Naval Facilities Engineering Systems Command Pacific
JBPHH HI

Draft

Deep Soil Vapor Extraction Pilot Study Work Plan Red Hill Bulk Fuel Storage Facility

JOINT BASE PEARL HARBOR-HICKAM O‘AHU HI

February 2023

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February 2023

Prepared for NAVFAC Pacific by
AECOM Technical Services Inc
1001 Bishop Street Suite 1600
Honolulu HI 96813-3698

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ACRONYMS AND ABBREVIATIONS

1MN	1-methylnaphthalene
2MN	2-methylnaphthalene
A3	Adit 3 Tunnel
AECOM	AECOM Technical Services, Inc.
AS	air sparging
BH	borehole
btf	below tunnel floor
CO_2	carbon dioxide
DOH	Department of Health, State of Hawaiʻi
DSVMP	deep nested soil vapor monitoring point
EPA	Environmental Protection Agency, United States
GAC	granular activated carbon
HAR	Hawaiʻi Administrative Rules
HC	hydrocarbon
ID	inner diameter
JP-5	Jet Propellant 5
LNAPL	light nonaqueous-phase liquid
Navy	Department of the Navy, United States
OD	outer diameter
PID	photoionization detector
ppmv	part per million by volume
PQ	diamond drill coring (4.83-inch)
PQO	project quality objective
PVC	polyvinyl chloride
QC	quality control
RA	Regulatory Agency
SVE	soil vapor extraction
SVMP	soil vapor monitoring point
TO	task order
TPH-d	total petroleum hydrocarbons – diesel range organics
TPH-o	total petroleum hydrocarbons – residual or motor oil range organics
TW	temporary well
UV	ultraviolet
VOC	volatile organic compound

1. Introduction and Purpose

This deep soil vapor extraction (SVE) pilot study work plan (Work Plan) describes the methods and procedures to be conducted at the Red Hill Bulk Fuel Storage Facility (Red Hill Facility). The purpose of the pilot study is to evaluate the effectiveness of using SVE to remove volatile hydrocarbons by phase transfer as well as enhancing biodegradation of Jet Propellant 5 (JP-5) impacts in the vertical interval between the shallow, perched groundwater zone and the elevation of the basal water table. The deep SVE pilot study will be implemented in three phases:

1. *Phase 1:* Conduct testing on two pilot study extraction wells with pre-determined locations.
2. *Phase 2:* Assuming that the outcome of first test phase is favorable, use the findings of the first phase to site two additional pilot study extraction wells and test those wells.
3. After completion of Phases 1 and 2, operate the SVE pilot study system for 6 months to gather longer-term operational data.

The testing conducted during both phases will assess the efficacy of SVE and bioventing in the deep unsaturated zone and collect data needed for post-pilot SVE system operation and full-scale design. Proposed locations for the installation of SVE wells and deep, nested soil vapor monitoring points (DSVMPs) for the first phase of testing were identified through the review of site characterization activities completed between November 2021 and October 2022. These locations may be altered depending on the results of additional characterization completed prior to the pilot study or tunnel constructability considerations such as overhead or below-grade utilities. The potential installation and location of additional deep SVE wells and deep soil vapor monitoring points (SVMPs) for the second phase of testing will be determined based on the results of SVE testing performed during the first phase.

The sequence of major field activities include:

- Phase 1
  - Install two deep SVE wells and two DSVMPs to approximately 60–70 feet below tunnel floor (btf) using an electric drilling rig with multiple screening intervals.
  - Complete SVE testing using the two installed SVE wells and the (five) existing and (two) newly installed DSVMP monitoring network to determine optimal extraction flow rate(s), petroleum hydrocarbon and fixed gas content in the extracted gas, and vertical and lateral vacuum distribution (i.e., radius of influence).
- Phase 2
  - Install up to two additional deep SVE wells and up to two additional DSVMPs to approximately 60–70 feet btf using an electric drilling rig with multiple screening intervals at locations determined based on the zone of influence observed during Stage 1.
  - Complete SVE testing using the additional SVE wells along with the (five) existing and (four) newly installed DSVMPs in the monitoring network to verify optimal extraction flow rate(s), petroleum hydrocarbon and fixed gas content in the extracted gas, and vertical and lateral vacuum distribution.
- Operate the SVE pilot study system for 6 months at the optimal extraction flow rate determined during the pilot studies or at the maximum flow capacity of the pilot study system if the optimal flow rate for multiple SVE wells is greater than system capacity.

2. Roles and Responsibilities

This contract is to be carried out under Naval Facilities Engineering Systems Command contract number N62742-17-D-1800, contract task order N6274222F0212.

Table 1: Roles and Responsibilities

Role	Name
AECOM Project Manager	Ed Sloan
AECOM Quality Manager	Robin Boyd
AECOM CLEAN Health and Safety Manager	Devon Molitor
AECOM Operations Manager	Skyler Pauli
AECOM Task Manager	George Sauer
AECOM Technical Subject Matter Expert	Brad Koons
AECOM Project Chemist	John Fong
AECOM Field Team Leader	Rachel Tucci
AECOM Site Safety Manager	George Sauer
AECOM Site Safety and Health Officers	• George Sauer • Stuart Anderson • Justin Wood • Petros Paulos • Andy Burkemper • Chris Beza
AECOM Site Geologist/Sampling Technicians	• Rachel Tucci • Collin Ferguson • Gita Datt
Subcontractors	• Well Installation – VWD • Utilities Clearance – GH

AECOM AECOM Technical Services, Inc.
GH GeoTek Hawaii
VWD Valley Well Drilling

3. Background

3.1 CLIMATE

The climatological condition of the surrounding area consists of warm to moderate temperatures and low to moderate rainfall. The average annual precipitation is approximately 40 inches, which mainly occurs between November and April (Giambelluca, Nullet, and Schroeder 1986). Average temperatures range from low 60s to high 80s degrees Fahrenheit.

3.2 SOIL AND GEOLOGY

Red Hill is located within the Ko‘olau Volcanic Series. The Ko‘olau formation consists of basaltic lava flow that erupted from a fissure line approaching 30 miles in length and trending in a northwest rift zone (Wentworth and Macdonald 1953). Pāhoehoe and a‘ā lava flows are present in the Ko‘olau formation. The valleys on either side of Red Hill Ridge were formed as a result of fluvial erosion and are filled with sedimentary deposits (alluvium and colluvium), also known as valley fill, underlain by residual (weathered basalt), also known as saprolite. Saprolite zones in Hawai‘i are typically around 75 feet thick but can be 300 feet thick or greater beneath the valley floors or in areas of high precipitation (Hunt Jr. 1996; Macdonald, Abbott, and Peterson 1983) The results of a recently conducted geophysical seismic survey in North and South Hālawa Valleys, Red Hill, and Moanalua

Valley (DON 2018) found that valley fill and saprolite extend much deeper in the valleys surrounding Red Hill, particularly in the center of the valleys and below the streambeds.

The Red Hill Facility is located in region which has its soils mapped as Helemano-Wahiawā association consisting of well-drained, moderately fine-textured and fine-textured soils (USDA SCS 1972). The surfaces of the basaltic flows have been weathered to form reddish-brown clayey silt, which is where the name “Red Hill” was derived from. These soils typically range from nearly level to moderately sloping and occur in broad areas dissected by very steep gulches, which typically formed in material weathered from basalt to a depth of approximately 10 feet below ground surface. Along the slopes, the basaltic bedrock is covered with approximately 10–30 feet of Ko‘olau residuum. These soils were derived from weathering of the underlying basalt bedrock or were deposited as alluvium/ colluvium. The younger alluvium/colluvium deposits were derived from fractured basalts and tuff. Beneath the surficial soils, alternating layers of clay and basalts are encountered at depth. The northwestern slope of Red Hill is generally barren of soil and consists of outcropping basalt lava flows to the valley floor.

3.3 GROUNDWATER

Near the Red Hill Facility, the basal aquifer water table lies between 15 and 20 feet above mean sea level, and regionally groundwater flows toward Pearl Harbor (mauka to makai), although potential exists for variability in localized flow directions depending on geologic formations and other factors.

The Red Hill Facility is located at the administrative boundary between the Waimalu Aquifer System of the Pearl Harbor Aquifer Sector and the Moanalua Aquifer System of the Honolulu Aquifer Sector. The underlying aquifer is classified as a basal, unconfined, flank-type aquifer and is currently used as a drinking water source.

There is a United States Department of the Navy (Navy) Supply Well 2254-01 (also known as Red Hill Shaft), located within the Adit 3 Tunnel. The nearest Honolulu Board of Water Supply public drinking water supply well (Honolulu Board of Water Supply Hālawa Shaft Well 2354-01) is located hydraulically cross-gradient of the Facility approximately 4,400 feet to the northwest and pumps water from the basal aquifer.

3.4 SURFACE WATER

Surface water features in the general vicinity of the Adit 3 and the Red Hill Facility include South Hālawa Stream. Potential recharge (run-on and operational water use) from the Hālawa Quarry north of the tank farm Facility may also impact groundwater flow in this area. In Hālawa Valley, stream flow may contribute water to perched groundwater within alluvial material (valley fill) but is generally isolated from the underlying basal aquifer. Most precipitation percolates to the basal aquifer and does not maintain base flows in the streams (Izuka 1992). Groundwater that flows beneath the Facility does not intercept surface water inland of the ocean shoreline (DON 2007). Both South Hālawa Stream and Moanalua Stream (to the north and south of Red Hill Ridge, respectively) are located approximately 170 feet or more above the basal water table.

3.5 HISTORICAL LAND USE

Prior to the 1940s, the surface of Red Hill supported sugar cane and pineapple agriculture. Navy historical documentation shows that Red Hill ground surface was exposed and modified during the construction of the tank farms which began in 1940. A 1952 aerial image shows unmaintained land of the ridge of Red Hill and agriculture on the lower reaches of Red Hill north of the Moanalua Golf Course.

3.6 CURRENT LAND USE

The Red Hill Facility is located on land zoned by the county as a mix of F-1 Federal and Military and P-1 Restricted Preservation districts. All major structures at the Facility are located underground. Populated areas closest to the facility are ‘Aiea to the West and Honolulu to the Southeast. Honolulu is a heavily populated and urbanized community.

Preservation land is located east and northeast of the Facility boundary. To the southeast are residential single-family homes in Moanalua Valley; a high cliff face with a 100–200-foot elevation difference exists between the Facility and this residential area. Southwest of the tank farm area on the lower southwest flank of Red Hill are the public Red Hill Elementary School and residential apartments, and further west is U.S. Coast Guard Housing on F-1 Military land. North of the western segment of the Facility boundary in South Hālawa Valley is the State Animal Quarantine Station, private businesses in Hālawa Industrial Park, and the State-operated Hālawa Correctional Facility. To the north of the Correctional Facility at the lower reaches of an inter-valley ridge that forms the north wall of South Hālawa Valley is the open-pit Hālawa Quarry operated by the Hawaiian Cement Company.

3.7 CONCEPTUAL SITE MODEL

Characterization of the Red Hill tunnel system near the Adit 3 entrance to and past the intersection of the Pearl Harbor tunnel (hereafter referred to as the Adit 3 Tunnel) began immediately after the November 20, 2021 JP-5 release. Investigation activities to determine the nature and extent of JP-5 impacts in the Adit 3 study area are ongoing. The network of completed subsurface investigation locations as of January 31, 2023, including boreholes (BHs), temporary wells (TWs), and SVMPs, is presented on Figure 1.

Locations in the Adit 3 Tunnel are identified using a coordinate system starting at the point of origin located on the eastern edge of the Navy Well 2254-01 pumping station doorway. The coordinates represent the distance in feet from the origin, whereby coordinates with positive (+) values are to the west in the direction of the Adit 3 Tunnel entrance, and coordinates with negative (-) values are to the east.

The JP-5 release occurred from an overhead pipe near station Adit 3 Tunnel (A3)-375. Fuel moved along the tunnel floor toward the Adit 3 Sump, approximately 700 feet west of the release point (Figure 1). The Hume Line, a 6-inch diameter concrete drainage pipe that runs beneath the tunnel floor, is shown in plan view and cross section view on Figure 1 and Figure 2, respectively. The Hume Line was initially installed as a water management system and set at approximately 2.5–3 feet btf to act as a conduit for groundwater to migrate to the sump and limit tunnel flooding. The Hume Line was constructed with a loose connecting bell piping configuration. The top of the pipe was left unsealed to allow groundwater to enter the pipe, while the bottom of the pipe appears to have been grouted to limit vertical seepage and to direct fluids to the sump. The extent and condition of the Hume Line is not fully understood. Based on sewer camera footage collected during the initial site investigation, the Hume Line appears to have a blockage at approximately A3-60.

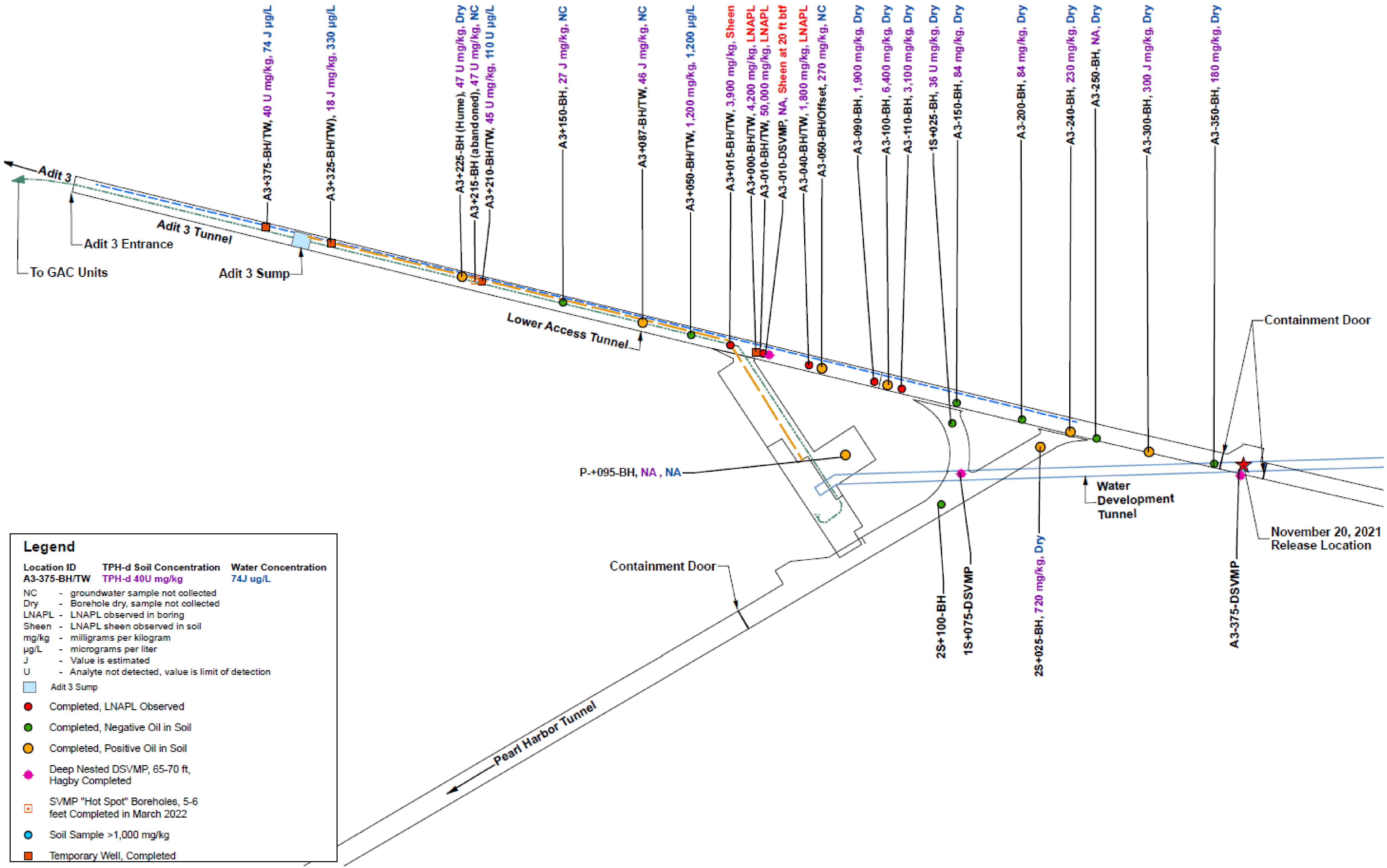


Figure 1: In-Progress Field Map (as of January 31, 2023), Adit 3 LNAPL Site Characterization, November 20, 2021, JP-5

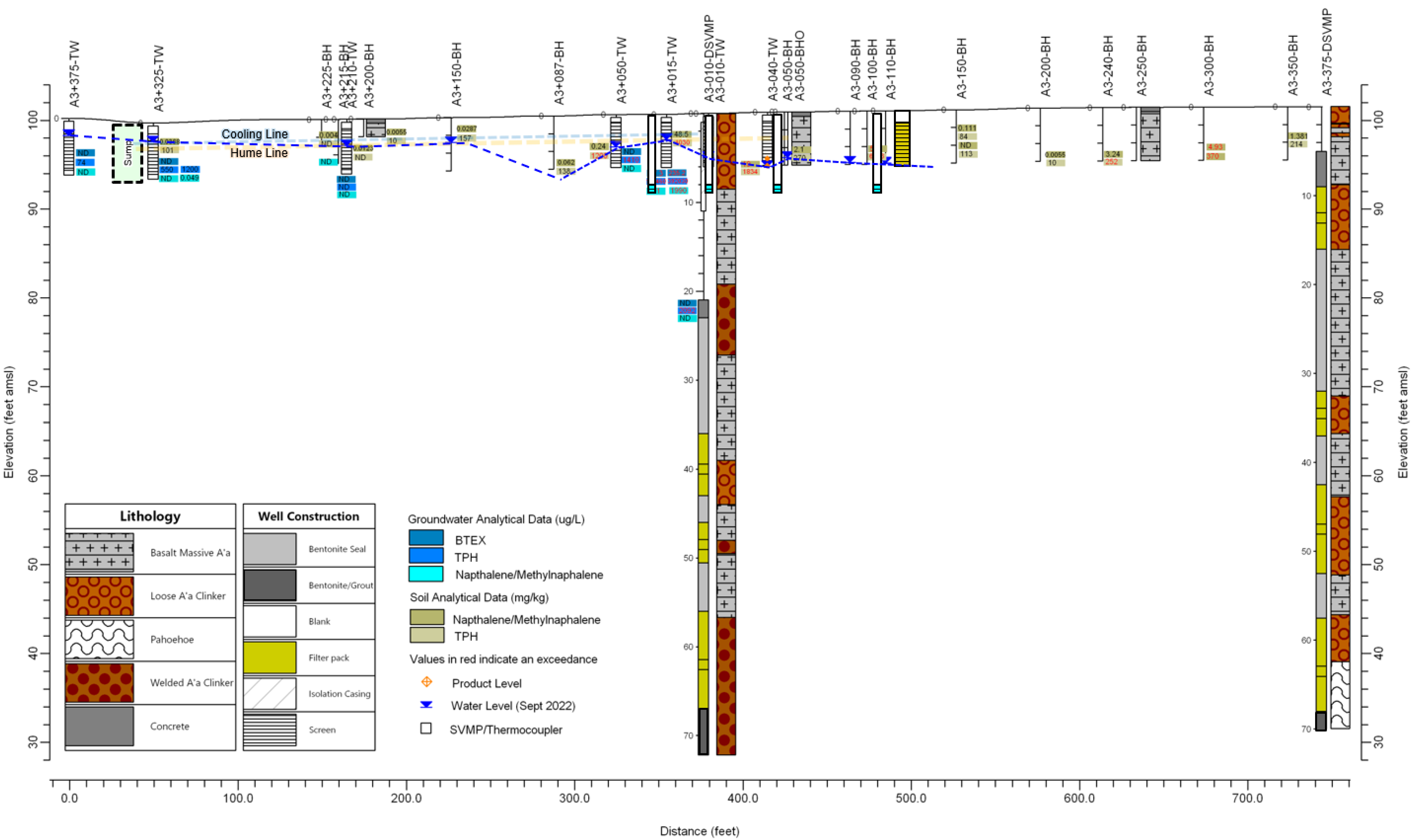


Figure 2: Investigation Area Cross Section

Figure 2 shows a deep cross section of the Adit 3 Tunnel based on the current understanding of the stratigraphy and the distribution of perched groundwater. Detailed descriptions of lithology were documented from cores collected during the installation of DSVMPs (A3-010-DSVMP, A3-375-DSVMP, and 1S+075-DSVMP), two of which are shown on Figure 2 (A3-010-DSVMP and A3-375-DSVMP), indicating the presence of massive aʻā basalt, welded aʻā clinker, loose (unwelded) aʻā clinker, and pāhoehoe. The remainder of the BHs were completed using a hammer drill to a maximum penetration depth of approximately 6 feet btf. During advancement of BHs using the hammer drill, subsurface materials were pulverized prior removal from the BH; thus, good quality undisturbed samples could not be obtained for detailed lithologic assessment. Where hard drilling was noted during advancement of the hammer drill, the lithology is presented as massive basalt Figure 2).

The distribution of JP-5 impacts in the subsurface is presented on Figure 1 and Figure 2. Additionally, a network of deep and intermediate-depth SVMPs is currently under construction within Adit 3. Table 2 outlines all SVMPs that have been constructed as of December 2022 (DON 2022b). The deep and intermediate SVMPs have been installed using methods that allow for the collection of intact cores for lithologic assessment to define the thickness and extent of the perched groundwater unit. The current understanding of the of the JP-5 distribution is based on fluid level gauging data (i.e., accumulations of light nonaqueous-phase liquid [LNAPL] or sheen in BHs and TWs), results of hydrophobic dye testing (i.e., OIL-IN-SOIL test kits), and concentrations of petroleum hydrocarbons detected in soil and groundwater. Shallow subsurface impacts beneath the Adit 3 Tunnel appear to be concentrated in the vicinity of the pumping station entrance (from approximately A3+050 to A3-110). LNAPL accumulations are consistently observed in A3-010-TW and A3-040-TW, indicating that LNAPL is present in shallow subsurface materials at an LNAPL saturation greater than residual levels in this area. It appears that LNAPL extends to the west at least as far as A3+050, where concentrations of total petroleum hydrocarbons – diesel range organics (TPH-d) (C10–C24) in soil and groundwater (1,200 milligrams per kilogram and 1,200 micrograms per liter, respectively) indicate the presence of LNAPL. To the east, LNAPL has been observed at the bottom of BH A3-110-BH, consistent with TPH-d analytical results in soil collected from this location. The presence of LNAPL may extend further to the east of A3-110 at depths greater than approximately 6 feet btf (the maximum depth characterized using the hammer drill rig). The lateral and vertical extent of impacts will be refined based on data collected during installation of intermediate and deep SVMPs, monitoring wells and vertical BH profiling. A list of completed and proposed installations that will be used during the pilot study activities, including details on the purpose/type of installation and estimated completion depths activities, is provided in Table 3.

4. Technology Overview

4.1 Soil Vapor Extraction

SVE is an in-situ remediation technology that induces air flow in the vadose zone to promote mass transfer of volatile petroleum hydrocarbon compounds from adsorbed, dissolved, and nonaqueous liquid phases into the gas phase, where it is removed under vacuum and treated above ground. Additionally, by inducing the flow of oxygen-rich air through the vadose zone, enhanced aerobic biodegradation of petroleum hydrocarbons is promoted.

The extracted vapors are processed through a vapor/liquid separator to remove liquids and excess moisture before the air is treated. The vapor stream is then processed through granular activated carbon (GAC) to treat the vapor stream prior to releasing it to the atmosphere. The pilot study data will be used to improve the understanding of air permeability distribution in the deep unsaturated zone, and to determine SVE well spacing relationships for full-scale SVE operation as well as establishing an estimate of initial mass removal rates based on analytical data of the vapor stream extracted.

The SVE system used for the pilot study will be mobilized from the Navy's former Onizuka Village site. The system has the capacity to run at 275 standard cubic feet per minute at approximately 3.4 pounds per square inch (psi) and requires 230-volt, 3-phase power. An operations and maintenance manual for the SVE system is included as Appendix A.

5. Project Quality Objectives

As a component of preparing this work plan, project quality objectives (PQOs) were developed for the study following Naval Facilities Engineering Systems Command, Pacific Environmental Restoration Program Procedure I-A-1, *Development of Project Quality Objectives*. The standard operating procedures are included in Appendix B. The PQOs (Steps 1 through 5) are presented in Table 2 for reference and were used to guide work plan development. PQO achievement for the pilot studies are presented in Section 7 and in other applicable sections of the work plan.

Table 2: Project Quality Objectives for Deep Soil Vapor Extraction Pilot Study

Problem (Step 1):	The efficacy of in situ SVE to deplete the mass of petroleum hydrocarbons in the deep subsurface is uncertain at the Site. Application of SVE Is a proven in-situ remediation technology that has been shown to reduce the mass of petroleum hydrocarbons in the subsurface at numerous sites by promoting direct mass transfer of volatile hydrocarbons into the gas phase, and by enhancing aerobic biodegradation processes.			
Study Goals (Step 2)	Study Questions (Step 2)	Data Needs and Schedule (Step 3)	Study Area (Step 4)	Analytical Approach (Step 5)
Determine design and optimal operating parameters for Deep SVE system.	What is the estimated ZOI for Vertical Deep SVE wells?	During SVE step and constant rate tests: • Distribution of soil gas pressure in the deep unsaturated zone • Concentrations of oxygen, carbon dioxide, methane, and helium tracer in soil gas	Deep massive a'ā	Changes in subsurface gas pressure and soil gas composition in response to changes in vapor extraction flow rate will be utilized as indicators of the SVE zone of influence: • Measure vacuum response at deep and shallow soil vapor monitoring points. A measurable vacuum response at the monitoring points during vapor extraction indicates that a pressure gradient is present in the direction of the monitoring point, demonstrating that soil gas in the vicinity of the monitoring point is being captured. • Measure concentrations of oxygen, carbon dioxide, and methane in soil gas measured in nested and shallow soil vapor monitoring points. During vapor extraction, the vadose zone is aerated by drawing air from the atmosphere into the subsurface. The flow of atmospheric air is therefore expected to increase the concentration of oxygen in the subsurface while reducing concentrations of petroleum hydrocarbon biodegradation products such as carbon dioxide and methane. In addition to providing a line of evidence for assessing air flow distribution in the subsurface, changes in concentrations of these gases in response to changes in vapor extraction flow rates will provide a means of evaluating microbiological activity. • Measure concentrations of helium tracer in extracted vapor.
	What are the appropriate vapor extraction flow rates and applied vacuum levels? What is the appropriate spacing for the additional SVE wells and DSVMPs? Are additional vertical SVE Wells necessary to adequately address the Adit 3 investigation area?	During SVE step and constant rate tests: • Vapor extraction flow rates • Vacuum measurements at extraction point(s) • Distribution of soil gas pressure in deep unsaturated zone during step tests, and constant rate vapor extraction tests • Concentrations of petroleum hydrocarbons, oxygen, carbon dioxide, and helium in extracted soil gas • Concentrations of oxygen, carbon dioxide, and methane in soil gas		• Air permeability distribution will be evaluated based on changes in subsurface gas pressure at different distances from the extraction points in response to changes in vapor extraction rates and characteristics of the helium tracer breakthrough curve. • Appropriate vapor extraction flow rates and applied vacuum levels for longer-term SVE operation will be determined based on maintaining a pore volume exchange rate to optimize mass transfer of volatiles and ensure that the subsurface is adequately aerated to promote aerobic biodegradation. • If soil gas monitoring points located within the target remediation zone do not exhibit evidence of induced air flow during pilot testing activities (e.g., no measurable vacuum response and no change in composition of soil gas), the installation need/spacing requirements for additional vertical SVE points will be evaluated at each phase of the pilot testing implementation.
	What are the initial petroleum hydrocarbon mass removal rates?	Constant Rate SVE testing: • Vapor extraction flow rates • Concentrations of petroleum hydrocarbons in extracted soil gas • Concentrations of oxygen and carbon dioxide in extracted soil gas		• Measure vapor extraction flow rates. • Collect vapor samples for laboratory analysis to determine concentrations of petroleum hydrocarbons in extracted vapor. • Measure concentrations oxygen and carbon dioxide in extracted soil gas. Removal rates for volatile hydrocarbons by mass transfer into the vapor phase will be calculated by multiplying the concentration of volatile petroleum hydrocarbons in the extracted vapor (mass of petroleum hydrocarbons per unit volume of extracted vapor) by the measured volumetric vapor extraction flow rates (volume of extracted vapor per unit time). Vapor phase mass transfer rates will be compared to laboratory treatability test results to estimate the composition of the in-situ LNAPL, as well as the mass fraction of the remaining LNAPL that can likely be addressed through the vapor phase mass transfer mechanism. Mass removal by aerobic biodegradation (consumption of oxygen and/or production of carbon dioxide) will be calculated from measured vapor extraction flow rates and changes in oxygen and/or carbon dioxide relative to ambient, atmospheric levels. Rates of oxygen utilization and/or carbon dioxide production will be multiplied by representative stoichiometric coefficients to estimate rates of hydrocarbon biodegradation.
	Is SVE off-gas treatment capacity sufficient?	Constant Rate SVE testing: • Vapor extraction flow rates • Concentrations of petroleum hydrocarbons in extracted soil gas, and effluent air discharged to atmosphere		Mass loading rates and off-gas treatment efficiency will be evaluated based on measured vapor extraction flow rates and concentrations of volatile petroleum hydrocarbons measured in influent, mid-fluent, and effluent vapor samples. Data will be evaluated to verify treatment capacity of the off-gas treatment using activated carbon, and to estimate frequency of activated carbon changeouts for longer-term SVE operation.
	What is the connectivity between the deep SVE and the water development tunnel?	• Constant Rate Test • Concentration of helium recovered in the SVE Vapor Stream		A helium tracer test will be applied to the water development tunnel and the recovery rate will provide insight on the interconnection and ability of the deep SVE wells to influence the water development tunnel.
Determine design and optimal operating parameters for long-term SVE system.	How will the system efficiency change during long term operation? Are there any parameter/equipment which need to be adjusted to maintain effective operations?	During long-term operations: • Vapor extraction flow rates • Vacuum measurements at extraction point(s) • Changes in concentrations of petroleum hydrocarbons in extracted soil gas, and effluent air discharged to atmosphere	Both shallow subsurface and the deep massive a'ā	Changes in mass recovery rate and mass loading rate will be evaluated over time to quantify how operational efficiency of the SVE system may decrease overtime and how operational parameters may be shifted to aid in designing an optimal remediation system for the Red Hill Facility. Additionally, ROIs, soil gas composition, and extracted soil gas screening will be observed throughout the tunnel to aid in identifying changes in biodegradation rates over time.

ROI radius of influence
ZOI zone of influence

Table 3: Monitoring and Remediation Points

Monitoring Point/ Remediation Point	Type	Estimated/Completed Depth (ft btf)	Status
1S+075-DSVMP	Deep Nested SVMP	VMPs and thermocouples installed at 12, 29, 39, and 58 ft btf	Completed
A3-375-DSVMP	Deep Nested SVMP	VMPs and thermocouples installed at 12.5, 34.5, 47.5, and 63.5 ft btf	Completed
A3-010-DSVMP	Deep Nested SVMP	Open borehole from 12 – 21 ft btf; VMPs and thermocouples installed at 40, 48.5, and 62 ft btf	Completed
A3-215-DSVMP	Deep Nested SVMP	Nested screen depths to be determined during installation	Proposed
A3-110-DSVMP	Deep Nested SVMP	Nested screen depths to be determined during installation	Proposed
2S+040-DSVMP	Deep Nested SVMP	Nested screen depths to be determined during installation	Proposed (Pilot Study)
A3-290-DSVMP	Deep Nested SVMP	Nested screen depths to be determined during installation	Proposed (Pilot Study)
A3-75-DSVMP	Deep Nested SVMP	Nested screen depths to be determined during installation	Proposed (Pilot Study)
A3-175-DSVMP	Deep Nested SVMP	Nested screen depths to be determined during installation	Proposed (Pilot Study)
Deep SVE-1	SVE Extraction Point	Vapor extraction screen depths to be determined during installation	Proposed (Pilot Study)
Deep SVE-2	SVE Extraction Point	Vapor extraction screen depths to be determined during installation	Proposed (Pilot Study)
Deep SVE-3	SVE Extraction Point	Vapor extraction screen depths to be determined during installation	Proposed (Pilot Study)
Deep SVE-4	SVE Extraction Point	Vapor extraction screen depths to be determined during installation	Proposed (Pilot Study)
Hume Line Access	SVE Extraction Point	3.5 ft btf	Proposed
Hume Line Access-2	SVE Extraction Point	3.5 ft btf	Proposed
AS-1	Air Sparging Point	8.5–11 ft btf	Proposed
AS-2	Air Sparging Point	8.5–11 ft btf	Proposed
AS-3	Air Sparging Point	8.5–11 ft btf	Proposed
AS-4	Air Sparging Point	8.5–11 ft btf	Proposed
Shallow SVE-1	SVE Extraction Point	5–6 ft btf	Proposed
A3-230-SVMP	Shallow SVMP	3–5 ft btf	Proposed
A3-175-SVMP	Shallow SVMP	3–5 ft btf	Proposed
A3-105-SVMP	Shallow SVMP	3–5 ft btf	Proposed
A3-55-SVMP	Shallow SVMP	3–5 ft btf	Proposed
A3+010-SVMP	Shallow SVMP	3–5 ft btf	Proposed
A3+130-SVMP	Shallow SVMP	3–5 ft btf	Proposed
A3+190-SVMP	Shallow SVMP	3–5 ft btf	Proposed
A3+235-SVMP	Shallow SVMP	3–5 ft btf	Proposed
A3+305-SVMP	Shallow SVMP	3–5 ft btf	Proposed
A3+330-SVMP	Shallow SVMP	3–5 ft btf	Proposed

ft foot or feet
VMP vapor monitoring point

6. Field Work Activities

Field work activities include:

- Utilities and concrete metal clearance
- Drilling mobilization/demobilization
- Sequential SVE well installation and evaluation
  - Phase 1
    - SVE well installation (SVE-1 and SVE-2)
    - DSVMP installation (2S+025, A3-75)
      - Vacuum and gas composition testing at existing deep and intermediate SVMPs
      - Step and constant rate testing
    - Data evaluation of initial-stage SVE testing
  - Phase 2
    - Install remaining two deep SVE wells
    - Install up to two additional DSVMPs
- SVE step tests
- SVE constant rate test
- 6-month operation of SVE pilot study system

6.1 Interim Operation of Shallow SVE/Air Sparging

The deep SVE construction is scheduled to begin after the evaluation of the shallow air sparging (AS)/SVE field activities. It is anticipated that operation of the SVE equipment will continue on the shallow SVE wells/Hume Line through the duration of the construction of the deep SVE wells and associated monitoring points. Dependent on conditions exhibited and data evaluated during the shallow AS/SVE pilot study, the level of operation will vary. System operations are estimated to continue for approximately 2–4 months while construction activities continue in Adit 3. Operations will be temporarily halted during each stage of the deep SVE pilot testing.

6.2 Utilities and Concrete Metal Clearance

Geotech Hawaiʻi will clear a 3-foot radius at both the Phase 1 and Phase 2 proposed SVE and SVMPs identified on Figure 3. Utilities and metal will be cleared using shielded ground-penetrating radar between 200 and 500 megahertz. Anomalies will be marked on the ground using paint or colored crayon. The area cleared for drilling and excavation will be clearly identified.

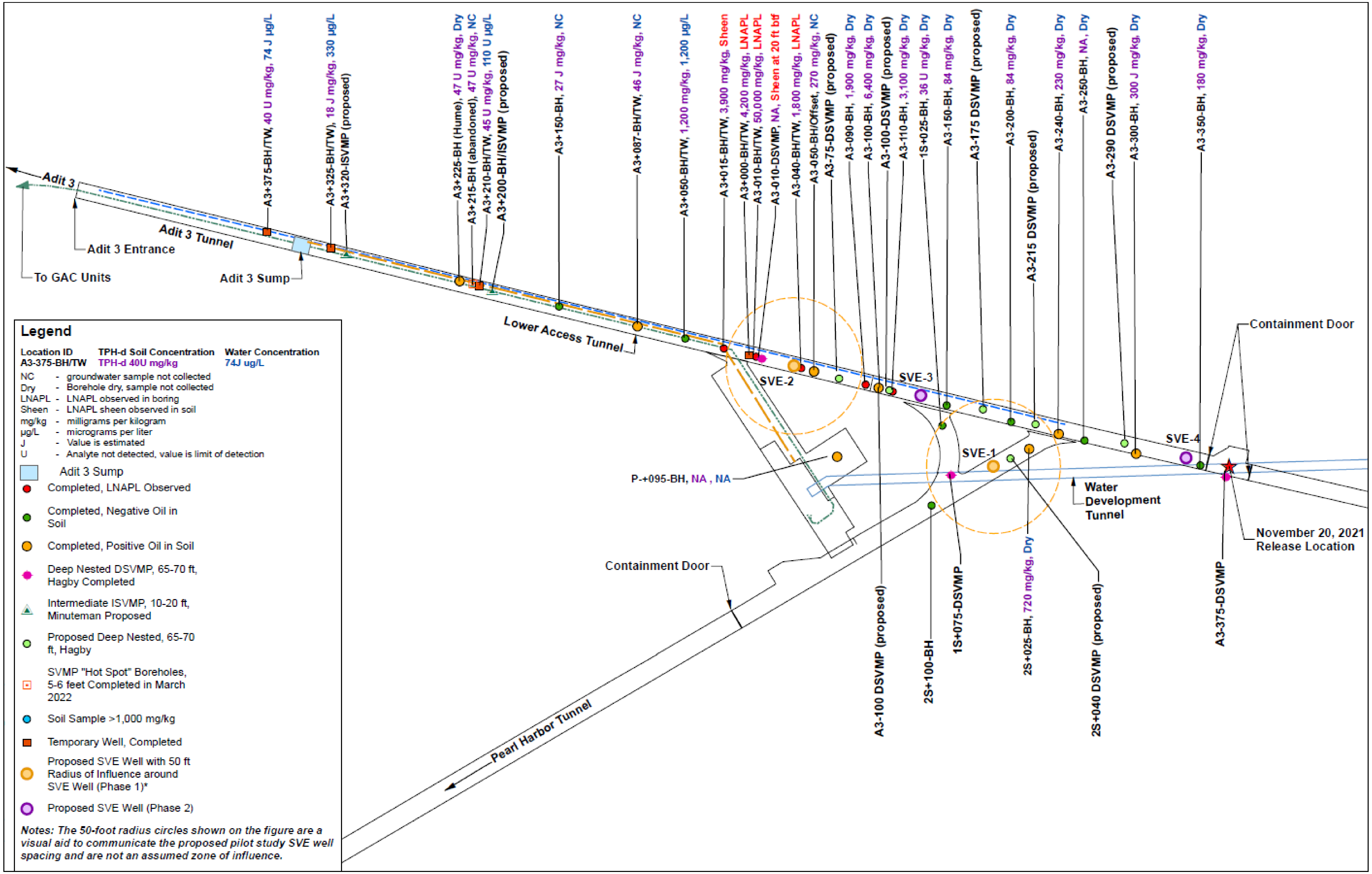


Figure 3: Proposed SVE Wells and SVMP Locations

6.3 DRILLING MOBILIZATION/DEMOBILIZATION

An electrical coring rig, such as the Hagby ONRAM 100, will be used to advance borings for both the SVE wells and the additional DSVMPs. As the Hagby rig is currently within the Adit 3 Tunnel, no mobilization is currently needed into the tunnel. If mobilization is required between boring locations, the tunnel train system will be used. The Hagby drilling efforts will require the use of an external power supply and generator with associated electrical conduit. The appropriate power supply and utility conduit are currently in place within the Adit 3 Tunnel. If the power source and/or conduit requires any modification, the Navy will be notified to provide adequate approval. Water can currently be sourced from a spigot at the pump station along the eastern wall. Water will be supplied through a minimum of 3/4-inch hose with heavy duty non-leak coupling hose and 3/4-inch shut-off ball valve. When drilling efforts are completed, the train will be used to move the Hagby rig.

6.4 STAGED SVE WELLS AND DEEP SVMP BORINGS

While installing the SVE and DSVMPs, the BHs and cuttings will be monitored for signs of potential LNAPL and impacts from the November 2021 leak. The SVE wells will be installed in a sequential fashion beginning with two initial SVE wells, SVE-1 and SVE-2. Currently in place and planned DSVMPs at 1S+075, A3-010, A3-100 and A3-240 will aid in the monitoring of the radius of influence and gas composition for the initial testing of SVE-1 and SVE-2. Based on Adit 3 soil boring observations, it is expected that there will be no perched water at SVE-1; however, SVE-2 is located in a region where known perched water has been identified with measurable accumulations of LNAPL. These two SVE wells provide different geologic conditions that will aid in assessing the potential radius of influence SVE wells may exhibit throughout the Adit 3 Tunnel.

6.4.1 Borehole Investigation

The electrical drill rig (e.g., Hagby ONRAM 100) will produce intact cores that will be inspected and documented at the surface. Cores will be inspected by a field geologist in a continuous fashion and logged on a field boring log identifying the visible physical properties of the cores. In general, each boring log will note the rock quality designation, color, texture, strength, degree and angle of fracturing, shape, size, and volume of voids, weathering, secondary staining or mineralization, and any LNAPL staining. The Munsell color chart will be used to describe the color of the core materials. Drill cuttings and core will also be screened (headspace screening) with a photoionization detector (PID) to aid in the evaluation of the level of subsurface LNAPL impacts.

To mitigate the risk of vertical migration of impacted water/LNAPL, in areas where perched water was identified in the shallow subsurface, a surface completion as shown on Figure 4 will be constructed. The following steps will be followed:

1. Coring will be reviewed through the confining layer until fracture basalt is identified.
2. The bottom 5 feet of the hole will be grouted via a tremie pipe.
3. The hole will be reamed to 4.9 inches outer diameter (OD) to a depth 2 feet from the bottom of the grout plug.
4. A 5-inch (5-inch) inner diameter (ID) steel or Schedule 80 polyvinyl chloride (PVC) isolation casing will be installed with centralizers to the depth of the reamed hole and with the annulus space being grouted to ground surface.
5. After 24 hours, 4.83-inch diamond drill coring (PQ) will continue from the bottom of the grout plug to total depth of the core hole.

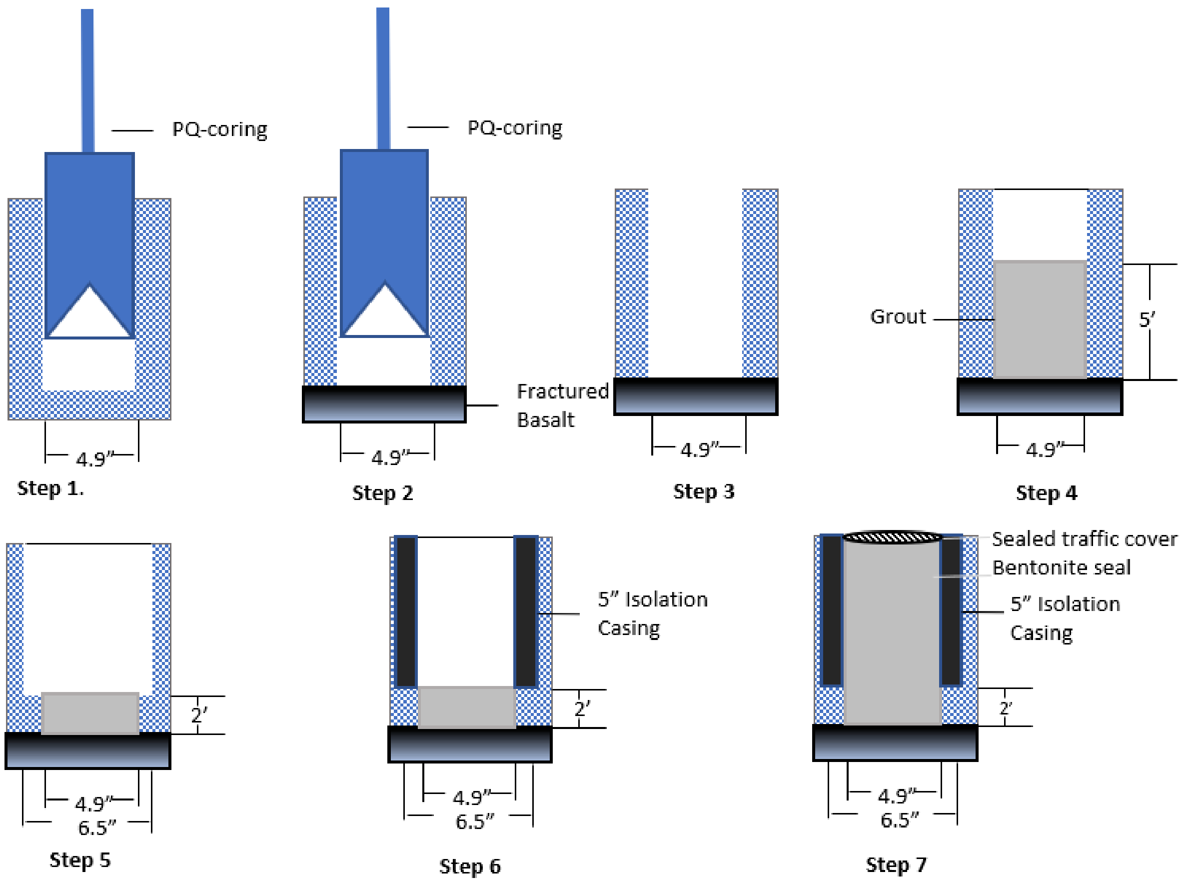


Figure 4: Conceptualized Isolation Casing Illustration

Lithologic descriptions, PID screening results, and other boring observations will be noted in the geological logs and in accordance with Procedure I-E, *Soil and Rock Classification*.

Drill cuttings and cores will have headspace readings performed with a PID to screen whether petroleum LNAPL may be present in the retrieved materials. The cuttings and/or core will be placed in an air-tight container. The inlet of the PID will be placed in the container to determine whether organic vapors are present.

If gross contamination is encountered (PID reading > 50 parts per million by volume [ppmv] with strong odors and visual evidence of oily staining/sheen/observation of mobile fuel), the cuttings/core will undergo further screening to evaluate whether petroleum LNAPL is present. Two methods will be used to screen for LNAPL:

- *Inspection with ultraviolet (UV) light:* The cuttings/core will be illuminated with UV light and visually inspected; UV light excites polyaromatic hydrocarbon compounds in petroleum, causing fluorescence within the visible light spectrum.
- *Shake testing:* The core/cuttings will be immersed in water and agitated; the water surface will be inspected to determine if droplets of LNAPL were displaced from the cuttings/core or if a petrogenic sheen is formed.

If additional screening indicates that LNAPL is not present in the cuttings/core, the drilling activities will continue. If additional screening does indicate the presence of LNAPL, the BH will be monitored for evidence of LNAPL discharge from the surrounding formation materials into the BH. Evaluation of potential LNAPL discharge will be monitored using an oil/water interface probe. The probe will be lowered into the BH to determine if any fluid is accumulating in the BH, and whether the fluid is LNAPL or water. The interface probe indicates the presence of petroleum products and groundwater using different audible signals. The following actions will be taken based on oil/water interface probe information:

- *No tone:* Indicates that there is no liquid in the BH; drilling will continue.
- *Water tone:* Indicates that some groundwater has accumulated in the BH; drilling will continue.
- *Petroleum tone:* Indicates that LNAPL has accumulated in the BH; drilling will stop.

If it is determined that petroleum entered the BH, the liquid will be removed and the BH monitoring using the oil/water interface probe will continue to determine if additional LNAPL discharges into the BH.

If LNAPL is determined to be rapidly entering the BH, temporary LNAPL pumping will be implemented to quantify LNAPL recoverability. Drilling will not resume until information gathered to assess the mobility of the LNAPL is shared with the State of Hawai‘i Department of Health (DOH) and the United States Environmental Protection Agency (EPA). Information will be given to DOH and EPA within 24 hours of the assessment. The agencies will have 24 hours to review and make recommendations before drilling resumes in accordance with the procedures outlined in Section 6.5.

6.4.1.1 Borehole Data Collection

After BH drilling activities have been completed, the associated tool will be removed, and additional data will be collected from the BH. These data will aid in characterizing the vertical profile of the BHs, primarily providing additional information on the degree of fracturing and whether there is evidence of natural source zone depletion occurring in the subsurface. This vertical profiling will aid in identifying intervals that would be most beneficial to install screens for the SVE wells and vertical placement of the soil vapor sampling probes for the DSVMPs. Borehole competency may limit the degree of BH profiling which can be completed.

6.4.1.2 Vertical Borehole Imaging

A down-hole imaging tool, SeeSnake or similar device, will be used to visually inspect the BH. The imaging tool will be lowered through the BH to inspect the geology and aid in the vertical profiling of the BH. Local geology, fracturing, signs of LNAPL impacts/staining, pore sizing, void space and local competency of the BH will be inspected during this stage of the investigation. The imaging will be recorded for future review.

6.4.1.3 Vertical Temperature Profiling

Subsurface temperature profiles will be recorded to identify zones in which elevated temperatures are measured which can indicate exothermic biodegradation of petroleum hydrocarbon. The temperature data will be logged automatically using data logging temperature sensors. The data loggers to be used are self-contained and SGS-certified as intrinsically safe for Class I, Division 1, groups A, B, C, and D (MadgeTech Temp1000IS, or similar model). A series of temperature sensors and automatic data loggers will be lowered through the BH at 5-foot intervals to measure the downhole temperatures. The data loggers will be suspended from the tunnel floor to the bottom of the BH. During the vertical temperature monitoring the BH will be sealed to limit heat exchange with the ambient air. The data loggers will be set to record every 30 seconds and will be deployed for a minimum of 2 hours. In addition to temperature profiling in open BHs, background temperature data will be recorded from at least one existing monitoring well located in an area where no LNAPL impacts have been identified. The temperature profile data from open BHs will be compared to representative background temperature profiles to calculate heat flux attributable to LNAPL biodegradation.

6.4.1.4 *Vertical Soil Vapor Profiling*

Subsurface vapor composition profiles will be measured using low-purge methods outlined by Sweeney and Ririe (2017). Data will be collected using a PID and multi-gas meter (e.g., Landtec GEM 5000 landfill gas meter) to measure concentrations of volatile organic compounds (VOCs), oxygen, carbon dioxide, and methane in the subsurface. A water trap, particulate filter, and activated carbon filter will be used on the multi-gas meter intake to protect the instrument from water and dust, and to remove VOCs from the vapor sample to prevent false positive or elevated methane readings associated with the presence of petroleum vapors. Subsurface vapor composition will be collected in 5-foot intervals through the total depth of the BH using a packer, such as the Solinst 800, to isolate portions of the BH. Biodegradation of petroleum hydrocarbons generally consumes oxygen and produces carbon dioxide and methane. The subsurface vapor profiling data will be reviewed for qualitative evidence of NAPL degradation (e.g., intervals of depleted oxygen, elevated carbon dioxide, or the presence of methane).

6.5 Communication Plan

The communication plan proactively focuses on three scenarios that are most likely to occur during drilling activities and the process that will be followed to notify the Navy, Regulatory Agencies (RAs) (i.e., DOH and EPA), and the stakeholder community. To expedite communication, a clear pathway for communication is outlined in Sections 6.5.1 through 6.5.2. The communication plan is in congruence with the site characterization work plan addendum submitted in May 2022 (DON 2022a).

6.5.1 Contamination Scenarios, Notifications, and Response Actions

Three scenarios are identified to address anticipated conditions encountered during drilling and notifications and response actions associated with each. The three scenarios include:

- *Scenario 1:* No contamination observed – PID reading < 10 ppmv.
- *Scenario 2:* Verified but moderate levels of contamination observed – 10 ppmv < PID reading < 50 ppmv with olfactory and visual evidence of oily staining and/or sheen.
- *Scenario 3:* Gross contamination observed – PID reading > 50 ppmv, strong olfactory and visual evidence of oily staining and/or sheen/observation of mobile fuel product.

Details regarding notification requirements and response actions for each scenario are summarized below and presented in Table 4.

Table 4: Triggers and Notifications for Three Contamination Scenarios

Trigger	AECOM to NFH EV1	NFH EV1 or NFH EV to Navy Leadership	NFH EV1 or NFH EV to DOH, EPA and/or CWRM
Drilling Updates	Daily via email or Daily Progress Report	As necessary; NFH EV1 via email and/or ESG and Stakeholder Calls	As necessary; NFH EV1 via email and AOC POC Call
Routine Drilling Progress Update	Daily via email or Daily Progress Report	Biweekly; NFH EV1 via ESG and Stakeholder Calls	Weekly; NFH EV1 via email and AOC POC Call
Drilling Data Update (e.g., water level parameters)	As data are collected and available	As necessary and biweekly; NFH EV1 via ESG and Stakeholder Calls	As collected; NFH EV1 after review via email
Scenario 1 – No Observable Contamination (PID readings < 10 ppmv with no other lines of evidence observed)			
PID reading < 10 ppmv; no samples collected and/or cores analyzed	Daily with drilling update	As necessary and biweekly; NFH EV1 via ESG and Stakeholder Calls	As necessary and weekly; NFH EV1 via email and AOC POC call
Scenario 2 – Moderate Contamination Observed (10 ppmv < PID reading < 50 ppmv with strong olfactory and visual evidence including sheen observed)			
PID reading < 10 ppmv; no samples collected and/or cores analyzed	Daily with drilling update	As necessary and biweekly; NFH EV1 via ESG and Stakeholder Calls	As necessary and weekly; NFH EV1 via email and AOC POC call
Scenario 3 – Gross Contamination Encountered (PID Reading > 50 ppmv with Strong Olfactory and Visual Oily Staining/Sheen/Observation Of Mobile Fuel Product)			
Gross contamination observed – PID reading > 50 ppmv, strong olfactory and visual evidence of oily staining and/or sheen/observation of mobile fuel product	Discontinue drilling; Notification immediately, within 1 hour of discovery of gross contamination, via call with follow up email	Immediately, within 24 hours of Navy notification; NFH EV via call with follow up email	Within 24 hours of Navy notification, immediately following concurrence from Navy Leadership NFH EV Verbal notification via call with follow up email, followed by written confirmation within 30 days

CWRM Commission on Water Resource Management, Department of Land and Natural Resources, State of Hawai‘i
ESG Executive Steering Group
POC point of contact
Notes:
AECOM: Sender will cc: Dustin Goto, Skyler Pauli, and George Sauer on all emails.
Navy Command:
Navy Leadership: (includes NRH Environmental Program Director, NRH Regional Engineer, Red Hill Program Management Office, Chief of Staff, Region Commander, Fleet Logistics Center, Defense Logistics Agency, Commander, and U.S. Pacific Fleet)
ESG: Executive Steering Group (Defense Logistics Agency, NFH, FLC, CNR)
NFH EV: Sherri Eng
NFH EV1: Dayna Fujimoto, Susan Lohr, Caroline Rossi
Regulatory Agencies (RAs): points of contact:
DOH: Fenix Grange, Lene Ichinotsubo, Robert Whittier

Scenario 1: No contamination observed – PID reading < 10 ppmv:

- AECOM Technical Services, Inc. (AECOM) will provide daily progress and observations to NFH EV1.
- Navy will notify the RAs weekly via email regarding progress and observations.
- Field screening and sampling procedures will occur described in Section 6.3.
- Isolation casing as described in Section 6.4.1 will be used to isolate perched water directly beneath the tunnel floor.

Scenario 2: Verified but moderate levels of contamination observed – 10 ppmv < PID reading < 50 ppmv with olfactory and visual evidence of oily staining and/or sheen:

- AECOM will provide daily progress and observations to NFH EV1.
- Navy will notify the RAs weekly via email regarding progress and observations.
- Field screening and sampling procedures will occur as described in Section 6.3.
- Isolation casing as described in Section 6.4.1 will be used to isolate perched water directly beneath the tunnel floor.

Scenario 3: Gross contamination observed – PID reading > 50 ppmv, strong odor and visual evidence of oily staining and/or sheen/observation of mobile fuel product:

- AECOM will provide immediate (within 2 hours) progress and observations to NFH EV1.
- The Navy <u>will notify DOH within 24 hours via phone call</u> and email regarding progress and observations.
- Field screening and sampling procedures will occur as described in Section 6.4.1. Drilling operations will be postponed while the field team determines whether mobile liquid is present.

6.5.2 Notifications for All Scenarios

- AECOM will keep NFH EV1 informed of drilling via Daily Progress Reports and telephone or email depending on the urgency of the notification.
- NFH EV1 will provide a weekly email progress update to RAs (DOH and EPA) (note: the State of Hawai‘i Department of Land and Natural Resources Commission on Water Resource Management will be notified if basal groundwater is encountered). The update will include:
  - Start of drilling, any delays, depth of groundwater (if any is encountered), and status of well completion
  - Rock coring – report progress and depth reached
  - Reaming hole to install casing
  - Observations
  - Testing conducted – water level, temperature, and depth profile
- NFH EV will notify Navy Leadership (includes N45, N4, Red Hill Program Management Office, Chief of Staff, Region Commander, Fleet Logistics Center, Defense Logistics Agency, Commander, and U.S. Pacific Fleet) prior to notifying RAs if the following occurs:
  - First sign of contamination
    - Elevated PID reading > 10 ppmv with other evidence of petroleum-impacted soil(only if PID reading is < 50 ppmv, NFH EV will notify RAs via email without prior notification of Navy Leadership)
  - Fuel product (LNAPL) is discovered

- NFH EV will notify RAs, with Navy Leadership approval:
  - Discovery of potentially impacted soil/drill cuttings (i.e., elevated PID reading $\geq$ 50 ppmv with olfactory and visual observations)
  - Stained material or cores
  - Discovery of mobile fuel in the vadose zone

Triggers and notification requirements for each scenario are listed in Table 4.

6.6 SVE Well Construction

Typical construction details for the SVE wells are outlined on Figure 5. An anticipated cross section identifying the placement of SVE wells in Adit 3 is shown on Figure 5. AECOM anticipates a terminal depth of approximately 60–70 feet with termination above, but in close proximity to the basal aquifer. A bentonite/grout plug will be placed in the bottom 2–5 feet of the bore hole. AECOM anticipates installing multiple screen intervals to evaluate the mass removal and extraction rate at different depths. The screen intervals will be determined upon review of the lithologic and vertical profile characterization data, with the goal of locating the SVE screen intervals at depths where LNAPL is suspected or directly identified. If there is nothing in the data set to indicate the presence of LNAPL or any intervals of interest, placement of screen intervals will be based on consideration of observed BH geology, fractures intersecting the BH, and, if applicable, groundwater discharge into the BH.

The following steps are anticipated for construction of all SVE wells (a typical SVE well construction diagram is illustrated on Figure 6):

1. After completion of the BH investigation, as stated earlier, a bentonite/concrete plug will be poured to the bottom of the BH via a tremie pipe, approximately 1 foot below the lowermost screen interval. The bentonite/grout plug will be a minimum of 2 feet thick.
2. SVE wells will be constructed using 2-inch-diameter, Schedule 80 PVC casing and 2-inch-diameter, 0.010-inch slot size stainless steel vee-wire screen.
3. After review of the vertical BH profile, the screen intervals will be identified.
   - AECOM anticipates the use of 5- to 15-foot-long screen intervals.
   - AECOM anticipates two or more screened intervals at each SVE well.
4. A sand filter pack will be placed in the annulus between the BH and the extraction well screen, extending from 1 foot below the base of the screen to approximately 1 foot above the top of the screen. Approximately 2 feet of dry bentonite chips above the lower sand pack, and bentonite/grout will be installed in the well annulus between the lower and upper screen intervals to a depth of approximately 1 foot below the base of the upper screen interval. The remaining annular space, from approximately 2 feet above the upper screen interval to the tunnel floor will be filled with hydrated bentonite and concrete.
5. A flush-mount, traffic-rated vault will be fitted for each SVE well.

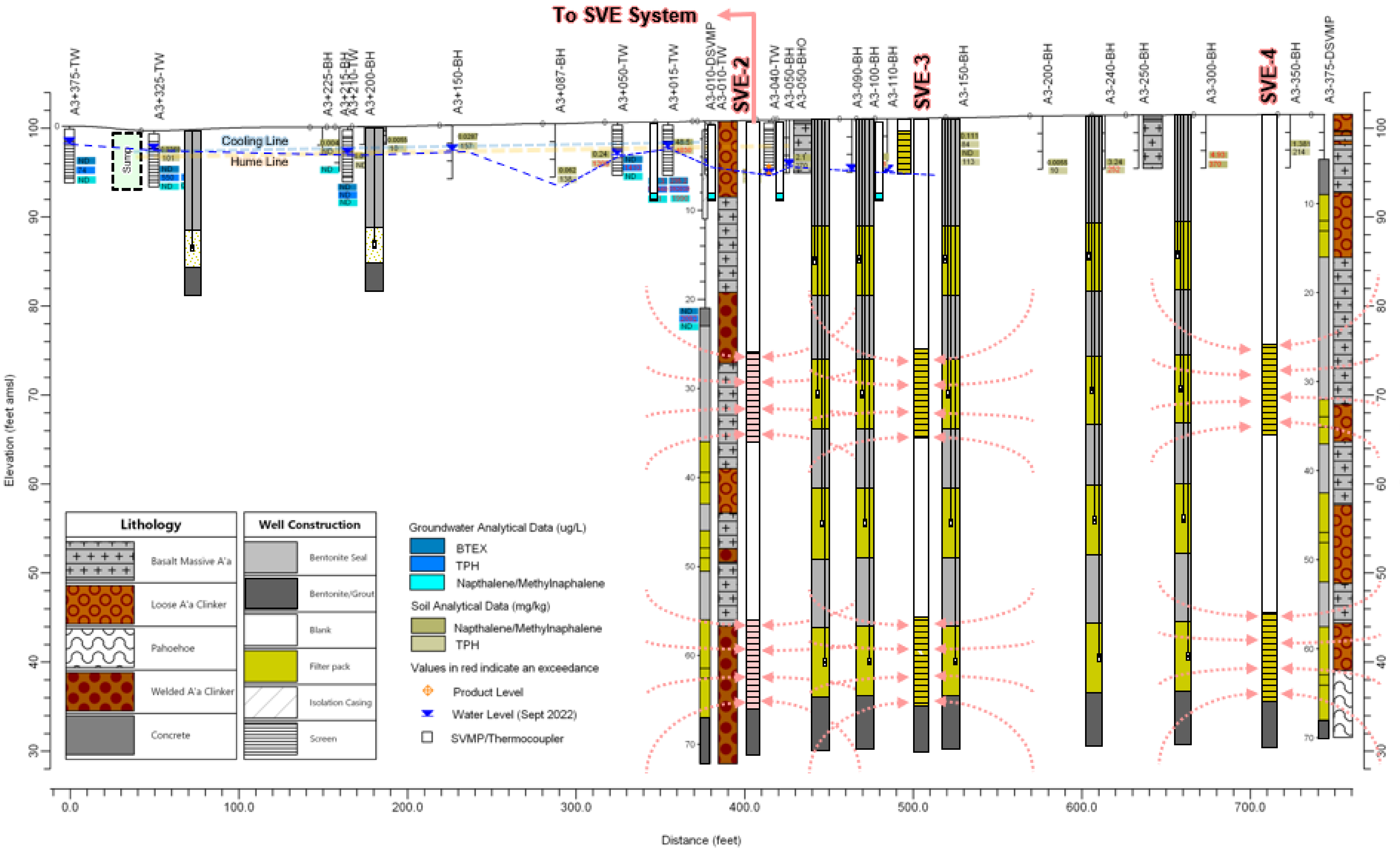
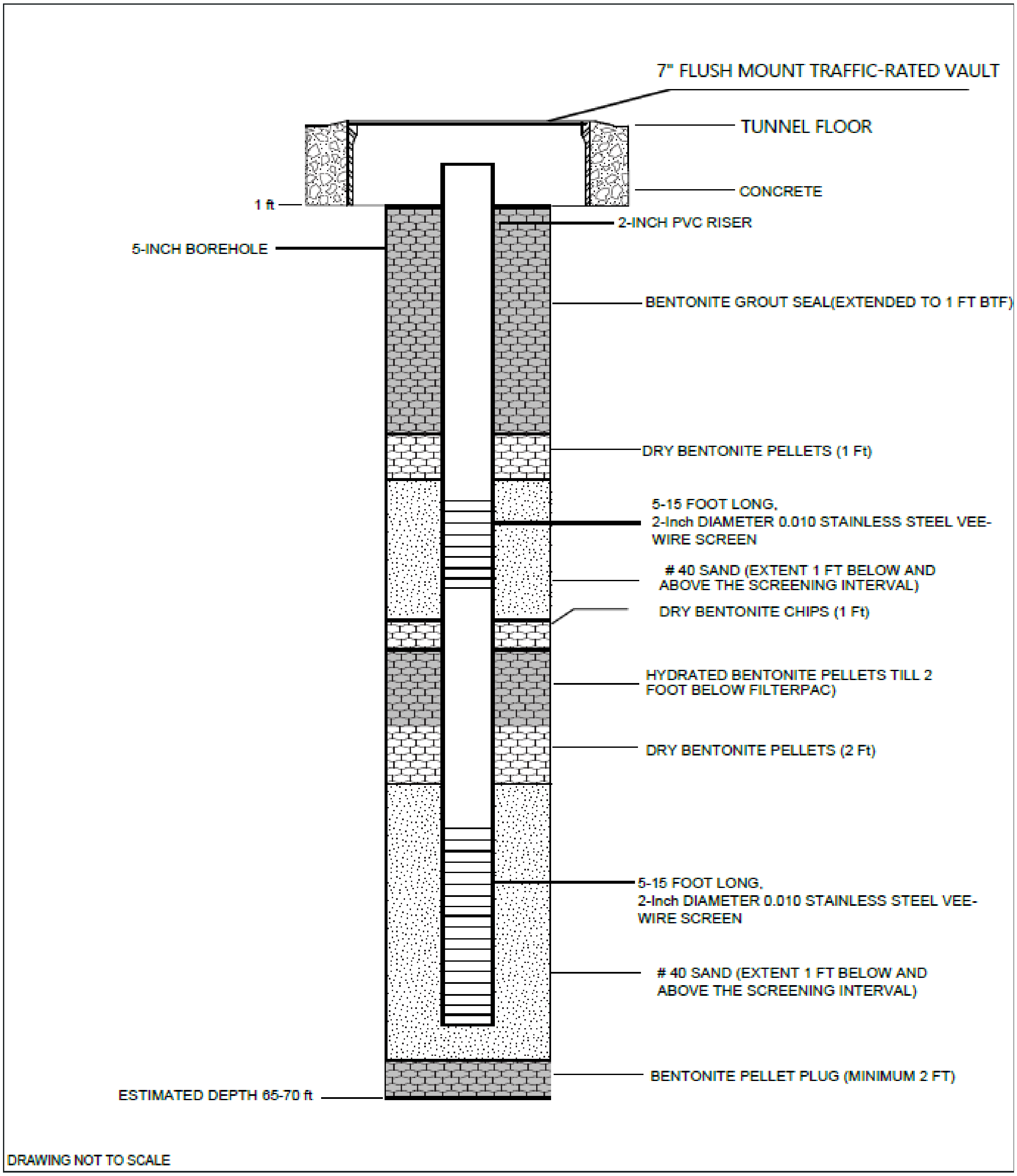


Figure 5: Adit 3 Cross Section with Proposed SVE Wells and DSVMPs



Deep SVE Well Construction Diagram

Remedial Action Pilot Study
Red Hill Adit 3 Tunnel

AECOM

Figure 6: Typical SVE Well Construction

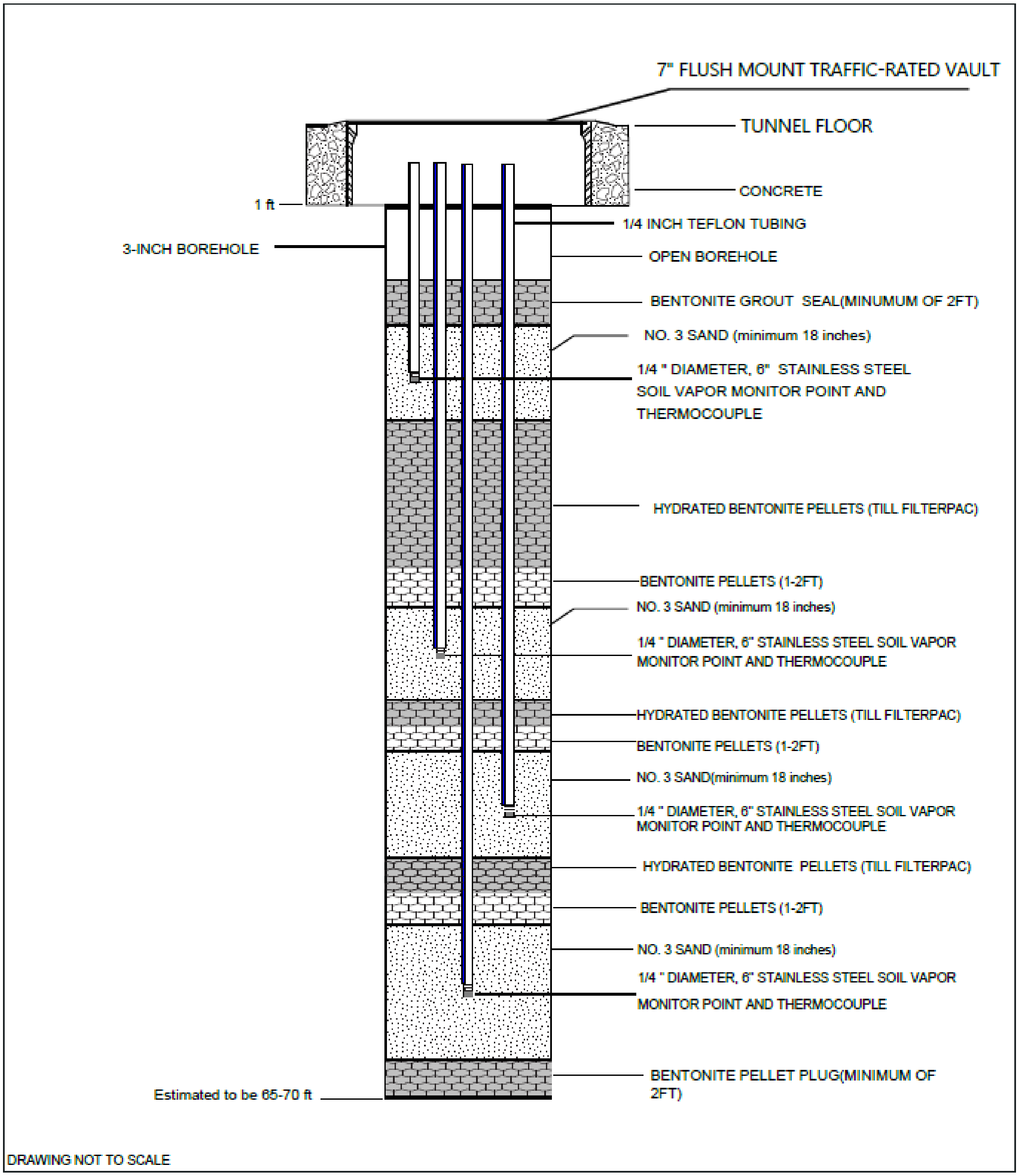
6.7 DEEP NESTED SVMP CONSTRUCTION

DSVMPs are anticipated to be installed to a terminal depth of approximately 60–70 feet btf with termination above, but in close proximately to the basal aquifer. Screening intervals will be determined after analyzing the BH characterization data and in accordance with the proposed SVE extraction wells to be installed. Additionally, a temperature probe is planned to accompany every screening internal. The completion of each DSVMP will follow the following steps (a typical DSVMP construction diagram is illustrated on Figure 7):

1. The bottom of the BH will be sealed with 2–5 feet of grout.
2. A vapor probe (stainless steel soil vapor implant, EPS 6-inch or similar model) will be installed to the desired screening interval with Teflon tubing through the Adit 3 subsurface.
3. A temperature probe, Physitemp PT-6 or similar model, will be installed in each screened interval.
4. An estimated 5-foot sand filter pack will be installed at each screening interval.
5. After each screening interval, 1–2 feet of dry bentonite chips will be installed followed by a hydrated bentonite pellets until the next desired screening interval.
6. Steps 2–4 are repeated until the final screening interval is placed. The remaining void space will be filled with concrete to approximately 1 foot below the tunnel floor.
7. Each vapor tube will be completed with ball valve finish.
8. The DSVMPs will be fitted with a traffic-rated flush-mount cover.

Materials:

- Stainless steel soil vapor implant (6-inch vapor implant, EPS 6-inch vapor implant, or similar model)
- 1/4-inch tubing
- 1/4-inch ball valve with 3/16-inch hose barb
- Swagelok connection between the tubing and the ball valve
- Sand (US Mesh 20-40)
- Bentonite
- Grout
- Cement
- Traffic-rated flush-mount well cap
- Temperature probe, PT6 or similar model



Nested DSVMPs Well Construction Diagram
Remedial Action Pilot Study
Red Hill Adit 3 Tunnel

AECOM

Figure 7: Typical DSVMP Construction

6.8 UTILITY CONNECTIONS

A 6-inch-diameter extraction pipe will be installed from the Adit 3 entrance through the tunnel to the easternmost SVE points using existing piping conduit supports. AECOM anticipates using Schedule 80 PVC with high-strength flexible piping to connect each SVE point. The connection between the 6-inch piping in the tunnel and the SVE system will be made using vacuum-rated flexible hose and/or PVC piping. It is anticipated that the 6-inch pipe will be reduced to 2-inch vapor extraction conveyance lines plumbed to each extraction point using a combination of Schedule 40 PVC and flexible hosing to establish the final connection to each extraction point.

The SVE wells will be fitted with a quick connect fitting to allow for easy connection to the 6-inch-diameter extraction pipe and the hardware placed below the tunnel floor. The branch lines to the SVE wells will have dedicated flow measurement devices, vacuum gauges, sample ports and various piping completions that will facilitate pilot study and operational data collection.

6.8.1 First Stage SVE Pilot Testing

SVE step and constant rate testing will occur at each well prior to the installation of additional SVE wells or DSVMPs. These tests will provide information on subsurface permeability and air flow conditions. This information will guide the installation of two additional DSVMP points as well as the placement of the remaining two SVE wells by allowing for an evaluation of the ROI at each extraction well. Table 5 outlines the tests anticipated and sequencing during the first stage testing. Step and constant rate test protocols are presented in Sections 7.3 and 7.4. Additionally, a helium tracer test will be performed on one of the SVE wells to further understand the airflow between the water development tunnel and the deep basalt.

Table 5: Initial Deep SVE Testing Protocol

Well	Test	Nearby Monitoring Points
SVE-1	Step Test, Constant Rate Test	A3-010-DVSMP, A3-075-DSVMP, A3-110-DSVMP
SVE-2	Step Test, Constant Rate Test	2S+075-DSVMP, 1S+25-DSVMP, A3-215 DSVMPs

7. Pilot Study Testing

7.1 BASELINE SAMPLING

Deep subsurface conditions will be evaluated prior to initiating any portion of the deep pilot study (a summary of the proposed baseline testing is listed in Table 6). All short-term operation of the SVE/AS system will be halted at least 3 days prior to collecting the baseline conditions of the soil. Baseline subsurface testing will include vacuum and soil gas composition monitoring in deep SVE wells, and both the deep and shallow SVMPs. The data collected will provide insight on the potential effectiveness of the extraction/volatilization of the subsurface gases and enhanced biodegradation due to the removal of the hydrocarbons and enhanced air flow through the subsurface.

AECOM will analyze soil gas from the deep and intermediate SVMPs. Differential pressure gauges, such as manometers, will be used at each vadose zone monitoring point to evaluate the initial gas pressure distribution in the unsaturated zone. Soil gas composition screening will be completed using a PID and a landfill gas meter to measure concentrations of VOCs, oxygen, methane, and carbon dioxide in soil gas. A water trap and a particulate filter will be installed between the tubing and the gas meter to protect the instrument from water and dust, and an activated carbon filter will be used on the multi-gas meter intake to remove VOCs from the gas sample to prevent VOCs from triggering a false methane reading. Soil gas will be purged using the internal pump on the field gas analyzers, and readings will be recorded every 30 seconds until stable concentrations are achieved (defined as three consecutive readings within 10 percent of each other with no consistent increasing or decreasing trend).

Table 6: Initial Baseline Testing

Activity	Location	Monitoring Points	Frequency	Equipment Needed
Soil Gas Screening (Oxygen, Methane, Carbon Dioxide, and VOCs)	Both shallow and deep SVMPs throughout the tunnel, each deep SVE (at each screening interval)	A3-010-DVSMP, A3-075-DSVMP, A3-110-DSVMP,2S+075-DSVMP, 1S+25-DSVMP, A3-215 DSVMPs and 10 proposed shallow VMPs	Readings will be collected until stabilization occurs. (record gases readings every 30 seconds until 3 consecutive readings are within 10% of each other).	PID, Landfill Gas meter
Differential Pressure	Each deep SVE (at each screening interval), SVMPs (both shallow and deep)	A3-010-DVSMP, A3-075-DSVMP, A3-110-DSVMP,2S+075-DSVMP, 1S+25-DSVMP, A3-215 DSVMPs and 10 proposed shallow VMPs	Allow for at least 30 seconds of stabilization and take an individual reading.	Manometer
Tunnel Air Monitoring	Throughout the investigation area	Work Area	Monitor continuously.	FID/PID

FID flame ionization detector

7.2 HELIUM TRACER TEST

A helium tracer study will be implemented to identify whether there is an airflow connection between the water development tunnel and surrounding basalt. A tracer test will be implemented because it is not feasible to measure vacuum influence within the water development tunnel. Air leakage from the water development tunnel into the SVE wells will decrease the horizontal zone of influence, but leakage is beneficial because it will result in airflow through potentially JP-5 filled void spaces between the water development tunnel and the terminal depth of SVE wells. The tracer study will allow for a better understanding of the permeability and specific yield of the deep unsaturated zone formation materials.

A known helium concentration will be injected into the water development tunnel shaft, known as Red Hill Shaft. The shaft will be sealed to limit the release of helium to the atmosphere and further define the influence the deep SVE wells will have on the water development tunnel. The helium concentration will be kept below 10 percent by volume to limit the buoyancy effect of helium and limit the vertical migration due to any factor other than suction force from SVE (Johnson et al. 2001).

The recovery rate will be calculated using Equation 1:

Equation 1: $$\%Recovery = \frac{SVE\ Flow\ Rate}{Helium\ Injection\ Rate} \times \%Helium\ in\ SVE\ gas \times 100$$

The recovery rate will be assessed during the step and constant rate test. A background assessment of the helium concentration from the SVE well will be collected to assess conditions prior to the addition of helium to the water development tunnel. A dielectric helium detector or similar model will be used to collect the background data as well as the analysis through the step and constant rate test.

7.3 SVE STEP TEST

A step test will be performed using the SVE system to evaluate the maximum extraction flow rates that can be achieved; the concentrations of petroleum hydrocarbons and fixed gases (e.g., oxygen, carbon dioxide, and methane) in the extracted vapor; and the vacuum at multiple screening intervals through the vertical SVE wells. AECOM will evaluate the flow rates to determine the maximum vacuum that can be achieved through the SVE wells while maintaining a laminar flow (Beckett and Huntley 1994).

During the step test, vacuum and flow will be monitored until stabilization is achieved. Data will be collected every 10 minutes to measure for stabilization, which is achieved after three consecutive measurements are within 10 percent of each other. Additionally, a PID and multi-gas meter (GEM or equivalent) will be used to assess the VOCs, oxygen, methane and carbon dioxide in the soil vapor exhaust. Three extraction flow rates (steps) are anticipated, but this may change due to environmental responses such as limited suction on an SVE point or inability to maintain stabilization parameters.

Table 7 lists the measurements that will be collected during the Step Tests.

Table 7: Step Test Measurements

Parameter	Anticipated Frequency (Step Test)
Extraction point vacuum	Approximately every 10 mins
Vapor extraction flow rate	Approximately every 10 mins
Vacuum measurements at wells/SVMPs	Approximately every 10 mins
Influent and effluent VOC readings at the SVE system	Approximately every 30 mins
Methane, oxygen, carbon dioxide	Approximately every 30 mins

7.4 SVE CONSTANT RATE TEST

A constant rate test will be completed after the evaluation of the step test field measurements. AECOM will identify the maximum extraction rate achieved at these SVE well while maintaining maximum vacuum influence and VOC extraction rate as well as laminar flow. During this portion of the test, a consistent airflow rate will be maintained from the extraction points. The subsurface response will be monitored throughout the test as well as the flow rate and vacuum at each extraction point. Field measurements will be collected every 30 minutes and will continue until stabilization occurs, defined as at least three consecutive readings within 10 percent of each other. Once stabilization occurs, two rounds of vapor samples will be collected pre-GAC filtration and post-GAC filtration within the SVE system. These samples will be collected immediately after stabilization and the second round will be collected at least 4 hours after stabilization has occurred. These vapor samples will be analyzed for EPA Method Task Order (TO) TO-17, TO-15, and TO-3. Table 8 lists the measurements that will be collected during the constant rate test.

Table 8: Constant Rate Test Measurements

Parameter	Anticipated Frequency (Step Test)
Extraction point vacuum	Approximately every 30 mins
Vapor extraction flow rate	Approximately every 30 mins
Vacuum measurements at wells/SVMPs	Approximately every 30 mins
Influent and effluent VOCs readings	Approximately every 30 mins
Methane, oxygen, carbon dioxide	Approximately every 30 mins
TO-17, TO-15, TO-3 samples	Once stabilization occurs and at least 4 hours after stabilization

Note: TO-17 is recommended as it captures a wider range of heavier distillates and will assist in calculating a more accurate estimate of mass removal.

8. Data Evaluation

Data collected from each pilot test will be used to evaluate the effectiveness of using SVE to remove volatile hydrocarbons by phase transfer and improving airflow in the subsurface to enhance biodegradation. The primary criteria that need to be met to consider SVE an effective technology at the Red Hill Facility for full-scale implementation include:

- Demonstrating that the technologies can be applied to deplete the mass of petroleum hydrocarbons in the deep basalt.
- Demonstrate the ability to influence air flow through the basalt.

If either of these criteria is not demonstrated, then SVE may be deemed inappropriate and/or infeasible for application to the deep vadose zone.

8.1 SVE Data Evaluation

The SVE zone of influence will be evaluated based on measured changes in subsurface gas pressure and soil gas composition at pilot test monitoring points screened above the basal aquifer in response to changes in the vapor extraction flow rate.

As described in Section 6, the SVE pilot study will be implemented in stages, and data collected during the initial stage of testing will be used to determine optimal SVE well spacing relationships for the next testing stage. Installation of additional SVE points (beyond the initial four locations proposed in this Work Plan) may be considered if SVMPs located within the target remediation zone do not exhibit evidence of induced air flow during the pilot testing activities (e.g., no measurable vacuum response and no change in oxygen content in soil gas). Pneumatic permeability values will be estimated from pressure drops between vacuum monitoring points located at different distances from vapor extraction points at the measured extraction rate using a modified form of Darcy's Law. Additionally, differences in vacuum response as a function of depth will be evaluated using measurements from vapor monitoring points screened at different depth intervals (i.e., subslab and through the basalt) to give an indication of the relationship of vertical to horizontal permeability.

Vapor extraction flow rates for longer-term SVE operation will be determined through evaluation of the pneumatic response data, changes in soil gas composition throughout the basalt, and mass removal rate trends observed in the SVE off-gas (Section 8.2). Vapor extraction rates will be determined based on achieving a pore volume exchange rate that is frequent enough to maintain a low extraction concentration relative to the initial subsurface source vapor concentrations to optimize mass transfer in diffusion-limited zones and to ensure that the subsurface is not oxygen-limited to maintain high rates of aerobic biodegradation.

8.2 Analysis Of Mass Removal

Removal rates for volatile hydrocarbons by mass transfer into the vapor phase will be calculated by multiplying the concentration of volatile petroleum hydrocarbons in the extracted vapor (mass of petroleum hydrocarbons per unit volume of extracted vapor) by the measured volumetric vapor extraction flow rates (volume of extracted vapor per unit time), as indicated in Equation 2:

Equation 2: $$Q_M = Q_V \cdot C_{HC}$$

Where:

Q_M	=	Petroleum hydrocarbon mass removal rate (mass/time)
Q_V	=	Volumetric vapor extraction flow rate (volume/time)
C_{HC}	=	Concentration of volatile petroleum hydrocarbons measured in extracted vapor (mass/volume)

Additionally, mass removal by aerobic biodegradation (consumption of oxygen and/or production of carbon dioxide) will be calculated based on stoichiometric relationships derived from the prevailing aerobic biodegradation reactions that deplete petroleum hydrocarbons. The flow of oxygen-rich atmospheric air into the subsurface provides oxygen to naturally occurring microorganisms that obtain energy for cell growth and maintenance through the transfer of electrons from electron donors (e.g., LNAPL hydrocarbon constituents and/or naturally occurring soil organic carbon) to a terminal electron acceptor such as oxygen. In the presence of oxygen, as in the case of an active SVE system, these biodegradation reactions result in the production of carbon dioxide (CO_2) and water according to the following stoichiometric relationship, where "a" and "b" represent the number of carbon and hydrogen atoms in a given hydrocarbon compound, respectively:

Equation 3: $$C_aH_b + \left(a + \frac{b}{4}\right) \cdot O_2 \rightarrow a \cdot CO_2 + \left(\frac{b}{2}\right) \cdot H_2O$$

The stoichiometric relationship from Equation 3 for aerobic mineralization of various hydrocarbon compounds (different values for a and b) can be expressed in terms of the mass of hydrocarbon (HC) degraded per unit mass of oxygen utilized (g-HC/g-O_2), or per unit mass of CO_2 gas produced (g-HC/g-CO_2). The mass ratio of hydrocarbon degraded to oxygen utilized or carbon dioxide produced is relatively invariant for a broad range of hydrocarbons. Using decane ($C_{10}H_{22}$) as a representative compound for the hydrocarbon impacts at the site, the resulting stoichiometric coefficient for aerobic oxidation of the hydrocarbon (S_{O_2}; 0.29 g-$C_{10}H_{22}$/g-O_2) and CO_2 production (S_{CO_2}; 0.32 g $C_{10}H_{22}$/g-CO_2) were calculated using molecular weights for each of the compounds represented in Equation 3 (Haynes, Lide, and Bruno 2012).

With the above stoichiometric coefficients, mass removal by aerobic biodegradation will be calculated using Equation 4:

Equation 4: $$R_{bio} = Q_V \cdot \left(\frac{C_i - C_i^{bkgd}}{100}\right) \cdot \rho_i \cdot S_i$$

Where:

R_{bio}	=	Rate of petroleum hydrocarbon mass removal rate (M/T)
C_i	=	Concentration of O_2 or CO_2 in extracted soil gas (vol%)
C_i^{bkgd}	=	Background concentration of O_2 or CO_2 (20.9 and 0.04 vol%, respectively)
ρ_i	=	Density of O_2 or CO_2 gas at normal temperature and pressure (M/L^3)
S_i	=	Stoichiometric coefficient

9. Additional Deep SVE Well Construction and Testing

Two additional SVE wells (SVE-3 and SVE-4) and up to two additional DSVMPs will be installed based on the data collected during initial testing of SVE-1 and SVE-2, assuming that the first stage of testing deems that SVE is an effective remediation technology. After calculations are completed to evaluate the radius of influence, the spacing and arrangement of the remaining SVE wells and DSVMPs will be determined. If the drilling locations for the DSVMPs or SVE wells are to be relocated from the locations previously cleared for utilities, a second round or utilities and metal clearance will be completed following the protocol outlined in Section 6.2.

The protocol for boring installation and SVE well and DSVMP construction presented in Section 6 will be used for the additional wells and DSVMPs. The sequenced construction allows for a more precise placement of the SVE wells as well as the DSVMPs to optimize the performance of the SVE system in the heterogenous subsurface environment.

The proposed additional SVE well and DSVMP locations will be communicated to DOH and EPA prior to installation.

SVE step tests and constant rate tests will be performed on the additional SVE wells following the procedures outlined in Section 8.

10. 6-Month Operation

Upon completion of the deep SVE step test and constant rate pilot test, a 6-month pilot study will be implemented to evaluate any potential changes over time in estimated petroleum mass removal, soil gas composition, and potential enhanced biodegradation. After the evaluation of the both the deep SVE and shallow SVE/AS, the most impactful and efficient arrangement of active SVE wells will be implemented. AECOM anticipates the 6-month operation will provide additional information to aid in identifying long term remedial design parameters as well as operations and maintenance requirements. It is anticipated that after initial startup, mass removal and effectiveness of the SVE system will vary over time and the 6-month operation aims to provide insight on operational efficiency as well as any changes that may be advised throughout operations. Some operational changes which may be advised could be treating different depth intervals or changing operational SVE wells. AECOM will continue to evaluate SVE data and estimate mass removal using the methodology outlined in Sections 8.1 and 8.2.

AECOM expects to perform regular monitoring 3-times a week throughout the investigation area as well as less frequent maintenance activities to maintain optimal SVE operation and monitor long term trends. Table 9 outlines the various operations and maintenance activities anticipated to be performed in the investigation area as well as their frequency. Field readings will be collected for all the parameters shown in Table 9, but additional monitoring of the operational leg, flow rate, vacuum reading, and temperature of the SVE system can be conducted remotely to allow for system oversight between site visits.

Table 9: 6-Month Operation and Maintenance of Red Hill SVE Testing

Activity	Location	Expected Frequency	Equipment Needed
Soil Gas Screening (Oxygen, Methane, Carbon Dioxide, VOCs)	Both Shallow and Deep SVMPs throughout the Tunnel	3 Times a Week	PID, Landfill Gas meter
Flow Rate	Active SVE Wells/Points	3 Times a Week	Manometer
Tunnel Air Monitoring	Throughout the Investigation Area	During each site visit	FID/PID
Perched LNAPL Gauging	Temporary wells throughout Adit 3	Weekly	Oil/Water Interface Probe
Temp Well Transducer Data Download	Temporary wells throughout Adit 3	Monthly	Computer
Influent and Effluent Gas sampling at the SVE System (TO-3, TO-15, TO-17)	SVE System	Monthly	Summa Canister and Sorbent Tubes
GAC Changeout	SVE System	TBD	Contractor-Executed Task
Check Oil Levels	SVE System	Weekly	N/A
Check Belt Tension	SVE System	Weekly	N/A
Check Air Filters	SVE System	Weekly	N/A

FID flame ionization detector
N/A not applicable

11. Project Schedule and Reporting

Based on initial estimates, AECOM has updated a Gantt chart with proposed field activities (Appendix C). The initial estimates are assuming ideal conditions with limited delays. Proposed field activities are under review by the Navy and DOH. A technical memorandum will be submitted 4 weeks after the completion of all the deep SVE pilot activities.

12. Sample Details

Additional details about collecting subsurface unconsolidated material, water, and vapor samples are presented in Appendix D. Table 10, Table 11, Table 12, and Table 13 list the sample identifiers for type/matrix, QC type, depth, and date, respectively.

Table 10: Sample Type and Matrix Identifiers

Identifier	Sample Type	Matrix
SO	Subsurface unconsolidated material	Unconsolidated material
WG	Groundwater	Water
WS	Surface water	Water
GS	Soil vapor	Gas
WQ	QC water	Water
SQ	QC soil	Unconsolidated material

QC quality control

Table 11: Field QC (SACODE) Type Identifiers

Identifier	Field or QC Sample Type	Description
N	Primary sample	All field samples, except QC samples
FD	Duplicate	Co-located for unconsolidated material
EB	Equipment blank	Water
TB	Field blank	Water

Table 12: Sample Depth Identifiers

Identifier	Field or QC Sample Type	Description
###.#-###.#	Beginning depth interval to end depth interval	Top and bottom of soil interval sampled

Table 13: Sample Date

Identifier	Field or QC Sample Type	Description
YYMMWK#	Sample collection date (expressed as week of sampling to allow pre-naming and flexibility in sampling activity)	YY = Year MM = Month WK# = Week of the month

12.1 HANDLING, SHIPPING, AND CUSTODY

All samples collected for analysis will be recorded in the field logbook in accordance with Procedure III-D, *Logbooks* (DON 2015). All samples will be labeled and recorded on chain-of-custody forms in accordance with Procedure III-E, *Record Keeping, Sample Labeling, and Chain-of-Custody* (DON 2015). Samples will be handled, stored, and shipped in accordance with Procedure III-F, *Sample Handling, Storage, and Shipping* (DON 2015). All samples collected on this project will be shipped to the analytical laboratory via overnight airfreight.

All samples received at the analytical laboratory will be managed in accordance with laboratory SOPs for receiving samples, archiving data, and sample disposal and waste collection, as well as storage and disposal per Section 5.8, "Handling of Samples," of the Department of Defense *Quality Systems Manual (QSM)* v. 5.4 (DoD and DOE 2021).

12.2 LABORATORY QC SAMPLES

Laboratory quality control (QC) samples will be prepared and analyzed in accordance with the methods and procedures listed in Appendix D.

13. References

Beckett, G. D., and D. Huntley. 1994. *Characterization of Flow Parameters Controlling Soil Vapor Extraction: Ground Water*. Vol. 32. No. 2, pp. 239–247.

Department of Defense and Department of Energy, United States (DoD and DOE). 2021. *Department of Defense (DoD) and Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories*. DoD/DOE QSM Ver. 5.4. Prepared by DoD Environmental Data Quality Workgroup and DOE Consolidated Audit Program Operations Team.

Department of the Navy (DON). 2007. *Red Hill Bulk Fuel Storage Facility Final Technical Report, Pearl Harbor, Hawaii*. Prepared by TEC, Inc. Pearl Harbor, HI: Naval Facilities Engineering Command, Pacific. August.

———. 2015. *Final Project Procedures Manual, U.S. Navy Environmental Restoration Program, NAVFAC Pacific*. JBPHH HI: Naval Facilities Engineering Command, Pacific. May.

———. 2018. *Seismic Profiling to Map Hydrostratigraphy in the Red Hill Area, Red Hill Bulk Fuel Storage Facility, Joint Base Pearl Harbor-Hickam, O‘ahu, Hawai‘i; March 30, 2018, Revision 00*. Prepared by Lee Liberty and James St. Claire, Boise State University, Boise, ID, for AECOM Technical Services, Inc., Honolulu, HI. Boise State University Technical Report BSU CGISS 18-01. Prepared for Defense Logistics Agency Energy, Fort Belvoir, VA, under Naval Facilities Engineering Command, Hawaii, JBPHH HI.

———. 2022a. *Preliminary Site Characterization Plan Addendum, November 2021 Release, U.S. Navy Well 2254-01, JBPHH, O‘ahu, Hawai‘i*. Prepared by AECOM Technical Services, Inc. JBPHH HI: Naval Facilities Engineering Systems Command, Hawaii. May.

———. 2022b. *Site Characterization Plan, Moderate Depth SVMP Addendum Red Hill Bulk Fuel Storage Facility (November 2021 Release, U.S. Navy Well 2254-01) Joint Base Pearl Harbor-Hickam Oahu HI*. Prepared by AECOM Technical Services, Inc. JBPHH HI: Naval Facilities Engineering Systems Command, Hawaii. May.

Giambelluca, T. W., M. A. Nullet, and T. A. Schroeder. 1986. *Rainfall Atlas of Hawaii*. Report R76. Honolulu, HI: Department of Land and Natural Resources, Division of Water and Land Development. June.

Haynes, W.M., David R. Lide, and Thomas J. Bruno, eds. 2012. *CRC Handbook of Chemistry and Physics*. 93rd ed. Boca Raton, FL: CRC Press.

Hunt Jr., C. D. 1996. *Geohydrology of the Island of Oahu, Hawaii*. Professional Paper 1412-B. Regional Aquifer-System Analysis—Oahu, Hawaii. U.S. Geological Survey.

Izuka, S. K. 1992. *Geology and Stream Infiltration of North Halawa Valley, Oahu, Hawaii*. Prepared in cooperation with the State of Hawaii Department of Transportation. Honolulu, HI. Water-Resources Investigations Report 91-4197. U.S. Geological Survey.

Johnson, R. L., P. C. Johnson, T. L. Johnson, and A. Leeson. 2001. “Helium Tracer Tests for Assessing Contaminant Vapor Recovery and Air Distribution During In Situ Air Sparging.” *Bioremediation Journal* 5 (4): 321–36.

Macdonald, G. A., A. T. Abbott, and F. L. Peterson. 1983. *Volcanoes in the Sea: The Geology of Hawaii*. 2nd ed. Honolulu, HI: University of Hawaii Press.

Sweeney, R.E., and G.T. Ririe. 2017. "Small Purge Method to Sample Vapor from Groundwater Monitoring Wells Screened Across the Water Table, Groundwater Monitoring & Remediation." *10.1111/Gwmr.12230*.

United States Department of Agriculture, Soil Conservation Service (USDA SCS). 1972. *Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii*. In cooperation with the University of Hawaii Agricultural Experiment Station. Washington, DC. August. https://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=HI.

Wentworth, C. K., and G. A. Macdonald. 1953. *Structures and Forms of Basaltic Rocks in Hawaii*. Geological Survey Bulletin 994. U.S. Geological Survey.

Appendix A:
SVE Operations and Maintenance Manual

Final

Soil Vapor Extraction System Operations and Maintenance Plan, Revision 1

Subsite ST32 Onizuka Village
Joint Base Pearl Harbor-Hickam, Hawaii

August 2016

Department of the Navy
Naval Facilities Engineering Command Hawaii
400 Marshall Road
JBPHH HI 96860-3139

CLEAN IV CTO KB06
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Final

Operations and Maintenance Plan for Subsite ST32 Onizuka Village, Revision 1

Contract Number: N62473-09-D-2622
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August 2016

Prepared for

Naval Facilities Engineering Command, Hawaii
400 Marshall Road
JBPHH HI 96860-3139

Prepared by:

CH2M HILL Kleinfelder, A Joint Venture
1132 Bishop Street Suite 1100, Honolulu, Hawaii 96813
(808) 943-1133

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Acronyms and Abbreviations

%	percent
A	ampere
AC	alternating current
AGM	absorbed glass mat
AHA	Activity Hazard Analysis
APP	Accident Prevention Plan
ASTM	ASTM International
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CD	compact disc
cfm/ft	cubic feet per minute per foot
CLEAN	Comprehensive Long-term Environmental Action—Navy
CTO	Contract Task Order
DC	direct current
DON	U.S. Department of the Navy
EAL	environmental action level
FAT	factory acceptance test
GAC	granular activated carbon
HDD	horizontal directional drilling
HDOH	State of Hawaii Department of Health
HDPE	high-density polyethylene
Hg	mercury
HMI	human machine interface
hp	horsepower
JBPHH	Joint Base Pearl Harbor-Hickam
JRTF	(former) John Rodgers Tank Farm
KCH	CH2M HILL Kleinfelder, A Joint Venture
kW	kilowatt
kWh	kilowatt hour
LEL	lower explosive limit
LGAC	liquid-phase granular activated carbon
LOTO	Lock Out/Tag Out

NAVFAC	Naval Facilities Engineering Command
Navy	United States Department of the Navy
O&M	operation and maintenance
P&ID	process and instrumentation diagram
PAH	polycyclic aromatic hydrocarbon
PID	photoionization detector
PLC	programmable logic controller
PMP	pressure monitoring point
PV	photovoltaic
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
RAO	Remedial Action Objectives
SAP	Sampling and Analysis Plan
scfm	standard cubic feet per minute
scfm/ft	standard cubic feet per minute per foot
SOC	State of Charge
SSHP	Site Safety and Health Plan
SVE	soil vapor extraction
T&D	transport and disposal
TCLP	toxicity characteristic leaching procedure
TPH	total petroleum hydrocarbons
USEPA	U.S. Environmental Protection Agency
V	volt
VFD	variable frequency drive
VGAC	vapor-phase granular activated carbon
VI	vapor intrusion
VMP	vapor monitoring point
VOC	volatile organic compound
W	watt
W.C.	water column

1.0 Introduction

1.1 Introduction

This Operations and Maintenance (O&M) Plan describes the methods and procedures to be used while conducting activities associated with the operation, maintenance, sampling, and monitoring of the soil vapor extraction (SVE) system at Subsite ST32 Onizuka Village, located at Joint Base Pearl Harbor-Hickam (JBPHH), Hawaii (**Figure 1-1**). The SVE System includes the SVE Building, the horizontal SVE wells, and an adjacent photovoltaic (PV) array to support off-grid operation. The SVE Building includes the SVE processing unit and electrical components and controls.

This O&M Plan was prepared for the Naval Facilities Engineering Command (NAVFAC) Hawaii by CH2M HILL Kleinfelder, a Joint Venture (KCH) under the NAVFAC Southwest Comprehensive Long-term Environmental Action, Navy (CLEAN) IV Contract N62473-09-D-2622, Contract Task Order (CTO) KB06.

1.2 Purpose and Objectives

The O&M Plan is intended to function as a manual for staff performing operations, maintenance, sampling, and performance monitoring activities in support of the SVE system. Performance monitoring tasks include a review of the physical characteristics of the SVE system components, flow rate measurements, pressure measurements, off-gas monitoring and sampling to support changeout of granular activated carbon, condensate monitoring and sampling, and sampling of vapor monitoring points (VMPs) along the routes of the three SVE wells.

Soil gas sampling to monitor hot spot concentrations in and round the housing units will be conducted under a separate effort, and is therefore not addressed in this O&M Plan. The data collected from the VMPs will be used in conjunction with other performance data to evaluate the effectiveness of the SVE System relative to remedial action objectives (RAOs). The SVE system is expected to operate until soil vapor concentrations are reduced to below State of Hawaii Department of Health (HDOH) Environmental Action Levels (EALs) (HDOH, Fall 2011, revised January 2012) and a rebound study concludes that concentrations will not increase once system operation is discontinued. This O&M Plan will be amended throughout the life of the SVE system, as necessary, to describe additional work activities or for revisions to existing procedures that may be performed as part of O&M. This August 2016 version is issued as Revision 1.

The O&M Plan includes the following:

- A detailed description of the SVE system (including system layout, components, SVE Building features, and monitoring locations
- Information on the O&M of the various major pieces of equipment

- Supporting information for O&M and installation instructions for major pieces of equipment
- Sampling requirements
- Information on performance monitoring

O&M Plan attachments include the following:

- An appendix with specific O&M manuals for major SVE and off-grid equipment (these documents are also maintained in the SVE Building)
- As-built drawings
- Performance monitoring forms
- Granular activated carbon (GAC) changeout procedures
- O&M Activity Hazard Analysis (AHA) and other supporting information

Standalone related documentation that supports this O&M Plan includes the Accident Prevention Plan (APP) (DON, 2014c) and the Final Treatability Study Implementation Plan for Subsite ST32 Onizuka Village, Joint Base Pearl Harbor-Hickam, Hawaii (DON, 2014b). The Implementation Plan comprises a Quality Control Plan, Health and Safety and Waste Management Plan, Environmental Protection Plan, and information on the basis of design and technical specifications.

2.0 Soil Vapor Extraction System Description

2.1 Site Overview

Onizuka Village is a military family housing residential community containing 304 homes. The Onizuka Village residential community development was built from 2009 to 2011 on land leased from the United States Department of the Navy (Navy) to Hickam Communities, LLC. As a subsidiary under developer Lend Lease, Hickam Communities, LLC developed and constructed the community and is currently responsible for operations, maintenance, and property management.

From the mid-1940s to the late 1970s, the area currently occupied by Onizuka Village was used as an airfield with a runway, taxiways, and aircraft parking aprons. Historical petroleum releases from petroleum, oil, and lubricants (POL) systems, aircraft refueling activities, or both have resulted in high concentrations of total petroleum hydrocarbons (TPH) in soil vapor at 4 to 6 feet below ground surface (bgs), observed in localized hotspots. The source of the observed soil vapor contamination is likely related to historical fuel releases associated with the former site use as an aircraft parking and refueling area along the flightline. In 2014, the SVE system was constructed as part of a Treatability Study to treat vadose zone soil vapor in hotspot areas to reduce the potential for future vapor intrusion (VI) impacts within nearby residential homes.

2.2 Soil Vapor Extraction System Overview

2.2.1 Soil Vapor Extraction System Layout

The key elements of the SVE system are the SVE wells (installed using horizontal directional drilling), the PV array, and the equipment contained in the SVE Building. The location of the three SVE wells and associated monitoring points are provided in **Figure 2-1** and **Figure 2-2**, respectively. SVE-1 has 370 feet of screen, SVE-2, 200 feet, and SVE-3, 360 feet. The three SVE wells meet at the children's playground in individual vaults. From the three vaults, individual conveyance pipes are bundled together, run under Freedom Avenue, and are terminated at the SVE Building. The horizontal well layout and geologic cross section location map is shown on **Figure 2-3**, and the geologic cross section where each horizontal well is located is shown on **Figures 2-4** through **Figure 2-6**. All horizontal well manway access locations were placed underground and are accessible by vaults, as shown on **Figure 2-1.** The SVE building and PV array were installed adjacent to the western side of Freedom Avenue.

2.2.2 Equipment Building

The SVE building is a steel-frame pre-fabricated enclosure built by Speed Space and delivered to Tetrasolv, who had installed the SVE process and off-grid electrical system in the building before shipment to the site (refer to Section 2.4 for additional contact information). Installation of the SVE process and PV electrical and other related equipment were then performed, both under contract to the Onion Equipment Company. The building is 36 feet long by 12 feet wide by 9 feet tall, painted brownstone to match specific Base requirements (this color shall be used for any future maintenance). The building was delivered to the site and installed by crane on a slab-on-grade. The slab-on-grade is surrounded by a 10-foot-wide concrete housekeeping apron. The configuration of the slab and housekeeping pad are shown in the foundation as-built drawing in Appendix C. The equipment layout inside the building is included on **Figure 2-7,** sections in **Figure 2-8,** and the process and instrumentation diagram (P&ID) in **Figure 2-9**. A picture of the completed building is shown in Photo 1. The building specifications, including the structural design of the building, are shown in Appendix A-3. The building has two rooms. A smaller room encloses the system electrical and charging components (electrical room) and is accessible by a single man-door. The other, larger, room encloses the process treatment components and is accessible by either a single man-door or a double door located at the end of the building. Concrete landings are also present at the exterior of each doorway.

REQUIREMENT FOR INTRUSIVE WORK: Because of the potential presence of pesticide-impacted soils, training must be provided by Hickam Communities Environmental (coordinated through the Lendlease Assistant Environmental Manager) before any excavation, soil borings, or similar work along the SVE wells, well vaults, SVE Building and fenced area.

A 10-horsepower (hp) Kaeser blower package with sound-attenuating enclosure rated for 275 standard cubic feet per minute (scfm) and 7 inches mercury (Hg) at 3,200 revolutions per minute (10 hp), is used to extract soil vapor from the three SVE wells. The blower also provides the motive force for passing the vapor over the vapor-phase granular activated carbon (VGAC). Any condensation extracted by the blower is contained in the 120-gallon moisture knockout separator, with the collected water purged using a centrifugal pump with level controls and then treated using liquid-phase GAC (LGAC) before discharge to an infiltration gallery outside the building.

For control and monitoring purposes, valves and instrumentation are installed on the three-leg SVE manifold, including an averaging pitot tube flow indicator, vacuum gauges, manual valves, and motor-actuated diaphragm (throttling) valves. A 4-inch main discharge galvanized steel trunk line with a mass flowmeter and a stainless-steel stack are installed on the discharge side of the blower. The discharge stack extends 5 feet above the roof of the building, and ends in a silencer as visible in Photo 1.

Before the acceptance and delivery to Hawaii of the SVE Building with its internal SVE process and electrical components, an onsite Factory Acceptance Test (FAT) was conducted by the KCH project engineer at the Tetrasolv facility. The inspection covered the following elements: general items, preparation for transportation, GAC system, blower system, piping installation, panels and service entrance, and testing protocol. A checklist was developed for use in support of the FAT. Items that needed resolution were identified, the recommended action noted, and the individual items tracked to completion. The completed FAT checklist is presented in Appendix A-5.

Photo 1. SVE system building

2.2.3 Electrical Components

The SVE system is not connected to the JBPHH electrical grid (i.e., is off-grid) and is entirely powered by the PV array located adjacent to the building.

Power conductor wire from the PV array runs in buried polyvinyl chloride (PVC) conduit adjacent to the northeastern side of the building, and enters the building's electrical room through conduit penetrations at the northern corner of the building (Photo 2). Inside the electrical room, the PV conductor wires enter the building in a junction box mounted on the wall. From there, the PV wire carry direct current (DC) to a series of six Outback FM80 charge controllers (Photo 3). The charge controller's function is to manage variable output from the PV array and the batteries to provide a balanced load.

The SVE system building and the PV array are each grounded to two separate 5/8-inch-diameter by 10-foot-long grounding rods. One is installed at the PV array, with the other passing through the sidewalk at the northeastern corner of the SVE building (Photo 2).

Also inside the electrical room is an Outback EnergyCell 2000RE rack mount containing 24 absorbent glass mat (AGM) batteries with connecting straps between the individual cells (Photo 4). Each battery weighs approximately 270 pounds. The battery rack is mounted on a 3/8-inch steel plate anchored to the floor structure of the building.

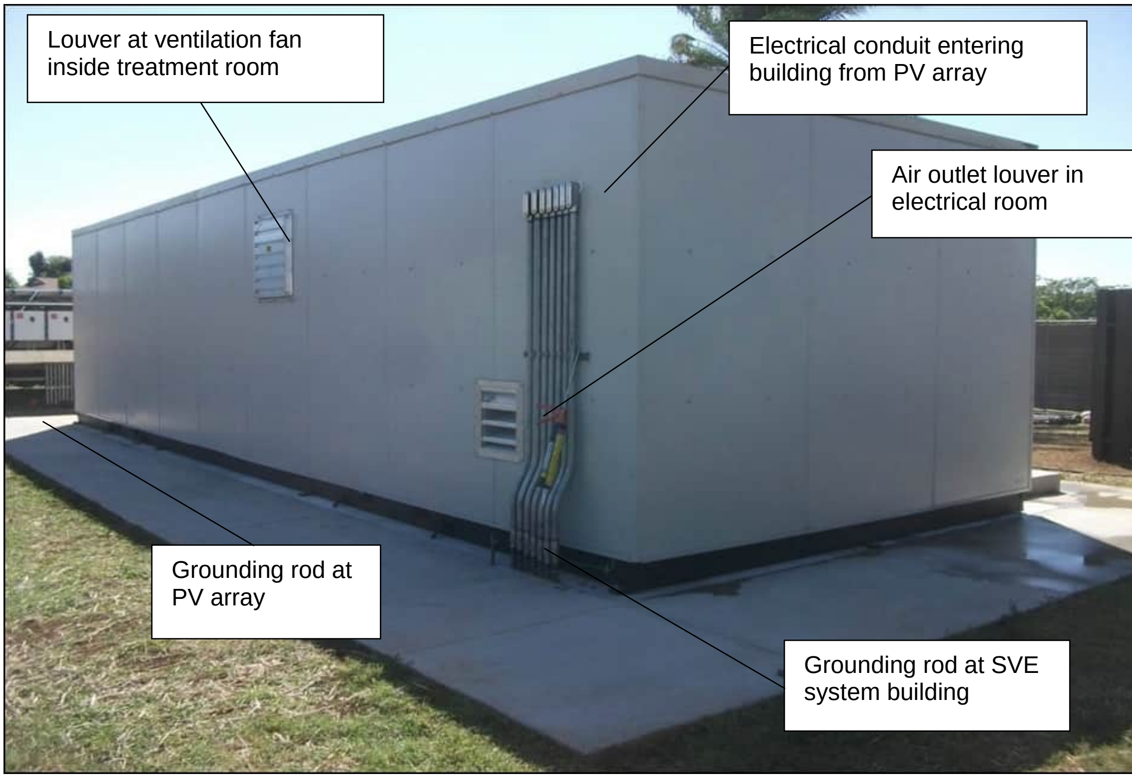

Photo 2. Electrical conduit entering SVE system building, and grounding rod locations

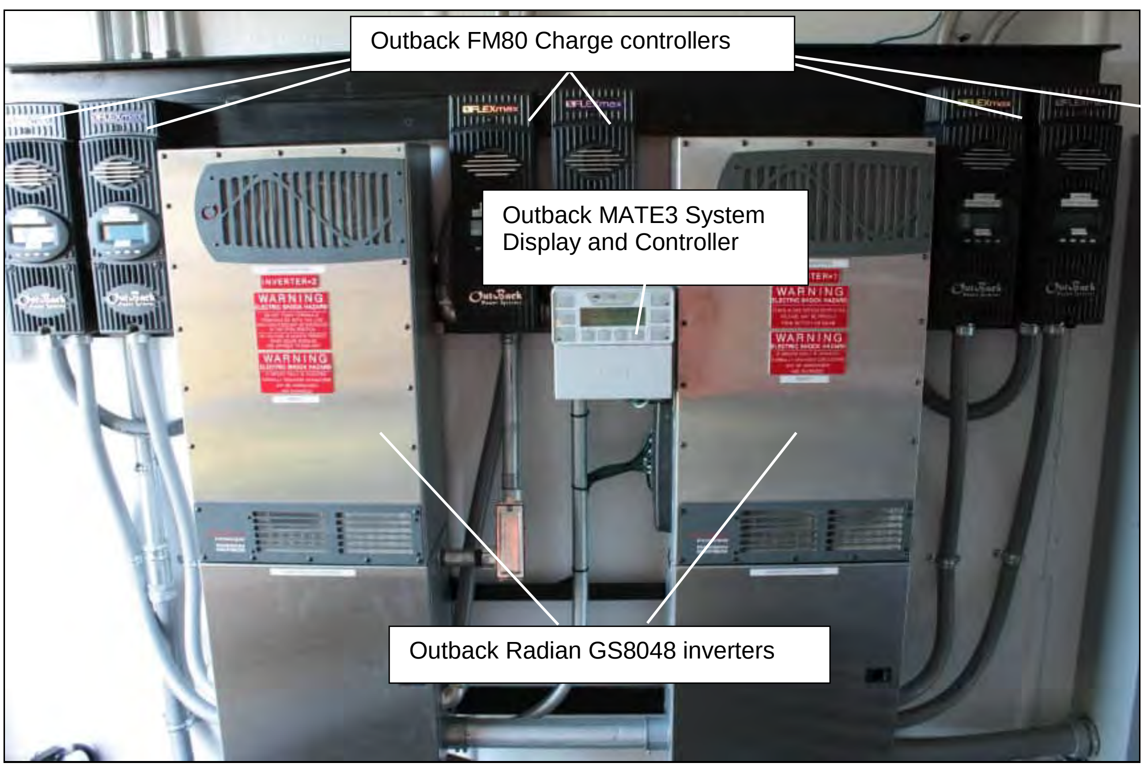

Photo 3. Charge controllers, Radian inverters, and MATE3 power system monitor

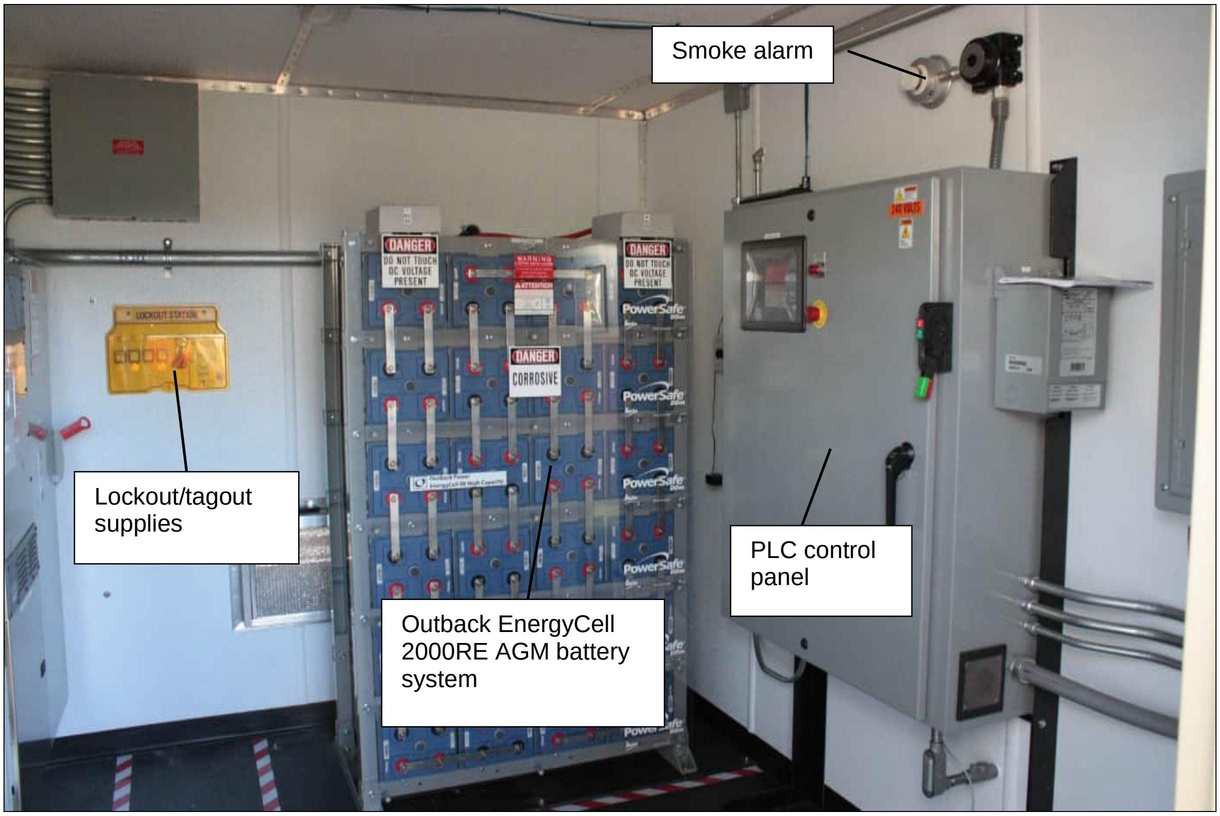

Photo 4. AGM battery system with plastic shields, PLC panel, smoke alarm, and lockout/tagout supplies

SAFETY TIP – the plastic safety shields covering the battery terminals must remain intact and in place at all times to prevent inadvertent contact with the battery terminals or the lead-plated copper inter-cell and inter-module connectors.

Two Outback Radian GS8048 inverters with load centers are mounted adjacent to the charge controllers (Photo 3) and work in a master/slave sequence. Because the PV array generates DC and most system components require alternating current (AC), the inverters convert DC to AC for the SVE process. The AC power goes to an AC breaker panel for ancillary loads. However, from the breaker panel, the AC power for the blower goes through a three-phase power converter. The charge controllers seek out the maximum power available from the PV array and use it to recharge the batteries, allowing the PV array to operate at an ideal voltage. The charge controllers use Maximum Power Point Tracking (refer to the Owner's Manual in Appendix E for additional details).

An Outback MATE3 System Display and Controller is mounted to the side of the master inverter and functions to monitor and control the Outback power charging and storage system (Photo 3). The plastic cover below the display screen is magnetically held onto the MATE3 and can be easily removed to reveal several function buttons. A code is required to access the MATE3.

A programmable logic controller (PLC) panel located in the electrical room contains a human machine interface (HMI) color touch screen that is the primary control panel for monitoring and controlling the SVE system (Photo 5). The touchscreen control panel is also controllable using a smartphone with a data connection. The "VNC Viewer" application is downloadable for free from the android or iOS app store. Once downloaded, the app will prompt you for a password. Once setup is complete, the operator will be able to view the same HMI touchscreen display as on the PLC panel at the site. System operation through the VNC Viewer is real-time, and programmable controls can be adjusted using the smartphone as a touchscreen.

The Kaeser blower is located inside the process room and is the source of vacuum for the SVE system (Photo 6). The blower requires routine maintenance, including air filter and oil changes. The maintenance schedule and instructions are provided inside the blower manual located in Appendix E.

OPERATIONAL TIP: This blower needs to be run with the correct amount and type of oil and be properly filtered, or major damage may result. Refer to Owner's Manual (located in Appendix E) and Table 3-4.

Additional electrical components of the SVE system include the following:

- DC disconnect that houses a switch for Lock Out/Tag Out (LOTO) (Photo 7).
- A GENTEC rotary phase converter that produces three-phase power for the blower (Photo 8).
- Two thermostat-controlled exhaust fans; one in the electrical room near the man door and one in the process room behind the VGAC vessels (Photos 8 and 9, respectively).
- Two Pyrotector Model 30-3003 explosion-proof smoke detectors installed in the SVE system; one in the electrical room and one in the process room (Photos 4 and 10, respectively). The smoke detectors are wired in parallel to the PLC, so if either one is activated, all power will be deactivate.
- One RKI Instruments explosive atmosphere detector mounted to the wall of the process room above the floor (Photo 10). The explosive atmosphere detector is pre-wired to deactivate all power in the event of an interior atmosphere that exceeds 25 percent of the lower explosive limit (LEL).
- In the SVE Building, lighting mounted to the ceiling with a standard light switch inside the entry door for both rooms. The process room has explosion-proof lighting mounted to the ceiling with a light switch inside the single man-door. In addition, the exterior of electrical room door is equipped with a solar-powered, motion sensitive exterior light.
- A main AC breaker panel is located inside the electrical room for the lights, flow transmitter, transfer pump, control panel, SVE blower, and exhaust fans (Photo 8).

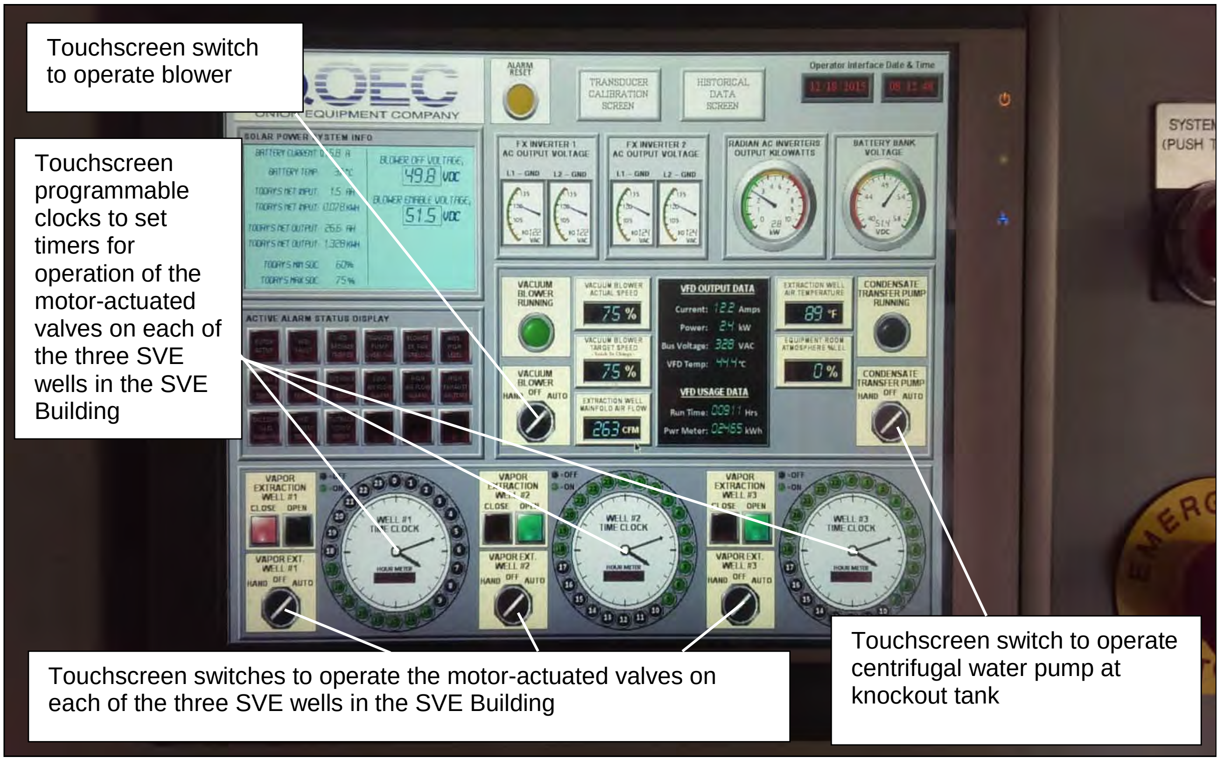

Photo 5. HMI control touchscreen

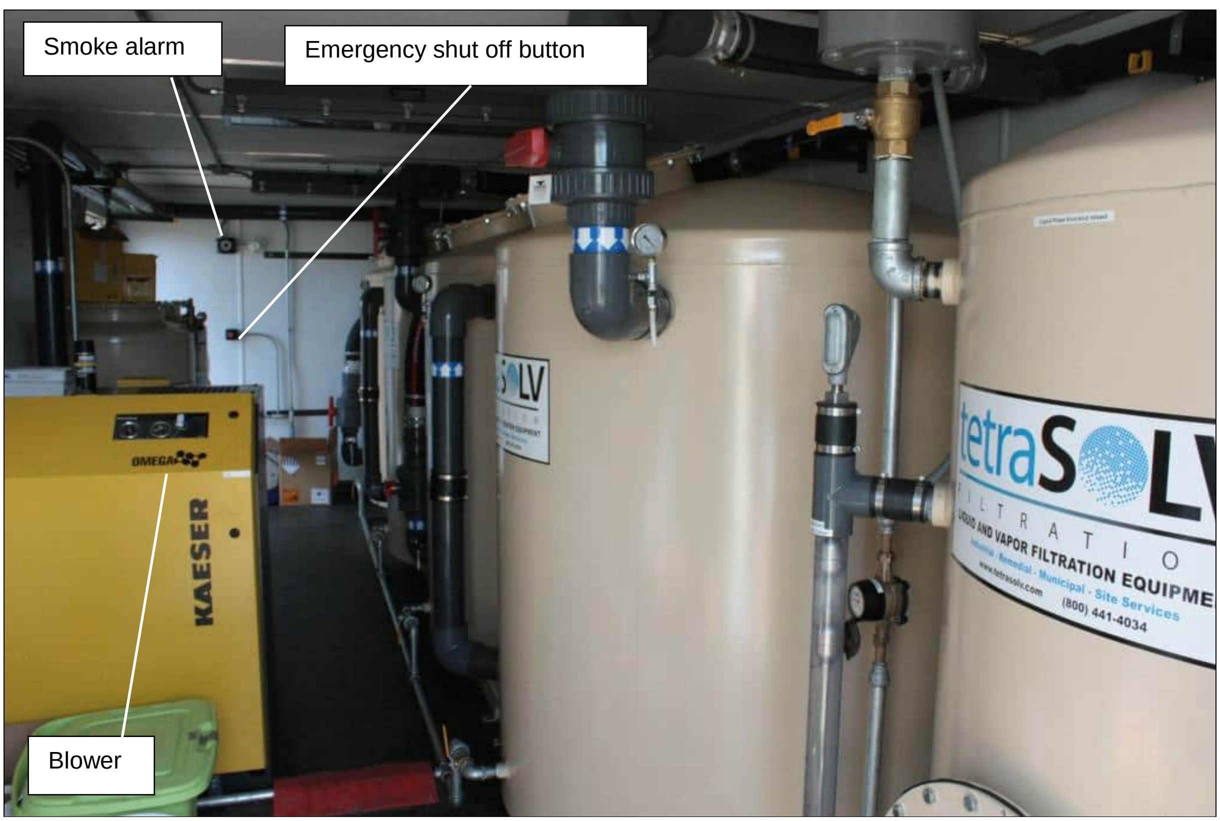

Photo 6. Inside of the treatment room

Photo 7. DC disconnect cabinet inside electrical room

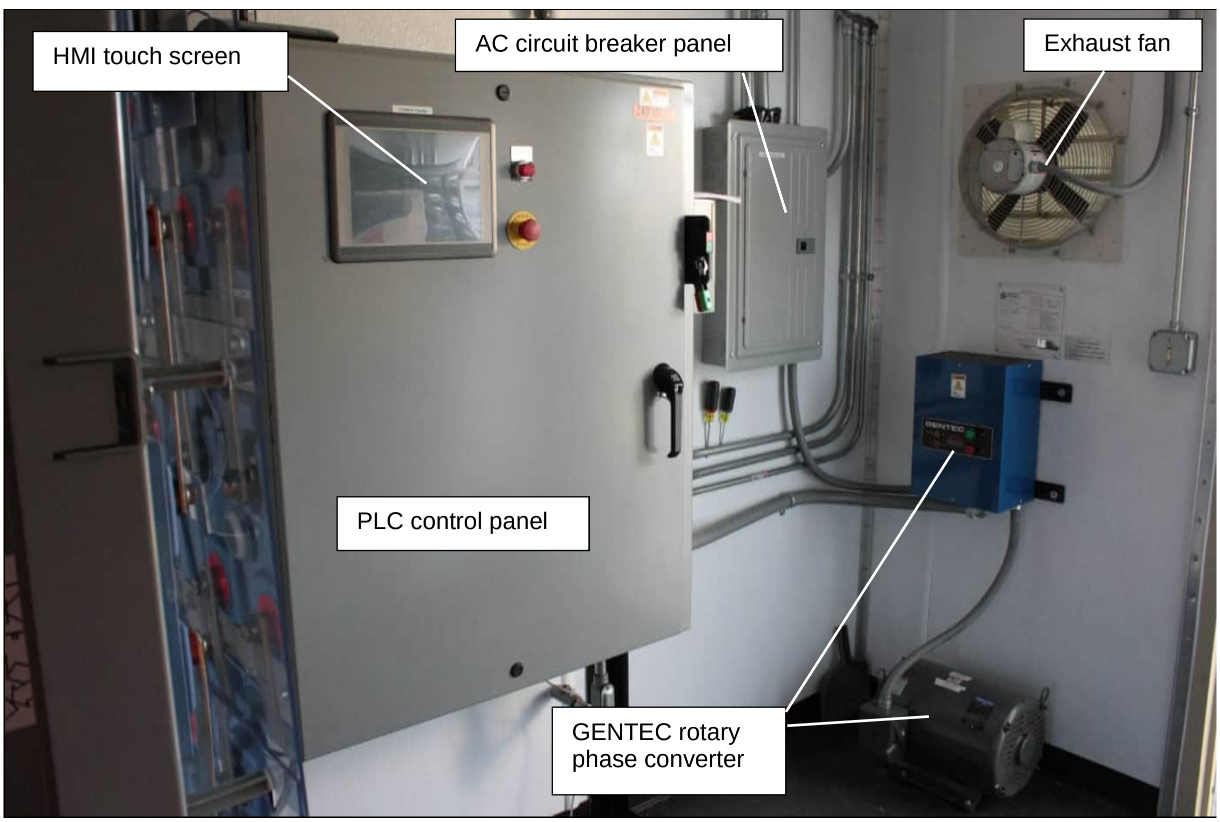

Photo 8. View of a portion of the inside of the electrical room

Photo 9. Location of exhaust fan in treatment room

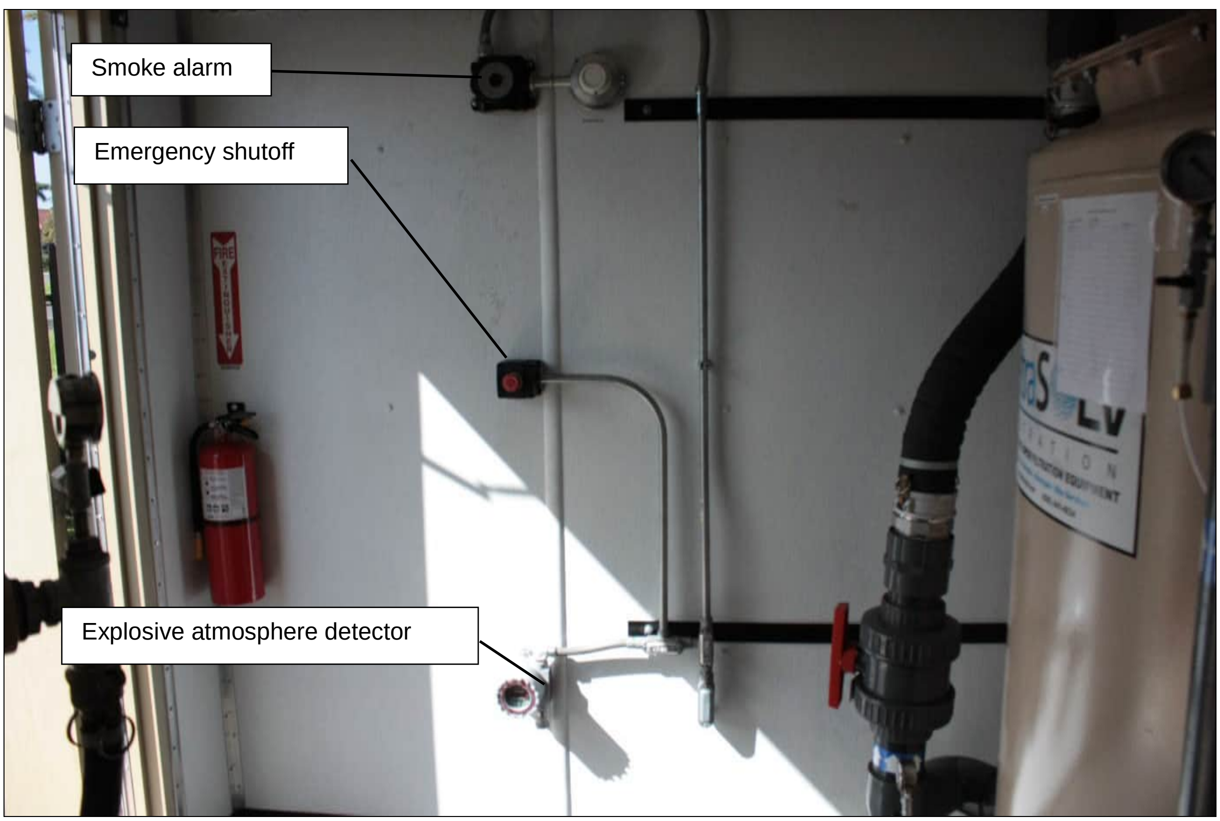

Photo 10. Explosive atmosphere detector

2.2.4 Off-grid Photovoltaic System

A total of 72 Suniva Monocrystalline ground-mounted PV panels (each 260 watts [W]) were installed to provide power to the SVE blower and auxiliary power requirements (Photo 11). These panels are mounted 3 to 5 feet above the ground and are secured on galvanized tubular steel supports and galvanized steel posts set in concrete.

Photo 11. 72-panel PV array

The PV system has been conservatively sized to support the blower and other loads. The SVE blower motor is rated for 11.3 kilowatts (kW) (at 460 V) including de-rate and efficiency factors, plus a 1.5 overpower factor for morning and afternoon operation. The PV array has been designed to supply 15.9 kW, or 40 percent surplus power. Surplus power is accumulated in the Outback EnergyCell 2000RE rack-mount AGM battery system.

The 72 PV panels are wired in six strings of 12 panels each. The PV conductors for each string of panels are bundled and routed into one of six SolarBos DC combiner boxes (Photo 11) mounted onto the PV array support posts. Each combiner box has a DC disconnect on the front panel.

Programmable voltage settings are used for the SVE system to automatically turn on in the morning and off in the evenings. Once the sun rises in the morning and allows the PV array to generate power that increases the battery bank voltage enough to cross a minimum voltage threshold, the blower will automatically turn on and begin operating. Likewise, after sunset, the battery bank voltage will drop. When it crosses a programmable shut-off threshold, the blower will automatically turn off overnight. Both the voltage thresholds can be manually adjusted, but should not require adjustment under normal operating conditions. However, if changes to these thresholds is required (for example, after sunset run time because of seasonal conditions, degradation in system performance, or similar) this should be done in concert with Coconut Coast Electric, Outback, or both (see contact information in Table 2-1 of [Section 2.4]).

2.2.5 Horizontal Soil Vapor Extraction Wells

Horizontal Directional Drilling (HDD) was used to drill boreholes in which the three SVE wells and the conveyance pipes were installed. The boreholes for the SVE wells were approximately 6.5 inches in diameter and of various lengths. The target depths for the SVE wells was approximately 6 to 7 feet bgs, with the intent of keeping the horizontal borehole at least 5 feet bgs and 2 feet above the water table. The SVE wells are constructed of fiberglass-reinforced epoxy riser pipe and screen. The following SVE well locations are shown in **Figure 2-1**:

- SVE-1 is a 4-inch-diameter well with 170 feet of riser and 370 feet of well screen. Because of the presence of five pre-existing, 30-inch-diameter storm drains running in parallel in between residences at 507 Koaaina Alley and 606 Kulekia Alley, there is a 40-foot-long section of high-density polyethylene (HDPE) cross-over pipe that connects the well screen on either side of the storm drain corridor. The cross-over pipe comes up and over the storm drains and is approximately 3.5 feet bgs at its shallowest depth. The depth of the SVE 1 well screen is approximately 6.5 feet bgs.
- SVE-2 is a 3-inch-diameter well with 170 feet of riser and 200 feet of well screen. The distant end of the well terminates underneath the residence at 433 Opulepule Alley. The depth of the SVE 2 well screen is approximately 7 feet bgs.
- SVE-3 is a 3-inch-diameter well with 160 feet of riser and 360 feet of well screen. The depth of the SVE 3 well screen is approximately 7 feet bgs.

The three SVE wells align to a common area near the children's playground off the northwestern corner of Kumama Alley inside Onizuka Village (Photo 12. At this location, each SVE well enters a dedicated steel-frame, flush-mount vault with a spring-assist cover (Photo 13). The termination of each well inside its vault includes an HDPE "Y" or "T" with the straight end terminating inside each vault with a female-threaded cleanout cap. The cleanout caps can be removed in the event that well maintenance is needed. The elbow portion of each SVE well connects to an HDPE ball valve, and then to HDPE conveyance pipe inside each vault. The ball valves contain a 2-inch-square operating nut and can be opened or closed using the dedicated wrench for these valves. The 2-inch operating nut wrench is generally stored inside one of the vaults.

OPERATIONAL TIP – If maintenance (such as flushing or redevelopment) is to be performed on any of the SVE wells, the ball valve to that well should be in the closed position to prevent any liquids, slurries, or solids from entering the conveyance pipe.

Photo 12. Location of SVE well vaults inside Onizuka Village

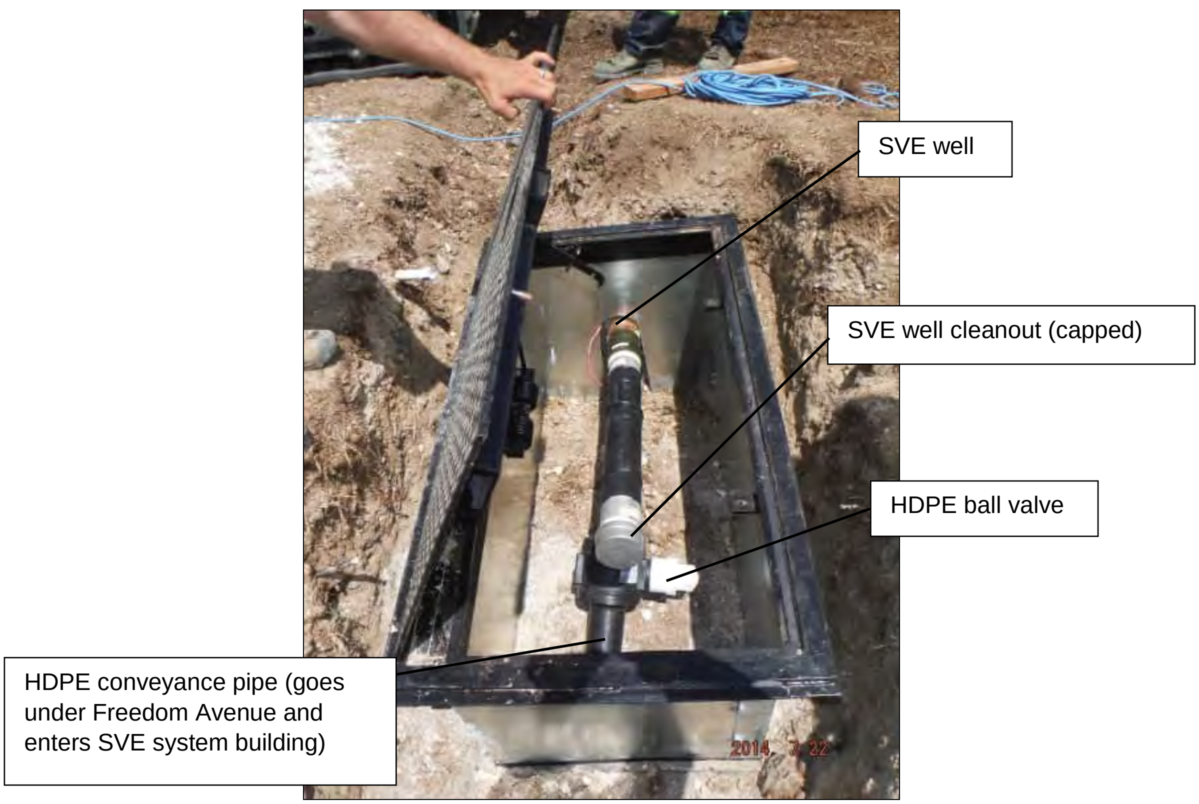

Photo 13. View inside a SVE well vault during installation

From the SVE well vaults inside Onizuka Village, the three conveyance pipes run in a single bundle through a 10-inch-diameter bore, underneath Freedom Avenue, and enter the SVE Building through a cutout in the floor. The maximum depth of the conveyance pipe underneath Freedom Avenue is approximately 12 feet bgs.

2.2.6 Remediation Components

At the entry point of the SVE well conveyance pipes inside the building, each SVE well includes a dedicated throttle valve (G.I.E. cast iron, unlined diaphragm valve), a vacuum gauge (4-inch stainless-steel case, glycerin filled, 0 to 15 inches Hg), and a flow indicator (Dwyer DS-300-3-inch Series averaging pitot tubes with Capsuhelic differential pressure gauges). Each leg is remotely controlled (open/closed) from the PLC by a dedicated Series 92 valve actuator (Photo 14).

Upon entering the SVE Building, vapor is routed across a knockout tank to separate and contain any liquid that may be entrained in the air flow (Photo 15). Once liquid is separated, vapor extracted by the SVE system is discharged to dual treatment trains of VGAC. Each of the two trains contains two 2,000-pound vessels of VGAC (or 4,000 pounds per train) for a total of 8,000 pounds for both trains (Photo 16). One train of two beds in lead-lag configuration is used until the first bed is saturated, after which time one or more beds from the second (back-up) treatment train are connected, using flexible hose. Sample ports are installed at the pre-treatment, intermediate-treatment, and post-treatment points in the process stream for each treatment train to facilitate breakthrough monitoring. Treated vapor effluent is routed through a single exhaust pipe with a silencer, positioned approximately 5 feet above the building roof or approximately 15 feet above ground (Photo 17).

Accumulated liquid inside the knockout tank is drained via a Goulds NPE centrifugal liquid pump through a pair of vessels (in series) containing LGAC to treat the liquid (Photo 18). The knockout tank has a float level set so that when a liquid volume threshold is reached, the centrifugal pump will automatically activate and pump the liquid out of the knockout tank and into the LGAC treatment vessels. Immediately downstream of the water pump, an in-line liquid flow meter (Omega Engineering turbine flow meter model number FTB793) is installed in the water line to quantify the accumulated volume of water pumped from the knockout tank (Photo 15). After treatment, liquid is gravity drained from the LGAC vessels to an infiltration gallery located on the northwestern side of the SVE Building (Photo 19). The infiltration gallery consists of 20 feet of 6-inch-diameter perforated Schedule 40 PVC drain tile, installed in a gravel trench (similar to a French drain system) approximately 5 feet bgs and backfilled with crushed gravel.

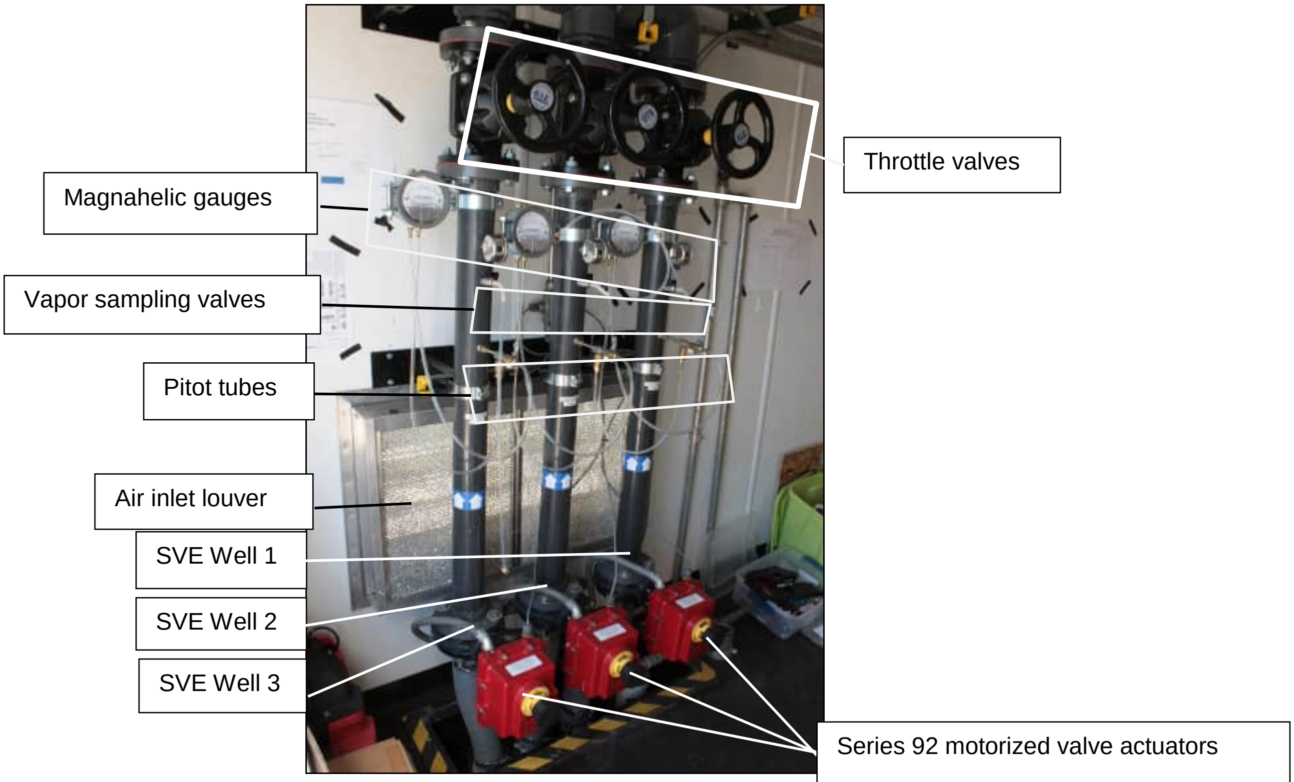

Photo 14. SVE well manifold at entry point inside SVE system building

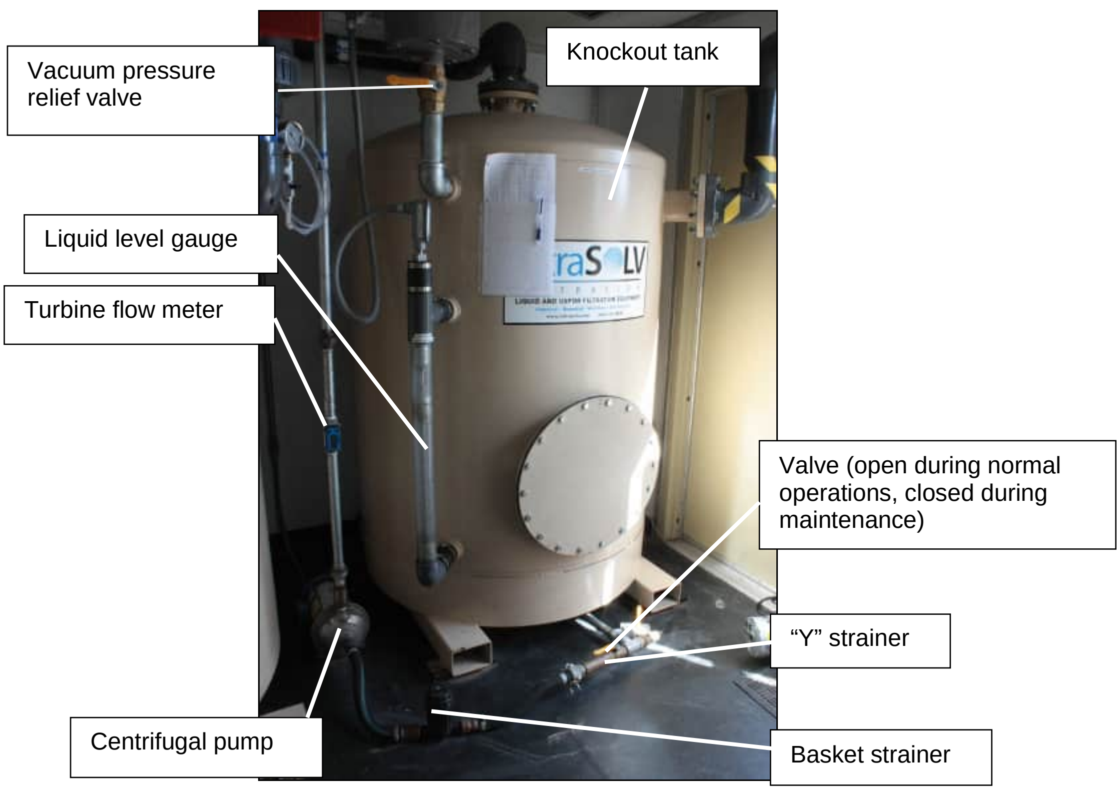

Photo 15. Liquid separation and discharge system

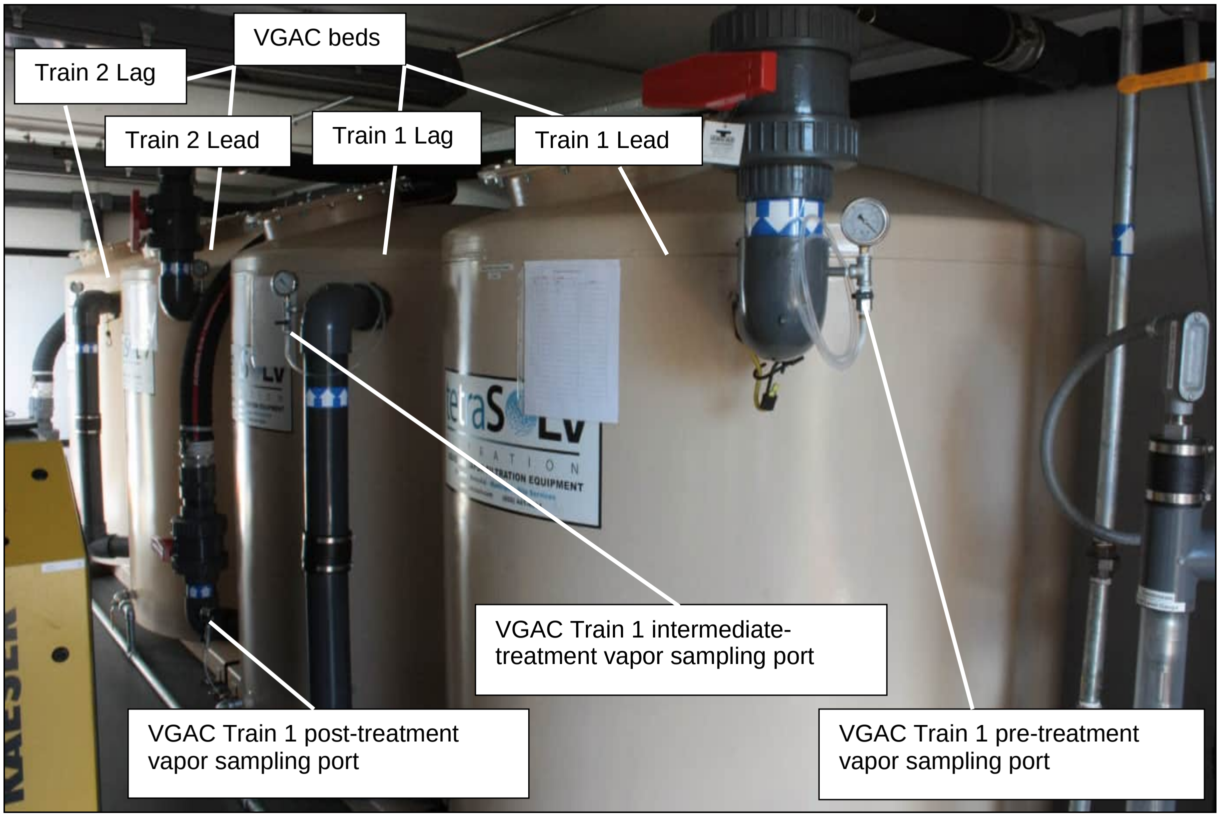

Photo 16. VGAC beds and vapor sampling ports

Photo 17. Exhaust stack on exterior of SVE system building with silencer

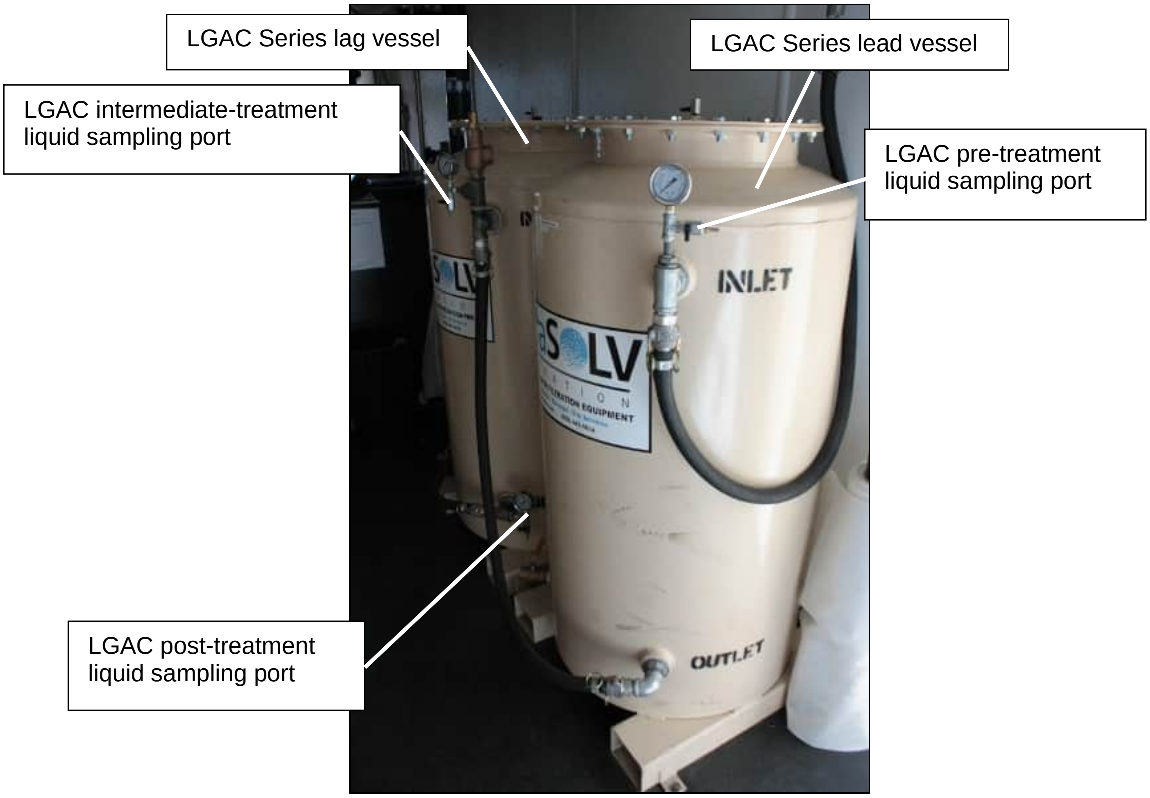

Photo 18. LGAC beds and liquid sampling ports

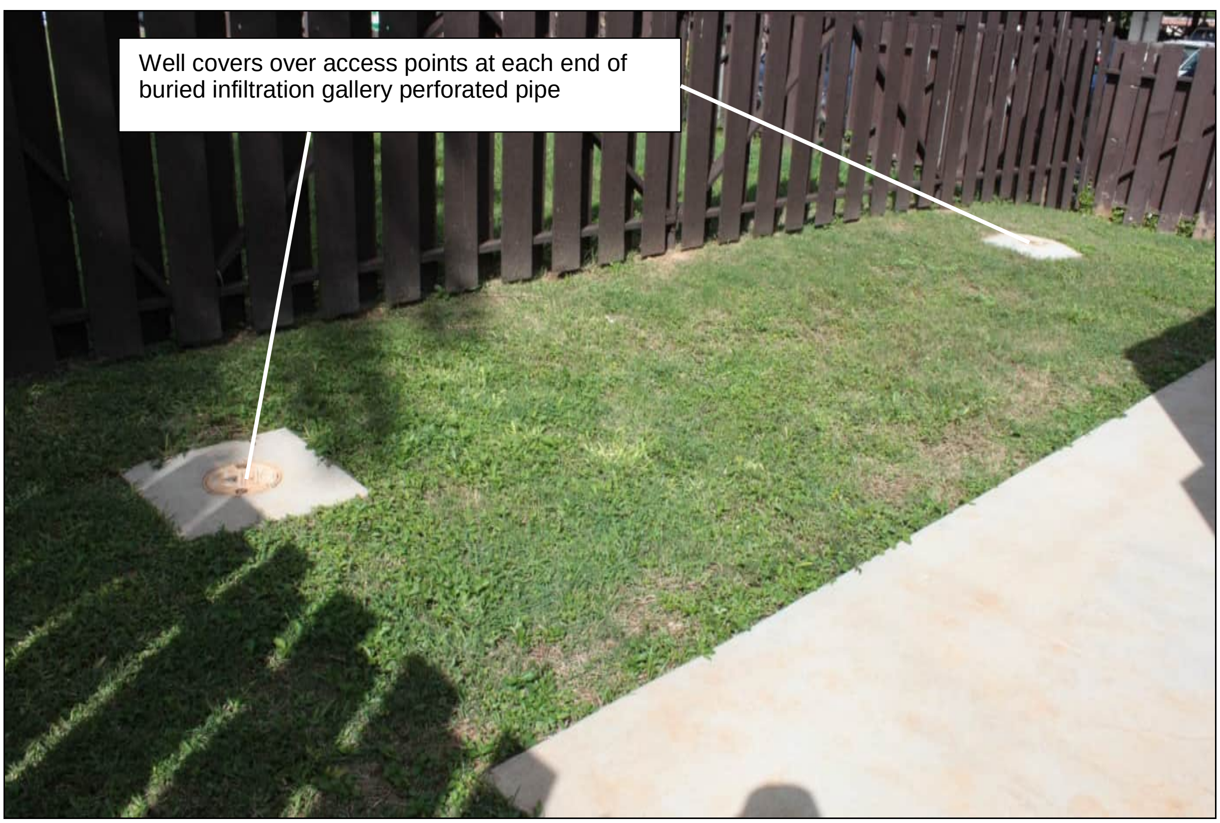

Photo 19. Infiltration gallery access points at the two well covers

2.3 Monitoring Locations

2.3.1 Vapor Monitoring Points and Pressure Monitoring Points

VMPs and pressure monitoring points (PMPs) are installed inside Onizuka Village to allow for monitoring of the SVE system performance. VMPs were constructed for soil vapor sampling. PMPs were constructed for the purpose of attaching a digital manometer to measure for the presence and magnitude of a negative pressure (vacuum) in soil. While the VMPs and PMPs were initially intended to be used for different monitoring purposes, they are actually constructed the same way using the same materials. Thirteen VMPs/PMPs are currently installed in proximity to SVE-1. Three VMPs/PMPs are currently installed in proximity to SVE-2. Six VMPs/PMPs are currently installed in proximity to SVE-3. The 22 VMP/PMP locations in relation to the SVE wells are shown in **Figure 2-1.** Boring logs for the VMP/PMP locations are presented on the compact disc (CD) in Appendix E.

VMPs and PMPs were constructed by installing a 6-inch-long screen implant in the middle of a 1.5-foot-thick interval of #3 Monterey sand in an open borehole. The screen implants are connected to sample tubing (3/16-inch inner diameter by ¼-inch outer diameter) with a barbed connection. Hydrated granular bentonite placed on top of the sand seals the screen implant and sanded interval from short circuiting to ambient air. The effective permeable zone for monitoring is the entire sanded interval. In general, the sanded interval of the VMPs and PMPs installed in Onizuka Village are approximately 1.5 foot thick and extend from approximately 4.5 to 6 feet bgs. Exceptions to this profile of sanded interval include the following:

- VMP3-06A is sanded from 3.5 to 6 feet bgs with screen implant from 4 to 4.5 feet bgs.
- SVE3-PMP01 is sanded from 3 to 5 feet bgs with screen implant from 3.25 to 3.75 feet bgs.
- SVE1-PMP08 is sanded from 6.5 to 8 feet bgs with screen implant from 7 to 7.5 feet bgs.

The VMPs and PMPs are completed at the ground surface with flush-mount traffic-rated well covers set in place with a small concrete pad.

Seven four-plex residential buildings (28 individual residences) located near the areas where TPH hotspots in soil gas were previously found also have sub-slab sampling ports in their garages. However, these ports are generally used for soil vapor sampling and not for SVE system O&M.

2.3.2 Groundwater Wells

At the onset of operation, the SVE-1 well was found to have a propensity for producing groundwater into the SVE well and into the SVE system knockout tank, especially following periods of prolonged heavy rains. In an effort to assess the nature of groundwater intrusion into well SVE-1, five temporary microwells were installed along portions of SVE-1 to allow for gauging the depth to groundwater with the SVE system powered on. The five temporary wells are identified as TW05 through TW09 in **Figure 2-1**. Boring logs for these wells are presented on the CD in Appendix E. These wells can be used to monitor the potential for groundwater updraw caused by vacuum in well SVE-1.

2.4 Listing of Supporting Firms and Personnel

Table 2-1 lists the firms and personnel involved in system installation.

TABLE 2-1
Listing of Firms and Personnel involved in System Installation

Supporting Firms/Contacts	Role	Contact Number
Applied Science Laboratory (Kathy McKinley)	Analytical Lab for vapor and condensate samples	541.768.3144
Lendlease Corporation (Grant Arnold)	Assistant Environmental Manager (Environmental point of contact for Hickam Communities; responsible for coordinating environmental issues, including pesticide-impacted soil awareness training, for work within Onizuka village)	808.343.2134
Coconut Coast Electric (Gary Seals)	Electrical Modifications	808.651.7732
PCS (Jingbo Chang)	Investigation Derived Waste and GAC management and vacuum truck services	808.545.4599
Outback Power(Mark Mays)	Off-grid Design Engineer	425.232.1649
Kyle Combs	PLC Programmer (coordinate through Coconut Coast Electric)	765.748.1919
Speed Space	Fabricator of the building	800.418.2666
Tetrasolv (Doug Dallmer)	Installer of SVE Building Internals and oversaw onsite installation	713.703.6516
Ohana Nui (Michelle Aguinaldo)	Grounds maintenance inside fenced area of SVE Building	808.422.8383

3.0 Operation and Maintenance

3.1 Equipment Maintenance

This section discusses major pieces of equipment including the blower, PV array, AGM batteries, liquid separation discharge system, GAC changeout, and exterior building maintenance. Monthly maintenance checklists for these items are provided in Appendix A-6 and Appendix B-6. Detailed information regarding installation and O&M for all equipment is discussed in Section 3.2 for both the SVE system (Section 3.2.1) and off-grid components (Section 3.2.2). The following details additional information relative to O&M provided in Appendixes A and B.

Soil Vapor Extraction System

- Appendix A-1, O&M Manual (Onion Equipment Company)
- Appendix A-2, Building Layout, P&ID, and Electrical Schematics
- Appendix A-3, Fabrication and Installation Drawings
- Appendix A-4, GAC Changeout Procedure
- Appendix A-5, Factory Acceptance Testing Checklist
- Appendix A-6, Checklist for Monthly Inspection for SVE Process, Wells, and Ancillary Equipment [Note that the inspection frequency in the checklist may be increased if operational issues manifest or troubleshooting is required.]

Off-grid System

- Appendix B-1, O&M Manual for Off-grid System
- Appendix B-2, Electrical Drawings (PV and Control Room)
- Appendix B-3, Re-start Inverter/Load Center Rewiring One-line Diagram
- Appendix B-4, Inspection Form and Warranty
- Appendix B-5, Emergency Shutdown Procedure
- Appendix B-6, Checklist for AGM Quarterly Battery Inspection

3.1.1 Blower

The KAESER DB 166 C blower requires routine maintenance. Refer to the KAESER Assembly and Operating Manual (Appendix E) for maintenance instructions and associated safety precautions (a copy of the manual will be kept in the SVE Building).

SAFETY NOTE: It is important to switch off and lock out the power supply to the blower, and to verify the absence of voltage before working on live components, the vacuum system, or the drive system. Also, touching the fan wheel or the belt drive while the machine is running can result in serious injury.

Tables 3-1 and 3-2 summarize the maintenance schedule in the KAESER Assembly and Operating Manual. A maintenance log is kept with the blower to keep track of all maintenance activities performed. Tables 3-3 and 3-4 present recommended blower spare parts and the type of blower lubricant, respectively.

TABLE 3-1
Regular Blower Maintenance Tasks

Interval	Maintenance Task	See Chapter in Operating Manual for Task Instructions
24 hours after initial commissioning	Check belt tension	10.4
50 hours after initial commissioning	Check all screwed electrical connections and tighten if necessary	--
500 hours after initial commissioning	Change the lubricating oil	10.7
Up to 500 hours Or monthly	Check the oil level	10.5
	Check belt tension	10.4
	Check the air filter	10.8
Up to 2,000 hours At least annually	Drive motor bearings with re-greasing facility: Regrease the motor bearings	10.9.1
Up to 3,000 hours* At least annually	Change the SF220 lubricating oil (An adhesive label identifying the used lubricant is attached to the blower block)	10.7
Up to 3,000 hours At least annually	Change the air filter	10.8
Up to 6,000 hours* At least annually	Change the SF220 lubricating oil (An adhesive label identifying the used lubricant is attached to the blower block)	10.7
Annually	Check the safety relief valve	10.10
	Check all screwed electrical connection and tighten if necessary	--
Up to 12,000 hours At the latest every 3 years	Replace the drive belt	10.4
As needed	Check rotors for contamination	10.4

Notes:

hours = operating hours

*The intervals for lubricating oil changes at high thermal stresses much be reduced and can be determined upon analyses of the oil.

TABLE 3-2
Regular Blower Service Tasks – only an authorized KAESER service representative should carry out service work

Interval	Service Task
Up to 12,000 hours At the latest every 3 years.	Permanently greased drive motor bearings: Have motor bearings checked
Up to 12,000 hours At the latest every 3 years.	Fan motor (sound enclosure): Have motor bearings checked
Every 20,000 hours or At the latest every 5 years	Drive motor bearings with regreasing fittings: Have motor bearings checked

TABLE 3-3
Recommended Blower Spare Parts

Name	Quantity	Number
Air Filter	1	1250
Sealing Ring	1	1252
Drive Belts (set)	1	1800

TABLE 3-4
Blower Lubricating Oils

Name	Quantity (quarts)	Material Number
OMEGA FLUID SB-220	1	831057.00010
	5	831057.0
OMEGA FLUID FGB-220	1	892702.00020
	5	892702.00010

3.1.2 Photovoltaic Array

The PV Array should be inspected monthly for the following items:

- Check PV racking and associated bonding hardware for corrosion, damage, or deformation (repair or replace if observed).
- Check visible portions of PV conductors to look for compromises in the wire insulation (such as nicks or cuts). Note: do not touch any exposed portion of wire.
- Inspect the top side of the PV panels to look for cracks, excessive debris, and similar.
- Inspect the bottom side off the PV panels to look for cracks or significant scratches in the white backing of the panels.

The top of the PV panels should be cleaned quarterly for efficient solar power generation. When cleaning the panels, use a gentle stream of water and mild soaps such as automotive detergents. If there are any questions on the selection of soaps, contact the PV supplier. Panels should be cleaned in the early morning or late afternoon when it is cooler and there is no direct sun, as **applying cold water to the surface of hot panels may crack the glass of the panels and must be avoided**. A soft brush or sponge on a long extension pole can be used to access the panels. Do not use abrasive scrubbers or aggressive chemicals to clean the panels. **Do not use any soaps that contain bleach**. The following is a general sequence for cleaning the surface of the PV array:

- Wet the panels and rinse off any loose debris that has accumulated. Avoid contacting the PV panels with the hose and nozzle or any metal parts of the cleaning instruments used.
- Mix the soap solution per the manufactures or PV vendor recommendations in a clean bucket or pail.
- Re-wet the section of panel to be cleaned.
- Clean the panel with a soft sponge or brush, moving from high to low.
- Rinse the section that was cleaned.
- Repeat sequence for the remaining sections of the PV array.
- After the PV array is cleaned, rinse the entire surface again.
- Please note the following:
  - If the water being used to clean the array becomes dirty or contains grit or loose debris (that could scratch the array) prepare a clean bucket of solution.
  - Do not use any bleach containing soap.

The nearest source of potable water is at the gas station, 250 feet from the PV array. This area can be reached with a series of 5/8- or 3/4-inch inside diameter hoses (the larger diameter hose is preferred to maintain adequate water pressure). Wet the array before cleaning and rinse the panels moving from high to low.

3.1.3 Absorbed Glass Mat Battery System

A licensed electrician experienced with the specific equipment and battery system used will conduct quarterly electrical inspections of the off-grid PV system. The inspections will focus on the battery rack and the balance of the electrical system as defined herein. An example checklist for documenting the required information during the inspection is provided in Appendix B-6.

Following the inspection and before the conduct of subsequent inspections, the past inspection checklist and any ongoing observations (if any), should be noted and the example checklist revised as appropriate. Each inspection will be concluded with a brief summary including the completed checklist, data sheets, pictures, and other supporting information. The inspections are currently contracted to be conducted by Coconut Coast Electric (see Section 2.4 for contact information).

The procedure for conducting the inspection and testing of the AGM batteries is a requirement for maintaining the battery warranty, as stated in Section 11.3, Maintenance Records, of the 2008 EnerSys document *PowerSafe Safety, Storage, Operating and Maintenance Manual for VRL Battery Systems mSeries, DDm, DDS, DDV, and SC* (provided on the Appendix E CD). The minimum inspection frequency required to maintain the warranty is quarterly. Additional inspections may be necessary if there is excessive depth of discharge, if corrosion or leaks are observed on the batteries or interconnection strapping, and if there are problems starting or shutting down or degradation in run time. The following sections of the EnerSys document provide further information regarding the AGM battery inspection:

- Section 11.1, Battery Cleaning (pages 22 and 23): Clean batteries as specified in the procedure if there is evidence of dust accumulation or mild corrosion. Because the system is new, heavy post corrosion is not anticipated.
- Section 11.3, Update Maintenance Records (page 26): Use current RE-2000 install sheet (page 28) as a comparative baseline to track the following:
  - Individual cell voltages
  - Cell to cell connection resistance (ohms)
  - Terminal connection resistance (ohms)
  - Equipment room ambient temperature
- Battery Capacity Test, as described in Section 11.2.1: Should only be performed if the “State of Charge” (SOC) shown on the MATE3 drops below 40 percent on a daily basis.

Additional areas for inspection are included on the checklist in Appendix B-6.

3.1.4 Liquid Separation and Discharge System

Inspection of the liquid separation and discharge system should be conducted monthly, with maintenance performed as needed. During normal system operations, the valve handle at the base of the knockout tank in between the tank outlet and the centrifugal liquid pump needs to remain open so that liquid collected in the knockout tank can drain through the pump, into the LGAC vessels, and out to the infiltration gallery. If any maintenance of the liquid discharge system is needed, this valve will need to be closed first.

MAINTENANCE NOTE: The “Y” strainer and basket strainer in-line between the knockout tank and centrifugal pump should be inspected and cleaned monthly to prevent clogging of the line. These strainers can be cleaned by simply disassembling them, flushing with clean water, and reassembling.

The centrifugal pump and the Omega Engineering turbine flow meter should be verified to be working properly. Consult the equipment manuals (on the CD in Appendix E) if maintenance is needed. For the pump to turn on automatically, the liquid level gauge on the outside of the knockout tank needs to remain clean. Particulates entrained in the water inside the liquid level gauge clear tube may settle and cause a coating to build up. Monthly inspections should verify that the components inside the liquid level gauge are clean enough to allow the floating mechanism to freely float and sink with the water level. If needed, the components inside the float tube and the inside walls of the clear tube can be cleaned by first draining the water in the knockout tank to a level at least below the bottom of the gauge. The gauge can then be disassembled and cleaned before being reassembled.

After treatment in the LGAC vessels, liquid effluent is drained by gravity from the LGAC vessels to the infiltration gallery. The two 8-inch-diameter well covers from the northern end of the building should be inspection monthly by opening the covers and inspecting the visible portions of the infiltration gallery piping to ensure water is properly infiltrating into the ground and not pooling.

3.1.5 Granular Activated Carbon Changeout

The SVE process has two VGAC trains and one LGAC train. Each VGAC train includes two 2,000-pound vessels of VGAC for a total of 4,000 pounds per train, or 8,000 pounds for both. The LGAC train is comprised of two 500-pound beds for a total of 1,000 pounds. VGAC changeout is determined when breakthrough occurs based on ongoing monitoring (see Section 3.3.3). When one of the two trains has breakthrough, the exhaust gas flow is valved over to the remaining train. When the second train approaches breakthrough, then both trains are changed out. Alternatively, the trains can be changed out as breakthrough occurs. Similarly, LGAC is changed out as dictated by sampling results (see Section 3.3.3) or a minimum changeout of once per year. Spare VGAC and LGAC is inventoried at the former John Rodgers Tank Farm (JRTF) or other NAVFAC-designated location. Refer to the GAC Changeout Procedure in Appendix A-4 and the AHA for O&M (which includes GAC changeout) in Appendix F-2 .

The carbon changeout and transport and disposal process includes the following work, which will be provided by a yet-to-be-determined subcontractor (see Section 2.4 for contact information):

- Mobilize and demobilize equipment necessary to support changeouts, including the vacuum extraction and refill unit, flatbed truck, and forklift. The GAC vessels are located inside a building with no roof access. There is approximately 18 inches between the interior roof and the VGAC access lids (Photo 9). Vacuum extraction of the carbon will require using an extended length of hose (at least 30 feet) to reach from the building to the vacuum equipment. Work around the SVE Building requires the use of an all-terrain, extended-reach forklift. A rough terrain, extended reach forklift is required to place and remove supersacks from the fenced area.
- Use a Hurricane 500 (or equivalent) (see Appendix A-4) diesel-powered and trailer-mounted suction unit to remove and refill the vessels (Industrial Vacuum). The unit includes a cyclonic separator, baghouse, and blower safety filter. Fugitive emissions will be controlled during the GAC changeout process so there is no visible emission. The equipment is available for rent locally. While removing the GAC, look for and document the location of any evidence of channeling within the bed.
- Place spent GAC in supersacks on wooden pallets outside the SVE Building, ready to be loaded, secured, transported, and off-loaded at the JRTF (or other on-Base designated location) for staging before disposal.

- Before securing the spent GAC in the supersacks, collect analytical samples to support disposal (see Section 3.3.3). While staged on-Base, the GAC will be analyzed and profiled for subsequent disposal.
- Load, secure, transport, and off-load fresh GAC from the JRTF to the SVE Building to refill the GAC vessels.
- Before refilling with fresh GAC, inspect each vessel for any mechanical issues including the grates, supports, and for any signs of corrosion.
- Refill the appropriate vessels with fresh GAC using suction to convey carbon from the supersacks to the vessels while minimizing dust generation.
- Level and smooth the top of the carbon vessels to mitigate channeling. Replace and secure the vessel manway and perform clean-up activities.

Reactivated **coconut-shell** VGAC and LGAC is supplied from the Continental United States and shipped by barge to Oahu for off-loading and subsequent inspection, loading, securing, transport, and off-loading at the JRTF location or other NAVFAC-designated location. GAC will be provided in lined, waterproof supersacks (1,000 pounds per sack), on wooded pallets. Once off-loaded at the JRTF, the GAC will be covered with 10-mil black plastic and secured.

3.1.6 Fire Extinguishers and Safety Equipment

The electrical room and the process rooms in the SVE Building each have a 10-pound ABC dry chemical fire extinguisher mounted on the wall inside the doorway to each room. The fire extinguishers should be inspected monthly, and shaken and inverted to prevent the powder from settling and packing. The fire extinguishers should be serviced and recertified every year. If a fire extinguisher is used, regardless of quantity, it should be serviced and completely recharged. During this monthly inspection, also inspect the balance of the site safety equipment and signage.

3.1.7 General Exterior Maintenance

The exterior of the SVE Building, wood fence surrounding the SVE system building, and PV array will be inspected monthly to monitor their condition. Fence inspection should also include the gate, to monitor the functionality of the hinges and locking mechanisms. Any deficiencies should be repaired a soon as possible.

Grass and weeds cannot be allowed to grow to heights where they would create shade on the PV panels. Vegetation can be maintained by cutting, pulling from the roots, or lightly applying commercially available, household-type grass and weed killer. The use of any herbicide must be approved by the Base and a material safety data sheet made available onsite.

The Hickam landscaping contractor (**Ohana Nui)** has agreed to cut the grass inside the fenced area on a regular basis. Ohana Nui was provided the combination to the lock on the access gate. In the event that the current lock combination is no longer accurate, or if the lock type is changed, Ohana Nui should be notified. The primary point of contact at Ohana Nui is Michelle Aguinaldo at (808) 422-8383 or michelle@ohana-nui.com.

3.2 Soil Vapor Extraction Facility Supporting Information

This section summarizes available installation and O&M manuals, cutsheets, and other information applicable to both the SVE and off-grid systems. This information is stored in the SVE Building and presented on CD as Appendix E.

3.2.1 Soil Vapor Extraction System Supporting Information

A standalone O&M manual for the process portion of the SVE Building is provided in Appendix A-1. The following bullets list installation and O&M manuals and cutsheets of vendor-provided equipment for the process portion of the SVE Building. The listed items are provided on the CD in Appendix E; a hard copy of each is maintained onsite in the SVE Building.

- Rotary Blower Assembly and Operating Manual (KAESER)
- Blower Installation Data Sheet (KAESER)
- Rotary Phase Converter Operation and Installation Manual (GENTEC)
- M2A Transmitter (Catalytic LEL Detector) Operator’s Manual (RKI INSTRUMENTS)
- Liquid Transfer Pump Model NPE/NPE-F Instruction Manual (GOULDs)
- NPE 316L SS cutsheet (GOULDS)
- Explosion-Proof Exhaust Fan Cutsheet (CCI THERMAL TECHNOLOGIES)
- 3200 See-Flo Indicator (ERDCO)
- Float Switches (FPI SENSORS INTERNATIONAL)
- Diaphragm Valves and Actuators (GIE, INC)
- Lateral Drain Pipe (MW MATTSON/WITT)
- Bottom Load Multi-Jet Meters (MASTER METER)
- Pressure and Vacuum Relief (NATIONAL VACUUM EQUIPMENT, INC
- 93 NPT Full Port Hot Forged Brass Ball Valves (RUBINETTERIE UTENSILERIE)
- ST51 Mass Flow Meters Installation and Operation Guide (FCI FLUID COMPONENTS)
- In-Line Flow Conditioning Plates Cutsheet (SIERRA)
- Immersible Thermal Gas Mass Flow Meter Cutsheet (SIERRA)
- Explosion-Proof Smoke Detector Instructions (PYROTECTOR)
- Compact Filter Silencers Cutsheet (SOLBERG)
- Check Valves Cutsheet (STRATAFLO)
- Electric Actuators (Series 92) (ASAHI/AMERICA)
- Temperature Switches (AUTOMATION DIRECT, PROSENSE)
- D-Ring Lifting Lugs (TANDEMLOC)
- LGAC Vessel Elevation and Plan (TETRASOLV)
- Moisture Separator Elevation an Plan (TETRASOLV)
- VGAC Vessel Elevation and Plan (TETRASOLV)

3.2.2 Off-grid Photovoltaic System

A standalone O&M manual for the off-grid portion of the SVE Building (including the PV Array) is provided in Appendix B-1. The following bullets list installation and O&M manuals and cutsheets of vendor-provided equipment for the PV Array and electrical room. The listed items are provided on the CD in Appendix E; a hard copy of each is maintained onsite in the SVE Building.

- Flex Max Charge Controller (OUTBACK)
- Flex Max Quick Start Manual (OUTBACK)
- Flex Net DC User's Guide (OUTBACK)
- GS Load Center Installation Manual (OUTBACK)
- MATE3 Owner's Manual Addendum (OUTBACK)
- VRLA Battery Systems, Safety, Storage, Operating and Maintenance Manual (ENERSYS)
- EnergyCell RE High Capacity Battery Installation Guide and Owner's Manual (OUTBACK)
- Radian Series Inverter/Charger Installation Manual (OUTBACK)
- Radian Series Quick Start Guide, Setup and Programming (OUTBACK)
- Radian Mate3 Startup Guide (OUTBACK)
- AXS Port SunSpec Modbus Interface Owner's Manual (OUTBACK)
- HUB Communication Manager User's Manual (OUTBACK)
- Exhaust Fan (16 inch, 115 Volt) (Purchased GRAINGER and DAYTON Product)
- PV Cell Cutsheet (SUNIVA)
- PV Installation Manual (SUNIVA)
- Combiner Boxes Heavy Duty Switches (SIEMENS)
- Power Supply Cable (X-FLEX)
- •Direct Current (DC) Disconnect (EATON)
- Voltage Drop Calculation

3.3 Sampling

3.3.1 Flow Rate Monitoring and Targets

Flow rate monitoring is conducted to evaluate operation of the blower and performance of the horizontal wells. Flow rate data can be collected from the appropriate SVE well manifold leg inside the building (Photo 14).

The flow rate should be checked using the Dwyer DS-300 averaging pitot tubes, combined flow at the mass flowmeter, blower motor amperage, and battery voltage (charge) status from the HMI.

Flow at individual header legs must be calculated based on differential pressure measurements at the three Dwyer DS-300 pitot tubes (one for each manifold leg). The temperature of the extracted vapor should also be recorded. The DS-300 instruction sheet is available online and can be downloaded from the following location: http://www.dwyer-inst.com/PDF_files/DS-300_iom.pdf. The startup team should download this instruction sheet.

The flow equation, solving for flow ("Q"), uses measured input parameters static line pressure (low pressure), differential pressure (difference between static and dynamic pressure), and temperature. Additional information may be found online at http://www.engineeringtoolbox.com/pitot-tubes-d_612.html).

Any Gas

$$Q\ (SCFM) = 128.8 \times K \times D^2 \times \sqrt{\frac{P \times \Delta P}{(T + 460) \times S_s}}$$

Where

K = flow coefficient of 0.67 for 3-inch pipe (as measured at the manifold)

D = pipe inside diameter (2.9 inches)

P = static line pressure is measured in pounds per square inch atmospheric (psia) on the gauges (psia = gauge pressure + 14.7). Delta P is the difference between static (low) pressure and dynamic pressure across the pitot tube (refer to engineering toolbox link above).

Ss = specific gravity of Air at 60 F = 1

T = temperature in degrees Fahrenheit + 460 (degrees Rankine [R])

The above flow equation can also be downloaded in spreadsheet form from the Dwyer website at http://www.dwyer-inst.com/Products/DS_Calculator.cfm

The main line (header where all three manifold legs are connected) mass flowmeter has a direct-read (local) display in scfm, and can also be read remotely and from the HMI/touchscreen. Flow velocity measurements and calculated flow will be recorded on the weekly performance monitoring form in Appendix D-1.

3.3.1.1 Flow and Vacuum Targets

The target SVE flow is 0.5 scfm per foot (scfm/ft) of screen. Flow targets for each SVE well are shown in Table 3-5.

TABLE 3-5
Target Flow Rates

SVE Well	Screen Length (feet)	Target Flow Rate (scfm)
SVE-1	500	250
SVE-2	200	100
SVE-3	360	180

The practical flow limit of the blower at 100 percent motor speed setting using the variable frequency drive (VFD) is approximately 275 scfm. Expected vacuum level, as measured at the SVE manifold legs, is 6 to 8 inches Hg (80 to 110 inches water column [w.c.]). (Note: the dynamic pressure measured across the pitot tube is not the same as the vacuum pressure in the line.)

If the blower needs to be operated at less than 100 percent motor speed to reduce blower motor amperage (so not to exceed the 23-ampere [A] upper limit) and extend the service time of the batteries, flow can be rotated between all three wells at approximately 0.3 to 0.4 scfm/ft. Note that blower motor amperage is strongly influenced by vacuum pressure (load) on the blower, and less influenced by flow and motor revolutions per minute. For example, during the FAT, the sample-measured amperages shown in Table 3-6 were recorded as a function of vacuum.

TABLE 3-6
Factory Acceptance Testing Results

Motor Speed (%)	Vacuum (inches Hg)	Flow Rate (scfm)	Amperage (A)
50	7	135	19
50	10	135	23
75	5.5	248	15
75	7.5	228	19
100	5	315	18
100	5	300	24

Note:

23 A is the maximum motor amperage recommended for sustained, long-term operation.

% = percent

3.3.2 Exhaust Sampling

Inlet-gas and off-gas samples from the SVE system can be collected from the following locations:

- At each inlet riser from SVE 1, SVE 2, and SVE 3 intake pipes (before being combined for treatment by VGAC)
- Between the lead and lag vessels of the VGAC trains
- At the outlet of the VGAC train being used (or inlet to the exhaust stack)

These samples can be used to track VGAC performance, monitor and determine VGAC breakthrough, evaluate mass removal rates, and perform Title V permit requirement comparisons.[1] Note that only two of the four VGAC vessels (one train) will be operated at any given time; the other train will be used once breakthrough occurs on the first. Samples will be collected in 1-liter Summa canisters. Flow controllers will be set to 200 milliliters per minute.

[1] As described in Section 4.3.1.1 of the SAP, uncovered sources emitting less than 1 ton per year of each air pollutant and less than 0.1 ton per year of each hazardous air pollutant are exempt from modification of the JBPHH Title V permitting requirements (Hawaii Administrative Rules 60.1-62(d)(1)). Also, no modifications to the current JBPHH Title V permit are anticipated to be necessary. The applicable action levels for post-treatment off-gas samples are the JBPHH Title V permit limits. HDOH permit requirements will be used to assess permit exemption applicability and air emission treatment options.

SVE off-gas samples will be analyzed in an offsite laboratory for the following:

- Volatile organic compounds (VOCs) by U.S. Environmental Protection Agency (USEPA) Method TO-15
- TPH, gasoline-range organics by USEPA Method TO-3
- Fixed gases (oxygen, nitrogen, carbon monoxide, carbon dioxide, and methane) by ASTM International (ASTM) Method D-1946

Mass removal rates will be estimated by using the concentration data from the analytical samples and the exhaust flow rate from the mass flowmeter . The fixed gas data can be used in combination with published biodegradation rate constants to estimate the rate of biodegradation in the subsurface.

Sample collection procedures and analytical methods are described in Worksheet #14 of the Sampling and Analysis Plan (SAP) (DON, 2014a). An Analytical Reference Limits and Evaluation table is provided in Worksheet #15 of the SAP. Worksheet #19 of the SAP identifies field sampling requirements, including analytical methodology, container type and volume, preservation and holding times. Worksheet #27 outlines sample custody procedures, sample nomenclature, and sample shipping procedures. Worksheet #30 lists analytical laboratories that have been used for site sample analyses.

3.3.3 Granular Activated Carbon Related Sampling

The results of the off-gas samples will be used to determine breakthrough and the changeout of a particular VGAC train. Based on the results of the startup monitoring, GAC consumption is estimated at one train per month. Once one train is expended, the second train will be valved into service. When the new train approaches breakthrough, both trains will be changed out; alternatively, the VGAC can be changed out as each train is expended. The results of the off-gas samples can also be used to determine whether the off-gas requires treatment through the VGAC trains in order to achieve the Title V permit limits.

Following removal of the VGAC or LGAC, a composite sample from each will be collected from the supersacks and the samples submitted to a laboratory for analysis in accordance with Navy and waste disposal facility requirements. It is anticipated that GAC analytical testing will required for benzene, toluene, ethylbenzene, and xylenes (BTEX), TPH, polycyclic aromatic hydrocarbon (PAH), toxicity characteristic leaching procedure (TCLP) – As (arsenic), TCLP-Cd (cadmium), TCLP-Cr (chromium), TCLP-Pb (lead), and chlorinated pesticides, though it is recommended to consult PVT landfill waste acceptance requirements of the disposal facility prior to waste characterization sampling. The worksheets from the SAP identified in the previous section that outline sample collection, analysis, and handling requirements also apply to GAC sampling.

Once the analytical data is returned, coordinate with the JBPHH Environmental Engineer at the Hickam Environmental Storefront to develop the waste profiles, manifests, and documentation for transport and disposal (T&D) at the PVT Landfill. It is anticipated that GAC analytical testing will be required to confirm that the spent GAC conforms to the waste profile. Documentation must be submitted and reviewed by the system environmental manager before T&D. A NAVFAC representative will sign documentation requiring generator signature.

3.3.4 Field Documentation and Sample Management

3.3.4.1 Field Logbooks

Field logbooks will be used to document where, when, how, and from whom any vital project information was obtained. Logbook entries will be complete and accurate enough to permit reconstruction of field activities. Field logbooks will be maintained with pertinent information. Field logbooks will be bound with consecutively numbered pages. Each page will be dated and the time of entry noted in military time. All entries will be legible, written in black or blue ink, and signed by the individual making the entries. Language will be factual, objective, and free of personal opinions or other terminology that might prove inappropriate.

At a minimum, the following information will be recorded during the collection of each environmental sample:

- Sample location and description
- Sampler name(s)
- Date and time of sample collection
- Designation of sample as composite or grab
- Type of sample (i.e., matrix)
- Type of sampling and equipment used
- Field observations and details important to analysis or integrity of samples (e.g., heavy rains, odors, colors)
- All field instrument readings
- Lot numbers of the sample containers, sample tag numbers, chain-of-custody form numbers, and chain-of-custody seal numbers
- Shipping arrangements (overnight air bill number)
- Recipient laboratory name

In addition to the sampling information, the following specifics will also be recorded in field logbooks for each day of sampling:

- Names of team members and their responsibilities
- Time of site arrival/entry onsite and time of departure from site
- Names of other personnel or visitors onsite
- A summary of any meetings or discussions with any potentially responsible parties, their representatives, or federal, state, or other regulatory agencies

- Deviations from sampling and analysis plans and procedures and a summary of the approval process for the deviation
- Changes in personnel and responsibilities, as well as reasons for the changes
- Levels of safety protection
- Calibration readings for any equipment used and equipment model and serial number

3.3.4.2 Chain-of-Custody Records

Chain-of-custody records are used to document sample collection and shipment to a laboratory for analysis. All sample shipments will be accompanied by a chain-of-custody record. Forms will be completed and sent with the samples for each laboratory and each shipment (i.e., each day). If multiple containers are sent to a single laboratory on a single day, forms will be completed and sent with the samples for each container. Information on all samples collected for analysis must be included on the forms.

The chain-of-custody record will identify the contents of each shipment and maintain the custodial integrity of the samples. In general, a sample is considered to be in someone's custody if it is either in someone's physical possession, in someone's view, in a locked container, or kept in a secured area that is restricted to authorized personnel. The field team leader or designee will sign chain-of-custody records. The field team leader or designee will sign the "relinquished by" box and note the date, time, and air bill number.

3.3.4.3 Reporting

Sampling results will be presented in quarterly and yearly reporting as required.

3.4 Performance Monitoring

Performance monitoring is focused on the off-grid system, individual SVE well risers, and the overall remediation process including the following:

- Battery pack SOC and voltage (read as percent SOC on MATE3 display)
- Battery room temperature (use standard thermometer)
- VFD setting (read as percent blower speed from HMI touchscreen display)
- Current (in A) and wattage (in W) (read from HMI touchscreen display)
- Charge controller output (kW) (read from HMI touchscreen display)
- Totalizer on the effluent pump from the knockout tank (read from liquid flowmeter located just downstream of the liquid centrifugal pump near the knockout tank)
- Blower flow rate in cfm (read from HMI touchscreen display)
- Blower temperature (read from front dial display on the blower)
- Blower run time (from hour meter) (read from HMI touchscreen display)
- PID sampling of train in use (pre-VGAC, intermediate-VGAC, and post-VGAC)

- PID breathing zone

The performance monitoring form is presented in Appendix D-1. Initially, after startup, performance monitoring was conducted weekly, but the requirement has been reduced to biweekly as of January 2016. Further reductions in frequency may be appropriate depending on continued uniformity of system performance. Alternatively, an increase in frequency may be required for specialized troubleshooting.

3.5 System Inspections

The following inspections will be conducted on the SVE system:

- Quarterly inspection of AGM battery rack, inverter load center, and ancillary equipment associated with the off-grid PV system (see Appendix B-6)
- Performance monitoring (see Appendix D-1)
- Pressure monitoring (see Appendix D-2)
- Monthly inspection of the overall systems, including the following: effluent discharge system, GAC treatment system (including process piping), general building inspections, and SVE vault inspections as presented in the Checklist in Appendix A-6

Details of the inspections are included on the individual inspection checklists referenced above.

3.6 Pressure Monitoring Form

Eleven permanent vadose zone monitoring points have been installed to monitor the SVE capture zone (**Figure 2-1**). The probes are installed at depths of approximately 5 to 7 feet bgs, dependent on the depth to groundwater. The vadose zone monitoring points are completed with a steel flush mount cover set in concrete. If either a shallow water table or the presence of clay in the screened interval is encountered during installation, sample locations may be modified in the field.

Short-term differential pressure monitoring data can be collected using a digital manometer at each of the VMPs. The pressure differential monitoring will be conducted to evaluate the lateral extent of the pressure field. The field form for pressure monitoring is included in Appendix D-2. O&M personnel will consider issuance of status reports, investigation of well field performance, and other such requirements, to determine the frequency of pressure monitoring and its recording on this form.

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4.0 Health and Safety

An APP that includes a Site Safety and Health Plan (SSHP) (DON, 2014c) has been prepared in accordance with 29 *Code of Federal Regulations* 1910 and 1926. The APP addresses the potential hazards associated with the field activities. Subcontractors are responsible for health and safety procedures specific to their particular work components and are required to develop and submit an AHA to the system operator for review before the start of field work.

A safety notification describing the overall hazards and precaution of working in and around AGM batteries, the O&M AHA, and the GAC and blower oil material safety data sheet are presented in Appendixes F-1, F-2, and F-3, respectively.

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5.0 References

State of Hawaii Department of Health (HDOH). 2011. *Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater*. Fall 2011, revised January 2012.

U.S. Department of the Navy (DON). 2016. *Treatability Study Report for Subsite ST32 Onizuka Village, Joint Base Pearl Harbor-Hickam, Hawaii.*

U.S. Department of the Navy (DON). 2014a. *Sampling and Analysis Plan, Treatability Study for Subsite ST32 Onizuka Village, Joint Base Pearl Harbor-Hickam, Hawaii.* January.

U.S. Department of the Navy (DON). 2014b. *Treatability Study Implementation Plan for Subsite ST32 Onizuka Village, Joint Base Pearl Harbor-Hickam, Hawaii.* April.

U.S. Department of the Navy (DON). 2014c. *Accident Prevention Plan, Treatability Study for Onizuka Village, Joint Base Pearl Harbor-Hickam, Hawaii.* June.

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Figures

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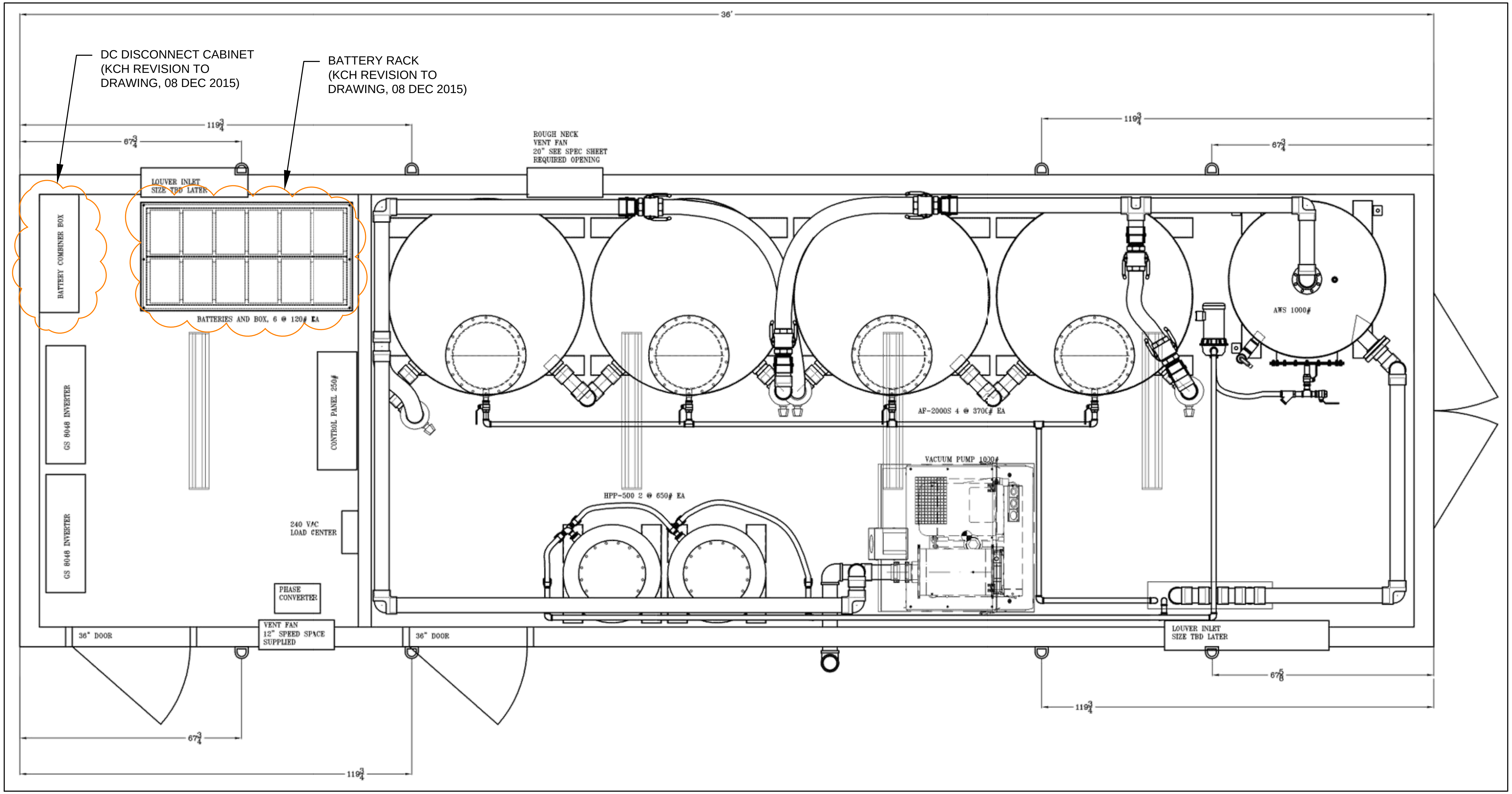

SOURCE:
AS BUILT DRAWING ENTITLED BUILDING LAYOUT, DRAWING # M-1 / R3, BY TETRASOLV FILTRATION, DATED MARCH 30, 2014.

Equipment Building Plan Layout

O&M Plan for Subsite ST32 Onizuka Village
Joint Base Pearl Harbor-Hickam, Hawaii

FIGURE

2-7

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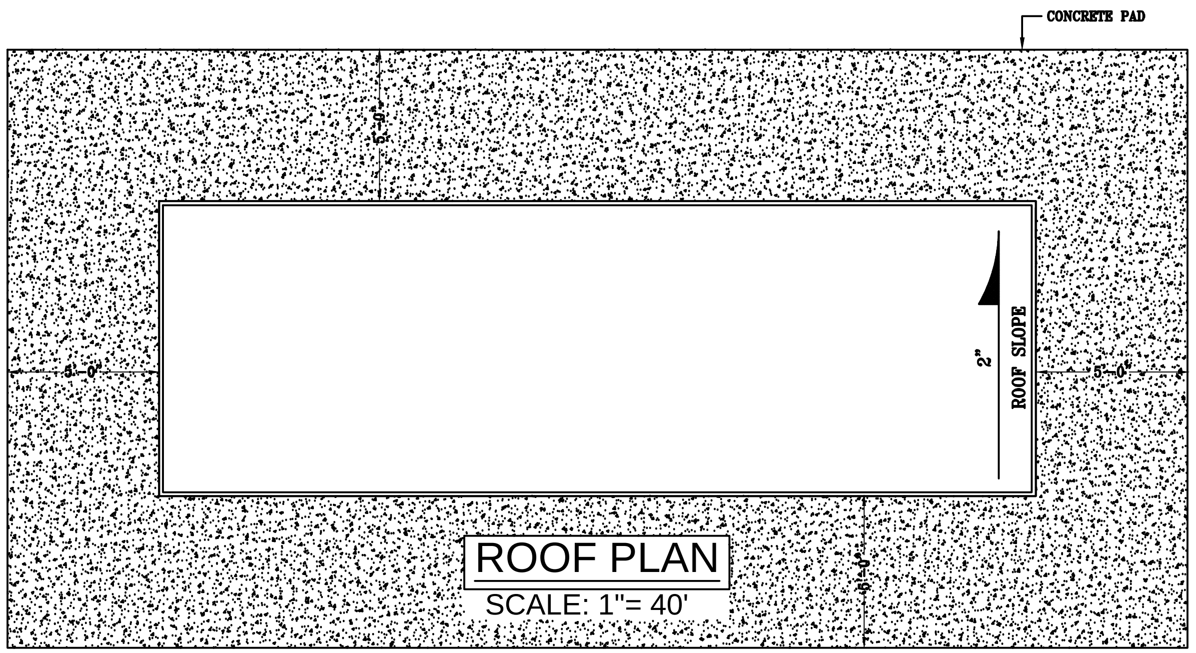
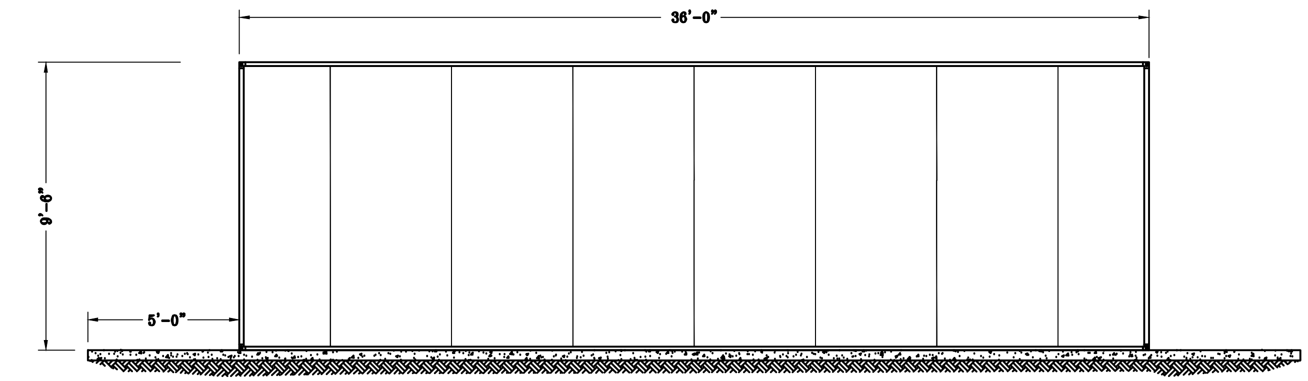


ROOF PLAN
SCALE: 1"= 40'



EAST WALL FRAMING
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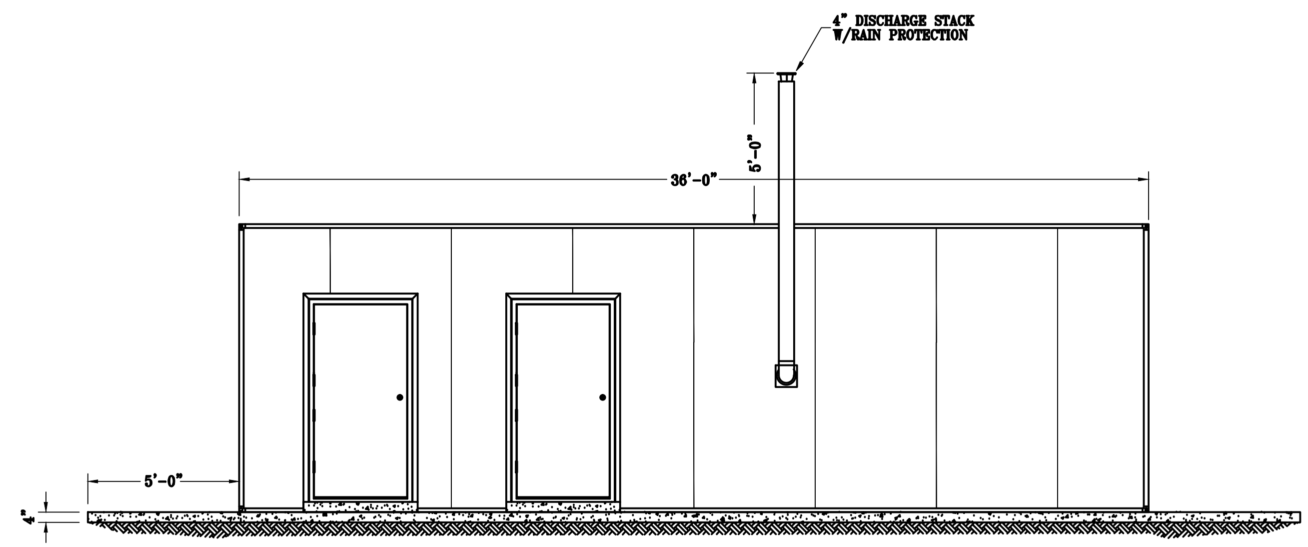

WEST WALL FRAMING
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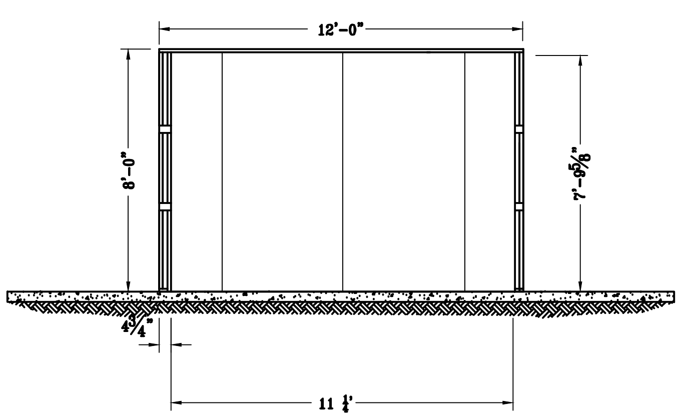
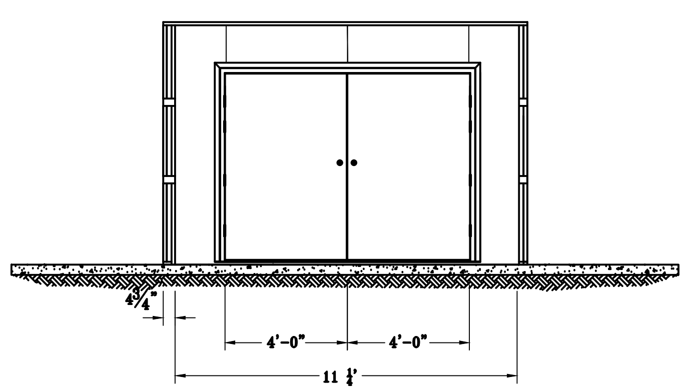


NORTH WALL



SOUTH WALL

NORTH/SOUTH WALL FRAMING
SCALE: 1"= 40'

Equipment Building
Sections and Details

O&M Plan for Subsite ST32 Onizuka Village
Joint Base Pearl Harbor-Hickam, Hawaii

KCH

FIGURE
2-8

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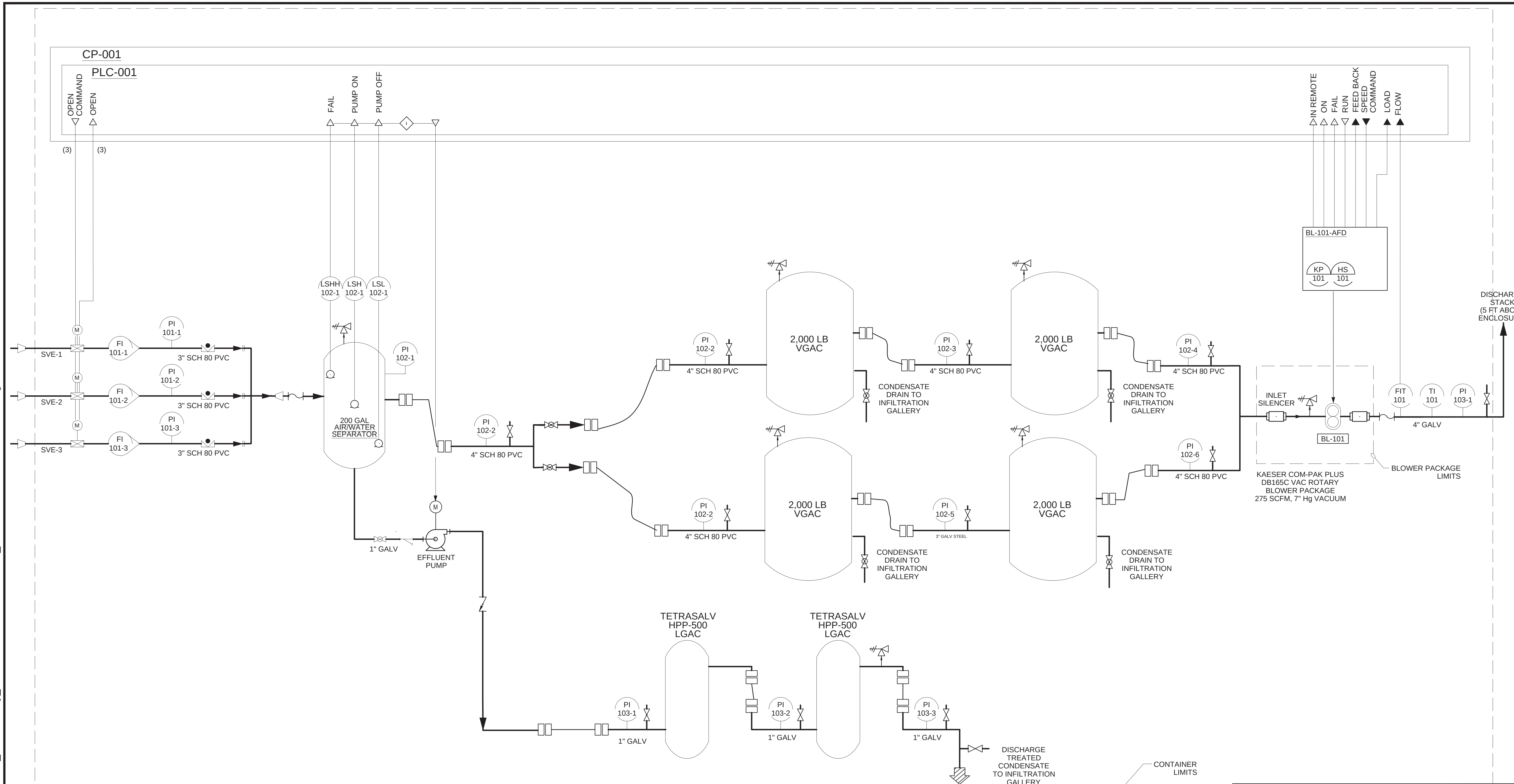

LEGEND

	UNION		BALL VALVE	PI 101	PRESSURE INDICATOR	FI 101	FLOW INDICATOR (AVERAGING PITOT TUBE)		REDUCER COUPLING
	DIAPHRAGM VALVE		PRESSURE/VACUUM RELIEF VALVE	TI 101	TEMPLERATURE INDICATOR		QUICK - CONNECT / CAMLOCK FITTING	M	MOTORIZED VALVE
	SAMPLE PORT		Y-STRAINER	FIT 101	FLOW INDICATOR/TRANSMITTER		HIGH TEMP PRESSURE / VACUUM RATED HOSECAM-AND-GROOVE FITTINGS	S	SELENOID VALVE

CHECK VALVE

NOTE:
REFER TO THE APPENDICIES FOR A PROCESS AND INSTRUMENTATION DRAWINGS PREPARED BY THE FABRICATOR.

SVE Piping and Instrumentation Diagram

O&M Plan for Subsite ST32 Onizuka Village
Joint Base Pearl Harbor-Hickam, Hawaii

FIGURE
2-9

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Appendix A
SVE System

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Appendix A-1
O&M Manual (Onion Equipment Company)

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ERRATA SHEET FOR
SOIL VAPOR EXTRACTION SYSTEM
OPERATION & MAINTENANCE MANUAL
JOINT BASE PEARL HARBOR HICKAM, HAWAII

The attached Operations & Maintenance (O&M) Plan for the Soil Vapor Extraction System (SVE) at Joint Base Pearl Harbor Hickam, Hawaii, was prepared by Onion Equipment Company (OEC). This standalone document is contained in the overall O&M Plan for the SVE System, SVE Wells, and Off-Grid PV System. The errata items to the subject report are considered minor (refer to table below).

Location	Revision	Reason for Change
Cover Sheet	Section B, C, and D are not applicable	Information referenced is contained in other locations
Section 3.4, Step 3, 5th sentence	Delete and replace with “Take amperage readings, as necessary, for each component, and record on a checklist to compare to manufactures information. Table 3-1 can be used to record amperage readings for the blower as a function of SVE well vacuums.”	Clarification of Text
Section 4.4, 1st Paragraph, last sentence	Delete and replace with “When the level in the tank activates the pump will turn on.”	Clarification of Text

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ONION EQUIPMENT COMPANY

Operation & Maintenance Manual

SVE System
Joint Base Pearl Harbor
Hickam, Hawaii
Job# 14-01A

CONTENTS

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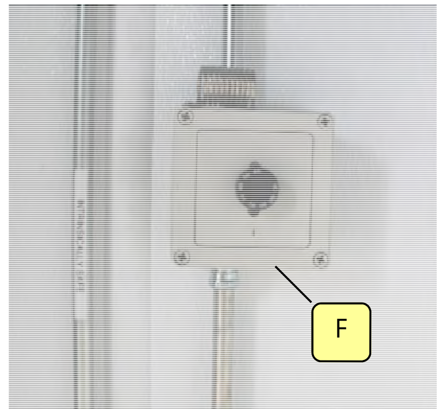
1.0 GENERAL DESCRIPTION

Table 1.1
System Specifications

Description	Specification
Footprint	12' x 36' x 9' H
SVE Design	275 SCFM @ 7"Hg
Shipping Weight	28,750 lbs
Operating Weight	31,500 lbs
Power Requirement	230V/3PH/60HZ
Amperage Requirement	100



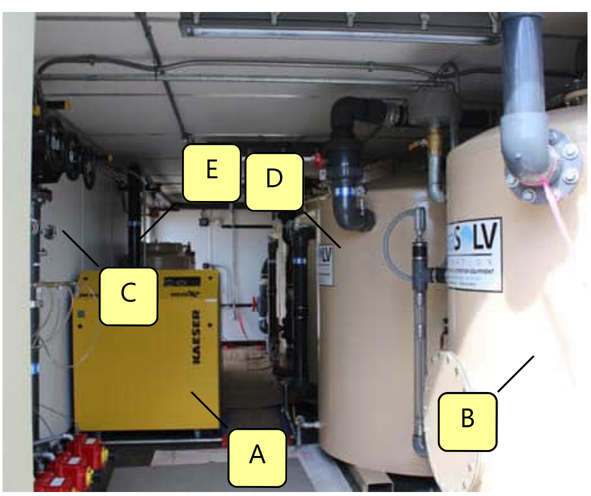
During normal operation extracted vapors upon exiting the soil extraction wells pass through a moisture knockout followed by an inline air filter into the suction side of the PDB. When the fluid level in the Air Water Separator (AWS) reaches the pump activation set point the system starts the transfer operation until the pump deactivation point is reached.

1.1 SVE System

The Soil Vapor Extraction System (SVE) consists of multiple integrated components designed to pull vacuum on a common manifold in order to extract vapors and liquid out of ground wells. The system utilizes a Positive Displacement Blower (PDB) to create vacuum.

<u>Component</u>

A - Vacuum Blower (PDB)
B - Moisture Separator
C - SVE Manifold
D - Vapor Carbon Filters
E - Liquid Carbon Filters
F - Exhaust Fan TStat
G - E-Stop
H - Inlet Louver / Filter Wall
I - Exhaust Fan
J - Bypass Louver
K - SVE Room Heater



(equipment room)

1.2 Building HVAC

It is important that the building climate be monitored and adjusted for seasonal variations.

- ***IMPORTANT: HVAC ducting and inlets, louvers, etc. should be regularly inspected to insure no restriction or debris would impede the free flow of air.***

On the equipment room divider wall (1) thermostats control the SVE Room Ventilation Fan.

Located on the left side of the blower is the inlet louvers. The inlet louvers have removable filter panels which will require replacement at periodic intervals depending upon the site conditions. The filter panel fabric is available from a wide variety of sources. OEC typically uses a 1" thick polyester filter media roll we obtain from Grainger (P/N 2W186). This material comes in rolls of varying lengths and should be cut to the required length.

1.3 Building Disconnect

The building disconnect is located on the end of the building.

In case of emergency the disconnect can be used to disconnect the entire structure from the electrical power supply.

- ***WARNING: In case of manual disconnect system restart should only be attempted after verification of safe operation. This includes elimination of explosive and electrical hazards.***

2.0 HEALTH AND SAFETY

It is important that the entire O&M manual be read prior to set up and operation of the system. If you have any questions please contact OEC at the number listed below.

- Always adhere to "lockout/tagout" procedures when servicing the system.
- Wear appropriate safety equipment when operating system. OEC recommends hearing and eye protection be utilized while the system is operating.

♦ ***WARNING: Certain components of the compressor and vacuum blower may hot during operation and immediately after shutdown. Even after shutdown system may cause burns upon contact for extended period of time.***

Fire Extinguishers are located inside the building below the light switch and outside adjacent to the entry door. First Aid Kit is located above the fire extinguisher.

Emergency Stop Buttons are located in each room of the structure and on the front of the Control Panel inside the structure. An additional ESB is located on the compressor.

♦ ***WARNING: The compressor ESB ONLY functions for the air compressor and has no interlink to the system controls.***

(Control Panel)

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3.0 INSTALLATION & STARTUP

3.1 Shipment & Unloading

Upon arrival at the site the system should be thoroughly checked for any damage that may have occurred during shipment. Any damage should be noted with the carrier and OEC immediately.

3.2 Positioning

- ***WARNING: Failure to follow the procedures outlined below can result in damage to the system.***

The building should be positioned on a firm level surface capable of supporting the entire system at full operational weight. The building should be leveled and firmly supported and anchored.

Any loose components should be connected to the system at this time.

3.3 Inspection

Perform the following inspections after un-loading the system. Note any discrepancies and contact OEC immediately.

- Check the system exterior for damage which may have occurred during shipment. Inspect the support structures and piping support for damage.
- Inspect the piping system for damage. Insure the valves operate properly. Check installed instruments and instrument installation points for damage.

3.4 Set Up

- Prior to completing the remaining steps, Section 6 (Control Panel Operation) should be read.

Step 1: A qualified electrical contractor with experience in industrial wiring systems shall make electrical connections. Connect the Control Panel to the fused primary feed. (see table 1.1 for electrical requirements).

- ***IMPORTANT: At the time of installation local code requirements may necessitate changes to the wiring of the system. Any changes should be discussed with OEC prior to completion.***

Step 2: Check rotation of 3 Phase motors. All motors were tested at the factory to have the same rotation,

- ***WARNING: Do not operate any other components until this test has been completed. Some components may be severely damaged if run in reverse direction.***

Step 3: Individually test each component in manual mode. Review the manual for the component to be tested. Scroll to the component screen on the control panel and place the component in hand mode. Listen to the component. Take amperage readings on each line and compare to those in table 3.1. Discontinue operation and contact OEC immediately if discrepancies exceed 20% or unusual sounds, vibration or smells are present.

- ***IMPORTANT: These tests should be completed prior to connection the system to exterior piping. If piping has been connected we recommend temporary disconnection during this test.***

Step 4: Test all system faults and interlocks.

Step 5: Connect the site piping to the system process piping.

- ***IMPORTANT: All piping connected to the process piping rack should be <u>self supported</u>. We also recommend the use of flexible joints wherever system piping connects to the site piping.***

Table 3.1
Operational System Amperage Readings @ ______ VAC

Device	Serial Number	Pressure / Vacuum	Line 1	Line 2	Line 3
Blower / Kaeser DB166C VAC	4946				

4.0 SVE SYSTEM OVERVIEW & OPERATION

4.1 Positive Displacement Blower (PDB)

The system uses a vacuum pump to extract vapor and liquid from the subsurface.

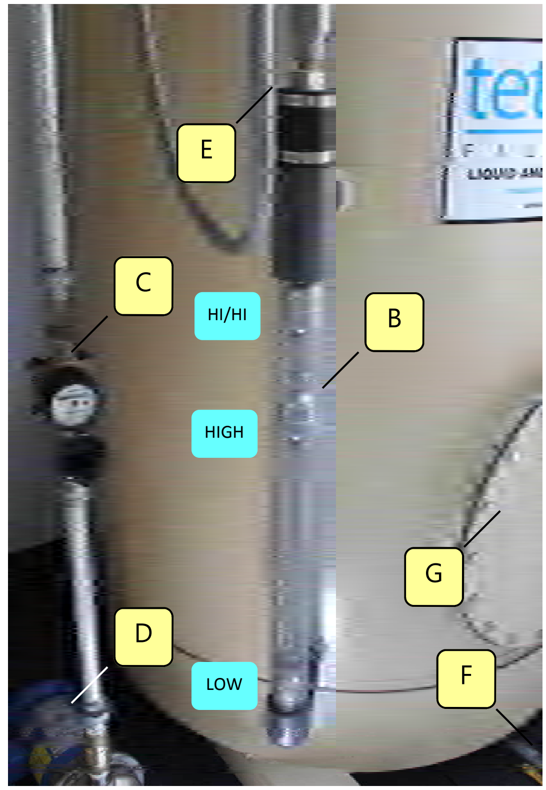
General operation of the PDB consist of monitoring the oil level, temperature and belt condition. Specific O&M Instructions should be obtained in the PDB blower manual.

- ***CAUTION: Prior to operating the PDB read all start-up instructions.***

Component

A - Check Valve
B - Site Tube
C - Liquid Flow Meter
D - Transfer Pump
E - Level Switch
F - Maintenance Drain
G - Inspection Manway

- ***WARNING: Operation of the PDB manually should be done with extreme caution. If liquid levels go beyond the 'EMERGENCY HIGH' point they may cause damage to the pump or be discharged out the discharge line.***



Air Water Separator and Transfer System

Positive Displacement Blower

4.2 AWS Separator & Transfer System

The AWS system separates entrained liquid from the air stream.

The AWS system should be cleaned and inspected on a regular basis as site conditions warrant. Prior to servicing manually pump the AWS system until the lower pump set level clears. Next open the drain valve to fully drain the AWS tank. The side inspection manway can then be removed. Inspected the interior of the tank for corrosion and or lining failure. Be sure to carefully clean the area around the suction pump and drain pickup. It may be necessary to disconnect the pump suction tube. Remove accumulated solids and reclose the inspection manway after cleaning the gasket surface and carefully cleaning the gasket. It is also recommended at this time that the level detection sensor be removed and cleaned.

- ***CAUTION: Take care not to lodge debris in the*** *suction port assembly which may impair or clog the pump.*

4.3 Level Detection

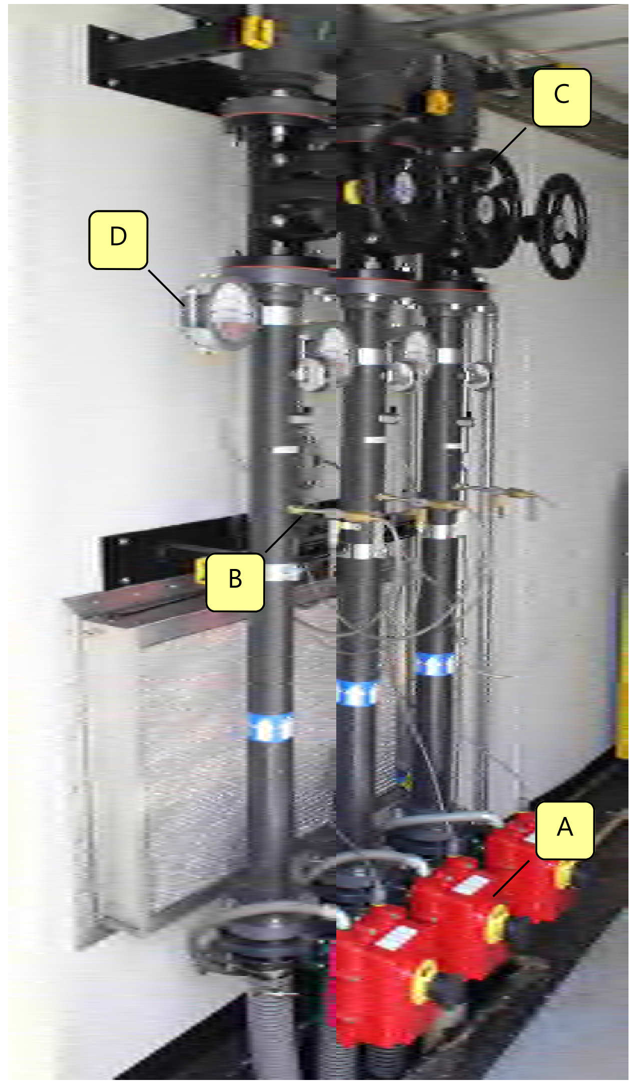
The AWS system detects level using a 3 point level switch. The switch consists of 3 floats connected to a single rod. The float operates a magnetic switch contained in the rod. When the float is down the switch is open and closed when the float is up. This configuration is referred to as NORMALLY OPEN. The floats are referred to as HI/HI, HI and LOW. The HI/HI level indicates a critical failure of the transfer system such as pump failure, closed valve, etc. The HI level indicates to the control panel to operate the associated transfer pump. The LOW level indicates to the control panel to shut off the associated pump.

The site tube should be cleaned or replaced whenever the liquid level cannot be easily observed. The site tube is easily removed by loosening the hose clamps where the tube connects to the tank. A mild solution of muriatic acid works well for cleaning the tube.

4.4 AWS Transfer Pump

The AWS transfer pump operates to transfer liquids from the AWS tank. In the AUTO position this pump will start and stop automatically by the control panel. When the level in the tank activates the pump the to operate.

Vacuum Bleed Valve



SVE Manifold

Component

A - Isolation Valve
B - Flow Measuring Tube
C - Diaphragm Valve
D - Flow Meter

- ***WARNING: Operation of the AWS transfer pump manually should be done with extreme caution. Dry running of the pump for even short periods can cause damage.***

4.5 SVE Manifold

The SVE manifold consists of 3" SVE Legs. Periodic cleaning of the flow meters, transmitters and gauges is recommended to insure accurate operation. Refer to each component O&M Manual for recommended cleaning procedure.

4.5 Activated Carbon System

Vapors from the extraction wells after passing through the moisture separator pass through vapor phase activated carbon filters. The vapor carbon removes trace organic contaminants from the vapor stream. The activated carbon system needs to be monitored for organic breakthrough and periodically replacement of the media.

Separated liquid from the moisture separator likewise is treated with liquid phase activated carbon filters. Refer to the carbon filter O&M Instructions for specific information pertaining to carbon filter operation.

Vapor Carbon

Liquid Carbon

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6.0 CONTROL PANEL OPERATION

6.1 Control Panel Overview

The control panel enclosure houses the Process Logic Controller (PLC). The PLC and Operator Interface Screen (OIS) provide operational and control of the sparge system. All OIS screens have a common OIS date and time.

Date and Time can be changed by pressing the field and entering the new value.

The Event Banner lists operator actions in the order completed.

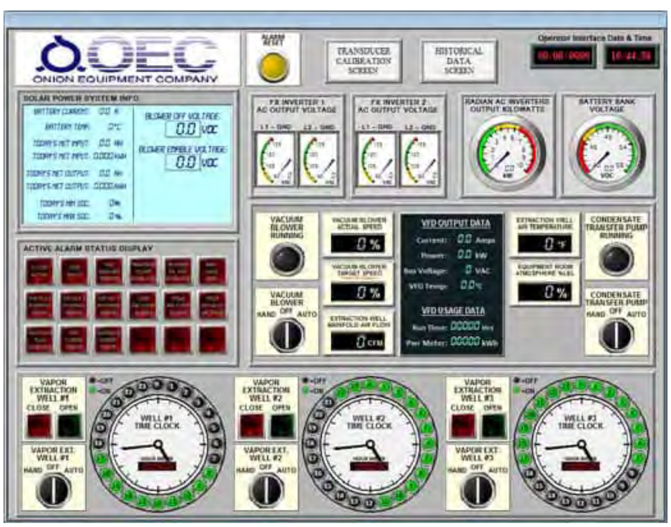
6.2 Emergency Stop Button

The ESB is activated by pushing the button in. Once pushed the button will remain down until pulled upward which cancels the ESB mode. Always wait at least 15 seconds before turning the system back on to give the PLC time to reset.

Activating the ESB also activates the Shunt Trip System which disconnects all power from the system.

After ESB activation follow the procedures in Section 6.3 (Shunt Trip System Restart).

- ***WARNING: Only use the ESB in case of emergency shutdown.***



(operator interface screen)

- ***WARNING: Use extreme caution when working in the interior panel area. If voltage is present there are many surfaces which may cause electrocution.***

6.3 Operator Interface Screens OIS

The operator interface screens allow configuration and display of system information and variables. The OIS is a touch screen. User configured values are changed by touching the display where the information desired to be changed is displayed.

Alarm Status Display - Active alarms displayed in illuminated RED. Refer to System Faults/Alarms table 6.1 for description of alarms.

System Variables - System variables can be configured by pressing the corresponding SETPOINT value and inputting the desired value.

Refer to Table 6.2 - System Variables Table for a list of variables with their associated input screen and description.

- ***CAUTION: Carefully consider input variables and the consequences of overall system operation before changing values.***

Certain motorized and actuated have Hand/Off/Auto selection. "OFF" selection disables the device from operation. "HAND" places the device into manual mode and all operational controls are by-passed.

- ***CAUTION: HAND operation of the devices will bypass all or many SAFETY controls is only recommended for certain situations and only for limited duration. Damage to equipment and or personnel is possible in HAND mode. HAND operation requires careful consideration of consequences during manual operation.***

"AUTO" places the device in standard operating mode.

Table 6.1 - System Faults / Alarms

Fault	Description	Action
Transfer Pump Overload	Transfer Pump Overload Detected	
SVE room LEL High Limit	LEL Warning Level above set point	
Blower Exhaust Fan Overload	Overload Detected	
SVE Valve Position Error	Corresponding Valve Positioner Error (Quan. 3)	
Low Air Flow Alarm	Air Flow Below Setpoint	
High Air Flow Alarm	Air Flow Below Setpoint	
E-Stop Active	E-Stop activated or in continuity in alarm circuit	
SVE Blower VFD Fault	VFD Malfunction	
VFD Breaker Tripped	Circuit Breaker Tripped	
High Exhaust Air Temp	Exhaust high temp setpoint reached	
AWS Level High	Hi/Hi Level Float in Moisture Separator Activated	
VFD Communication Failure	Failure of VFD Communication	
Outback Communication Error	Failure of Outback Charging Communication	

Table 6.2 - System Variables

Screen	Variable	Description
SVE CONTROL	SVE WELL VACUUM READINGS / LOW VAC SETPOINT (Quantity 6)	Low level vacuum alarm setpoint for low vacuum alarm on corresponding well.
SVE CONTROL	SVE WELL VACUUM READINGS / HIGH VAC SETPOINT (Quantity 6)	High level vacuum alarm setpoint for low vacuum alarm on corresponding well.
SVE CONTROL	HVE RECOVERY MANIFOLD / LOW VAC SET-POINT	Low level vacuum alarm setpoint for low vacuum alarm on HVE manifold.
SVE CONTROL	HVE RECOVERY MANIFOLD / HIGH VAC SET-POINT	High level vacuum alarm setpoint for low vacuum alarm on HVE manifold.
SVE CONTROL	HVE RECOVERY MANIFOLD / LOW FLOW SETPOINT	Low level flow alarm setpoint for low flow alarm on HVE manifold.
SVE CONTROL	HVE RECOVERY MANIFOLD / HIGH FLOW SETPOINT	High level flow alarm setpoint for high flow alarm on HVE manifold.
VAPOR EXTRACTION WELL TIMERS	Biosparge Well Timer Function (Available for each Biosparge Well)	Select individual hours of operation for selected Biosparge Well.
HORIZONTAL BIOSPARGE SETTINGS	LOW AIR FLOW ALARM SET POINT	Low level flow alarm setpoint for low flow alarm on Biosparge manifold.
HORIZONTAL BIOSPARGE SETTINGS	HIGH AIR FLOW ALARM SET POINT	High level flow alarm setpoint for high flow alarm on Biosparge manifold.
HORIZONTAL BIOSPARGE SETTINGS	Horizontal Well Timer Function (Available for each Horizontal Well)	Select days of week and individual hours of operation for selected Horizontal Well.

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7.0 MAINTENANCE

7.1 Preventative Maintenance

Table 7.1 contains a summary of normal maintenance items and intervals. This list is not intended to replace the manual for the installed components. We do not guarantee its accuracy or completeness.

7.2 Extended Shut Down

If the system will be shutdown for extended periods certain procedures should be taken to protect the system.

Remove instrumentation and store in a protected manner.

Completely drain and clean AWS tank, compressed air storage tank, compressed air filters, suction strainers, wye strainers. Remove compressed air heat exchanger exhaust hood and replace with weather tight cover. Seal all air inlets. Place desiccant pads as recommended by desiccant manufacturer for local climate and replace as recommended. Additional desiccant pads should be placed in all control panel and interior of machinery.

Table 7.1
Preventative Maintenance

Component	Action	Frequency
Painted surfaces	Inspect and repair painted surfaces	6 months
Building Exterior	Inspect Roof, caulking on installed devices. Verify louver operation. Clean and lubricate louvers.	6 Months
RSAC and PDB	See service intervals in manual	-
HVAC System	Clean heater coils, clean louvers, clean fan blades.	6 Months
Air Filters	Clean and inspect, verify auto drain function	Weekly
All	Check for proper relief points on PRV's and VRV's. Verify accuracy of instrumentation.	Monthly
Receiver Tank	Clean and inspect, verify auto drain function, test level switch	90 Days
Control Panel	Test all system interlocks and faults	90 Days
AWS Tank	Clean and Inspect Tank Interior, Verify Backup Level Switch, Verify Level Transmitter Accuracy	90 Days
LEL Detector	As per site HSP and Manufacturer Recommendation	TBD
ESB	Verify shunt trip and ESB's	Annually
Air Flow Meters	Remove and clean and inspect FCI meters. Remove clean and inspect CDI meters.	90 Days
Liquid Flow Meter	Remove clean and inspect liquid flow meter	90 Days

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Appendix A-2
Building Layout, P&ID, and Electrical Schematics

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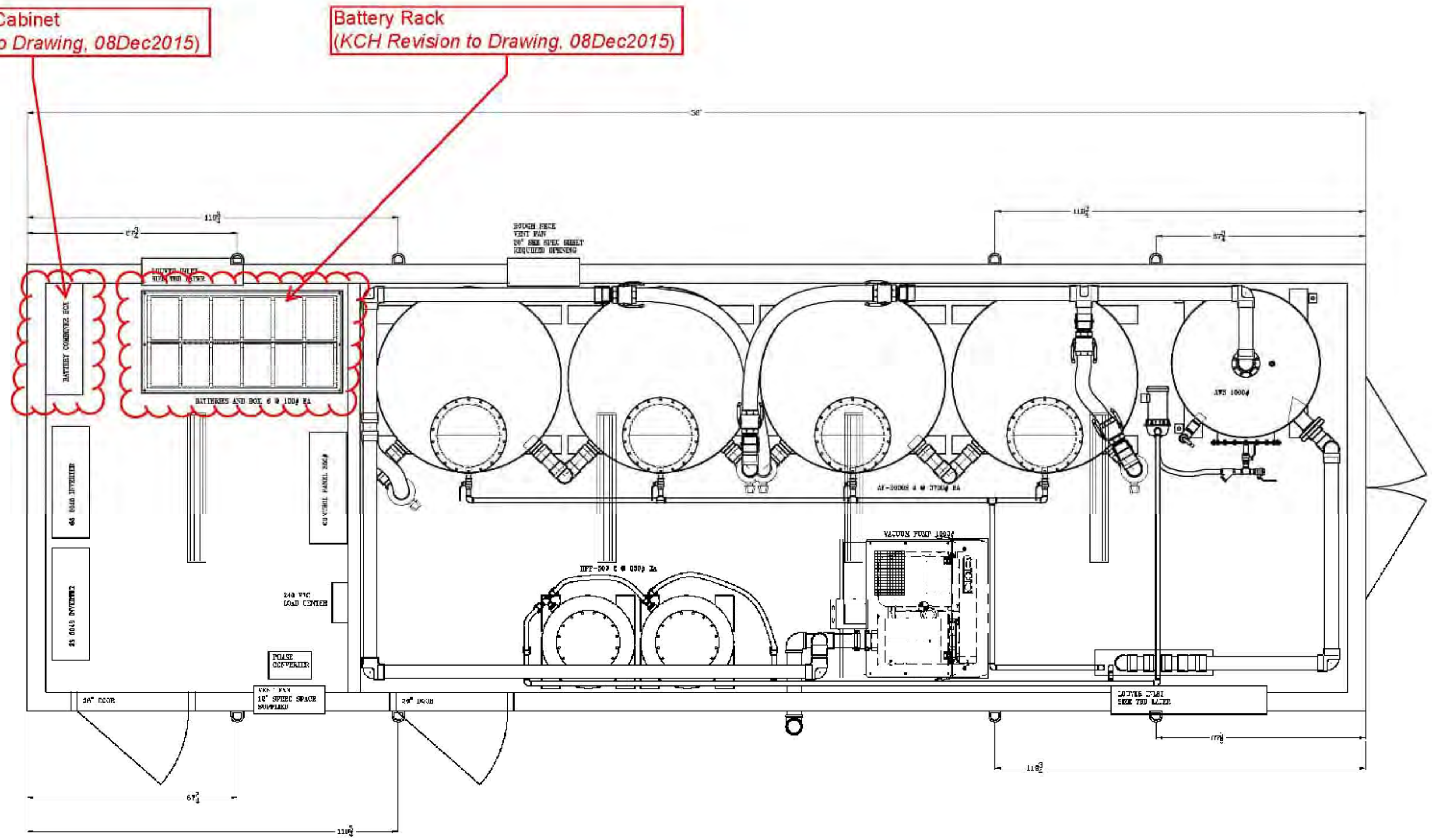

AS BUILT DRAWING

Note D-rings are located on the base of the building and requires the use of a spreader to keep the lifting straps off the side of the building

Designed by	Approved by	Customer	Job Number	Date	Scale/Unit
D Grieves	E Patterson	CH2M Hill	13-05A	March 30, 2016	NTS

Building Layout

Layout
Pearl Harbor, I

Drawing#

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MASTER BILL OF MATERIAL

ITEM	QTY	DESCRIPTION
100	1	VACUUM PUMP, KAESER COMPAC PLUS, MODEL DB166C, 10 HP 230/3/60 4" INLET/OUTLET, 2?? CFM @ 7" HG WITH SOUND ENCLOSURE
103	4	VAPOR PHASE CARBON [illegible], TETRASOLV FILTRATION MODEL MV-2000 4" [illegible], 2000 LB [illegible] GAC EA
104	1	AIR WATER SEPARATOR TETRASOLV FILTRATION MODEL MV/8-4 [illegible] GAL
105	1	CENTRIFUGAL PUMP GOULDS NPE MODEL 2 [illegible] 1.25 x 1.5 x 6 [illegible] 10-15 GPM, 35ft TDH
106	2	LIQUID PHASE CARBON FILTER, TETRASOLV FILTRATION MODEL HFP 500 1" FNPT I/O, 500 LB REACT GAC EA
201	1	AIR FILTER SOLBERG FS 19P 100, 1" FNPT
202	1	

ITEM	QTY	DESCRIPTION
401	3	DIAPHRAGM VALVE, [illegible] MODEL SF[illegible], 2" NPT
402	7	BALL VALVE [illegible] 1" BRONZE SS BALL TEFLON SEAT
403	1	SPRING LOADED CHECK VALVE
404	13	BALL VALVE [illegible] 1/4" BRONZE, SS BALL, TEFLON SEAT
405	3	3" BUTTERFLY VALVE ASAHI/AMERICA TYPE 57 W/ELECTRIC ACTUATOR SERIES 92
406	1	1" BRONZE WYE STRAINER
407	4	4" PVC [illegible] UNION BALL VALVE
800	1	FLOW METER/TOTALIZER MASTER METER MODEL AWWA C708
801		
802	11	VACUUM GAUGE [illegible] 4"/4A, 0-30" HG
803	1	PRESSURE RELIEF VALVE NATIONAL VACUUM MODEL 4705
804	1	MASS FLOW METER, [illegible] MODEL 6405 [illegible], 4-20 mA OUTPUT
805		
806	4	FLOW INDICATOR, [illegible] MODEL DS300-3, MAGNEHELIC [illegible] GAUGE [illegible] INDICATOR
807	3	PRESSURE GAUGE, PIC MODEL 201L, [illegible] 201L-[illegible] 0-60 PSI
808	1	VORTAB, [illegible] MODEL 64CS FLO4

ITEM	QTY	DESCRIPTION
809	1	LEVEL SWITCH [illegible] SENSORS [illegible] LEVELS AND LENGTH [illegible]

SYSTEM INTERLOCKS

ALARM	ACTION
ALL	SYSTEM SHUTDOWN

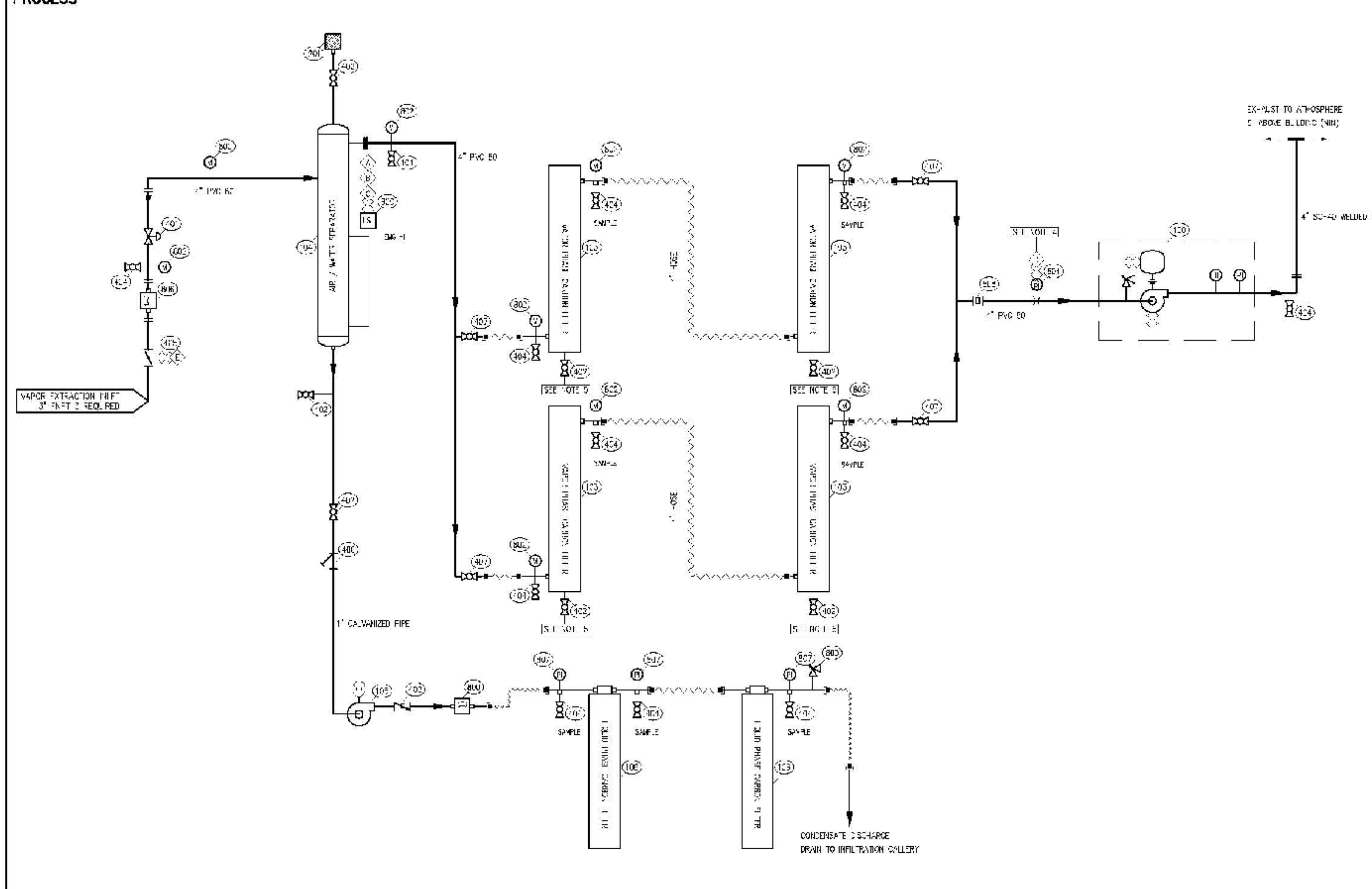
NOTES

1. ALL QUICK CONNECT FITTINGS ALUMINUM WITH BUNA-N GASKETS
2. ALL HOSE GOODYEAR [illegible] HOSE / SYNTHETIC RUBBER
3. PRIMARY SYSTEM VOLTAGE 230V 3 PHASE 60 HZ SOLAR POWERED
4. USE VORTAB RECOMMENDED PIPE LENGTHS
5. DRAINS TO GRAVITY DRAIN THROUGH FLOOR TO INFILTRATION GALLERY

BILL OF MATERIAL TAG LEGEND

1XX – SPECIALIZED PROCESS EQUIPMENT	6XX – HEATING AND VENTILATION
2XX – STANDARD PROCESS EQUIPMENT	7XX – NOT USED
3XX – CONTROL PANELS	8XX – INSTRUMENTATION
4XX – VALVES	9XX – OTHER
5XX – LIGHTING	0XX – NOT USED

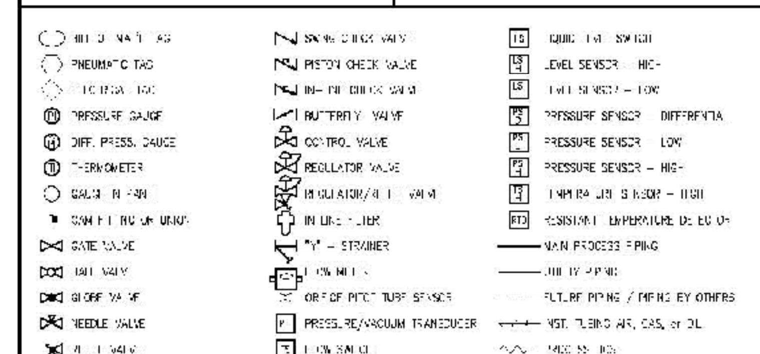
PROCESS



ELECTRICAL TERMINATIONS

- A HIGH LIQUID LEVEL SHUTDOWN [illegible] NO
- B HIGH LIQUID LEVEL PUMP START
- C LOW LIQUID LEVEL PUMP STOP
- D FLOW INDICATION, 4-20 mA OUTPUT
- E FLOW CONTROL VALVE

PNEUMATIC TERMINATIONS



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Fx: (2??) ?95-3?58

CHEVRON [illegible] | JOINT BASE PEARL HARBOR, HICKAM, HAWAII

PROCESS AND INSTRUMENTATION FLOW DIAGRAM

FOR

SOLAR POWERED SVE SYSTEM

DRAWN BY	CHECKED BY	APPROVED BY	DATE	SCALE	JOB NO.	DRAWING NO.	REV
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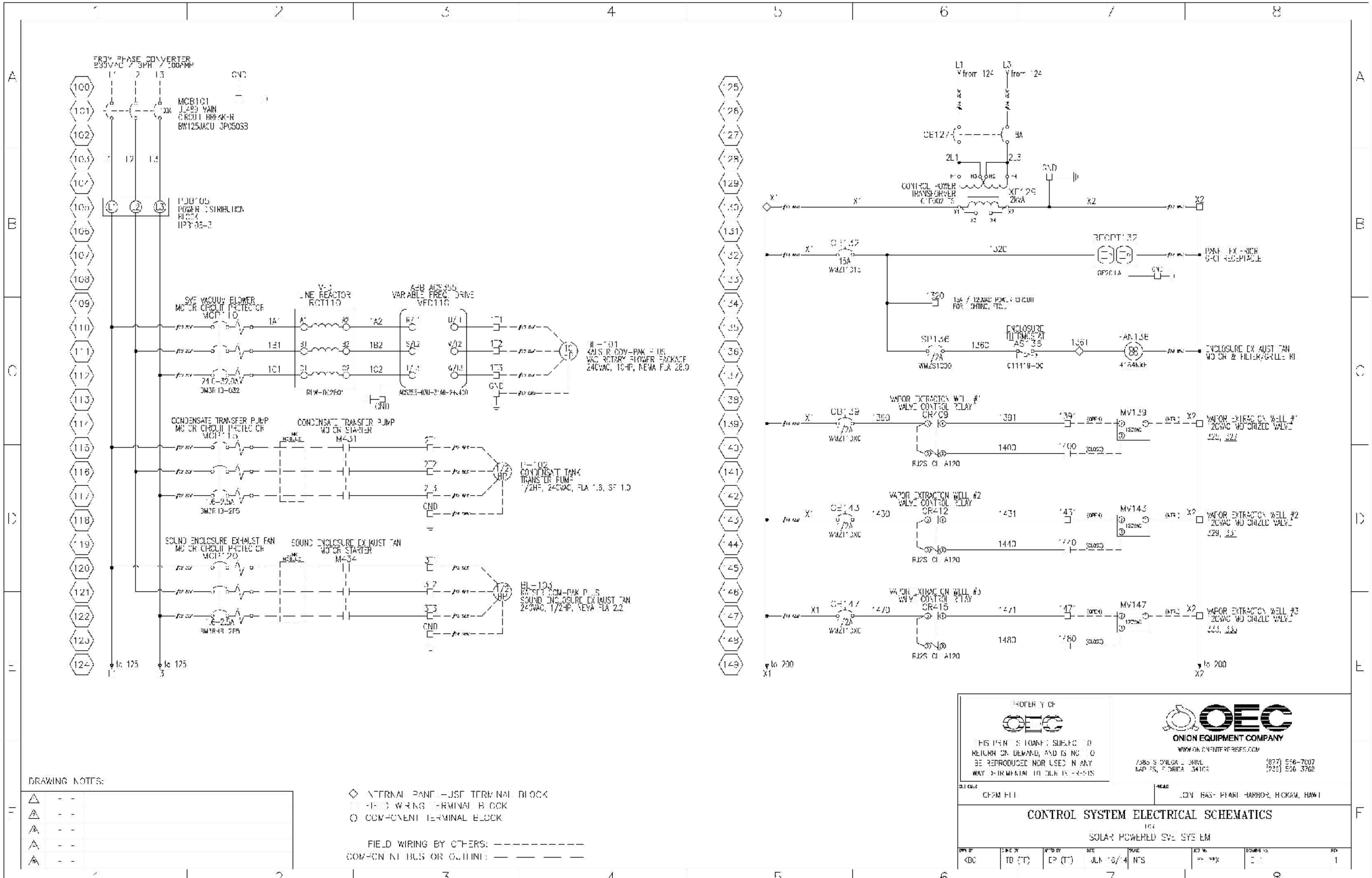
FROM PHASE CONVERTER
MCB101
PDB105
POWER DISTRIBUTION BLOCK
SVE VACUUM BLOWER MOTOR CIRCUIT PROTECTOR
LINE REACTOR
RCT110
VARIABLE FREQ. DRIVE
VFC110
CONDENSATE TRANSFER PUMP MOTOR CIRCUIT PROTECTOR
CONDENSATE TRANSFER PUMP MOTOR STARTER
M431
CONDENSATE TANK TRANSFER PUMP
SOUND ENCLOSURE EXHAUST FAN MOTOR CIRCUIT PROTECTOR
SOUND ENCLOSURE EXHAUST FAN MOTOR STARTER
M434
SOUND ENCLOSURE EXHAUST FAN
CONTROL POWER TRANSFORMER
RECPT132
GFCI RECEPTACLE
ENCLOSURE THERMOSTAT
FAN135
ENCLOSURE EXHAUST FAN
VAPOR EXTRACTION WELL #1 VALVE CONTROL RELAY
MV139
VAPOR EXTRACTION WELL #1 MOTORIZED VALVE
VAPOR EXTRACTION WELL #2 VALVE CONTROL RELAY
MV143
VAPOR EXTRACTION WELL #2 MOTORIZED VALVE
VAPOR EXTRACTION WELL #3 VALVE CONTROL RELAY
MV147
VAPOR EXTRACTION WELL #3 MOTORIZED VALVE
DRAWING NOTES:
INTERNAL PANEL FUSE TERMINAL BLOCK
FIELD WIRING TERMINAL BLOCK
COMPONENT TERMINAL BLOCK
FIELD WIRING BY OTHERS:
COMPONENT BUS OR OUTLINE:
PROPERTY OF OEC
OEC
ONION EQUIPMENT COMPANY
CONTROL SYSTEM ELECTRICAL SCHEMATICS
SOLAR POWERED SVE SYSTEM

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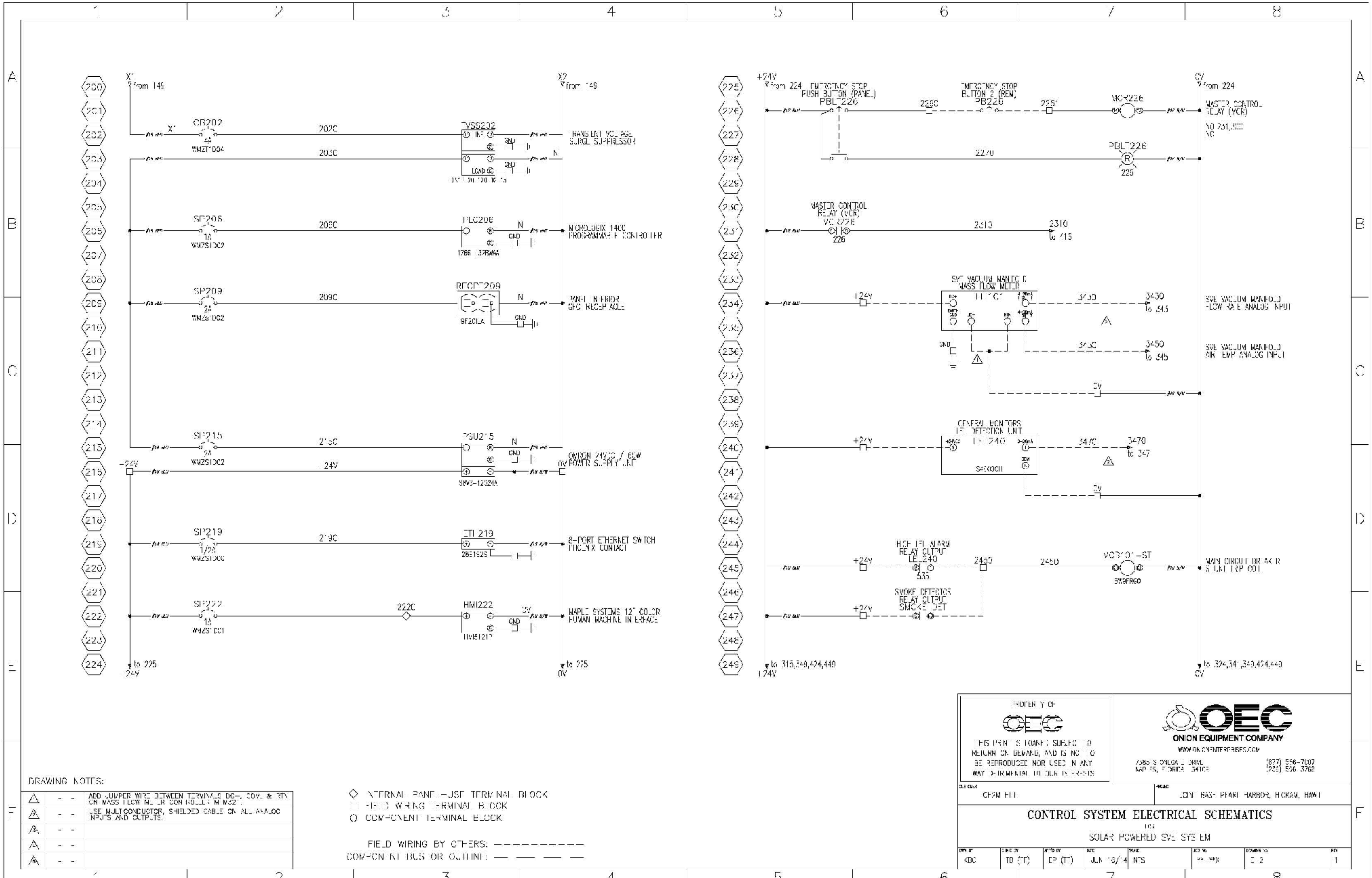

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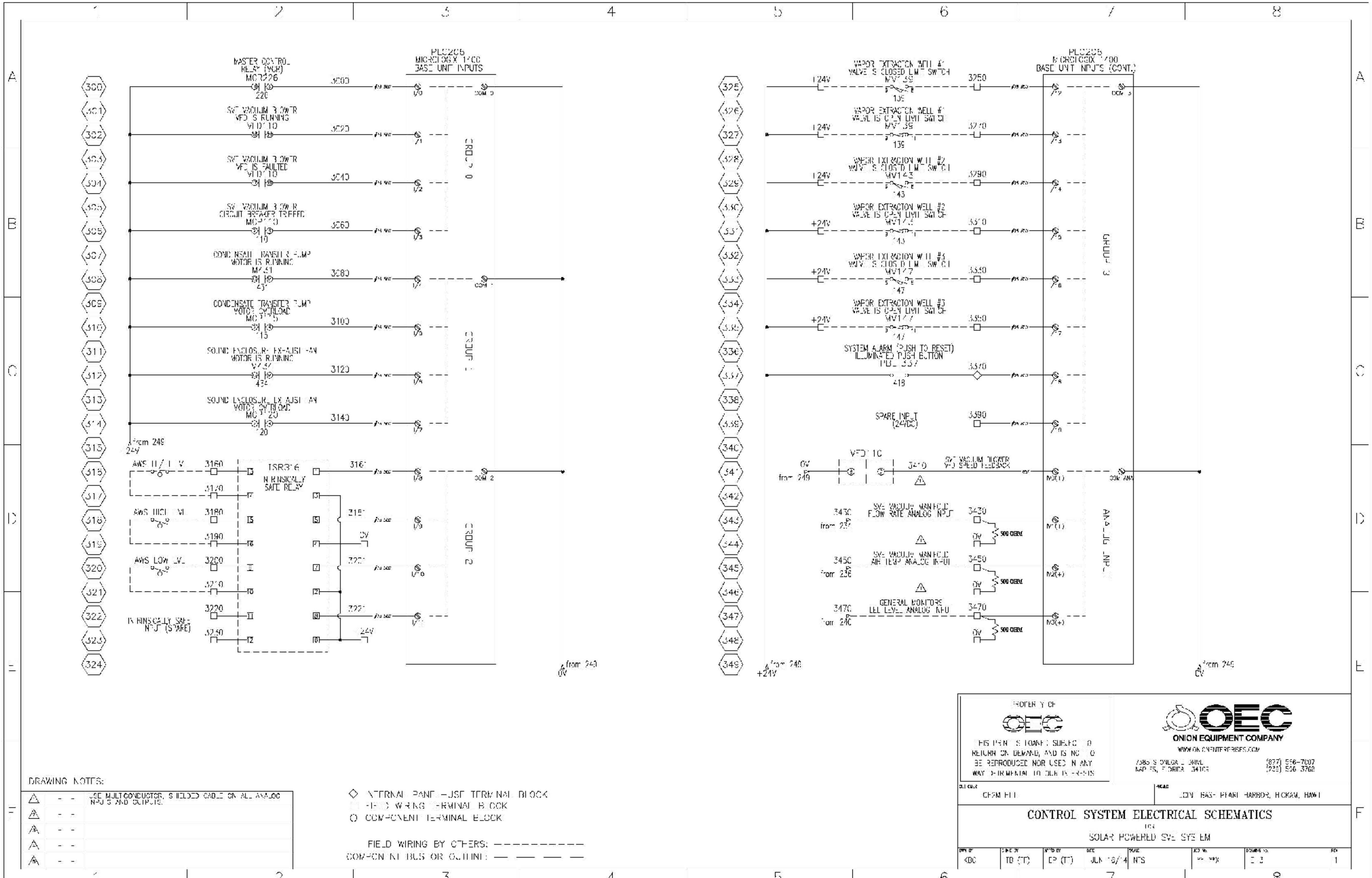

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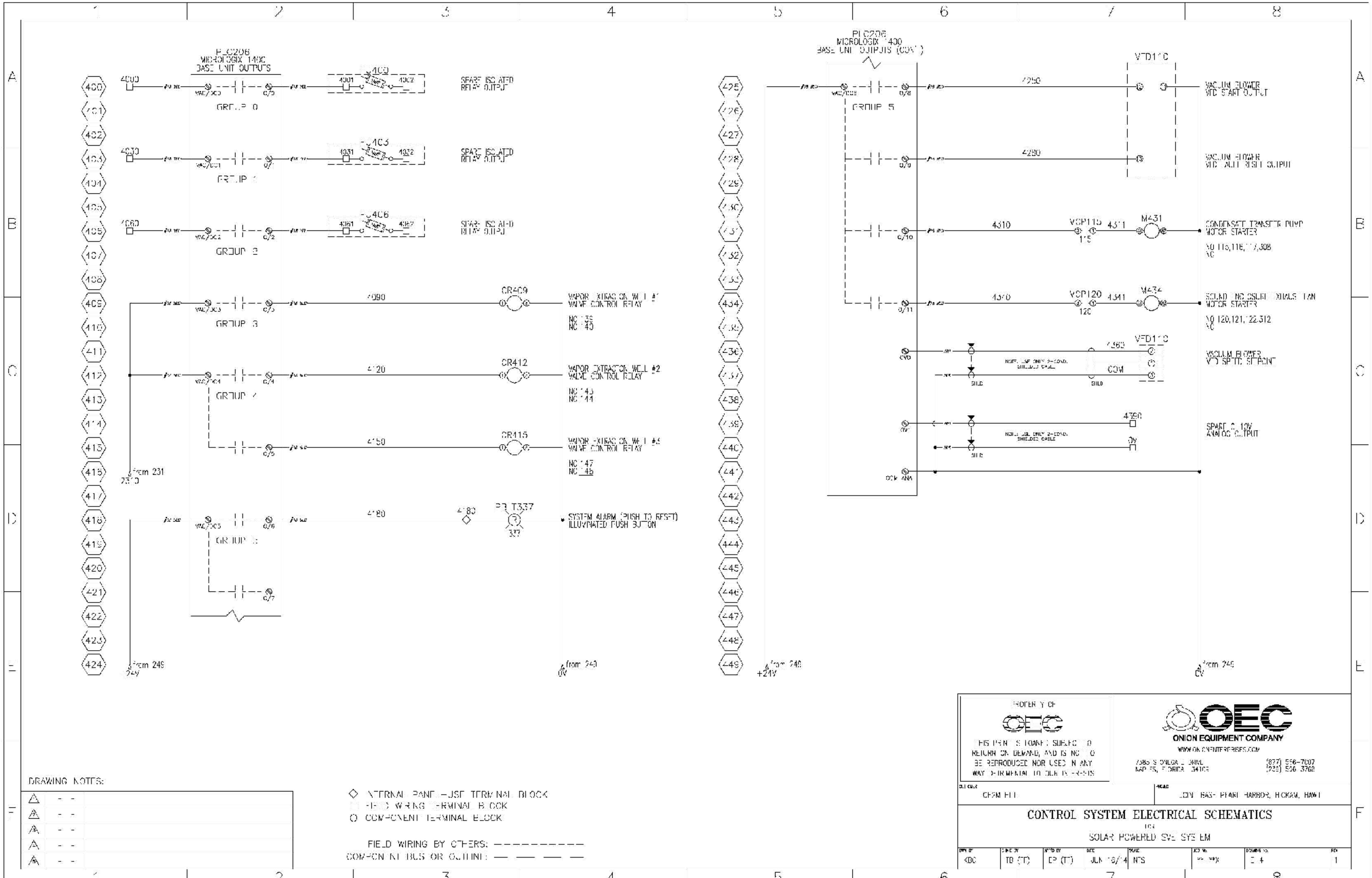

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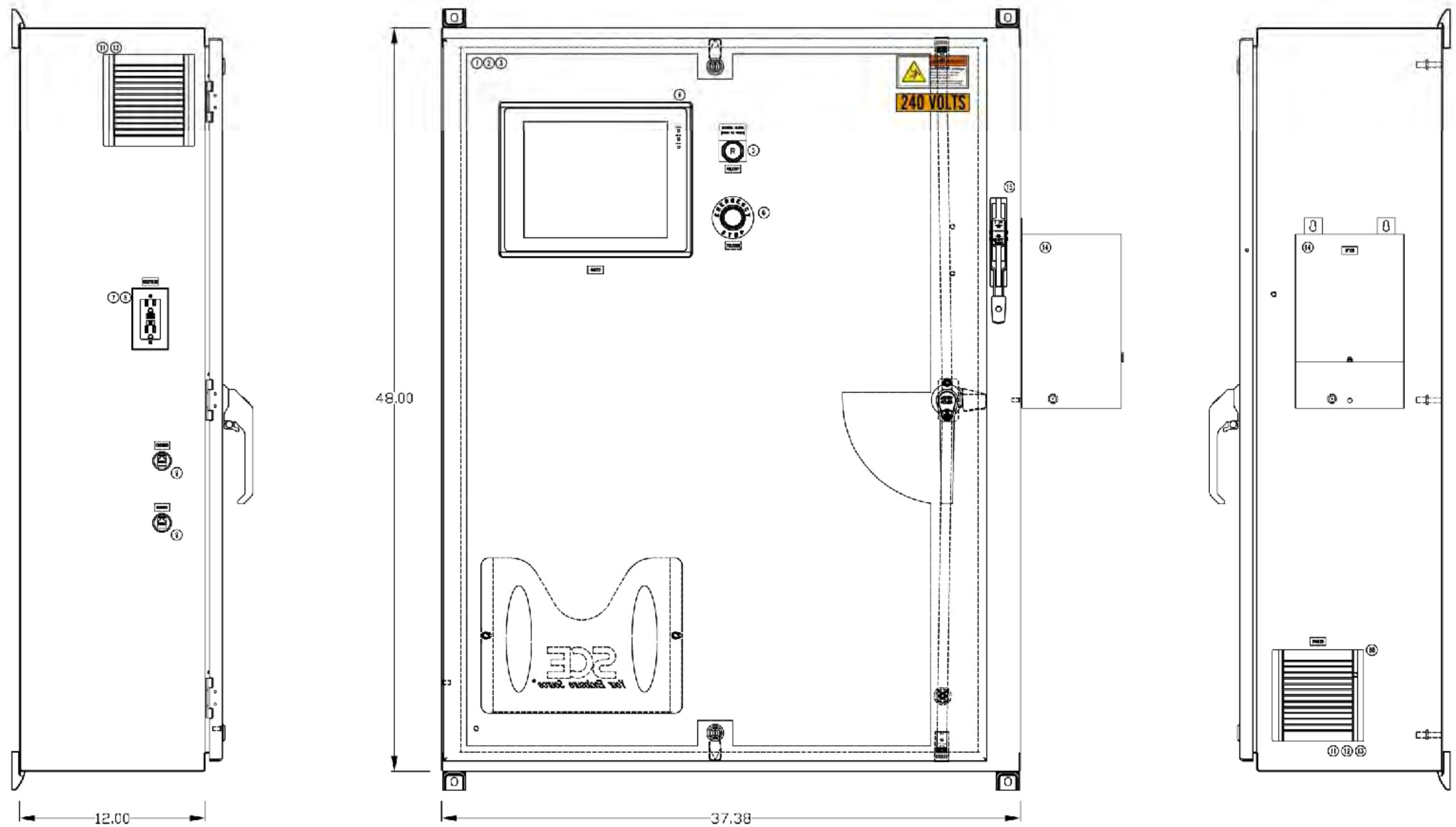
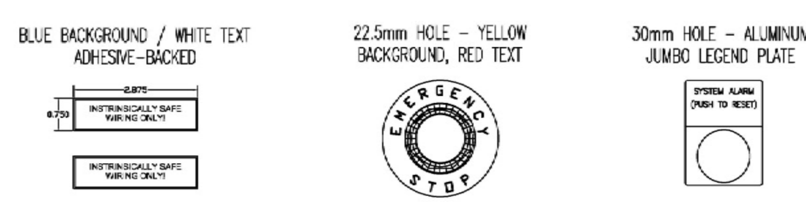


BILL OF MATERIAL

ITEM #	QTY	CATALOG	MANUFACTURER	DESCRIPTION
1	1	SCE-48XEL3712LP	SAGINAW C&E	NEMA 4/12 DISCONNECT ENCLOSURE 48" x 36" x 12"
2	1	SCE-48P36	SAGINAW C&E	48" x 36" SUB PANEL - WHITE PAINTED STEEL
3	1	SCE-ELMFK4	SAGINAW C&E	ENCLOSURE FOOT MOUNTING KIT
4	1	HMI5120P	MAPLE SYSTEMS	12" COLOR OPERATOR INTERFACE TOUCH SCREEN
5	1	ALD29910DN-R-24V	IDEC	30mm ILLUMINATED PUSH BUTTON, 24V LED, RED LENS
6	1	XW1E-LV411Q4M-R	IDEC	22mm ILLUM. RED E-STOP PUSH BUTTON, MAINT.
7	1	GF20ILA	HUBBELL	20A GFCI RECEPTACLE - IVORY
8	1	SS26	HUBBELL	STAINLESS STEEL GFCI COVER PLATE
9	6	M22-RJ45-SA	EATON	ETHERNET, CAT5e, IN-LINE COUPLER, STR. FOR RJ-45
10	1	4606N	EBM-PAPST	EX. FAN, 120VAC, 120x120x38mm, 105.9 CFM, 18W
11	2	LZ40N	EBM-PAPST	EXHAUST GRILLE & FILTER KIT
12	1	LZ126	EBM-PAPST	1M MOLDED 2-PRONG PLUG FOR EX. FAN
13	4	LZ40-1	EBM-PAPST	FILTER SCREEN MOUNTING BRACKET KIT
14	1	C1F002LES	HAMMOND	2kVA 1-PH. TRANSFORMER, 480/240 PRI x 120/240 SEC
15	1	BW9F0GA-15A	FUJI ELECTRIC	MAIN CIRCUIT BREAKER DISCONNECT HANDLE



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7385 STONEGATE DRIVE
NAPLES, FLORIDA 34109
(877) 566-7007
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CUSTOMER	PROJECT
CH2M HILL	JOINT BASE PEARL HARBOR, HICKAM, HAWII

CONTROL SYSTEM ELECTRICAL SCHEMATICS
FOR
SOLAR POWERED SVE SYSTEM

DWN BY	CHK'D BY	APP'D BY	DATE	SCALE	JOB No.	DRAWING No.	REV
KBC	TB (TF)	EP (TF)	JUN 16/14	NTS	**-**X	E-5	1

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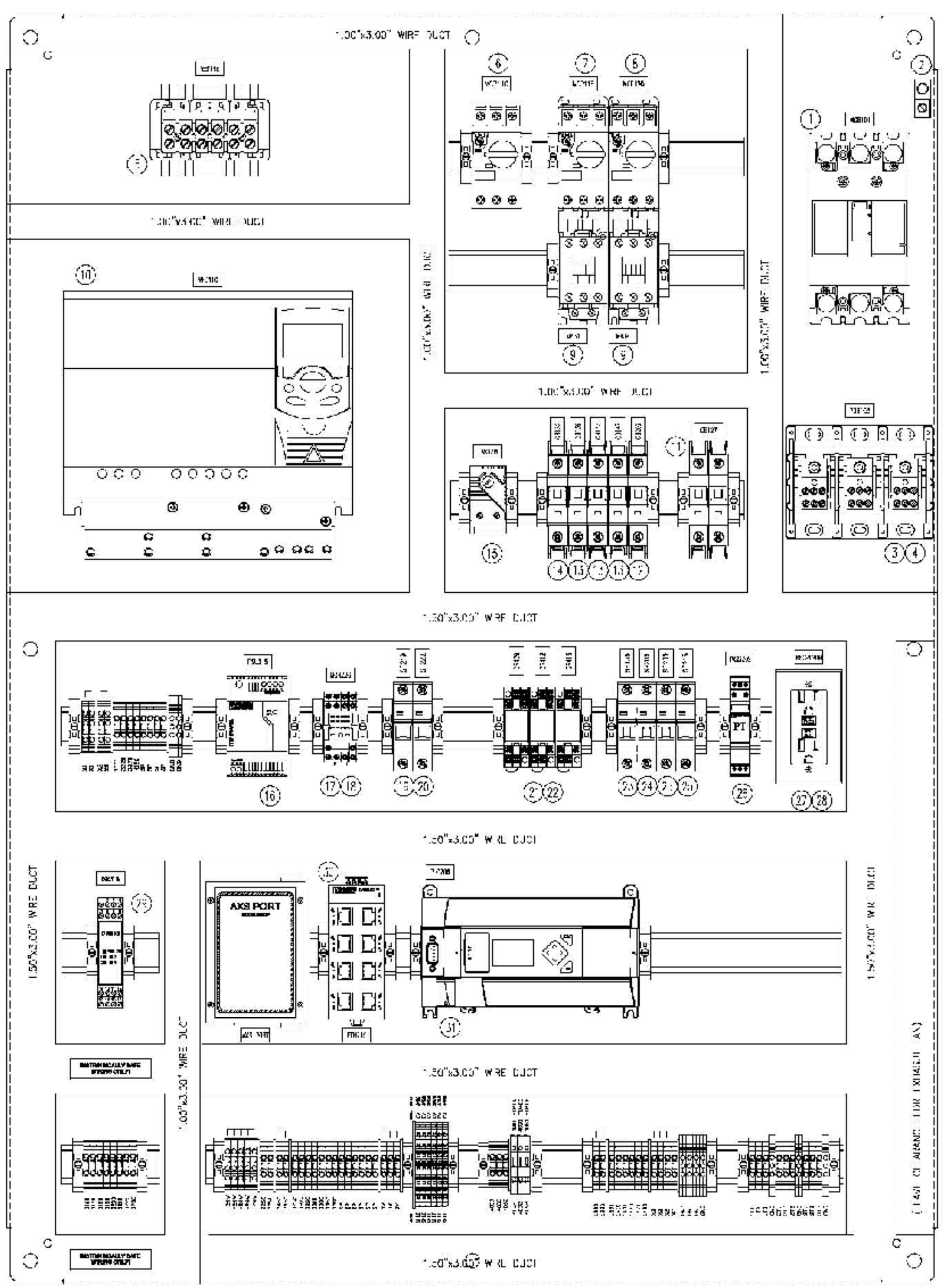
CONTROL PANEL INTERIOR LAYOUT



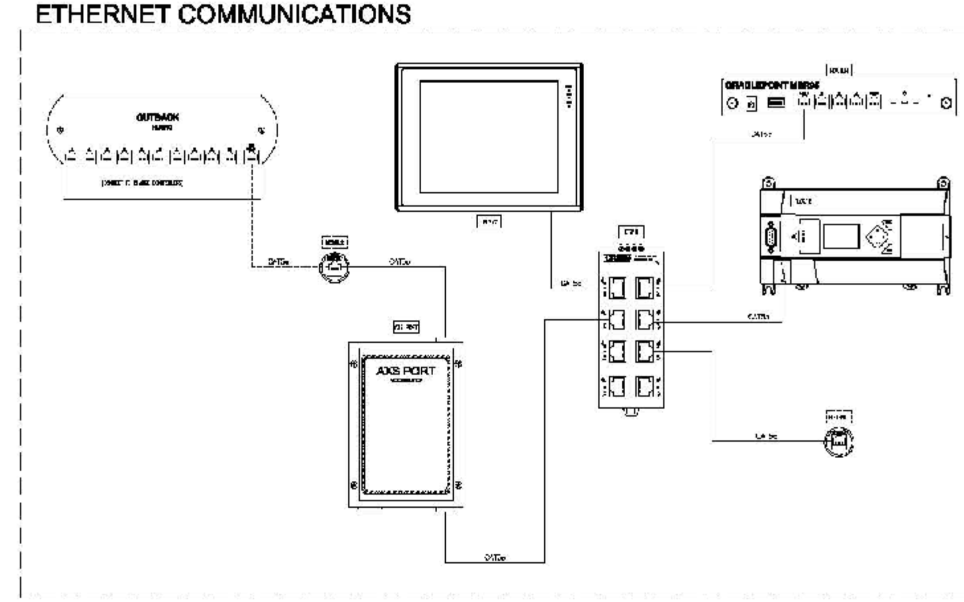
VFD110 MODIFIED PARAMTERS

PARAM #	DESCRIPTION	VALUE
1106	REF1 MAX	3500 RPM
1301	MINIMUM AI1	-0.6%
1401	RELAY OUTPUT 1	FAULT
1501	AO1 CONTENT SEL	OUTPUT FREQ.
1504	MINIMUM AO1	4.0 mA
1805	DO SIGNAL	RUN
2001	MINIMUM SPEED	900 RPM
2002	MAXIMUM SPEED	3500 RPM
2007	MINIMUM FREQ	[illegible]0.0 Hz
2202	ACCELER TIME 1	0.3 s
2203	DECELER TIME 1	0.0 s
2301	PROP GAIN	5.05
2302	INTEGRATION TIME	1.24 s
2304	ACC COMPENSATION	0.23 s
3401	SIGNAL1 PARAM	OUTPUT FREQ.
3408	SIGNAL2 PARAM	PID 1 SETPNT
3415	SIGNAL3 PARAM	PID 1 FBK
4005	ERROR VALUE INV	YES
4006	UNITS	InWC
4009	100% VALUE	56.0 InWC
4011	INTERNAL SETPNT	0.0 InWC
9902	APPLIC MACRO	PID CONTROL
9906	MOTOR NOM CURR	8.8A
9908	MOTOR NOM SPEED	3500 RPM

BILL OF MATERIAL

ITEM #	QTY	CATALOG	MFG	DESCRIPTION
1	1	BW125JAGU-3P050SB	FUJI ELECTRIC	UL489, 50AMP MOLDED CASE CIRCUIT BREAKER
2	1	CX70-14-CY	PANDUIT	#4-#14 COPPER MECHANICAL LUG
3	1	HPB105-3	EDISON	DIST. BLOCK, 1-POLE 175AMP 1-LINE/6-LOAD
4	1	PBC38	EDISON	DISTRIBUTION BLOCK COVER PLATE
5	1	RLW-002801	MTE	LINE REACTOR, 240V, 10HP, 3% INDUCTANCE
6	1	BM3RHB-032	FUJI ELECTRIC	MOTOR CIRCUIT PROTECTOR 45mm 24-32AMP
7	1	BM3RHB-2P5	FUJI ELECTRIC	MOTOR CIRCUIT PROTECTOR 45mm 1.6-2.5AMP
8	1	BM3RHB-2P5	FUJI ELECTRIC	MOTOR CIRCUIT PROTECTOR 45mm 1.6-2.5AMP
9	2	SC-E02G-24VDC	FUJI ELECTRIC	CONTACTOR 9A, 24VDC COIL, 43mm
10	1	ACS355-03U-31A0-2+J400	ABB	VFD, 10HP, 240VAC. w/ ADVANCED INTERFACE
11	1	WMZT2D06	EATON	UL489 2-POLE 6AMP CIRCUIT BREAKER
12	1	WMZT1D04	EATON	UL489 1-POLE 4AMP CIRCUIT BREAKER
13	3	WMZT1D00	EATON	UL489 1-POLE 1/2AMP CIRCUIT BREAKER
14	1	WMZT1D15	EATON	UL489 1-POLE 15AMP CIRCUIT BREAKER
15	1	011419-00	STEGO	EXHAUST FAN THERMOSTAT ADJ. 32F to 140F
16	1	2866351	PHOENIX CONTACT	DC POWER SUPPLY, CLASS 2, 24V, 60 WATT
17	1	RU4S-D-D24	IDEC	6A-24VDC MINATURE SQUARE BASE RELAY
18	1	SY4S-05C	IDEC	7A 14-BLADE RELAY BASE
19	1	WMZS1D00	EATON	UL1077 SUPPLEMENTARY PROTECTOR 1-POLE, 1/2AMP
20	1	WMZS1D01	EATON	UL1077 SUPPLEMENTARY PROTECTOR 1-POLE, 1AMP
21	3	RJ2S-CL-A120	IDEC	GENERAL PUPOSE RELAY, DPDT, 8A, 120VAC COIL
22	3	SJ2S-07LW	IDEC	RELAY SOCKET, DPDT, IEC FINGER-SAFE; RJ1
23	1	WMZS1C00	EATON	UL1077 SUPPLEMENTARY PROTECTOR 1-POLE, 1/2AMP
24	1	WMZS1D01	EATON	UL1077 SUPPLEMENTARY PROTECTOR 1-POLE, 1AMP
25	2	WMZS1D02	EATON	UL1077 SUPPLEMENTARY PROTECTOR 1-POLE, 2AMP
26	1	2856812	PHOENIX CONTACT	UL-1449, 120V, 10kA TRANSIENT VOLTAGE SURGE SUPP.
27	2	GF20ILA	HUBBELL	20AMP GFCI RECEPTACLE - IVORY
28	1	SS26	HUBBELL	STAINLESS STEEL GFCI COVER PLATE
29	1	D1031Q	GMI SAFETY	4-CH. INTRINSIC SAFETY BARRIER, 24VDC, TRANSISTOR OUT
30	1	2891929	PHOENIX CONTACT	8-PORT UNMANAGED ETHERNET SWITCH
31	1	1766-L32BWAA	ALLEN BRADLEY	MICROLOGIX 1400 PROGRAMMABLE CONTROLLER

ETHERNET COMMUNICATIONS



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ONION EQUIPMENT COMPANY
WWW.ONIONENTERPRISES.COM
7585 S ONLGATE DRIVE
NAPLES, FLORIDA 34109
(877) 596-7007
(239) 596-3762

CUSTOMER: CH2M HILL

PROJECT: JOINT BASE PEARL HARBOR, HICKAM, HAWAII

CONTROL SYSTEM ELECTRICAL SCHEMATICS
FOR
SOLAR POWERED SVE SYSTEM

DRN BY	CHKD BY	APPD BY	DATE	SCALE	JOB No.	DRAWING No.	REV
KBC	TB (TT)	EP (TT)	JUN 16/14	NTS	[illegible]	E-6	1

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Appendix A-3
Fabrication and Installation Drawings

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SPEED SPACE

BUILDING LOCATION: ANDERSON, INDIANA

OCCUPANCY GROUP: B

CONSTRUCTION TYPE: VB

MODEL	SIZE	SQ. FOOTAGE
SS1236	11'-9" X 36'-0"	423

DESIGN CODES

2008 INDIANA BUILDING CODE (2006 IBC/UFC W/IN AMEND)
2008 INDIANA MECHANICAL CODE (2006 IMC W/IN AMEND)
2010 INDIANA ENERGY CONSERVATION CODE
2009 INDIANA ELECTRIC CODE (2008 NFPA 70)
THIS UNIT IS TO MEET ALL UFC STANDARDS

INDEX	
0	COVER SHEET
0a	GENERAL NOTES
1	FLOOR PLAN
2	NOT USED
3	NOT USED
4	EXTERIOR ELEVATIONS
4a	EXTERIOR ELEVATIONS
5	CROSS SECTION
6	FRAME DETAILS

KEVIN M. FINN REGISTERED No. 19600032 STATE OF INDIANA PROFESSIONAL ENGINEER

6-12-14

DESIGN LOADS

ROOF LIVE LOAD:	30 PSF
WIND: SPEED:	120 MPH EXP. C
SEISMIC DESIGN CAT.:	E
FLOOR LIVE LOAD:	50 PSF

Kevin M. Finn, P.E., Inc.
1716 Elkhart Rd., Suite 1
Goshen, IN 46526
IN Lic. # PE19600032

SPEED ////// //////SPACE

65213 CR 31
GOSHEN, IN 46528

CUSTOMER:	
DEALER:	ONION EQUIPMENT
DRAWN BY: SJM	SCALE: NTS	DATE: 3/27/14
COVER SHEET	DWG #: 0	SERIAL #: A-8618	QUOTE# S022414GR4

REVISIONS	
NO.	DATE

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BUILDING CODE

1) BUILDER/DEALER SHALL BE RESPONSIBLE FOR ON SITE BARRIER FREE PROVISIONS; STEPS, RAMPS/ PARKING SIGNS, ETC. AND SHALL COMPLY TO THE AMERICANS WITH DISABILITIES ACT AND ALL STATE & LOCAL CODES OR REQUIREMENTS.
2) DOORS SHALL BE READILY OPENABLE FROM THE EGRESS SIDE WITHOUT THE USE OF A KEY.
3) CORROSIVE RESISTANT FLASHING AT TOP & SIDES OF DOORS, WINDOWS AND AT ROOF PENETRATIONS.
4) CLOTHES RODS AND HAT SHELVES SHALL BE MOUNTED NO HIGHER THAN 54 INCHES.
5) THE LOWER 12 INCHES OF ALL DOORS SHALL HAVE A SMOOTH UNINTERUPTED SURFACE.
6) POTABLE WATER TO BE SUPPLIED @ SITE BY OTHERS.
7) ADEQUATE TOILET FACILITIES SHALL BE LOCATED IN AN ADJACENT BUILDING UNDER SAME OWNERSHIP. WITHIN 500' OF THIS UNIT
8) THIS BUILDING IS NOT INTENDED TO BE OCCUPIED EXCEPT FOR SERVICE AND MAINTENANCE PERSONNEL.
9) THIS BUILDING SHALL MEET ALL IBC/UFC STANDARDS.

STRUCTURAL

1) TRUSSES TO BE CERTIFIED FOR LOAD AND APPLICATION USED.
2) INTERIOR PARTITIONS TO BE CONSTRUCTED TO WITHSTAND A 5 PSF HORIZONTAL FORCE.
3) INTERIOR WALL BOARD SHALL BE 1/4 INCH MINIMUM THICKNESS OR CONFORM TO SECTION 1422.5 (TESTED WITH MATERIALS SUSPENDED FROM THE NON-COMBUSTIBLE BACKING).
4) ALL LUMBER TO BE GRADED AND MARKED.
5) COMPRESSION PLATED REQUIRED TO ENSURE WOOD TO WOOD CONTACT AT BEARING WALL TO ROOF JOINTS.
6) DADOS AND NOTCHING NOT TO OCCUR IN CENTER 1/3rd OF THE LENGTH OF THE WALL STUDS.
7) EXTERIOR BRACING MAY BE PROVIDED WITH T1-11 WOOD SIDING, 7/16 INCH HARDBOARD SIDING, "STORMBRACE" EXTERIOR SHEATHING OR 3/8 INCH CDX PLYWOOD.

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No. 19600032
STATE OF
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PROFESSIONAL ENGINEER

6-2-14

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65213 CR 31
GOSHEN, IN 46528

CUSTOMER:				REVISIONS	
DEALER: ONION EQUIPMENT				NO.	DATE
DRAWN BY: SJM	SCALE: NTS	DATE: 3/27/14			
GENERAL NOTES	DWG #: 0a	SERIAL #: A-8618		QUOTE#	S022414GR4

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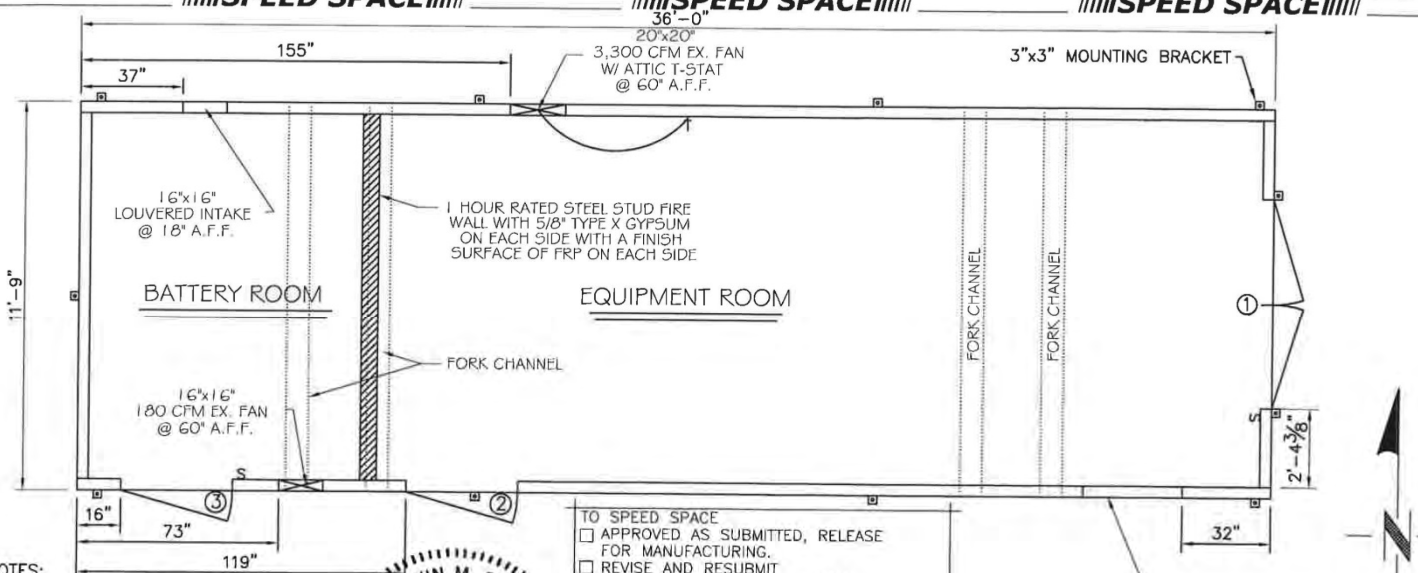

TO SPEED SPACE
☐ APPROVED AS SUBMITTED, RELEASE FOR MANUFACTURING.
☐ REVISE AND RESUBMIT
CUSTOMER NAME ________ DATE ____
DEALER NAME ________ DATE ____
DOORS MAY REQUIRE ADJUSTMENT DUE TO SHIFTING DURING TRANSPORT ADJUSTMENT IS RESPONSIBILTY OF CUSTOMER

NOTES:
1. RECESSED FLOOR SYSTEM
2. 20 GA WELDED STEEL UNDER BELLY
3. FLAT ROOF
4. 8'–0" CEILING HEIGHT
5. 5/8" TYPE X GOLD EXTERIOR SHEATHING
6. .045 EPDM RUBBER ROOF COVERING
7. CRANE LIFTING LUGS (8)
8. 5/8" PLYWOOD ROOF SHEATHING
9. INDIANA P.E. DRAWINGS
10. MOUNTING BRACKETS

KEVIN M. FINN REGISTERED No. 19600032 STATE OF INDIANA PROFESSIONAL ENGINEER

6/2/24

NOTE: INTAKE LOUVERS TO HAVE BUG SCREENS

ROOF		2x6 STEEL @ 16" O.C.
WALLS	*	2x4 14 GA, @ 16" O.C. FRP LAMINATED TO 1/2" CDX
FLOOR	*	2x6 13 GA, STEEL TUBE @ 12"O.C. 3/16" STEEL PLATE (PAINTED)
SIDING	SANDSTONE	CENTURY SERIES SIDING
	COLOR	FRAMING

DOOR & WINDOW SCHEDULE
1. 7284 20 GA. STEEL W/STEEL DOOR /BLANK/CLOSER 76 1/4"x86 1/4"
2. 3684 20 GA. STEEL W/STEEL DOOR /BLANK/CLOSER 40 1/2"x86 1/4"
3. 4084 20 GA. STEEL W/STEEL DOOR /BLANK/CLOSER 44 1/2"x86 1/4"

NOTE: DOORS ARE TO BE KEYED WITH TWO SETS OF KEYS

DOORS MAY REQUIRE ADJUSTMENT DUE TO SHIFTING DURING TRANSPORT
ADJUSTMENT IS RESPONSIBILTY OF CUSTOMER
OVERALL DIMENSIONS ARE OUTSIDE OF FRAME TO OUTSIDE OF FRAME. DIMENSIONS DO NOT INCLUDE SHEATHING, SIDING, OR ANY OTHER PROTRUSION SUCH AS DOOR KNOBS, A/C SLEEVES, SPRINKLERS, ETC...

SPEED////// //////SPACE.

65213 CR 31
GOSHEN, IN 46528

CUSTOMER:				REVISIONS	
DEALER: ONION EQUIPMENT				NO.	DATE
DRAWN BY: SJM	SCALE: NTS	DATE: 3/27/14			
PRODUCTION FLOOR PLAN	DWG #: 1	SERIAL #: A-8618		QUOTE#	S022414GR4

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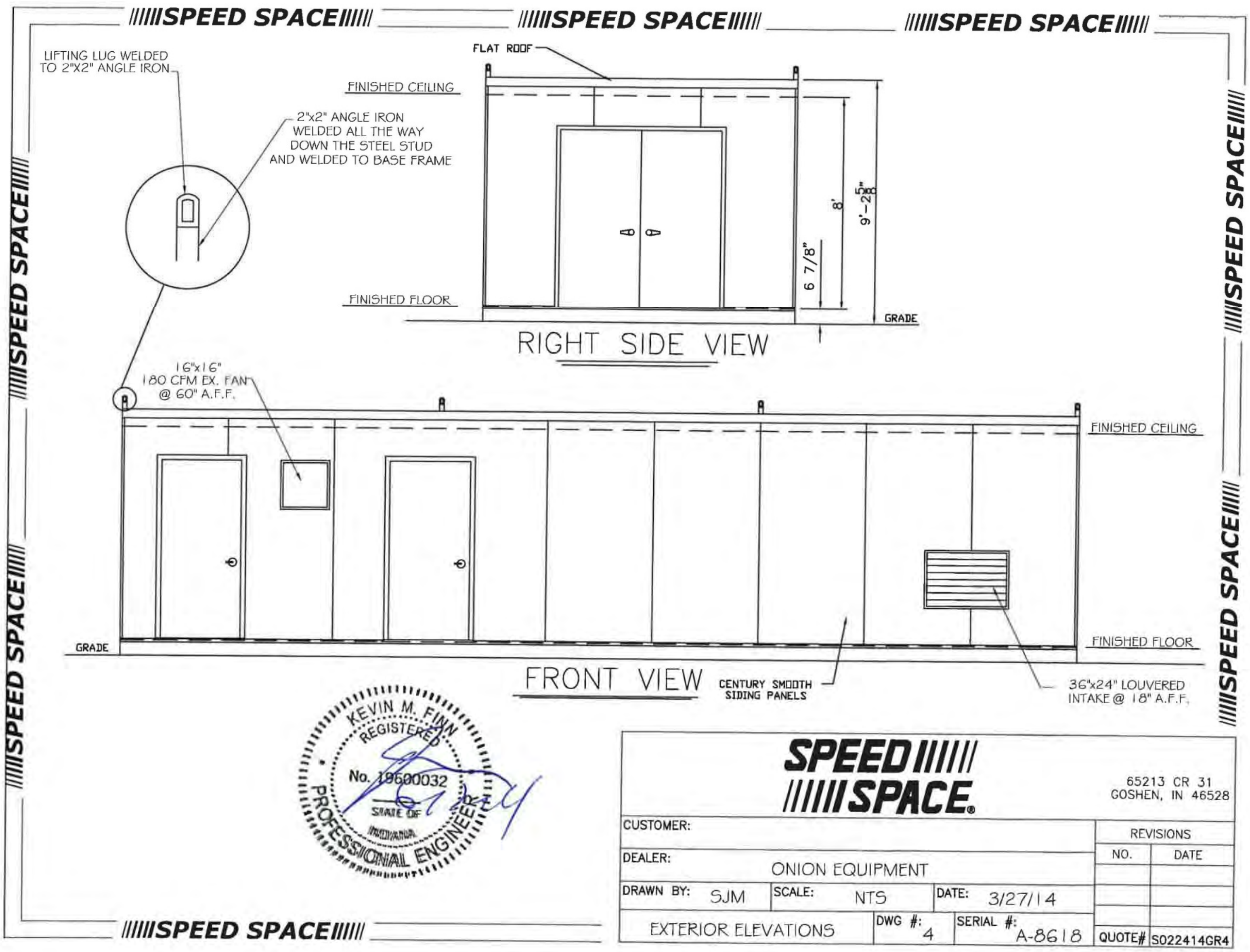

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LIFTING LUG WELDED TO 2"X2" ANGLE IRON
2"x2" ANGLE IRON WELDED ALL THE WAY DOWN THE STEEL STUD AND WELDED TO BASE FRAME
FLAT ROOF
FINISHED CEILING
FINISHED FLOOR
6 7/8"
8'
9'-2 5/8"
GRADE
RIGHT SIDE VIEW
16"x16" 180 CFM EX. FAN @ 60" A.F.F.
FRONT VIEW
CENTURY SMOOTH SIDING PANELS
36"x24" LOUVERED INTAKE @ 18" A.F.F.
KEVIN M. FINN REGISTERED No. 19600032 STATE OF INDIANA PROFESSIONAL ENGINEER
SPEED ////// //////SPACE®
65213 CR 31 GOSHEN, IN 46528
CUSTOMER:
DEALER: ONION EQUIPMENT
DRAWN BY: SJM
SCALE: NTS
DATE: 3/27/14
EXTERIOR ELEVATIONS
DWG #: 4
SERIAL #: A-8618
REVISIONS
NO.
DATE
QUOTE# S022414GR4

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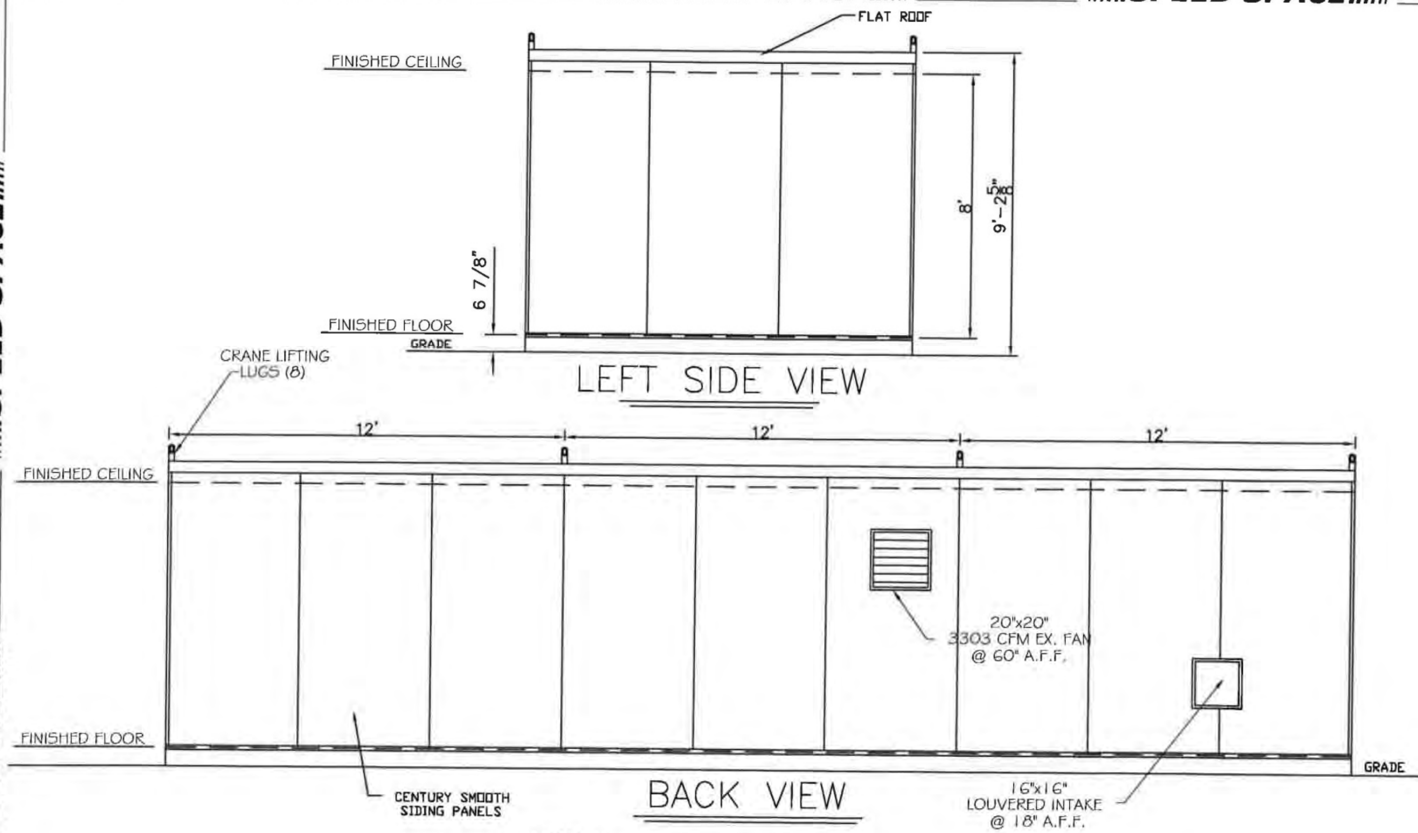

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65213 CR 31
GOSHEN, IN 46528

CUSTOMER:				REVISIONS	
DEALER: ONION EQUIPMENT				NO.	DATE
DRAWN BY: SJM	SCALE: NTS	DATE: 3/27/14			
EXTERIOR ELEVATIONS	DWG #: 4a	SERIAL #: A-8618		QUOTE#	S022414GR4

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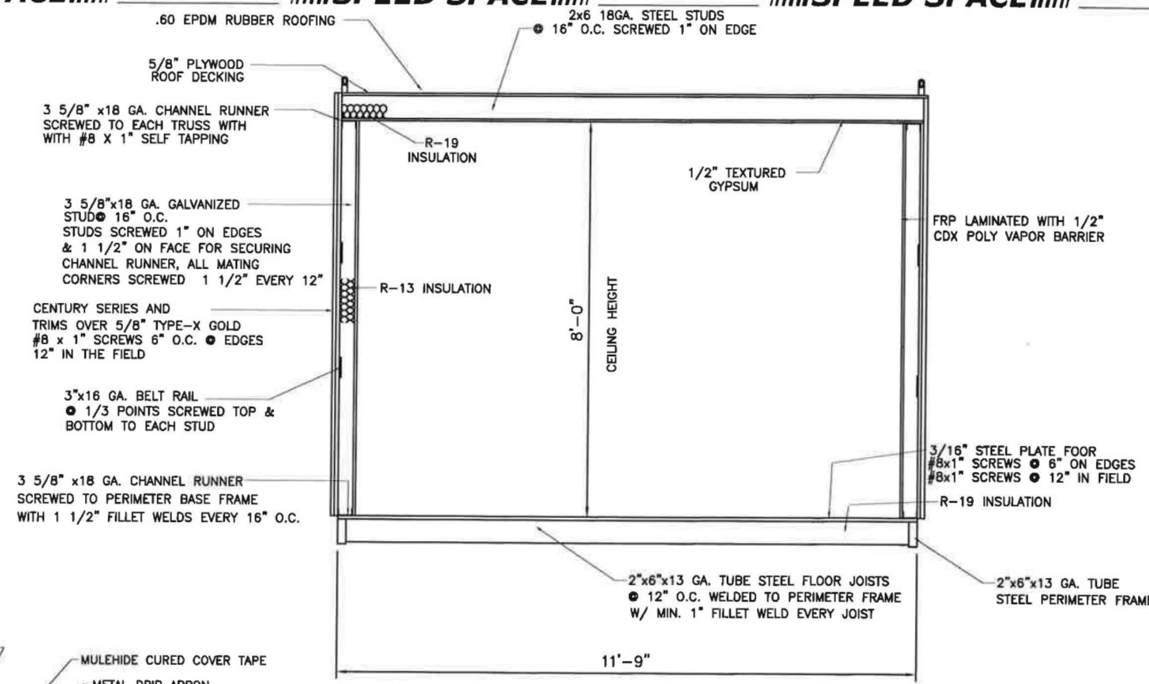
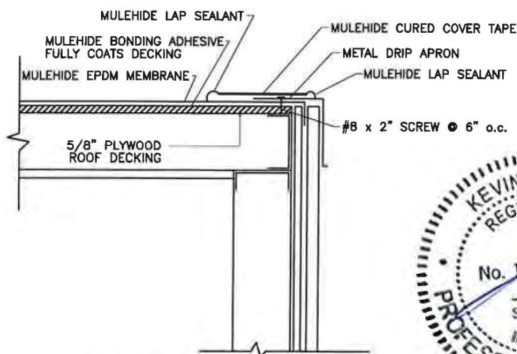


CROSS SECTION



ROOF TRIM DETAIL

MULEHIDE DETAIL MHE-102

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65213 CR 31
GOSHEN, IN 46528

CUSTOMER:			
DEALER: ONION EQUIPMENT			
DRAWN BY: SJM	SCALE: NTS	DATE: 3/27/14	
CROSS SECTION	DWG #: 5	SERIAL #: A-8618	QUOTE# S022414GR4

REVISIONS	
NO.	DATE

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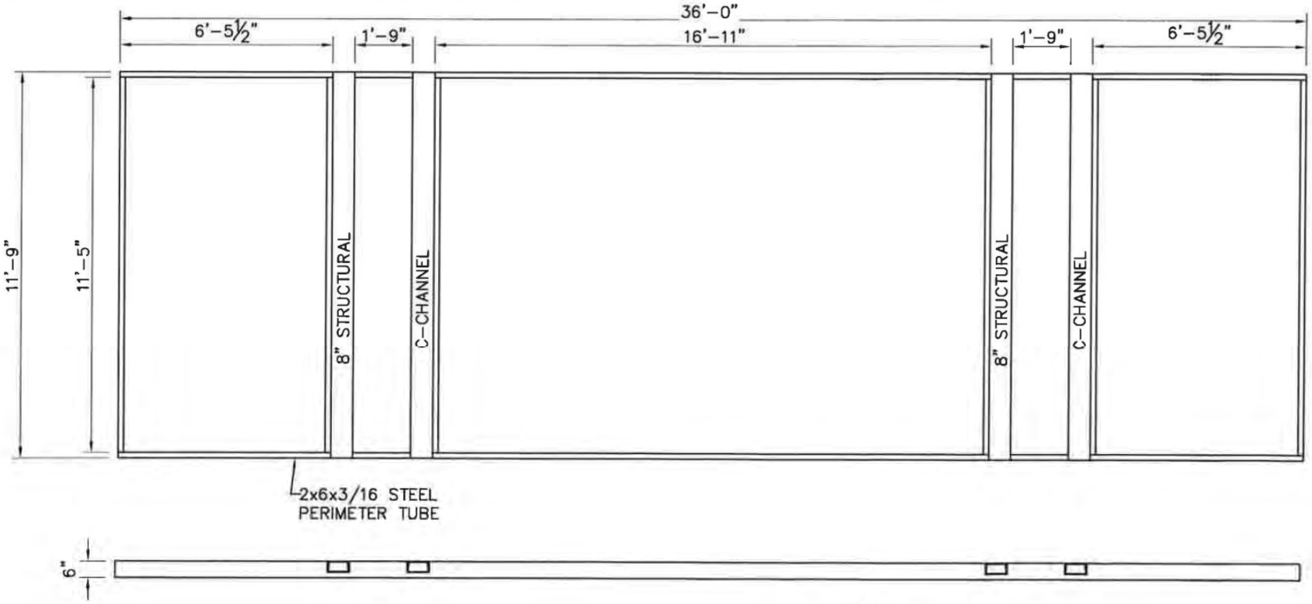

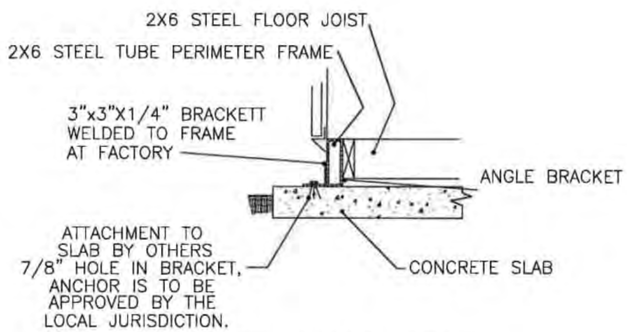

ATTACHMENT DETAIL

KEVIN M. FINN REGISTERED No. 19600032 STATE OF INDIANA PROFESSIONAL ENGINEER

UNIT MUST BE SQUARE
FRAME MUST BE FLAT

SPEED //////
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GOSHEN, IN 46528

CUSTOMER:				REVISIONS	
DEALER: ONION EQUIPMENT				NO.	DATE
DRAWN BY: SJM	SCALE: NTS	DATE: 3/27/14			
FRAME DETAILS	DWG #: 6	SERIAL #: A-8618		QUOTE#	S022414GR4

KCH-2622-KB06-0071

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ENGR: KEVIN M. FINN, P.E., INC.
1716 ELKHART RD., STE. 1
GOSHEN, IN 46526

THIS CALCULATION CONSIDERS THE STEEL FLOOR JOIST.
AND ANALYZES THE DESIGN SUPPORTING THIS CONSIDERATION.

A-8618 WIND SPEED - 120 MPH, EXP. C 2006 IBC w 2008 IN AMEN

NOMINAL WIND LOAD = 27.104 PSF

IMPORTANCE FACTOR - 1

TOTAL Cp = 1

TOTAL WIND LOAD USED FOR LATERAL RESISTANCE DESIGN = 27.10 PSF

WALL TRIB. WIDTH = 1.33 FT O.C.

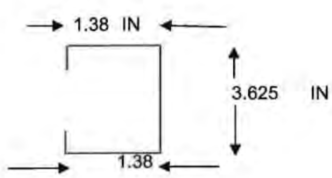
APPLIED UNIFORM LOAD AT WALL STUD = 36.05 PLF

EFFECTIVE LENGTH OF WALL STUD L = 8 FT

APPLIED BENDING MOMENT TO EACH END FRAME W x L^2 / 8 = 3460.6 IN-LBS

<u>WALL STUD = USE 3-5/8" x 18 GA. C-CHANNEL STUD</u>

Io =	0.71	t =	0.0451 IN
Sx =	0.3920	d =	3.625 IN
A =	0.34	width =	1.38 IN
Fy =	33 ksi	LDF =	1



RESULTANT BENDING STRESS = fb = M/Sx = 8828.16 psi

ALLOWABLE Fb = 19800 psi

CHECK DEFLECTION δ = 5W'L^4/384EI = 0.1614 IN

VS. ALLOWABLE DEFELCTION = L/240 = 0.4 IN - OK

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SPEED SPACE SUBJECT: FLOOR JOIST ANALYSIS

ENGR: KEVIN M. FINN, P.E., INC.
1716 ELKHRART RD., STE. 1
GOSHEN, IN 46526

THIS CALCULATION CONSIDERS THE STEEL FLOOR JOIST
AND ANALYZES THE DESIGN SUPPORTING THIS CONSIDERATION.

SERIAL NO. A-8618

IMPORTANCE FACTOR - 1 FLR LIVE LOAD = 50 PSF
TOTAL Cp = 1 FLR DEAD LOAD= 10 PSF

TOTAL LOADS FOR FLOOR JOIST LOADING = 60.00 PSF

FLOOR TRIB. WIDTH 1 FT O.C.

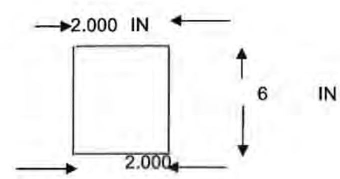
APPLIED UNIFORM LOAD AT FLOOR JOIST = 60.00 PLF

EFFECTIVE LENGTH OF FLOOR JOIST L = 11.3 FT

APPLIED BENDING MOMENT TO EACH JOIST W x L^2 / 8 = 11492.10 IN-LBS

FLOOR JOIST = USE SINGLE 2" x 6" x 13 GA. STEEL TUBE

Io =	5.899273	IN^4	t =	0.0897	IN
Sx =	1.9664	IN^3	d =	6	IN
A =	1.361	IN^2	width =	2.000	IN
Fy =	36	ksi	LDF =	1	



RESULTANT BENDING STRESS = fb = M/Sx = 5844.16 psi

ALLOWABLE Fb = 21600 psi

CHECK DEFLECTION δ = 5W'L^4/384EI = 0.10722 IN

VS. ALLOWABLE DEFELCTION = L/360 = 0.376667 IN - OK

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SPEED SPACE

SUBJECT: ROOF JOIST ANALYSIS

ENGR: KEVIN M. FINN, P.E., INC.
1716 ELKHART RD., STE. 1
GOSHEN, IN 46526

THIS CALCULATION CONSIDERS THE STEEL ROOF JOIST
AND ANALYZES THE DESIGN SUPPORTING THIS CONSIDERATION.

A-8618

WIND SPEED - 90 MPH
NOMINAL WIND LOAD = 20.933 PSF
IMPORTANCE FACTOR - 1
ROOF LIVE LOAD = 30 PSF (ROOF LOAD CONTROLS)
TOTAL Cp = 1
ROOF DEAD LOAD= 10 PSF

TOTAL WORST CASE (WIND OR ROOF LOADS) USED FOR ROOF JOIST LOADING = 40.00 PSF

WALL TRIB. WIDTH = 1.33 FT O.C.

APPLIED UNIFORM LOAD AT ROOF JOIST = 53.20 PLF

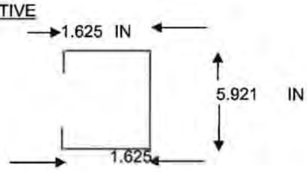
EFFECTIVE LENGTH OF ROOF JOIST L = 11.33 FT

APPLIED BENDING MOMENT TO EACH END FRAME W x L^2 / 8 = 10243.84 IN-LBS

ONE STANDARD INSTALLATION AND ONE ANGLED

ROOF JOIST = USE SINGLE 6" x 18 GA. CSJ STEEL STUD - CONSERVATIVE

Io =	2.316	IN^4	t =	0.0451	IN
Sx =	0.7720	IN^3	d =	5.921	IN
A =	0.447	IN^2	width =	1.625	IN
Fy =	33	ksi	LDF =	1	



RESULTANT BENDING STRESS = fb = M/Sx = 13269.22 psi

ALLOWABLE Fb = 19800 psi

CHECK DEFLECTION δ = 5W'L^4/384EI = 0.121 IN

VS. ALLOWABLE DEFELCTION = L/240 = 0.5665 IN - OK

CHECK SHEAR - (30 PSF + 10 PSF) x 11.75'/2 x 1.33' O.C. / A = 699.22 PSI - ok

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No. 19600032
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SUBJECT: WIND - LATERAL RESISTANCE ANALYSIS

ENGR: KEVIN M. FINN, P.E.
2700 W. WILDEN AVE. 4
GOSHEN, IN 46528

THIS CALCULATION CONSIDERS THE LATERAL ANALYSIS ON THE HORIZONTAL DIAPHRAGM OF WIND AND ANALYZES THE DESIGN SUPPORTING THIS CONSIDERATION.

WIND SPEED - 120 MPH exp. C -3 SECT — Factor CONVERT B TO C = 1.21
IMPORTANCE FACTOR - 1 — 2006 INTERNATIONAL BUILDING CODE / 2008 IN BC
WIND CONDTION EXCEEDS SEISMIC DESIGN CATEGORY B
qs = 20.98 PSF — MODEL REFERENCE: A-8618

TOTAL WIND LOAD = qs x Ce x = 25.38 PSF

TOTAL HORIZONTAL FORCE APPLIED AT TOP OF ROOF TO TOP PLATE CONNECTIION -

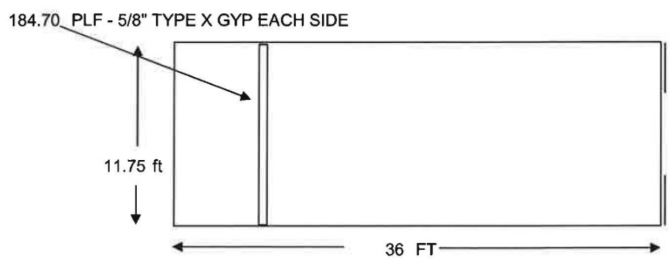
ROOF PROJECTION = 0.75 FT - ACTUAL ROOF PROJECTION
WALL PROJECTION = 8 FT

FORCE (PLF) AT TOP OF WALL = 120.57 PLF

APPLIED FORCE AT RIGHT ENDWALL (27' SECTION) = 1627.69 LBS

RESULTANT APPLIED MAXIMUM DIAPHRAGM SHEAR LOAD= 138.53 PLF - 11' 9" Diaphragm Depth
5/8" APA RATED SHEATHING
EFFECTIVE SHEARWALL LENGTH EACH ENDWALL (WORST CASE) OF UNIT LENGTH =
4.66 FT - SHEARWALL

RESULTANT SHEARWALL LOAD = 349.29 PLF - OKAY FOR 1/2" APA RATED SHEATHING
TYPE X GOLD GYPSUM



SHEARWALL TOTAL (ft) = 4.66

SHEARWALL HOLDDOWN REACTION - 11.25 FT DISTANCE FROM CENTER OF HOLDDOWN TO END OF SHEARWALL - BASED ON RESULTANT SHEARWALL LOAD x WALL HT. / (SHEARWALL LENGTH - DISTANCE END TO FASTENER L

= 1028.32 LBS < 1100 LBS - ACTUALLY USED

KEVIN M. FINN
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No. 19600032
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SPEED SPACE
65213 CR 31
Goshen, IN 46528
(574) 642-2666
engineering@speedspace.org

Subject: Seismic Vs. Wind
5/28/2014

Engr: Kevin M. Finn, P.E., Inc.
1716 Elkhart Rd., Ste 1
Goshen, IN 46526

LOCATION - ANDERSON, IN

2006 IBC w 2008 IN AMENDMENTS
PROJECT: 11' 9" x 36' A-8618

30 PSF ROOF LIVE LOAD

TW (wt) = l x w x (25 psf + (30-30)0.25)= 4387.5 LBS

TOTAL LOAD = ROOF DL & 1/2 WALL DL & 25% OF (30-30)LL
Cs IS THE MINIMUM Cs VALUE CALCULATED TO THE LEFT

Sds = 0.40
S = 2.00
Sd1 = 0.20 IE = 1
R = 6

Vr = CsW = 292.5 LBS

Cs =Sds / (R/IE) = 0.0667

SITE CLASS - D SEISMIC DESIGN CATEGORY - D

Cs = SD1/((R/IE)T) = 0.33 ← need not exceed
Cs = 0.044SdsIE = 0.0176 (abs. Min)

V = 292.50 lbs

T=0.1N= 0.1000

Fa = 1.1
Fv = 2

ROOF, WALL, FLOOR HEIGHT = 8 FT
WALL LENGTH = 36 FT

SEISMIC VS. WIND

WIND BASED ON WIND - WALL LOAD CALC - 120 MPH, EXP. C

q = 20.09 B to C = 1.21 W = q(GCp) = 24.31 PSF

TOTAL WIND FORCE ON LONGITUDINAL WALL = 3500.3 LBS - BASED ON WIND UPPER 1/2 OF WALL
(WIND CONTROLS)

TOTAL FORCE ON END WALL = 1142.46 LBS - BASED ON WIND - UPPER 1/2
VS. SEISMIC = 292.50 LBS - WIND CONTROLS ON THE ENDWALL

KEVIN M. FINN
REGISTERED
No. 19600032
STATE OF
INDIANA
PROFESSIONAL ENGINEER

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Design Loads

$Bldg_{dl} := 16000 \cdot lbf$ Maximum Building Dead Load applied to (8) Lug Config.

Bldg Information

$wall_{ht} := 9 \cdot ft + 2.625 \cdot in$ wall height

$bldg_{length} := 36 \cdot ft + 0 \cdot in$ building length

$bldg_{width} := 11 \cdot ft + 9 \cdot in$ building width

$FS := 1.33$

Lifting Element Information

$N_{lugs} := 8$

$Lug_{spacing} := 12 \cdot ft + 0 \cdot in$ lug spacing

$Lug_{capacity} := 3600 \cdot lbf$ lug capacity

$Angle_{leg} := 2 \cdot in$ angle leg ht.

$Angle_{thk} := 0.25 \cdot in$ angle thk

$Angle_{area} := 0.938 \cdot in^2$ angle area

Weld Information

$t_w := 0.125 \cdot in$ weld thickness

$F_{EXX} := 60 \cdot ksi$ weld tensile strength

$t_b := 0.25 \cdot in$ base metal thickness

$F_y := 36 \cdot ksi$ base metal yield strength

5/8" A307 Bolt Information

$T_{bolt} := 5900 \cdot lbf$ bolt tensile capacity (see AISC-ASD Table 1-B)

$$PLF_{bldg} := \frac{(Bldg_{dl})}{2 \cdot bldg_{length}} \qquad PLF_{bldg} = 222.2 \cdot plf$$

$$P_{lug} := FS \cdot \left[PLF_{bldg} \cdot (Lug_{spacing})\right] \qquad \text{maximum load per lug} \qquad P_{lug} = 3546.7\,lbf$$

$$Lug_{capacity} = 3600.0\,lbf \geq P_{lug} = 3546.7\,lbf \qquad CHECK_{lug} = \text{"OK"}$$

Weld Strength

$$t_e := 0.7071 \cdot t_w \qquad t_e = 0.088 \cdot in$$

$$R_1 := t_e \cdot (0.30 \cdot F_{EXX}) \qquad \text{fillet weld strength}$$

$$t := \min(t_w, t_b)$$

$$R_2 := t \cdot (0.40 \cdot F_y) \qquad \text{base metal strength} \qquad R = \begin{pmatrix} 1.59 \\ 1.80 \end{pmatrix} \cdot kli$$

$$R := \min(R) \qquad R = 1.59 \cdot kli$$

$$weld_{min.length} := \frac{P_{lug}}{R} \qquad weld_{min.length} = 2.2 \cdot in$$

$$weld := \begin{bmatrix} 2(1.35 \cdot in) \\ \frac{(8 \cdot ft)}{11} \\ 6 \cdot in \end{bmatrix} \qquad weld = \begin{pmatrix} 2.7 \\ 8.7 \\ 6.0 \end{pmatrix} \cdot in$$

NORTH CAROLINA PROFESSIONAL SEAL 28002 ENGINEER WILLIAM R. HEIDEN III

June 12, 2014

$$weld_{length} := \min(weld) \qquad weld_{length} = 2.70 \cdot in$$

Connection Summary: C.G. Eye Nut threaded onto 5/8" A307 bolt. The A307 bolt is to be welded to the 2x2x1/4" thk. angle. 2x2x1/4"thk. angl stitch welded to the wall stud & fully welded (6" min.) to the base frame

$$CHECK_{weld} = \text{"OK"}$$

Angle Tensile Strength

$$T_{angle} := 0.60 \cdot F_y \cdot Angle_{area} \qquad T_{angle} = 20260.8\,lbf$$

$$T_{angle} = 20260.8\,lbf \geq P_{lug} = 3546.7\,lbf \qquad CHECK_{angle} = \text{"OK"}$$

Bolt Strength

$$T_{bolt} = 5900.0\,lbf \geq P_{lug} = 3546.7\,lbf \qquad CHECK_{bolt} = \text{"OK"}$$

Note: The building must be evenly lifted using rated spreader bars that span the width of the building attaching to (8) lugs. The spreader bar width must match the building width so as to maintain a direct axial (vertical) load on the lifting lugs. Lateral &/or impact loads must not be placed on the angle or lug attachment points.
(Crosby Group "Eye Nut" or equivalent, 3600 lb. min. working load)

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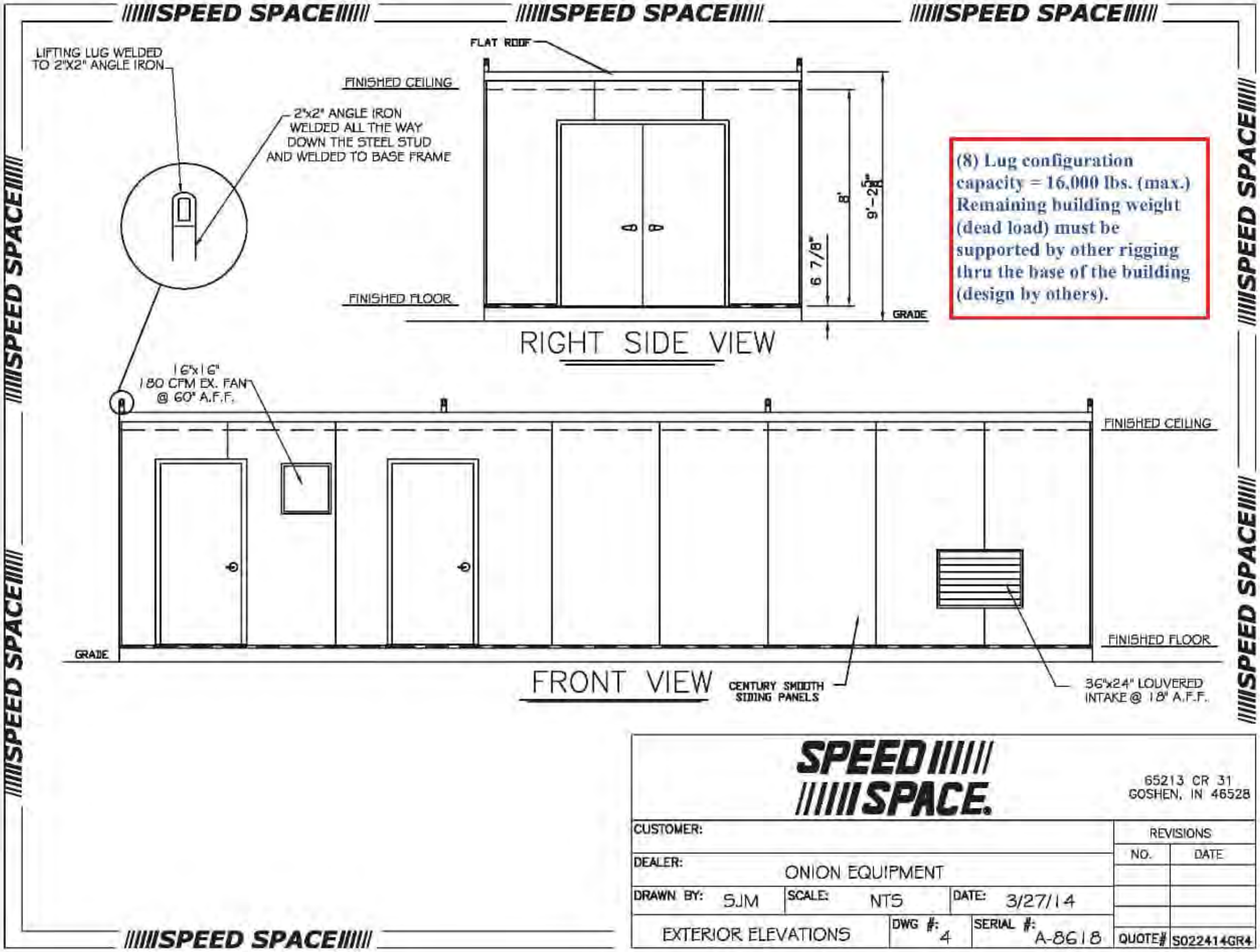
SPEED SPACE
LIFTING LUG WELDED TO 2"X2" ANGLE IRON
2"x2" ANGLE IRON WELDED ALL THE WAY DOWN THE STEEL STUD AND WELDED TO BASE FRAME
FLAT ROOF
FINISHED CEILING
FINISHED FLOOR
8'
9'-2 5/8"
6 7/8"
GRADE
RIGHT SIDE VIEW
(8) Lug configuration capacity = 16,000 lbs. (max.) Remaining building weight (dead load) must be supported by other rigging thru the base of the building (design by others).
16"x16" 180 CFM EX. FAN @ 60" A.F.F.
FINISHED CEILING
FINISHED FLOOR
GRADE
FRONT VIEW
CENTURY SMOOTH SIDING PANELS
36"x24" LOUVERED INTAKE @ 18" A.F.F.
SPEED SPACE.
65213 CR 31 GOSHEN, IN 46528
CUSTOMER:
DEALER: ONION EQUIPMENT
DRAWN BY: SJM
SCALE: NTS
DATE: 3/27/14
EXTERIOR ELEVATIONS
DWG #: 4
SERIAL #: A-8618
REVISIONS
NO.
DATE
QUOTE# S022414GR4

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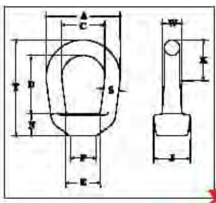
Forged Eye Nuts

G-400

- Forged Steel - Quenched and Tempered.
- Hot Dip galvanized.
- Tapped with standard UNC class 2 threads after galvanizing.
- Meets or exceeds all requirements of ASME B30.26 including identification, ductility, design factor, proof load and temperature requirements. Importantly, these products meet other critical performance requirements including fatigue life, impact properties and material traceability, not addressed by ASME B30.26.
- Also available in blank (as forged) item (S-4028) or on request with metric threading (M-400).
- Recommended for In-Line pull.



G-400 Eye Nuts

Size No.	"S" Stock Size (in.)	G-400 Stock No	Std. Tap Size	Working Load Limit (lbs.)*	Weight Per 100 (lbs.)	Dimensions (in.)									
						A	C	D	E	F	J	K	N	T	W
1	.25	1090438	1/4	520	.09	1.25	.75	1.00	.75	.50	.69	.63	.38	1.72	.31
2	.31	1090474	3/8	1250	.17	1.62	1.00	1.20	.83	.56	.81	.89	.50	2.09	.41
3A	.38	1090517	1/2	2250	.28	2.00	1.25	1.44	1.09	.81	1.00	1.09	.62	2.55	.50
4	.50	1090535	5/8	3600	.60	2.50	1.50	1.92	1.35	1.00	1.31	1.31	.69	3.25	.69
5	.63	1090553	3/4	5200	1.00	3.00	1.75	2.38	1.59	1.12	1.50	1.57	.88	3.89	.84
6	.75	1090571	7/8	7200	1.65	3.50	2.00	2.63	1.96	1.38	1.88	1.77	.94	4.32	1.00
7	.88	1090599	1	10000	2.69	4.00	2.25	3.06	2.21	1.56	2.13	2.02	1.07	5.01	1.19
8	1.00	1090633	1-1/4	15500	4.38	4.50	2.50	3.50	2.46	1.88	2.38	2.27	1.25	5.78	1.38
9	1.13	1090651	1-3/8	18500	5.00	5.00	2.75	4.00	2.69	2.00	2.56	2.53	1.38	6.51	1.50
10	1.25	1090679	1-1/2	22500	6.78	5.62	3.12	4.31	3.09	2.25	3.00	2.82	1.50	7.06	1.66
11	1.50	1090697	2	40000	14.60	7.12	4.10	6.20	4.09	3.13	3.75	3.68	2.06	9.91	1.94

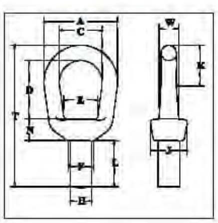
*Working Load Limit shown is for In-Line pull. Ultimate Load is 5 times the Working Load Limit. Rating based on standard tap size.

Min. Eye Nut Size & Lifting Capacity

Rigging Accessories

S-405

- Forged Steel — Quenched and Tempered.



S-405 Lifting Eyes

Size No.	S-405 Stock No	Working Load Limit Threaded (lbs.)*	Maximum Thread Diam. (in.)	Weight Each (lbs.)	Dimensions (in.)											
					A	C	D	E	F	H†	J	K	L	N	T	W
1	1090269	850	.31	.10	1.25	.75	1.02	.66	.50	.34	.69	.67	.69	.42	2.46	.31
2	1090287	1250	.38	.20	1.62	1.00	1.20	.75	.56	.41	.81	.92	.94	.55	3.00	.41
3	1090303	2250	.50	.50	2.00	1.25	1.44	1.00	.81	.53	1.13	1.13	1.25	.68	3.69	.50
4	1090321	3600	.63	.79	2.50	1.50	1.92	1.19	1.00	.66	1.31	1.38	1.50	.80	4.59	.69
5	1090349	5200	.75	1.25	3.00	1.75	2.28	1.38	1.12	.78	1.50	1.66	1.75	.98	5.55	.84
6	1090367	7200	.88	2.25	3.50	2.00	2.50	1.63	1.38	.91	1.88	1.91	1.88	1.06	6.16	1.00
7	1090385	10000	1.00	3.25	4.00	2.25	2.92	1.88	1.56	1.03	2.13	2.16	2.06	1.20	7.07	1.19
8	1090401	12500	1.13	4.70	4.50	2.50	3.35	1.94	1.88	1.16	2.38	2.47	2.50	1.40	8.16	1.38
10	1090410	18000	1.50	9.33	5.62	3.12	3.81	2.75	2.25	1.53	3.00	2.98	3.21	1.69	9.96	1.66

*Ultimate Load is 5 times the Working Load Limit. Rating based on UNC thread size shown in Max Thread Diameter column.
† Dimension before machining (as forged)

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Appendix A-4
GAC Changeout Procedure

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GAC CHANGEOUT PROCEDURE
SOIL VAPOR EXTRACTION SYSTEM O&M PLAN
SUBSITE ST32 ONIZUKA VILLAGE
JOINT BASE PEARL HARBOR-HICKAM, HAWAII

Following a determination that total petroleum hydrocarbon (TPH) has saturated the granular activated charcoal (GAC) (refer to Section 3.3.3 of the Operations and Maintenance [O&M] Plan), it will be necessary to change out the GAC. This involves using an industrial vacuum to remove and place the spent GAC in supersacks, followed by placing fresh GAC into the vessels.

Before conducting GAC changeout, all site personnel are responsible for knowing, understanding, and following the safety procedures outlined in the health and safety plan, and in the task-specific procedural activity hazard analyses (AHAs) (refer to Appendix F-2 and F-3 for the O&M AHA and the material safety data sheets for GAC, respectively). All tools and equipment need to be thoroughly inspected before use. Any deficiencies found will be repaired before use. The soil vapor extraction (SVE) system will be powered off before performing GAC changeout.

Materials recommended for GAC changeout include (but are not limited to) the following:

- Supersacks to contain spent GAC
- An industrial vacuum, such as the diesel-powered Hurricane 500 (cutsheet for Hurricane 500 provided with this GAC changeout procedure)
- Flexible hose long enough to reach from the vacuum unit to the GAC vessels (roughly 6-inch diameter, or similar)
- An all-terrain, extended reach forklift
- Fresh GAC
- Pallets (one for each supersack of GAC) removed from the vessels (Note that one supersack holds 1,000 pounds so two supersacks are required to support changeout of one vessel.)
- Stepstool or short ladder
- Socket wrench to remove GAC vessel manways and for placement of the manway adapter
- Photoionization detector (PID) to monitor air quality for presence of volatile organic compounds (VOCs) in ambient air/breathing zone
- Personal protective equipment (PPE) (i.e., hardhat, safety glasses, hearing protection, hand protection, safety-toe work boots, and work clothes)

Extraction of Spent Vapor GAC

An industrial vacuum, such as the diesel-powered Hurricane 500, can be used to extract the spent GAC and temporarily contain the material in a hopper mounted on the vacuum. The hopper can be elevated or lowered to the desired height before GAC removal. An all-terrain, extended reach forklift is required to be positioned with the forks under the hopper. The hoops at the top of an empty supersack can then be slipped onto the forks so that the forks hold the empty supersack under the hopper to contain spent GAC when it is being transferred from the hopper to the sack [Photo 1]. The industrial vacuum can be parked just outside the gated entrance to the SVE system building. Flexible hose should be securely attached to the inlet port of the vacuum using a hose clamp, duct tape, or similar means of attachment. A sufficient length of hose is needed to reach from the vacuum unit to each of the GAC vessels requiring changeout. A "stinger" can be constructed at the intake end of the hose to assist in manipulating the hose inside the GAC vessels during extraction.

Access to each vessel is gained by removing the bolts to remove the manway cover. The operator will need to use a step stool or short ladder to remove the manway cover. Immediately upon opening each manway, a PID should be used to monitor and document air quality. After setup, the vacuum is started and the operator manually manipulates the flexible vacuum hose inside the GAC vessel to remove all extractable GAC. The GAC vessels are not intended for personnel entry and confined space entry is not allowed. The operator must vacuum out the spent GAC until it can be visually confirmed that there are no deposits of spent GAC remaining [Photo 2]. Only minor residual amounts of spent GAC can be left. Following removal of the GAC from the vessel, the vessel internals should be inspected.

Storage of Spent GAC

Spent GAC in the vacuum hopper can then be transferred from the hopper to the super sack directly underneath it. Supersacks containing spent GAC must be placed on top of wooden pallets and can be temporarily staged either inside the fenced area at the SVE system building (limited space and difficult access), but after the work is completed they need to be transferred to the former John Rogers Tank Farm (JRTF) contractors waste staging area (or other designated location) on JBPHH pending final disposition. Before sealing the supersacks a representative sample of GAC needs to be collected to support waste profiling to support transport and disposal. The forklift can be used to move and position supersacks to their staging location. If supersacks containing spent GAC are to be staged at the JRTF, the supersacks must be loaded onto a transport vehicle and they must be driven out to JRTF. The pallets GAC supersacks can't be transported by forklift. A forklift would then also be needed to offload the supersacks from the transport vehicle to the staging area (placed on a pallet). All supersacks containing spent GAC must be tied up and secured under 10-mil black plastic sheeting or a tarp properly anchored.

Refilling Vessels with Fresh GAC

To refill a vessel with fresh GAC, a fabricated manway adapter equipped with a male and a female camlocks is installed over the manway [Photo 3]. This adapter can be secured to the manway opening using the same nuts and bolts that are used to secure the manway cover [Photo 4]. Fresh GAC in supersacks can be positioned outside the fenced area and adjacent to the industrial vacuum unit. With the GAC vessel manway adapter secured on the vessel, the flexible hose can be re-routed so that the vacuum intake end is accessible to the fresh GAC in the supersacks and the outlet end of the hose is firmly and securely attached to one of the camlock fittings of the manway adapter. Using the industrial vacuum unit, the operator then manually manipulates the intake end of the hose to suck fresh GAC from the supersack adjacent to the vacuum unit, which will then convey the fresh GAC into the vessel through the manway adapter. As noted, the manway adapter has dual camlock ports. One of the ports must remain open to ambient air during backfill of fresh GAC to allow for airflow through the vessel. The GAC vessels should be filled to a level just below where the soil vapor enters each vessel during normal SVE system operation [Photo 5]. Once the GAC is placed in the vessel it should be consolidated as required. After fresh GAC has been transferred into a vessel, the manway adapter can be removed and the primary manway cover reinstalled and secured.

Changeout of Spent Liquid GAC

Changeout of the liquid GAC (LGAC) is generally performed in the same manner, with the added step that liquid inside the LGAC vessels must be drained first. Each LGAC vessel has a valve near the bottom that can be opened to drain the liquid [Photo 6]. So long as the LGAC train is still extracting chemicals from the liquid and breakthrough of the LGAC has not occurred, the drained liquid can be transferred to the infiltration gallery at the wellheads adjacent to the northwest side of the SVE system building [Photo 7]. If the extraction capacity of the LGAC has been reached, the drained liquid must be contained, managed, and disposed of as investigation-derived waste (IDW).

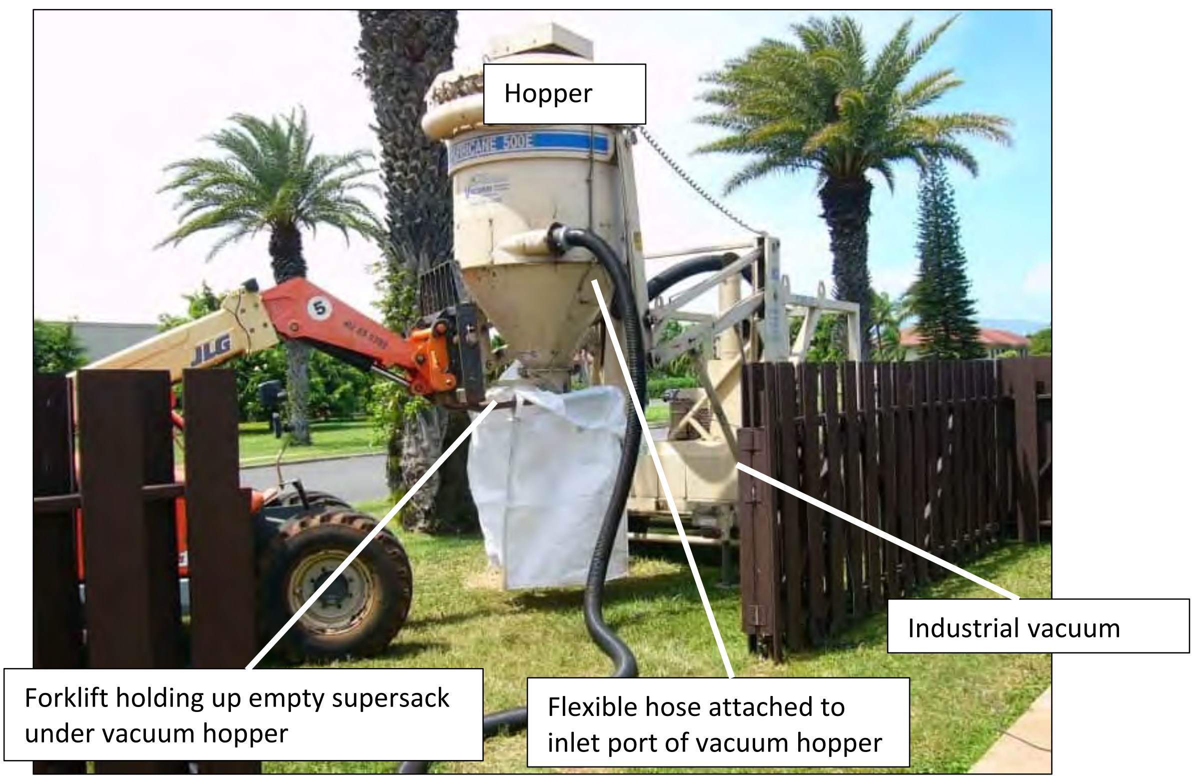

Photo 1. Setup for containment of extracted spent carbon.

Photo 2. View inside a GAC vessel after all extractable spent carbon has been removed.

Photo 3. Manway adapter used to fill vessels with fresh GAC.

Photo 4. Manway adapter secured onto GAC vessel and flexible hose attached during refill of vessel with fresh GAC.

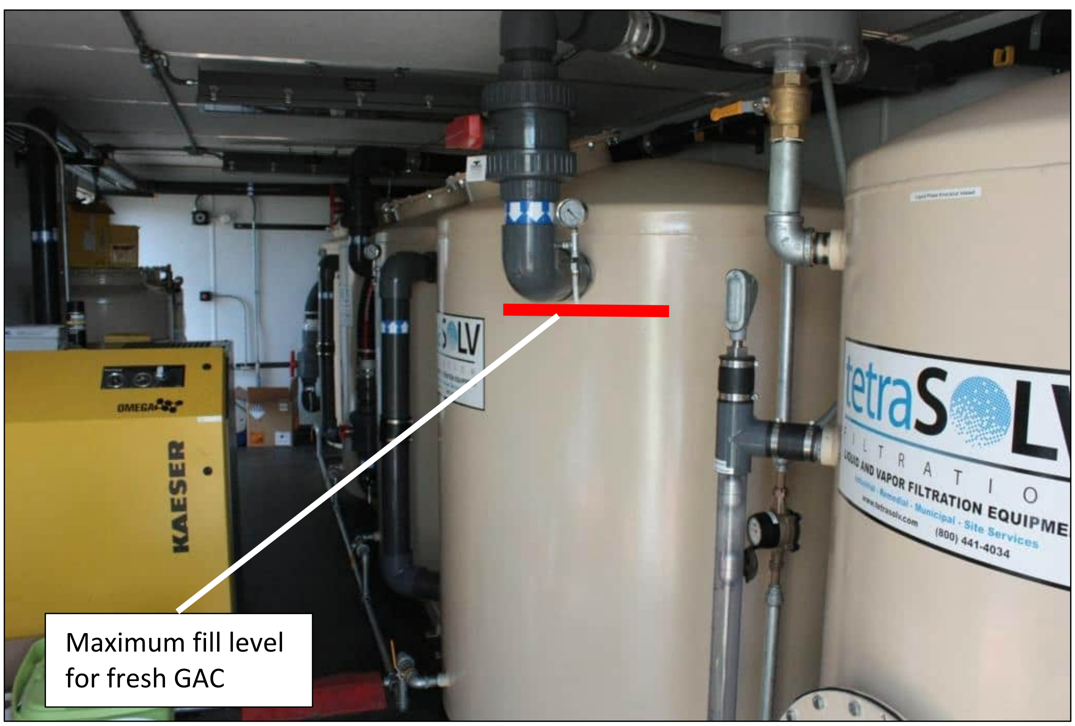

Photo 5. Maximum fill level during replenishment with fresh GAC. Gray pipe above red line is soil vapor intake into GAC vessel.

Photo 6. Valve location on an LGAC train vessel used to drain liquid before LGAC changeout.

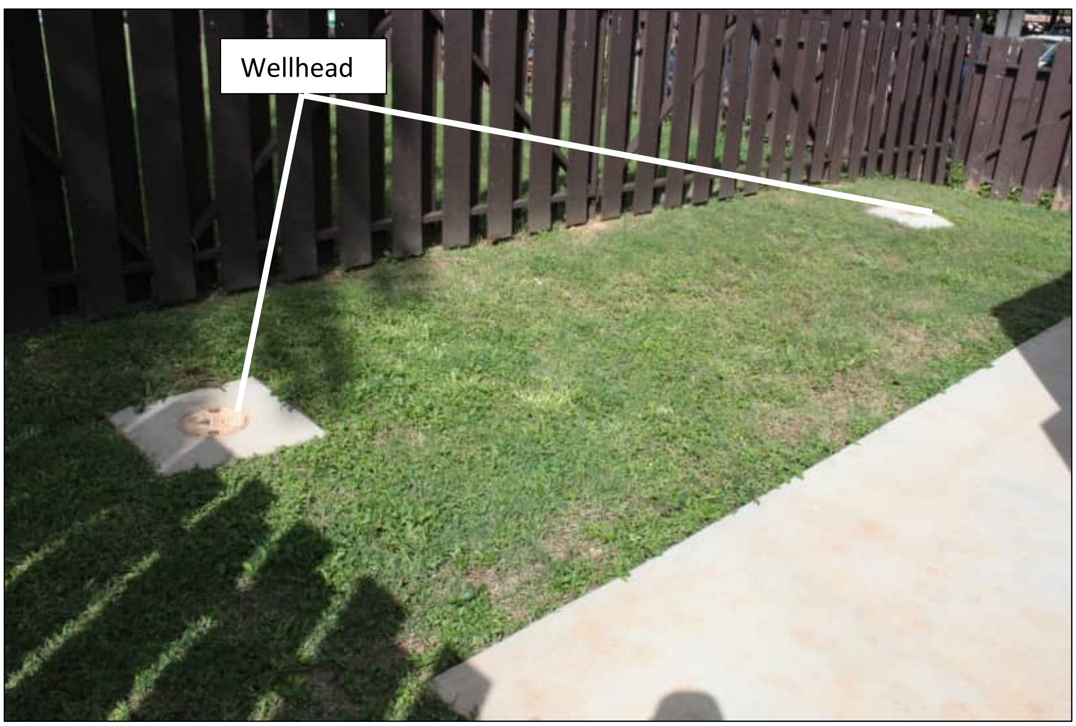

Photo 7. Wellheads of the infiltration gallery.

HURRICANE 500

HURRICANE 500 SPECIFICATIONS

- TRAILER MOUNTED Chassis - Tandem 7000# axles, 4"x 6" rectangular tube frame; four, 8 lug P235R- 16 ten ply, radials. DOT lighting with electric brakes.
- POWER SOURCE John Deere turbo-charged diesel engine, 6 cylinder, 170 HP @ 2400 RPM.
- P.T.O (clutch) Twin Disc 11.5"
- VACUUM AIR FLOW (blower) Positive displacement, 2350 CFM capable of 27" Hg, 5 belt driven with guard. (Roots 616 DV For equal)
- FILTRATION SYSTEM (3-Stage)
  Stage 1: Cyclonic separation.
  Stage 2: Baghouse / 37 Teflon coated, quick change filter bags with continuous reverse pulse air cleaning.
  Stage 3: High efficiency blower safety filter.
- HYDRAULICS 3.5 GPM, 2200 PSI, direct driven
- ENCLOSURE Lockable steel shroud over engine. (fiberglass shroud available)
- INSTRUMENT PANEL (fully enclosed) 12 volt key start. Murphy safety system (low oil pressure/ high water temperature-auto shut down)
  Gauges: oil pressure, water temperature, ammeter, tachometer with hour meter, filter cleaning on/off switch, material vacuum & dump time controls.
- AIR COMPRESSOR Direct drive Midland twin cylinder; water cooled and oil pressure fed. Midland air dryer with electronic heater.
  AMSE certified air tank mounted on vibration isolators. (Provides air to pneumatic controls and the self cleaning filter system)

STANDARD EQUIPMENT

- Paint-one color (custom lettering available)
- Wet or dry operation
- Tool box
- Automatic cone vibrator
- 100 gallon fuel tank
- Adjustable pintle hook
- Emergency stop button
- 10" inspection door (Hopper)

OPTIONS

- Spare tire & carrier
- Cold weather package
- HEPA filtration
- Slide gate discharge
- Auxiliary 50 gallon fuel tank
- Hydraulic lift leg to level trailer
- 16" manhole on baghouse
- High reach package for discharge up to 11'
- Asbestos / hazardous waste package
- Parking brake
- Fiberglass locking shroud
- Auger in cone
- Auxiliary air hose 120 PSI
- Skid mount
- Hydraulic surge brake
- 4 point certified lifting cage
- 150 HP electric motor

SAFETY FEATURES

- OSHA approved belt guard
- Remote emergency stop button
- Safety struts for baghouse
- Emergency brake away chain
- Wheel chocks
- Optional HEPA filtration
- Electric brakes
- Low oil or high temp engine shutdown

Dimensional Drawing On Reverse Side

INDUSTRIAL VACUUM

Industrial Vacuum Equipment Corporation
N7959 Birch Road • Ixonia, WI 53036
800-331-4832 • 920-261-1136 • FAX 920-261-7117
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INDUSTRIAL VACUUM

HURRICANE

HURRICANE 500

DIMENSIONS

WIDTH 8'3"　　WEIGHT 9,500 lbs.

*High reach options up to 11 ft available.

Appendix A-5
Factory Acceptance Testing Checklist

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Item #	Description	Observation and Actions	Resolution	Date Resolved
General Items				
1	All major equipment installed; Vapor and Liquid Phase GAC canisters, pump stand, batteries, etc.	All installed	n/a	8/7/14
2	Verify installation of D-rings (4 on each side) for crane lift	All installed	n/a	8/7/14
3	Finalize Building Plan Drawing showing location of D-Rings and other updated features	Completed	n/a	8/13/14
4	Double check all wiring terminations per Outback diagram	**Action Item - Tetrasolv**	Complete	8/15/14
5	Provide pre-threaded mount for wireless outdoor antenna and procure adapter/connector for antenna with any necessary connecting cable	**Action Item - Tetrasolv**	Will be done today	8/22/14
6	Program lower limit on VFD of 25%	**Action item – Tetrasolv**	Will be completed today	8/14/14
7	Verify battery cable size and secure mounting in battery cabinet for shipping. Verify fan and thermocouple in battery cabinet	Cable and batteries installed, discussed installation of hold down rods for shipping. **Fan and thermocouple to be installed week of 8/11/14**	Complete	8/18/14
8	Check battery voltage status/display on PLC. Check overall PLC function (to extent possible) with regard to battery status	Batteries could not be tested during shop test (A/C power only). Combined voltage will be displayed on PLC. Discussed testing individual battery voltages under load, once delivered. **Tetrasolv to confirm individual battery test procedure with OES.**	We will attempt this today	8/22/14

Item #	Description	Observation and Actions	Resolution	Date Resolved
Transportation Related				
1	Verify approach to labeling, packaging, and anchoring PVC flanged piping that is remove for shipping.	PVC header pipes for VGAC beds are joined by rubber fernco fitting, which will be loosened and lowered so the pipes are not touching/rigidly mounted during shipping. The ferncos will be refitted at the site.	n/a	8/7/14
2	Discharge Stack	4" galvanized steel shipped secured inside building for shipping, to be mounted once delivered. The penetration through the wall will need to be sealed once mounted.	n/a	8/7/14
3	Confirm method to secure door, lovers, etc. to support shipping.	Louvers will be secured with tape and/or zip ties. Doors will be keyed alike (keys in control panel)	n/a	8/7/14
4	External Antenna for Verizon Modem	**Action item for Tetrasolv – ensure proper adapter for antenna (requested by programmer) is provided and provide location for external mounting of antenna**	Will do today	8/22/14
5	Assume tube lighting will be removed before shipment and packaged and secured for shipping	LED bulbs to be shipped wrapped in bubble wrap.	n/a	8/7/14
6	Temporary seal slot in floor (there are rogue waves along the shipping route)	**Per conference call 8/12/14, slot to be covered with form fitting plywood and sealed with non-hardening caulk or similar method. Same method to be used for discharge stack opening.**	n/a	8/7/14
7	UL or Other Certified Inspection of Panels	MET Labs Inspection week of 8/11/14, exact date TBD Action item –**Confirm MET Labs test date**	Complete	8/20/14
8	Status of O&M Manual Including Startup and Shutdown Procedures	O&M Manual to be prepared by Tetrasolv, will be forwarded after building ships	n/a	8/7/14

Factory Acceptance Testing of *SVE Building*

Item #	Description	Observation and Actions	Resolution	Date Resolved
9	Determination of spare parts inventory, finalize list and set delivery date (gaskets, seals, indicator lights, fuses, etc.)	No spare parts were part of the SOW. Near term, the only spare parts needed should be LED bulbs (in case of breakage/defects) and blower oil (first blower oil change is 500 h). Blower oil is Kaeser Omega SB 220 synthetic blower fluid. **Action item for KCH – order 5 quarts of SB 220 (or approved equivalent, it's a straight 50 weight synthetic) oil delivered to site**	n/a	8/7/14
10	Ability to access the programming remotely?	Yes – Verizon equipment installed	n/a	8/7/14
11	Lighting installed, spare bulbs?	Yes. **Action Item –confirm part # and manufacturer for spare LED bulbs**		
12	Spare exterior panel, touch up paint	Spare panel to be shipped with container. **Action item – Tetrasolv to order/ship 2 gallons of touch up paint to site**		
13	Backup program available for reload	Will be maintained by Tetrasolv/ and programmer	n/a	8/7/14
14	Confirm and make arrangements (RAPID GATE PASS) for Doug to come to the Site.	Discussed with OEM. **Action item – confirm site visit by Tetrasolv**	I did the rapid gate pass info. Should be set	
Vapor Phase GAC				
1	Anchorage of VPGAC Vessels	Anchored with Grade 8 bolts	n/a	8/7/14
2	Accessibility to upper access to support GAC Change-out	Yes – at least 2-3 feet of clearance	n/a	8/7/14
3	Confirmation of presence of vapor sampling points between GAC vessels	**Per conference call 8/12/14 Doug please confirm sample ports are located on influent, intermediate, and effluent points for each pair of VGAC beds; on the inlet to the blower; on each of the three manifold legs (I did not see these during the shop test), and on the influent, intermediate, and effluent points for the LGAC beds.**	All are in place, See Attached pics.	8/22/14

Item #	Description	Observation and Actions	Resolution	Date Resolved
4	Presence of drain valves on GAC vessels	Yes	n/a	8/7/14
5	Ability to run GAC Vessels in two trains of two vessels, sufficient valves present	Yes	n/a	8/7/14
6	GAC loaded to proper fill level, record if virgin or regenerated	VGAC beds not yet loaded during shop test. **Action item for Tetrasolv – fill beds before shipping**	Complete	8/22/14
7	Look at stack configuration, penetration, and packaging for installation when arrives at site, and ask what the SCFM is so we can run an emission calculation.	4" penetration in wall, stack not viewed during shop test, will be shipped loose. Max scfm will be approximately 310 scfm, confirmed during shop test	n/a	8/7/14
8	Confirm shipment date and arrival date	Target ship date is Monday August 18. **Action item - Tetrasolv to confirm ship date with Matson**		
9	Identify the sail date and what the vessel number is from Matson and loading window at pier and method of loading on vessel	**Action item - Tetrasolv to confirm ship date and port arrival in Long Beach**		
Blower System				
1	Blower safety guards and sound deadening are installed	Yes	n/a	8/7/14
2	Verify blower amp draw at various VFD settings using amp meter	50%, 7" Hg. 135 cfm 19 A 50%, 10" Hg. 135 cfm 23 A 75%, 5.5" Hg, 248 cfm 14.6 A 75%, 7.5" Hg, 228 cfm 19 A 100%, 5" Hg, 315 cfm 19 A 100%, 7.5" Hg, 300 cfm 24 A 26.5 max motor A with safety factor 23-24 A max recommended by Programmer Note that amp draw is sensitive to applied vacuum pressure and rpm (load)	n/a	8/7/14

Factory Acceptance Testing of *SVE Building*

Item #	Description	Observation and Actions	Resolution	Date Resolved
3	Verify knock-out tank is plumbed correctly (up-flow through tank) and pump out functionality.	Yes	n/a	8/7/14
4	Check liquid phase GAC plumbing, leak check if possible	**Action item - Tetrasolv to conduct leak check.** Thread sealant noticed on most joints (not all)	Scheduled for today	8/22/14
5	Blower motor rotation confirmed	Yes	n/a	8/7/14
6	Discharge stack supports	**Action item – Tetrasolv to install pre-threaded mounts for galvanized discharge stack and ship bracing loose with container**	Complete	8/18/14
7	Vibration isolators in place	Yes	n/a	8/7/14
8	Vibration damping between stack and blower body – vent penetration sealed	Not completed, will be completed on-site		
Piping Installation				
1	Labels and flow direction on piping	**Action item for Tetrasolv – install labels**	Complete	8/20/14
2	Inspection of entry of SVE Piping manifold and connection to VGAC	Connections are 3" FNPT on the bottom of the manifold legs. Connection to VGAC is overhead Sch 80 PVC via vacuum rated petroleum hose with camlocks	n/a	8/7/14
3	Piping installed with proper connections for support and to minimize vibration	Yes	n/a	8/7/14
Panels and Service Entrance				
1	Arc Flash stickers on disconnects	**Action item for Tetrasolv and/or MET – install arc flash stickers**	Complete	8/20/14
2	Labels of circuits in panel boards	**Action item for Tetrasolv – label circuits in fuse box and also connections in load center panels**	Complete	8/20/14
3	Lockout Tagout tangs on breakers	**Action item for Tetrasolv – install lockout tang for main fuse box**	Working on this should know today	8/22/14

Factory Acceptance Testing of *SVE Building*

Item #	Description	Observation and Actions	Resolution	Date Resolved
4	Conduit runs neat and organized	Yes	n/a	8/7/14
5	Will electrical service entrance access be cut at fabricator or in field	In field – 7 one-inch penetrations	n/a	8/7/14
6	Outback Radian diagram (.pdf)	Action item - to be forwarded by Tetrasolv	Complete	8/20/14
7	Continuity checks complete before electrical energizing	Action item - to be completed by Tetrasolv /MET	Complete	8/14/14
8	Confirm status of programming	To be completed by Wednesday 8/13/14. **Action item for KCH - confirm programming status Wednesday**	Will complete today	8/22/14
Testing Procedure				
1	Testing procedure 1) Motor rotation 2) No excessive vibration 3) Vapor leaks in piping 4) Testing of telemetry system 5) Programming and any hard wired interlocks	1) Pass 2) Pass 3) Action item 4) On-site test 5) On-site test		

NOTE: Names of personnel with specific actions were removed from the checklist and replaced with company names

Appendix A-6
Checklist for Monthly Inspection of SVE Process, Wells, and Ancillary Equipment

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Checklist for Monthly Inspection
SVE Process, Wells, and Ancillary Equipment
Off-Grid Solar Powered SVE System
Joint Base Pearl Harbor, Hickam, Hawaii
Note: AGM Batteries, Inverter Load System, and Auxiliary AC and DC Electrical Equipment covered under Checklist in Appendix 2F and Performance Monitoring under Appendix D

Item	Inspection Details	Observations	Recommendations (Describe If Any)
Effluent Discharge Related System			
ED-1	Inspect physical condition of the effluent pump and ensure valve handle at base of knockout tank is open		
ED-2	Remove and clean the “Y” Strainer and Basket Strainer		
ED-3	Inspect liquid level gauge for any particulate or coating and allow the floating mechanism to move freely. If necessary disassemble and clean the unit.		
ED-4	Open the two (2) well covers at the infiltration gallery and inspect for standing water		
GAC Treatment System			
GC-1	Confirm setting of the manual throttle values		
GC-2	Confirm functioning of the Magnehelic gauges		
GC-3	Confirm setting of the motorized valve actuators		
GC-4	Confirm sample valves are closed		
GC-5	Inspect that valves are in the proper position for the Train being used.		
GC-6	Confirm sample ports are closed on both VGAC and LGAC Trains		
GC-7	Confirm exhaust fan is operational behind VGAC vessels		
General Building			
B-1	Inspect functionality of indoor and outdoor lighting		
B-2	Confirm signage on building door and fence are in place and clean		
B-3	Confirm all safety equipment is present		
B-4	Confirm that fire extinguishers have been inspected and tagged as such, monthly		

Checklist for Monthly Inspection
SVE Process, Wells, and Ancillary Equipment
Off-Grid Solar Powered SVE System
Joint Base Pearl Harbor, Hickam, Hawaii
Note: AGM Batteries, Inverter Load System, and Auxiliary AC and DC Electrical Equipment covered under Checklist in Appendix 2F and Performance Monitoring under Appendix D

Item	Inspection Details	Observations	Recommendations (Describe If Any)
B-5	Inspect fencing and proper functioning of the gate and lock mechanisms		
B-6	Inspect for excessive growth in grass and weeds around building and PV array and coordinate with Base for removal		
B-7	Inspect the inlet air louvers are functional and not blocked		
	Confirm the proper opening, closing, and locking of building doors		
B-8	Inspect and clean the inside building floor and concrete pad and stoups around the building		
SVE Vaults			
SV-1	Confirm vault lids are free of an obstructions		
SV-2	Open vault and confirm functionality of the lid mechanism		
SV-3	Inspect and remove any debris in the vaults		
SV-4	Confirm SVE well cleanout cap is in place		
SV-5	Confirm ball valve in proper position based on system operation		
Date	**Time of Inspection (Local)**	**Personnel Present**	**Weather Conditions**

Attach pictures and additional sheets as necessary.

Appendix B
Off-Grid Electrical System

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Appendix B-1
O&M Manual for Off-Grid System

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PV OFF-GRID O&M
SOIL VAPOR EXTRACTION SYSTEM O&M PLAN
SUBSITE ST32 ONIZUKA VILLAGE
JOINT BASE PEARL HARBOR-HICKAM, HAWAII

The SVE system and its ancillary components are entirely powered by the PV array adjacent to the building (off-grid system). The primary direct current (DC) disconnect at the PV array is a series of 6 combiner boxes at the north end of the PV array [see Photo 1]. Each combiner box is associated with a string of 12 PV panels. In order for the PV array to supply DC current to the Outback charging system inside the SVE system building, the switches on the outside of the combiner boxes must be turned to ON. For safety reasons, only a qualified electrician should open the combiner box doors or work directly with PV wiring.

An additional DC disconnect switch is located inside the electrical room [Photo 2]. This switch is housed in a large cabinet and is clearly labeled as the DC Disconnect on the outside (all six PV circuits feed into this disconnect). This switch must also be ON for the DC current circuit to be connected and power to be provided to the SVE system components. If maintenance on the PV and/or electrical portion of the system is required, the DC disconnects at the combiner boxes and inside the electrical room must be locked out and tagged out (LOTO) by a qualified electrician.

Any amount of sunlight on the PV array will always produce DC current. With DC disconnects in the ON (or closed circuit) position, the current will run to the Outback charge management system. Primary components of the Outback system include six charge controllers to help manage the charge from the PV array, two Radian inverters to convert DC to alternating current (AC), the Mate 3 to program and monitor the system, and the battery bank to absorb and maintain a charge for a constant source of power [Photos 2 and 3]. At the base of each of the two Radian inverters is a load center behind a stainless steel cover door [Photo 2]. Behind this door is a series of breakers that control power to the internal Outback charging components. These breakers can be opened to break the circuit and cut off power to the Outback charge system. **For additional details refer to the emergency shutdown procedure in Appendix B-5.**

The circuit breaker panel for the lights, ventilation fans, three phase converter, and the programmable logic control (PLC) panel is located to the right of the PLC panel [Photo 4]. Individual equipment that each breaker switch is assigned to, is labeled adjacent to the switch. In addition, the PLC cabinet has an on/off handle on the right side that will shut down power to the PLC panel when in OFF position [Photo 5]. This position is labeled on the base of the handle and is **colored green**. If the handle is in OFF position, powered will be cut off to the PLC panel. To supply power back to the PLC, the handle must be switched up to the ON position which is **colored red**. This handle has a safety mechanism in the right side of the base of the handle through the use of a screw on the side of the handle base [Photo 5]. When the handle is switch up to ON, it will only go approximately half way then stop. At this position, a flathead screwdriver must turn the screw to release a lock mechanism and allow for the handle to travel all the way up to the ON position, and provide power to the PLC panel. The PLC panel door can be opened for maintenance or inspection at the handle on the front of the panel [Photo 4]. When the PLC is powered on, there is live current inside the cabinet and the door can only be opened by a trained and qualified electrician.

Touchscreen Control Panel

The touchscreen control panel allows for programmable control of the SVE system operation. It also provides real-time system status data. Programmable controls and system status data are summarized below.

The touchscreen control panel is also controllable using a smartphone with a data connection. The "VNC Viewer" application is downloadable for free from the android or iOS app store. Once downloaded, the app will prompt you for a password, which is currently established as "111111". Once setup is complete, the operator will be able to view the same HMI touchscreen display as on the PLC panel at the site. System operation through the VNC Viewer is real-time, and programmable controls can be adjust using the smartphone as a touchscreen.

Programmable Controls

Blower Enable and Off Voltage Settings

The SVE system is engineered so that the blower will turn on automatically in the morning when sunlight on the PV panels increases the voltage of the battery bank to reach a programmed voltage threshold. This is the "Blower Enable Voltage" [Photo 6]. Once the blower is on and the system is running, it will run until the battery bank voltage drops to reach the "Blower Off Voltage", which is generally after the sun stops generating power from the PV array. The "Blower Enable Voltage" and "Blower Off Voltage" values can be programmed using the HMI touchscreen by tapping inside the rectangular area labeled on the touchscreen and entering the desired value once the numerical keyboard pops up. Once the voltage reaches the "Blower Enable Voltage" and turns the blower on, the load created will instantly decrease the voltage by one to 1.5 volts.

The "Blower Off Voltage" should be set at least 2 volts lower than the enable voltage to prevent the system from repeatedly turning on and off in relatively quick succession.

Date and Time

The "Operator Interface Date & Time" at the upper right corner of the touchscreen displays the current date and time of day. Each of these can be adjusted as necessary by tapping on the day or time display, which will then bring up a pop-up window to allow for adjustment.

Vacuum Blower Switch and Target Speed

The vacuum blower digital switch located generally near the center of the touchscreen has three settings; HAND, OFF, and AUTO [Photo 6]. Because the system is engineered to run automatically, during normal operation the blower should generally be left in **AUTO**. If the blower needs to be manually shut down, tap OFF and the switch will move to that position and shut the blower down. If the blower is to be turned on, but not on an automatic schedule, tap **HAND** to manually turn it on. If the blower is run on **HAND** mode, it will not shut down automatically and must either be switched back to **OFF** or **AUTO**. Anytime the blower is on, the light will turn **green** at VACUUM BLOWER RUNNING.

The speed of the variable frequency drive (VFD) to control the vacuum rate of the blower is controllable in percentages. To change the percent VFD, synonymous with blower speed, tap under **"Touch to Change"** in the VACUUM BLOWER TARGET SPEED window [Photo 6]. A pop-up will appear with a numerical keypad that is used to adjust the blower speed. **The minimum speed accepted is 25%.** In general, the higher the speed, the higher the load put on the charging system and the sooner the battery bank voltage will reach the OFF threshold after the sun has set.

In general, a speed of 75% is recommended so that a sufficient vacuum is applied to the SVE wells, while allowing the voltage to keep the system running after sunset

Vapor Extraction Wells #1, 2, and 3

The three SVE wells each have their own switch with **HAND**, **OFF**, and **AUTO** settings [Photo 6]. Tapping the word **HAND** will engage the motorized actuator at the well manifold inside the equipment room to open the valve. Tapping **OFF** will engage the actuator for that well to close. Tapping **AUTO** will have the actuator for that well either be open or closed, based on the 24-hour clock dial for each well [Photo 6]. The timers for each well can be set by tapping the hour numbers to either have a well be **ON** (**green display color** for the hour) or **OFF** (**black display color** for the hour). **THERE MUST NEVER BE A TIME WHERE THE BLOWER IS ON AND NONE OF THE ACTUATOR VALVES ARE OPEN. THIS CONDITION WILL DEADHEAD THE BLOWER AND POTENTIALLY DAMAGE THE SVE SYSTEM**. Each well has an indicator light to easily determine whether a well is opened or closed.

Condensate Transfer Pump

The condensate transfer pump is the liquid centrifugal pump located at the knockout tank inside the treatment room. When the water level inside the knockout tank reaches a threshold level, as determined by float gauge, the pump will automatically turn on and drain the knockout tank. This will function automatically if the switch [Photo 6] on the touchscreen is turned to **AUTO**. Using the touchscreen, the switch can also be manually operated by switching to **HAND**, or can be turned off by switching to **OFF**.

System Status Data

The on/off voltage settings are programmed in the blue panel titled "**Solar Power System Info**" at the upper left of the touchscreen. Additional data pertaining to the system charging and power status are displayed in this panel. These data are drawn directly from the Outback Mate 3 mounted in between the Outback Radian inverters. The State of Charge (SOC) on the display reflects the daily minimum and maximum charge capacity of the battery bank as a whole.

The Active Alarm Status Display panel on the touchscreen include numerous alarms within the system designed to be protective of the integrity of the system. If operational conditions of the system change such that an alarm is tripped, the corresponding alarm light will turn on in red color. The fault can then be fixed and the **yellow** "**Alarm Reset**" button at the top of the touchscreen can be tapped to reset the alarm status [Photo 6].

The AC voltage and kilowatt output data coming out of the Radian inverters, as well as the current battery bank voltage, are displayed on electronic dials near the top of the touchscreen. These real-time data are not controlled by the touchscreen, but are data output directly sourced from the Mate 3. Additional system data output provided on the display include; extraction well air temperature, equipment room atmosphere % LEL, and variable frequency drive (VFD) output and usage data.

As a general rule of thumb, it is desired that the "Current" under VFD Output Data not exceed 23 amps for an extended period of time.

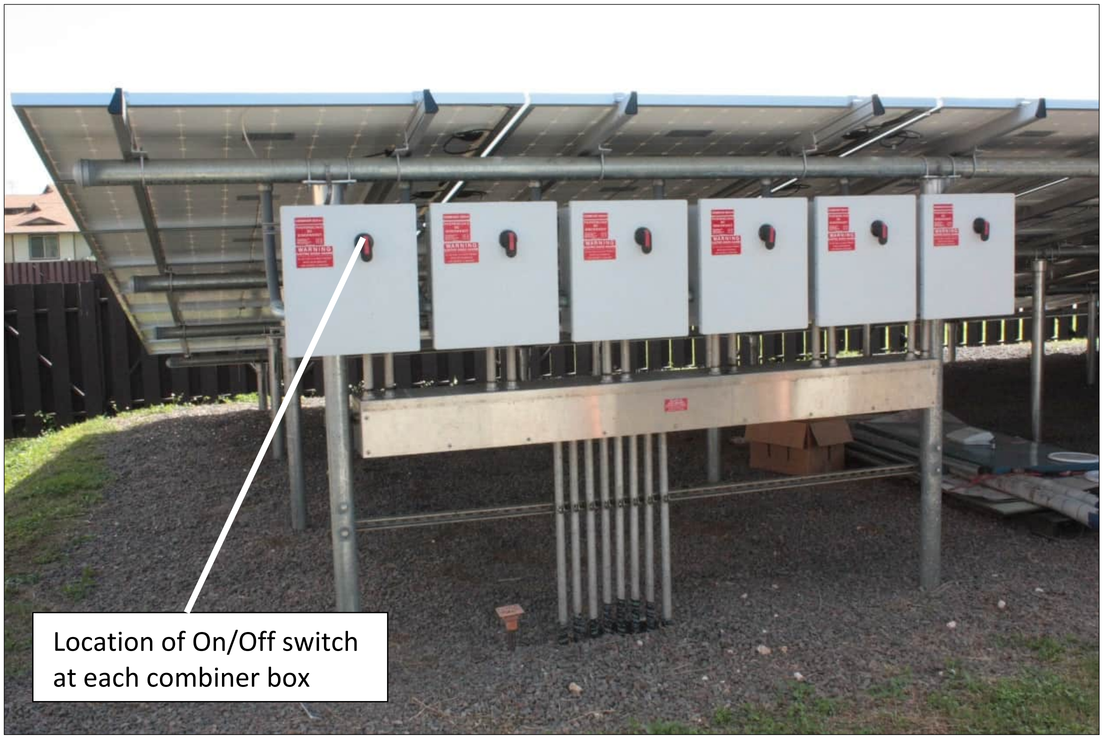

Photo 1. Combiner boxes at PV array.

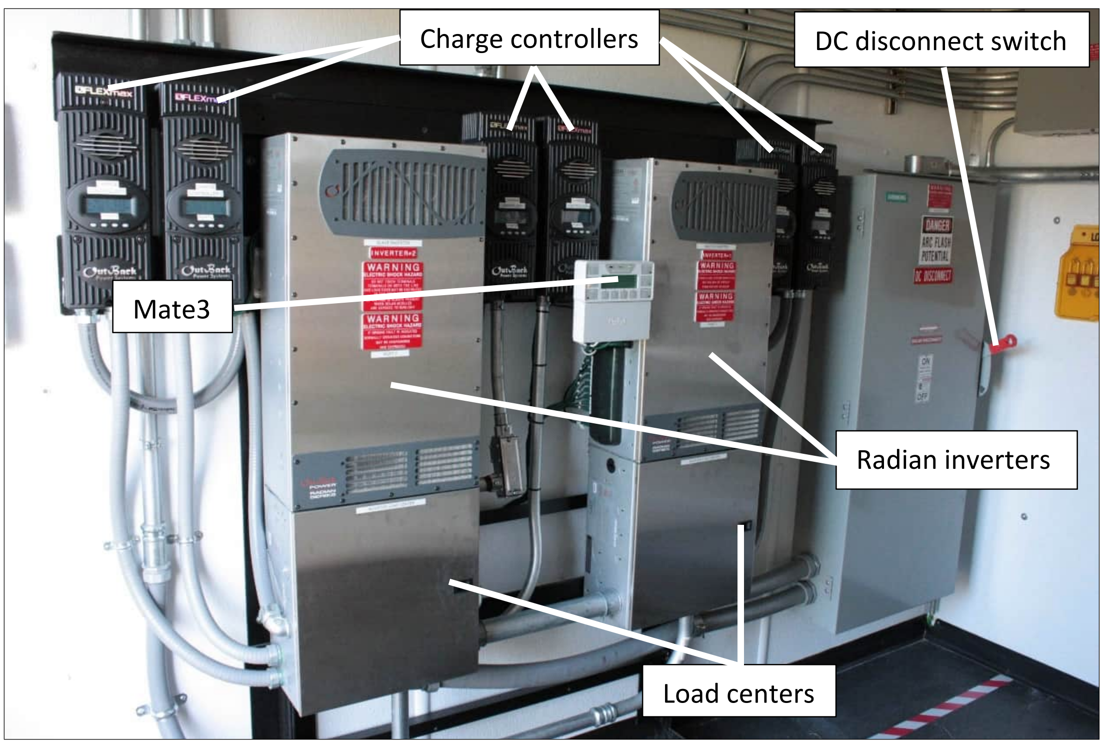

Photo 2. DC disconnect switch and Outback charge management system

Photo 3. Battery bank

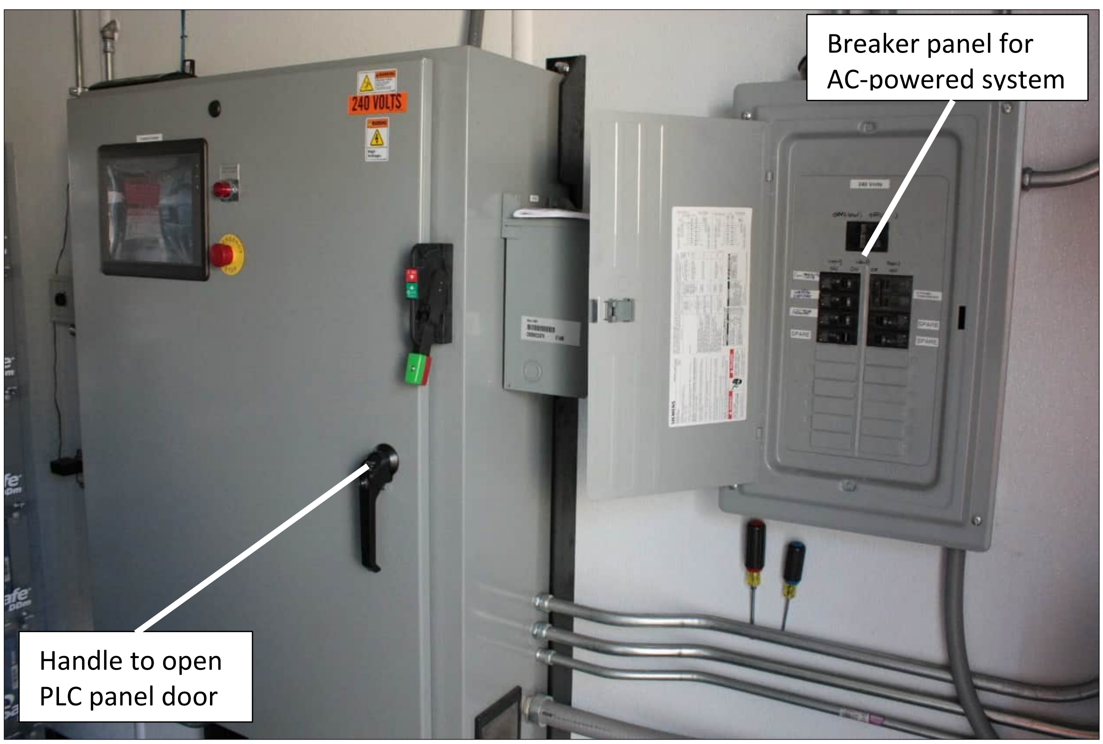

Photo 4. Circuit breaker panel for AC-powered system components

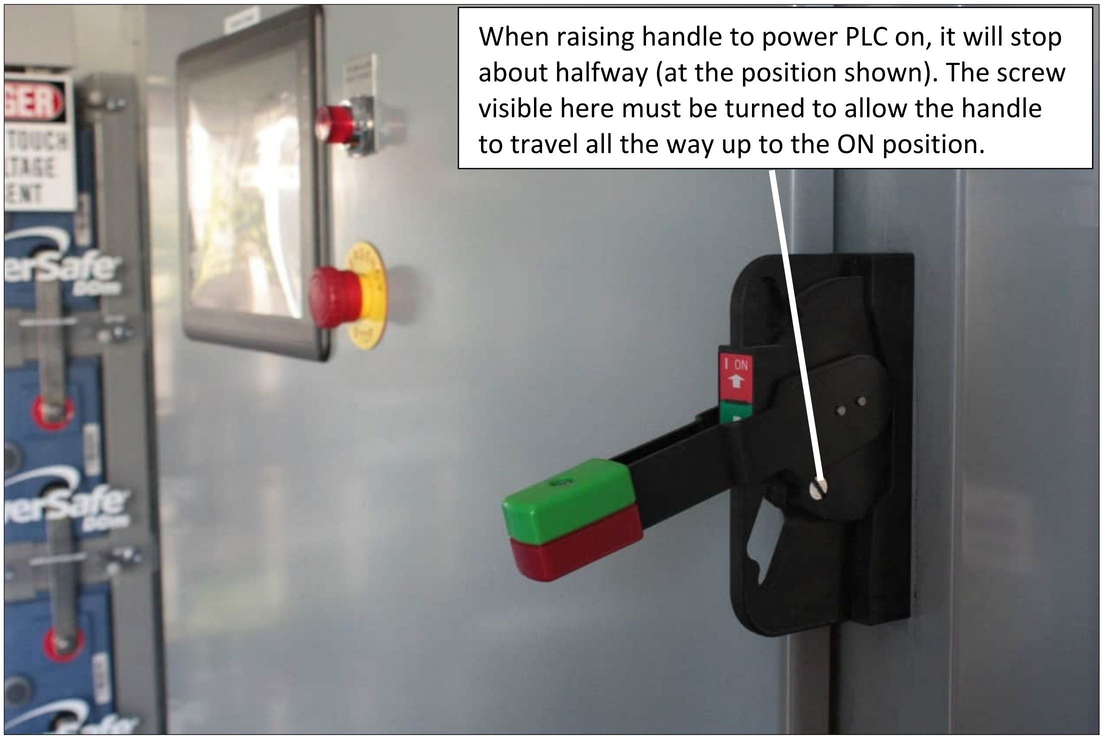

Photo 5. PLC panel on/off handle and unlock mechanism (screw)

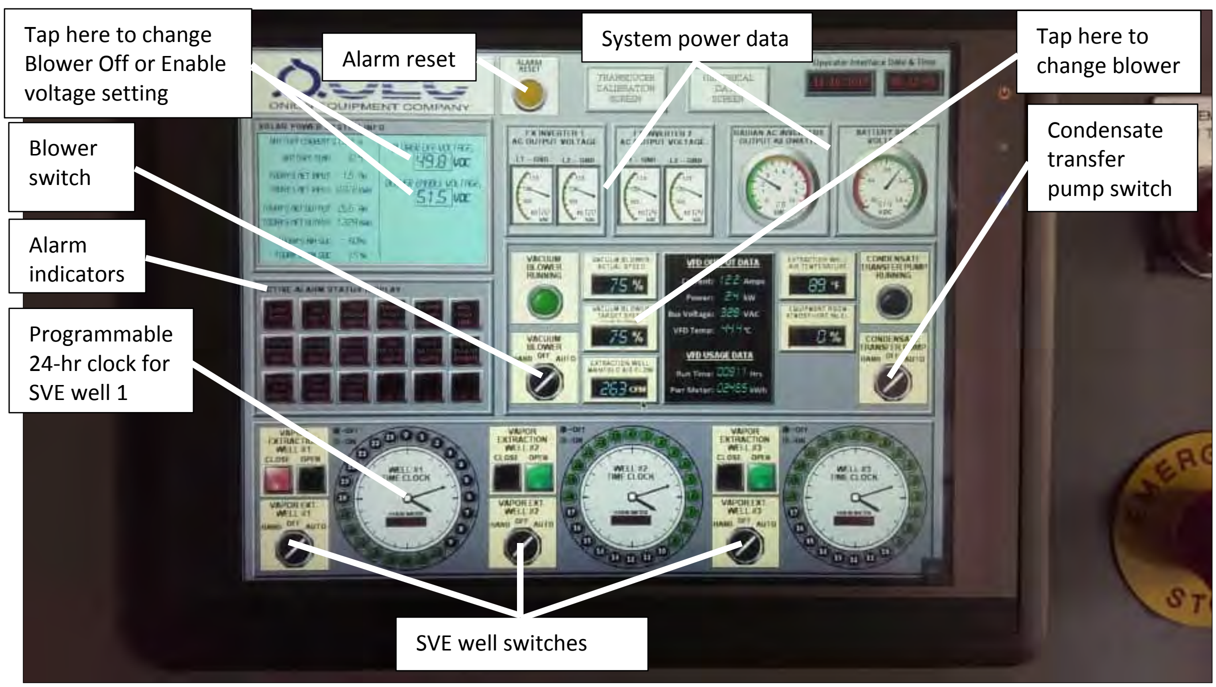

Photo 6. Primary controls and data display on the HMI touchscreen

Appendix B-2
Electrical Drawings (PV and Control Room)

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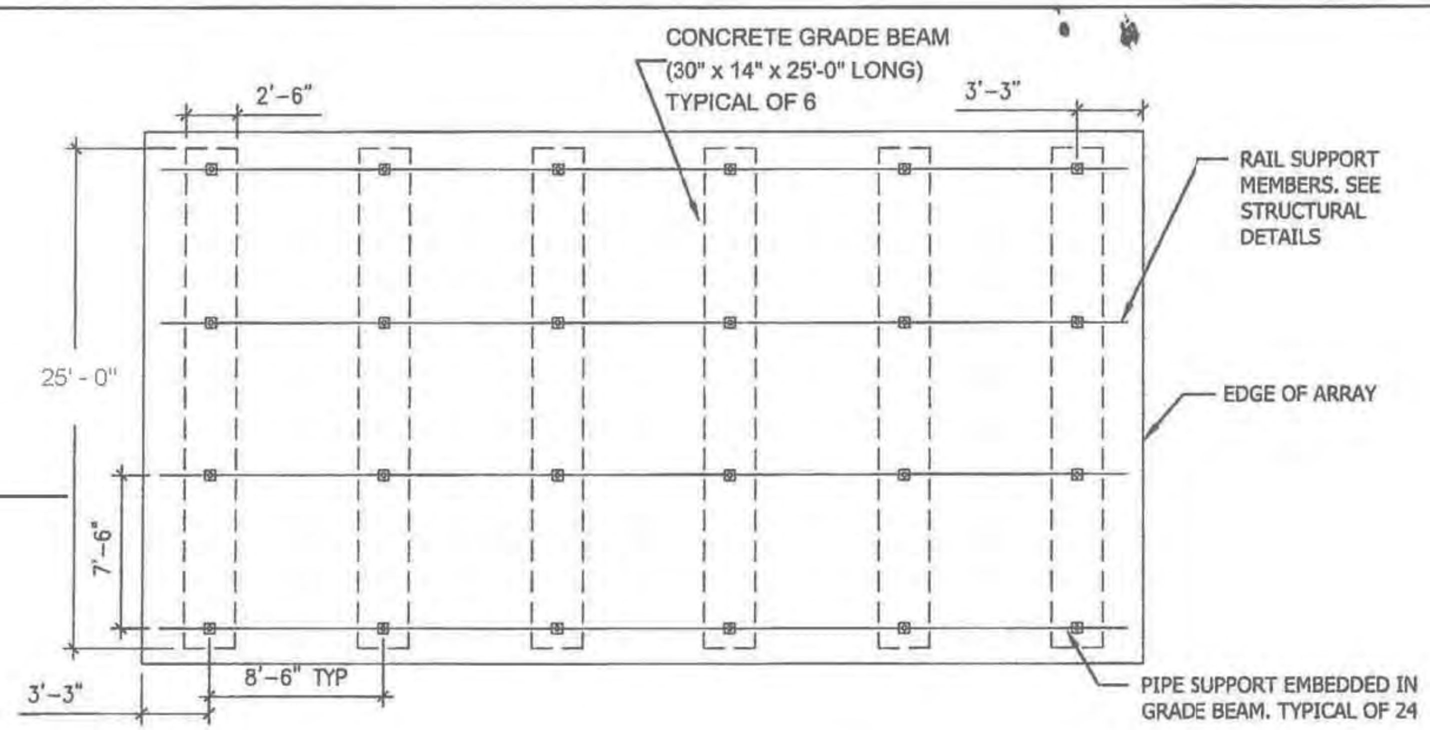
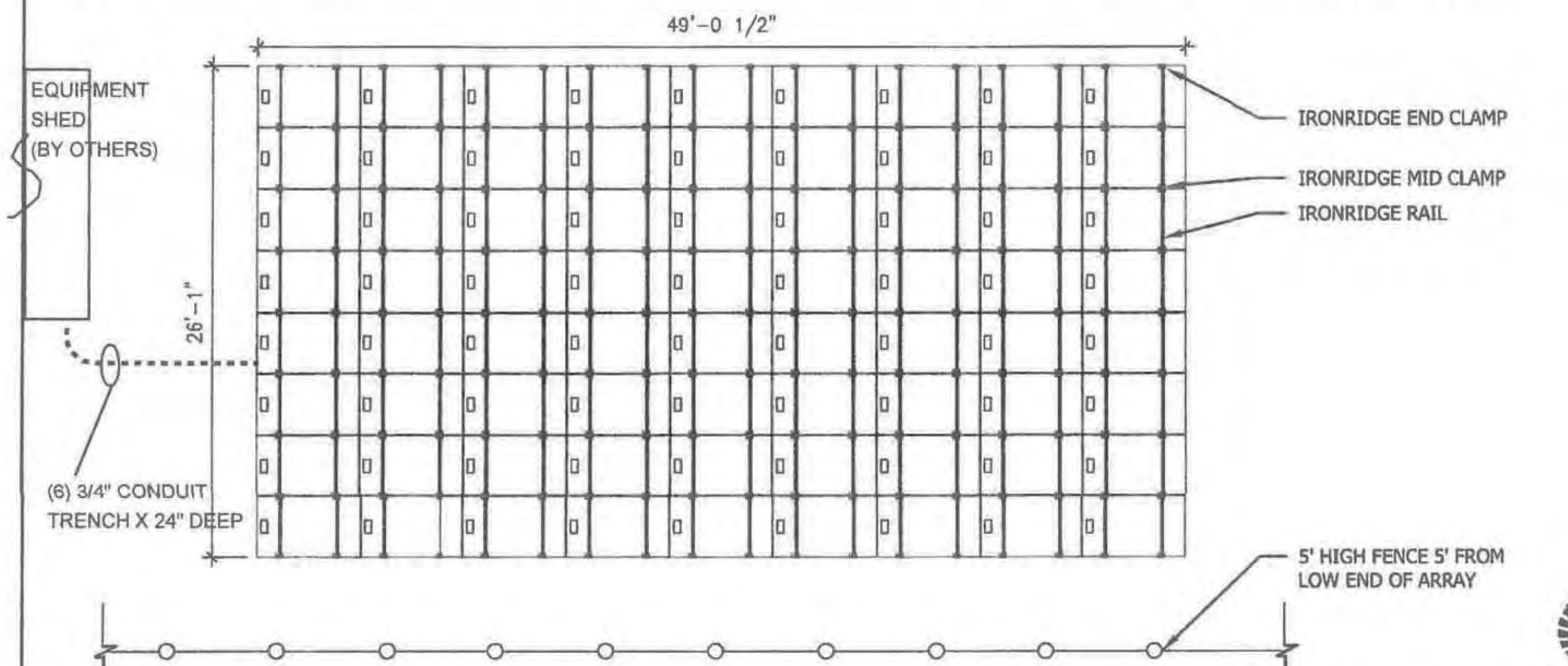


GRADE BEAM LAYOUT

SCALE 1/8" = 1'-0" (2)



PANEL LAYOUT

SCALE 1/8" = 1'-0" (1)

System Specifications

Solar Modules
(72) – SUNIVA OPT-265-60-4-100 – 265 watt

Inverters
(2) – OUTBACK – RADIAN GS8048A

Mounting System
IRONRIDGE RACKING

System Size
19.08 kW DC (STC)

PAUL W. CRAIG LICENSED PROFESSIONAL ENGINEER No. 11988-E HAWAII U.S.A.

EXP: 30 APRIL 2016

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION

Signature - Paul W. Craig

17 July 2014

Date

PETER LOFQUIST LICENSED PROFESSIONAL ENGINEER No. 14820 HAWAII U.S.A.

6/18/14

The IronRidge products and pipe support structure have been reviewed by Starling Madison Lofquist, Inc. for compliance with the structural calculations. The foundations have been designed by others.

sunetric

SOLAR ENERGY DESIGN AND INSTALLATION

905 Kalanianaole Highway #21
Kailua, Hawaii 96734
(808) 262-6600
info@sunetric.com
www.sunetric.com

OFF-GRID PV SYSTEM

JOINT BASE PEARL HARBOR HICKAM, HAWAII

DATE	05/09/2014
PROJECT MANAGER:	PF
DESIGNED BY:	SD
DRAWN BY:	SD
CHECKED BY:	

NO.	DATE	REVISIONS

ROOF PLAN - BUILDING ELEVATIONS

Sheet 1 of 3

E1-1

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PAUL W. CRAIG
LICENSED PROFESSIONAL ENGINEER
No. 11988-E
HAWAII U.S.A.
EXP: 30 APRIL 2016

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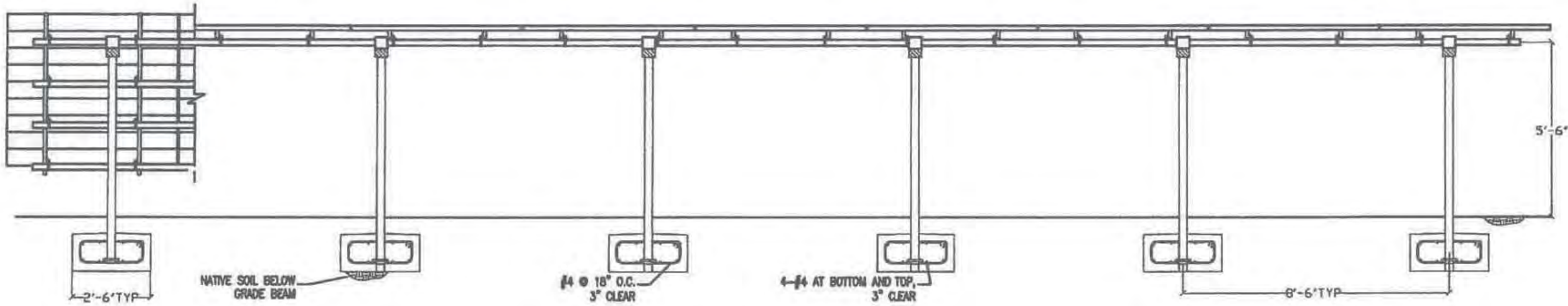
Paul W. Craig
Signature - Paul W. Craig
17 July 2014
Date

sunetric
SOLAR ENERGY DESIGN AND INSTALLATION
905 Kalanianaole Highway #21
Kailua, Hawaii 96734
(808) 262-6600
info@sunetric.com
www.sunetric.com

OFF-GRID PV SYSTEM

JOINT BASE PEARL HARBOR
HICKAM, HAWAII



NORTH ELEVATION

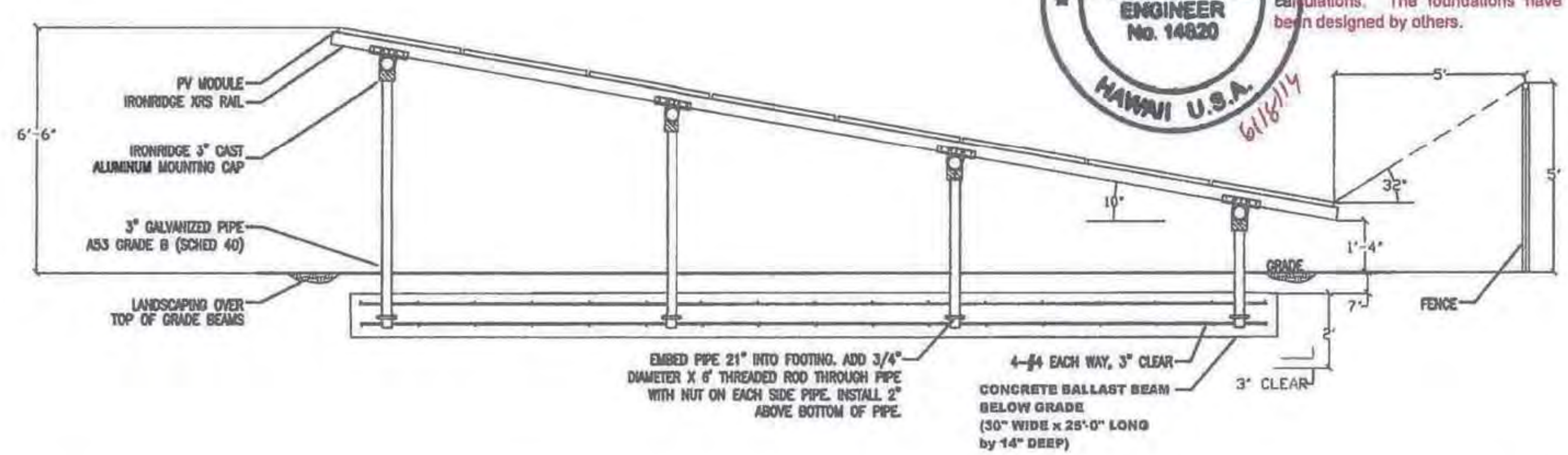
SCALE 3/8" = 1'-0" (2)

PETER LOFQUIST
LICENSED PROFESSIONAL ENGINEER
No. 14820
HAWAII U.S.A.
6/18/14

The IronRidge products and pipe support structure have been reviewed by Starling Madison Lofquist, Inc. for compliance with the structural calculations. The foundations have been designed by others.

CONCRETE NOTES:

1. CONSTRUCTION SHALL CONFORM TO INTERNATIONAL BUILDING CODE-2006 AND LOCAL REGULATORY AGENCIES REQUIREMENTS.
2. ALL CONCRETE WORK SHALL COMPLY WITH ACI 301 & 318 LATEST EDITION.
3. ALL SLAB ON GRADE WORK SHALL BE DONE IN ACCORDANCE WITH ACI 302.IR.
4. CONCRETE SHALL BE 3000 PSI @ 28 DAY COMPRESSIVE STRENGTH.
5. MAXIMUM SLUMP 4". WATER TO CEMENT RATIO: FROM .47 TO .53
6. AGGREGATE GRADATION AND QUALITY SCALE SHALL BE IN ACCORDANCE WITH ACI 302-IR.
7. REINFORCEMENT SHALL BE ASTM A615 GR60.
8. MINIMUM CONCRETE COVER SHALL BE 3" TO EARTH, 2" TO SKY.
9. CONTRACTOR SHALL VERIFY ALL PERTINENT DIMENSIONS PRIOR TO BEGINNING OF CONSTRUCTION.



ARRAY SECTION VIEW

SCALE 1/4" = 1'-0" (1)

DATE:	05/09/2014
PROJECT MANAGER:	PF
DESIGNED BY:	SD
DRAWN BY:	SD
CHECKED BY:	

NO.	DATE	REVISIONS

ARRAY SECTION VIEW

Sheet 2 of 3

E1-2

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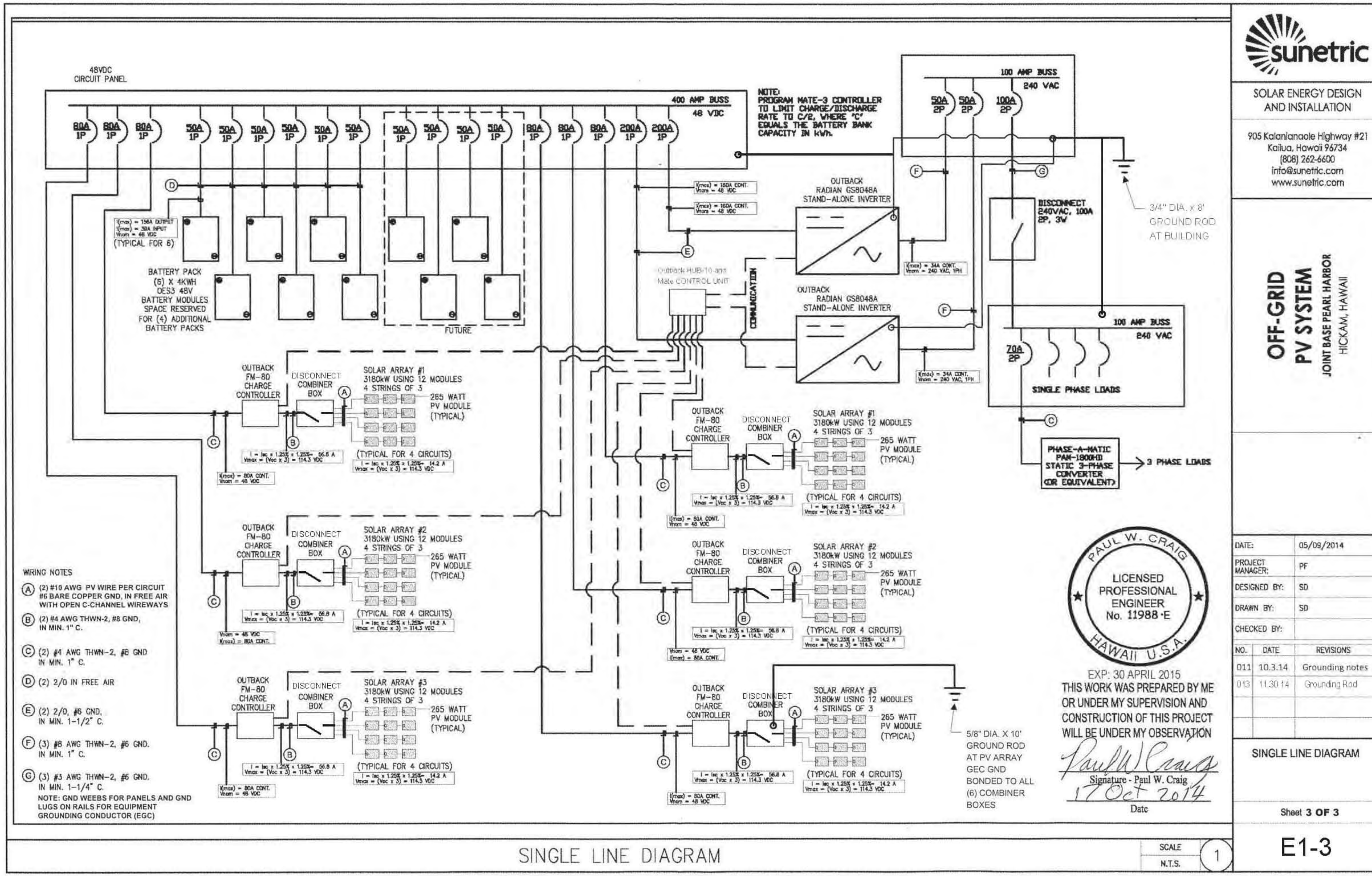
48VDC CIRCUIT PANEL
400 AMP BUSS
48 VDC
NOTE: PROGRAM MATE-3 CONTROLLER TO LIMIT CHARGE/DISCHARGE RATE TO C/2, WHERE "C" EQUALS THE BATTERY BANK CAPACITY IN kWh.
100 AMP BUSS
240 VAC
BATTERY PACK (6) X 4KWH OES3 48V BATTERY MODULES SPACE RESERVED FOR (4) ADDITIONAL BATTERY PACKS
(TYPICAL FOR 6)
FUTURE
OUTBACK RADIAN GS8048A STAND-ALONE INVERTER
Outback HUB-10 and Mate CONTROL UNIT
COMMUNICATION
DISCONNECT 240VAC, 100A 2P, 3W
3/4" DIA. x 8' GROUND ROD AT BUILDING
SINGLE PHASE LOADS
PHASE-A-MATIC PAM-1800HD STATIC 3-PHASE CONVERTER (OR EQUIVALENT)
3 PHASE LOADS
OUTBACK FM-80 CHARGE CONTROLLER
DISCONNECT COMBINER BOX
SOLAR ARRAY #1 3180kW USING 12 MODULES 4 STRINGS OF 3
SOLAR ARRAY #2 3180kW USING 12 MODULES 4 STRINGS OF 3
SOLAR ARRAY #3 3180kW USING 12 MODULES 4 STRINGS OF 3
265 WATT PV MODULE (TYPICAL)
(TYPICAL FOR 4 CIRCUITS)
5/8" DIA. X 10' GROUND ROD AT PV ARRAY GEC GND BONDED TO ALL (6) COMBINER BOXES
WIRING NOTES
(A) (2) #10 AWG PV WIRE PER CIRCUIT #6 BARE COPPER GND, IN FREE AIR WITH OPEN C-CHANNEL WIREWAYS
(B) (2) #4 AWG THWN-2, #8 GND, IN MIN. 1" C.
(C) (2) #4 AWG THWN-2, #8 GND IN MIN. 1" C.
(D) (2) 2/0 IN FREE AIR
(E) (2) 2/0, #6 GND, IN MIN. 1-1/2" C.
(F) (3) #8 AWG THWN-2, #6 GND. IN MIN. 1" C.
(G) (3) #3 AWG THWN-2, #6 GND. IN MIN. 1-1/4" C.
NOTE: GND WEEBS FOR PANELS AND GND LUGS ON RAILS FOR EQUIPMENT GROUNDING CONDUCTOR (EGC)
PAUL W. CRAIG
LICENSED PROFESSIONAL ENGINEER
No. 11988-E
HAWAII U.S.A.
EXP: 30 APRIL 2015
THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION
Signature - Paul W. Craig
17 Oct 2014
Date
sunetric
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905 Kalanianaole Highway #21
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info@sunetric.com
www.sunetric.com
OFF-GRID PV SYSTEM
JOINT BASE PEARL HARBOR
HICKAM, HAWAII
DATE: 05/09/2014
PROJECT MANAGER: PF
DESIGNED BY: SD
DRAWN BY: SD
CHECKED BY:
NO. DATE REVISIONS
011 10.3.14 Grounding notes
013 11.30.14 Grounding Rod
SINGLE LINE DIAGRAM
Sheet 3 OF 3
E1-3
SINGLE LINE DIAGRAM
SCALE N.T.S.
1

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Appendix B-3
Re-start Inverter/Load Center Rewiring One-Line Diagram

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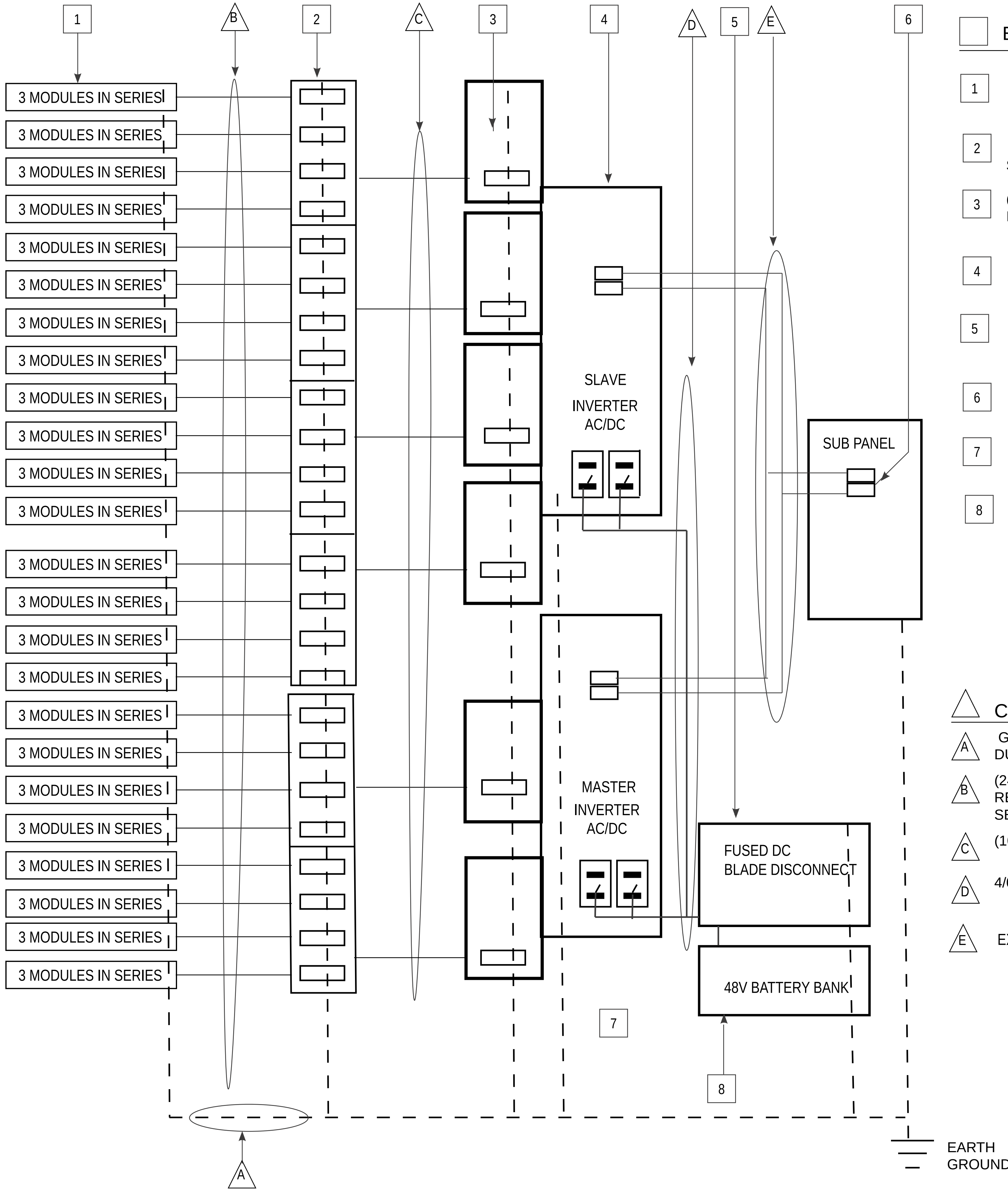

EQUIPMENT SCHEDULE (NEGATIVE GROUND)

1. 72 Photovoltaic Modules
   3PV MODULES WIRED IN SERIES CREATING 24 PARALLEL STRINGS
2. (6) IDENTICAL COMBINER BOXES
   SOLAR BOS CS12 SOLAR COMBINER BOX W/ 4 15 A STRING FUSES
3. (6) OUTBACK POWER FM80 CHARGE CONTROLLERS, W/ (6) 80A PV INPUT BREAKERS AND (6) OB80A GND FAULT BREAKERS
4. (2) OUTBACK POWER RADIAN 8048 OFF GRID 8000WATT INVERTERS W/ DUAL 50Aac OUTPUT BREAKERS AND DUAL 175Adc INPUT BREAKERS
5. SIEMENS BLADE TYPE DC DISCONNECT W/ (2) 350ADC FUSES
6. 125A BR SUB PANEL
   (1) 2P 100A CUTTLER HAMMER BREKAER
7. (2) 175A DC DISCONNECT BREAKERS IN EACH INVERTER
8. 48V BATTERY BANK (W/ (2) 175A DC DISCONNECT)

CONDUIT AND CONDUCTOR SCHEDULE:

- A: GROUND CONDUCTOR #8AWG THWN-2 INSULATED GROUND CONDUCTOR RAN SEPARATELY
- B: (24) #10AWG UVRATED STRING CONDUCTORS ENTERING 1" STRAIN RELIEF INTO LIQUID TIGHT FLEX, WITH #8 GROUND CONDUCTOR RAN SEPARATELY PER COMBINER
- C: (10) #4AWGTHWN-2 ARRAY CONDUCTORS IN 1" EMT W/ # 6AWG GROUND CONDUCTOR TO INVERTER
- D: 4/0 Cu DC CONDUCTORS IN 2" EMT CONDUIT W/ #8 THNN GROUND CONDUCTOR > 10' TO INVERTER LOAD CENTERS
- E: EXISTING #1CU AC CONDUCTORS IN 1 1/4" EMT

COCONUT COAST ELECTRIC, INC.
(808) 651 7732 gary@solsystems.org

SUBSITE ST32
ONIZUKA VILLAGE
SVE SYSTEM INSTALLATION
JOINT BASE PEARL HARBOR
HICKAM, HAWAII

SYSTEM SIZE:
19.8 KW - PV SYSTEM

DATE:
01/30/2016

REV. DATE:
___/___/_________

SINGLE LINE WIRING DIAGRAM

SHEET: 1

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Appendix B-4
Inspection Form and Warranty

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OutBack Batteries

Limited Warranty

OutBack Power Technologies, Inc. ("OutBack") provides a limited warranty ("Warranty") against defects in materials and workmanship for its battery products ("Product"). The Warranty term for a particular Product series is defined on Table 1 (see below). The Warranty term is defined the same for all Product models in that Product series.

"Stable Grid" is defined as a utility grid company or service which experiences few power failures. A battery backup system would be used infrequently and for short term backup only. The system would incur minimal Product usage.

"Unstable Grid" is defined as a utility grid company or service which experiences frequent or recurring power failures. A battery backup system would incur noticeable (more than minimal) Product usage.

Table 1 Warranty Term

Product Series	U.S. or Canada		International	
	Stable Grid	Unstable Grid/Off Grid	Stable Grid	Unstable Grid/Off Grid
EnergyCell RE	Two (2) years	Two (2) years	One (1) year	One (1) year
EnergyCell GH	Four (4) years	One (1) year	Four (4) years	One (1) year

The term of this Warranty begins on the Product initial purchase date, or initial ship date, whichever is later. This must be indicated on the invoice, bill of sale, and/or registration submitted to OutBack. This Warranty applies to the original Product purchaser, and is transferable only if the Product remains installed in the original use location.

The warranty does not apply to any Product or Product part that has been modified or damaged by the following:

- installation or removal;
- normal wear and tear;
- accident, abuse, or neglect;
- shipping or transportation;
- lightning, fire, floods or acts of God;
- incidents not foreseeable by OutBack;
- operation with temperature variation more than 5°F (2.78°C) between cells
- routine or daily discharge of more than 40% of capacity
- charging, discharging, or commissioning contrary to instructions
- incidental or consequential damage caused by other components of the power system;
- alteration, disassembly, or service by an unauthorized facility
- any other make/model in the same battery bank as the Product

OutBack's liability for any defective Product, or any Product part, shall be limited to the repair or replacement of the Product, at OutBack's discretion. OutBack does not warrant or guarantee workmanship performed by any person or firm installing its Products. This Warranty does not cover the costs of installation, removal, shipping (except as described below), or reinstallation of Products or parts of Products.

THIS LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY APPLICABLE TO OUTBACK PRODUCTS. OUTBACK EXPRESSLY DISCLAIMS ANY OTHER EXPRESS OR IMPLIED WARRANTIES OF ITS PRODUCTS, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. OUTBACK ALSO EXPRESSLY LIMITS ITS LIABILITY IN THE EVENT OF A PRODUCT DEFECT TO REPAIR OR REPLACEMENT IN ACCORDANCE WITH THE TERMS OF THIS LIMITED WARRANTY AND EXCLUDES ALL LIABILITY FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION ANY LIABILITY FOR PRODUCTS NOT BEING AVAILABLE FOR USE OR LOST REVENUES OR PROFITS, EVEN IF IT IS MADE AWARE OF SUCH POTENTIAL DAMAGES. IF YOU ARE A CONSUMER THAT PURCHASED THIS PRODUCT IN A MEMBER STATE OF THE EUROPEAN UNION, YOU MAY HAVE ADDITIONAL STATUTORY RIGHTS UNDER DIRECTIVE 1999/44/EC. THESE RIGHTS MAY VARY FROM EU MEMBER STATE TO EU MEMBER STATE. SOME STATES (OR JURISDICTIONS) MAY NOT ALLOW THE EXCLUSION OR LIMITATION OF WARRANTIES OR DAMAGES, SO THE ABOVE EXCLUSIONS OR LIMITATIONS MAY NOT APPLY TO YOU.

How to Register the Product

To register your product, use the online form at the following website location:

http://www.outbackpower.com/resources/warranty/

Or, complete the Registration card provided with the product and mail it to the address on the card.

Arranging for Warranty Service

In the event of a failure, Warranty service is provided by the installer, dealer, or distributor. Defective Product will be replaced under Warranty. In the event that the installer, dealer, or distributor cannot provide support or needs more information, contact OutBack Technical Support at +**1.360.435.6030** or direct at **+1.360.618.4363** or **support@outbackpower.com**. To ensure Warranty coverage, this contact must be within the Warranty period beginning on the invoice date. During this period, OutBack Power Technologies will repair or replace a Product covered under this Warranty that is confirmed defective.

Troubleshooting

One party will need to work with an OutBack Technical Support representative to perform troubleshooting. This is a required step and requires a qualified technician to be present at the site of the Product with a quality DC voltmeter. The OutBack representative will request voltmeter readings and other information. Because Product performance is dependent on temperature, in order to validate the Warranty OutBack may request documentation verifying that the Product was operated in a temperature-controlled environment.

If OutBack determines the Product or Product part is defective and that the defect is covered under this Warranty, OutBack will then and only then ship a repaired or replacement Product or Product part to the purchaser freight prepaid, non-expedited, using a carrier of OutBack's choice, where applicable. The warranty period of any repaired or replacement Product or Product part is ninety (90) days from the date of shipment from OutBack, or the remainder of the initial warranty term, whichever is greater. OutBack reserves the right to request Products to be returned to OutBack for analysis.

This Warranty is void for any Product that has been modified by the customer without authorization by OutBack. A Product with a voided warranty will be treated the same as one with an expired warranty.

IMPORTANT: Recycle Batteries

Batteries are considered hazardous waste and must be recycled according to local jurisdiction. The following websites and phone numbers provide additional information for recycling electronic products and batteries.

Recycling Information

Earth 911, USA

Website: http://www.Earth911.com
Address: 14646 N. Kierland Blvd., Suite 100
Scottsdale, AZ 85254
Phone: +1.480.337.3025 (direct)

Environmental Protection Agency, USA

Website: http://www.epa.gov/wastes/conserve/materials/ecycling/donate.htm
Address: EPA USA
Office of Resource Conservation and Recovery (5305P)
1200 Pennsylvania Avenue NW
Washington, DC 20460

Keep America Beautiful, USA

Website: http://www.kab.org/
Email: info@kab.org
Address: 1010 Washington Boulevard
Stamford, CT 06901
Phone: +1.203.659.3000 (Main number)
Fax: +1.203.659.3001

OurEarth.org, USA

There is a place on the website for contacting OurEarth using email. No direct email address is provided.

Website: http://www.ourearth.org
Address: P.O. Box 62133
Durham, NC 27715
Phone: +1.410.878.6485

National Institute of Recyclers, Mexico

Website: http://www.inare.org.mx/
Email: a57841279@prodigy.net.mx, margarita@inare.org.mx
Phone: +1.55.57.85.9160
Fax: +1.55.57.84.1279

Office of Waste Management, Canada

Website: http://www.portaec.net/library/recycling/recycling_in_canada.html
Address: Office of Waste Management
Conservation and Protection
Environment Canada
Ottawa, Ontario K1A 0H3
Phone: +1.819.997.2800

EuroRecycle.net, Europe

The following website provides general information about recycling in Europe. It also provides a list of companies and organizations that provide recycling information or assistance.

Website: http://euro.recycle.net
Email: http://euro.recycle.net/cgi-bin/feedback1.cgi?w=27
(This is an online form providing a means to contact the owners of the website.)

El cliente debe asegurar el envío o aceptar el riesgo de pérdida o daños durante el envío. Si es necesaria una caja de envío para la devolución de un Producto, OutBack se la enviará bajo petición.

IMPORTANTE:

OutBack no se hace responsable de los daños durante el transporte ocasionados por Productos incorrectamente embalados, de las reparaciones que estos daños podrían requerir ni de los costes de estas reparaciones.

Si, a la recepción del Producto, OutBack determina que el Producto o parte del Producto es defectuoso y que el defecto se incluye en los términos de esta Garantía, OutBack enviará entonces y solo entonces al comprador un Producto reparado o de sustitución o la parte del Producto a portes pagados, en envío no urgente, empleando un servicio de mensajería elegido por OutBack.

Si el Producto se avería en un plazo igual o inferior a noventa (90) días desde la fecha de compra original, OutBack lo cambiará por uno nuevo. Si el Producto se avería en un plazo superior a noventa (90) días e inferior o igual a la duración de la garantía, OutBack, a su criterio, reparará y devolverá el Producto, o enviará un Producto de repuesto. OutBack determinará si un Producto debe ser reparado o sustituido de acuerdo con la antigüedad y el modelo del Producto. OutBack autorizará el envío por adelantado de un repuesto en función de la antigüedad y el modelo del Producto.

En los casos en los que un comerciante o distribuidor de OutBack cambie un Producto de más de noventa (90) días por otro nuevo, OutBack NO indemnizará a dicho comerciante o distribuidor con existencias nuevas a menos que el intercambio haya sido autorizado por adelantado por OutBack.

Solución de problemas/Ningún honorario encontrado de defecto

En caso de que falle un Producto, el cliente se deberá contactar con un representante del servicio de asistencia técnica de OutBack y llevar a cabo los pasos que se le indiquen para la resolución del problema. Este paso debe realizarse antes de que se pueda efectuar una devolución. La resolución de problemas requiere que esté presente en las instalaciones del Producto un técnico calificado con un voltímetro de calidad tanto de CC como de CA. Deberá proporcionar al representante de OutBack las lecturas del voltímetro, los mensajes de error del Producto y cualquier otro tipo de información. Una gran cantidad de problemas puede resolverse en las instalaciones del Producto. Si el cliente no está dispuesto o no puede proporcionar estas lecturas (o visitar las instalaciones) y se descubre que el Producto no tiene problemas tras la devolución, OutBack puede obligar al cliente a pagar hasta 180,00 dólares americanos por la mano de obra y la manipulación.

Fuera de Garantía

Si un Producto está fuera de garantía, OutBack podrá repararlo y sustituirlo si el cliente asume los costes. De forma alternativa, si fuese aplicable y bajo petición, OutBack puede enviar por adelantado piezas de repuesto a cambio de una suma de dinero.

Si es necesaria una caja de envío para la devolución de un Producto fuera de garantía, OutBack se la enviará bajo petición. El cliente es responsable del pago del envío a OutBack.

El período de garantía de cualquier Producto reparado o de sustitución, así como de cualquier parte del Producto, es de noventa (90) días a partir de la fecha de envío desde OutBack, o igual al período de validez restante de la garantía inicial, el que sea mayor de los dos.

Esta Garantía queda anulada para cualquier Producto que haya sido modificado por el cliente sin la autorización de OutBack. Un Producto con una garantía anulada se tratará del mismo modo que uno con la garantía vencida.

Actualizaciones de Garantía

Para les actualizaciones de la declaración de garantía, consulte el sitio web siguiente:

http://www.outbackpower.com/resources/warranty/

Información sobre el reciclaje

IMPORTANTE: Reciclaje de sistemas electrónicos y baterías

Las baterías se consideran residuos peligrosos y se deben reciclar de acuerdo con la normativa local. Los inversores y otros sistemas electrónicos contienen metales y plásticos que se deben reciclar. Los siguientes sitios web y números de teléfono proporcionan información adicional para el reciclaje de productos electrónicos y baterías.

Earth 911, EE. UU.

Sitio web:	http://www.Earth911.com
Dirección:	14646 N. Kierland Blvd., Suite 100 Scottsdale, AZ 85254
Tel.:	+1.480.337.3025 (directo)

Agencia para la protección del medio ambiente (EPA), EE. UU.

Sitio web:	http://www.epa.gov/wastes/conserve/materials/ecycling/donate.htm
Dirección:	EPA USA Office of Resource Conservation and Recovery (5305P) 1200 Pennsylvania Avenue NW Washington, DC 20460

Keep America Beautiful, EE. UU.

Sitio web:	http://www.kab.org/
Correo electrónico:	info@kab.org
Dirección:	1010 Washington Boulevard Stamford, CT 06901
Tel.:	+1.203.659.3000 (Número principal)
Fax:	+1.203.659.3001

Instituto nacional de recicladores, México

Sitio web:	http://www.inare.org.mx/
Correo electrónico:	a57841279@prodigy.net.mx, margarita@inare.org.mx
Tel.:	+1.55.57.85.9160
Fax:	+1.55.57.84.1279

Departamento de recursos naturales de Canadá

Sitio web:	http://www.nrcan-rncan.gc.ca/mms-smm/busi-indu/rec-rec-eng.htm
Dirección:	580 Booth Ottawa, ON K1A 0E8
Tel.:	+1.613.995.0947
Teléfono para sordomudos:	+1.613.996.4397 (Teléfono general y para sordomudos: de lunes a viernes, de 8:30 a.m. a 4:30 p.m., hora del Este)

EuroRecycle.net, Europa

El siguiente sitio web proporciona información sobre el reciclaje en Europa. También incluye una lista de compañías y organizaciones que proporcionan información y ayuda sobre el reciclaje.

Sitio web:	http://euro.recycle.net
Correo electrónico:	http://euro.recycle.net/cig-bin/feedback1.cgi?w=27 (Esta dirección es un formulario en línea que se utiliza como medio para ponerse en contacto con los propietarios del sitio web).

OutBack POWER
member of The alpha Group™

5-Year Limited Warranty

OutBack Power Technologies, Inc. ("OutBack") provides a five (5) year limited warranty ("Warranty") against defects in materials and workmanship for its inverter/chargers, charge controllers, communication/monitoring products , and system integration equipment and enclosures ("Product"), with the exception of the OBX OutBack Extreme Series products, which have a one (1) year limited warranty.

The term of this Warranty begins on the Product(s) initial purchase date, or the date of receipt of the Product(s) by the end user, whichever is later. This must be indicated on the invoice, bill of sale, and/or warranty registration card (or online form) submitted to OutBack. This Warranty applies to the original OutBack Product purchaser, and is transferable only if the Product remains installed in the original use location.

The warranty does not apply to any Product or Product part that has been modified or damaged by the following:

- installation or removal;
- alteration or disassembly;
- normal wear and tear;
- accident or abuse;
- corrosion;
- lightning;
- repair or service provided by an unauthorized repair facility;
- operation or installation contrary to manufacturer product instructions;
- fire, floods or acts of God;
- shipping or transportation;
- incidental or consequential damage caused by other components of the power system;
- any product whose serial number has been altered, defaced or removed;
- any other event not foreseeable by OutBack.

OutBack's liability for any defective Product, or any Product part, shall be limited to the repair or replacement of the Product, at OutBack's discretion. OutBack does not warrant or guarantee workmanship performed by any person or firm installing its Products. This Warranty does not cover the costs of installation, removal, shipping (except as described below), or reinstallation of Products or parts of Products.

THIS LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY APPLICABLE TO OUTBACK PRODUCTS. OUTBACK EXPRESSLY DISCLAIMS ANY OTHER EXPRESS OR IMPLIED WARRANTIES OF ITS PRODUCTS, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. OUTBACK ALSO EXPRESSLY LIMITS ITS LIABILITY IN THE EVENT OF A PRODUCT DEFECT TO REPAIR OR REPLACEMENT IN ACCORDANCE WITH THE TERMS OF THIS LIMITED WARRANTY AND EXCLUDES ALL LIABILITY FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION ANY LIABILITY FOR PRODUCTS NOT BEING AVAILABLE FOR USE OR LOST REVENUES OR PROFITS, EVEN IF IT IS MADE AWARE OF SUCH POTENTIAL DAMAGES. IF YOU ARE A CONSUMER THAT PURCHASED THIS PRODUCT IN A MEMBER STATE OF THE EUROPEAN UNION, YOU MAY HAVE ADDITIONAL STATUTORY RIGHTS UNDER DIRECTIVE 1999/44/EC. THESE RIGHTS MAY VARY FROM EU MEMBER STATE TO EU MEMBER STATE. SOME STATES (OR JURISDICTIONS) MAY NOT ALLOW THE EXCLUSION OR LIMITATION OF WARRANTIES OR DAMAGES, SO THE ABOVE EXCLUSIONS OR LIMITATIONS MAY NOT APPLY TO YOU.

How to Register the Product

To register your product, use the online form at the following website location:

http://www.outbackpower.com/resources/warranty/

Or, complete the Warranty Registration card provided with the product and mail it to the address provided on the card.

How to Arrange for Warranty Service

During the warranty period beginning on the invoice date, OutBack Power Technologies will repair or replace products covered under this limited warranty that are returned to OutBack Power Technologies' facility or to an OutBack Power Technologies authorized repair facility, or that are repaired on site by an OutBack Power Technologies authorized repair person.

Contacting OutBack Technical Support

To request warranty service:

Telephone: **+1.360.435.6030** (Main Office)
+1.360.618.4363 (Technical Support)

Email: **support@outbackpower.com**

To ensure warranty coverage, this contact must be within the effective warranty period. If service is required, the OutBack Technical Support representative will issue a Return Material Authorization (RMA) number.

Return Material Authorization (RMA)

A request for an RMA number requires all of the following information:

1. Product model and serial number;
2. Proof-of-purchase in the form of a copy of the original Product purchase invoice or receipt confirming the Product model number and serial number;
3. Description of the problem;
4. Validation of problem by Technical Support, and
5. Shipping address for the repaired or replacement equipment.

Upon receiving this information, the OutBack representative can issue an RMA number.

Returning Product to OutBack

After receiving the RMA number, the customer must pack the Product(s) authorized for return, along with a copy of the original purchase invoice and product registration, *in the original Product shipping container(s) or packaging providing equivalent or reasonable protection*. The RMA number must be written on the outside of the packaging where it is clearly visible.

If Product is within the warranty period, OutBack will cover pre-paid shipping with prior arrangement.

The Product(s) must be shipped back to OutBack Power Technologies in their original or equivalent packaging, to the following address:

OutBack Power Technologies
RMA # ____________________
17827 – 59th Avenue N.E.
Arlington, WA 98223 USA

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The customer must insure the shipment, or accept the risk of loss or damage during shipment. If a shipping box is needed for return of a Product, OutBack will, upon request, send a shipping box.

> **IMPORTANT:**
> *OutBack is not responsible for shipping damage caused by improperly packaged Products, the repairs this damage might require, or the costs of these repairs.*

If, upon receipt of the Product, OutBack determines the Product or Product part is defective and that the defect is covered under the terms of this Warranty, OutBack will then ship a repaired or replacement Product or Product part to the purchaser freight prepaid, non-expedited, using a carrier of OutBack's choice, where applicable.

If Product fails in ninety (90) or fewer days from original purchase date, OutBack will replace with a new Product. If Product fails after ninety (90) days and up to expiration of warranty, OutBack will, at its discretion, either repair and return a Product, or ship a replacement Product. OutBack will determine whether a Product is to be repaired or replaced in accordance with Product age and model. OutBack will authorize advance shipment of a replacement based on Product age and model.

In cases where an OutBack dealer or distributor replaces a Product more than ninety (90) days old with a new Product, OutBack will NOT compensate that dealer or distributor with new stock unless the exchange was authorized in advance by OutBack.

Troubleshooting/No-Fault-Found Fee

In the event of a Product failure, the customer will need to work with an OutBack Technical Support representative to perform the necessary troubleshooting. This is a required step before a return can be performed. Troubleshooting requires a qualified technician to be present at the site of the Product, with a quality voltmeter that measures both DC and AC. The OutBack representative will request voltmeter readings, error messages, and other information. Several problems can be resolved on-site. If the customer is unable to provide the requested information and the Product is found to have no problems upon return, OutBack may choose to charge additional labor and handling fees up to $180.00 U.S.

Out of Warranty

If Product is out of warranty, OutBack will repair and return Product for a fee. Alternately, if applicable, OutBack will advance-ship replacement parts for a fee upon request.

If a shipping box is needed for return of out-of-warranty Product, OutBack will send a shipping box upon request. The customer is responsible for paying shipping to OutBack.

The warranty period of any repaired or replacement Product or Product part is ninety (90) days from the date of shipment from OutBack, or the remainder of the initial warranty term, whichever is greater.

This Warranty is void for any Product that has been modified by the customer without authorization by OutBack. A Product with a voided warranty will be treated the same as one with an expired warranty.

Warranty Updates

For updates to the warranty statement, check the following website:

http://www.outbackpower.com/resources/warranty/

Recycling Information

> **IMPORTANT: Recycle Electronics and Batteries**
> Batteries are considered hazardous waste and must be recycled according to local jurisdiction. Inverters and other electronics contain metals and plastics that should also be recycled. The following websites and phone numbers provide additional information for recycling electronic products and batteries.

Earth 911, USA

Website: http://www.Earth911.com
Address: 14646 N. Kierland Blvd., Suite 100
Scottsdale, AZ 85254
Phone: +1.480.337.3025 (direct)

Environmental Protection Agency, USA

Website: http://www.epa.gov/wastes/conserve/materials/ecycling/donate.htm
Address: EPA USA
Office of Resource Conservation and Recovery (5305P)
1200 Pennsylvania Avenue NW
Washington, DC 20460

Keep America Beautiful, USA

Website: http://www.kab.org/
Email: info@kab.org
Address: 1010 Washington Boulevard
Stamford, CT 06901
Phone: +1.203.659.3000 (Main number)
Fax: +1.203.659.3001

OurEarth.org, USA

There is a place on the Website for contacting OurEarth.org using email. No direct email address is provided.

Website: http://www.ourearth.org
Address: P.O. Box 62133
Durham, NC 27715
Phone: +1.410.878.6485

National Institute of Recyclers, Mexico

Website: http://www.inare.org.mx/
Email: a57841279@prodigy.net.mx, margarita@inare.org.mx
Phone: +1.55.57.85.9160
Fax: +1.55.57.84.1279

Office of Waste Management, Canada

Website: http://www.portaec.net/library/recycling/recycling_in_canada.html
Address: Office of Waste Management
Conservation and Protection
Environment Canada
Ottawa, Ontario K1A 0H3
Phone: +1.819.997.2800

EuroRecycle.net, Europe

The following website provides general information about recycling in Europe. It also provides a list of companies and organizations that provide recycling information or assistance.

Website: http://euro.recycle.net
Email: http://euro.recycle.net/cgi-bin/feedback1.cgi?w=27
(This is an online form providing a means to contact the owners of the website.)

De cinco años (5) limitó garantía

OutBack Power Technologies, Inc. ("OutBack") proporciona cinco (5) años de garantía limitada ("Garantía") contra defectos en materiales y habilidad para sus inversor/corceles, controladores de carga, monitor de batería y productos de comunicación ("Producto"), a excepción del Interior de OBX productos de serie Extremos, que tienen un uno (1) año de garantía limitada.

El plazo de vigencia de esta Garantía comienza en la fecha de compra inicial del Producto, o en la fecha de la recepción del Producto por el usuario final, la fecha que sea posterior. Esto debe indicarse en la factura, recibo y/o registro de la garantía enviado a OutBack. Esta Garantía es aplicable al comprador original del Producto OutBack, y es transferible únicamente si el Producto permanece instalado en el lugar de uso original.

La garantía no es aplicable a ningún Producto o parte del Producto que haya sufrido modificaciones o daños por lo siguiente:

- Instalación o desmontaje;
- Modificación o desarme;
- Desgaste normal;
- Accidente o abuso;
- Corrosión;
- Rayos;
- Reparación o servicio realizados por un taller no autorizado;
- Funcionamiento o instalación contrarios a las instrucciones del fabricante;
- Fuego, inundación o fuerza mayor;
- Transporte;
- Daños accidentales o derivados, ocasionados por otros componentes del sistema eléctrico;
- Cualquier producto cuyo número de serie haya sido alterado, desfigurado o eliminado;
- Cualquier otra circunstancia no prevista por OutBack.

La responsabilidad de OutBack por cualquier Producto defectuoso, o cualquier parte del Producto, estará limitada a la reparación o sustitución del Producto, a criterio de OutBack. OutBack no garantiza los trabajos realizados por la persona o empresa que instale sus Productos. Esta Garantía no cubre los costos de instalación, desmontaje, transporte (salvo las excepciones que se describen más adelante) o reinstalación de los Productos o partes de Productos.

ESTA GARANTÍA LIMITADA ES LA ÚNICA GARANTÍA APLICABLE A PRODUCTOS OUTBACK. OUTBACK RECHAZA EXPRESAMENTE CUALQUIER OTRA GARANTÍA EXPLÍCITA O IMPLÍCITA DE SUS PRODUCTOS, INCLUIDAS, ENTRE OTRAS, LAS GARANTÍAS IMPLÍCITAS DE COMERCIABILIDAD O IDONEIDAD PARA UN FIN DETERMINADO. OUTBACK TAMBIÉN LIMITA EXPRESAMENTE SU RESPONSABILIDAD EN CASO DE REPARACIÓN O SUSTITUCIÓN DE UN PRODUCTO DEFECTUOSO DE ACUERDO CON LOS TÉRMINOS DE ESTA GARANTÍA LIMITADA Y EXCLUYE TODA RESPONSABILIDAD POR LOS DAÑOS ACCIDENTALES O DERIVADOS, INCLUYENDO, SIN LIMITACION ALGUNA, CUALQUIER RESPONSABILIDAD POR LA INDISPONIBILIDAD DE LOS PRODUCTOS O LUCRO CESANTE, INCLUSO EN EL CASO DE QUE HAYA SIDO ADVERTIDA DE TALES DAÑOS POTENCIALES. SI ES UN CONSUMIDOR QUE ADQUIRIÓ ESTE PRODUCTO EN UN ESTADO MIEMBRO DE LA UNIÓN EUROPEA, PUEDE TENER DERECHOS LEGALES ADICIONALES BAJO LA DIRECTIVA 1999/44/CE. ESTOS DERECHOS PUEDEN VARIAR DE UN ESTADO MIEMBRO DE LA UE A OTRO. ALGUNOS ESTADOS (O JURISDICCIONES) NO CONTEMPLAN LA EXCLUSIÓN O LIMITACIÓN DE GARANTÍAS O DAÑOS, POR LO QUE ESTAS LIMITACIONES O EXCLUSIONES PUEDEN NO AFECTARLE.

Cómo registrar el producto

Para registrar su producto, utilice la forma en línea en la posición siguiente de sitio web:

http://www.outbackpower.com/resources/warranty/

O, completa la tarjeta de Matrícula de Garantía proporcionado con el producto y envíe lo a la dirección proporcionado en la tarjeta.

Cómo solicitar el servicio de la garantía

Durante el plazo de garantía que comienza en la fecha de la factura, OutBack Power Technologies reparará o cambiará aquellos productos cubiertos por esta garantía limitada que sean devueltos a las instalaciones de OutBack Power Technologies o a un taller de reparación autorizado por OutBack Power Systems, o que sean reparados en las instalaciones del consumidor por un técnico de reparaciones autorizado por OutBack Power Technologies.

Para contactar OutBack Apoyo Servicio de asistencia técnica

Para solicitar el servicio de la garantía:

Teléfono: **+1.360.435.6030** (Oficina principal)
+1.360.618.4363 (Asistencia técnica)
Correo electrónico: **support@outbackpower.com**

Para asegurar la cobertura de la garantía, deberá ponerse en contacto con OutBack durante el período efectivo de la garantía. Si fuese necesario el servicio, el representante de la asistencia técnica de OutBack emitirá un número de autorización de devolución del material (RMA).

Autorización de devolución de material (RMA)

Para solicitar un número RMA debe facilitarse toda la información que se indica a continuación:

1. modelo y número de serie del Producto,
2. la prueba de compra en forma de copia de la factura original del Producto o un recibo que confirme el número de modelo y el número de serie del Producto,
3. descripción del problema,
4. la validación del problema por asistencia técnica; y
5. dirección de envío del equipo reparado o de sustitución.

Tras la recepción de esta información, el representante de OutBack podrá emitir un número RMA.

Devolución de un Producto a OutBack

Después de recibir el número RMA, el cliente debe embalar el/los Producto/s autorizado/s para su devolución, junto con una copia de la factura de compra original y el certificado de garantía, en el embalaje original del Producto/s o en un embalaje que ofrezca una protección equivalente o razonable. El número RMA debe escribirse en el exterior del embalaje donde se pueda ver claramente.

Si el producto se encuentra dentro del período de garantía, OutBack cubrirá los costos prepagos del transporte con previo acuerdo.

El Producto o los Productos deben enviarse de vuelta a OutBack Power Technologies en su embalaje original o equivalente a la siguiente dirección:

OutBack Power Technologies
RMA # ____________________
17827 – 59th Avenue N.E.
Arlington, WA 98223 Estados Unidos

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Product Registration Form

The purchase of an OutBack Power Technologies product is an important investment. Registering the products will help us maintain the standard of excellence you expect from us in terms of performance, quality, and reliability.

Please take a moment to register and provide us with some important information. Registration can be done as follows:

❒ Go to the following website:
http://www.outbackpower.com/resources/warranty/ or

❒ Fill out the information on this page and mail it the address below.

Registro del Producto

La adquisición de un producto de OutBack Power Technologies es una inversión importante. Al registrar nuestros productos, nos ayudará a mantener el estándar de excelencia que espera de nosotros en términos de rendimiento, calidad y fiabilidad.

Dedique unos minutos al registro del producto y a proporcionarnos información importante. El registro se puede hacer del siguiente modo:

❒ Diríjase al siguiente sitio web:
http://www.outbackpower.com/resources/warranty/ o

❒ Llene la información en esta página y envíelo la dirección abajo.

La Forme d'enregistrement de produit

L'achat d'un produit d'OutBack Power Technologies est un investissement important. Enregistrer les produits aideront nous maintient la norme d'excellence que vous prévoyez de nous sur le plan de l'exécution, de la qualité, et de la fiabilité.

S'il vous plaît prendre un moment pour enregistrer et fournir nous avec des informations importantes. L'enregistrement peut être fait comme suit :

❒ Aller au site Web suivant : http://www.outbackpower.com/resources/warranty/
ou

❒ Remplir les informations sur cette page et l'envoie l'adresse au-dessous.

Produktregistrierung

Der Kauf eines Produkts, das von OutBack Power Technologies gemacht wird, ist eine wichtige Investition. Registrieren der Produkte wird uns helfen, den Standard der Vortrefflichkeit Sie beizubehalten, erwarten von uns in Begriffen der Leistung, Qualität, und Zuverlässigkeit.

Bitte nehmen Sie einen Moment zu registrieren und uns mit einigen wichtigen Informationen zu versorgen. Registrierung kann folgendermaßen gemacht werden:

❒ Gehen Sie zur Folgenden Website:
http://www.outbackpower.com/resources/warranty/ oder

❒ Füllen Sie die Informationen über diese Seite aus und schicken Sie es die Adresse unten ab.

OutBack Power Technologies
Attn: Warranty Registration
17825 – 59th Avenue N.E.
Suite B
Arlington, WA 98223 USA

Please check ALL factors affecting purchase decision:	**Marque TODOS los factores que afectan la decisión de compra:**	**S'il vous plaît vérifier TOUS les facteurs qui affectent la décision d'achat :**	**Bitte prüfen Sie ALLE Faktoren, die Kaufentscheidung beeinflussen:**
❒ Grid-Interactive Capability ❒ Product Reputation ☒ Back-up Capability ❒ Reputation of OutBack Power Technologies ❒ Value ❒ Looks ❒ Other____________________	❒ Capacidad de interactivo en la red eléctrica ❒ Reputación del producto ❒ Capacidad de respaldo ❒ Reputación de OutBack Power Technologies ❒ Valor ❒ Apariencia ❒ Otros ____________________	❒ La capacité pour fonctionner comme réseau interactif ❒ Réputation de produit ❒ La capacité pour fonctionner comme la Sauvegarde ❒ La réputation d'OutBack Power Technologies ❒ Valeur ❒ Apparence ❒ Autre____________________	❒ Fähig von Bedienung Netz-interaktiv ❒ Produktruf ❒ Backup Befähigung ❒ Ruf von OutBack Power Technologies ❒ Wert ❒ Erscheinung ❒ Anderer__________________

Extended Warranty

Where required by local authority, OutBack Power Technologies offers a five-year (5) extension to the standard five-year (5) Limited Warranty for certain products for a total effective warranty coverage period of ten (10) years. To request a limited warranty extension, mail this page with payment in the appropriate amount, to OutBack Power Technologies at the address provided above.

Please submit within 90 days of the first retail sale of the product and indicate the quantity of each product.

- Radian Series Inverter/Charger — $899 USD per unit
- GTFX or GVFX Series Inverter/Charger — $599 USD per unit
- FLEXmax Series Charge Controller — $250 USD per unit

Garantía prolongada

Dónde es necesario por administración local, OutBack Power Technologies ofrece cinco años (5) extensión al estándar de cinco años (5) Garantía Limitada para ciertos productos para un período efectivo total de alcance de garantía de diez (10) años. Para solicitar una extensión limitada de garantía, envíe esta página con el pago en la cantidad apropiada, a OutBack Power Technologies en la dirección indicada anteriormente.

Favor de someter dentro de 90 días de la primera venta del producto e indique la cantidad de cada producto.

- Inversor/Cargador de la serie Radian — $899 USD por unidad
- Inversor/Cargador de la Serie GTFX o GVFX — $599 USD por unidad
- Regulador de carga de la Serie FLEXmax — $250 USD por unidad

Extension de garantie

Où exigé par l'autorité locale, OutBack Power Technologies offre un cinq-an (5) l'extension au cinq-an de norme (5) A Limité Garantie pour les certains produits pour une période de couverture de garantie efficace totale de dix (10) les ans. Pour demander une extension limitée de garantie, envoyer cette page avec le paiement dans la quantité appropriée, à OutBack Power Technologies à l'adresse fournie au-dessus.

S'il vous plaît soumettre dans 90 jours de la première vente au détail du produit et indiquer la quantité de chaque produit.

- L'onduleur/chargeur de la gamme Radian — $899 USD par l'unité
- L'onduleur/chargeur de la gamme GTFX ou GVFX — $599 USD par l'unité
- Contrôleur de charge de la gamme FLEXmax — $250 USD par l'unité

Ausgedehnte Garantie

Zu wo erforderlich durch Kommune, OutBack Power Technologies einem fünf jährigen (5) Verlängerung der Standard fünf jährig (5) beschränkte Haftung für gewisse Produkte für eine gesamte effektive Garantie Abdeckung Periode von zehn (10) Jahre anbietet. Um eine beschränkte Haftung Verlängerung zu erbitten, schicken Sie diese Seite mit Zahlung im passenden Betrag, zu OutBack Power Technologies an der Adresse ab, die oben versorgt wird.

Bitte reichen Sie innerhalb 90 Tagen des ersten Einzelhandels Verkauf des Produkts ein und zeigen Sie die Quantität jedes Produkts an.

- Radian Baureihen Wechselrichter/Lader — $899 USD pro Einheit
- Wechselrichter/Lader der GTFX oder GVFX Baureihe — $599 USD pro Einheit
- Laderegler der FLEXmax Baureihe — $250 USD pro Einheit

SYSTEM OWNER (Propietario del sistema, Propriétaire de système, System Eigentümer)

Name (Nombre , Nom, Name)	
Address (Dirección, Adresse, Anschrift)	
City, State, Postal or Zip Code (Ciudad, Estado, Código Postal, La ville, l'État, Postal ou la Fermeture à glissière Code, Stadt, Staat, Postalisch oder Schwung Kodiert)	
Country (País , Pays , Land)	
Telephone Number (Teléfono, Numéro de téléphone, Telefon)	
E-mail (Correo electrónico, e-mail, E-mail)	

FIRMWARE UPDATES (Actualizaciones de Firmware, Remettre à jour de microprogramme, Firmware Aktualisierungen)

Do you want to be notified about firmware updates?
¿Quiere ser notificado acerca de actualizaciones de Firmware?
Voulez-vous être notifiés de remettre à jour de microprogramme ?
Wollen Sie über Firmware-Aktualisierungen benachrichtigt werden?

☒ YES (Si, Oui, Ja) ☐ NO (No, Non, Nein)

SYSTEM PURCHASE (Sistema adquirido, Achat de système, Systemkauf)

Product Model Number (Número de modelo del producto, Le Nombre de Modèle de produit, Produktmodellnummer)	Re2000
Product Serial Number (Número de serie del producto, Numéro de série de produit, Produktseriennummer)	E4200198935 +
Sold by (Vendido por, Vendu par, Verkauft durch)	Coconut Coast Electric
Purchase Date (Fecha de compra, Acheter la Date, Kaufen Sie Datum)	09/01/2015

INSTALLATION INFORMATION (Información sobre instalación, Informations sur l'installation, Installationen Informationen)

System Install/Commission Date (Fecha de instalación/puesta en marcha del sistema, La Date d'installer / Mise en service de système, System Installieren Sie/Kommission Datum)	09/17/2015		
PV Array Wattage (Dimensiones de la matriz del sistema, Valeur en watts de générateur PV (photovoltaïque), PV-Feld Watt zahl)	19KW	**Nominal Voltage ➔** (Voltaje nominal de la matriz del sistema , Tension nominal, Nennwert Spannung)	48VDC
Type of PV Modules (Tipo de Módulos de FV, Le type de Modules de PV, Typ von PV Modulen)	Suniva OPT265-60-4-100		
System Battery Bank Size (Amp-Hours) (Tamaño del banco de las baterías del sistema (Amp-hora), La Taille du groupe de batteries du système (les Ampères-Heures), Systembatteriebankgröße (Ampere-Stunden))	1716AH		
Brand and Model of Batteries (Marca y modelo de las baterías, Marquer et Modèle des batteries, Marke und Modell von Batterien)	Outback Power RE2000		
Brand and model of Generator (if used) (Marque y el modelo de Generador (si utilizado), Marquer et le modèle de Générateur (si utilisé), Marke und Modell des Generators (wenn verwendet))	N/A		

INSTALLER INFORMATION (Información Sobre el instalador, Informations d'installateur, Monteur-Information)

Contractor Number (Número de contratista, Nombre d'entrepreneur, Unternehmer-Nummer)	Coconut Coast Elec. C-26809
Installer Name (Nombre del instalador, Nom d'installateur, Monteur-Name)	Gary D. Seals
Installer Address (Dirección del instalador, Adresse d'installateur, Monteur Anschrift)	430 Kaholalele rd
Installer City, State, Postal or Zip Code, Country (Ciudad, Estado, Código Postal, País del instalador; La ville d'installateur, l'État, Postal ou la Fermeture à glissière Code, Pays; Monteur Stadt, Staat, Postalisch oder Schwung Kodiert)	Kapaa, Hi 96746
Installer Telephone/E-mail (Teléfono/correo electrónico/del instalador, Installateur téléphone/e-mail, Monteur Telefone/e-Mail)	808-651-7732 gary@solsystems.org

EXTENDED WARRANTY (La Garantía prolongada, Garantie Prolongée, Ausgedehnte gebetene Garantie):

	Product (producto, produit, Produkt):	**Quantity** (cantidad, quantité, Quantität):
Make payable to (Haga pagadero a, Faites payable, Machen Sie zahlbar):	**Inverter/Charger** (Inversor/cargador, Onduleur / chargeur, Wechselrichter/Lader) ☐ Radian ☐ GTFX/GVFX	
OutBack Power Technologies	**Charge Controller** (Regulador de carga, Contrôleur de charge, Laderegler) ☐ FLEXmax 60 ☐ FLEXmax 80 ☐ FM Extreme	
Total: $		

Battery Inspection Sheet: Hickam AFB SVE site

Outback RE-2000

9/10/2015
checked by G. seals

CRATE #	CELL #	LAST 3 OF CELL SERIAL #	CELL VOLTAGE VOLTS DC	
CRATE 126	1	595-A	2.16	
	2	595-B	2.16	
	3	594-A	2.16	
	4	594-B	2.16	
	5	938-A	2.16	
	6	938-B	2.16	
	7	996-A	2.6	
	8	996-B	2.16	
	9	937-A	2.16	
	10	937-B	2.16	
	11	597-A	2.16	
	12	597-B	2.16	
CRATE 127	13	935-A	2.15	
	14	935-B	2.15	
	15	957-A	2.15	
	16	957-B	2.15	
	17	973-A	2.14	
	18	973-B	2.14	
	19	947-A	2.16	
	20	947-B	2.16	
	21	956-A	2.15	
	22	956-B	2.15	
	23	964-A	2.15	
	24	964-B	2.15	
CRATE 129	25	511-A	2.16	
	26	511-B	21.6	
	27	538-A	21.6	
	28	538-B	2.16	
	29	540-A	2.15	
	30	540-B	2.15	
	31	516-A	2.16	
	32	516-B	2.16	
	33	530-A	2.16	
	34	530-B	2.16	
	35	531-A	2.15	
	36	531-B	2.15	
CRATE	37	982-A	2.16	
	38	982-B	2.16	
	39	954-A	2.14	
	40	954-B	2.14	
	41	951-A	2.14	
	42	951-B	2.14	
	43	941-A	2.14	

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Appendix B-5
Emergency Shutdown Procedure

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EMERGENCY SHUTDOWN

FOR

HICKAM AFB SVE POWER ROOM

1- TURN OFF SOLAR PV SUPPLY

TO BE DONE AT COMBINER BOXES 1-6

TURN DISCONNECT SWITCHES LEFT COUNTER CLOCKWISE TO OFF POSITION

DISCONNECT SWITCHES

2- TURN OFF AC & DC BREAKERS AT (2) INVERTER LOAD CENTERS

TO BE DONE IN ELECTRICAL ROOM BELOW INVERTERS

TURN ALL AC & DC BREAKERS TO OFF POSITIONS (START AT TOP LEFT OF EACH LOAD CENTER AND MOVE DOWN AND RIGHT) **SWITCHING LARGE 175ADC BREAKERS OFF LAST**

AC BREAKERS

DC BREAKERS (LAST)

4- TURN OFF DC DISCONNECT BLADE SWITCH

TO BE DONE IN ELECTRICAL ROOM

IN BACK LEFT CORNER OF ELECTRICAL ROOM LARGE RED HANDLE - PULL DOWN

DC BATTERY DISCONNECT

REVERSE ORDER TO RESTART

Call Gary Seals Coconut Coast Electric w/ any questions 808-651-7732 gary@solsystems.org

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Appendix B-6
Checklist for AGM Quarterly Battery Inspection

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Checklist For Quarterly Inspection
AGM Battery Rack, Inverter Load Center, and Ancillary Equipment
Off-Grid Solar Powered SVE System
Joint Base Pearl Harbor, Hickam, Hawaii

Item	Inspection Details	Observations	Recommendations (Describe If Any)
AGM Battery Rack Related Inspections			
AGM-1	Clean batteries as specified in the procedure if evidence of dust accumulation, mild corrosion		
AGM-2	Update Maintenance Records use current RE-2000 install sheet as a comparative baseline to track the following;		
	Individual cell voltages		
	Cell to cell connection resistance (ohms)		
	Terminal connection resistance (ohms)		
	Equipment room ambient temperature		
AGM-3	Other Items Noted		
Balance of System Related Inspections			
BSI-1	Batteries including floor plate, proper operation of shields, and check rack is level in all directions		
BSI-2	Signage is in place and readable inside of control room and on the door		
BSI-3	Fan in control room operational and filter free of dust and debris		
BSI-4	Connections within the main DC Disconnect (De-energize)		
BSI-5	Charge controller and record settings		
BSI-6	Low voltage (DC) instrumentation and control wiring		
BSI-7	Operability of the PLC as related to the proper operation of the battery and inverter system		
BSI-8	AC power side in the Control Room		
BSI-9	Interior and connections within the combiner boxes (De-energize)		
BSI-10	System grounds		

Item	Inspection Details	Observations	Recommendations (Describe If Any)
BSI-11	Mate 3 and download data to review proper operation		
BSI-12	Other Items Noted		
PV Array Related Equipment			
PV-1	Conduct general inspection under and around the PV Array		
PV-2	Check PV racking and associated bonding hardware for corrosion, damage, or deformation (repair or replace if observed)		
PV-3	Check visible portions of PV conductors to look for compromises in the wire insulation (nicks, cuts, etc.). Note: do not touch any exposed portion of wire		
PV-4	Inspect the top side of the PV panels to look for cracks, excessive debris, etc.		
PV-5	Inspect the bottom side off the PV panels to look for cracks or significant scratches in the white backing of the panels.		
PV-6	Observe for and remove any vegetation that could impede the operation of the PV Array		
Date	**Time of Inspection (Local)**	**Personnel Present**	**Weather Conditions**

List Attachments Associated with Checklist (including pictures)

- Completed Battery Maintenance Report (from PowerSafe Safety, Storage, Operating and Maintenance Manual for VRL Battery Systems mSeries, DDm, DDS, DDV, and SC, 2008 by EnerSys, page 28)
- Pictures
- Other support documentation

Appendix C
Foundation Design Drawing

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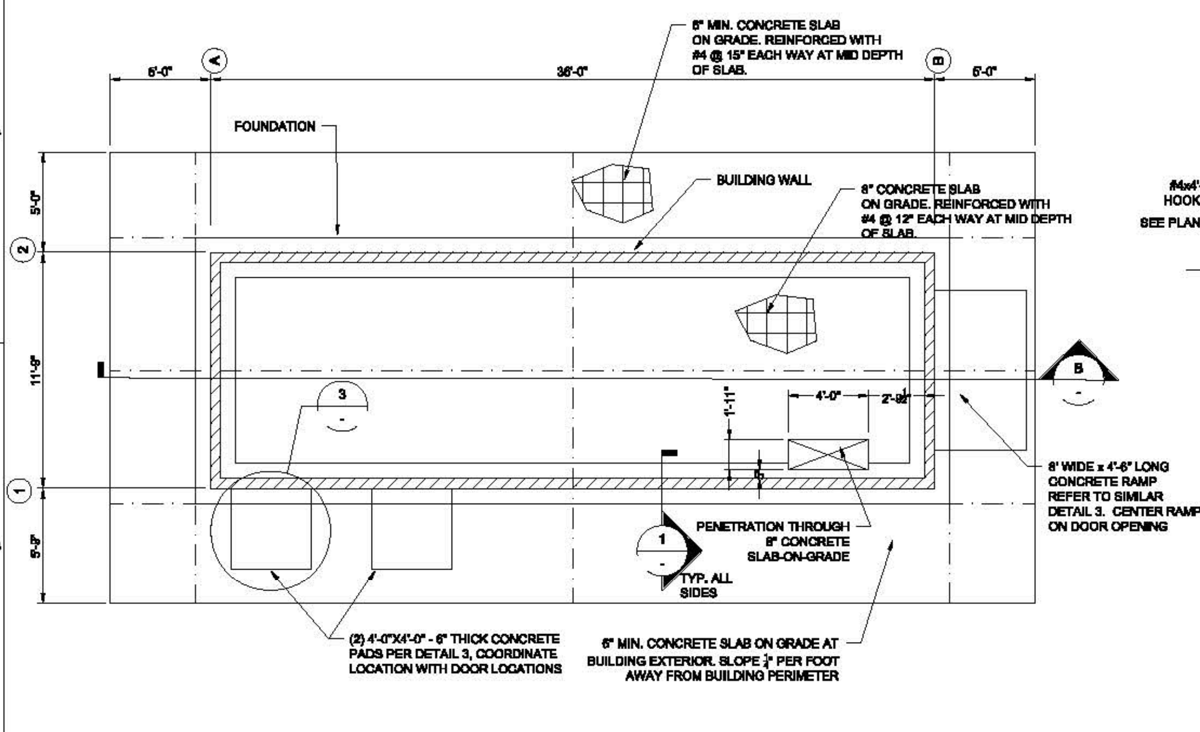
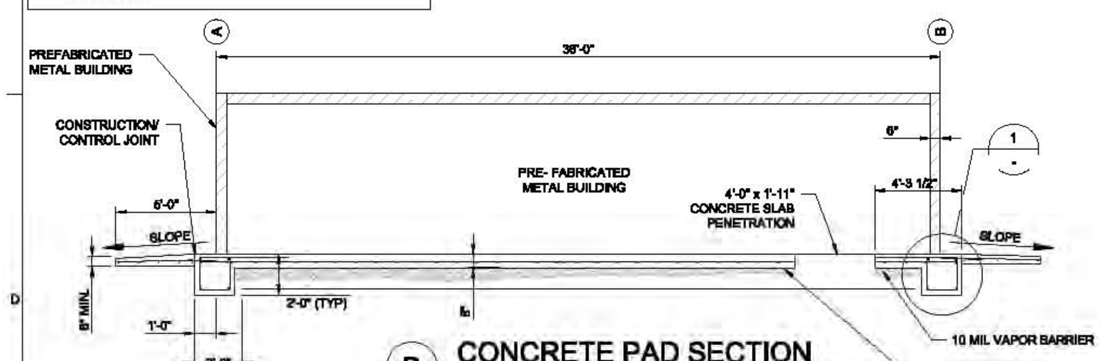
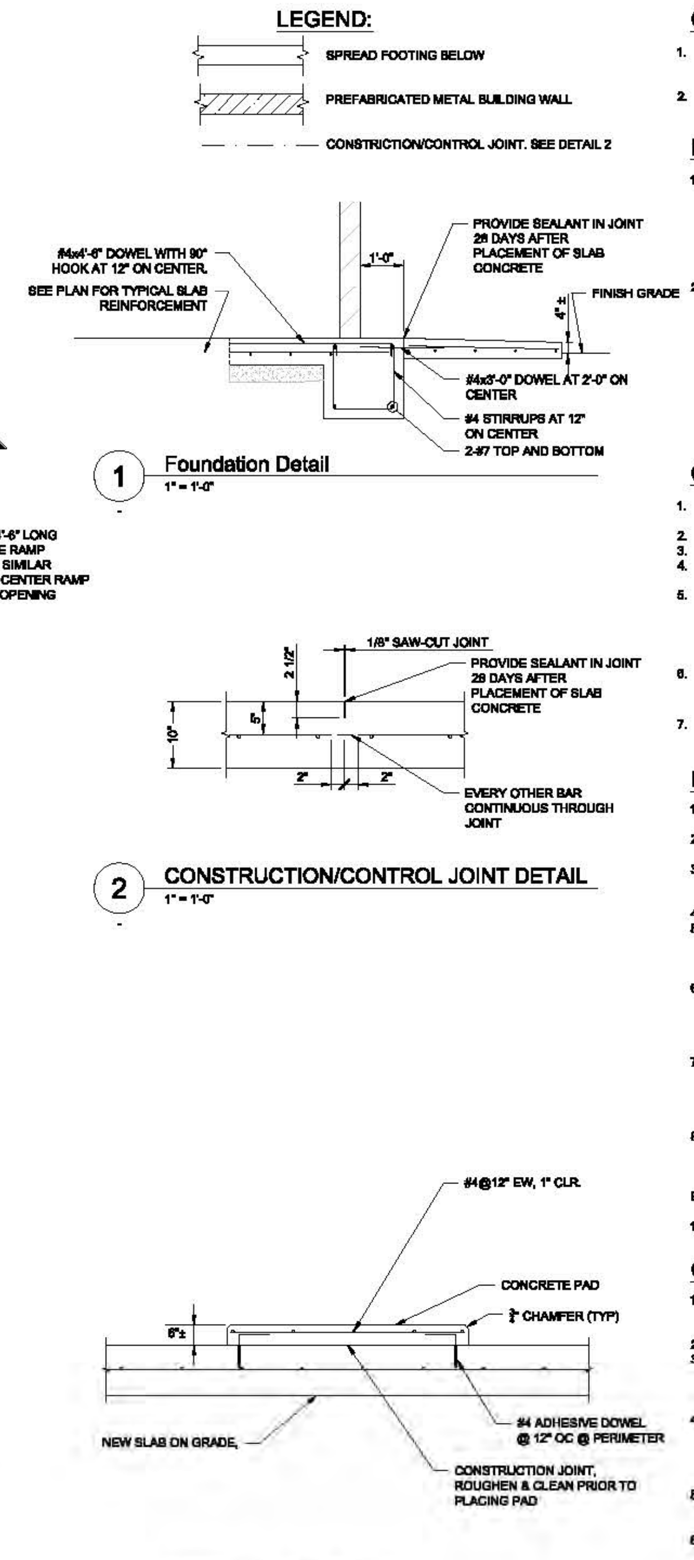


A CONCRETE PAD PLAN
1/4" = 1'-0"

PLAN NOTES:
1. 8" CONCRETE PAD AND PERIMETER FOOTINGS SHALL BE A MONOLITHIC CONCRETE PLACEMENT. THE EXTERIOR 6" MIN. SLAB ON GRADE MAY BE PLACED SEPARATELY.
2. AT CONTRACTORS OPTION, THE SIDES OF THE 2'x2' PERIMETER FOUNDATION MAY BE "LAID BACK" AND PLACED NEAT AGAINST THE SUBGRADE.



B CONCRETE PAD SECTION
1/4" = 1'-0"



GENERAL

1. STRUCTURES ARE DESIGNED TO ACT AS A STRUCTURAL UNIT UPON COMPLETION. DESIGN AND PROVIDE NECESSARY BRACING, TEMPORARY SUPPORTS, AND SHORING TO RESIST FORCES, INCLUDING UPLIFT, ON THE STRUCTURE DURING CONSTRUCTION.
2. WORK SHALL BE COORDINATED WITH THE VARIOUS TRADES TO AVOID CONFLICT OR INTERFERENCE WITH REINFORCING STEEL OR STRUCTURAL STEEL MEMBERS.

DESIGN CRITERIA

1. APPLICABLE CODES AND SPECIFICATIONS:
   ALL APPLICABLE LOCAL BUILDING CODES
   I.B.C 2006 INTERNATIONAL BUILDING CODE WITH AMENDMENTS
   A.C.I 318-08, BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE AND COMMENTARY
2. DESIGN LOADS

DEAD LOAD	AS SPECIFIED BY BUILDING MANUFACTURER
LIVE LOAD:	
ROOF LIVE LOAD	AS SPECIFIED BY BUILDING MANUFACTURER
GROUND FLOOR LIVE LOAD	150 PSF
WIND LOAD:	AS SPECIFIED BY BUILDING MANUFACTURER
SEISMIC LOAD:	AS SPECIFIED BY BUILDING MANUFACTURER

CONCRETE

1. ALL CAST IN PLACE CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF FC=4000 PSI
2. STEEL REINFORCING BARS SHALL CONFORM TO A.S.T.M. A615, GRADE 60.
3. CONCRETE DESIGN IS IN CONFORMANCE WITH A.C.I. 318-08 FOR BUILDINGS.
4. DETAIL FABRICATE AND ERECT REINFORCEMENT BARS, INCLUDING BAR SUPPORTS, SPACERS, ETC. IN ACCORDANCE WITH THE LATEST EDITION OF A.C.I. 315
5. CONCRETE COVER FOR REINFORCEMENT BARS SHALL CONFORM TO THE FOLLOWING, UNLESS INDICATED OTHERWISE ON THE DRAWINGS:
   CAST AGAINST EARTH: 3 INCHES
   EXPOSED TO WEATHER OR EARTH: 2 INCHES
6. CONCRETE FINISHES:
   EXTERIOR: LIGHT BROOM
   INTERIOR: NON SLIP
7. SEALANTS: 1 COMPONENT SELF LEVELING POLYURETHANE
   BASIS OF DESIGN SHALL BE SIKAFLEX 1SL BY SIKA CORP.

FOUNDATIONS

1. ALL FOOTINGS SHALL BEAR ON COMPETENT SOIL WITH A BEARING CAPACITY OF 2000 PSF OR GREATER.
2. ALL FOOTINGS SHOULD BE EMBEDDED AT LEAST 24 INCHES BELOW THE LOWEST ADJACENT FINISH GRADE.
3. LOCATE ALL EXISTING UNDERGROUND UTILITIES PRIOR TO BEGINNING ANY WORK. RELOCATE AND/OR PROVIDE ADEQUATE MEANS OF SUPPORT AND PROTECTION OF ALL UTILITIES AT ANY TIMES WHILE PERFORMING WORK.
4. PERFORM ALL CLEARING, GRUBBING, AND STRIPPING WORK WITHIN THE LIMITS SHOWN.
5. OVER-EXCAVATE AT LEAST 36 INCHES IN DEPTH AND 12 INCHES BEYOND FOOTING LINES AND GRADES AS SHOWN OR AS REQUIRED TO ACCOMPLISH THE CONSTRUCTION AND AS APPROVED BY THE ENGINEER. IF HARD INTACT CORAL IS ENCOUNTERED SHALLOWER THAN 36 INCHES, PROVIDE A MINIMUM OF 24-INCH OVER-EXCAVATION INTO THE CORAL.
6. THE SUBGRADE BELOW THE FOOTINGS SHALL BE PROBED FOR POSSIBLE CAVITIES OR VOIDS TO A DEPTH OF AT LEAST 15 FEET. THE PROBES SHALL BE SPACED AT 15 FEET INTERVALS. IF CAVITIES OR VOIDS ARE FOUND, NOTIFY AND COORDINATE WITH THE ENGINEER ON TREATMENT METHOD. PROBING HOLES SHALL BE GROUTED WITH SAND-CEMENT-WATER MIXTURE.
7. AS APPROVED BY THE ENGINEER, AFTER COMPLETION OF OVER-EXCAVATION AND PRIOR TO BACKFILLING, SCARIFY, THOROUGHLY MOISTURE CONDITIONED TO WITHIN 2 PERCENT OF OPTIMUM MOISTURE CONTENT AND COMPACT TO AT LEAST 95 PERCENT RELATIVE COMPACTION THE TOP 8 INCHES OF SUBGRADE. COMPACTION IS NOT REQUIRED IF THE BOTTOM OF OVER-EXCAVATION CONSISTS OF INTACT CORAL
8. PROOF-ROLL THE EXCAVATION SURFACE WITH A LOADED DUMP TRUCK OR SIMILAR HEAVY-WHEELED VEHICLE TO DETECT SOFT OR LOOSE ZONES. IF SOFT OR LOOSE ZONES ARE FOUND, EXCAVATE THE SOFT OR LOOSE MATERIAL TO A DEPTH ACCEPTED BY THE ENGINEER, THEN FILL WITH CLSM. .
9. REPLACE OVER-EXCAVATION WITH CLSM TO THE FOOTING LINES AND GRADES AS SHOWN.
10. CLSM SHALL HAVE A 28-DAY UNCONFINED COMPRESSIVE STRENGTH OF AT LEAST 500 PSI.

CONCRETE SLAB-ON-GRADE

1. LOCATE ALL EXISTING UNDERGROUND UTILITIES PRIOR TO BEGINNING ANY WORK. RELOCATE AND/OR PROVIDE ADEQUATE MEANS OF SUPPORT AND PROTECTION OF ALL UTILITIES AT ANY TIMES WHILE PERFORMING WORK.
2. PERFORM ALL CLEARING, GRUBBING, AND STRIPPING WORK WITHIN THE LIMITS SHOWN.
3. OVER-EXCAVATE AT LEAST 36 INCHES IN DEPTH AND 12 INCHES BEYOND SLAB LINES AND GRADES AS SHOWN OR AS REQUIRED TO ACCOMPLISH THE CONSTRUCTION AND AS APPROVED BY THE ENGINEER. IF HARD INTACT CORAL IS ENCOUNTERED SHALLOWER THAN 36 INCHES, PROVIDE A MINIMUM OF 24-INCH OVER-EXCAVATION INTO THE CORAL.
4. THE SUBGRADE BELOW THE SLAB SHALL BE PROBED FOR POSSIBLE CAVITIES OR VOIDS TO A DEPTH OF AT LEAST 10 FEET. THE PROBES FREQUENCY SHALL BE AT LEAST ONE PROBE PER 50 SQUARE FEET OF SLAB AREA. IF CAVITIES OR VOIDS ARE FOUND, NOTIFY AND COORDINATE WITH THE ENGINEER ON TREATMENT METHOD. PROBING HOLES SHALL BE GROUTED WITH SAND-CEMENT-WATER MIXTURE.
5. PLACE SPECIFIED EARTHFILL TO THE LINES AND GRADES SHOWN. PLACE FILL MATERIAL IN MAXIMUM 8 INCH LIFTS AND COMPACT EACH LIFT TO NOT LESS THAN 95 PERCENT RELATIVE COMPACTION IN ACCORDANCE WITH ASTM D1557.
6. PROOF-ROLL THE EXCAVATION SURFACE WITH A LOADED DUMP TRUCK OR SIMILAR HEAVY-WHEELED VEHICLE TO DETECT SOFT OR LOOSE ZONES. IF SOFT OR LOOSE ZONES ARE FOUND, EXCAVATE THE SOFT OR LOOSE MATERIAL TO A DEPTH ACCEPTED BY THE ENGINEER, THEN FILL WITH CLSM.
7. CLSM SHALL HAVE A 28-DAY UNCONFINED COMPRESSIVE STRENGTH OF AT LEAST 500 PSI.

FILENAME: G-1001.dwg PLOT DATE: 2014, Jun 24 PLOT TIME: 3:41pm

NO.	DATE	REVISION	BY	APVD
DSGN	DR	CHK	APVD	
A. GILLUM	M. MERCEDE	P. DESAUTELS	P. DESAUTELS	

CH2MHILL.
400 EMBASSY ROW
6600 PEACHTREE DUNWOODY, SUITE 600
ATLANTA, GA 30328 PH: 770.604.9095

TSIP FOR SUBSITE ST32
ONIZUKA VILLAGE
JOINT BASE PEARL HARBOR-HICKAM, HAWAII

HICKAM AFB BLOWER HOUSE
CONCRETE PAD PLAN

NONE
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	JUNE 2014
PROJ	484321
DWG	G-1001
SHEET	1 of 1

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Appendix D
Performance and Pressure Monitoring Forms

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Appendix D-1
Performance Monitoring Log

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Performance Monitoring Log

KB06 Onizuka Village Treatability Study

Name:________________________		Date:_________________________	
Time:________________________		Weather:_________________________	

BATTERIES/INVERTERS		SVE SYSTEM (Circle The Operating Well Leg/s)		
Battery Pack SOC (%)		SVE-1		Vacuum (in Hg)
Battery Pack Voltage (V)				Flow (fpm)
Battery Room Temperature (F):		SVE-2		Vacuum (in Hg)
VFD Setting (%)				Flow (fpm)
Current (amps):		SVE-3		Vacuum (in Hg)
Power (kW):				Flow (fpm)
Charge Controller 1 Output (kW)		Effluent Pump Totalizer		(gallons)
Charge Controller 2 Output (kW)		Blower Flow Rate		(cfm)
Charge Controller 3 Output (kW)		Blower Effluent Temp		(F)
Charge Controller 4 Output (kW)		Blower Run Time		(Hours)
Charge Controller 5 Output (kW)				
Charge Controller 6 Output (kW)				

Performance Monitoring Log

KB06 Onizuka Village Treatability Study

VAPOR PHASE CARBON PID SAMPLING

Pre VGAC 1		VOCs/PPM
		LEL %
Mid Bed		VOCs/PPM
		LEL %
Post VGAC 2		VOCs/PPM
		LEL %
Breathing Zone:		VOCs/PPM
Discharge Stack Noise Level:		dBA

COMMENTS:

Appendix D-2
Pressure Monitoring Form

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KB06 Onizuka Village Treatability Study – Pressure Monitoring Form

Date: ____________________ Name: ________________________

				MultiRAE		GEM2000						
	Location	**Time**	**VMP/PMP Vacuum (inWC)**	**VOCs (ppmv)**	**LEL (%)**	**With Carbon Filter? (Y/N)**	**CH_4 (%)**	**CO_2 (%)**	**O_2 (%)**	**Balance (%)**	**LEL (% CH_4)**	**Comments**
SVE-1	**SVE1-PMP1**											
Well-Vac (inHg):	**SVE1-PMP2**											
Blower Speed (%):	**VMP3-06A**											
	SVE1-PMP5											
	SVE1-PMP6											
	SVE1-PMP7											
	SVE1-PMP3											
	SVE1-PMP8											
	VMP3-14											
	SVE1-PMP9											
	VMP3-02											
	SVE1-PMP10											
	SVE1-PMP4											

KB06 Onizuka Village Treatability Study – Pressure Monitoring Form

Date: ______________________________ Name: ____________________________________

				MultiRAE		GEM2000						
	Location	**Time**	**VMP/PMP Vacuum (inWC)**	**VOCs (ppmv)**	**LEL (%)**	**With Carbon Filter? (Y/N)**	**CH_4 (%)**	**CO_2 (%)**	**O_2 (%)**	**Balance (%)**	**LEL (% CH_4)**	**Comments**
SVE-2	**SVE2-PMP2**											
Well-Vac (inHg):	**SVE2-PMP1**											
Blower Speed (%):	**VMP2-11**											
SVE-3	**SVE3-PMP2**											
Well-Vac (inHg):	**VMP2-21**											
Blower Speed (%):	**SVE3-PMP3**											
	VMP2-15											
	VMP2-08											
	SVE3-PMP1											

KB06 Onizuka Village Treatability Study – Pressure Monitoring Form

Date: ______________________________ Name: ____________________________________

				MultiRAE		GEM2000						
	Location	Time	VMP/PMP Vacuum (inWC)	VOCs (ppmv)	LEL (%)	With Carbon Filter? (Y/N)	CH_4 (%)	CO_2 (%)	O_2 (%)	Balance (%)	LEL (% CH_4)	Comments
MWs	**MW-01**											
	MW-02											
	MW-04											
	SS01-MW15											
	Temp Well TW5											
	Temp Well TW6											
	Temp Well TW7											
	Temp Well TW8											
	Temp Well TW9											

(blue)	Proximal portion monitoring points
(orange)	Distal portion monitoring points

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Appendix E
CD of Supporting Information

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Appendix F
Health and Safety Supporting Information

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Appendix F-1
Safety Notification

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Safety Notification

Before conducting any operations and maintenance (O&M) activities, the attached Accident Prevention Plan (APP) and the associated Activity Hazard Analysis (AHAs) will be reviewed and understood. If there are any questions, if something is not clear, or if the work activity is not covered in the APP and AHA, STOP WORK, and notify John Culley, the KCH Program Health and Safety Manager (206-660-3367) to determine the appropriate action and needed resource to provide the necessary clarification and/or guidance. Note that the included AHA is not applicable to AGM battery system modification and replacement.

NOTE 1: O&M on the Absorbent Glass Mat (AGM) batteries and all electrical systems will only be conducted by a QUALIFIED ELECTRICIAN which is Coconut Coast Electric.

NOTE 2: Only a qualified electrician can Lock Out Tag Out Equipment.

Before the start of any work activity, review the appropriate vendor-provided information in the banker box at the site and/or from the Internet for the specific model installed. In particular, but not limited to the following:

- **For work involving the AGM batteries, it is REQUIRED that information and all Safety Requirements be reviewed and understood in the following documents:**
  - **Outback Power "EnergyCell RE High Capacity Battery Installation Guide and Owner's Manual"**
  - **EnerSys PowerSafe "Safety, Storage, Operating and Maintenance Manual"**
- **Before any work on the Rotary Blower, the following manual will be reviewed including all safety measures:**
  - **Assembly and Operating Manual, Rotary Blower, DB C vac, KAESER**
- **A complete listing of all manuals and equipment cut sheets is provide in Section 3.2.1 for the SVE System and Section 3.2.2 for the Off-Grid Photovoltaic System, if the information is not referenced in these sections please contact the appropriate vendor**

IF UNSURE STOP WORK

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Appendix F-2
O&M Activity Hazard Analysis

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Activity Hazard Analysis (AHA)
SVE System and PV Array Operation and Maintenance

ACTIVITY/WORK TASK:	Soil Vapor Extraction (SVE) System and Photovoltaic (PV) Array Operation and Maintenance	Overall Risk Assessment Code (RAC) (Use highest code)	M
	SIGNATURES	Activity #	AHA #

PWD/OICC/ROICC OFFICE	
NAME & DATE ACCEPTED BY GDA:	
CONTRACT NUMBER:	N62473-09-D-2622
TASK ORDER/DELIVERY #:	CTO KB06
PRIME CONTRACTOR:	KCH
SUBCONTRACTOR:	n/a
NAME AND DATE OF REVIEWER:	
DATE OF INITIAL INSPECTION:	
CONTRACTOR COMPETENT PERSON:	Ryan Ketza/HNL (not applicable to electrical work, only can be a licensed electrician)
SITE SAFETY and HEALTH OFFICER	Ryan Ketza/HNL
ACCEPTANCE BY GOVERNMENT DESIGNATED AUTHORITY (GDA)	
E = EXTREMELY HIGH (PWO/OICC/ROICC)	
H = HIGH RISK (FEAD DIRECTOR)	
M = MODERATE RISK (CM or ET or PAR)	
L = LOW RISK (ET or PAR)	

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Review each **"Hazard"** with identified safety **"Controls"** and determine (RAC)

Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" .Place the highest RAC at the top of AHA. This is the overall risk assessment code for this activity

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible after controls are in place

"Probability" is the likelihood to cause an incident, near miss, or accident did occur and identified as: Frequent, Likely, Occasional, Seldom, or Unlikely after controls are put in place.

Job Steps	Hazards	Controls	RAC
General site safety	Electrocution	• Only licensed/qualified electricians are authorized to work on energized systems including opening panels, removing panel covers, voltage measurements, and Lock Out-Tag Out. • Heed all posted signage identifying locations of electrical systems and do not work in these areas. • Assume all electrical equipment and wires are energized until verified otherwise by testing. • **Know the location of all E-Stops and Disconnects**	L

IAW EM 385 01.A.13 Contractor-Required AHA "Work will not begin until the AHA for the work activity has been accepted by the GDA"
The AHA shall be reviewed and modified as necessary to address changing site condition, operations or change of competent/qualified persons. This AHA is NOT APPLICABLE for the removal or replacement of the AGM Batteries or any other Construction related work.

Activity Hazard Analysis (AHA)
SVE System and PV Array Operation and Maintenance

Job Steps	Hazards	Controls	RAC
	Hand Tools and Hand Injury	• Inspect before use and confirm hand tools are in good condition and sufficient for the work. • Use hand tools only for their intended purpose. • Where protective work gloves when using hand tools that allow for sufficient manual dexterity for the work. • Beware of hand placement, protect your hand in the event the tool slips.	**L**
	Hand injury	• Refer to hand tools section. • Avoid pinch points. • Confirm there is no stored mechanical energy that can be released.	L
	Eye injury	• Wear protective eyewear that meets American National Standards Institute (ANSI) Z-87 at all times	L
	Head injury	• Wear ANSI-approved hardhats at all times when overhead hazards are present, in the manner they are designed (for example, brim forward, no modifications, and no ball caps underneath).	L
	Injuries from slips/trips/falls	• Keep walking path around SVE Building and PV Array clear, if possible. Ensure floor in SVE Building is free of debris and dirt. • Avoid wet or slippery areas. • Maintain good housekeeping by consolidating supplies out of walkways and immediate work areas. • Keep extension cords bundled as much as possible. • Identify any immoveable obstructions to field team for awareness by communicating potential hazard and flagging obstructions. Avoid area if possible. • Work at a steady pace, do not run and hurry.	L
Changing oil at blower motor	Hand injury	• Allow time for the blower oil to cool before changing. • Use properly sized socket and wrench to loosen and tighten nuts. • Wear protective gloves. • Switch off the power supply disconnecting device and verify that it is locked in the OFF position.	L
	Contact with oil	• Read and understand the applicable procedures in the Kaeser Assembly and Operating Manual for the Rotary Blower which is maintained in the SVE Building. • Wear long-sleeved clothing, protective gloves, and eye protection.	L
	Oil release	• Contain used oil immediately from the drain valve. • Collect and properly dispose of waste oil and containers.	L

Activity Hazard Analysis (AHA)
SVE System and PV Array Operation and Maintenance

Job Steps	Hazards	Controls	RAC
Absorbent Glass Mat (AGM) Battery Rack	Hand tools	• Use only an electrician that has experience specific to AGM batteries. • Before O&M on or around the AGM Batteries, refer to the *Outback PowerSafe DDm Installation Manual for Modular Battery Systems (Publication No. US-DDm-IM-003 November 2003 as well as the EnerSys Safety, Storage, Operating, and Maintenance Manual (Publication No. US-VR-OM-002 March 2008)*, both of which are maintained in the SVE Building. • DO NOT REMOVE plastic protective shields over the battery terminals and connections on the battery rack.	L
Operating Electrical Power Tools with use of extension cords	Electric Shock/Electrocution	• Purchase and use power tools that have been approved by a national testing laboratory, such as Underwriter's Laboratories (UL) or equivalent and equipped with either a 3-prong plug or classified as "Double-Insulated" • Visually inspect each power tool used before each day's usage. Check for cuts, exposed wiring, damaged plugs, missing ground pins, and cracked housing. If damaged, the power tool must be tagged with a "Damaged or Defective Equipment – DO NOT USE" tag or equivalent and removed from service immediately. • Purchase extension cords that have been approved by a national testing laboratory, such as UL or equivalent. Do not use "homemade" extension cords. • Visually inspect extension cords before each day's usage. Check for cuts, exposed wiring, damaged plugs, and missing ground pins. If damaged, extension cords must be removed from service immediately. • Periodically conduct testing of extension cord's grounding, resistance or conductivity per applicable regulations. • Protect employees by using ground fault circuit interrupter or electronic load detector on extension cords, at wall sockets, or integrated in the electrical system. • Avoid fastening extension cords using staples, nails or with wire. • Extension cords are not intended for permanent use, only temporary.	M
Changing air filter at blower	Hand injury	• Read and understand the applicable procedures in the Kaeser Assembly and Operating Manual for the Rotary Blower which is maintained in the SVE Building. • Wear protective gloves.	

Activity Hazard Analysis (AHA)
SVE System and PV Array Operation and Maintenance

Job Steps	Hazards	Controls	RAC
		• Switch off the power supply disconnecting device and verify that it is locked in the OFF position. • Properly dispose of dust filter as municipal solid waste. • Refer to “Hand Tools” section. • Use hand tools designed for the intended purpose to remove the access plate and attach the steel plate for connection to the vacuum hose • Watch out for any sharp edges on covers • Provide ladder access, as needed for air filter above granular activated carbon (GAC) vessels, including a second person to steady any ladder, stool, or platform.	L
Change Fluorescent Light Bulbs	Hand Injury and Falls	• Use hand tools designed for the intended purpose • Watch out for any sharp edges on covers • Ladder access is required, including a second person to steady any ladder, stool, or platform. • Have the second person assist with providing the new light bulbs and handling the spent bulbs • Properly package the bulbs for handling and disposal	M
	Ladder hazards	• Use correct ladder safety procedures (maintain three-point contact while on ladder, do not stand on or near top step, and do not overextend your reach). • Use a tool belt or bucket attached to a hand line to raise and lower tools and equipment. • Ensure ladder is set on level surface. • Do not stand on unopened A-frame ladder. • Do not use the ladder if damaged. • Tie-off the ladder. • If using an extension ladder to gain access to a working surface, the ladder must extend 3 feet beyond the working surface • Perform a ladder inspection: 1. Ladder locks are fully functional 2. Ladder feet should be of the non-skid variety and in satisfactory condition (never loose or worn) 3. Rungs are not damaged 4. Vertical rails are intact 5. Inspect entire ladder for flaws, cracks, distortion, dents, bad pulleys, and loose rivets and fasteners.	M

Activity Hazard Analysis (AHA)
SVE System and PV Array Operation and Maintenance

Job Steps	Hazards	Controls	RAC
Cleaning of photovoltaic panels	Slips, trips, falls	• If using a step-stool, platform, or ladder ensure three points of contact at all times. If using a ladder do not overreach and insure it is firmly anchored. • A second person will be present at all times when doing work at elevation to steady the stool, ladder, and platform • Us a long-handled soft brush or squeegee to reach panel glass in the central portion of the array • Situational awareness; observe ground level and avoid sloped areas as much as possible • Maintain good housekeeping	L
	Cracking panel glass	• Do not apply cold water onto hot glass. • Where possible, apply water in the early morning or late afternoon. • Situational awareness, use caution. • Do not use high pressure water application (standard garden hose-type pressure is sufficient). • Use car wash soap for cleaning of the PV array, avoid getting in the eye's by using googles. • Ensure use of a hose to rinse the PV arrays doesn't get hung up on the stool, ladder, or platform.	L
Application of standard off-the-shelf weed killer	Contact with chemical	• Maintain product Safety Data Sheets onsite and follow product instructions at all times. • Keep flow rate very low to avoid excessive application or overspray. • Wear nitrile gloves for hand protection and safety glasses for eye protection.	L
Collecting pressure readings at Vapor Monitoring Points and Pressure Monitoring Points inside Onizuka Village And SVE Vault Access	Hand and eye injury	• Be aware of potential pinch points. • Wear gloves that provide physical hand protection. • Use properly sized socket and wrench to loosen and tighten nuts on well covers. • Wear ANSI-rated eye protection.	L
	Biological hazards consisting of ant colonies, centipedes, etc.	• Once a well cover is opened, visually inspect inside of well vault before reaching gloved hand in to pull out the downhole monitoring tubing.	L
	Slips, trips, falls when walking around inside Onizuka Village	• Situational awareness; observe ground level and avoid sloped areas and muddy spots as much as possible when walking. • Maintain good housekeeping.	L

IAW EM 385 01.A.13 Contractor-Required AHA "Work will not begin until the AHA for the work activity has been accepted by the GDA"
The AHA shall be reviewed and modified as necessary to address changing site condition, operations or change of competent/qualified persons. This AHA is NOT APPLICABLE for the removal or replacement of the AGM Batteries or any other Construction related work.

Activity Hazard Analysis (AHA)
SVE System and PV Array Operation and Maintenance

Job Steps	Hazards	Controls	RAC
Off-gas monitoring/sampling, and condensate sampling inside SVE building	Hand and eye injury	• Be aware of potential pinch points. • Wear gloves that provide physical hand protection. • Use properly sized socket and wrench to loosen and tighten nuts on well covers. • Wear ANSI-rated eye protection.	L
	Exposure to liquid or vapor	• Do not open sampling valves until proper fittings have been attached so that liquids or vapor cannot escape the SVE system. • Wear nitrile gloves. • Perform air monitoring and wear appropriate personal protective equipment (PPE) according to the Accident Prevention Plan and Site Safety Health Plan	M
	Muscle strain	• Do not lift heavy sample coolers by yourself; split loads and/or get help. • Observe a path before carrying something and clear path if needed and is possible.	L
Oversight of GAC change-out	Improper subcontractor training	• Ensure that subcontractor has valid forklift training credentials before operating a forklift. • Inspect all heavy equipment and trucks for leaks and ensure in a good condition • Ensure all spent and fresh activated GAC is stored on pallets in good condition in water-proof supersacks. • Ensure Material Safety Data Sheet for GAC is onsite and understood by the site personnel. • Use proper hand tools and access as applicable to the work for the hand removal of the GAC vessel covers. • Monitor subcontractor and verify they are following their own AHAs for their changeout procedures. • Ensure Subcontractor has present at the site the instruction for the Hurricane (or equivalent) vacuum system including provisions for fueling (units are diesel operated. • Provide monitoring equipment for the vapor space above the GAC. • Ensure Subcontractor has required respirator training.	L

Activity Hazard Analysis (AHA)
SVE System and PV Array Operation and Maintenance

Equipment to be Used	Training Requirements and Competent or Qualified Personnel name(s)	Inspection Requirements
	• 40-hour/8-hour Hazardous Waste Operations and Emergency Response • Electrical Safety Awareness • Hand tools	
PPE	• General PPE usage	• Inspect before use; replace if deficient • Ensure appropriate for the intended use

IAW EM 385 01.A.13 Contractor-Required AHA "Work will not begin until the AHA for the work activity has been accepted by the GDA"
The AHA shall be reviewed and modified as necessary to address changing site condition, operations or change of competent/qualified persons. This AHA is NOT APPLICABLE for the removal or replacement of the AGM Batteries or any other Construction related work.

Activity Hazard Analysis (AHA)
SVE System and PV Array Operation and Maintenance

Instructions for completing Contractor Activity Hazard Analysis

1. **Activity/Work Task – Insert work/task this AHA is written for; such as, excavation, scaffold building, foundation preparation.**
2. **PWO/OICC/ROICC – Insert name of Public Works Office, Officer In Charge of Construction Office or Resident Officer in Charge of Construction (PWD/OICC/ROICC)**
3. **Enter name and date AHA accepted by Government Designated Authority (GDA)**
4. **Enter contract number**
5. **Enter Task order or Delivery order number**
6. **Enter Prime Contractors name**
7. **Enter Subcontractors name**
8. **Enter date preparatory meeting was held**
9. **Enter date initial inspection was performed**
10. **Enter name of contractor competent person on site for this activity**
11. **Enter name of Prime Contractor Site Safety and Health Officer**
12. **Level of government person responsible for accepting the AHA, progressive signatures as level of risk increases.**
13. **Overall Risk Assessment code is highest code assigned to any job step after hazards are assessed and controls have been assigned**
14. **Schedule number is activity number from production daily reports**
15. **AHA number is the sequential number of all AHA's for this contract.**
16. **Job steps is the complete sequence of work, not general statements to complete the entire activity**
17. **Hazards is the known safety risks associated with completing the task**
18. **Controls is the safety measures in place to reduce the hazard to the lowest level possible**
19. **Risk Assessment code is where Severity and Probability intersect, place that letter E, H, M, or L in the RAC column**
20. **List all equipment to be used to complete this activity; that is, crane, backhoe, vehicle, and all heavy equipment**
21. **List the training requirements required by Engineering Manual (EM) 385, Safety Spec 01356 or Occupational Safety and Health Administration (OSHA) that apply to this task.**

    List competent person(s) required for specific tasks in EM 385.
    List qualified person(s) required for specific tasks in EM 385.
    List CPR/First Aid training and qualification dates.
22. **List all inspection requirements of EM 385, Governmental Safety Requirements Specifications, or OSHA 29 *Code of Federal Regulations* 1926.**

IAW EM 385 01.A.13 Contractor-Required AHA "Work will not begin until the AHA for the work activity has been accepted by the GDA".
The AHA shall be reviewed and modified, as necessary, to address changing site condition, operations, or change of competent and qualified persons. This AHA is NOT APPLICABLE for the removal or replacement of the AGM batteries or any other construction-related work.

Appendix F-3
GAC and Blower Oil Material Safety Data Sheets

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SAFETY DATA SHEET

(REACH regulation (EC) n° 1907/2006 - n° 453/2010)

SECTION 1 : IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

1.1. Product identifier

Product name : EcoSorb C Series
Product code : Activated Carbon.

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use as an adsorbent in industrial, professional and consumer setting.

Use descriptor system (REACH) :

SU3 : PROC 1, 2, 3, 4, 5, 8a, 8b, 9, 14, 15, 22
SU22 : PROC 1, 2, 3, 4, 5, 8a, 8b, 9, 15
SU21 : PC 2, 3, 29, 35, 37, 39
The annexed exposure scenarios provide a complete listing per sector.

1.3. Details of the supplier of the safety data sheet

Registered company name : Jacobi Carbons GmbH.
Address : Lurgiallee 6-8.D-60439 .Frankfurt am Main.Germany.
Telephone : +49 69 719 107 0. Fax : +49 69 710 330 03.
msds@jacobi.net
www.jacobi.net

1.4. Emergency telephone number : +49 69 719 107 0.

Association/Organisation : Jacobi Carbons GmbH.

SECTION 2 : HAZARDS IDENTIFICATION

2.1. Classification of the substance or mixture

In compliance with EC regulation No. 1272/2008 and its amendments.

This substance does not present a physical hazard. Refer to the recommendations regarding the other products present on the site.

This substance does not present a health hazard with the exception of possible occupational exposure thresholds (see paragraphs 3 and 8).

This substance does not present an environmental hazard. No known or foreseeable environmental damage under standard conditions of use.

In compliance with directives 67/548/EEC, 1999/45/EC and their amendments.

This substance does not present a physical hazard. Refer to the recommendations regarding the other products present on the site.

This substance does not present a health hazard with the exception of possible occupational exposure thresholds (see paragraphs 3 and 8).

This substance does not present an environmental hazard. No known or foreseeable environmental damage under standard conditions of use.

2.2. Label elements

In compliance with EC regulation No. 1272/2008 and its amendments.

No labelling requirements for this substance.

2.3. Other hazards

May cause CO and CO2 emanations in the event of a fire.

According to the ECHA Guidance on chemical safety assessment, Chapter R11, section R11.1.2.1: "The PBT and vPvB criteria of Annex XIII to the Regulation do not apply to inorganic substances". As Activated Carbon - HDS type is to be considered as an inorganic substance, the PBT assessment is not applicable.

Wet Activated Carbon depletes oxygen from air and, therefore, dangerously low levels of oxygen may be encountered. Whenever workers enter a vessel containing activated carbon, the oxygen content should be determined and work procedures for potentially low oxygen areas should be followed.

SECTION 3 : COMPOSITION/INFORMATION ON INGREDIENTS

3.1. Substances

Composition :

Identification	(EC) 1272/2008	67/548/EEC	Note	%
CAS: 7440-44-0 EC: 931-328-0 REACH: 01-2119488894-16-0013 ACTIVATED CARBON - HIGH DENSITY SKELETON (AC-HDS)			[1]	100%

Information on ingredients :

A porous, amorphous, high surface area adsorbent material composed largely of elemental carbon.

[1] Substance for which maximum workplace exposure limits are available.

SECTION 4 : FIRST AID MEASURES

As a general rule, in case of doubt or if symptoms persist, always call a doctor.

NEVER induce swallowing by an unconscious person.

4.1. Description of first aid measures

In the event of exposure by inhalation :

Fresh air, rest.

Obtain medical attention if cough or respiratory symptoms develop.

In the event of splashes or contact with eyes :

Wash thoroughly with soft, clean water for 15 minutes holding the eyelids open.

If there is any redness, pain or visual impairment, consult an ophthalmologist.

In the event of splashes or contact with skin :

Rince with water and soap.

Remove contaminated clothes.

Obtain medical attention if irritation becomes apparent.

In the event of swallowing :

Give at least 1/2 L of water to drink.

Obtain mediacl attention if gastrintestinal symptoms develop.

Do not induce vomiting.

4.2. Most important symptoms and effects, both acute and delayed

When large amounts are ingested orally, congestion may occur.

4.3. Indication of any immediate medical attention and special treatment needed

Specific and immediate treatment :

N/A

Information for the doctor :

Medications efficiency can be reduced by the adsorbing power of the activated carbon.

SECTION 5 : FIREFIGHTING MEASURES

Non-flammable.

5.1. Extinguishing media

Suitable methods of extinction

In the event of a fire, use :
- foam
- sprayed water or water mist
- powder
- carbon dioxide (CO_2)

Unsuitable methods of extinction

In the event of a fire, do not use :
- water
- water jet

in the closed areas, in order to avoid the water contamination.

5.2. Special hazards arising from the substance or mixture

A fire will often produce a thick black smoke. Exposure to decomposition products may be hazardous to health.

Do not breathe in smoke.

In the event of a fire, the following may be formed :
- carbon monoxide (CO)
- carbon dioxide (CO_2)
- other decomposition products for the saturated activated carbon.

After a fire, smoldering hotspots within the activated carbon may be present for a long time.

Activated Carbon which has been allowed to smolder for a long time in a confined space may accumulate carbon monoxide above its lower explosion limit.

5.3. Advice for firefighters

Due to the toxicity of the gas emitted on thermal decomposition of the products, fire-fighting personnel are to be equipped with autonomous insulating breathing apparatus.

SECTION 6 : ACCIDENTAL RELEASE MEASURES

6.1. Personal precautions, protective equipment and emergency procedures

Consult the safety measures listed under headings 7 and 8.

For first aid worker

First aid workers will be equipped with suitable personal protective equipment (See section 8).

6.2. Environmental precautions

Prevent any material from entering drains or waterways.

6.3. Methods and material for containment and cleaning up

Retrieve the product by mechanical means (sweeping/vacuuming).

6.4. Reference to other sections

See also sections 2 & 8

SECTION 7 : HANDLING AND STORAGE

Requirements relating to storage premises apply to all facilities where the substance is handled.

7.1. Precautions for safe handling

Prevent dust generation. Apply good working practices and engineering procedures during discharge.

See the exposure controls and personal protection measures in the section 8.

Fire prevention :

Prevent access by unauthorised personnel.

Recommended equipment and procedures :

For personal protection, see section 8.

Observe precautions stated on label and also industrial safety regulations.

Ensure containment and adequate ventilation.

Whenever workers enter a vessel containing activated carbon, the oxygen content should be determined and work procedures for potentially low oxygen areas should be followed.

Prohibited equipment and procedures :

No smoking, eating or drinking in areas where the substance is used.

7.2. Conditions for safe storage, including any incompatibilities

Keep away from any chemical (solvents and strong oxidisers).

Keep away from heat sources.

Store in a well-ventilated area.

Storage

Store and keep away from any chemical (solvents and strong oxidisers).

Storage of wet activated carbon in a closed area can deplete oxygen from air.

Packaging

Store in the closed, original packaging.

7.3. Specific end use(s)

No data available.

SECTION 8 : EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Control parameters

Occupational exposure limits :

Non otherwise classified dusts : 10 mg/m3

- UK / WEL (Workplace exposure limits, EH40/2005, 2007) :

CAS	TWA :	STEL :	Ceiling :	Definition :	Criteria :
7440-44-0	4 mg/m3	-	-	-	R

Biological limits :

/

Derived no effect level (DNEL) or derived minimum effect level (DMEL):

Final use:	**Workers.**
Exposure method:	Inhalation.
Potential health effects:	Short term local effects.
DNEL :	3 mg of substance/m3
Exposure method:	Inhalation.
Potential health effects:	Long term systemic effects.

DNEL : 3 mg of substance/m3

Final use: **Consumers.**
Exposure method: Inhalation.
Potential health effects: Short term local effects.
DNEL : 0.5 mg of substance/m3

Exposure method: Inhalation.
Potential health effects: Long term systemic effects.
DNEL : 0.5 mg of substance/m3

8.2. Exposure controls

Suitable technical inspections

Local exhaust ventilation is recommended.

For the use of Granular Activated Carbon, no risk management measures are mandatory, but only recommended.

Personal protection measures, such as personal protective equipment

Use personal protective equipment that is clean and has been properly maintained.

Store personal protective equipment in a clean place, away from the work area.

Never eat, drink or smoke during use. Remove and wash contaminated clothing before re-using. Ensure that there is adequate ventilation, especially in confined areas.

- Eye / face protection

Avoid contact with eyes.

Before handling powders or dust emission, wear mask goggles in accordance with standard EN166.

- Hand protection

Wear suitable protective gloves in the event of prolonged or repeated skin contact.

- Body protection

Work clothing worn by personnel shall be laundered regularly.

- Respiratory protection

Avoid breathing dust.

Type of FFP mask :

Wear a disposable half-mask dust filter in accordance with standard EN149.

Category :

- FFP2

Particle filter according to standard EN143 :

- P (White)

Exposure controls linked to environmental protection

Local exhaust ventilation to remove material at source.

Contained storage.

Regulated waste disposal.

SECTION 9 : PHYSICAL AND CHEMICAL PROPERTIES

9.1. Information on basic physical and chemical properties

General information :

Physical state : Solid in granules.
Odour: None
Color: Black

Important health, safety and environmental information

pH :	Not relevant.
pH (aqueous solution) :	7-11
Boiling point/boiling range :	Not specified.
Flash point interval :	Not relevant.
Explosive properties, lower explosivity limit (%) :	NA
Explosive properties, upper explosivity limit (%) :	NA
Vapour pressure (50°C) :	Not relevant.
Vapour density :	NA
Density :	200-700 kg/m3
Miscibility :	NA
Water solubility :	Insoluble. 0 Method for determining the water solubility : OCDE Guideline 105 (Water solubility).
Partition coefficient: n-octanol/water :	NA
Viscosity :	NA
Evaporation rate :	NA
Melting point/melting range :	Not specified.
Self-ignition temperature :	Not specified.
Decomposition point/decomposition range :	Not specified.

9.2. Other information

Physical and chemical properties of the saturated activated carbon may be different from the virgin material.

SECTION 10 : STABILITY AND REACTIVITY

10.1. Reactivity

This product shows no reactivity under the specified conditions of storage, shipment and use.

10.2. Chemical stability

This substance is stable under the recommended handling and storage conditions in section 7.

10.3. Possibility of hazardous reactions

In contact with solvents and strong oxidisers.

10.4. Conditions to avoid

Avoid :
- formation of dusts
- heating
- heat
- humidity

Dusts can form an explosive mixture with air.

10.5. Incompatible materials

Keep away from :
- combustible material
- strong oxidising agents
- strong acids
- solvents

10.6. Hazardous decomposition products

The thermal decomposition may release/form :
- carbon monoxide (CO)
- carbon dioxide (CO_2)

SECTION 11 : TOXICOLOGICAL INFORMATION

11.1. Information on toxicological effects

11.1.1. Substances

Based on the physical and chemical properties of activated carbons, the absence of effects on toxicological studies and the therapeutic use of activated carbons as adsorbing agents for the treatment of acute poisoning and acute diarrhoea, it can be expected that Activated Carbon is not absorbed via the oral, dermal and inhalation routes.

Acute toxicity :

ACTIVATED CARBON - HIGH DENSITY SKELETON (AC-HDS) (CAS: 7440-44-0)

Oral route : LD50 > 2000 mg/kg
Species : Rat
OECD Guideline 423 (Acute Oral toxicityAcute Toxic Class Method)

Inhalation route : LC50 > 64.4 mg/l
Species : Rat
OECD Guideline 403 (Acute Inhalation Toxicity)

Skin corrosion/skin irritation :

ACTIVATED CARBON - HIGH DENSITY SKELETON (AC-HDS) (CAS: 7440-44-0)

Corrosivity : No observed effect.
Species : Rabbit
OECD Guideline 404 (Acute Dermal Irritation / Corrosion)

Serious damage to eyes/eye irritation :

ACTIVATED CARBON - HIGH DENSITY SKELETON (AC-HDS) (CAS: 7440-44-0)

Corneal haze : Average score = 0.00
Species : Rabbit
Duration of exposure : 72 h
OECD Guideline 405 (Acute Eye Irritation / Corrosion)

Iritis : Average score = 0.00
Species : Rabbit
Duration of exposure : 72 h
OECD Guideline 405 (Acute Eye Irritation / Corrosion)

Conjunctival redness : Average score = 0.67
Species : Rabbit
Duration of exposure : 72 h
OECD Guideline 405 (Acute Eye Irritation / Corrosion)

Conjunctival oedema : Average score = 0.33
Species : Rabbit
Duration of exposure : 72 h
OECD Guideline 405 (Acute Eye Irritation / Corrosion)

Respiratory or skin sensitisation :

- Inhalation No information available
- Skin Not sensitising.

ACTIVATED CARBON - HIGH DENSITY SKELETON (AC-HDS) (CAS: 7440-44-0)

Local lymph node stimulation test : Non-Sensitiser.
Species : Mouse

OECD Guideline 429 (Skin Sensitisation: Local Lymph Node Assay)

Germ cell mutagenicity :

All the key studies indicate that the substance does not show any genotoxic potential. Therefore, it can be concluded that the substance is not mutagenic and does not need to be classified for mutagenicity according to the criteria outlined in Annex I of 1272/2008/EC (CLP / EU GHS) and Annex VI of 67/548/EEC (DSD/DPD).

ACTIVATED CARBON - HIGH DENSITY SKELETON (AC-HDS) (CAS: 7440-44-0)

Mutagenesis (in vitro) :	Negative. Species : Bacteria OECD Guideline 471 (Bacterial Reverse Mutation Assay)
Ames test (in vitro) :	Negative. With or without metabolic activation. Species : S. typhimurium TA1535

Carcinogenicity :

No data available

Reproductive toxicant :

No data available

Specific target organ systemic toxicity - single exposure :

ACTIVATED CARBON - HIGH DENSITY SKELETON (AC-HDS) (CAS: 7440-44-0)

Oral route :	C > 2000 mg/kg bodyweight Species : Rat

SECTION 12 : ECOLOGICAL INFORMATION

12.1. Toxicity

12.1.1. Substances

As Activated Carbon is insoluble in water, no toxicity is expected.

12.2. Persistence and degradability

Activated Carbon - HDS type is a refractory materail and not amenable to break down by any natural chemical or enzymatic processes.

AC - HDS cannot be rendered into a soluble form capable of being absorbed.

Therefore it cannot find its way to any cell site where it could be conceivably be biodegraded.

12.3. Bioaccumulative potential

The substance has a very low potential to bioaccumulate in aquatic species (e.g. fish), i.e. a BCF < 10.

The substance has no log Kow, the substance size will impede passing membranes (particles with size > 0.5µm) and is not soluble in water. The bioaccumulation study is thus infeasible.

12.4. Mobility in soil

No data available, as the substance is insoluble.

12.5. Results of PBT and vPvB assessment

According to the ECHA Guidance on chemical safety assessment, Chapter R11, section R11.1.2.1: "The PBT and vPvB criteria of Annex XIII to the Regulation do not apply to inorganic substances". As Activated Carbon - HDS type is to be considered as an inorganic substance, the PBT assessment is not applicable.

12.6. Other adverse effects

No data available.

SECTION 13 : DISPOSAL CONSIDERATIONS

Proper waste management of the substance and/or its container must be determined in accordance with Directive 2008/98/EC.

13.1. Waste treatment methods

Do not pour into drains or waterways.

Waste :

Waste management is carried out without endangering human health, without harming the environment and, in particular without risk to water, air, soil, plants or animals.

Recycle or dispose of waste in compliance with current legislation, preferably via a certified collector or company.

Do not contaminate the ground or water with waste, do not dispose of waste into the environment.

Soiled packaging :

Empty container completely. Keep label(s) on container.

Give to a certified disposal contractor.

Codes of wastes (Decision 2001/573/EC, Directive 2006/12/EEC, Directive 94/31/EEC on hazardous waste) :

- Exhausted Activated Carbon from Water Treatment: 19 09 04
- Exhausted Activated Carbon from flue gas treatment : 19 01 10*
- Exhausted Activated Carbon from Mineral Chemistry wastes : 06 07 02* - AC used for the chlorine production / 06 13 02* - saturated AC (except section 06 07 02*).
- Other applications: see the regulations of wates nomenclatures.

SECTION 14 : TRANSPORT INFORMATION

Transport product in compliance with provisions of the ADR for road, RID for rail, IMDG for sea and ICAO/IATA for air transport (ADR 2011 - IMDG 2010 - ICAO/IATA 2012).

14.0. Classification and special disposures:

ADR/RID: special disposure 646 (physically activated carbon)

IMDG: special disposure 925 (physically activated carbon)

IATA: special disposure A3

- Transport classification, by taking into account the special disposures:

ADR/RID: not dangerous

IMDG: not dangerous

IATA: not dangerous (if, when tested, doesn't meet the defined criteria).

.

- Details for classification:

See details below

14.1. UN number

1362

14.2. UN proper shipping name

UN1362=CARBON, ACTIVATED

14.3. Transport hazard class(es)

- Classification :

4.2

14.4. Packing group

III

14.5. Environmental hazards

-

14.6. Special precautions for user

ADR/RID	Class	Code	Pack gr.	Label	Ident.	LQ	Provis.	EQ	Cat.	Tunnel
	4.2	S2	III	4.2	40	0	646	E1	4	E

IMDG	Class	2°Label	Pack gr.	LQ	EMS	Provis.	EQ		
	4.2	-	III	0	F-A,S-J	223 925	E1		
IATA	Class	2°Label	Pack gr.	Passager	Passager	Cargo	Cargo	note	EQ
	4.2	-	III	472	0.5 kg	472	0.5 kg	A3	E1
	4.2	-	III	Forbidden	Forbidden	-	-	A3	E1

14.7. Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code

No data available.

SECTION 15 : REGULATORY INFORMATION

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

- Particular provisions :

No data available.

15.2. Chemical safety assessment

A chemical safety assessment according to the rules stipulated in REACH directive has been performed. The appendices provide an overview of the risk management measures as based on this assessment.

SECTION 16 : OTHER INFORMATION

Since the user's working conditions are not known by us, the information supplied on this safety data sheet is based on our current level of knowledge and on national and community regulations.

It is at all times the responsibility of the user to take all necessary measures to comply with legal requirements and local regulations.

The information in this safety data sheet must be regarded as a description of the safety requirements relating to the substance and not as a guarantee of the properties thereof.

In compliance with directives 67/548/EEC, 1999/45/EC and their amendments.

Safety phrase :

S 22 Do not breathe dust.

Abbreviations :

DNEL : Derived No-Effect Level

ADR : European agreement concerning the international carriage of dangerous goods by Road.

IMDG : International Maritime Dangerous Goods.

IATA : International Air Transport Association.

ICAO : International Civil Aviation Organisation

RID : Regulations concerning the International carriage of Dangerous goods by rail.

WGK : Wassergefahrdungsklasse (Water Hazard Class).

MATERIAL SAFETY DATA SHEET

KAESER COMPRESSORS
Built for a lifetime.™

Date Issued: 02/02/2013
MSDS No: KAESER OMEGA FG-220

OMEGA FGB-220

1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: OMEGA FGB-220
GENERAL USE: Lubricant and corrosion inhibitor
CHEMICAL FAMILY: Synthetic based lubricant

MANUFACTURER
Manufactured for Kaeser Compressors, Inc.
511 Sigma Drive
Fredericksburg, VA 22408
Product Stewardship: 281-354-8600

24 HR. EMERGENCY TELEPHONE NUMBERS
USA : 800-424-9300
International : 703-527-3887(collect calls accepted)

2. HAZARDS IDENTIFICATION

POTENTIAL HEALTH EFFECTS

EYES: May cause irritation.

SKIN: May irritate the skin after prolonged periods of contact.

INGESTION: May cause diarrhea.

INHALATION: Hydrocarbon mist may line breathing passages with oil making breathing difficult.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Name	Wt.%	CAS
Poly Alpha Olefin Synthetic	58 - 62	68037-01-4
Synthetic Olefin	38 - 42	9003-29-6
Synthetic Corrosion and Antiwear	0.5 - 1	80939-62-4
Synthetic Oxidation Inhibitor	0.2 - 0.5	41484-35-9

COMMENTS: This product contains no hazardous substances within the definition of OSHA Regulation 29 CFR 1910.1200.

4. FIRST AID MEASURES

EYES: Flush with water until all residual material is gone. If irritation persists, seek medical help.

SKIN: Wash thoroughly with hand cleanser, followed by soap and water. Contaminated clothing should be dry cleaned before reuse.

INGESTION: Wash out mouth immediately. Do not induce vomiting. Consult physician.

INHALATION: Clear air passage. If respiratory difficulty continues, seek medical help.

5. FIRE FIGHTING MEASURES

FLASH POINT AND METHOD: 232°C (450°F) COC

AUTOIGNITION TEMPERATURE: > 315°C (600°F)

EXTINGUISHING MEDIA: Foam, dry powder, Halon®, carbon dioxide, sand, earth and water mist. Unsuitable: Water jet.

OTHER CONSIDERATIONS: Not flammable at ambient temp.

FIRE FIGHTING EQUIPMENT: Self-contained breathing apparatus.

6. ACCIDENTAL RELEASE MEASURES

SMALL SPILL: Contain spill and keep from entering waterways. Absorb on porous material. Large quantities can be pumped.

ENVIRONMENTAL PRECAUTIONS

LAND SPILL: Do not allow it to enter drains.

SPECIAL PROTECTIVE EQUIPMENT: Wear gloves and protective overalls.

7. HANDLING AND STORAGE

HANDLING: No special handling precautions necessary.

STORAGE: Do not store at elevated temperatures.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

PERSONAL PROTECTIVE EQUIPMENT

EYES AND FACE: Glasses, if applied to parts in motion.

SKIN: Oil-proof gloves for hypersensitive persons.

RESPIRATORY: Hydrocarbon absorbing respirator if misting.

PROTECTIVE CLOTHING: Overalls.

9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE: Liquid

ODOR: Mild Hydrocarbon

COLOR: Clear

pH: Neutral

PERCENT VOLATILE: None

VAPOR PRESSURE: < 0.01

VAPOR DENSITY: Greater than air

BOILING POINT: > 371°C (700°F)

POUR POINT: -40°C

FLASH POINT AND METHOD: 232°C (450°F) COC

EVAPORATION RATE: Negligible

DENSITY: > 0.8

OXIDIZING PROPERTIES: None

10. STABILITY AND REACTIVITY

STABILITY: Chemically stable under normal conditions. No photoreactive agents.

CONDITIONS TO AVOID: Powerful sources of ignition and extreme temperatures.

HAZARDOUS DECOMPOSITION PRODUCTS: Burning generates smoke, airborne soot, hydrocarbons and oxides of carbon, sulfur and nitrogen. Residue mainly comprised of soot and mineral oxides.

INCOMPATIBLE MATERIALS: Strong inorganic and organic acids, oxidizing agents.

11. TOXICOLOGICAL INFORMATION

ACUTE

ORAL LD_{50}: > 2000 mg/kg

Notes: Extrapolated from component data

INHALATION LC_{50}: Not applicable.

SKIN EFFECTS: Very mild

CHRONIC: None known.

SUBCHRONIC: Not known

CARCINOGENICITY

IARC: No

NTP: No

OSHA: No

SENSITIZATION: Not known

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL DATA: Due to its fluid nature and specific gravity, this product will float or spread across water making it a nuisance contaminant. It is not thought to be toxic to marine or land organisms.

BIOACCUMULATION/ACCUMULATION: Relatively well behaved. Bioaccumulation potential nil.

13. DISPOSAL CONSIDERATIONS

DISPOSAL METHOD: Consider recycling. This product, as sold, does not meet the RCRA characteristics of a hazardous waste. Under RCRA, it is the responsibility of the user, at the time of disposal, to determine whether the product meets the RCRA criteria for hazardous waste. Contact a waste disposal company or local authority for advice.

EMPTY CONTAINER: See waste disposal section listed above.

14. TRANSPORT INFORMATION

DOT (DEPARTMENT OF TRANSPORTATION)

UN/NA NUMBER: N/A

OTHER SHIPPING INFORMATION: Nonhazardous

ROAD AND RAIL (ADR/RID): Bulk Nonhazardous

AIR (ICAO/IATA): Bulk Nonhazardous

VESSEL (IMO/IMDG): Bulk Nonhazardous

15. REGULATORY INFORMATION

UNITED STATES

SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)

311/312 HAZARD CATEGORIES: None

313 REPORTABLE INGREDIENTS: N/A

CERCLA (COMPREHENSIVE RESPONSE, COMPENSATION, AND LIABILITY ACT)

CERCLA REGULATORY: Nonhazardous

TSCA (TOXIC SUBSTANCE CONTROL ACT)

TSCA REGULATORY: All components are listed

CALIFORNIA PROPOSITION 65: N/A

CANADA

WHMIS (WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM): Not regulated

DOMESTIC SUBSTANCE LIST (INVENTORY): All components are listed

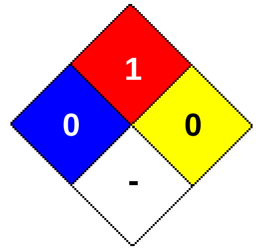
16. OTHER INFORMATION

REVISION SUMMARY: New MSDS

HMIS RATING

HEALTH:	**0**
FLAMMABILITY:	**1**
PHYSICAL HAZARD:	**0**
PERSONAL PROTECTION:	

NFPA CODES



MANUFACTURER DISCLAIMER: As of issue date, the information contained herein is accurate and reliable to the best of our knowledge. We do not warrant or guarantee its accuracy or reliability and shall not be liable for any loss or damage arising out of the use thereof. It is the user's responsibility to satisfy itself that the information offered for its consideration is suitable for its particular use.

Appendix B:
Standard Operating Procedures

OIL IN SOIL SCREENING KIT

The OIL-IN-SOIL field screening test kit is an inexpensive, simple, and rapid qualitative sampling test for identifying the presence of hydrocarbons including light nonaqueous-phase liquids (LNAPLs) and dense nonaqueous-phase liquids (DNAPLs) in soil. The OIL-IN-SOIL test kit is a visually enhanced version of the old soil/water shake test for the presence of oils and petroleum products. Users add soil to a line on the label, add water to another line on the label and shake the jar to release the dyes.

The kit comes in three colors: one kit uses the original SUDAN IV, which colors the hydrocarbon red. The OIL-IN-SOIL kits also come in a royal blue color called OIL-IN-SOIL RB. A colored ring or spot indicates the presence of oil or petroleum at above 2,500 parts per million (ppm) total petroleum hydrocarbons). A Styrofoam ball turning pink or light blue, depending on the dye used will indicate hydrocarbon down to 500 ppm. Many DNAPLs will give indications below 10 ppm because of their ability to penetrate the styrene used in the jar.

Application: The OIL-IN-SOIL field screening test kits are useful tools for reducing the cost of Phase 1 and Phase 2 site assessments, by reducing the time and costs associated with delineating the perimeter, depth, and direction of spills in soil. They are also often used with core samples to identify organic substances.

Environmental Benefits: Rapid delineation of hydrocarbons and DNAPL spill boundaries in soil results in more rapid removal of contaminants from the environment. The OIL-IN-SOIL kit uses a *de minimis* quantity of Sudan IV which is encapsulated in a soluble cube – thus decreasing the hazards to the test user from airborne particulate Sudan IV and overcoming the problems associated with the disposal of larger quantities of a mutagenic dye. We have recently switched to a new manufacturer whose dye is non-mutagenic.

Performance: The OIL-IN-SOIL kits provide an inexpensive, consistent tool for the detection of hydrocarbons (± 500 ppm total petroleum hydrocarbons) in soil. They are easy to use and require minimal training, thus reducing the need for ongoing expensive technical support on-site. The OIL-IN-SOIL kits have been sold commercially for several years and are used for Phase 1 and Phase 2 site assessments by most major environmental companies and several utility companies throughout the USA.

Simple as 1, 2, 3:

1. Add soil to the first line on the label.
2. Add water to the second line on the label.
3. Close and shake the jar to release the dyes and observe the color change.

MANUFACTURER'S GUARANTEE:

We will replace any broken or defective kits purchased through PINE Environmental Services or OIL-IN-SOIL, LLC.

If you are not satisfied with our product, return any defective kits for a refund. We reserve the right not to provide refunds if the kits have been tampered with in any way, or if not used in accordance with the OIL-IN-SOIL Instructions.

A SDS IS NOT NECESSARY FOR THIS PRODUCT BECAUSE OF EXTREAMLY SMALL QUANTITIES OF DYES USED IN SUGAR CUBE. However product in soil may be hazardous. SDS for Dyes used is available.

RECOMMENDED PROTECTIVE EQUIPMENT:
Because you are testing for petroleum products, always use gloves and safety glasses when using the OIL-IN-SOIL™ kits.

Shelf Life is at least 10 years when kept away from DIRECT SUNLIGHT or temperatures more than 90° F.

OIL IN SOIL, LLC
Southampton ,PA
USA

OIL I N SOIL ™

OIL IN SOIL, LLC
352 2nd Street Pike , Box 327
Southampton, PA 18966 - USA
Tel: (215) 687-0355

Manufacturers of Soil Screening Kits for:
Diesel Fuel - Heating Oil – Hydraulic Fluid
Gasoline – Lubricating Oil – Mineral Oil –
Kerosene and many other petroleum based products

OIL-IN-SOIL ™

Oil Screening Test Kit

Instruction Manual

"Congratulations on purchasing the easiest and fastest test kit available today for screening hydrocarbons and DNAPL!"

INTRODUCTION:
The OIL-IN-SOIL™ screening kit is composed of a plastic bottle; a label indicating recommended soil and water levels; a small Styrofoam ball, and a cube containing finely dispersed dyes which is glued to the inside of the jar lid.

In the RED version of the screening test kit the cube is impregnated with two dyes:

- OIL RED, a Red Azo Dye (Chemically Equivalent to SUDAN IV™ and NON Mutagenic) soluble in most petroleum products, red color and a
- Fluorescent Green/Yellow water soluble dye to color the water and provide a visual backdrop for the red dye.

The dual dye method is employed to improve detection by the user. The Blue soil test kits all contain only a blue anthraquinone dye and is primarily for users who are red-green colorblind.

USING THE KIT:
OIL-IN-SOIL kits are designed with ease of use in mind. Simply follow the instructions on the label:

Step 1 Fill the bottle with soil to the line "*Fill soil to HERE*" →
Note: Do not compact the soil.
Step 2 Fill the bottle to the line "*Fill water to HERE*" →
Note: ensure water is warm enough to dissolve the cube.

Step 3 Replace cap on bottle and shake jar until cube is **completely** dissolved.

If petroleum is present in the sample a red meniscus (or red spots on the side of the jar) will appear within 30-60 seconds. If color is not immediately apparent in the jar – check the polystyrene ball. The presence of ANY color on the ball (even a faint pink halo or hue) indicates the presence ore more than a small quantity in that sample material. Conversely, a "clean white" ball indicates, in general, that there is less than 500ppm petroleum..

Note: Whenever possible, use tap or bottled water for the screening tests. However, salt water can be used if necessary.

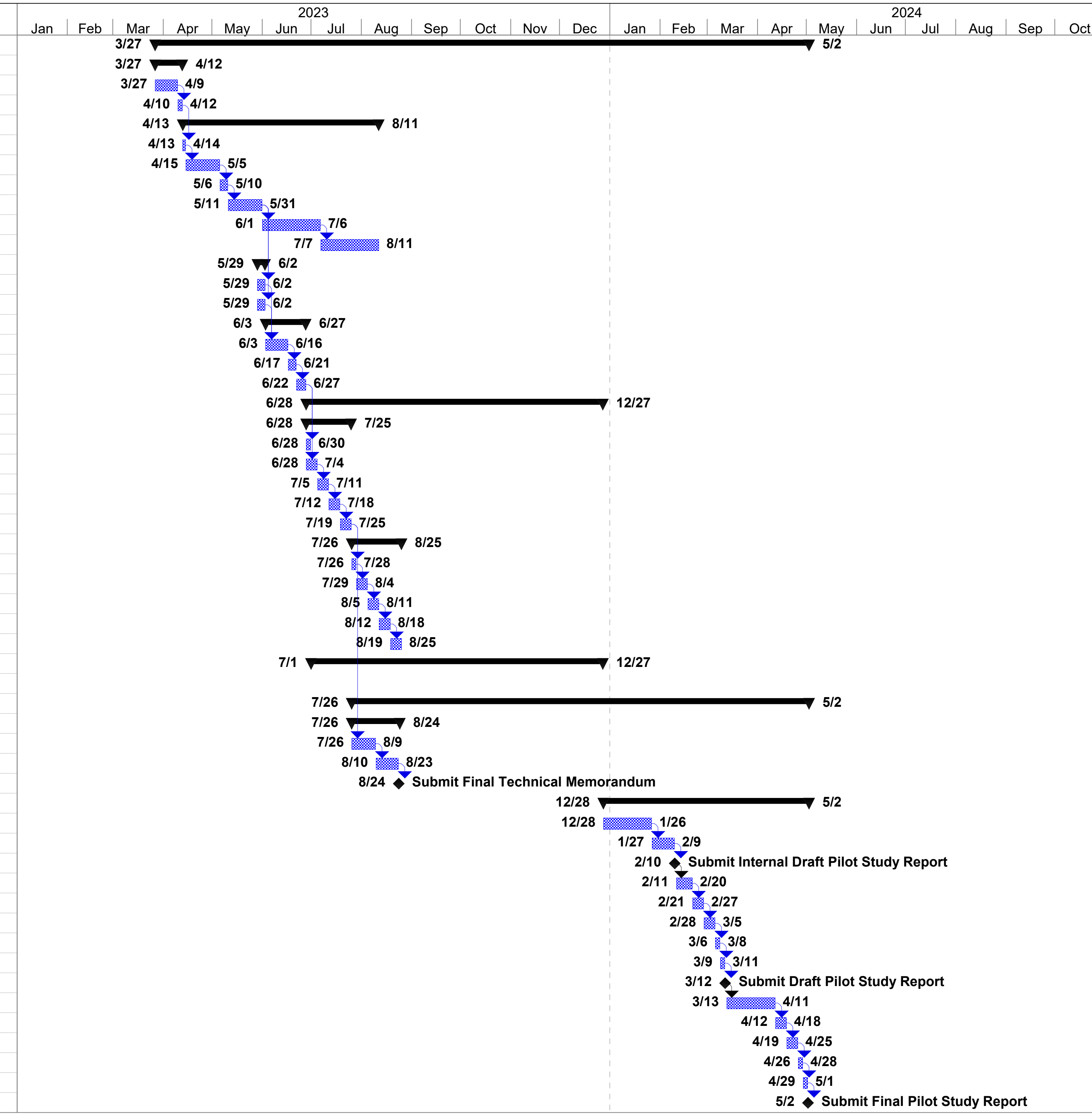
Cold water can inhibit the rapid release of viscous hydrocarbons from soil and cause False Negative results. Therefore, at temperatures below 68º F (20º C), we recommend an insulated jug with hot tap water.

Appendix C:
Gantt Chart

AS and SVE Pilot Study Activities (actual dates are TBD)

Last Updated: Mon 2/27/23

ID	Task Name	Dur	Start	Finish	Predecessors
1	**AS and SVE Pilot Study Activities**	**403 days**	**Mon 3/27/23**	**Thu 5/2/24**	
2	**Site Prep**	**17 days**	**Mon 3/27/23**	**Wed 4/12/23**	
3	Site Prep	14 days	Mon 3/27/23	Sun 4/9/23	
4	Land Survey and Utility Clearance	3 days	Mon 4/10/23	Wed 4/12/23	3
5	**Drilling**	**121 days**	**Thu 4/13/23**	**Fri 8/11/23**	
6	Drilling Mob	2 days	Thu 4/13/23	Fri 4/14/23	4
7	Air Sparging Point Installation	21 days	Sat 4/15/23	Fri 5/5/23	6
8	Shallow SVE Well Construction	5 days	Sat 5/6/23	Wed 5/10/23	7
9	Shallow VMP Installation	21 days	Thu 5/11/23	Wed 5/31/23	8
10	Deep SVMP Installations	36 days	Thu 6/1/23	Thu 7/6/23	9
11	Deep SVE Installations	36 days	Fri 7/7/23	Fri 8/11/23	10
12	**Hume Line**	**5 days**	**Mon 5/29/23**	**Fri 6/2/23**	
13	Hume Line Cutout	5 days	Mon 5/29/23	Fri 6/2/23	9FS-3 days
14	Hume Line Investigation and Vault Installation	5 days	Mon 5/29/23	Fri 6/2/23	9FS-3 days
15	**Equipment Mob and Install**	**25 days**	**Sat 6/3/23**	**Tue 6/27/23**	
16	Mob SVE SKID and Generator	14 days	Sat 6/3/23	Fri 6/16/23	13,14
17	Mob AS Equipment	5 days	Sat 6/17/23	Wed 6/21/23	16
18	Utility Connection	6 days	Thu 6/22/23	Tue 6/27/23	17
19	**Pilot Test**	**183 days**	**Wed 6/28/23**	**Wed 12/27/23**	
20	**Shallow AS/SVE Start-Up (~four weeks)**	**28 days**	**Wed 6/28/23**	**Tue 7/25/23**	
21	Baseline Monitoring	3 days	Wed 6/28/23	Fri 6/30/23	18
22	SVE Step Test	7 days	Wed 6/28/23	Tue 7/4/23	18
23	SVE Constant Rate Test	7 days	Wed 7/5/23	Tue 7/11/23	22
24	AS and SVE Step Test	7 days	Wed 7/12/23	Tue 7/18/23	23
25	AS and SVE Constant Rate Test	7 days	Wed 7/19/23	Tue 7/25/23	24
26	**Deep SVE Start-Up (~four weeks)**	**31 days**	**Wed 7/26/23**	**Fri 8/25/23**	
27	Baseline Monitoring	3 days	Wed 7/26/23	Fri 7/28/23	25
28	Phase 1 Deep SVE Step Testing	7 days	Sat 7/29/23	Fri 8/4/23	27
29	Phase 1 Deep SVE Constant Rate Testing	7 days	Sat 8/5/23	Fri 8/11/23	28
30	Phase 2 Deep SVE Step Testing	7 days	Sat 8/12/23	Fri 8/18/23	29
31	Phase 2 Deep SVE Constant Rate Testing	7 days	Sat 8/19/23	Fri 8/25/23	30
32	**Long-Term Pilot Test (six months)**	**180 days**	**Sat 7/1/23**	**Wed 12/27/23**	
33	Long-Term Pilot Test	180 days	Sat 7/1/23	Wed 12/27/23	31
34	**Reporting**	**282 days**	**Wed 7/26/23**	**Thu 5/2/24**	
35	**Technical Memorandum**	**30 days**	**Wed 7/26/23**	**Thu 8/24/23**	
36	Prepare Technical Memorandum	15 days	Wed 7/26/23	Wed 8/9/23	25
37	Peer Review/Tech Edit	14 days	Thu 8/10/23	Wed 8/23/23	36
38	Submit Final Technical Memorandum	1 day	Thu 8/24/23	Thu 8/24/23	37
39	**Pilot Study Report (combined shallow and deep)**	**127 days**	**Thu 12/28/23**	**Thu 5/2/24**	
40	Prepare Internal Draft	30 days	Thu 12/28/23	Fri 1/26/24	33
41	Peer Review/Tech Edit	14 days	Sat 1/27/24	Fri 2/9/24	40
42	Submit Internal Draft Pilot Study Report	1 day	Sat 2/10/24	Sat 2/10/24	41
43	Navy Review	10 days	Sun 2/11/24	Tue 2/20/24	42
44	Prepare/Submit RTCs	7 days	Wed 2/21/24	Tue 2/27/24	43
45	Navy Concurrence of RTCs	7 days	Wed 2/28/24	Tue 3/5/24	44
46	Prepare Draft Pilot Study Report	3 days	Wed 3/6/24	Fri 3/8/24	45
47	Peer Review/Tech Edit	3 days	Sat 3/9/24	Mon 3/11/24	46
48	Submit Draft Pilot Study Report	1 day	Tue 3/12/24	Tue 3/12/24	47
49	Regulator Review	30 days	Wed 3/13/24	Thu 4/11/24	48
50	Prepare/Submit RTCs	7 days	Fri 4/12/24	Thu 4/18/24	49
51	Regulator Concurrence of RTCs	7 days	Fri 4/19/24	Thu 4/25/24	50
52	Prepare Final Pilot Study Report	3 days	Fri 4/26/24	Sun 4/28/24	51
53	Peer Review/Tech Edit	3 days	Mon 4/29/24	Wed 5/1/24	52
54	Submit Final Pilot Study Report	1 day	Thu 5/2/24	Thu 5/2/24	53



Project: Schedule.mpp

Task		Summary		Project Summary	
Milestone	◆	Summary Progress		Progress	

Run Date: Mon 2/27/23

Appendix D:
Analytical Data Package Requirement
for Chemical Analyses

Appendix D.1:
Analytical Data Package Requirements

GC-FID Stage 4 Deliverables

Item No.	Deliverable
1	Chain of custody
2	Sample results with analysis and extraction/preparation dates
3	Summary of MS/MSD/Duplicate recoveries and control limits (listing or link with associated samples)
4	Summary of LCS/LCSD recoveries and control limits (listing or link with associated samples)
5	Method blanks (listing or link with associated samples)
6	Summary of surrogate recoveries
7	Summary of initial calibration data (RF and %RSD, or r if applicable)
8	Summary of continuing calibration (%D)
9	Injection logs
10	Extraction/preparation logs
11	Case narrative to discuss anomalies
12	Raw data associated with the summary forms listed above
13	Raw data for item #2 which includes chromatograms, logbooks, quantitation reports, and spectra

Note: The data deliverable package must have a table of contents and be paginated.
%D percent difference
%RSD percent relative standard deviation
MS matrix spike
MSD matrix spike duplicate
LCS laboratory control sample
LCSD laboratory control sample duplicate
RF response factor

GC-MS Stage 4 Deliverables

Item No.	Deliverable
1	Chain of custody
2	Sample results with analysis and extraction/preparation dates
3	Summary of MS/MSD/Duplicate recoveries and control limits (listing or link with associated samples)
4	Summary of LCS/LCSD recoveries and control limits (listing or link with associated samples)
5	Method blanks (listing or link with associated samples)
6	Summary of instrument blanks - metals only (listing or link with associated samples)
7	Summary of surrogate recoveries
8	Summary of initial calibration data (RRF and %RSD, or r if applicable)
9	Summary of continuing calibration (%D and RRF)
10	Summary of internal standards (area response and retention time)
11	Summary of instrument tuning (listing or link with associated samples, must show 12-hour clock)
12	Injection logs
13	Extraction/preparation logs
14	Case narrative to discuss anomalies
15	Raw data associated with the summary forms listed above
16	Raw data for item #2 which includes chromatograms, logbooks, quantitation reports, and spectra

Note: The data deliverable package must have a table of contents and be paginated.
GC-MS gas chromatography-mass spectrometry
RRF relative response factor
%RSD percent relative standard deviation

GC Stage 4 Deliverables

Item No.	Deliverable
1	Chain of custody
2	Sample results with analysis and extraction/preparation dates
3	Summary of MS/MSD/Duplicate recoveries and control limits (listing or link with associated samples)
4	Summary of LCS/LCSD recoveries and control limits (listing or link with associated samples)
5	Method blanks (listing or link with associated samples)
6	Summary of initial calibration data (correlation coefficient, r)
7	Summary of continuing calibration (%D or % recovery), if applicable
8	Injection logs
9	Extraction/preparation logs, if applicable
10	Case narrative to discuss anomalies
11	Raw data associated with the summary forms listed above
12	Raw data for item #2, which includes logbooks, quantitation reports, and spectra

Note: The data deliverable package must contain a table of contents and be paginated.

Appendix D.2:
Field Sampling, Analytical, and
Quality Management Reference Tables

Table D.2-1: Location-Specific Sampling Methods/SOP Requirements

Sampling Location/ ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Sampling SOP Reference
TBD	Soil gas	0-70	VOCs, TPH-d/o	8	Procedure I-B-3 Soil Gas Sampling
TBD	Perched water	0-70	N, 1MN, 2MN TPH-d/o	TBD	Procedure I-B-1 -groundwater sampling
TBD	Investigation derived waste	0-70	TCLP RCRA 8 - 1311/6010/7470 BTEX+HVOC - 8260C TPH-g - 8260C TPH-d/o - 8015C PAHs (full list) - 8270D PCB Aroclors - 8082A MIS Preparation	TBD	Procedure I-B-1 soil sampling

Notes:
Procedures are from the Project Procedures Manual (DON 2015).
Actual number of unconsolidated material samples will be dependent on field observations during coring.
Volumes for field duplicate, and MS/MSD samples will only be collected if sufficient unconsolidated material is present at each sampling interval. If limited volume is present, collecting volume for TPH will take priority.
One equipment blank will be collected during each unconsolidated material sampling event.

1MN 1-methylnaphthalene
2MN 2-methylnaphthalene
bgs below ground surface
BTEX benzene, toluene, ethylbenzene, and xylenes
ft foot or feet
ID identification
PAH polynuclear aromatic hydrocarbon
TBD to be determined
TPH-g total petroleum hydrocarbons – gasoline range organics
TPH-o total petroleum hydrocarbons – residual or motor oil range organics

Table D.2-2: Analyte List and Reference Limits

Matrix Unconsolidated Material

Analyte	CAS Number	Screening Criterion [a] Gross Contamination/Direct Exposure/Leaching to Groundwater (mg/kg)	Project LOQ Goal (mg/kg)	Project LOD Goal (mg/kg)	LOQ	Laboratory-Specific Limits (mg/kg)	
						LOD	DL
TPH							
TPH-d (C10–C24)	—	500/220/940	73	22	50	30	9.9
TPH-o (C24–C40)	—	500/9,400/1,000	—	—	50	30	20
PAHs							
1-Methylnaphthalene	90-12-0	500/170/4.2	1.4	0.42	0.005	0.0015	0.00063
2-Methylnaphthalene	91-57-6	500/39/4.1	1.4	0.41	0.005	0.003	0.0021
Naphthalene	91-20-3	500/28/4.4	1.5	0.44	0.005	0.004	0.0016

— no data
mg/kg milligrams per kilogram
[a] DOH Tier 1 EALs (Summer 2016, updated January 2017).

Matrix Perched Water

Analyte	CAS Number	Screening Criterion [a] Gross Contamination/Drinking Water Toxicity (µg/L)	Project LOQ Goal (µg/L)	Project LOD Goal (µg/L)	LOQ	Laboratory-Specific Limits (µg/L)	
						LOD	DL
TPH							
TPH-d (C10–C24)	—	500/400	400	400	110	100	65
TPH-o (C24–C40)	—	500/2,400	500	500	350	300	180
PAHs							
1-Methylnaphthalene	90-12-0	10/27	10	10	0.10	0.032	0.019
2-Methylnaphthalene	91-57-6	10/24	10	10	0.20	0.08	0.039
Naphthalene	91-20-3	21/17	17	17	0.10	0.080	0.031

— NA
µg/L micrograms per liter
[a] DOH Tier 1 EALs (Summer 2016, updated January 2017).

Table D.2-3: Preparation and Analytical Requirements for Field and QC Samples

Matrix	Analytical Group	Preparation Reference/Method SOP Analytical Reference/Method SOP	Containers	Sample Volume	Preservation Requirement	Maximum Holding Time (preparation/analysis)
Soil gas	TPH-d, TPH-o	TBD	TBD	TBF	NA	Samples to be analyzed within 14 days.
	VOCs	TBD	TBD	TBD	NA	Samples to be analyzed within 14 days.
Unconsolidated Material	TPH-d, TPH-o	TBD	1 × 8-oz glass jar, Teflon-lined lid	30 g	Cool to ≤ 6°C	Samples extracted within 14 days and analyzed within 40 days following extraction.
	PAHs	TBD	TBD	30 g	Cool to ≤ 6°C	Samples extracted within 14 days and analyzed within 40 days following extraction.
Perched Water	TPH-d, TPH-o	TBD	2 × 250mL glass	250 mL	Cool to ≤ 6°C	Samples extracted within 7 days and analyzed within 40 days following extraction.
	PAHs	TBD	2 × 250mL glass	250 mL	Cool to ≤ 6°C	Samples extracted within 7 days and analyzed within 40 days following extraction.

g gram
HCl hydrochloric acid
L liter
mL milliliter
oz ounce

Table D.2-4: Analytical Services

Matrix	Analytical Group	Sampling Locations/ ID Numbers	Analytical SOP	Data Package Turnaround Time	Laboratory/Organization (name and address)
Unconsolidated Material	TPH-d, TPH-o PAHs (1-methylnaphthalene, 2-methylnaphthalene, naphthalene)	TBD	TBD	14 business days after samples are received at laboratory	TBD
Perched Water	TPH-d, TPH-o PAHs (1-methylnaphthalene, 2-methylnaphthalene, naphthalene)	TBD	TBD	14 business days after samples are received at laboratory	TBD
Soil gas	TPH-d, TPH-o, VOCs	TBD	TBD	14 business days after samples are received at laboratory	TBD

ID identification
TBD to be determined
[a] Laboratory meets DoD Environmental Laboratory Accreditation Program or American Association of State Highway and Transportation Officials accreditation requirements, as applicable, to support project needs.