRUCTIONS

3.1 LO: Print the Daily Log Sheet (attached).

3.2 LO: Complete, review and sign the Daily Log.

3.3 LO: Scan each Daily Log to the designated directory on the network and place the paper copy in the file cabinet located in the treatment system building.

The data below will be automatically collected and stored.

No.	Parameter Description	Instrument Description	Instrument P&ID Symbol	Value	Unit
1	Extraction well EW-1 flow rate	Liquid flow transmitter	FM-101		gpm
2	Extraction well EW-1 total flow	Liquid flow transmitter	FM-101		gallons
3	Extraction well EW-2 flow rate	Liquid Flow transmitter	FM-201		gpm
4	Extraction well EW-2 total flow	Liquid flow transmitter	FM-201		gallons
3	Extraction well EW-1 level	Submersible level transmitter	SP-101		feet
4	Extraction well EW-2 level	Submersible level transmitter	SP-201		feet
5	GWETS effluent flow rate	Liquid flow transmitter	FM-1		gpm
	GWETS effluent total flow	Liquid flow transmitter	FM-1		gallons
6	Air stripper sump level	Differential pressure transmitter	SPT-1		inches
7	Bag filters inlet pressure	Pressure transmitter	PT-1		psig
8	Air stripper vacuum	Differential pressure transmitter	PT-2		in.w.c.
9	Air stripper effluent air flow	Air velocity transmitter	AFT-1		CFM
10	Building inside temperature	Temperature transmitter	TT-1		CFM

The data below will be manually collected by the Operator. Refer to Table I2-1 for normal/expected operating ranges.

Operator Manual Daily Log Sheet

Date: Time: Names:

No.	Parameter Description	Instrument Description	Instrument P&ID Symbol	Value	Unit
1	Extraction well EW-1 total flow	Liquid flow transmitter	FM-101		gallons
2	Extraction well EW-2 total flow	Liquid flow transmitter	FM-201		gallons
3	GWETS effluent total flow	Liquid flow transmitter	FM-1		gallons
	GWETS effluent total flow	Liquid flow totalizer	MFT-1		gallons
4	Air stripper sump level	Differential pressure transmitter	SPT-1		inches
5	Bag filter BF-1 inlet pressure	Pressure gauge	PG-301		psig
6	Bag filter BF-1 outlet pressure	Pressure gauge	PG-302		psig
7	Bag filter BF-2 inlet pressure	Pressure gauge	PG-303		psig
8	Bag filter BF-2 outlet pressure	Pressure gauge	PG-304		psig
9	LGAC-1 inlet pressure	Pressure gauge	PG-401		psig
10	LGAC-2 inlet pressure	Pressure gauge	PG-402		psig
11	Air stripper vacuum	Differential pressure transmitter	PT-2		in.w.c.
12	Blower inlet vacuum	Differential pressure gauge	LPG-1		in.w.c.
13	Blower outlet pressure	Differential pressure gauge	LPG-2		in.w.c.
14	VGAC-1 outlet pressure	Differential pressure gauge	LPG-3		in.w.c.
15	Blower outlet air temperature	Temperature gauge	TG-1		deg.F
16	VGAC-1 outlet air temperature	Temperature gauge	TG-2		deg.F
17	VGAC-2 outlet air temperature	Temperature gauge	TG-2		deg.F
18	Air stripper effluent air flow	Air velocity transmitter	AFT-1		CFM
19	Bag filters inlet pressure	Pressure transmitter	PT-1		psig
20	Building inside temperature	Temperature transmitter	TT-1		CFM

The following additional general information will also be included on Daily Log Sheet:

- Time operator arrived and left the site
- Reason for the site visit (i.e., regular bi-weekly visit or visit due to an alarm)
- Maintenance completed that day
- Checks and inspections completed that day
- Samples collected that day
- Other work completed that day
- Problems encountered

4. REFERENCES

- Remediation Contractor's ESH Handbook, Lockheed Martin Corporation Energy, Environment, Safety & Health; Revision 2, May, 2014

AIR STRIPPER CLEANING	Identifier: DOP-002 Revision: 0 Effective Date: TBD	Page: 1 of 4

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	11/26/19	All	New Procedure
1	01/09/20	All	RTO comments response

RESPONSIBLE PERSONNEL	
LO:	Lead Operator
OM:	Operations Manager
SC:	Subcontractor

1. INTRODUCTION

1.1 Purpose

This Detailed Operating Procedure (DOP) provides instructions for cleaning the air stripper.

1.2 Scope and Applicability

This DOP applies to the operation and maintenance of the air stripper located at the Lockheed Martin groundwater extraction and treatment system at the Middle River Complex in Middle River, Maryland. The air stripper cleaning will be performed by the performing contractor personnel and would occur as required for the treatment system.

2. PREREQUISITES

2.1 Field Preparations

2.1.1 LO: ***Conduct on-site Health & Safety meeting with responsible personnel prior to air stripper cleaning***.

2.1.2 LO: Stage cleaning equipment and supplies listed in the "equipment required" inside the treatment system building.

2.1.3 LO: Obtain the current working edition of "Daily Logs".

2.1.4 LO: Ensure that a copy of "Air Stripper Manufacturer Manual" is available for reference.

2.1.5 LO: Refer to the "Daily Logs" to ensure that there are no operational issues reported/recorded that would prevent a normal system shut down or startup. If issues are noted, then exit this procedure until resolution is obtained.

2.1.6 LO: Shut down the system.

2.1.7 LO: Verify that no emergency stops are in effect (e.g., hurricane, flood). If in effect, exit this procedure. Verify that weather is such that carbon will not be blown around during wind gusts or rain.

2.2 Planning and Coordination

2.2.1 LO: IF any of the following events occur,

THEN exit this procedure

AND go to identified procedure:

A. ***A hurricane event requiring a treatment system shutdown; refer***

to the applicable sections of the Site Specific Health and Safety Plan.

B. ***A flooding event requiring a treatment system shutdown; refer to applicable sections of the Site Specific Health and Safety Plan.***

2.3 EQUIPMENT REQUIRED

Wrenches, nitrile gloves, neoprene apron, plastic sheeting, bristle brush, pressure washer, wet vac, 5-foot tall work platform.

3. CLEANING PROCEDURE

Tray fouling due to iron precipitation, solids loading, or bio-fouling is evidenced by increased pressure on the blower inlet, decreased stripper performance (removal rates not being met) or noticeable discoloration on the trays. Stripper cleaning is required when trays are fouled.

3.1 Air Stripper Disassembly

In this procedure, air stripper trays will be disconnected and removed for cleaning.

3.1.1 LO: ***Don PPE***.

3.1.2 LO: ***Shut down the system and make sure that all system process equipment (blower, transfer pump, and well pumps) is locked out in accordance with SOP 007 "Lockouts and Tagouts".***

3.1.3 LO: Use plastic sheeting to line the floor sump to protect floor but allow the water to drain to the sump.

3.1.4 LO: Disconnect the stripper vapor discharge pipe from the stripper exhaust stack piping and 1-inch PVC groundwater feed line from the top of the stripper.

3.1.5 LO: Unscrew the hold-down rod nuts (cranks) and remove the gasket hold-down ring.

3.1.6 LO: Remove the stripper trays and place them on plastic sheeting. The tray seal pots will have some water remaining in them.

3.2 Cleaning Procedure

In this procedure, the fouled trays will be cleaned using a pressure washer and brush.

3.2.1 LO: Prepare pressure washer for work. Connect a temporary garden hose from the pressure washer to a potable water source in the nearby pump shed.

3.2.2 LO: Using a pressure washer and medium bristle brush clean any residue from the tray surfaces, concentrating on the sieve holes. DO NOT USE SOAP or cleaning agents unless they will be thoroughly rinsed from the trays; soap residue can affect stripper performance. Liquid from washing will drain to the floor sump.

3.2.3 LO: For hard to remove scales and precipitates, a dilute (5%-10%) muriatic acid and water solution can be used to rinse or soak the trays. To accomplish this an open top rectangular plastic tank (30"L x 30"W x 12"D) will be used to soak the trays in acid solution. The remaining acid solution will be neutralized before disposal. Be certain to completely rinse the acid solution off the trays before reassembling the unit.

3.2.4 LO: Reassemble the trays--note that they are numbered and that a mark is used to assist in proper alignment of the trays during reassembly. Check to make sure the gasket is still seated correctly and undamaged.

3.2.5 LO: Reinstall the gasket hold-down ring and the hold-down rod nuts (cranks.) The hold-down tensioning springs should be compressed to a length of 3-1/2 inches for proper gasket sealing.

3.2.6 LO: Reattach all piping connections.

3.2.7 LO: Use a utility sump pump to pump all liquids accumulated in the floor sump to a waste collection drum (properly maintained and labeled). Drum's contents will be disposed in accordance with the procedures described in SOP-013.

3.2.8 LO: Dispose of trash and used PPE per SOP-011 "Trash Procedures".

3.2.9 LO: Restart the system as described in SOP-003 "Routine Start-up/Shut-down".

4. REFERENCES

- "Air Stripper Manufacturer Manual"
- SOP-007 "Lock-out/Tag-out"
- SOP-003 "Routine Start-up/Shut-down"
- DOP-001 "Daily Logs"
- SOP-010 "Waste Disposal"
- SOP-011 "Trash Procedure

QED
Environmental Systems

EZ-Stacker Air Stripper

Operation & Maintenance Manual

P/N 95166 □/1□/13

QED
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IMPORTANT—PLEASE READ

Thank you for choosing QED treatment equipment to handle your air stripping needs. This manual contains information relating to equipment commonly ordered as part of a QED stripper system. This manual is generic, and your specific order may not include all the equipment listed within this manual. Upon receipt of this equipment, it is important for the customer to do the following:

1. Inspect all the pieces of equipment shipped to verify the order is complete,
2. Confirm that vendor-specific instructions are included for each piece of equipment,
3. Remove any additional instructions that have been included in this manual which are not part of your specific sales order. This will avoid future confusion.

A specific example of this relates to the transfer pumps. This manual includes operation and maintenance instructions for centrifugal transfer pumps, although sometimes pumps are not part of the customer's specific order. Upon inspection of equipment, if the customer finds that pumps are not part of their order, the pump instructions should be removed from this manual. The other pieces of equipment should similarly be inspected and checked that the associated instructions are included in this manual, and any non-relevant instructions are removed.

Should you have any questions about your QED equipment, please contact the QED Service Department at 1-800-624-2026 or 734-995-2547. Thank you for your order and good luck with startup.

QED EZ-Stacker™ Operations and Maintenance Manual

Introduction

This manual contains instructions for installing, start-up and operation of a QED EZ-Stacker™ Air Stripper for the treatment of dissolved-VOC-contaminated waters. The EZ-Stacker™ Air Stripper is a sieve tray type of stripper which accomplishes mass transfer by creating a large amount of fine air bubbles into which volatile organics are stripped. Efficient stripping with this type of a unit is affected by:

- Water temperature-- higher temperature allows better stripping
- Specific compound being stripped--higher Henry's Law constant equals better stripping
- Air to water ratio--the higher the air to water ratio (air flow for a given water flow) the better the stripping
- Stripper efficiency--certain design elements, such as tray design affect stripping efficiency
- Surfactants (soaps, cleaning agents, etc.) and oil/grease can negatively impact stripping efficiency

From an operation standpoint the single most important factor is ensuring that the recommended amount of clean air is flowing through the stripper. Air flow is most affected by tray fouling (typically with precipitated iron oxides) which creates back pressure on the blower and causes it to operate at a lower air flow point on its curve. Maintaining clean trays and using the excess capacity on the blower can help control fouling conditions. Occasional gasket replacement can be anticipated depending on the frequency of stripper disassembly and reassembly. The stripper blowers and any transfer pumps should be regularly maintained based upon the manufacturer's maintenance schedule. All other stripper components are largely maintenance free. Please refer to Figure 1 at the end of this manual for understanding terminology.

Installation

<u>Installing Skid Mounted Systems</u>

Complete skid mounted systems arrive at your site as shown in Figure 1. A system of this type is mounted, piped and optionally wired at the factory. All components and functions are 100% wet checked.

> **Influent piping**. Connect system influent piping to the influent feed pump or directly to the stripper at the piping connection located on the top of the stripper. Factory piped influent feed pump systems use flexible pressure hose between the pump and the stripper influent piping connection and includes a check valve to prevent air backup into a transfer tanks or oil water separator. If the stripper

influent is plumbed directly on site, a flexible hose connection is recommended to ease stripper disassembly and reassembly during use.

Effluent piping. Factory piped effluent discharge pump systems use flexible pressure hose between the stripper discharge piping connection, located at the bottom of the stripper sump and the effluent discharge pump. Factory installed gravity discharge piping connects at the same discharge point on the stripper sump and utilizes a gravity drain kit which includes a siphon break and water head seal. If the stripper is plumbed on site connect the discharge pump to the stripper sump at the discharge connector. Gravity drain piping should be a minimum of 2-3" in diameter (depends on the model) and designed as shown in Figures 4 or 5.

Blower piping. *Important! Total sump pressures should never exceed 50" WC! This will void QED Warranty.* The blower piping that connects the blower to the air stripper are typically of an inverted-U shape, with a high leg to reduce the chance of flooding the blower in the event of an unforeseen flood condition.

On EZ-2.xP models, QED typically use regenerative blowers sized so that they do not require much, if any, throttling of the airflow. Regenerative blowers are limited in the amount of throttling that can be applied, since added backpressures may cause the blower motor to run above full-load-amp condition and cause the blower motor to overheat. If customer is installing their own piping kit on an oversized regenerative blower, it is recommended that an air dilution/bleed valve be installed in the blower piping to provide flexibility in controlling airflow.

Stripper Air Discharge Stack. The stripper discharge pipe is located on top of the air stripper and is 4"or 6" in diameter (depending upon model). The wider section of the discharge porting contains the demister element which removes entrained water droplets from the air exiting the stripper. Coalesced water droplets collect on the demister and then fall back into the stripper top tray. Piping or ducting for the stripper discharge stack should be of equal diameter or larger to avoid creating excess back pressure on the stripper blower. A flexible coupling, such as a Fernco brand, is recommended to connect the discharge pipe to the stripper air discharge stack to ease unit disassembly for cleaning. It is also important to pipe the air stripper air discharge such that it is not in proximity with the air stripper blower inlet; this minimizes the risk of sending already-contaminated air back into the air stripper and reducing stripper performance.

Sensors. Normal sensors used with this type of air stripper include a sump high level alarm float sensor, sump low air pressure sensor and optional discharge pump on-off float sensor. If these sensors are supplied with the stripper they will be installed in the stripper sump and piping. Often the system control panel must be mounted in a remote location from the stripper (in cases where the location is classified as an explosion hazard area.) If the panel is to be remotely-mounted a licensed electrician should hook the stripper sensors up to the panel. It is

important that these sensors be tested prior to operating the stripper. A frequent cause of improperly operating systems are float sensors which act in the opposite sense of that which the control panel expects (normally-open vs. normally-closed). It is also important to conform to electrical code requirements for classified areas; sensors may require intrinsically safe barriers.

Installing Bare Stripper Sump and Tray Systems

Bare stripper sump and tray systems are provided in cases where the contractor will mount the stripper to a user supplied skid or concrete pad. These systems are supplied with a second gasket compression ring that anchors the gasket compression rods at the bottom of the stripper. The bottom gasket compression ring has tabs protruding around its circumference which allow mounting of the ring to a skid or concrete pad.

If the blower is purchased from the factory it is recommended that the blower piping package also be purchased. If the contractor is supplying their own blower it must meet the typical performance specifications listed below to achieve the desired contaminant removals. If the air stripper is built to non-standard parameters, the performance specifications below may not apply.

Air Flow:	140 cfm (for EZ-2.xP) or 280 cfm (for EZ-4.xP) at maximum system back pressure
Pressure:	Sufficient to over come tray, piping and air treatment process back pressures at a flow rate of 140cfm. *Important! Total sump pressures should never exceed 50" WC! This will void QED Warranty.*
Tray Back Pressures	16-20"H_2O for 4-trays; 24-30"H_2O for 6-trays (assuming no add'l pressure from equipment downstream of air stack).

The blower piping should include a high leg which acts to reduce the risk of flooding the blower if the high sump level sensor was to malfunction in the stripper sump. See Figures 2 and 3 (for models EZ-2.xP and EZ-4.xP, respectively) for examples of proper blower piping configurations.

The EZ-2.xP models typically use regenerative blowers sized so that they do not require much, if any, throttling of the airflow. Regenerative blowers are limited in the amount of throttling that can be applied, since added backpressures can cause the blower motor to run above full-load-amp conditions and overheat. If customer is installing their own piping kit on an oversized regenerative blower, it is recommended that an air dilution/bleed valve be installed in the blower piping to provide flexibility in controlling airflow. A throttle valve is shown in Figure 1; a dilution/bleed valve is not shown.

Influent and effluent piping and sensor hook-up should be as described in the section on skid mounted systems, above.

Startup

The EZ-Stacker™ stripper is designed to start up dry without priming the sealpot or throttling the blower. The stripper blower should be running before water is introduced to the stripper. Water flows into the top tray and proceeds tray by tray to the stripper sump. Stripper seal pots fill with water and allow complete start up during intermittent operation. IMPORTANT: Before starting the system verify correct blower motor rotation (plus any other motors within the treatment system).

Verify that the sump air pressure is 16-20" H_2O for 4-tray systems or 24-30" H_2O for 6-tray systems (it is normal to see lower sump pressures at the very start of operation before the seal pots and trays fill with water.) Sump pressures lower than these values may indicate either a blower throttle which is not sufficiently open or insufficiently-compressed tray seal gaskets. *If the system configuration includes additional backpressure (from vapor phase carbon, for example), the sump pressures will be greater than these values. it is important that the blower is sized to accommodate the added pressures, being careful that air stripper sump pressures never exceed 50" WC. Total sump pressures exceeding 50" WC will void QED Warranty!* Check the blower piping throttle valve and make sure the hold-down rods are tightened firmly, but not over tightened. The hold-down tensioning springs should be compressed to a length of 3-1/2 inches for proper gasket sealing.

Step by step startup includes:

1. Power the main control panel on.
2. Turn the blower on. For QED supplied control panels set the motor operation switch to AUTO.
3. Turn the stripper feed pump on (allow water to enter the stripper for gravity feed systems.) For QED supplied control panels set the motor operation switch to AUTO (some systems have a delay timer on the feed pump--check control panel documentation for details.)
4. Turn the discharge pump on. For QED supplied control panels set the motor operation switch to AUTO.
5. Open or close the blower air flow throttle and air dilution valve (if required) to produce a sump pressure reading of 16-20"H_2O for 4-tray systems or 24-30"H_2O for 6-tray systems (these are typical values, but these may differ depending whether any other pressures need to be accounted for. NOTE: It is normal to see

lower sump pressures at the very start of operation due to sealpots and trays filling with water.

Operation

Stripper operation is normally automatic. One option for QED supplied control panels is a blower time-out relay which continues to run the blower for several minutes after the feed pump stops. Continued blower operation insures that any residual water left on the stripper trays has sufficient time to strip before the blower shuts down. A time of at least 15 minutes is recommended. Strippers with start-stop cycles of more than 2-4 times per hour should be set to run continuously.

For sites with high dissolved iron content stripper cleaning may be required. Tray fouling is evidenced by increasing sump back pressure. Opening the blower air flow throttle will allow continued operation in some situations and will lengthen the time between tray cleanings. It is most important to maintain an air flow of 140cfm through the unit. If the stripper air flow decreases the stripping efficiency decreases. Below 100 cfm air flow the stripper will start begin to "weep" water through the tray holes from upper trays to lower trays before the water has had sufficient residence time for removal. If stripper performance falls off, check for tray fouling or a blower air flow throttle that is not opened sufficiently.

Maintenance

Tray fouling due to iron precipitation, solids loading, or bio-fouling is evidenced by increased sump pressures, decreased stripper performance (removal rates not being met) or noticeable discoloration on the trays. Stripper cleaning is required when trays are fouled.

<u>Step by step cleaning includes</u>:

1. Before working on any equipment lock-out power to the unit.
2. Disconnect the stripper discharge pipe from the stripper exhaust stack piping.
3. Unscrew the hold-down rod nuts (cranks) and remove the gasket hold-down ring.
4. Remove the stripper trays. Please note the tray seal pots will have some water remaining in them.
5. Using a pressure washer and medium bristle brush clean any residue from the trays surfaces, concentrating on the sieve holes. DO NOT USE SOAP or cleaning agents unless they will be thoroughly rinsed from the trays; soap residue can affect stripper performance.

6. For hard to remove scales and precipitates a dilute (5%-10%) muriatic acid and water solution can be used to rinse or soak the trays. Be certain to completely rinse the solution off the trays before reassembling the unit.
7. Reassemble the trays--note that they are numbered and that a mark is used to assist in proper alignment of the trays during reassembly. Check to make sure the gasket is still seated correctly and undamaged.
8. Reinstall the gasket hold-down ring and retension the hold-down rod nuts (cranks.) The hold-down tensioning springs should be compressed to a length of 3-1/2 inches for proper gasket sealing.
9. Reattach any pipe and exhaust stack connections.
10. Follow Start-Up instructions, above.

Other stripper maintenance items include:

1. Periodically check blower for vibration. Bearings may require eventual service or conditions of excessive motor start / stop cycles may lead to premature motor or blower failure.
2. Check gasket condition during disassembly for cleaning. The gasket is designed to allow numerous assembly and disassemblies before requiring replacement. Contact QED for information and pricing about gasket replacement kits.
3. The stripper demister element is essentially maintenance free, although dried inorganic residue can build up within the demister and affect demister operation. This condition is evidenced in water droplets not being removed by the demister and blowing out of the stripper exhaust stack--occasionally on start-up water is discharged from the stripper stack, which is normal. The demister may be cleaned with a dilute muriatic and water solution (5%-10%) as instructed for tray cleaning.
4. Solids may build up in the sump. These solids can be suctioned out during tray cleaning operations.
5. Periodically check the structural integrity of the stripper sump, trays and top. Check bulkhead nuts for snugness. Cracks or loose fittings will normally be evidenced by water leakage.

Troubleshooting

Some common problems include:

1. *Leaks*. Leaks around trays or at the sump indicate an insufficiently compressed tray gasket. Make sure the hold-down tensioning springs are compressed to a length of 3-1/2 inches for proper gasket sealing. Also check for damaged gaskets (over compressed gaskets, cut gaskets, loose gaskets, etc.) Damaged gaskets

should be replaced with new gaskets. Contact QED for information and pricing about gasket replacement kits. For leaks at fittings, check for fitting tightness.

2. *Stripper not meeting removal requirements*. Contaminated stripper air is the most common reason for poor stripping performance within the low-ppb concentration range--make sure that the stripper blower intake is drawing in clean, uncontaminated air. Check for sufficient air flow through the stripper. Check that trays are clean. Check that demister is not clogged or causing increased blower back pressure. Check any stripper air discharge treatment units for increased back pressure. Check that stripper influent flow or concentration has not increased beyond the design basis used to predict stripper performance. Make sure that the influent does not have surfactants (soaps, etc.), oils, grease, or other immiscible phases in the influent stream. Surfactants are evidenced by increased foaming through the stripper unit.

3. *Sump pressure not at recommended levels*. Check sump pressure gauge tubing for accumulated water that could impair gauge performance. Check gaskets for damage and proper seating. Check for proper hold-down spring tensioning. Check blower piping connections for leakage. Check blower for proper rotation. Check design of gravity drain piping if piping is not QED-supplied. Check blower intake filter / silencer (if included) for clogging. Order new filter elements from QED.

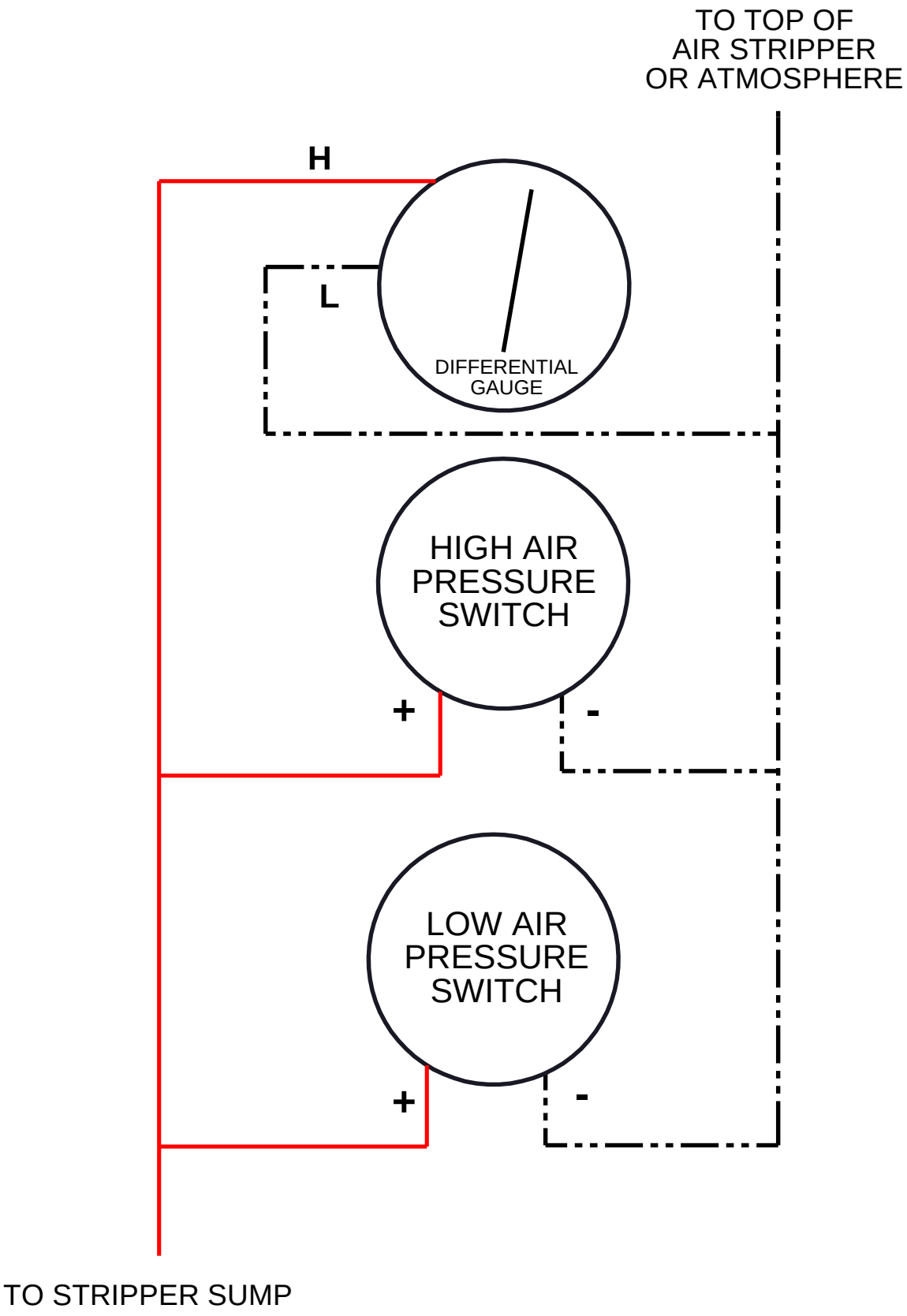
4. *Stripper cleaning frequency seems excessive*. At sites with high iron loading, consider iron sequestering agents or other technology which will reduce/prevent iron precipitation or allow for easier cleaning.

Please investigate all the above-mentioned items while troubleshooting. For additional problem solving assistance contact QED Service at:

Phone: **1-800-624-2026**
FAX: **1-734-995-1170**
24 Hour Service Hot Line: **1-800-272-9559**

Please have the following information ready for the QED Service person:

1. Identify the product or system involved by QED order number.
2. Specify where, when, and from whom the product was purchased.
3. Describe the nature of the defect or malfunction.



AIR STRIPPER GAUGE AND PRESSURE SWITCH CONNECTION DIAGRAM (Optional)

QED TREATMENT EQUIPMENT WARRANTY

QED Environmental Systems Inc. (QED) warrants to the original purchaser of its products that, subject to the limitations and conditions provided below, the products, materials and/or workmanship shall reasonably conform to descriptions of the products and shall be free of defects in materials and workmanship. Any failure of the products to conform to this warranty will be remedied by QED in the manner provided herein.

QED warrants the equipment components of its manufacture for a period of one (1) year from date of delivery. Our sole obligation during this warranty will be to repair or replace (at our option) the defective components. We are not responsible for consequential damages. Labor costs are not included.

Purchaser's exclusive remedy for breach of said warranty shall be as follows: if, and only if, QED is notified in writing within the applicable warranty period of the existence of any such defects in the said products, and QED upon examination of any such defects, shall find the same to be within the term of and covered by the warranty running from QED to Purchaser, QED will, at its option, as soon as reasonably possible, replace or repair any such product, without charge to Purchaser. If QED for any reason, cannot repair a product covered hereby within four (4) weeks after receipt of the original Purchaser's notification of a warranty claim, then QED's sole responsibility shall be, at its option, either to replace the defective product with a comparable new unit at no charge to the Purchaser, or to refund the full purchase price. In no event shall such allegedly defective products be returned to QED without its consent, and QED's obligations of repair, replacement or refund are conditioned upon the Purchaser's return of the defective product to QED.

IN NO EVENT SHALL QED ENVIRONMENTAL SYSTEMS INC. BE LIABLE FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES FOR BREACH OF SAID WARRANTY.

The foregoing warranty does not apply to major subassemblies and other equipment, accessories, and other parts manufactured by others, and such other parts, accessories, and equipment are subject only to the warranties supplied by their respective manufacturers. In the event of failure of any such product or accessory, QED will give assistance to Purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in light of the manufacturer's own warranty.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY (INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANT ABILITY AND FITNESS FOR A PARTICULAR PURPOSE), WHICH OTHER WARRANTIES ARE EXPRESSLY EXCLUDED HEREBY, and of any other obligations or liabilities on the part of QED, and QED neither assumes nor authorizes any person to assume for it any other obligation or liability in connection with said products, materials and/or workmanship.

It is understood and agreed that QED shall in no event be liable for incidental or consequential damages resulting from its breach of any of the terms of this agreement, nor for special damages, nor for improper selection of any product described or referred to for a particular application.

This warranty will be void in the event of unauthorized disassembly of component assemblies. Defects in any equipment that result from abuse, operation in any manner outside the recommended procedures, use and applications other than for intended use, or exposure to chemical or physical environment beyond the designated limits of materials and construction will also void this warranty.

The equipment is warranted to perform as specified under the conditions specified here and within the air stripper model or QED will make the necessary changes at no cost to the owner. Some restrictions apply. Requirements for warranty consideration include, (but are not limited to):

1. Current operating conditions do not differ from the previously-modeled conditions.
2. The system should be cleaned regularly to maintain system performance.

3. The equipment is installed, operated and maintained according to QED's instruction or non-QED manufactured subassembly manufacturer's instructions.
4. Air stripper influent air is not "dirty" (does not contain VOC's, etc.).
5. No surfactants, oils, greases, or other immiscible phases are present in the water.
6. Each influent contaminant does not exceed 25% of its maximum solubility under modeled conditions.

QED shall be released from all obligations under all warranties if any product covered hereby is repaired or modified by persons other than QED's service personnel unless such repair by others is made with the consent of QED. If any product covered hereby is actually defective within the terms of this warranty, Purchaser must contact QED for determination of warranty coverage. If the return of a component is determined to be necessary, QED will authorize the return of the component, at owner's expense. If the product proves not to be defective within the terms of this warranty, then all costs and expenses in connection with the processing of the Purchaser's claim and all costs for repair, parts and labor as authorized by owner hereunder shall be borne by the Purchaser.

In the event of air stripper performance issues, QED may require customer to conduct a variety of troubleshooting steps. These include, but are not limited to, modifying operational parameters, cleaning air stripper system, modifying (temporarily or permanently) process piping, and obtaining reasonable and necessary influent/effluent samples. These steps are the responsibility of the customer and will be conducted by customer prior to consideration by QED for a site visit. These steps and the associated costs incurred are the responsibility of the customer, regardless of future action. Should customer request a site visit by QED or accept a site visit offer by a QED-trained technician, the visit and associated costs: a) will be the responsibility of the customer at $500/day, plus travel, lodging, and meals, if the visit finds improper sampling, process piping installation, or equipment operation inconsistent with QED's Operation and Maintenance Manual; or b) will be the responsibility of QED if the visit finds QED responsible for the performance issue(s) raised.

The original Purchaser's sole responsibility in the instance of a warranty claim shall be to notify QED of the defect, malfunction, or other manner in which the terms of this warranty are believed to be violated. You may secure performance of obligations hereunder by contacting the Customer Service Department of QED and:

1. Identify the product or system involved by QED order number.
2. Specify where, when, and from whom the product was purchased.
3. Describe the nature of the defect or malfunction covered by this warranty.
4. If applicable, send the malfunctioning component, ***after receiving a Return Authorization Code (RAC) Number by the QED Service Department, to:***

QED Environmental Systems Inc.
2355 Bishop Circle West
Dexter, MI 48130

Attn: ***R.A.C. No.****(Return Authorization Code Number provided by QED Service Dept.)*

rev 12/21/98

Figure 1. Typical Configuration of EZ-Stacker 4 Series (Actual configuration will vary)

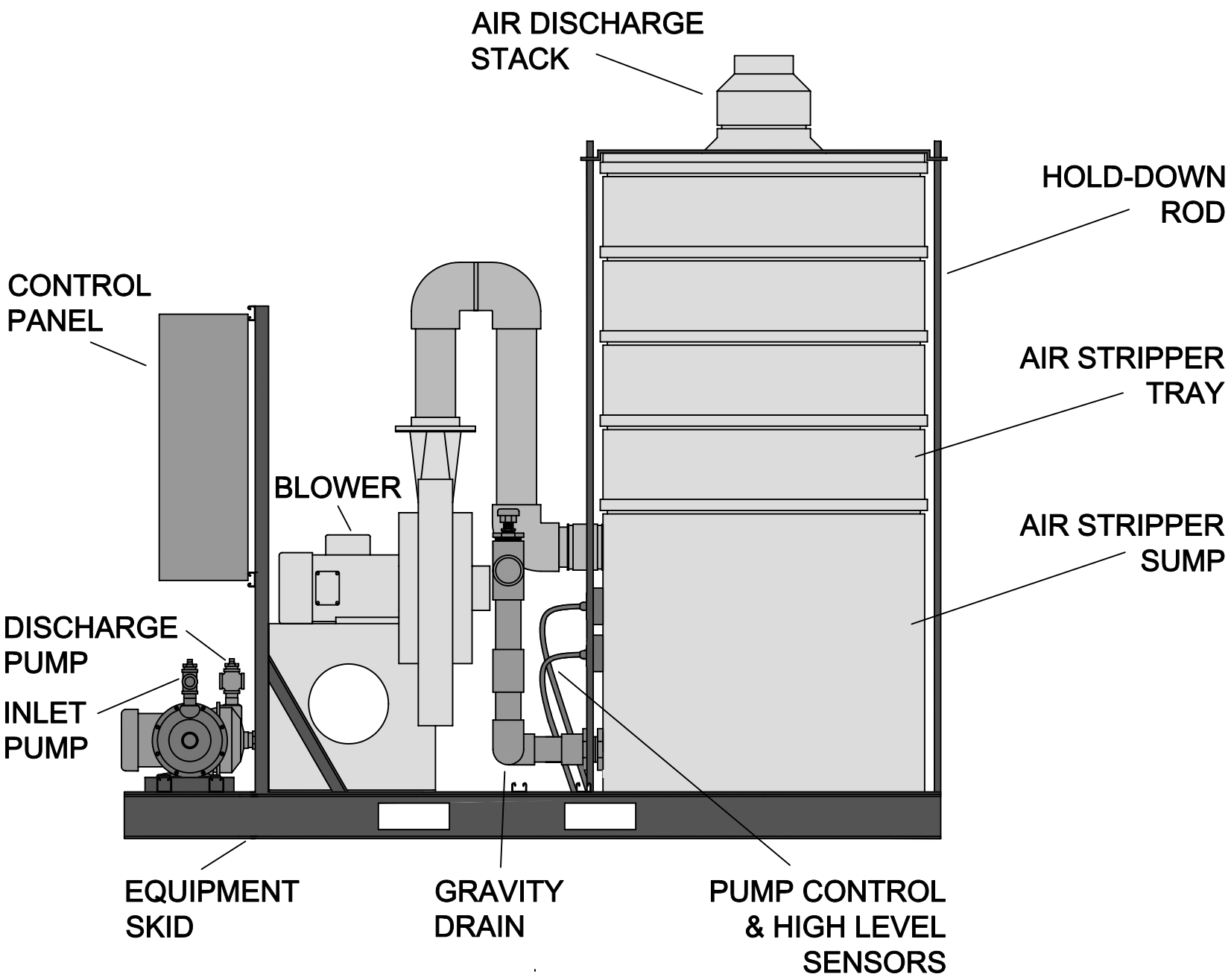
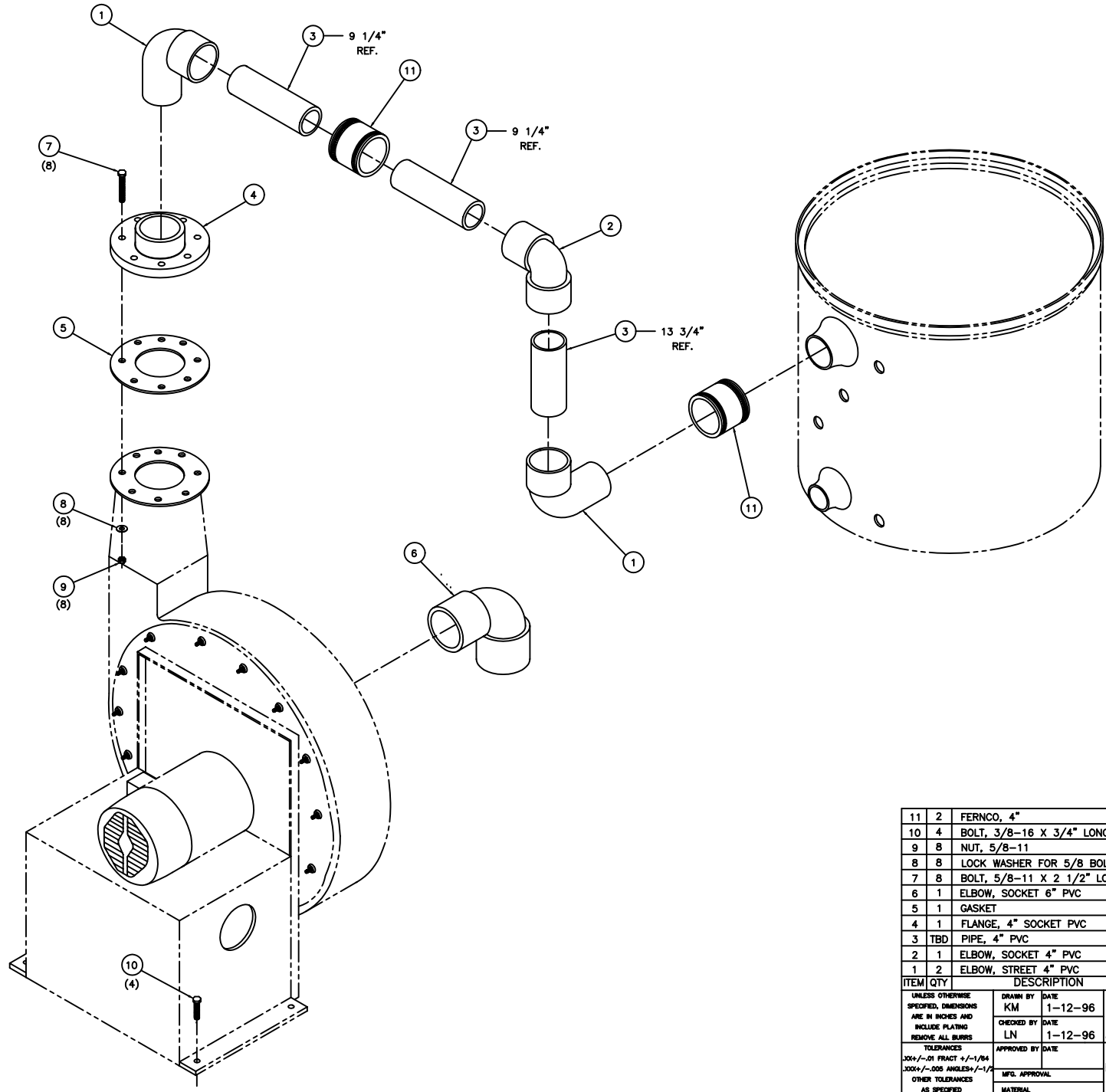


Figure 2. Typical Blower Kit for EZ-4.X Stacker
(Actual assembly and dimentions may vary)



ITEM	QTY	DESCRIPTION	PART #
11	2	FERNCO, 4"	802165
10	4	BOLT, 3/8-16 X 3/4" LONG	EXPENSED
9	8	NUT, 5/8-11	EXPENSED
8	8	LOCK WASHER FOR 5/8 BOLT	EXPENSED
7	8	BOLT, 5/8-11 X 2 1/2" LONG	EXPENSED
6	1	ELBOW, SOCKET 6" PVC	802113
5	1	GASKET	805032
4	1	FLANGE, 4" SOCKET PVC	802202
3	TBD	PIPE, 4" PVC	802251
2	1	ELBOW, SOCKET 4" PVC	802114
1	2	ELBOW, STREET 4" PVC	802120

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES AND INCLUDE PLATING REMOVE ALL BURRS

TOLERANCES
.XX+/-.01 FRACT +/-1/64
.XXX+/-.005 ANGLES+/-1/2
OTHER TOLERANCES AS SPECIFIED

EZ-STACKER (4 SERIES)

NEXT ASS'Y | USED ON

DRAWN BY: KM | DATE: 1-12-96
CHECKED BY: LN | DATE: 1-12-96
APPROVED BY | DATE
MFG. APPROVAL
MATERIAL
FINISH

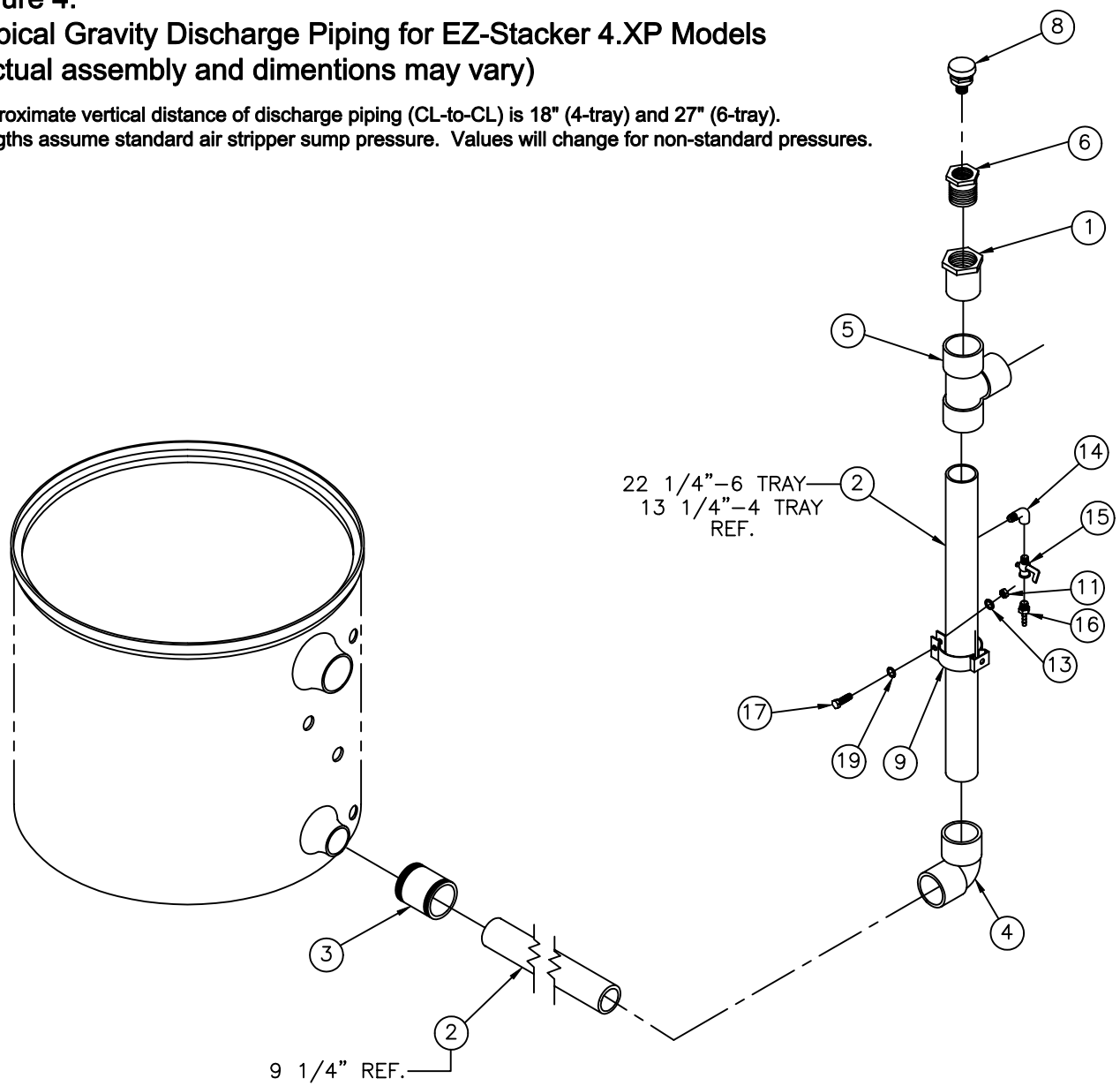
Q.E.D.
ENVIRONMENTAL SYSTEMS INC.
6155 JACKSON ROAD, ANN ARBOR, MI.

TITLE
BLOWER KIT W/O BLOWER
ASSEMBLY/BOM/KIT

DRAWING NUMBER BLKIT4 | REV B
SCALE N.T.S. | SHEET 1 OF 2

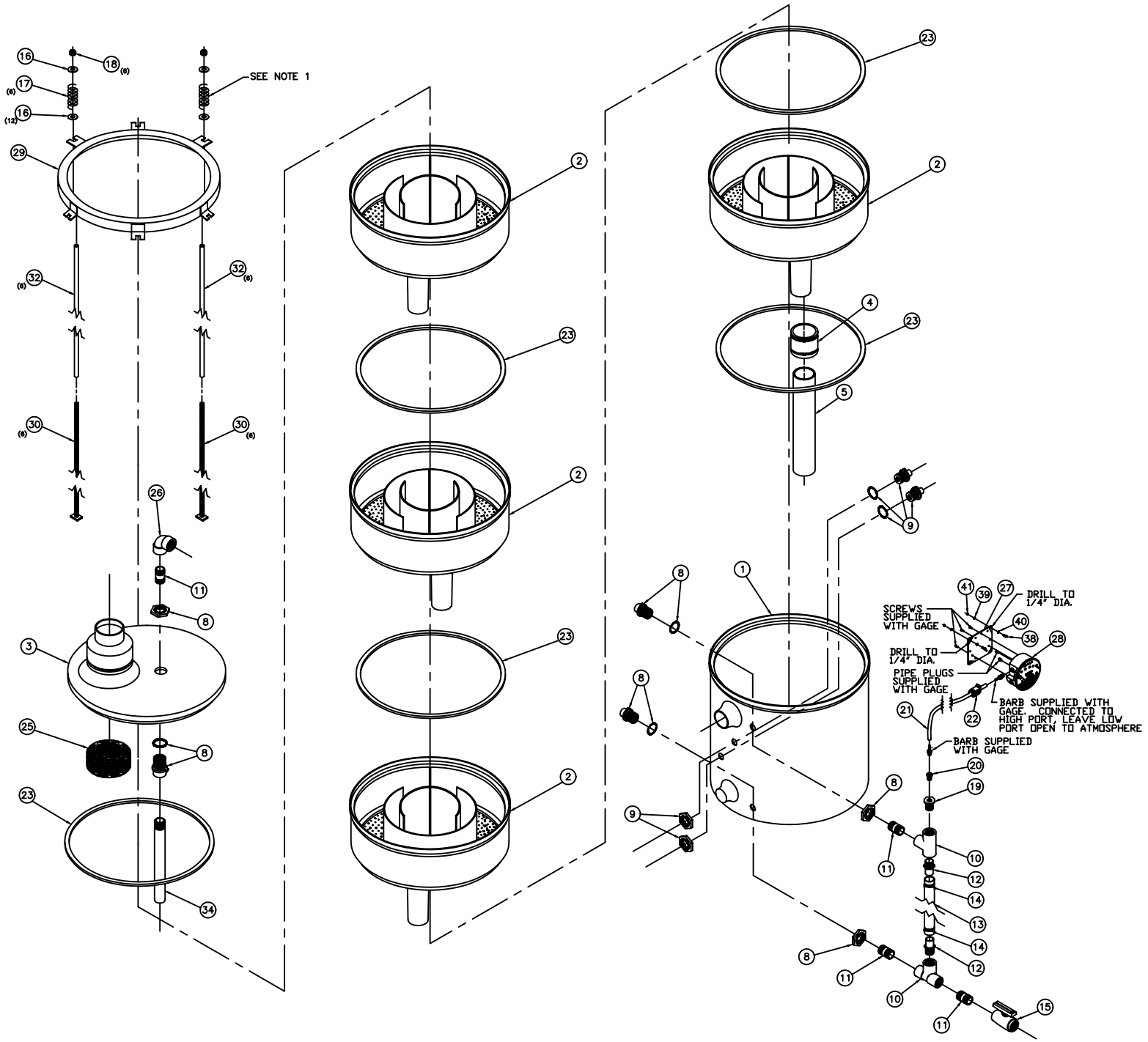
Figure 4.
Typical Gravity Discharge Piping for EZ-Stacker 4.XP Models
(Actual assembly and dimentions may vary)

Approximate vertical distance of discharge piping (CL-to-CL) is 18" (4-tray) and 27" (6-tray).
Lengths assume standard air stripper sump pressure. Values will change for non-standard pressures.



ITEM	QTY	DESCRIPTION	PART #
20			
19	1	FLAT WASHER FOR 5/16" BOLT	EXPENSED
18			
17	1	5/16–18 UNC HEX BOLT 1 1/2" LG.	EXPENSED
16	1	BARB 1/8"MPT X 3/16" BARB	803094
15	1	COCK, SHUTOFF 1/8"MPT X 1/8"FPT BRASS	803095
14	1	ELBOW, STREET 1/8" FPT BRASS	34149
13	1	LOCK WASHER FOR 5/16/BOLT	EXPENSED
12			
11	1	5/16–18 UNC NUT	EXPENSED
10			
9	1	HANGER 3" PIPE	805196
8	1	BREAKER, VACUUM 1/2" MPT	805026
7			
6	1	BUSHING, PVC 1 1/2" X 1/2"	802065
5	1	TEE, PVC 3" SOCKET	802215
4	1	ELBOW, 90 DEGREE PVC 3" SCH 80	802217
3	1	FERNCO 3" COUPLER	802166
2	TBD	PIPE 3" PVC SCH 80	802221
1	1	BUSHING, PVC 3" SOC X THD.	802239

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES AND INCLUDE PLATING REMOVE ALL BURRS	DRAWN BY KM	DATE 1–12–96	QED ENVIRONMENTAL SYSTEMS INC. 6155 JACKSON ROAD, ANN ARBOR, MI.
	CHECKED BY LN	DATE 1–12–96	
TOLERANCES .XX+/–.01 FRACT +/–1/64 .XXX+/–.005 ANGLES+/–1/2 OTHER TOLERANCES AS SPECIFIED	APPROVED BY	DATE	TITLE GRAVITY DRAIN ASSEMBLY/BOM/KIT
	MFG. APPROVAL		
EZ–STACKER (4 SERIES)	MATERIAL		DRAWING NUMBER GDKIT3S REV A
NEXT ASS'Y USED ON	FINISH		SCALE N.T.S. SHEET 1 OF 1



ITEM	QTY	DESCRIPTION	PART #
41	2	NUT 1/4"	EXPENSED
40	2	WASHER, FLAT 1/4"	EXPENSED
39	2	WASHER, LOCK 1/4"	EXPENSED
38	2	BOLT 1/4" HEX HD.	EXPENSED
37			
36			
35			
34	1	PIPE 1" PVC 12.50 LG (THD. ONE END)	802162
33			
32	6	TUBING, NYLON 1/2" OD X 3/8" ID 66" LG	35097
31			
30	6	TIE ROD ASSEMBLY	804042
29	1	RING, TOP HOLD DOWN 37.88 OD	804060
28	1	MAGNEHELIC DIFFERENTIAL PRESSURE GAGE INCLUDES THE FOLLOWING: SCREWS, 6-32 RD. HD. (2) PIPE PLUG 1/8" (2) BARBS, 1/8" MPT X 3/16 BARB (2)	EZPGAUGE
27	1	BRACKET, MOUNTING	805179
26	1	ELBOW 90 DEGREES PVC 1" MPT SCH 80	802037
25	1	DEMISTER 3 PADS OF 37/97 3.60 HIGH X 10" DIA.	804053
24			
23	5	GASKET, ROUND	804059
22	1	PINCH VALVE	36559
21	TBD	TUBING, CLEAR 5/16" O.D. X 3/16" I.D.	802248
20	1	REDUCER, BUSHING 1/4" X 1/8" BRASS	34103
19	1	REDUCER, BUSHING 1" X 1/4" BRASS	803054
18	6	NUT, 3/8-16 ZINC PLATED STEEL	805180
17	6	SPRING, NICKEL PLATED	805214
16	12	WASHER, FLAT 3/8 ZINC PLATED STEEL	805181
15	1	VAVLE, BALL PVC 1" FPT X 1" FPT	802196
14	2	CLAMPS, HOSE 13/16 X 1 1/2"	805055
13	.66 FT	TUBING, CLEAR PVC 1" I.D. 3/16" WALL	802236
12	2	BARB, NYLON 1" MPT X 1" BARB	805020
11	4	NIPPLE, CLOSE PVC 1" SCH 80	802103
10	2	TEE, PVC 1" FPT SCH 80	802028
9	2	BULKHEAD FITTING (RAVEN) 1/2" FPT	802169
8	3	BULKHEAD FITTING (RAVEN) 1 FPT	802171
7			
6			
5	1	PIPE, PVC 3" 17.50 LG REF.	802156
4	1	FERNCO 3" COUPLER	802166
3	1	TRAY, TOP	804049
2	4	TRAYS, WITH SECONDARY PARTS	804050
1	1	SUMP	804051

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES AND INCLUDE PLATING REMOVE ALL BURRS
TOLERANCES .XX+/-.01 FRACT +/-1/64 .XXX+/-.005 ANGLES+/-1/2
OTHER TOLERANCES AS SPECIFIED
4.4 EZ STACKER
NEXT ASS'Y | USED ON

DRAWN BY KM DATE 1-11-96
CHECKED BY LN DATE 1-12-95
APPROVED BY | DATE
MFG. APPROVAL
MATERIAL
FINISH

Q.E.D.
ENVIRONMENTAL SYSTEMS INC.
6155 JACKSON ROAD, ANN ARBOR, MI.

TITLE
EZ-4.4 P
ASSEMBLY/BOM/KIT

DRAWING NUMBER EZ-4.4P REV E
SCALE N.T.S. SHEET 1 OF 1

nyb | The New York Blower Company®
7660 QUINCY STREET–WILLOWBROOK, ILLINOIS 60527-5530
TEL: [630] 794-5700 • FAX: [630] 794-5776 • WEB: http://www.nyb.com • E-MAIL: nyb@nyb.com

INSTALLATION, MAINTENANCE, OPERATING INSTRUCTIONS

IM-140

PRESSURE BLOWERS
TYPE HP PRESSURE BLOWERS

⚠ WARNING

THIS FAN HAS MOVING PARTS THAT CAN CAUSE SERIOUS BODILY INJURY. BEFORE OPERATING OR STARTING MAINTENANCE READ THE INSTALLATION AND MAINTENANCE INSTRUCTIONS AND THE AMCA SAFETY PRACTICES MANUAL PROVIDED WITH THIS FAN.

DURING OPERATION

1. KEEP BODY, HANDS, AND FOREIGN OBJECTS AWAY FROM THE INLET, THE OUTLET, AND THE OTHER MOVING PARTS OF THE FAN SUCH AS SHAFTS, BELTS, AND PULLEYS.

2. DO NOT OPERATE AT EXCESSIVE SPEEDS OR TEMPERATURES.

BEFORE STARTING MAINTENANCE WORK:

LOCK POWER SUPPLY IN OFF POSITION AND IMMOBILIZE FAN WHEEL.

98-0250

A WORD ABOUT SAFETY

The above **WARNING** decal appears on all **nyb** fans. Air moving equipment involves electrical wiring, moving parts, sound, and air velocity or pressure which can create safety hazards if the equipment is not properly installed, operated and maintained. To minimize this danger, follow these instructions as well as the additional instructions and warnings on the equipment itself.

All installers, operators and maintenance personnel should study AMCA Publication 410, "Recommended Safety Practices for Air Moving Devices", which is included as part of every shipment. Additional copies can be obtained by writing to New York Blower Company, 7660 Quincy St., Willowbrook, IL 60527.

ELECTRICAL DISCONNECTS

Every motor driven fan should have an independent disconnect switch to isolate the unit from the electrical supply. It should be near the fan and must be capable of being locked by maintenance personnel while servicing the unit, in accordance with OSHA procedures.

MOVING PARTS

All moving parts must have guards to protect personnel. Safety requirements vary, so the number and type of guards needed to meet company, local and OSHA standards must be determined and specified by the user. Never start a fan without having all safety guards installed. Check regularly for damaged or missing guards and do not operate any fan with guards removed. Fans can also become dangerous because of potential “windmilling”, even though all electrical power is disconnected. Always block the rotating assembly before working on any moving parts.

SOUND

Some fans can generate sound that could be hazardous to exposed personnel. It is the responsibility of the system designer and user to determine sound levels of the system, the degree of personnel exposure, and to comply with applicable safety requirements to protect personnel from excessive noise. Consult **nyb** for fan sound power level ratings.

AIR PRESSURE AND SUCTION

In addition to the normal dangers of rotating machinery, fans present another hazard from the suction created at the fan inlet. This suction can draw materials into the fan where they become high velocity projectiles at the outlet. It can also be extremely dangerous to persons in close proximity to the inlet, as the forces involved can overcome the strength of most individuals. Inlets and outlets that are not ducted should be screened to prevent entry and discharge of solid objects.

⚠ DANGER

DO NOT OPEN UNTIL THE POWER SUPPLY HAS BEEN LOCKED OFF AND THE SHAFT HAS STOPPED ROTATING.
FAILURE TO DO THIS CAN RESULT IN SERIOUS BODILY INJURY.

98-0249

ACCESS DOORS

The above DANGER decal is placed on all **nyb** cleanout doors. These doors, as well as access doors to the duct system, should never be opened while the fan is in operation. Serious injury could result from the effects of air pressure or suction.

Bolted doors must have the door nuts or fasteners securely tightened to prevent accidental or unauthorized opening.

RECEIVING AND INSPECTION

The fan and accessories should be inspected on receipt for any shipping damage. Turn the wheel by hand to see that it rotates freely and does not bind. If dampers or shutters are provided, check these accessories for free operation of all moving parts.

F.O.B. factory shipping terms require that the receiver be responsible for inspecting the equipment upon arrival. Note damage or shortages on the Bill of Lading and file any claims for damage or loss in transit. **nyb** will assist the customer as much as possible; however, claims must be originated at the point of delivery.

HANDLING AND STORAGE

Fans should be lifted by the base, mounting supports, or lifting eyes only. Never lift a fan by the wheel, shaft, motor, motor bracket, housing inlet, outlet, or any fan part not designed for lifting. A spreader should always be used to avoid damage.

On a direct drive Arrangement 8 fan, lifting holes are provided in the motor base to assist in handling the fan assembly. These lifting holes should be used in conjunction with the lifting eyes when lifting and positioning the fan onto its foundation. A heavy round steel bar or appropriate fixture can be passed through the lifting holes to simplify attachment of the lifting device. Be sure to follow all local safety codes when moving heavy equipment.

Whenever possible, fans and accessories should be stored in a clean, dry location to prevent rust and corrosion of steel components. If outdoor storage is necessary, protection should be provided. Cover the inlet and outlet to prevent the accumulation of dirt and moisture in the housing. Cover motors with waterproof material. Refer to the bearing section for further storage instructions.

Check shutters for free operation and lubricate moving parts prior to storage. Inspect the stored unit periodically. **Rotate the wheel by hand every two weeks to redistribute grease on internal bearing parts.**

FAN INSTALLATION

nyb wheels are dynamically balanced when fabricated. Complete assembled fans are test run at operating speeds to check the entire assembly for conformance to **nyb** vibration limits. Nevertheless, all units must be adequately supported for smooth operation. **Ductwork or stacks should be independently supported as excess weight may distort the fan housing and cause contact between moving parts.** Where vibration isolators are used, consult the **nyb** certified drawing for proper location and adjustment.

Slab-Mounted Units

A correctly designed and level concrete foundation provides the best means of installing floor-mounted fans. The mass of the base must maintain the fan/driver alignment, absorb normal vibration, and resist lateral loads. The overall dimensions of the concrete base should extend at least six inches beyond the base of the fan. The weight of the slab should be two to three times the weight of the rotating assembly, including the motor. The foundation requires firmly anchored fasteners such as the anchor bolts shown in Figure 1.

Move the fan to the mounting location and lower it over the anchor bolts, leveling the fan with shims around the bolts. Fasten the fan securely. When grout is used, shim the fan at least 3/4-inch from the concrete base. (See Figure 1.) When isolation is used, check the **nyb** certified drawing for installation instructions.

Elevated Units

When an elevated or suspended structural steel platform is used, it must have sufficient bracing to support the unit load and prevent side sway. The platform should be of welded construction to maintain permanent alignment of all members.

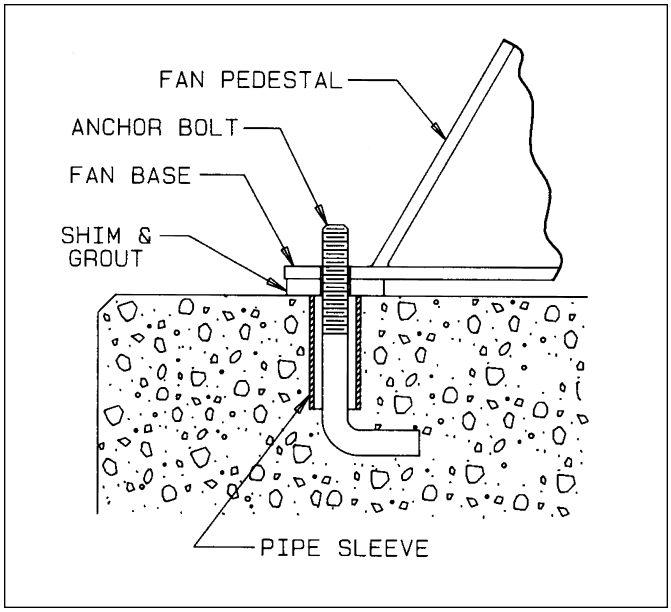


Figure 1

V-BELT DRIVE

Installation

1. Remove all foreign material from the fan and motor shafts. Coat shafts with machine oil for easier mounting. Mount the belt guard backplate at this time if partial installation is required prior to sheave mounting.
2. Mount sheaves on shafts after checking sheave bores and bushings for nicks or burrs. Avoid using force. If resistance is encountered, lightly polish the shaft with emery cloth until the sheave slides on freely. Tighten tapered bushing bolts sequentially so that equal torque is applied to each.
3. Adjust the motor on its base to a position closest to the fan shaft. Install belts by working each one over the sheave grooves until all are in position. Never pry the belts into place. On **nyb** packaged fans, sufficient motor adjustment is provided for easy installation of the proper size belts.
4. Adjust sheaves and the motor shaft angle so that the sheave faces are in the same plane. Check this by placing a straightedge across the face of the sheaves. Any gap between the edge and sheave faces indicates misalignment. Important: This method is only valid when the width of the surface between the belt edge and the sheave face is the same for both sheaves. When they are not equal, or when using adjustable-pitch sheaves, adjust so that all belts have approximately equal tension. Both shafts should be at the right angles to the center belt.

Belt Tensioning

1. Check belt tension with a tensioning gage and adjust using the motor slide base. Excess tension shortens bearing life while insufficient tension shortens belt life, can reduce fan performance and may cause vibration. The lowest allowable tension is that which prevents slippage under full load. Belts may slip during start-up, but slipping should stop as soon as the fan reaches full speed. For more precise tensioning methods, consult the drive manufacturer's literature.
2. Recheck setscrews, rotate the drive by hand and check for rubbing, then complete the installation of the belt guard.

3. Belts tend to stretch somewhat after installation. Recheck tension after several days of operation. Check sheave alignment as well as setscrew and/or bushing bolt tightness.

COUPLING

Coupling alignment should be checked after installation and prior to start up. Alignment is set at the factory, but shipping, handling, and installation can cause misalignment. Also check for proper coupling lubrication. For details on lubrication and for alignment tolerances on the particular coupling supplied, see the manufacturer's installation and maintenance supplement in the shipping envelope.

Installation

Most **nyb** fans are shipped with the coupling installed. In cases where the drive is assembled after shipping, install the coupling as follows:

1. Remove all foreign material from fan and motor shafts and coat with machine oil for easy mounting of coupling halves.
2. Mount the coupling halves on each shaft, setting the gap between the faces specified by the manufacturer. Avoid using force. If mounting difficulty is encountered, lightly polish the shaft with emery cloth until the halves slide on freely.

Alignment

1. Align the coupling to within the manufacturer's limits for parallel and angular misalignment (see Figure 2). A dial indicator or laser can also be used for alignment where greater precision is desired. Adjustments should be made by moving the motor to change shaft angle, and by the use of foot shims to change motor shaft height. Do not move the fan shaft or bearing.
2. When correctly aligned, install the flexible element and tighten all fasteners in the coupling and motor base. Lubricate the coupling if necessary.
3. Recheck alignment and gap after a short period of operation, and recheck the tightness of all fasteners in the coupling assembly.

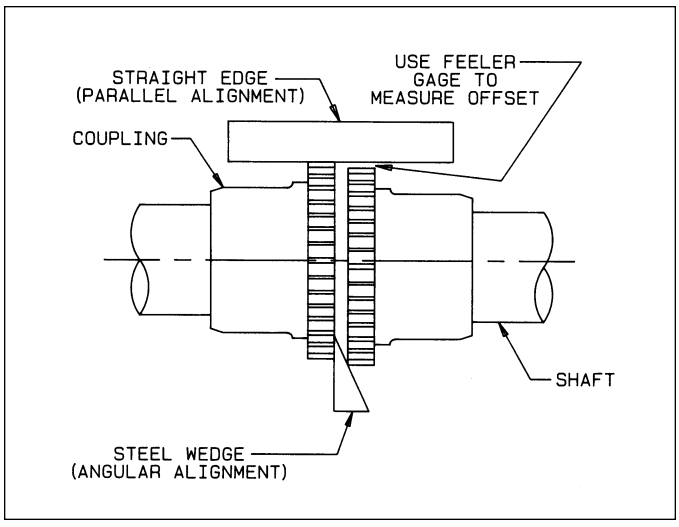


Figure 2

START-UP

Safe operation and maintenance includes the selection and use of appropriate safety accessories for the specific installation. This is the responsibility of the system designer and requires consideration of equipment location and accessibility as well as adjacent components. All safety accessories must be installed properly prior to start-up.

Safe operating speed is a function of system temperature and wheel design. Do not under any circumstances exceed the maximum safe fan speed published in the **nyb** engineering supplement, which is available from your **nyb** field sales representative.

⚠ CAUTION

BEFORE INITIAL OPERATION:

1. **TIGHTEN ALL SET SCREWS IN FAN WHEEL.**
2. **TIGHTEN ALL SET SCREWS IN BEARINGS.**
3. **REPEAT AFTER 8 HOURS OF OPERATION.**
4. **REPEAT AGAIN AFTER TWO WEEKS OPERATION.**

98-0271

Procedure

1. If the drive components are not supplied by **nyb**, verify with the manufacturer that the starting torque is adequate for the speed and inertia of the fan.
2. Inspect the installation prior to starting the fan. Check for any loose items or debris that could be drawn into the fan or dislodged by the fan discharge. Check the interior of the fan as well. Turn the wheel by hand to check for binding.
3. Check drive installation and belt tension.
4. Check the tightness of all setscrews, nuts and bolts. When furnished, tighten hub setscrews with the wheel oriented so that the setscrew is positioned underneath the shaft.
5. Install all remaining safety devices and guards. Verify that the supply voltage is correct and wire the motor. “Bump” the starter to check for proper wheel rotation.
6. Use extreme caution when testing the fan with ducting disconnected. Apply power and check for unusual sounds or excessive vibration. If either exists, see the section on Common Fan Problems. To avoid motor overload, do not run the fan for more than a few seconds if ductwork is not fully installed. On larger fans, normal operating speed may not be obtained without motor overload unless ductwork is attached. Check for correct fan speed and complete installation. Ductwork and guards must be fully installed for safety.
7. Setscrews should be rechecked after a few minutes, eight hours and two weeks of operation (see Tables 1 & 2 for correct tightening torques).

NOTE: Shut the fan down immediately if there is any sudden increase in fan vibration.

Table 1 - WHEEL SETSCREW TORQUES

Setscrew Size	Carbon Steel Setscrew Torque*	
Diameter (in.)	lb.-in.	lb.-ft.
1/2	600	50
5/8	--	97
3/4	--	168

*** Stainless Steel setscrews are not hardened and should not be tightened to more than 1/2 the values shown.**

Table 2 - BEARING SETSCREW TORQUE, lb.-in.

Setscrew	Manufacturer				
Diameter	Link-Belt	Sealmaster	SKF	McGill	Dodge
1/4	90	65	50	85	--
5/16	185	125	165	165	160

Note: Split pillow block bearings are fixed to the shaft with tapered sleeves and generally do not have setscrews.

FAN MAINTENANCE

nyb fans are manufactured to high standards with quality materials and components. Proper maintenance will ensure a long and trouble-free service life.

Do not attempt any maintenance on a fan unless the electrical supply has been completely disconnected and locked. In many cases, a fan can windmill despite removal of all electrical power. The rotating assembly should be blocked securely before attempting maintenance of any kind.

The key to good fan maintenance is regular and systematic inspection of all fan parts. Inspection frequency is determined by the severity of the application and local conditions. Strict adherence to an inspection schedule is essential.

Regular fan maintenance should include the following:

1. Check the fan wheel for any wear or corrosion, as either can cause catastrophic failures. Check also for the build-up of material which can cause unbalance resulting in vibration, bearing wear and serious safety hazards. Clean or replace the wheel as required.
2. Check the V-belt drive for proper alignment and tension (see section on V-belt drives). If belts are worn, replace them as a set, matched to within manufacturer's tolerances. Lubricate the coupling of direct-drive units and check for alignment (see section on couplings).
3. Lubricate the bearings, but do not over lubricate (see the bearing section for detailed specifications).
4. Ceramic-felt shaft seals require no maintenance, although worn seals should be replaced. When lip-type shaft seals are provided, lubricate them with "NEVER-SEEZ" or other anti-seize compound.
5. During any routine maintenance, all setscrews and bolts should be checked for tightness. See the table for correct torques.
6. When installing a new wheel, the proper wheel-to-inlet clearance must be maintained (see Figure 3).

WHEEL BALANCE

Airstreams containing particulate or chemicals can cause abrasion or corrosion of the fan parts. This wear is often uneven and can lead to significant wheel unbalance over time. When such wear is discovered, a decision must be made as to whether to rebalance or replace the wheel.

The soundness of all parts should be determined if the original thickness of components is reduced. Be sure there is no hidden structural damage. The airstream components should also be cleaned to remove any build-up of foreign material. Specialized equipment can be used to rebalance a cleaned wheel that is considered structurally sound.

Balance weights should be rigidly attached at a point that will not interfere with the housing nor disrupt airflow. Remember that centrifugal forces can be extremely high at the outer radius of a fan wheel. Welding is the preferred method of balance weight attachment. Be sure to ground the welder directly to the fan wheel. Otherwise, the welding current could pass through the fan bearings and damage them.

WHEEL-INLET CLEARANCE

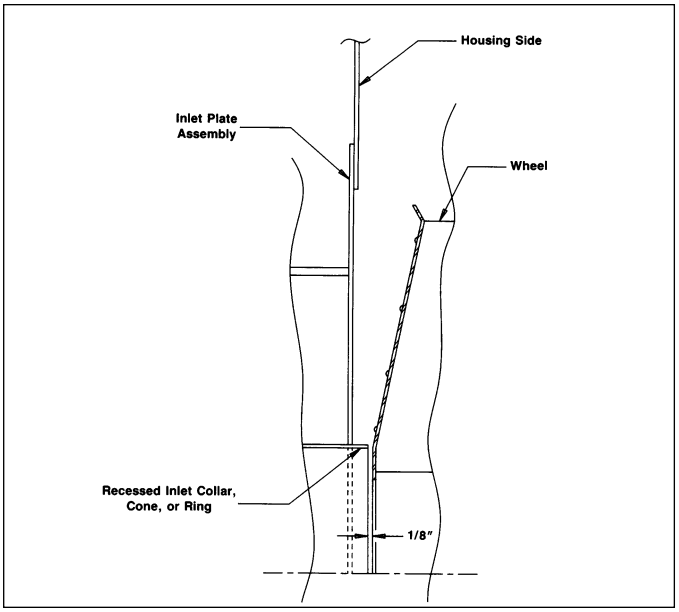


Figure 3

BEARINGS

Storage

Any stored bearing can be damaged by condensation caused by temperature variations. Therefore, **nyb** fan bearings are filled with grease at the factory to exclude air and moisture. Such protection is adequate for shipment and subsequent immediate installation.

For long term or outdoor storage, mounted bearings should be regreased and wrapped with plastic for protection. **Rotate the fan wheel by hand at least every two weeks to redistribute grease on internal bearing parts.** Each month the bearings should be purged with new grease to remove condensation, since even a filled bearing can accumulate moisture. Use caution when purging, as excessive pressure can damage the seals. Rotate the shaft while slowly adding grease.

Operation

Check the setscrew torque before start-up (see table for correct values). Since bearings are completely filled with grease at the factory, they may run at an elevated temperature during initial operation. Surface temperatures may reach 180°F. and grease may bleed from the bearing seals. This is normal and no attempt should be made to replace lost grease. Bearing surface temperatures will decrease when the internal grease quantity reaches a normal operating level. Relubrication should follow the recommended schedule.

Lubrication

Use the table for relubrication scheduling according to operating speed and shaft diameter. Bearings should be lubricated with a premium quality lithium-based grease conforming to NLGI Grade 2. Examples are:

Mobil	-	Mobilith AW2	Chevron	-	Amolith #2
Texaco	-	Premium RB	Shell	-	Alvania #2

These greases are for bearing surface temperatures of 40°F. to 180°F. For surface temperatures of 181°F. to 230°F. use Mobilith SHC220.

Do not use “high temperature” greases, as many are not formulated to be compatible with fan bearings.

Add grease to the bearing while running the fan or rotating the shaft by hand. Be sure all guards are in place if lubrication is performed while the fan is operating. Add just enough grease to cause a slight purging at the seals. Except on split pillowblocks. Completely filled bearings will run hotter until a sufficient amount of grease is purged out of the seals.

Split pillowblock bearings (Link-Belt P-LB6800 & P-LB6900, SKF SAF 22500, Dodge SAF-XT) should be cleaned and repacked at approximately every eighth lubrication interval. This requires removal of the bearing cap. Clean out old grease and repack the bearing with fresh grease. Pack the bearing fully and fill the housing reservoir to the bottom of the shaft on both sides of the bearing. Replace the bearing cap, being careful not to mix caps as they are not interchangeable from one bearing to another. **Do not over lubricate.**

BEARING LUBRICATION INTERVAL [months]

RPM / Shaft	1 - 500	501- 1000	1001- 1500	1501- 2000	2001- 2500	2501- 3000	3001- 3500	3501- 4000
1 7/16	6 / 6	6 / 4	5-6 / 4	4-6 / 2	4-6 / 2	3-5 / 1	2-4 / 1	2-4 / 1
1 11/16	6 / 6	6 / 4	4-6 / 2	4-6 / 1	2-4 / 1	2-4 / 1	2 / 1-2	1-2 / 1-2
2 3/16			6	4-6	4	2-4	2	--
2 7/16			6	4-6	4	2-4	2	--
2 15/16			4-6	4-6	2-4	2	1-2	--

Ball Bearings & Split Split Pillowblock Spherical Roler Bearings → / ← **Non- Split Pillowblock Spherical Roller Bearings**

NOTE:

1. **These are general recommendations only; specific manufacturer’s recommendations may vary slightly.**
2. **Assumes clean environment, -20°F. to 120°F.**
   a. **Consult The New York Blower Company for operation below -20°F. ambient.**
   b. **Ambient temperatures greater than 120°F. will shorten bearing life.**
   c. **Under extremely dirty conditions, lubricate more frequently.**
3. **Assumes horizontal mounting configuration. For vertically mounted applications, lubricate twice as frequently.**

COMMON FAN PROBLEMS

Excessive Vibration

A common complaint regarding industrial fans is “excessive vibration”. **nyb** is careful to ensure that each unit is precisely balanced prior to shipment; however, there are many other causes of vibration including:

1. Loose mounting bolts, setscrews, bearings or couplings.
2. Misalignment or excessive wear of couplings or bearings.
3. Misaligned or unbalanced motor.
4. Bent shaft due to mishandling or material impact.
5. Accumulation of foreign material on the wheel.
6. Excessive wear or erosion of the wheel.
7. Excessive system pressure or restriction of airflow due to closed dampers.
8. Inadequate structural support, mounting procedures or materials.
9. Externally transmitted vibration.

Inadequate Performance

1. Incorrect testing procedures or calculations.
2. Fan running too slowly.
3. Fan wheel rotating in wrong direction or installed backwards on shaft.
4. Wheel not properly centered relative to inlet cone.
5. Damaged or incorrectly installed cut off sheet or diverter.
6. Poor system design, closed dampers, air leaks, clogged filters, or coils.
7. Obstructions or sharp elbows near inlets.
8. Sharp deflection of airstream at fan outlet.

Excessive Noise

1. Fan operating near “stall” due to incorrect system design or installation.
2. Vibration originating elsewhere in the system.
3. System resonance or pulsation.
4. Improper location or orientation of fan intake and discharge.
5. Inadequate or faulty design of supporting structures.
6. Nearby sound reflecting surfaces.
7. Loose accessories or components.
8. Loose drive belts.
9. Worn bearings.

Premature Component Failure

1. Prolonged or major vibration.
2. Inadequate or improper maintenance.
3. Abrasive or corrosive elements in the airstream or surrounding environment.
4. Misalignment or physical damage to rotating components or bearings.
5. Bearing failure from incorrect or contaminated lubricant or grounding through the bearings while arc welding.
6. Excessive fan speed.
7. Extreme ambient or airstream temperatures.
8. Improper belt tension.
9. Improper tightening of wheel setscrews.

REPLACEMENT PARTS

It is recommended that only factory-supplied replacement parts be used. **nyb** fan parts are built to be fully compatible with the original fan, using specific alloys and tolerances. These parts carry a standard **nyb** warranty.

When ordering replacement parts, specify the part name, **nyb** shop and control number, fan size, type, rotation (viewed from drive end), arrangement and bearing size or bore. Most of this information is on the metal nameplate attached to the fan base.

For assistance in selecting replacement parts, contact your local **nyb** representative or visit: http://www.nyb.com.

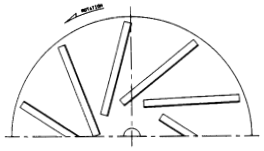
Example: Part required: Wheel/shaft assembly
Shop/control number: B-10106-100
Fan description: Size 2206A10 Pressure Blower
Rotation: Clockwise
Arrangement: 4

Suggested replacement parts include:

Wheel	Component parts: Damper
Shaft •	Motor
Bearings*	Coupling*
Shaft Seal*	Sheaves*
	V-Belts*

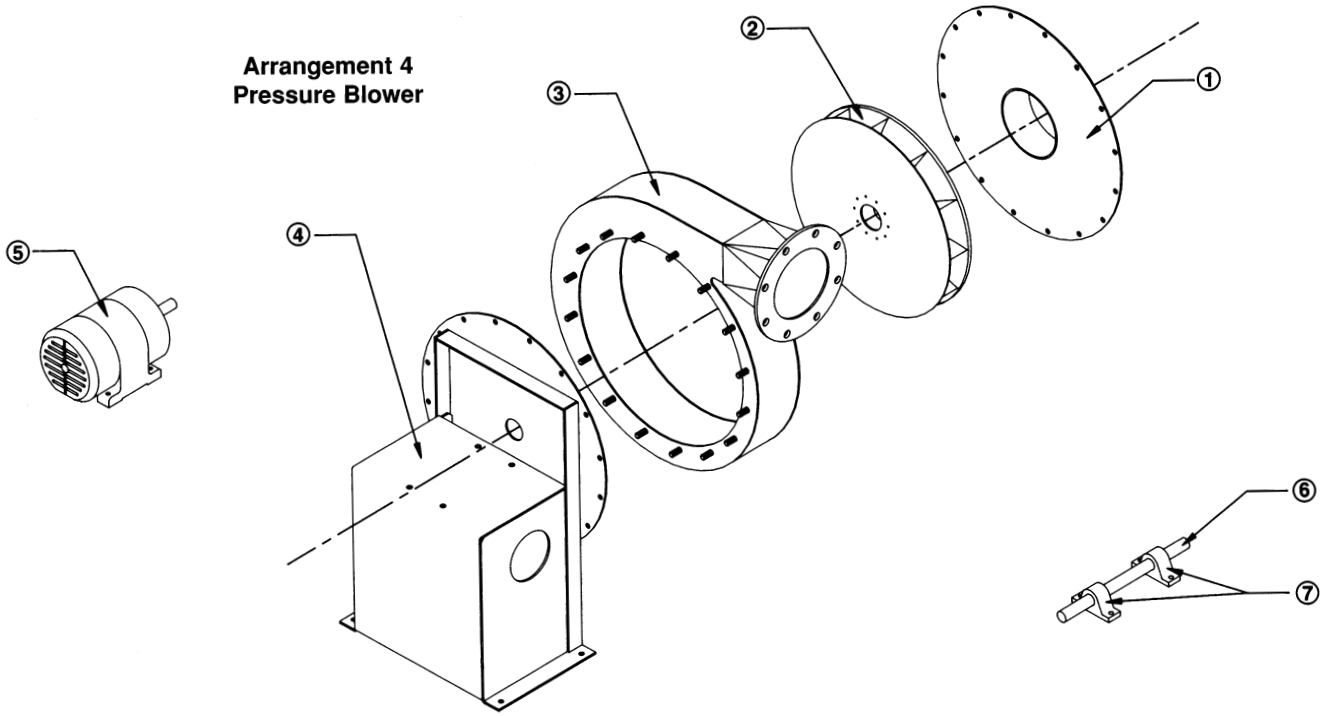
• For Arrangement 1/8 fan only.

SPECIFY ROTATION AS VIEWED FROM DRIVE SIDE

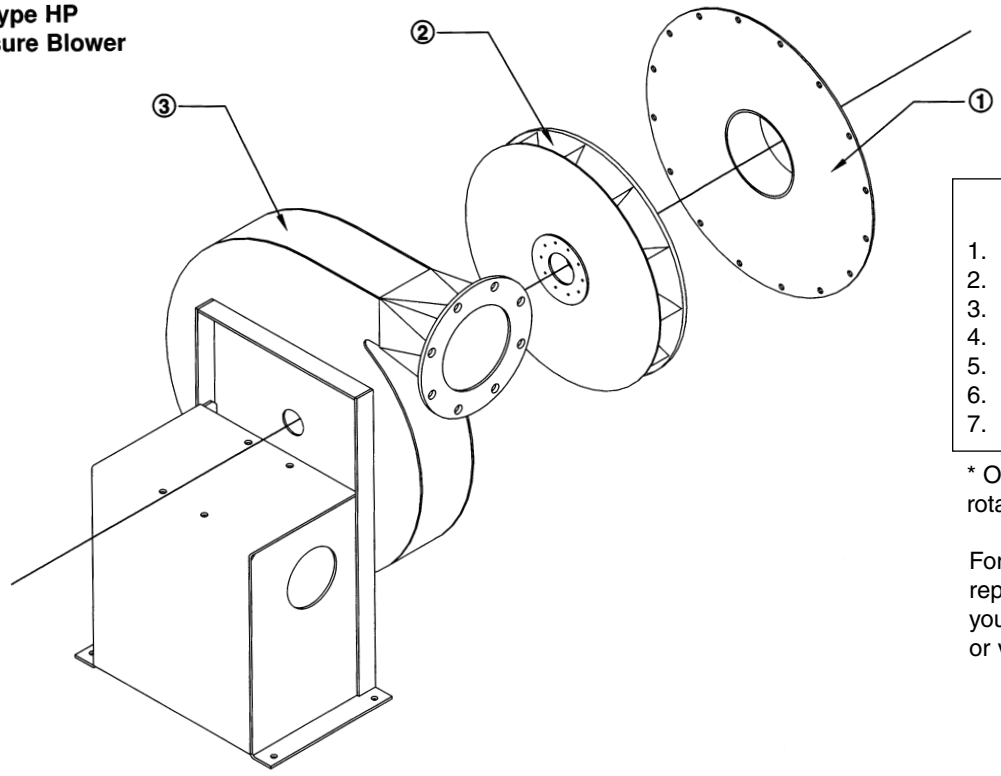


ARROW INDICATES COUNTER CLOCKWISE ROTATION

Arrangement 4
Pressure Blower



Arrangement 4
Type HP
Pressure Blower



Parts List

1. Inlet Plate Assembly
2. Wheel*
3. Housing*
4. Pedestal Assembly
5. Motor
6. Shaft
7. Bearings

* Order for parts must specify rotation.

For assistance in selecting replacement parts, contact your local **nyb** representative or visit: http://www.nyb.com.

Form 300 GPB SW
Printed in U.S.A.

Using Performance Curves

Performance is shown according to outlet sizes for quick reference to duct diameter and velocity. Brake horsepower increments are identified on each curve. Recommended standard blower size and motor combinations are based on the most efficient area of operation and are indicated by the arrows. Nonstandard combinations are generally available, but are usually less efficient than the standard combinations.

SIZING NOMENCLATURE

7-digit model number designates the wheel diameter, outlet size, wheel type, and nominal motor horsepower.

Note: the last two digits showing motor horsepower are not required for Arrangement 1 Pressure Blowers.

EXAMPLE

21 — Wheel diameter

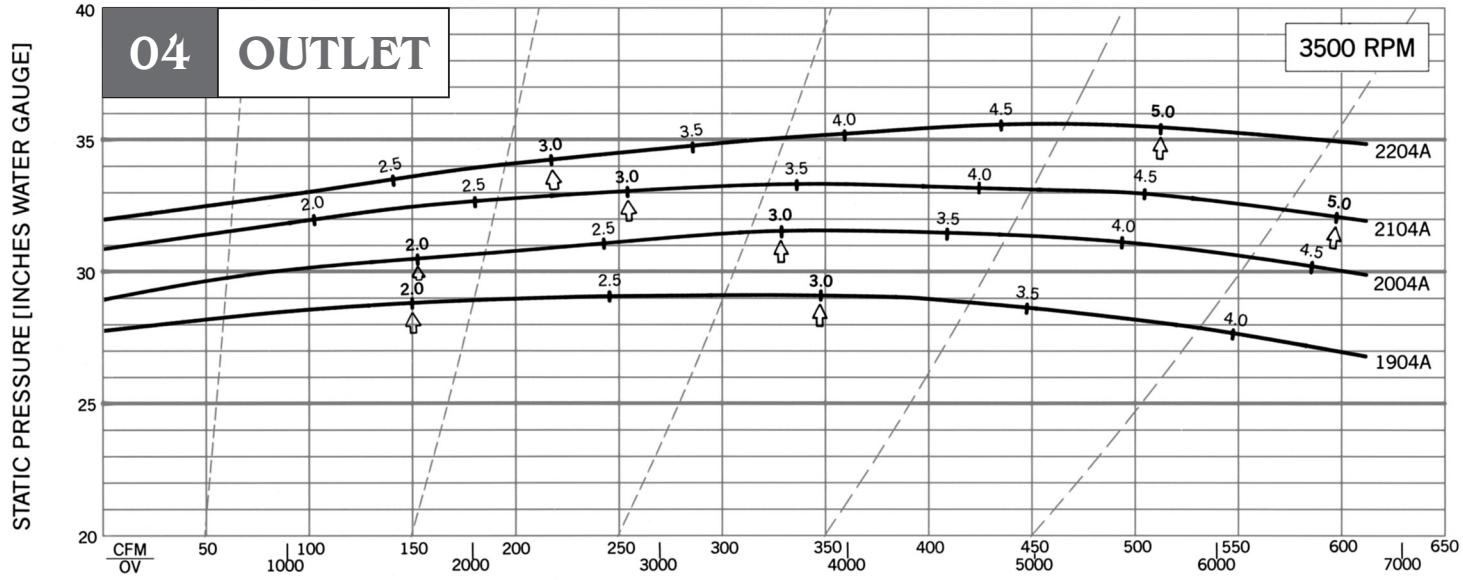
06 — Outlet size [inches]

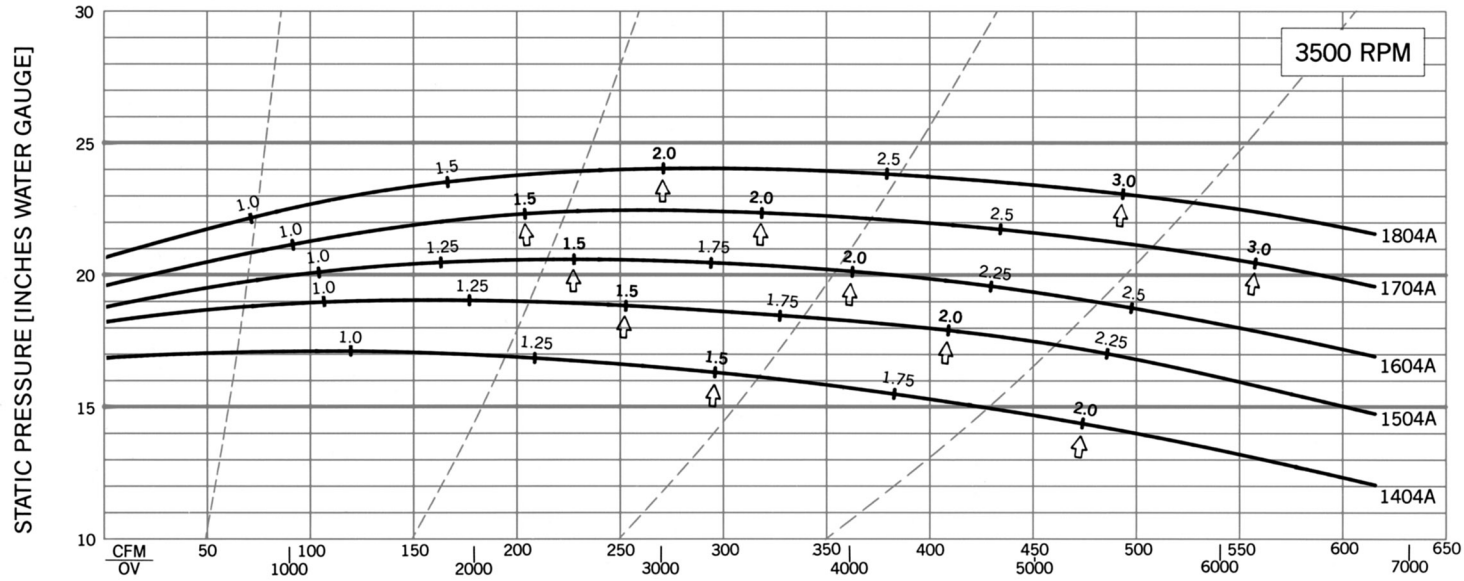
A — Wheel type
A = aluminum
S = steel/ stainless steel

7½ — Nominal horsepower

PROCEDURE	STEPS	EXAMPLE
Determine the appropriate outlet size.	1	The 06 outlet is selected for 800 CFM at 32″SP.
Plot the CFM and SP [standard] and follow a projected system line up to the pressure curve that meets or slightly exceeds the required performance.	2	A Size 2106A will provide 820 CFM at 33.6″SP.
Determine the BHP required for the point of operation . . . see page 4 for steel or stainless-steel wheel factors.	3	2106A requires 6.3 BHP. 2106S requires 7.2 BHP [6.3 x 1.15].
Read to the right to select motor horsepower.	4	A 7½ HP motor will cover both wheel types.

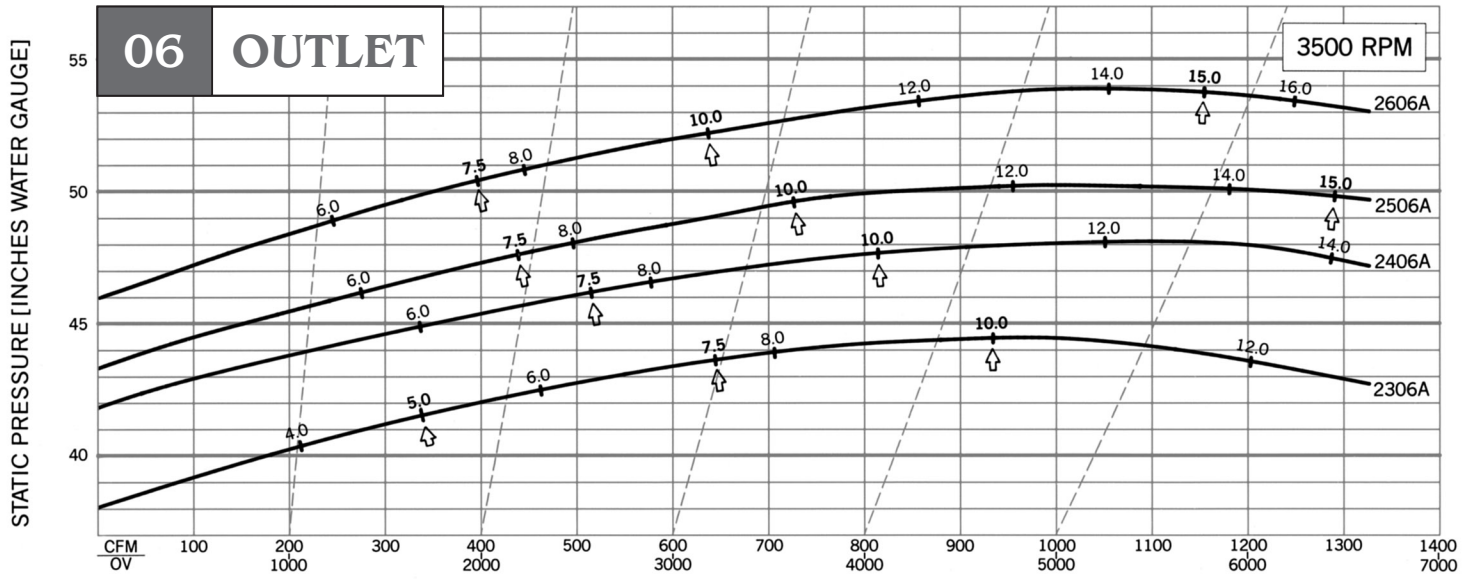
Note: The horsepower coverage of a given motor will increase 15% when a 1.15 service factor motor is utilized.

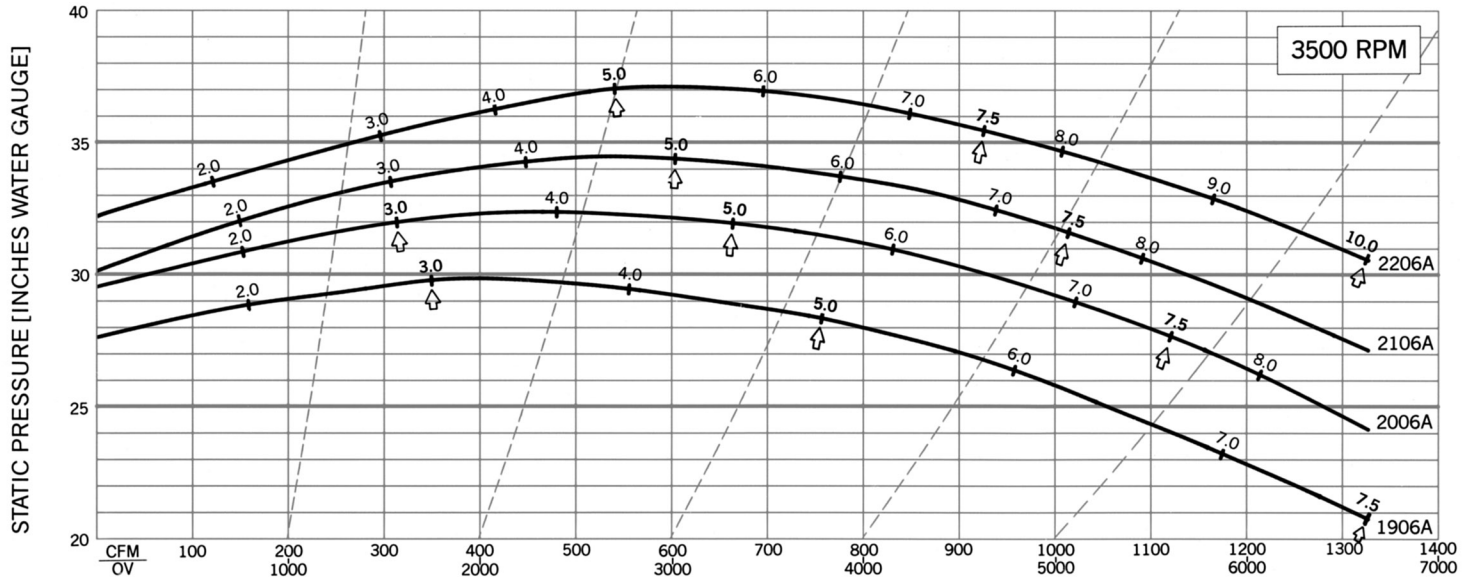


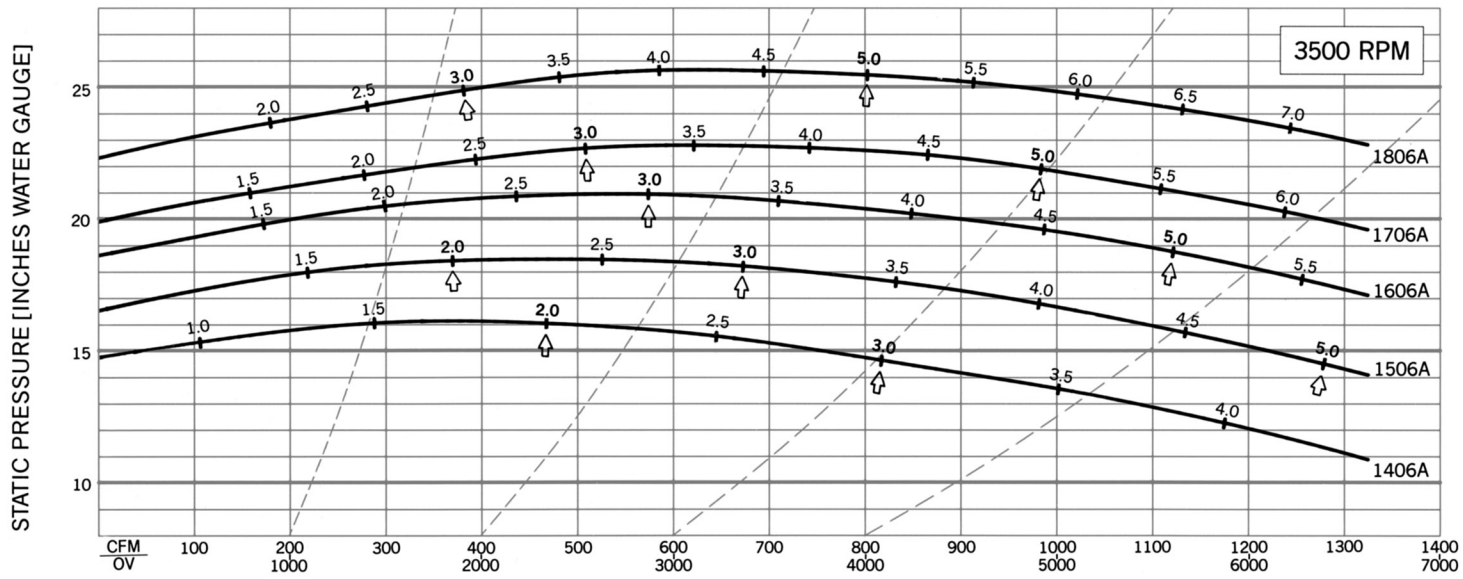


Performance shown is installation Type B: Free inlet, Ducted outlet. Power rating (BHP) does not include drive losses. Performance ratings do not include the effects of appurtenances in airstream.

06 OUTLET

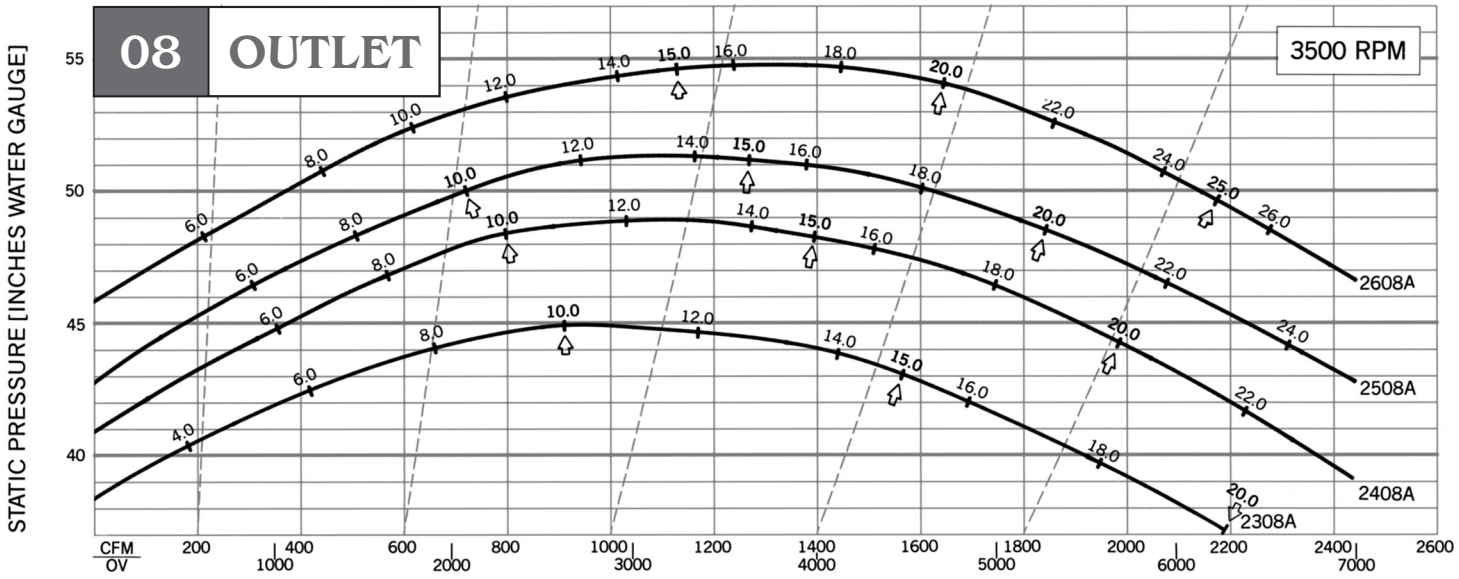


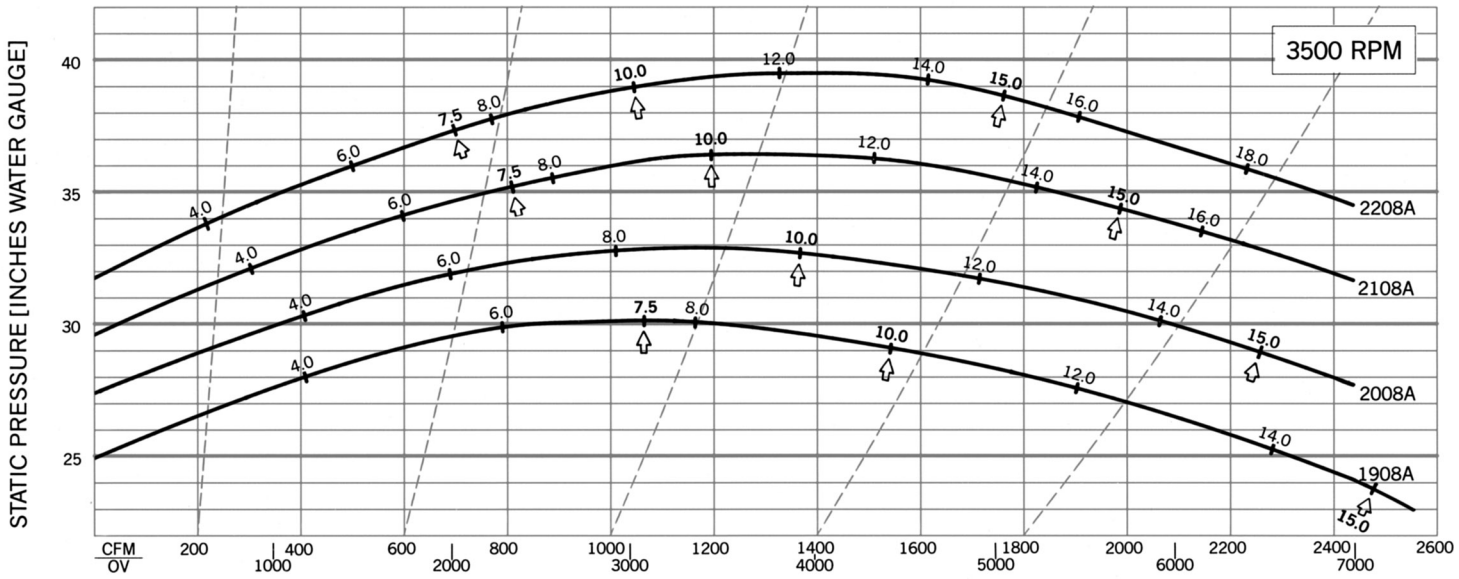


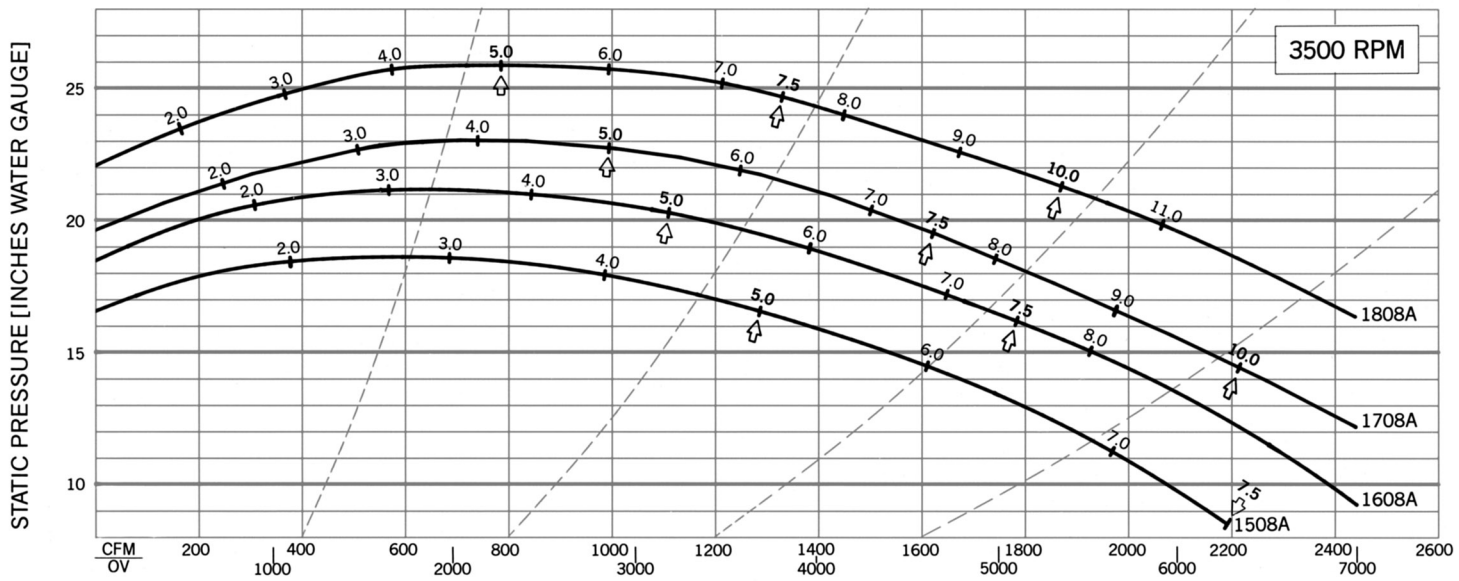


Performance shown is installation Type B: Free inlet, Ducted outlet. Power rating (BHP) does not include drive losses. Performance ratings do not include the effects of appurtenances in airstream.

08 OUTLET







Performance shown is installation Type B: Free inlet, Ducted outlet. Power rating (BHP) does not include drive losses. Performance ratings do not include the effects of appurtenances in airstream.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC.

Recommended

SAFETY PRACTICES

for Users and Installers of Industrial and Commercial Fans

AMCA Publication 410-96

FOREWORD

i. This publication has been prepared by the Air Movement Division of the Air Movement and Control Association International, Inc. (AMCA International). The information contained in this publication has been derived from many sources. The suggestions made necessarily should be general in their meaning and cannot be applied literally to all specific situations or conditions.

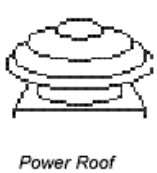
ii. ***The safe installation and operation of fans is the responsibility of the system designer, installer, maintainer, and user.*** From the initial system design through the life of the equipment, safety should be a foremost consideration. Some areas which require some special attention include system design, layout and construction, fan performance specification, foundation and installation details, storage procedures, start-up and commissioning procedures, operation, maintenance, and repair. Specific safety requirements are mandated by federal, state, and local codes. *Recommended Safety Practices for Users and Installers of Industrial and Commercial Fans* is published by AMCA International for assistance. System designers, installers, maintainers, and users should consult and properly comply with all applicable codes and guidelines.

iii. The safety recommendations contained herein are intended to assist designers, installers, maintainers, or other users of air moving devices in the safe operation and use of the devices mentioned. These recommendations do not represent the only methods, procedures, or devices appropriate for the situations discussed. Caution should be used at all times when working in or around moving parts.

iv. AMCA International disclaims any and all warranties, expressed or implied, regarding the products sold by the manufacturer with which this booklet has been provided. Further, AMCA International recommends that competent personnel be consulted in deciding what is the preferred or recommended safety procedure in a particular instance where the guidelines contained in this booklet are unclear or in any way incomplete.

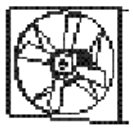
v. AMCA International has offered the information within this booklet to assist in the safe operation, maintenance, and use of the products sold by members of AMCA International. In so doing, AMCA International does not assume any legal duties of the designer or manufacturer to instruct or warn about their product. AMCA International expressly disclaims liability for any injury or damage arising out of the operation or use of the product or the guidelines contained herein.

vi. These recommended safety practices were adopted by the AMCA International membership on April 28, 1996.

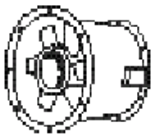


Power Roof Ventilator

Wall Exhauster



Propeller Fan



Axial Fan

1. INTRODUCTION

Centrifugal Fan

Upblast Roof Exhauster

1.1 Fans and other air moving devices are made in a wide variety of types, sizes, and arrangements. This publication addresses the proper use and installation of industrial and commercial fans. It is not intended to address residential and consumer fans.

1.2 Various "size" factors are important when assessing potential for injury; some factors are: diameter of impeller (wheel, rotor, propeller), rotational inertia, voltage, and current.

1.3 This guide is intended to assist in the safe installation of air moving equipment and to warn operating and maintenance personnel of the commonly recognized hazards associated with this equipment.

1.4 ***Handling and installation should always be performed only by experienced and trained personnel who are aware of the hazards associated with rotating equipment. Failure to comply with these practices may result in death or serious bodily injury.*** In addition to following the manufacturer's installation instructions, care should be taken to ensure compliance with specific safety requirements mandated by federal, state, and local codes. Industry safety standards and practices published by AMCA International and by other recognized agencies and associations should be consulted and followed where applicable.

2. PERSONNEL SAFETY ACCESSORIES

2.1 GENERAL

2.1.1 Protective devices are incorporated as standard construction on some types of fans but on many fans, these devices are offered as optional accessories. This is done because the need for the devices and the design required will frequently depend upon the type of system, fan location, and operating procedures being employed. Proper protective safety devices; company safety standards; specific safety requirements mandated by federal, state, and local codes; and industry safety standards and practices published by AMCA International and by other recognized agencies and associations should be determined by the user, who should specify and obtain the appropriate devices from the fan manufacturer or others, and should not allow operation of the equipment without them. Examples of available devices include the following:

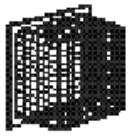
2.2 FAN GUARDS

2.2.1 All fans have moving parts which require guarding in the same way as other moving machinery. Fans located less than seven (7) feet above the floor require special consideration. Specific safety requirements should comply with mandated federal, state, and local codes; and industry safety standards and practices published by AMCA International and by other recognized agencies and associations should be followed.

2.2.2 Roof-mounted fans and other fans which are not generally accessible may not require safety guards which might otherwise be appropriate. Where accessibility to these fans is occasional or infrequent, the expense of permanent guarding may be reduced through the use of lockout switches and suitable warnings. In such cases, maintenance personnel

should engage the lockout switch before undertaking any maintenance or repairs. As is the case with other machinery involving moving parts, common sense and caution will preserve personal safety.

Industrial Type Guard For Propeller Fan



Maximum Safety Guard for Propeller Fan

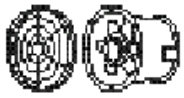
Screen on Roof Ventilator

2.3 INLET AND OUTLET GUARDS

2.3.1 Axial and centrifugal fans are often connected directly to ductwork which will prevent contact with the internal moving parts; when an exposed inlet or outlet represents a hazard, a suitable guard should be installed.

Centrifugal Fan Protected by Ductwork

Inlet or Outlet Guard on Centrifugal Fan



Guard for Axial Fan With Non-Ducted Inlet or Outleg

2.4 DRIVE GUARDS

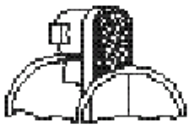
2.4.1 Fans may be driven directly from the motor shaft or through a belt drive. Where the bearing assembly, rotating shaft, sheaves, or belts are exposed, a suitable guard may need to be provided. Some example guards are shown below.

Drive Coupling Guard

Heat Slinger Guard (Shaft and bearing guard omitted for clarity

Shaft and Bearing Guard

2.4.2 Drive guards may be required for tubular centrifugal or axial fans to cover the exposed drive sheave and belts outside the fan housing.



Drive Guard - Axial Fan

2.4.3 A typical centrifugal fan drive guard may vary with the arrangement. Safety guards should be used when drive systems are accessible to personnel. In restricted areas, omission of the back cover may be acceptable.

Drive Guard - Centrifugal Fan

2.4.4 Dampers and their linkage may operate suddenly without warning at high speeds Dampers and their linkage contain pinch points which should be identified and guarded.

3. HIDDEN DANGERS

3.1 GENERAL

3.1.1 In addition to the obvious hazards associated with the moving parts of rotating machinery, fans present additional potential hazards that are not so obvious and should be considered by the system designer and user for safe operation.

3.2 SUCTION AND AIR PRESSURE

3.2.1 Fans operate by creating suction and air pressure which can be hazardous. Solid objects can be drawn into a fan's inlet and then become dangerous projectiles when they are exhausted through the fan's outlet. ***Solid objects can also cause fan failure or impeller failure due to imbalance or damage to the impeller blades.*** Personnel in close proximity to a fan inlet can be overcome by the suction, and drawn into the fan.

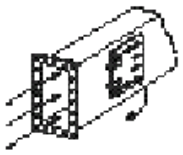
Special Purpose Intake Screen

3.2.2 Whenever there is a possibility that solid objects can be drawn into a remote intake, the intake should be guarded at all times. Before a guard is removed, the fan should be disconnected and the power supply locked out.

3.2.3 Where fans are installed over an occupied area, safety guards should be provided to prevent dropped objects from entering this area during installation and maintenance.

3.2.4 Access doors to a fan or duct system should never be opened while the fan is operating or coasting to a stop. On the downstream (or pressure) side of the system, releasing the door with the system in operation may result in an explosive opening. On the upstream (or suction) side, the inflow may be sufficient to draw in tools, clothing, and other materials. The power supply should always be locked out prior to accessing a fan or ductwork.

3.2.5 Fan design sometimes requires access doors to be supplied with internal components such as a plug to fill a hole in the fan casing. These doors can often be heavy and difficult to handle. Care should be exercised when opening, removing, and installing these components.



Bolted Access Door in Duct

3.3 WINDMILLING

3.3.1 Even when the power supply is locked out, fans may cause injury or damage if the impeller is subject to "windmilling" which is the turning of the impeller and drive components due to a draft in the system. To guard against this hazard, the impeller should be secured to physically restrict rotational movement.

3.4 TEMPERATURE

3.4.1 Many fans, fan motors, and fan components run at temperatures that could burn someone who comes in contact with the hot areas, including discharged or leaking gases. If this potential hazard is present, steps should be taken so that personnel working near the fan are aware of the danger and can exercise caution.

3.5 FAN NOISE AND ENVIRONMENT

3.5.1 Some fans can generate sound that could be haz ardous to exposed personnel. Sound pressure can be measured in the field, but obtaining accurate data is difficult. The environment in which the fan operates can impact the ability to obtain accurate fan sound readings. Consult the manufacturer for fan sound data. It is the responsibility of the system designer, installer, user, and maintainer to comply with specific safety requirements mandated by federal, state, and local codes; and to follow industry safety standards and practices published by AMCA International and by other recognized agencies and associations, regarding personnel safety from exposure to fan noise associated with use and exposure to equipment.

Hearing Protection

3.6 STROBOSCOPIC EFFECT

3.6.1 The stroboscopic effect of certain lights in combination with certain fan speeds may cause a rotating assembly to appear stopped. In these cases, irregular markings can be placed on the moving parts to prevent this type of effect. Personnel should be warned that the fan may be in motion even if it appears not to be.

3.7 SPECIAL PRUPOSE FANS AND SYSTEMS

3.7.1 The hidden dangers associated with Special Purpose Fans used in special systems are covered in Section 6.

4. POWER ISOLATION

4.1 Every fan should be installed with a suitable device allowing it to be completely disconnected or isolated from the power supply.

4.2 Many fans are started by remote switches or push-buttons, by interlocks with other equipment, or by automatic controls. Before performing any maintenance, inspection, or other activity which will require removal of guards, ductwork, access doors, etc., or exposure of moving parts, the fan power supply should be locked out and the fan tagged out of service.

4.3 In some installations other equipment, such as gas burners, may be interlocked with the fan so that disconnecting the fan will automatically shut off the burner or other device. Maintenance on systems of this type should be performed only under the supervision of competent engineering personnel and in accordance with applicable codes and standards.

Remote Switch

Disconnect Switch

Lock Carried by Maintenance Personnel

4.4 In cases where the fan is power driven by a source other than an electric motor, appropriate provisions should be made for the isolation or disengagement of the power supply.

5. START-UP CHECK LIST

5.1 GENERAL

5.1.1 Before putting any fan into initial operation, the manufacturer's instructions should be followed. Transportation, handling, and installation can cause fasteners to loosen, and cause misalignment of fan components. Carefully follow this check list when commissioning equipment.
5.1.2 Lock out the primary and all secondary power sources.
5.1.3 A complete inspection should be made of all of the ductwork and the interior of the fan. Make certain there is no foreign material which can be drawn into or blown through the fan or ductwork. Appropriate protective measures and safety practices should be observed when entering or working within these areas. These measures might include the use of goggles, respirators, or other personal protective devices.
5.1.4 Make sure the foundation or mounting arrangement and the duct connections are adequately designed and installed per drawings and in accordance with recognized acceptable engineering practices and with the fan manufacturer's recommendations.
5.1.5 Check and tighten all bolts, fasteners, and set screws as necessary.
5.1.6 Check the fan assembly and bearings for proper grounding to prevent static electricity discharge.
5.1.7 Ensure power and drive components such as motor starter, variable frequency drive, or hydraulic power unit are properly sized, matched, and connected to the fan.
5.1.8 Check bearings for recommended lubricant and lubrication amount.
5.1.9 Spin the rotating assembly to determine whether it rotates freely, without hitting anything, and is not grossly out of balance.
5.1.10 Inspect impeller for proper rotation for the fan design.
5.1.11 Check alignment of drives and all other components.
5.1.12 Check the belt drive for proper sheave selection and installation and make sure the sheaves are not reversed (excessive speeds could develop).
5.1.13 Check for recommended belt tension.
5.1.14 Properly secure all safety guards.
5.1.15 Assure that all appropriate warnings have been put in place.
5.1.16 Secure all access doors to the fan and ductwork.
5.1.17 Momentarily energize the fan to check the direction of rotation. Listen as the fan coasts to a stop for any unusual noise, identify the source, and take corrective action as necessary.
5.1.18 Switch on the electrical supply and allow the fan to reach full speed. Check carefully for:

(1) Excessive vibration
(2) Unusual noise
(3) Proper belt alignment
(4) Proper lubrication
(5) Proper amperage, voltage, or power values.
(6) If any problem is indicated, **SWITCH OFF IMMEDIATELY.**
(7) Lock out the power supply. Secure the fan impeller if there is a potential for windmilling. Check carefully for the cause of the trouble, correct as necessary, and repeat check list procedure.

5.2 Even if the fan appears to be operating satisfactorily, shut down after a brief period, lock out the power supply, and recheck items 5.1.5 through 5.1.17 as the initial start-up may have loosened the bolts, fasteners, and set screws.
5.3 The fan may now be put into operation, but during the first eight hours of running, it should be closely observed and checked for excessive vibration and noise. At this time checks should also be made of motor input current and motor and bearing temperatures to ensure that they do not exceed manufacturer's recommendations.
5.4 After eight hours of operation, the fan should be shut down and the power locked out. Check list items 5.1.5 through 5.1.17 should be inspected and adjusted if necessary.
5.5 After twenty-four (24) hours of satisfactory operation, the fan should be shut down (locked out) and the drive belt tension should be readjusted to recommended tension.
5.6 After commissioning and start-up, the fan should be operated and maintained in accordance with the manufacturer's and component manufacturer's recommendations. Some basic guidelines for **WARNING SIGNS** and **ROUTINE MAINTENANCE** are included in Sections 7 and 8 of this publication. These sections are meant as a supplement to other publications and are not intended to replace the manufacturer's instructions.

6. SPECIAL PURPOSE FANS

6.1 Most fans are designed to handle clean air at standard temperatures between 32 F and 120 F. These fans should not be placed in systems or used for other than their design intended use. *Special Purpose Fans* are designed for use in systems that may include extreme temperatures, explosive, toxic, or special gases, material handling, corrosive environments, or other special hazards which should be carefully considered. Specific safety requirements should comply with mandated federal, state, and local codes; and industry safety standards and practices published by AMCA International and by other recognized agencies and associations should be followed.
6.2 Where the system will handle explosive or flammable material (i.e., dust, fumes, vapors or gases), fans of spark-resistant construction should be used.
6.3 Fans connected by ductwork or other piping may contain gases other than air which are hazardous. In these cases, procedures should be established to prevent exposure of personnel working on or near the fan, and by maintenance personnel who may need to enter the fan. Appropriate personal protective equipment as determined by the material safety data sheet, and system operators should be utilized. Appropriate environmental protective measures should also be taken.
6.4 Fan inlet boxes, housings, ductwork, and other system components which are large enough to permit entry should be considered confined spaces. System areas may also serve as low points where heavy gases, liquids, or other substances may accumulate and present explosive, fire, health, or suffocation hazards. Appropriate protective measures and safety practices should be observed when entering or working within these areas.
6.5 Material-handling fans are specially designed to allow the fan to handle a specific type of material without excessive accumulation of material on the fan impeller. Fans handling corrosive gases or erosive material should be checked periodically. If loss of material is evident, the fan should be shut down, power supply locked out, and tagged out of service. The manufacturer or other qualified personnel should be consulted to determine if the fan is within safety limits for operation. To ensure satisfactory operation it is essential to observe the manufacturer's limitations concerning the type of material to be handled by the fan.
6.6 Fan ratings and maximum speed limits are typically based on the use of air at 70 F. At temperatures above the normal range (specified by the manufacturer), a reduction should be made in the maximum speed limit. Information on this reduction and on other precautions to be taken for high temperature applications should be obtained from the fan manufacturer. Personnel working near high temperature fans should be aware that coming in contact with the fan's housing, ductwork, or handled gases could result in serious burns. Where the danger of burns is not apparent, appropriate warnings should be posted. Appropriate protective apparel should be worn whenever working in close contact with heated housings or ductwork.
6.7 Corrosive contaminants can be formed when moisture combines with an active airborne chemical. Fans subjected to corrosive contaminants will corrode; however, suitable protective coatings or material, if used in

the fan construction, can delay corrosion. Protected fans should be regularly inspected to ensure that the protection remains effective. Personnel working in environments with airborne chemicals may require personal protective apparel equipment.
6.8 Where liquid can accumulate within the fan, provide for the installation of adequately sized drains.
6.9 In those applications where there is a potential for chemical build-up (such as grease, creosote, etc.), periodic cleaning and proper drainage are necessary to avoid a fire hazard.

7. WARNING SIGNS

7.1 GENERAL

7.1.1 A change in the operating characteristics of a fan may indicate the need for maintenance. Sudden changes may indicate severe problems or dangerous conditions developing. Investigate any changes in the operational characteristics or unusual symptoms of the fan. Refer to AMCA Publication 202, *Troubleshooting*, for a more detailed explanation of investigating procedures. Consult your manufacturer or other qualified consultant with questions concerning changes observed.

7.2 EXCESSIVE VIBRATION

7.2.1 Operational vibration levels are one of the best indicators of the condition of the blower. Careful observation and monitoring of vibration levels can detect a minor problem in the early stages of development when correction is less costly and easier. Recommended maximum vibration levels should be obtained from the equipment manufacturer.
7.2.2 If excessive vibration is observed, stop the fan and lock it out until the cause is corrected. Check for material build-up on the impeller. Generally this will show up as material flaking off the fan impeller and causing an imbalance which may lead to catastrophic failure of the fan or its components. Excessive vibration can also be caused by looseness in the drive train, loose fasteners, misalignment or impeller damage. Contact the fan manufacturer or other qualified consultant to determine the maximum vibration level if it is not included in maintenance instructions.

7.3 NOISE

7.3.1 Changes to the sound level may indicate maintenance is needed. Some unusual noises often heard include: bearing noise indicating the bearings need lubricant or replacement; scraping or ticking noise indicating the rotating parts are hitting the stationary parts; squealing indicating the belt drive needs tensioning; repeated changing pitch of the blower indicating operation of the blower at too low a flow. If any of these noises or any other unusual noises are detected, their cause should be determined and corrective action taken as necessary.

7.4 HIGH MOTOR TEMPERATURES

7.4.1 Check that cooling air to the motor has not been diverted or blocked by dirty guards or similar obstacles. Check the input amperage. An increase in amperage may indicate that some major change has occurred in the system.

7.5 HIGH BEARING TEMPERATURES

7.5.1 This condition is usually caused by improper lubrication; this can be either "over," "under," or "unsuitable" lubrication. In every case, if the cause of the trouble is not easily seen, experienced personnel should examine the equipment before it is put back in operation.

7.6 POOR PERFORMANCE

7.6.1 Too much flow or pressure or too little flow or pressure is often a symptom of a change in the operating system. A fan will typically operate at the same performance in a static system some typical causes include: operating of the fan backwards after maintenance procedures; filters dirty or not in place; change or blockage in the ductwork; change in speed of the fan (switching the sheaves); loss or failure of the impeller. All of these causes and many others will affect the flow and pressure produced by the fan.

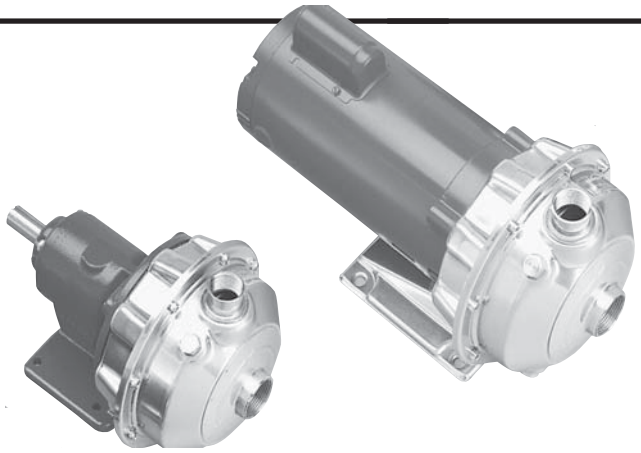
8. ROUTINE MAINTENANCE

8.1 A preventive maintenance program is an important aspect of an effective safety program. Consult your manufacturer or other qualified consultant with questions concerning changes observed during periodic inspections and routine maintenance.
8.2 The fan manufacturer's operating and maintenance recommendations, as well as the components manufacturer's instructions (such as motor, bearing, drives, etc.) should be strictly followed.
8.3 *Maintenance should always be performed by experienced and trained personnel who are aware of the hazards associated with rotating equipment.* Do not attempt any maintenance on a fan unless the fan power supply has been locked out and tagged out and the impeller has been secured.
8.4 When performing maintenance functions which include disassembly of the fan, careful consideration should be given to the size, weight, center of gravity, and lifting means of the fan components. It should also be noted that the outboard bearing on some fans such as arrangements 1, 8, 9, and 10 is often cap-loaded. Removal of the securing means may result in a sudden change in impeller position.
8.5 Historical data is often the best indicator for determining the operational condition of the fan. Maintenance logs which include relubrication, vibration levels, temperature levels, power requirements, inspection, and other pertinent records should be maintained and consulted as necessary when assessing the condition of the fan.
8.6 Under normal circumstances, handling clean air, the system should require cleaning only once a year. However, the fan and system should be checked at regular intervals to detect any unusual accumulation.
8.7 The fan impeller should be specially checked for build-up of material or dirt which may cause an imbalance with resulting undue wear on bearings and belt drives. A regular maintenance program should be established as needed to prevent material build-up.
8.8 Periodic inspection of the rotating assembly should be made to detect any indication of weakening of the rotor because of corrosion, erosion, or metal fatigue. Where signs of deterioration are found, lock out and tag out the impeller until the unit has been inspected and approved by a qualified consultant.

G&L Pumps

Installation, Operation and Maintenance Instructions

Model NPE/ NPE-F



DESCRIPTION & SPECIFICATIONS:

The Models NPE (close-coupled) and NPE-F (frame-mounted) are end suction, single stage centrifugal pumps for general liquid transfer service, booster applications, etc. Liquid-end construction is all AISI Type 316 stainless steel, stamped and welded. Impellers are fully enclosed, non-trimable to intermediate diameters. Casings are fitted with a diffuser for efficiency and for negligible radial shaft loading.

Close-coupled units have NEMA 48J or 56J motors with C-face mounting and threaded shaft extension. Frame-mounted units can be coupled to motors through a spacer coupling, or belt driven.

1. Important:

1.1. Inspect unit for damage. Report any damage to carrier/dealer immediately.

1.2. Electrical supply must be a separate branch circuit with fuses or circuit breakers, wire sizes, etc., per National and Local electrical codes. Install an all-leg disconnect switch near pump.

CAUTION

Always disconnect electrical power when handling pump or controls.

1.3. Motors must be wired for proper voltage. Motor wiring diagram is on motor nameplate. Wire size must limit maximum voltage drop to 10% of nameplate voltage at motor terminals, or motor life and pump performance will be lowered.

1.4. Always use horsepower-rated switches, contactor and starters.

1.5. Motor Protection

1.5.1. Single-phase: Thermal protection for single-phase units is sometimes built in (check nameplate). If no built-in protection is provided, use a contactor with a proper overload. Fusing is permissible.

1.5.2. Three-phase: Provide three-leg protection with properly sized magnetic starter and thermal overloads.

1.6. Maximum Operating Limits:

Liquid Temperature:	212° F (100° C) with standard seal. 250° F (120° C) with optional high temp seal.
Pressure:	75 PSI.
Starts Per Hour:	20, evenly distributed.

1.7. Regular inspection and maintenance will increase service life. Base schedule on operating time. Refer to Section 8.

2. Installation:

2.1. General

2.1.1. Locate pump as near liquid source as possible (below level of liquid for automatic operation).

2.1.2. Protect from freezing or flooding.

2.1.3. Allow adequate space for servicing and ventilation.

2.1.4. All piping must be supported independently of the pump, and must "line-up" naturally.

CAUTION

Never draw piping into place by forcing the pump suction and discharge connections.

2.1.5. Avoid unnecessary fittings. Select sizes to keep friction losses to a minimum.

2.2. Close-Coupled Units:

2.2.1. Units may be installed horizontally, inclined or vertically.

CAUTION

Do not install with motor below pump. Any leakage or condensation will affect the motor.

2.2.2. Foundation must be flat and substantial to eliminate strain when tightening bolts. Use rubber mounts to minimize noise and vibration.

2.2.3. Tighten motor hold-down bolts before connecting piping to pump.

2.3. Frame-Mounted Units:

2.3.1. It is recommended that the bedplate be grouted to a foundation with solid footing. Refer to Fig.1.

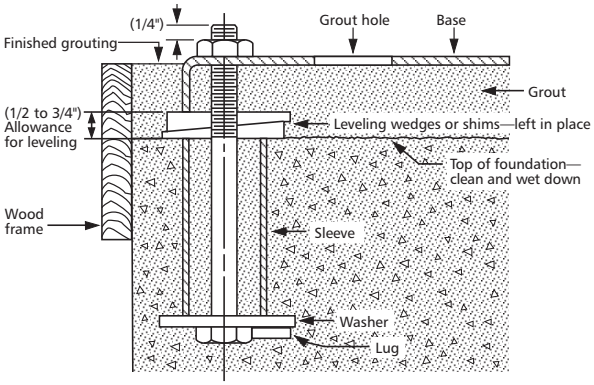


Figure 1

Goulds Pumps

ITT Industries

2.3.2. Place unit in position on wedges located at four points (two below approximate center of driver and two below approximate center of pump). Adjust wedges to level unit. Level or plumb suction and discharge flanges.

2.3.3. Make sure bedplate is not distorted and final coupling alignment can be made within the limits of movement of motor and by shimming, if necessary.

2.3.4. Tighten foundation bolts finger tight and build dam around foundation. Pour grout under bedplate making sure the areas under pump and motor feet are filled solid. Allow grout to harden 48 hours before fully tightening foundation bolts.

2.3.5. Tighten pump and motor hold-down bolts before connecting the piping to pump.

3. Suction Piping:

3.1. Low static suction lift and short, direct, suction piping is desired. For suction lift over 10 feet and liquid temperatures over 120 F, consult pump performance curve for Net Positive Suction Head Required.

3.2. Suction pipe must be at least as large as the suction connection of the pump. Smaller size will degrade performance.

3.3. If larger pipe is required, an eccentric pipe reducer (with straight side up) must be installed at the pump.

3.4. Installation with pump below source of supply:

3.4.1. Install full flow isolation valve in piping for inspection and maintenance.

CAUTION

Do not use suction isolation valve to throttle pump.

3.5. Installation with pump above source of supply:

3.5.1. Avoid air pockets. No part of piping should be higher than pump suction connection. Slope piping upward from liquid source.

3.5.2. All joints must be airtight.

3.5.3. Foot valve to be used only if necessary for priming, or to hold prime on intermittent service.

3.5.4. Suction strainer open area must be at least triple the pipe area.

3.6. Size of inlet from liquid source, and minimum submergence over inlet, must be sufficient to prevent air entering pump through vortexing. See Figs. 2-5

3.7. Use 3-4 wraps of Teflon tape to seal threaded connections.

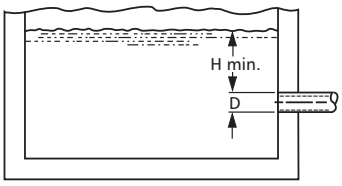


Figure 2

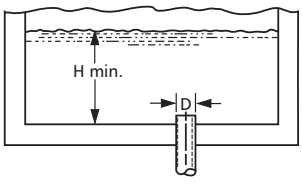


Figure 3

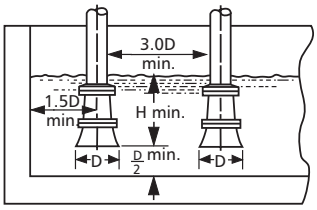


Figure 4

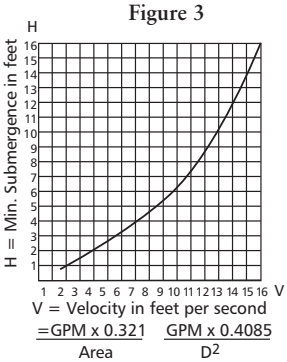


Figure 5

4. Discharge Piping:

4.1. Arrangement must include a check valve located between a gate valve and the pump. The gate valve is for regulation of capacity, or for inspection of the pump or check valve.

4.2. If an increaser is required, place between check valve and pump.

4.3. Use 3-4 wraps of Teflon tape to seal threaded connections.

5. Motor-To-Pump Shaft Alignment:

5.1. Close-Coupled Units:

5.1.1. No field alignment necessary.

5.2. Frame-Mounted Units:

5.2.1. Even though the pump-motor unit may have a factory alignment, this could be disturbed in transit and must be checked prior to running. See Fig. 6.

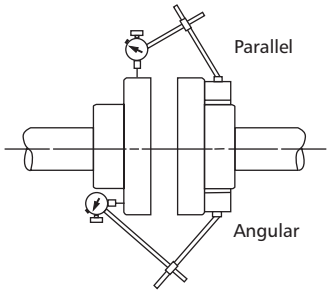


Figure 6

5.2.2. Tighten all hold-down bolts before checking the alignment.

5.2.3. If re-alignment is necessary, always move the motor. Shim as required.

5.2.4. Parallel misalignment - shafts with axis parallel but not concentric. Place dial indicator on one hub and rotate this hub 360 degrees while taking readings on the outside diameter of the other hub. Parallel alignment occurs when Total Indicator Reading is .005", or less.

5.2.5. Angular misalignment - shafts with axis concentric but not parallel. Place dial indicator on one hub and rotate this hub 360 degrees while taking readings on the face of the other hub. Angular alignment is achieved when Total Indicator Reading is .005", or less.

5.2.6. Final alignment is achieved when parallel and angular requirements are satisfied with motor hold-down bolts tight.

CAUTION

Always recheck both alignments after making any adjustment.

6. Rotation:

6.1. Correct rotation is right-hand (clockwise when viewed from the motor end). Switch power on and off quickly. Observe shaft rotation. To change rotation:

6.1.1. Single-phase motor: Non-reversible.

6.1.2. Three-phase motor: Interchange any two power supply leads.

7. Operation:

7.1. Before starting, pump must be primed (free of air and suction pipe full of liquid) and discharge valve partially open.

CAUTION

Pumped liquid provides lubrication. If pump is run dry,rotating parts will seize and mechanical seal will be damaged. Do not operate at or near zero flow. Energy imparted to the liquid is converted into heat. Liquid may flash to vapor. Rotating parts require liquid to prevent scoring or seizing.

7.2. Make complete check after unit is run under operating conditions and temperature has stabilized. Check for expansion of piping. On frame-mounted units coupling alignment may have changed due to the temperature differential between pump and motor. Recheck alignment.

8. Maintenance:

8.1. Close-Coupled Unit. Ball bearings are located in and are part of the motor. They are permanently lubricated. No greasing required.

8.2. Frame-Mounted Units:

8.2.1. Bearing frame should be regreased every 2,000 hours or 3 month interval, whichever occurs first. Use a #2 sodium or lithium based grease. Fill until grease comes out of relief fittings, or lip seals, then wipe off excess.

8.2.2. Follow motor and coupling manufacturers' lubrication instructions.

8.2.3. Alignment must be rechecked after any maintenance work involving any disturbance of the unit.

9. Disassembly:

Complete disassembly of the unit will be described. Proceed only as far as required to perform the maintenance work needed.

9.1. Turn off power.

9.2. Drain system. Flush if necessary.

9.3. Close-Coupled Units: Remove motor hold-down bolts.

Frame-Mounted Units: Remove coupling, spacer, coupling guard and frame hold-down bolts.

9.4. Disassembly of Liquid End:

9.4.1. Remove casing bolts (370).

9.4.2. Remove back pull-out assembly from casing (100).

9.4.3. Remove impeller locknut (304).

CAUTION

Do not insert screwdriver between impeller vanes to prevent rotation of close-coupled units. Remove cap at opposite end of motor. A screwdriver slot or a pair of flats will be exposed. Using them will prevent impeller damage.

9.4.4. Remove impeller (101) by turning counter-clockwise when looking at the front of the pump. Protect hand with rag or glove.

CAUTION

Failure to remove the impeller in a counter-clockwise direction may damage threading on the impeller, shaft or both.

9.4.5. With two pry bars 180 degrees apart and inserted between the seal housing (184) and the motor adapter (108), carefully separate the two parts. The mechanical seal rotary unit (383) should come off the shaft with the seal housing.

9.4.6. Push out the mechanical seal stationary seat from the motor side of the seal housing.

9.5. Disassembly of Bearing Frame:

9.5.1. Remove bearing cover (109).

9.5.2. Remove shaft assembly from frame (228).

9.5.3. Remove lip seals (138 & 139) from bearing frame and bearing cover if worn and are being replaced.

9.5.5. Use bearing puller or arbor press to remove ball bearings (112 & 168).

10. Reassembly:

10.1. All parts should be cleaned before assembly.

10.2. Refer to parts list to identify required replacement items. Specify pump index or catalog number when ordering parts.

10.3. Reassembly is the reverse of disassembly.

10.3.1. Impeller and impeller locknut assembled onto motor shaft with 10 ft-lbs of torque.

10.4. Observe the following when reassembling the bearing frame:

10.4.1. Replace lip seals if worn or damaged.

10.4.2. Replace ball bearings if loose, rough or noisy when rotated.

10.4.3. Check shaft for runout. Maximum permissible is .002" T.I.R.

10.5. Observe the following when reassembling the liquid-end:

10.5.1. All mechanical seal components must be in good condition or leakage may result. Replacement of complete seal assembly, whenever seal has been removed, is good standard practice.

It is permissible to use a light lubricant, such as glycerin, to facilitate assembly. Do not contaminate the mechanical seal faces with lubricant.

10.5.2. Inspect casing O-ring (513) and replace if damaged. This O-ring may be lubricated with petroleum jelly to ease assembly.

10.5.3. Inspect guidevane O-ring (349) and replace if worn.

CAUTION

Do not lubricate guidevane O-ring (349). Insure it is not pinched by the impeller on reassembly.

10.6. Check reassembled unit for binding. Correct as required.

10.7. Tighten casing bolts in a star pattern to prevent O-ring binding.

11. Trouble Shooting Chart:

MOTOR NOT RUNNING
(See causes 1 thru 6)

LITTLE OR NO LIQUID DELIVERED:
(See causes 7 thru 17)

POWER CONSUMPTION TOO HIGH:
(See causes 4, 17, 18, 19, 22)

EXCESSIVE NOISE AND VIBRATION:
(See causes 4, 6, 9, 13, 15, 16, 18, 20, 21, 22)

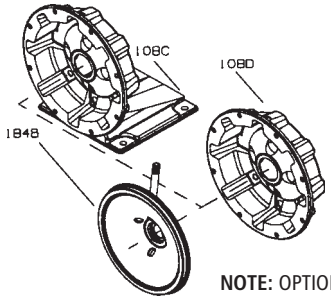
PROBABLE CAUSE:

1. Tripped thermal protector
2. Open circuit breaker
3. Blown fuse
4. Rotating parts binding
5. Motor wired improperly
6. Defective motor
7. Not primed
8. Discharge plugged or valve closed
9. Incorrect rotation
10. Foot valve too small, suction not submerged, inlet screen plugged.
11. Low voltage
12. Phase loss (3-phase only)
13. Air or gasses in liquid
14. System head too high
15. NPSHA too low:
    Suction lift too high or suction losses excessive.
    Check with vacuum gauge.
16. Impeller worn or plugged
17. Incorrect impeller diameter
18. Head too low causing excessive flow rate
19. Viscosity or specific gravity too high
20. Worn bearings
21. Pump or piping loose
22. Pump and motor misaligned

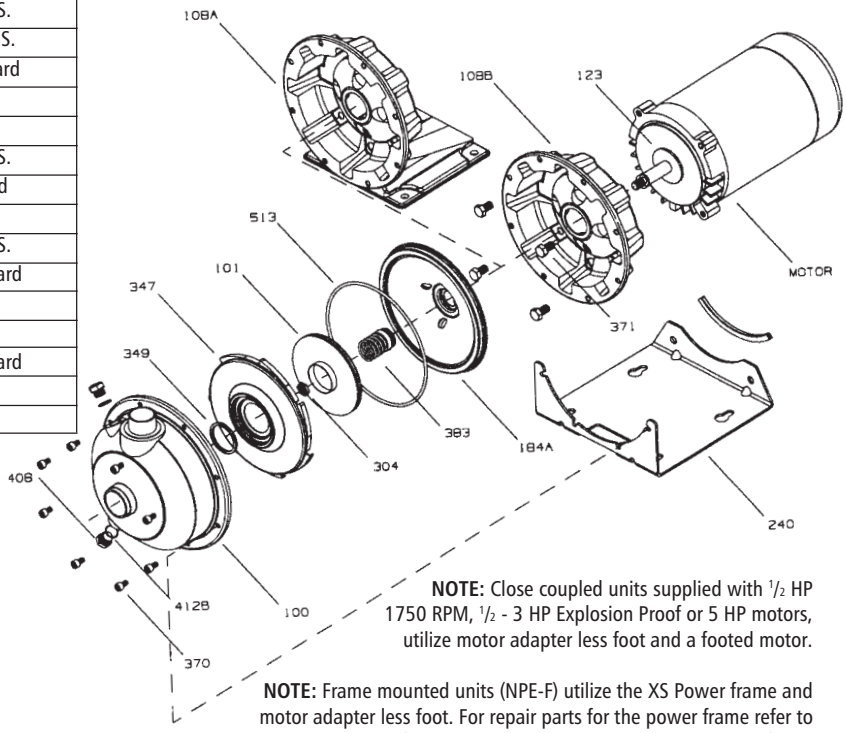
NPE Standard Repair Parts List

Item No.	Description	Materials of Construction
100	Casing	AISI 316L Stainless Steel
101	Impeller	
108A	Motor adapter with foot	
108B	Motor adapter less foot	
108C	Motor adapter with foot and Flush	
108D	Motor adapter less foot with Flush	
123	Deflector	BUNA-N
184A	Seal housing std.	AISI 316L S.S.
184B	Seal housing with seal flush	
240	Motor support	300 S.S.
	Rubber channel	Rubber
304	Impeller locknut	AISI 316 S.S.
347	Guidevane	AISI 316L S.S.
349	Seal-Ring, guidevane	Viton Standard
		EPR
		BUNA
370	Socket head screw, casing	AISI 410 S.S.
371	Bolts, motor	Steel/plated
383	Mechanical seal	
408	Drain and vent plug, casing	AISI 316 S.S.
412B	O-Ring, drain plugs	Viton, standard
		EPR
		BUNA
513	O-Ring, casing	Viton, standard
		EPR
		BUNA

Item 383 Mechanical Seal (⅝" seal)				
Rotary	Stationary	Elastomers	Metal Parts	Part No.
Carbon	Sil-Carbide	EPR	316SS	10K18
		Viton		10K55
Sil-Carbide		EPR		10K81
		Viton		10K62



NOTE: OPTIONAL SEAL FLUSH COMPONENTS



NOTE: Close coupled units supplied with ½ HP 1750 RPM, ½ - 3 HP Explosion Proof or 5 HP motors, utilize motor adapter less foot and a footed motor.

NOTE: Frame mounted units (NPE-F) utilize the XS Power frame and motor adapter less foot. For repair parts for the power frame refer to the XS-Power frame repair parts page in the parts section of your catalog. To order the power frame complete order item 14L61

GOULDS PUMPS LIMITED WARRANTY

This warranty applies to all water systems pumps manufactured by Goulds Pumps.

Any part or parts found to be defective within the warranty period shall be replaced at no charge to the dealer during the warranty period. The warranty period shall exist for a period of twelve (12) months from date of installation or eighteen (18) months from date of manufacture, whichever period is shorter.

A dealer who believes that a warranty claim exists must contact the authorized Goulds Pumps distributor from whom the pump was purchased and furnish complete details regarding the claim. The distributor is authorized to adjust any warranty claims utilizing the Goulds Pumps Customer Service Department.

The warranty excludes:

(a) Labor, transportation and related costs incurred by the dealer;
(b) Reinstallation costs of repaired equipment;
(c) Reinstallation costs of replacement equipment;
(d) Consequential damages of any kind; and,
(e) Reimbursement for loss caused by interruption of service.

For purposes of this warranty, the following terms have these definitions:

(1) "Distributor" means any individual, partnership, corporation, association, or other legal relationship that stands between Goulds Pumps and the dealer in purchases, consignments or contracts for sale of the subject pumps.
(2) "Dealer" means any individual, partnership, corporation, association, or other legal relationship which engages in the business of selling or leasing pumps to customers.
(3) "Customer" means any entity who buys or leases the subject pumps from a dealer. The "customer" may mean an individual, partnership, corporation, limited liability company, association or other legal entity which may engage in any type of business.

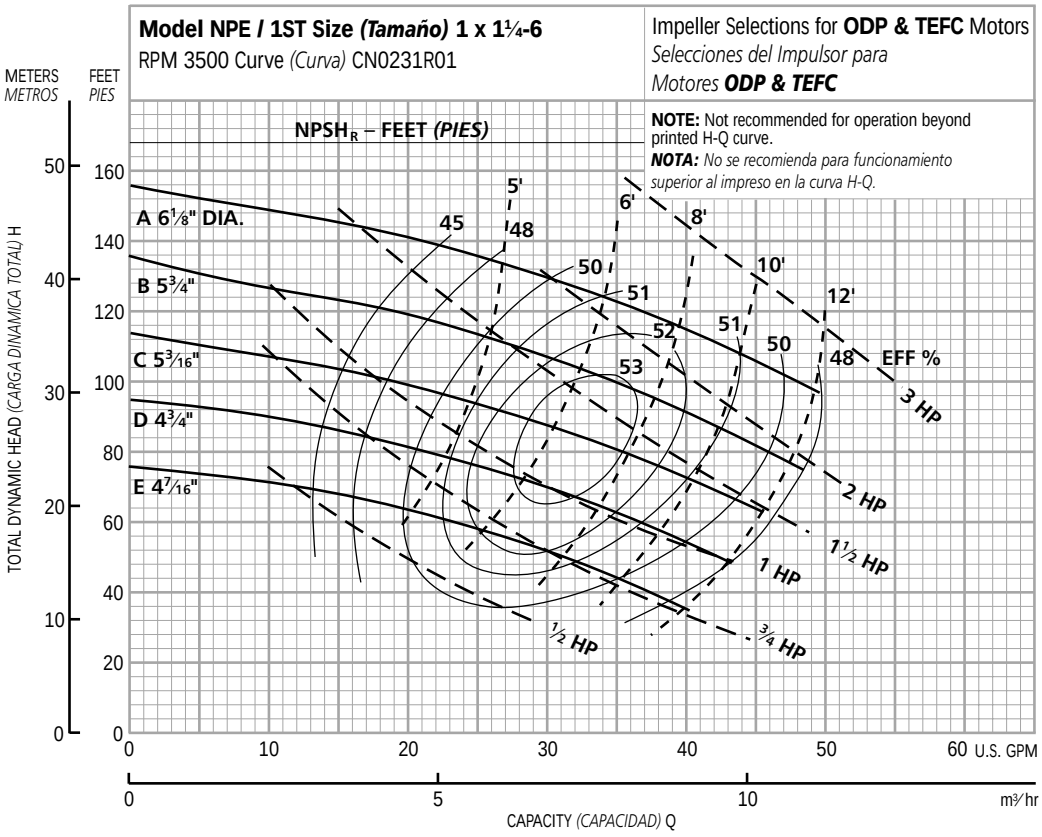
THIS WARRANTY EXTENDS TO THE DEALER ONLY.

Visit us at www.goulds.com

Printed in USA

Goulds Pumps
ITT Industries

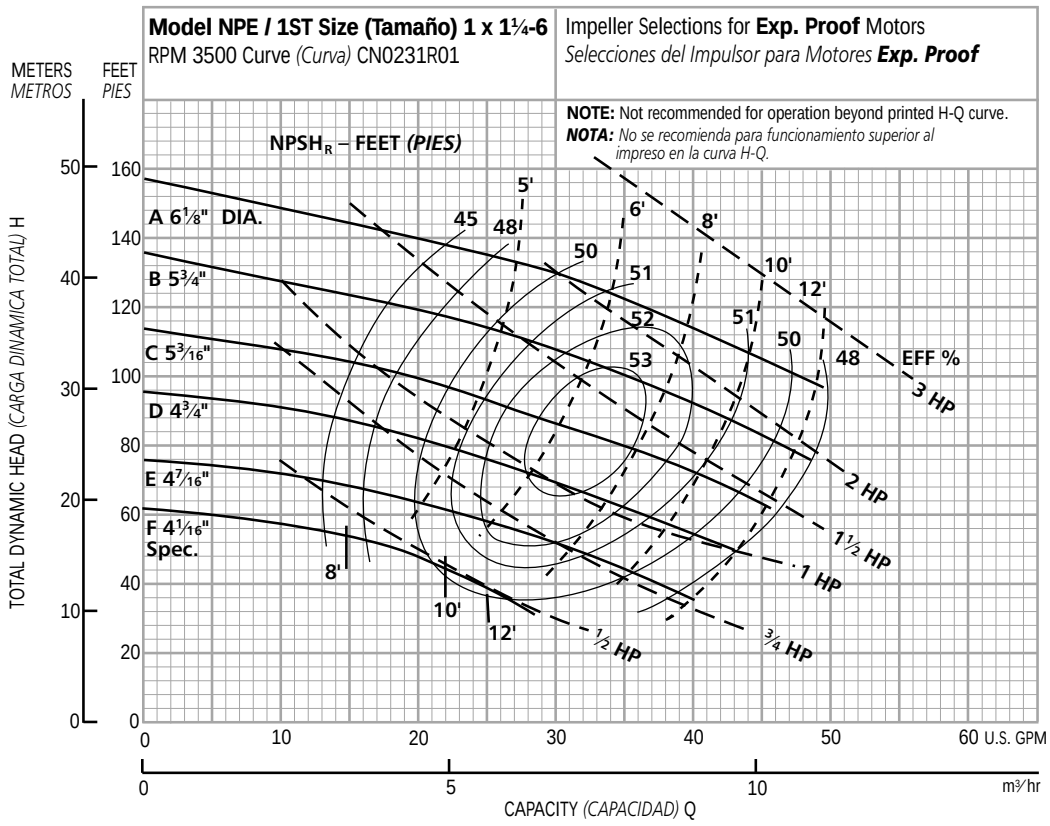
Performance Curves – 60 Hz, 3500 RPM
Curvas de Funcionamiento – 60 Hz, 3500 RPM



Ordering Code, *Código de Pedido*	Standard HP Rating, *Estándar HP Potencia*	Imp. Dia.
E	½	4⁷⁄₁₆"
D	¾	4¾
C	1	5³⁄₁₆
B	1½	5¾
A	2	6⅛

NOTE: Although not recommended, the pump may pass a ⅛" sphere.

NOTA: *Si bien no se recomienda, la bomba puede pasar una esfera de ⅛".*

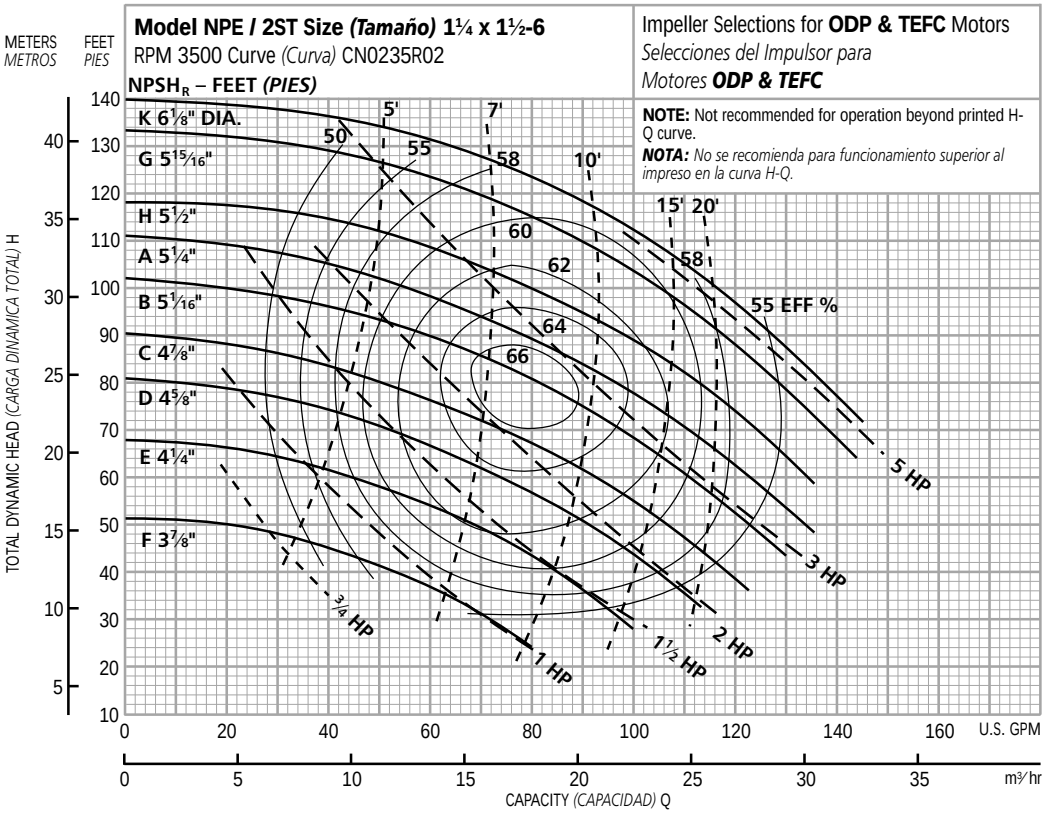


Ordering Code, *Código de Pedido*	Standard HP Rating, *Estándar HP Potencia*	Imp. Dia.
F	½	4¹⁄₁₆" spec.
E	¾	4⁷⁄₁₆
D	1	4¾
C	1½	5³⁄₁₆
B	2	5¾
A	3	6⅛

NOTE: Although not recommended, the pump may pass a ⅛" sphere.

NOTA: *Si bien no se recomienda, la bomba puede pasar una esfera de ⅛".*

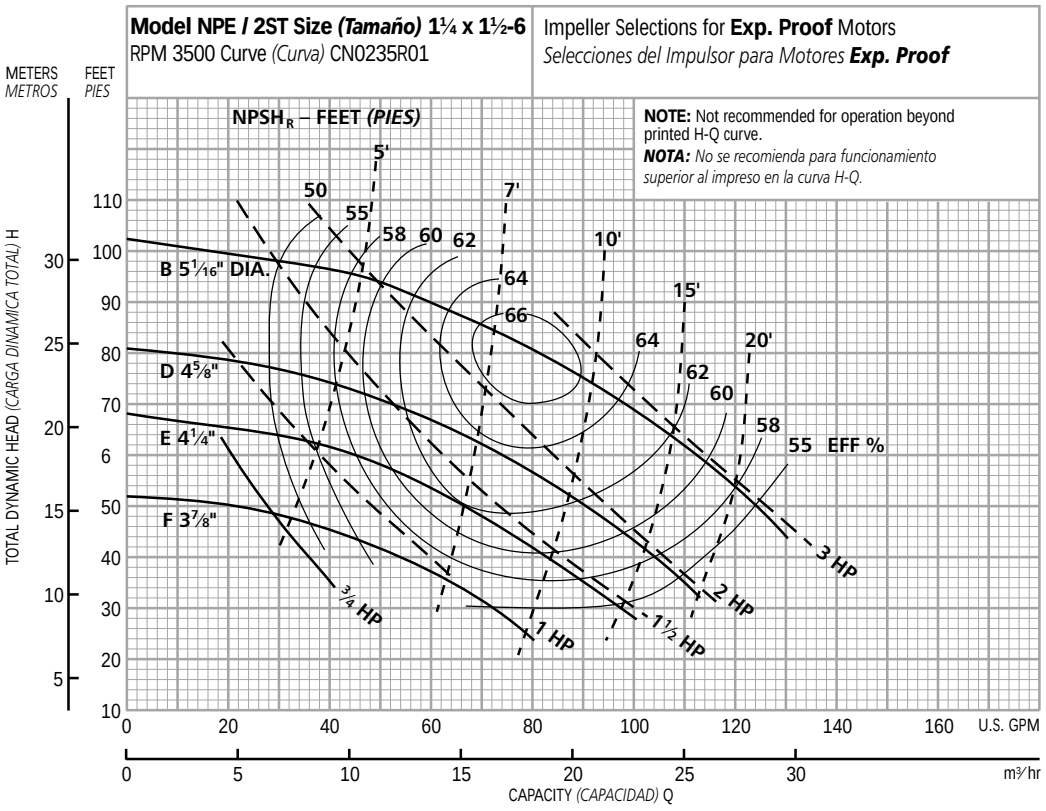
Performance Curves – 60 Hz, 3500 RPM
Curvas de Funcionamiento – 60 Hz, 3500 RPM



Ordering Code, *Código de Pedido*	Standard HP Rating, *Estándar HP Potencia*	Imp. Dia.
F	¾	3⅞"
E	1	4¼
D	1½	4⅝
C	2	4⅞
B	3	5 1/16
A	3	5¼
H	5	5½
G	5	5 15/16
K	5	6⅛

NOTE: Although not recommended, the pump may pass a 3/16" sphere.

NOTA: *Si bien no se recomienda, la bomba puede pasar una esfera de 3/16".*

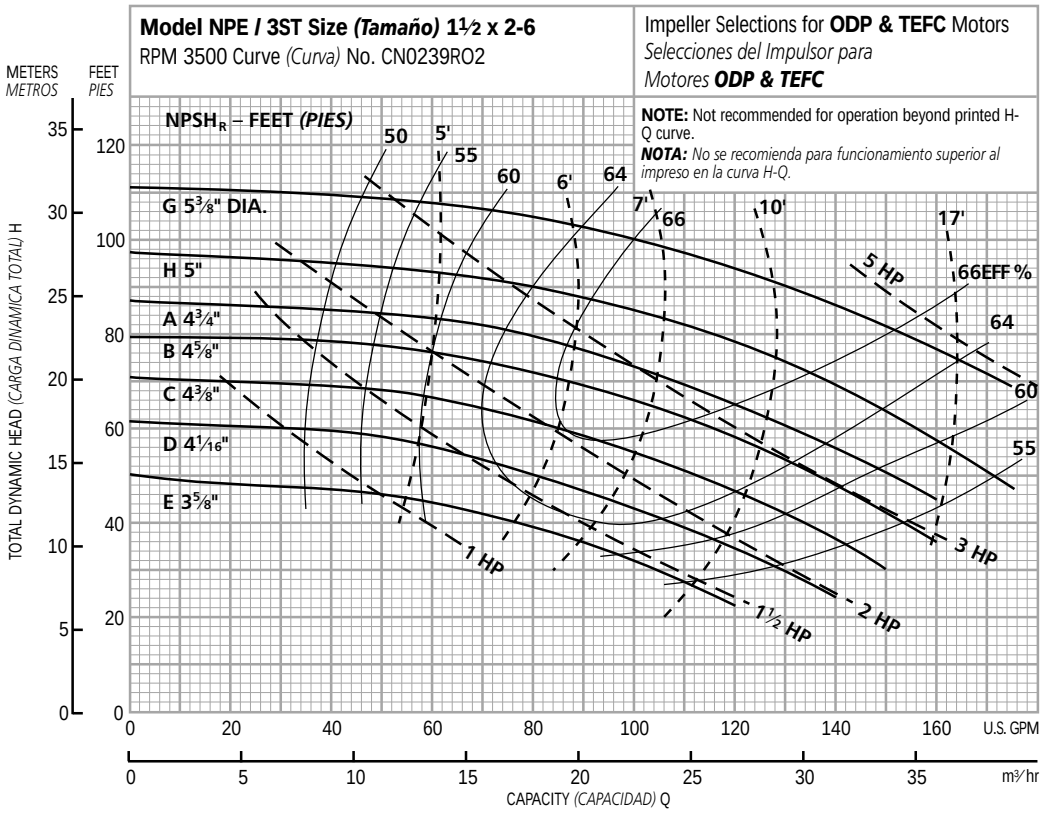


Ordering Code, *Código de Pedido*	Standard HP Rating, *Estándar HP Potencia*	Imp. Dia.
F	1	3⅞"
E	1½	4¼
D	2	4⅝
B	3	5 1/16

NOTE: Although not recommended, the pump may pass a 3/16" sphere.

NOTA: *Si bien no se recomienda, la bomba puede pasar una esfera de 3/16".*

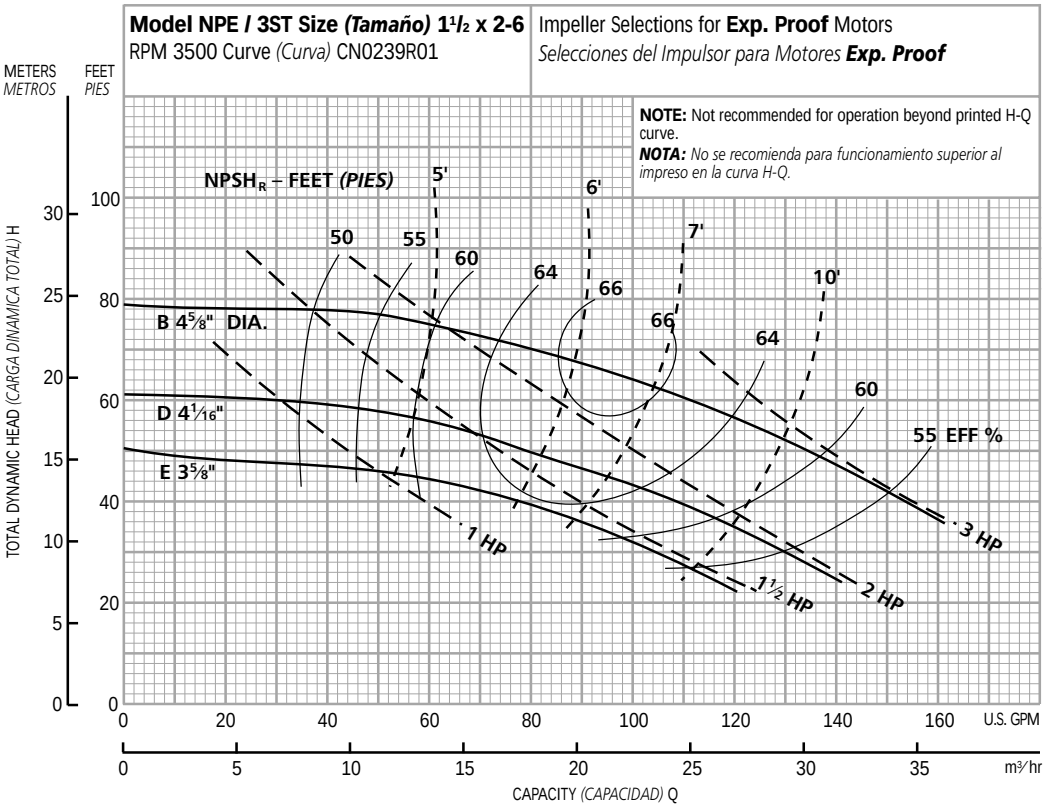
Performance Curves – 60 Hz, 3500 RPM
Curvas de Funcionamiento – 60 Hz, 3500 RPM



Ordering Code, *Código de Pedido*	Standard HP Rating, *Estándar HP Potencia*	Imp. Dia.
E	1	3⅝"
D	1½	4¹⁄₁₆
C	2	4⅜
B	3	4⅝
A	3	4¾
H	5	5
G	5	5⅜

NOTE: Although not recommended, the pump may pass a 11⁄32" sphere.

NOTA: *Si bien no se recomienda, la bomba puede pasar una esfera de 11⁄32".*



Ordering Code, *Código de Pedido*	Standard HP Rating, *Estándar HP Potencia*	Imp. Dia.
E	1½	3⅝"
D	2	4¹⁄₁₆
B	3	4⅝

NOTE: Although not recommended, the pump may pass a 11⁄32" sphere.

NOTA: *Si bien no se recomienda, la bomba puede pasar una esfera de 11⁄32".*

G&L Pumps

Repair Parts

MODEL

NPE/NPE-F

Goulds Pumps

ITT Industries

Effective February, 2003
RNPE

TABLE OF CONTENTS

NPE END SUCTION

NOTE:
For units built before September, 1997
The following upgrades are interchangeable.

(1) Item 349 Guidevane O-Ring was upgraded from O-Ring to Square Seal Ring.

(2) Pump Components have been upgraded from 304 SS to 316L SS

(3) Mechanical Seal upgrades as noted on page 1

(4) Pump Mounting location for motor adapter with foot to pump support are interchangeable.

NPE/NPE-F NUMBERING SYSTEM

1 ST 2 C 1 A 4 F

SEAL VENT/FLUSH OPTION

MECHANICAL SEAL and O-RING

4 = Pre-Engineered Standard

For Optional Mechanical Seal modify catalog order no. with Seal Code listed below.

21 Mechanical Seal (⅝" seal)						
Seal Code	**Rotary**	**Stationary**	**Elastomers**	**Metal Parts**	**Part No.**	**Casing O-Ring**
2	Carbon	Sil-Carbide	EPR	316 SS	10K18*	EPR
4			Viton		10K55***	Viton
5	Sil-Carbide		EPR		10K81	EPR
6			Viton		10K62**	Viton

Note: *Replaces obsolete 10K56 **Replaces obsolete 10K29 ***Replaces obsolete 10K46 and 10K24

Impeller Option Code . . . No Adder Required

For Optional Impeller Diameters modify catalog order no. with Impeller code listed below.

Select Optional Impeller Diameter from Pump Performance Curve.

Impeller Code	Pump Size		
	1 x 1¼-6	1¼ x 1½-6	1½ x 2-6
	Diameter	Diameter	Diameter
K		6⅛	
G		5 15/16	5⅜
H		5½	5
A	6⅛	5¼	4¾
B	5¾	5 1/16	4⅝
C	5 3/16	4⅞	4⅜
D	4¾	4⅝	4 1/16
E	4 7/16	4¼	3⅝
F	4 1/16	3⅞	

Note: Not recommended for operation beyond printed H-Q curve.

For critical application conditions consult factory.

Note: Not all combinations of motor, impeller and seal options are available for every pump model. Please check with G&L on non-cataloged numbers.

DRIVER

1 = 1PH, ODP 4 = 1 PH, TEFC 7 = 3 PH, XP
2 = 3 PH, ODP 5 = 3 PH, TEFC 8 = 575 V, XP
3 = 575 V, ODP 6 = 575 V, TEFC 0 = 1 PH, XP

HP RATING

C = ½ HP F = 1½ HP J = 5 HP
D = ¾ HP G = 2 HP
E = 1 HP H = 3 HP

DRIVER: HERTZ/POLE/RPM

1 = 60 HZ, 2 pole, 3500 RPM
2 = 60 HZ, 4 pole, 1750 RPM
3 = 60 HZ, 6 pole, 1150 RPM
4 = 50 HZ, 2 pole, 2900 RPM
5 = 50 HZ, 4 pole, 1450 RPM

MATERIAL

ST = Stainless Steel

PUMP SIZE

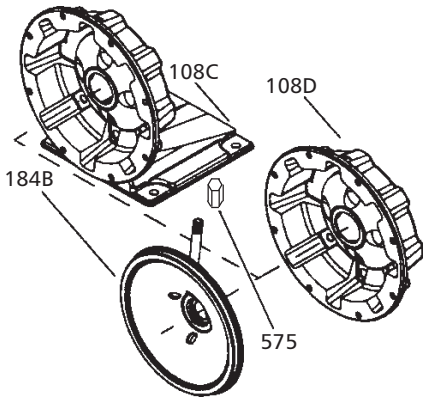
1 = 1 x 1¼ - 6 2 = 1¼ x 1½ - 6 3 = 1½ x 2 - 6

For Frame Mounted version, substitute the letters "FRM" in these positions.

NPE STANDARD REPAIR PARTS LIST

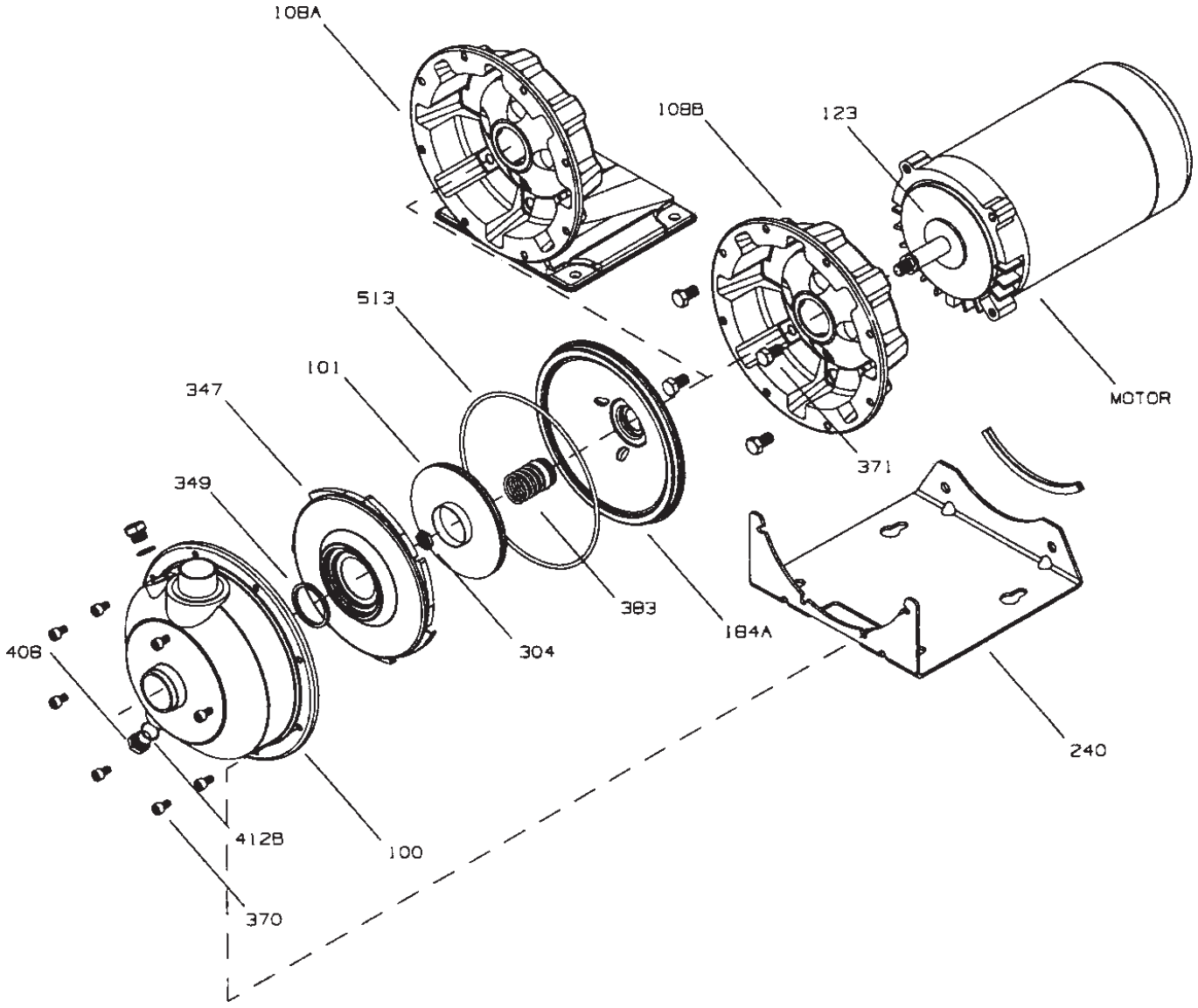
Item No.	Description	Materials of Construction	1ST 1 x 1¼	2ST 1¼ x 1½	3ST 1½ x 2	QTY.
100	Casing	AISI 316L SS	1L81	1L82	1L83	1
101	Impeller		See Impeller chart on page 4			1
108A	Motor adapter with foot		1L80			1
108B	Motor adapter less foot		1L87			
108C	Motor adapter with foot & flush		1L334			
108D	Motor adapter less foot with flush		1L335			
123	Deflector	BUNA-N	5K7			1
184A	Seal housing standard	AISI 316L SS	1L79			1
184B	Seal housing with seal flush		1L333			
240	Motor support	300 SS	4L320			1
	Rubber channel	Rubber	9K188			1
304	Impeller locknut	AISI 316 SS	13K286			1
347	Guidevane	AISI 316L SS	3L23	3L24	3L25	1
349	Seal ring, guidevane	Viton standard	5K269	5K270		1
		EPR	5K273	5K274		
		BUNA	5K271	5K272		
370	Socket head screw, casing	AISI 410 SS	13L65			8
371	Bolts, motor	Steel/plated	13K252			4
383	Mechanical seal		See Mechanical Seal Chart on Page 1			1
408	Drain and vent plug, casing	AISI 316 SS	6L3			2
412B	O-ring, drain plugs	Viton, standard	5L99			2
		EPR	5L80			
		BUNA	5L62			
513	O-ring, casing	Viton standard	5K206			1
		EPR	5K193			
		BUNA	5K4			
575	Pipe Cap	304 SS	6K150			1

NOTE:
OPTIONAL SEAL FLUSH COMPONENTS



NOTE:
Close coupled units supplied with ½ HP 1750 RPM, ½ - 3 HP Explosion Proof or 5 HP motors, utilize motor adapter less foot and a footed motor.

NOTE:
Frame mounted units (NPE-F) utilize the XS Power Frame and motor adapter less foot. For repair parts for the power frame refer to the XS-Power frame repair parts page in the parts section of your catalog. To order the power frame complete order item 14L61.



NPE STANDARD IMPELLERS

Impeller Code	Pump Size					
	1 x 1¼-6		1¼ x 1½-6		1½ x 2-6	
	Diameter	Part No.	Diameter	Part No.	Diameter	Part No.
K			6 1/8	2L885		
G			5 15/16	2L700	5 3/8	2L702
H			5 1/2	2L699	5	2L701
A	6 1/8	2L47	5 1/4	2L48	4 3/4	2L49
B	5 3/4	2L44	5 1/16	2L54	4 5/8	2L58
C	5 3/16	2L46	4 7/8	2L53	4 3/8	2L57
D	4 3/4	2L42	4 5/8	2L52	4 1/16	2L56
E	4 7/16	2L45	4 1/4	2L51	3 5/8	2L55
F	4 1/16	2L59	3 7/8	2L50		

NPE STANDARD IMPELLERS BY MOTOR SIZE AT 3500 RPM

For ODP/TEFC Units Built After September 1, 1997

HP	HP Code		1ST	2ST		3ST
			ODP/TEFC	ODP/TEFC		ODP/TEFC
½	C	Repair #	2L45			
		Dia.	4 7/16			
		Imp. Code	E			
¾	D	Repair #	2L42	2L50		
		Dia.	4 3/4	3 7/8		
		Imp. Code	D	F		
1	E	Repair #	2L46	2L51		2L55
		Dia.	5 3/16	4 1/4		3 5/8
		Imp.Code	C	E		E
1½	F	Repair #	2L44	2L52		2L56
		Dia.	5 3/4	4 5/8		4 1/16
		Imp. Code	B	D		D
2	G	Repair #	2L47	2L53		2L57
		Dia.	6 1/8	4 7/8		4 3/8
		Imp. Code	A	C		C
3	H	Repair #	2L47	2L48		2L49
		Dia.	6 1/8	5 1/4		4 3/4
		Imp. Code	A	A		A
5	J	Repair #		2L700	2L885	2L702
		Dia.		5 15/16	6 1/8	5 3/8
		Imp. Code		G	K	G

For Current Explosion Proof and All Units Built Before September 1, 1997

HP	HP Code		1ST		2ST			3ST		
			ODP	TEFC/EXP	ODP		TEFC/EXP	ODP	TEFC/EXP	
½	C	Repair #	2L45	2L59						
		Dia.	4 7/16	4 1/16						
		Imp. Code	E	F						
¾	D	Repair #	2L42	2L45	2L50					
		Dia.	4 3/4	4 7/16	3 7/8					
		Imp. Code	D	E	F					
1	E	Repair #	2L46	2L42	2L51		2L50	2L55		
		Dia.	5 3/16	4 3/4	4 1/4		3 7/8	3 5/8		
		Imp. Code	C	D	E		F	E		
1½	F	Repair #	2L44	2L46	2L52		2L51	2L56	2L55	
		Dia.	5 3/4	5 3/16	4 5/8		4 1/4	4 1/16	3 5/8	
		Imp. Code	B	C	D		E	D	E	
2	G	Repair #	2L47	2L44	2L53		2L52	2L57	2L56	
		Dia.	6 1/8	5 3/4	4 7/8		4 5/8	4 3/8	4 1/16	
		Imp. Code	A	B	C		D	C	D	
3	H	Repair #	2L47	2L47	2L48		2L54	2L49	2L58	
		Dia.	6 1/8	6 1/8	5 1/4		5 1/16	4 3/4	4 5/8	
		Imp. Code	A	A	A		B	A	B	
5	J	Repair #			2L700	2L885		2L702		
		Dia.			5 15/16	6 1/8		5 3/8		
		Imp. Code			G	K		G		

Note:** Max. Explosion Proof rating is 2 HP.

NPE CLOSE-COUPLED MOTORS

MODEL NPE 3500 RPM

HP	Single-Phase, 60 Hz, 115/230 V**, 56J Frame								
	Open, Drip-Proof①			Totally Enclosed, Fan Cooled			Explosion Proof		
	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)
½	E04853S	10.0/5.0	16	E04821	6.2/3.1	21	BBC04825	6.2/3.1	47
¾	E05853S	14.0/7.0	19	E05821	8.8/4.4	24	BBC05825	8.8/4.4	41
1	E06853S	16.0/8.0	22	E06821	11.6/5.8	26	BBC06825	11.6/5.8	49
1½	E07858S	21.4/10.7	31	E07821	16.2/8.1	35	BBC07825	16.2/8.1	56
2	E08854	26.8/13.4	36	E08821	20.8/10.4	39	BBC08825	20.8/10.4	60
3	E09854	14.0	40	E09821	11.89	44			
5	E10754	14.4	55						

Note:** 3 and 5 HP Single-Phase motors are 230 V only.

HP	Three-Phase, 60 Hz, 208-230/460 V, 56J Frame								
	Open, Drip-Proof①			Totally Enclosed, Fan Cooled			Explosion Proof		
	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)
½	E04873	2.6/1.3	19	E04876	1.9/.95	18	BBC04875	1.9/.95	27
¾	E05873	3.4/1.7	19	E05876	2.3/1.15	21	BBC05875	2.3/1.15	30
1	E06873	4.2/2.1	22	E06876	3.2/1.6	21	BBC06875	3.2/1.6	30
1½	E07878	5.8/2.9	25	E07876	4.8/2.4	27	BBC07875	4.8/2.4	37
2	E08874	6.9/3.3	39	E08876	5.4/2.7	33	BBC08875	5.4/2.7	44
3	E09874	7.2/3.6	31	E09876	7.6/3.8	37			
5	E10774	7.2/14.4	50	E10876	6.2/12.4	48			

① For vertical mounting order motor canopy separately - 9K272 for ½, ¾ and 1 HP single phase or 9K273 for all other ODP motors.

MODEL NPE 1750 RPM

HP	Single-Phase, 60 HZ, 115/230 V, 56J Frame								
	Open, Drip-Proof①			Totally Enclosed, Fan Cooled			Explosion Proof		
	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)
½	E04811	8.6/4.3	19	E04812	8.0/4.0	20	BBC04815	8.0/4.0	45

HP	Three-Phase, 60 HZ, 208-230/460 V, 56J Frame								
	Open, Drip-Proof①			Totally Enclosed, Fan Cooled			Explosion Proof		
	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)
½	E04831	3.76/4.0/2.0	20	E04832	1.77/1.6/.8	20	BBC04835	1.77/1.6/.8	45

Note: Explosion Proof Motors are class 1 and 2, Group D

Magnehelic® Differential Pressure Gage

OPERATING INSTRUCTIONS

SPECIFICATIONS

Dimensions: 4-3/4″ dia. x 2-3/16″ deep.

Weight: 1 lb. 2 oz.

Finished: Baked dark gray enamel.

Connections: 1/8″ NPT high and low pressure taps, duplicated, one pair side and one pair back.

Accuracy: Plus or minus 2% of full scale, at 70°F. (Model 2000-0, 3%; 2000-00, 4%).

Pressure Rating: 15 PSI (0,35 bar)

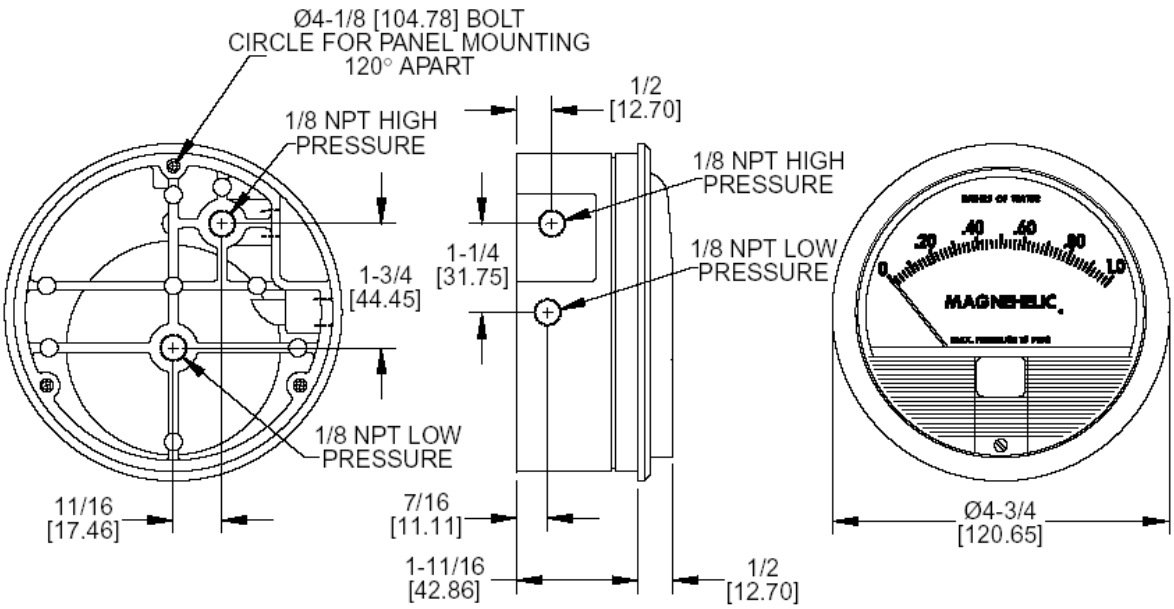
Ambient Temperature Range: 20° to 140°F (-7 to 60°C).

Standard gage accessories include two 1/8″ NPT plugs for duplicate pressure taps, two 1/8″ NPT pipe thread to rubber tubing adapters, and three flush mounting adapters with screws.

Caution: For use with air or compatible gases only.

For repeated over-ranging or high cycle rates, contact factory.

Not for use with Hydrogen gas. Dangerous reactions will occur.



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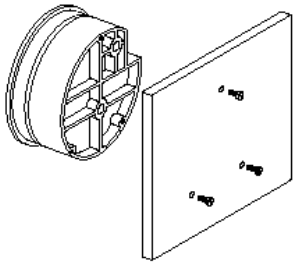
www.dwyer-inst.com
e-mail: info@dwyer-inst.com

MAGNEHELIC® INSTALLATION

1. Select a location free from excessive vibration and where the ambient temperature will not exceed 140°F. Also, avoid direct sunlight which accelerates discoloration of the clear plastic cover. Sensing lines my be run any necessary distance. Long tubing lengths will not affect accuracy but will increase response time slightly. Do not restrict lines. If pulsating pressures or vibration cause excessive pointer oscillation, consult the factory for ways to provide additional damping.

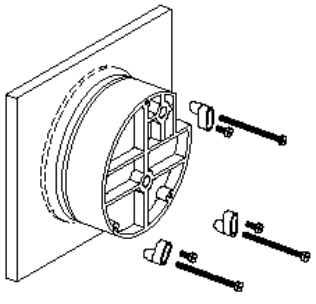
2. All standard Magnehelic gages are calibrated with the diaphragm vertical and should be used in that position for maximum accuracy. If gages are to be used in other than vertical position, this should be specified on the order. Many higher range gages will perform within tolerance in other positions with only rezeroing. Low range Model 2000-00 and metric equivalents must be used in the vertical position only.

3. Surface Mounting



Locate mounting holes, 120° apart on a 4-1/8″ dia. circle. Use No. 6-32 machine screws of appropriate length.

4. Flush Mounting



Provide a 4-9/16″ dia. opening in panel. Insert gage and secure in place with No. 6-32 machine screws of appropriate length, with adapters, firmly secured in place. To mount gage on 1-1/4″-2″ pipe, order optional A-610 pipe mounting kit.

5. To zero the gage after installation

Set the indicating pointer exactly on the zero mark, using the external zero adjust screw on the cover at the bottom. Note that the zero check or adjustment can only be made with the high and low pressure taps both open to atmosphere.

Operation

Positive Pressure: Connect tubing from source of pressure to either of the two high pressure ports. Plug the port not used. Vent one or both low pressure ports to atmosphere.

Negative Pressure: Connect tubing from source of vacuum or negative pressure to either of the two low pressure ports. Plug the port not used. Vent one or both high pressure ports to atmosphere.

Differential Pressure: Connect tubing from the greater of two pressure sources to either high pressure port and the lower to either low pressure port. Plug both unused ports.

When one side of the gage is vented in dirty, dusty atmosphere, we suggest an A-331 Filter Vent Plug be installed in the open port to keep inside of gage clean.

A. For portable use of temporary installation use 1/8″ pipe thread to rubber tubing adapter and connect to source of pressure with rubber or Tygon tubing.

B. For permanent installation, 1/4″ O.D., or larger, copper or aluminum tubing is recommended. See accessory bulletin S-101 for fittings.

Ordering Instructions:

When corresponding with the factory regarding Magnehelic® gage problems, be sure to include model number, pressure range, and any special options. Field repair is not recommended; contact the factory for repair service.

MAINTENANCE

Maintenance: No lubrication or periodic servicing is required. Keep case exterior and cover clean. Occasionally disconnect pressure lines to vent both sides of gage to atmosphere and re-zero. Optional vent valves, (bulletin S-101), should be used in permanent installations.

Calibration Check: Select a second gage or manometer of known accuracy and in an appropriate range. Using short lengths of rubber or vinyl tubing, connect the high pressure side of the Magnehelic gage and the test gage to two legs of a tee. Very slowly apply pressure through the third leg. Allow a few seconds for pressure to equalize, fluid to drain, etc., and compare readings. If accuracy unacceptable, gage may be returned to factory for recalibration. To calibrate in the field, use the following procedure.

Calibration:

1. With gage case, held firmly, loosen bezel, by turning counterclockwise. To avoid damage, a canvas strap wrench or similar tool should be used.
2. Lift out plastic cover and "O" ring.
3. Remove scale screws and scale assembly. Be careful not to damage pointer.
4. The calibration is changed by moving the clamp. Loosen the clamp screw(s) and move slightly toward the helix if gage is reading high, and away if reading low. Tighten clamp screw and install scale assembly.
5. Place cover and O-ring in position. Make sure the hex shaft on inside of cover is properly engaged in zero adjust screw.
6. Secure cover in place by screwing bezel down snug. Note that the area under the cover is pressurized in operation and therefore gage will leak if not properly tightened.
7. Zero gage and compare to test instrument. Make further adjustments as necessary.

Caution: If bezel binds when installing, lubricate threads sparingly with light oil or molybdenum disulphide compound.

Warning: Attempted field repair may void your warrenty. Recalibration or repair by the user is not recommended. For best results, return gage to the factory. Ship prepaid to:

Dwyer Instruments, Inc.

Attn: Repair Dept.

102 Indiana Highway 212

Michigan City, IN 46360

Trouble Shooting Tips:

•*Gage won't indicate or is sluggish.*

1. Duplicate pressure port not plugged.
2. Diaphragm ruptured due to overpressure.
3. Fittings or sensing lines blocked, pinched, or leaking.
4. Cover loose or "O"ring damaged, missing.
5. Pressure sensor, (static tips, Pitot tube, etc.) improperly located.
6. Ambient temperature too low. For operation below 20°F, order gage with low temperature, (LT) option.

•Pointer stuck-gage can't be zeroed.

1. Scale touching pointer.
2. Spring/magnet assembly shifted and touching helix.
3. **Metallic particles clinging to magnet and interfering with helix movement.**
4. Cover zero adjust shaft broken or not properly engaged in adjusting screw.

We generally recommend that gages needing repair be returned to the factory. Parts used in various sub-assemblies vary from one range of gage to another, and use of incorrect components may cause improper operation. After receipt and inspection, we will be happy to quote repair costs before proceeding.

Consult factory for assistance on unusual applications or conditions.

Use with air or compatible gases only.

Printed in U.S.A. 4/01 FR# 12-440212-00 Rev. 3

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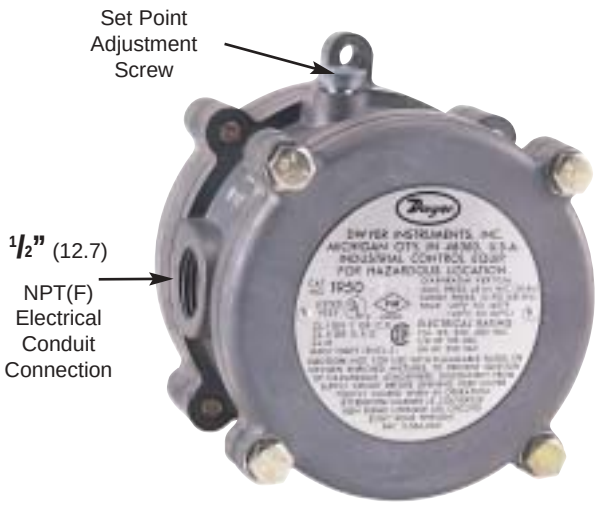
QED p/n EZ-LOWP - Dwyer p/n 1950-1

Kit Includes Pressure Switch, Fitting, Barb & Tubing

Series 1950 – Explosion-Proof Differential Pressure Switches

Specifications - Installation and Operating Instructions



Series 1950 Explosion-Proof Differential Pressure Switches combine the best features of the Dwyer Series 1900 Pressure Switch with an integral explosion-proof and weather-proof housing. Each unit is UL & CSA listed; FM approved for use in Class I, Groups C & D; Class II, Groups E, F, & G; and Class III atmospheres (NEMA 7 & 9). They are totally rain-tight for outdoor installations. Twelve models allow set-points from .03 to 20 inches w.c. and from .5 to 50 psi (3.4 to 345 kPa).

Easy access to the SPDT switch for electrical hook-up is provided by removing the top plate of the three-part aluminum housing. Adjustment to the set point of the switch can be made without disassembling the housing. The unit is very compact, about half the weight and bulk of equivalent conventional explosion-proof switches.

CAUTION

For use only with air or compatible gases. Use of the Model 1950 switch with explosive media connected to the Low pressure port (including differential pressure applications in such media) is not recommended. Switch contact arcing can cause an explosion inside the switch housing which, while contained, may render the switch inoperative. If switch is being used to sense a single positive pressure relative to atmosphere, run a line from the low pressure port to a non-hazardous area free of combustible gases. This may increase response time on -0 and -00 models.

NOTE: The last number-letter combination in the model number identifies the switch's electrical rating (number) and diaphragm material (letter). The 2F combination is standard as described in the physical data above. In case of special models, a number 1 rating is the same as 2; a number 3 or 4 rating is 10A 125, 250, 480 VAC; 1/8 H.P. 125 VAC; 1/4 H.P. 250 VAC; a number 5 or 6 rating is 1A 125 VAC. Letter B indicates a Buna-N diaphragm; N = Neoprene; S = Silicone; and V = Viton®.

UL and CSA Listed, FM Approved For
CL. I GR. C, D - CL. II GR. E, F, G - CL. III

Series 1950 Switches
Operating ranges and deadbands

To order specify Model Number	Operating Range: Inches, W.C.	Approximate Dead Band	
		At Min. Set Point	At Max. Set Point
1950-02	0.03 to 0.10	0.025	0.05
1950-00	0.07 to 0.15	0.04	0.05
1950-0	0.15 to 0.5	0.10	0.15
1950-1	0.4 to 1.6	0.15	0.20
1950-5	1.4 to 5.5	0.3	0.4
1950-10	3.0 to 11.0	0.4	0.5
1950-20	4.0 to 20.0	0.4	0.6
Model Number	**Operating Range: PSI**	**Approximate Dead Band**	
		Min. Set Point	Max. Set Point
1950P-2	0.5 to 2.0	0.3 PSI	0.3 PSI
1950P-8	1.5 to 8.0	1.0 PSI	1.0 PSI
1950P-15	3.0 to 15.0	0.9 PSI	0.9 PSI
1950P-25	4.0 to 25.0	0.7 PSI	0.7 PSI
1950P-50	15.0 to 50	1.0 PSI	1.5 PSI

PHYSICAL DATA

Temperature Limits: -40° to 140°F (-40° to 60°C); 1950P-8, -15, -25, -50: 0° to 140°F (-17.8° to 60°C); 1950-02: - 30° to 130°F (-34.4° to 54.4°C).
Rated Pressure: 1950: 45 in. w.c. (0.1 bar); 1950P: 35 psi (2.4 bar); 1950P-50 only: 70 psi (4.8 bar).
Maximum Surge Pressure: 1950: 10 psi (0.7 bar); 1950P: 50 psi (3.4 bar); 1950P-50 only: 90 psi (6.2 bar).
Pressure Connections: 1/8″ NPT(F).
Electrical Rating: 15A, 125, 250, 480 volts, 60 Hz. AC Resistive 1/8 H.P. @ 125 volts, 1/4 H.P. @ 250 volts, 60 Hz. AC.
Wiring Connections: 3-screw type; common, normally open and normally closed.
Conduit Connections: 1/2″ NPT(F).
Set point adjustment: Screw type on top of housing, field adjustable.
Housing: Anodized cast aluminum.
Diaphragm: Molded fluorosilicone rubber, 02 model: silicone on Nylon.
Calibration Spring: Stainless Steel
Installation: Mount with diaphragm in vertical position.
Weight: 3 1/4 lbs (1.5 kg), 02 model; 4 lbs, 7 oz. (2 kg).

RESPONSE TIME: Because of restrictive effect of flame arrestors, switch response time may be as much as 10-25 seconds where applied pressures are near set point.

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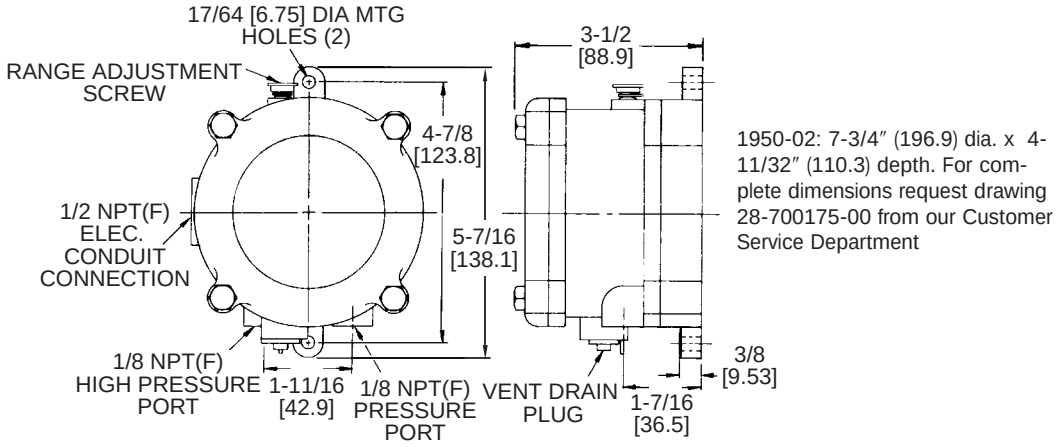
Series 1950 – Explosion-Proof Differential Pressure Switches

Specifications - Installation and Operating Instructions



1950 Switch Outline Dimensions

INSTALLATION

1. Select a location free from excess vibration and corrosive atmospheres where temperatures will be within the limits noted under Physical Data on page 1. Switch may be installed outdoors or in areas where the hazard of explosion exists. See page 1 for specific types of hazardous service.

2. Mount standard switches with the diaphragm in a vertical plane and with switch lettering and Dwyer nameplate in an upright position. Some switches are position sensitive and may not reset properly unless they are mounted with the diaphragm vertical.

3. Connect switch to source of pressure, vacuum or differential pressure. Metal tubing with 1/4″ O.D. is recommended, but any tubing which will not restrict the air flow can be used. Connect to the two 1/8″ NPT(F) pressure ports as noted below:

A. Differential pressures - connect pipes or tubes from source of greater pressure to high pressure port marked HIGH PRESS, and from source of lower pressure to low pressure port marked LOW PRESS.

B. Pressure only (above atmospheric pressure) - connect tube from source of pressure to high pressure port. The low pressure port is left open to atmosphere.

C. Vacuum only (below atmospheric pressure) - connect tube from source of vacuum to low pressure port. The high pressure port is left open to atmosphere.

4. To make electrical connections, remove the three hex head screws from the cover and after loosening the fourth captive screw, swing the cover aside. Electrical connections to the standard single pole, double throw snap switch are provided by means of terminals marked “COM” (common), “NO” (norm open), “NC” (norm closed). The normally open contacts close and the normally closed contacts open when pressure increases beyond the set point. Switch loads for standard models should not exceed the maximum specified current rating of 15 amps resistive. Switch capabilities decrease with an increase in ambient temperature, load inductance, or cycling rate. Whenever an application involves one or more of these factors, the user may find it desirable to limit the switched current to 10 amps or less in the interest of prolonging switch life.

ADJUSTMENT: To Change the Set point

1. Remove the plastic cap and turn the slotted Adjust-ment Screw at the top of the housing clockwise to raise the set point pressure and counter-clockwise to lower the set point. After calibration, replace the plastic cap and re-check the set point.

2. The recommended procedure for calibrating or checking calibration is to use a “T” assembly with three rubber tubing leads, all as short as possible and the entire assembly offering minimum flow restriction. Run one lead to the pressure switch, another to a manometer of known accuracy and appropriate range, and apply pressure through the third tube. Make final approach to the set point very slowly. Note that manometer and pressure switch will have different response times due to different internal volumes, lengths of tubing, fluid drainage, etc. Be certain the switch is checked in the position it will assume in use, i.e. with diaphragm in a vertical plane and switch lettering and Dwyer nameplate in an upright position.

3. For highly critical applications check the set point adjustment and if necessary, reset it as noted in step A.

MAINTENANCE

The moving parts of these switches need no maintenance or lubrication. The only adjustment is that of the set point. Care should be taken to keep the switch reasonably clean. Periodically the vent drain plug should be rotated, then returned to its original position. This will dislodge deposits which could accumulate in applications where there is excessive condensation within the switch.

 Printed in U.S.A. 6/01 FR# 26-440332-00 Rev. 9

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Warrick®
Series M Mechanical Tilt Float Switch
Installation and Operation Bulletin

Specifications

Cord	16 gauge, 2 or 3 conductor SJOW, Oil Resistant CPE
Contact Rating	13 amp @ 120/240 VAC, 1/2hp
Contact Design	SPST, Normally Open or Normally Closed, Common with N.O. & N.C. (Form C)
Temperature Rating	32°F to 140°F (0°C to 60°C)
Overall Weight	1.0 lbs. (not including weight)
Tether Method	Tie-wrap nylon, weight: 2.5 lbs.
Approvals	U.L. Recognized, CSA Certified

Installation

Tether Tie-Wrap (Fig 1)

Attach cord, using a tie-wrap, to a stationary structure. This is known as the tether point, it will determine the pumping range. The farther the float is placed from the tether point, the greater the pumping range. The minimum distance that the float should be placed from the tether point is 3 inches.

Tether-Weight (Fig 2)

Place tension-brand over the cord before installation. Place the weight at the desired position and secure with the tension-band. This position will determine the pumping range. The farther the float is placed from the tether point, the greater the pumping range. The minimum distance that the float should be placed from the tether point is 3 inches.

Notes:

1. To Prevent Motor Burnout - In a pumpdown application make sure the turn-off level is at least 2 inches above the intake of the submersible pump.

2. Securing Tether Points - Make sure levels are correct and that floats are free from any obstructions before securing tether points.

3. When using Tether Weight - Place the tension-band over the cord prior to installation.

Determine tether point using charts below as a reference

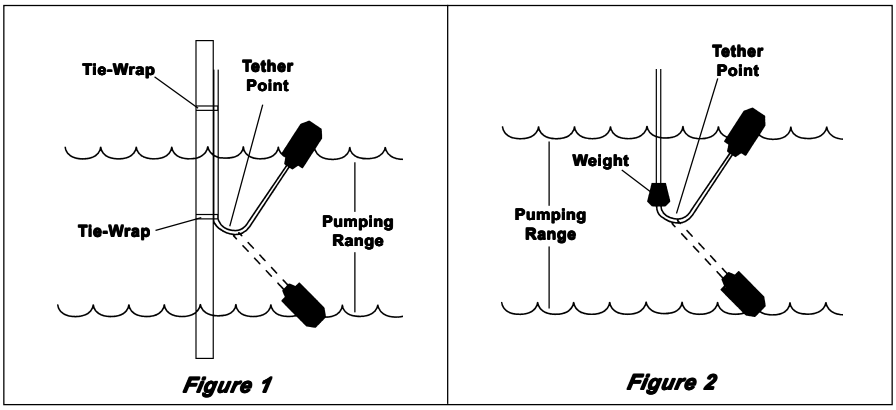
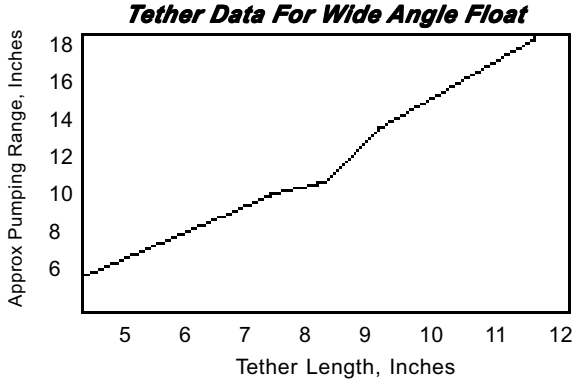
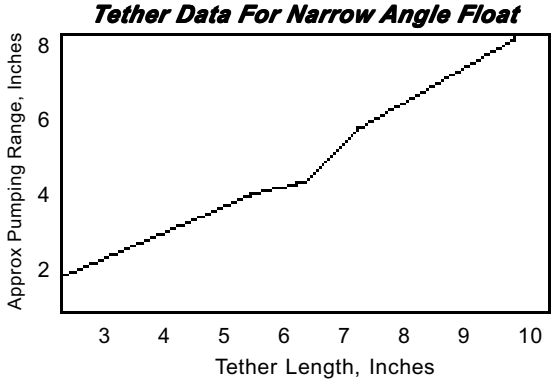


Figure 1 *Figure 2*

Tether Data For Wide Angle Float



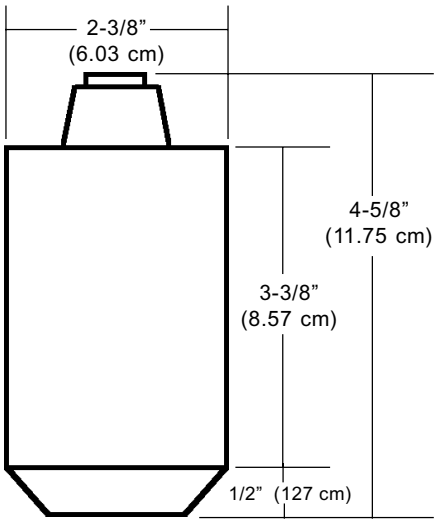
Tether Data For Narrow Angle Float



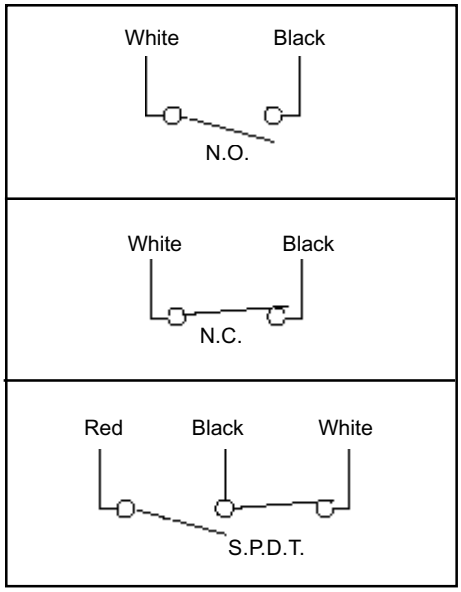
Notes:

1. Narrow angle pumping range is approximately 2 Ft. to 8 Ft.
2. Wide angle pumping range is approximately 5 Ft. to 18 Ft.

Dimensions



Contact Configurations



Important Points:

- Gems products must be maintained and installed in strict accordance with the National Electrical Code and the applicable Gems Product Instruction Bulletin that covers installation, operation and proper maintenance. Failure to observe this information may result in serious injury or damages.
- For hazardous area applications involving such things as, but not limited to, ignitable mixtures, combustible dust and flammable materials, use an appropriate explosionproof enclosure or intrinsically safe interface device.
- Please adhere to the pressure and temperature limitations shown throughout this catalog for our level and flow sensors. These limitations must not be exceeded. These pressures and temperatures take into consideration possible system surge pressures/temperatures and their frequencies.
- Selection of materials for compatibility with the media is critical to the life and operation of Gems products. Take care in the proper selection of materials of construction, testing is required.
- NSF-approved sensors are made of materials approved for potable water applica tions according to Standard 61.
- Stainless steel is generally regarded as safe by NSF and FDA.
- Life expectancy of switch contacts varies with application. Contact Gems if life cycle testing is required.
- Ambient temperature changes do affect switch set points, since the gravity of a liquid can vary with temperature.
- Our sensors have been designed to resist shock and vibration. However, shock and vibration should be minimized.
- Filter liquid media containing particulate and/or debris to ensure the proper operation of our products.
- Electrical entries and mounting points in an enclosed tank may require liquid/vapor sealing.
- Our sensors must not be field-repaired.
- Physical damage sustained by product may render it unserviceable.

Return Policy

Returns are accepted on stock items up to 30 days from date of order. You must contact our Returns Department for a Return Authorization (RA) number. Return the goods - freight prepaid - in the original container and include original packing slip. C. O. D. returns are not accepted. Gems reserves the right to apply restocking charges.

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Gems Sensors

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