

Installation & Maintenance Manual

Green Machine[™] - PMC / ISD - California

Revision 1.12



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About VST



Vapor Systems Technologies, Inc. began in 1989 with the vision of **One Company – One Integrated Solution**.

Today, that philosophy is still in place and getting stronger. Recognizing that a healthier environment is a need and not an option, VST has dedicated its undivided attention to the ever-changing, stringent regulations that govern fugitive

vapors at gasoline dispensing facilities (GDF). To this challenge, VST is committed to a continual R&D campaign of developing the most current, technologically advanced solutions to service not only the United States, but also the world.

VST specializes in the development, engineering, and manufacturing of products that are sold into the GDF segment of the petroleum industry. The VST focus provides our customers and users with exceptional products, services, and innovative solutions for improving the fueling-station experience as well as the world's air quality.

VST's product offering includes curb pump and vapor recovery hoses, safety breakaways, nozzles, and emission-control system - *Green Machine*. The ENVIRO-LOC™ vapor-recovery product offering represents the most innovative concept in the industry for trapping fugitive vapors from the front end (vehicle refueling) to the back end (vent risers) of the GDF site.

Notice

Vapor Systems Technologies, Inc. shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this publication.

No part of this publication may be translated to another language without the prior written consent of Vapor Systems Technologies, Inc.

1 This Document

1.1 Safety Icons

	<p>ELECTRICITY A potential shock hazard exists. High voltage is supplied to and exists in this device.</p>		<p>TURN POWER OFF Turn power off to the device and its accessories when installing and servicing the unit. Live power creates a potential spark hazard.</p>
	<p>EXPLOSIVE Gasoline and its vapors are extremely explosive if ignited.</p>		<p>NO POWER TOOLS Sparks from electric power tools can ignite gasoline and its vapors.</p>
	<p>FLAMMABLE Gasoline and its vapors are extremely flammable.</p>		<p>NO PEOPLE IN THE AREA Unauthorized people in the work area during installation and service of the device create a potential for personal injury.</p>
	<p>NO SMOKING Gasoline and its vapors can be ignited by sparks and embers of burning cigarettes.</p>		<p>READ ALL RELATED MATERIALS Read, understand, and follow all instructions, warnings, and requirements before you begin work.</p>
	<p>NO OPEN FLAMES Open flames from sources like lighters and matches can ignite gasoline and its vapors.</p>		<p>USE SAFETY BARRICADES Unauthorized people in the work area during installation and service of the device create a potential for personal injury. Therefore, always isolate your work area by using safety cones, barricades, etc.</p>
	<p>PINCH RISK Stay clear. Keeps hands and tools away from rotating machinery and moving parts.</p>		<p>ROTATING MACHINERY Stay clear. Keep hands and tools away from rotating machinery.</p>

1.2 Table of Terms & Abbreviations

ASC:	Authorized Service Contractor
AQMD:	Air Quality Management Districts
ATG:	Automatic Tank Gauge
CAPCOA:	California Air Pollution Control Office Association
CARB:	California Air Resources Board
CDFA:	California Department of Food & Agriculture
CVLD:	Continuous Vapor Leakage Detection, another name for Vapor Leak Detection
EO:	Executive Order
ESO:	Emergency Shut Off
EVR:	Enhanced Vapor Recovery
GDF:	Gasoline Dispensing Facility
GM:	<i>Green Machine</i>
HC:	Hydrocarbon
ISD:	In-Station Diagnostics
MAG Probe:	A type (brand) of Tank Inventory Probe
NEC:	National Electric Code
NFPA:	National Fire Protection Association
ORVR:	ON-Board Refueling Vapor Recovery
OSHA:	Occupational Safety Health Administration
Permeate:	Air return to atmosphere
PMC:	Pressure Management Control
PTO:	Permit to Operate
P/V Valve:	Pressure Vacuum Valve
TLS:	Tank Level System
Ullage:	Vapor space above liquid in a UST
UST:	Underground Storage Tank
VOC:	Volatile Organic Compounds
VST:	Vapor Systems Technologies, Inc.
WC:	Water Column

2 Safety



- The *Green Machine* will be installed near locations where highly flammable and explosive gasoline vapors may be present.
- Installation of the *Green Machine* must comply with the National Electric Code, federal, state, and local codes, as well as other applicable safety codes.
- Use extreme caution due to the risk of fire or explosion, which could result in serious injury or even death.



- If you are working in an area where vehicle traffic may occur, always block off the work area during installation, testing, and service to protect yourself and others.
- Do not use power tools that can generate sparks if there is a risk of flammable or explosive vapors being present.



- Read and understand all materials related to installing, testing, and operating the *Green Machine* prior to installation.

CAUTION: ALL SERVICEABLE / REPLACEMENT PARTS MUST BE OBTAINED FROM VST TO MAINTAIN SUITABILITY FOR A DIVISION 2 LOCATION.

3 Green Machine Description

3.1 Green Machine Theory of Operation

- The VST *Green Machine* does not interact directly with the other balance system hardware. It is in place to control the pressure in the UST to within limits specified by CARB.
- Under conditions where the GDF is operational and the balance system hardware is functioning normally, the inherent ORVR compatibility of the balance system (when using VST's ENVIRO-LOC nozzle) will produce a predominately negative gauge pressure in the ullage space of the UST. Under these conditions, the *Green Machine* will typically not need to operate.
- During periods of less activity, such as the GDF being shut down overnight, winter fuels being present or other conditions that promote the pressurization of the ullage space, the *Green Machine* will operate as needed to control the pressure in the ullage space to an accepted level. The *Green Machine* will turn on at an ullage pressure of +0.20 inches of water. Currently, the *Green Machine* unit is monitored and controlled through the TLS-350 PMC or ISD software and the VST Control Panel.
- When the UST pressure increases to above +0.20 inches of water, a TLS-350 AUX contact closes. The AUX contact is connected to the VST Control Panel, which is the mechanism that starts the *Green Machine*. The VST Control Panel manages the operation of the *Green Machine* including the ON, PURGE, and OFF cycles.
- These preset pressure measurements control the UST pressure below atmospheric pressure. The pressure data is provided to the TLS-350 for system monitoring functions.
- The TLS-350 monitors the UST pressure via a pressure sensor located in a dispenser.
See Figure 1.

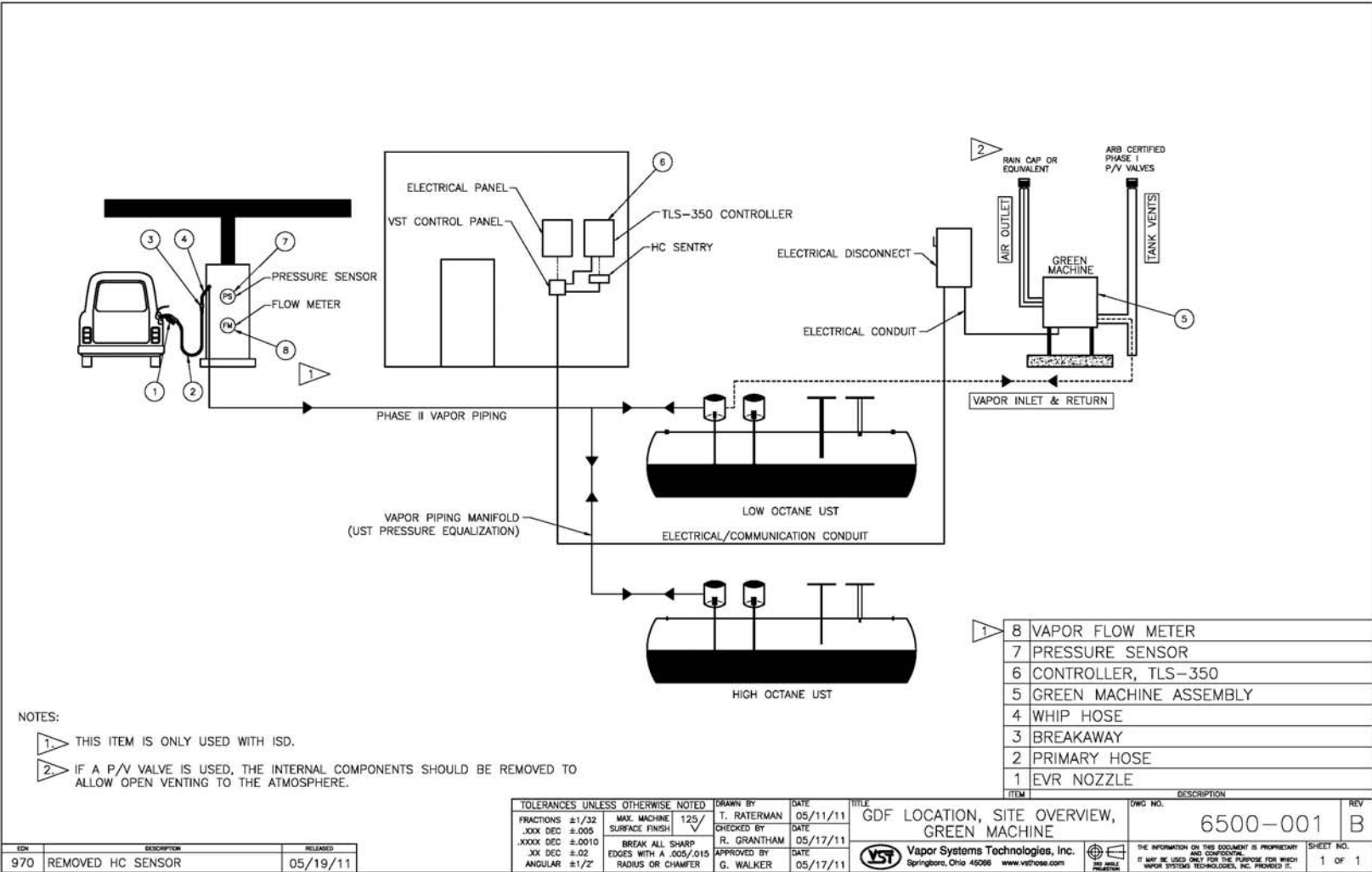


Figure 1: Green Machine GDF Layout

3.2 Regulations & Jurisdiction



Be sure to read and understand all site requirements before beginning an installation.

- Under vapor recovery rules, air pollution control districts have primary authority for regulating GDF's.
- Before modifying the facility, GDF operators should contact the local air district for specific information on local vapor-recovery requirements.
- Contact information for local air pollution control districts is available on the air district permit to operate (PTO) and/or the California Air Pollution Control Officers Association (CAPCOA) website at <http://www.capcoa.org>.
- “The area inside the *Green Machine* cover has been evaluated as a Class I, Division 2 hazardous area as defined by the National Electric Code /NFPA 70 Article 514 table 514.3(B)(1) and verified by Intertek.”

CAUTION

Always obtain approval from the local authority having jurisdiction.

Installation of the *Green Machine* must comply with (if applicable):

- CARB CP-201
- VST EVR E.O.
- Fire Marshal
- Water Board
- Local Air Pollution District
- ICC
- NEC
- NFPA 30 and 30A
- UL
- Any other applicable federal, state, and local codes

3.3 Green Machine Dimensions & Weight

Description	Dimensions	Weight
<i>Green Machine</i>	L-39" x W-27" x H-43" Height includes 18" legs	225 lbs. w/o Cover w/o Control Panel
<i>Green Machine</i> Aluminum Cover	L-39" x W-27" x H-25" (one-piece unit)	24 lbs.
<i>Green Machine</i> Fire-Resistant Enclosure (Optional)	L-41" x W-27" x H-36" (side panels are removable)	100 lbs.

3.4 Green Machine Replacement Components

CAUTION: ALL SERVICEABLE/REPLACEMENT PARTS MUST BE OBTAINED FROM VST TO MAINTAIN SUITABILITY FOR A DIVISION 2 LOCATION.

Part #	Description
GM-004	Coupling Rubber Sleeve

3.5 How the Green Machine is Shipped

The *Green Machine* is shipped with the following:

- *Green Machine* - VST-GM-CS1-100
 - Aluminum Cover
 - Control Panel
 - 4 Steel Legs
 - 16 3/8" bolts / washers / nuts
(to attach the legs to the *Green Machine* base)
 - HC Sentry Interface Module with 24 VDC power supply
 - HC Sentry Interface Cable
- Bolted to a skid
- Owner package with warranty paperwork to be filled out and returned to VST.

Shipping Check

When you open the container:

- Verify that all the items are in the shipping container.
- Visually inspect all the items for any obvious damage.

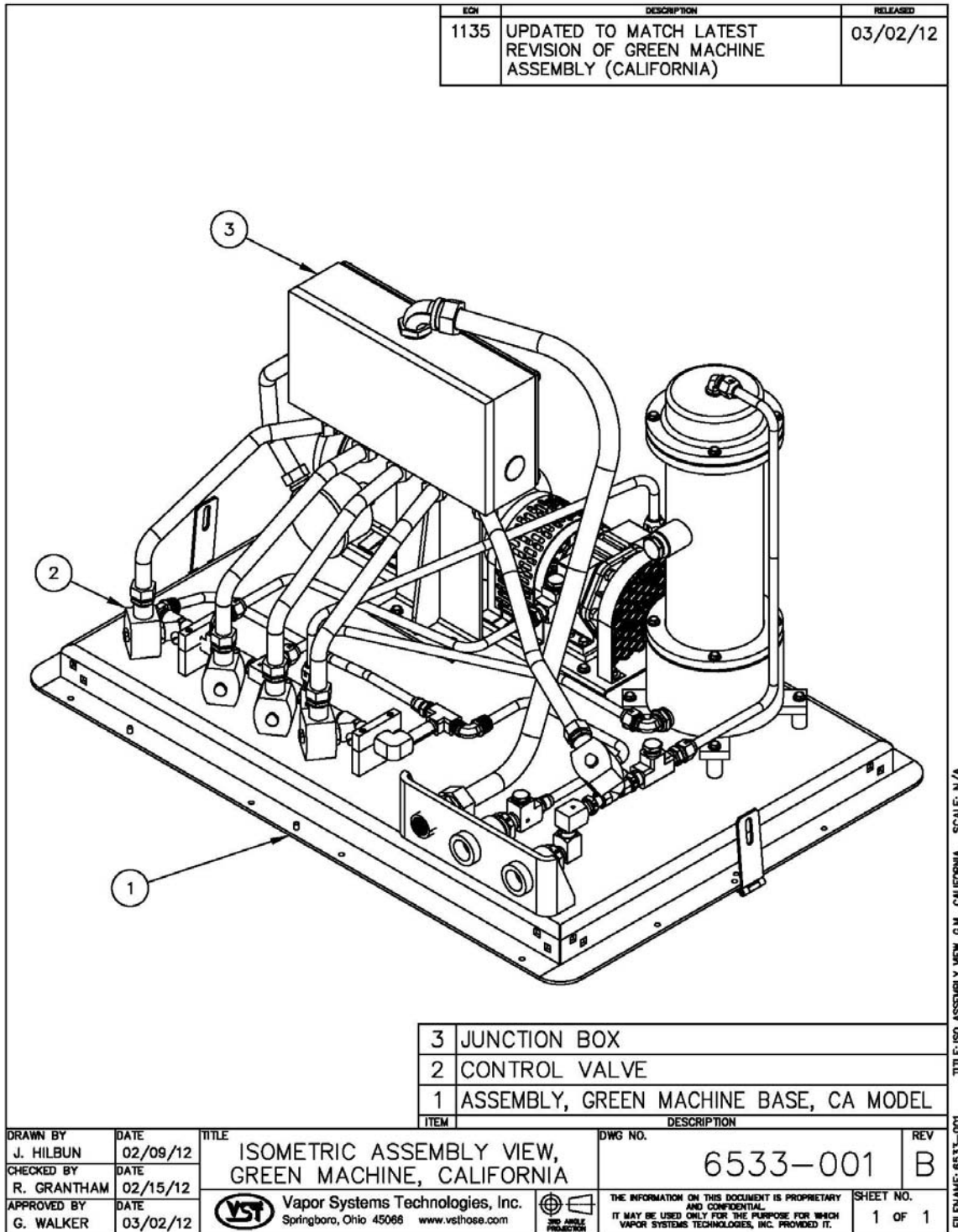


Figure 2: Green Machine Isometric View (1 of 2)

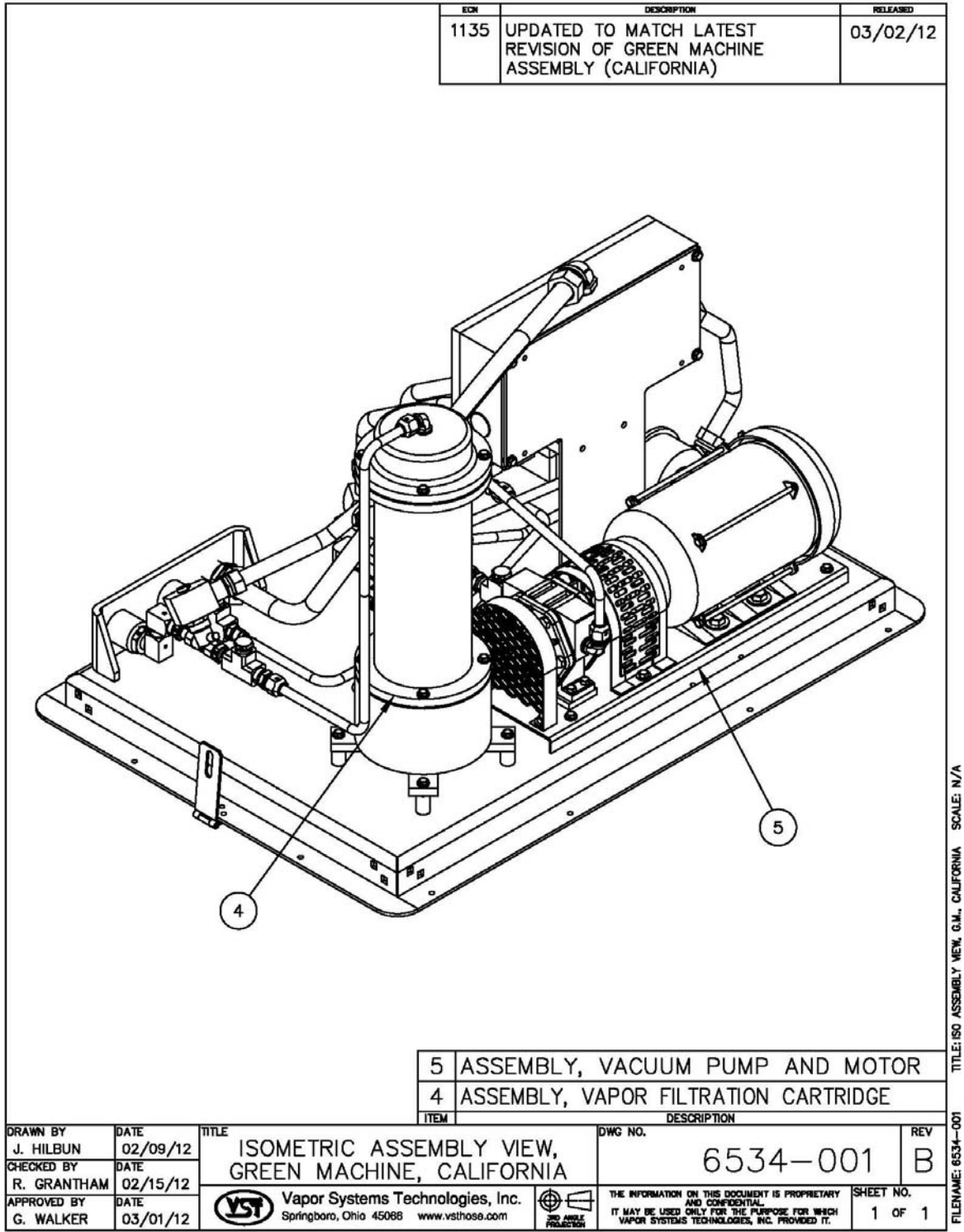


Figure 3: Green Machine Isometric View (2 of 2)

Installation

4 Snapshot of Site Requirements

Local Air Pollution Control District
<ul style="list-style-type: none"> GDF must contact the local air pollution control district for specific local vapor recovery requirements.
Common Requirements
<ul style="list-style-type: none"> The <i>Green Machine</i> must be protected from damage. VST recommends an 18" perimeter around the <i>Green Machine</i> for maintenance and testing. The <i>Green Machine</i> must be located at least 10' from the property line unless a variance is obtained from the local authority. The <i>Green Machine</i> must be located within 100' of the vent risers.
Ground-Mount Location
<ul style="list-style-type: none"> Obtain approval from the local jurisdiction for the <i>Green Machine</i> to be placed on the ground.
Vent Riser Mount
<ul style="list-style-type: none"> Obtain approval from the local jurisdiction for the <i>Green Machine</i> to be placed on the vent riser support structure. The support structure must be of adequate strength to support the <i>Green Machine</i>.
Roof-Mount Location
<ul style="list-style-type: none"> Obtain approval from the local jurisdiction for the <i>Green Machine</i> to be placed on the roof. Structure must be strong enough to hold the weight of the <i>Green Machine</i>. The height of the <i>Green Machine</i> must allow for the proper vapor-piping slope.
Canopy-Mount Location
<ul style="list-style-type: none"> Obtain approval from the local jurisdiction for the <i>Green Machine</i> to be placed on the canopy. Structure must be strong enough to hold the weight of the <i>Green Machine</i>. All safety and code concerns have been addressed.
UST Manifolding
<ul style="list-style-type: none"> UST's must be manifolded either below grade or at the vent risers. Only a single vent is required.
Dispensers
<ul style="list-style-type: none"> The dispenser vapor piping must be sized adequately to meet the maximum pressure drop requirement. A minimum one-inch (1") nominal internal diameter for the vapor down pipe is recommended.
UST Fuel Level Management
<ul style="list-style-type: none"> Must be able to access an Overfill Alarm contact with the VST Control Panel <i>Green Machine</i> Controller.

Snapshot of Site Requirements, cont.

VST Control Panel
<ul style="list-style-type: none"> • VST Control Panel completely powers the <i>Green Machine</i> via one 115VAC, 20-amp breaker.
<ul style="list-style-type: none"> • The VST Control Panel must be installed inside the GDF electrical room.
<ul style="list-style-type: none"> • The VST Control Panel is UL approved.
Vent Risers
<ul style="list-style-type: none"> • Only 1 vent riser is required for the installation of the <i>Green Machine</i>.
<ul style="list-style-type: none"> • Recommended slope of ¼" per foot on all vapor-piping connecting the <i>Green Machine</i> to the vent risers or to any other UST connection. (VST requires a minimum of 1/8" per foot minimum slope for all vapor piping.)
<ul style="list-style-type: none"> • Any type of trap, other than the ARB-approved liquid-condensate trap (regardless of the <i>Green Machine</i> location), is not permitted in any vapor lines connected to the <i>Green Machine</i>.
<ul style="list-style-type: none"> • A 5' radius around the vent riser P/V valve is a Class I, Div. 2 hazardous area as defined in NFPA 70.
Veeder-Root Controls
<ul style="list-style-type: none"> • Must have TLS-350 with appropriate Veeder-Root software installed.
CARB Requirements
<ul style="list-style-type: none"> • Executive Order: VR-203/204.

4.1 Pre-Installation Site Survey

- VST created a "*Green Machine* Pre-Installation Site Survey" as a guide to help certified installers and troubleshooters in the planning of a *Green Machine* installation.
- The "*Green Machine* Pre-Installation Site Survey" is to be completely filled out in advance of an installation so that installation problems and delays are reduced or avoided.
- You will find the "*Green Machine* Pre-Installation Site Survey" on our website at www.vsthose.com.

5 Contractor Supplied Components

5.1 Contractor Supplied - Vapor Piping Components

Quantity	Component(s)
2	1" diameter straight tee's with caps
2	1" diameter unions
2	1" diameter locking ball valves
1	Straight tee (sized to match existing vent riser)
1	1" x 2" galvanized reducer bushing
1	Straight tee with cap (sized to match new vent riser)
1	Rain cap (on new vent riser)
As required	1" diameter pipe, elbows, and misc. pipe fittings
5	<u>Locks</u> : 2- cover, 2-locking ball vales, 1-control cabinet

5.2 Contractor Supplied - Electrical Components

Component(s)
<ul style="list-style-type: none"> • Wires
<ul style="list-style-type: none"> • Conduits
<ul style="list-style-type: none"> • Fittings
<ul style="list-style-type: none"> • Seal-Offs
<ul style="list-style-type: none"> • Safety Disconnect Switch
<ul style="list-style-type: none"> • Optional 115 VAC Outlet
<ul style="list-style-type: none"> • 115 VAC relay

6 Ground Mount Installation

6.1 Protecting the Green Machine

- Take measures to protect the *Green Machine* and external vapor piping from damage in areas near vehicle traffic with guards, such as concrete-filled bollards or guardrails.
 - Check local codes for protective-device guidelines before setting the bollards or guardrails.
- A fence should not be required since there is a lockable cover on the *Green Machine* with lockable hasps to prevent tampering. The contractor will provide the locks for the hasps.
- VST requires a lockable ball valve be used at both the inlet and outlet connections at the *Green Machine*.
 - VST does not include any locks or lockable valves for the *Green Machine*; therefore, the contractor must provide them.
 - Lockable ball valves used in this application must be compatible with gasoline and gasoline vapor. For further requirements, consult the lockable-valve installation instructions provided by the manufacturer.
 - Some local jurisdictions may require that the lockable Safety Disconnect Switch, ball valves, and the cover be locked.
- The *Green Machine* standard aluminum cover and the optional 2-hour Fire Resistant Enclosure are both designed and built to withstand snow accumulation, rain, and landscaping sprinklers.

6.2 Ground-Mount Location

Ground Mount Requirements	
	<ul style="list-style-type: none"> The <i>Green Machine</i> must be protected from damage.
	<ul style="list-style-type: none"> VST recommends an 18" perimeter around the <i>Green Machine</i> for maintenance and testing.
	<ul style="list-style-type: none"> The <i>Green Machine</i> must be located at least 10' from the property line unless a variance is obtained from the local authority.
	<ul style="list-style-type: none"> The <i>Green Machine</i> must be located within 100' of the vent risers.
	<ul style="list-style-type: none"> The local jurisdiction must allow the <i>Green Machine</i> to be placed on the ground.
	<ul style="list-style-type: none"> To minimize the installation cost and to maximize operating efficiency, locate the <i>Green Machine</i> adjacent to the existing vent risers.
	<ul style="list-style-type: none"> A new air outlet vent riser connected to the <i>Green Machine</i> must be installed to release air to the atmosphere.
	<ul style="list-style-type: none"> VST requires setting the <i>Green Machine</i> on a concrete pad with the recommended following minimum dimensions: <ul style="list-style-type: none"> 6" concrete pad 3'6" long x 2'6" wide
	<ul style="list-style-type: none"> Follow the local jurisdiction's building codes: <ul style="list-style-type: none"> VST does not provide any hardware to install the <i>Green Machine</i> on the pad.

6.3 Installing the Green Machine on the Concrete Pad

1.	After the concrete has properly cured, install the expansion anchor bolts according to the manufacturer's recommendations.
2.	VST recommends using the HILTI KWIK TZ (KB-TZ) BOLT, KB-TZ 3/8" x 5", approved equal for seismic and non-seismic installations.
3.	Since seismic regulations may be different by location, VST has not included a specific drawing for this application. For seismic design reference, www.us.hilti.com .
4.	The contractor or design engineer is responsible for sizing the expansion anchors and the concrete pad to meet specifications required by local jurisdictions.
5.	After the appropriate anchor bolts have been installed, position the <i>Green Machine</i> onto the anchor bolts in the cement slab.
6.	Bolt the <i>Green Machine</i> into place (according to the manufacturer recommended installation guidelines) with 3/8" galvanized lock washers and bolts that are included with the expansion bolt.
7.	VST CANNOT BE RESPONSIBLE FOR DAMAGE CAUSED BY IMPROPER GREEN MACHINE FOUNDATION SUPPORT.

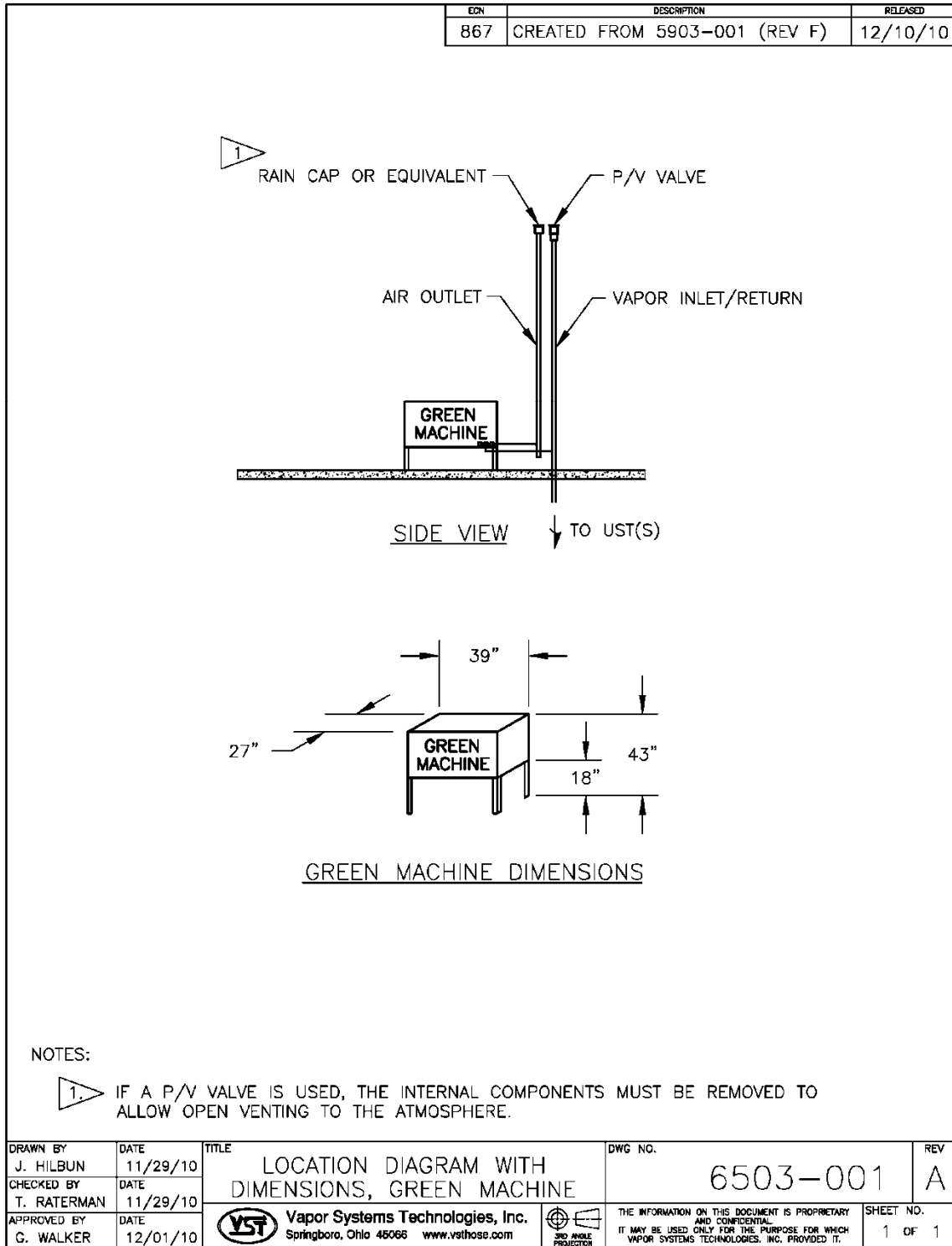


Figure 4: Location & Dimensions

6.4 After an Earthquake

- Insure the *Green Machine* unit is:
 - Level
 - All piping fittings are leak free by conducting a Leak Test as outlined in this document.
 - All the electrical fitting and connections are tight.

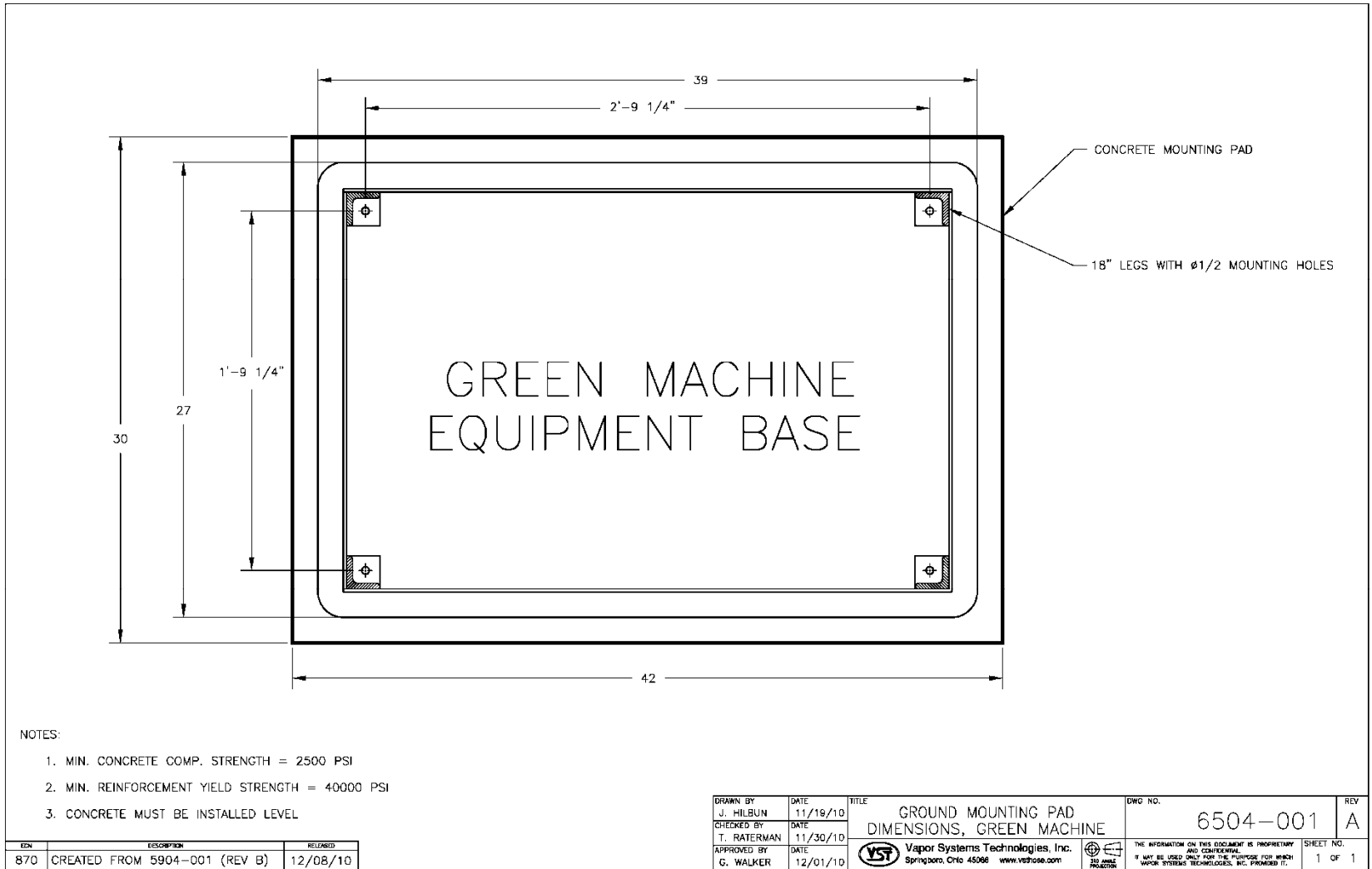


Figure 5: Mounting Pad Plan View

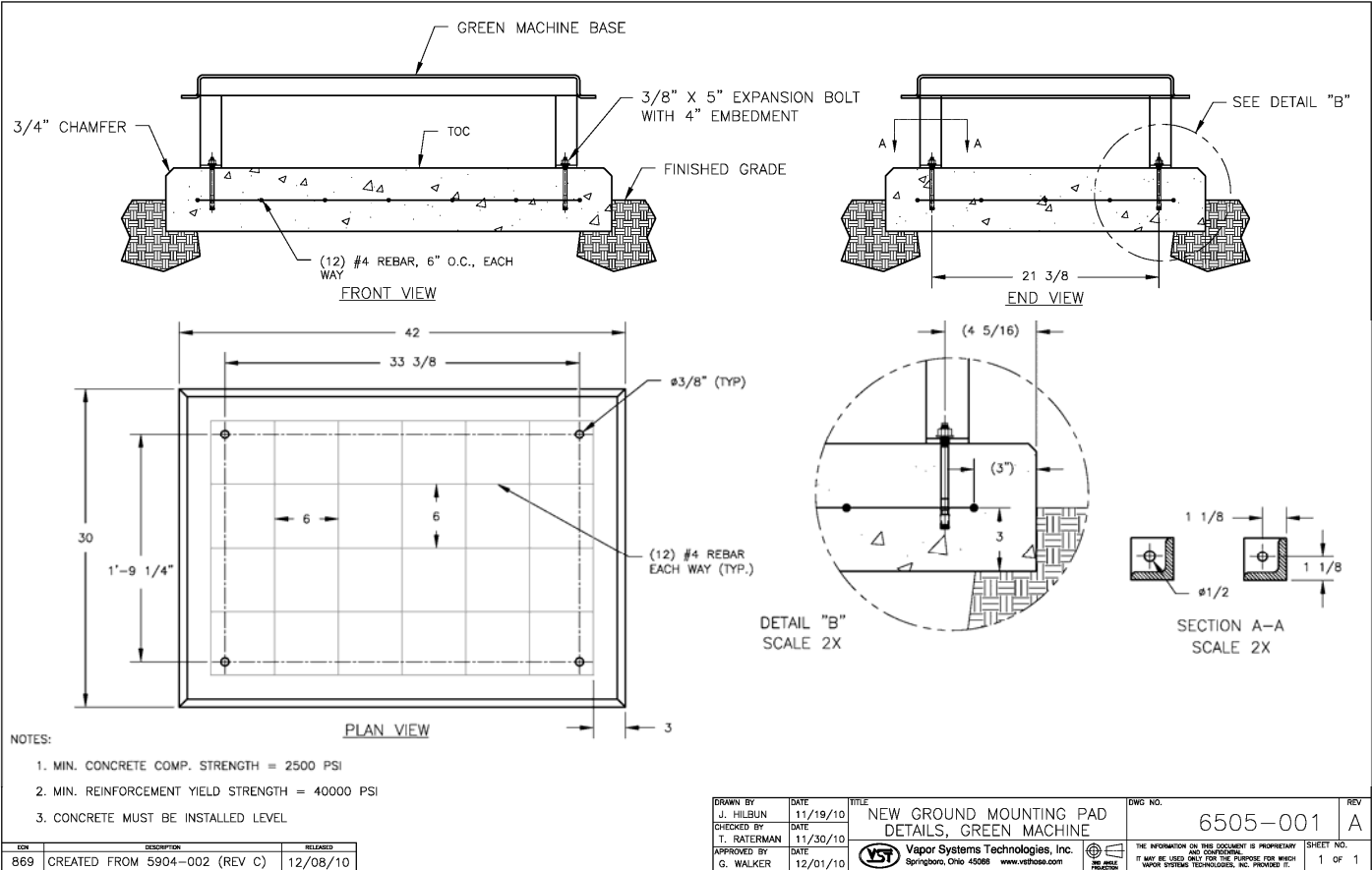


Figure 6: 6" Mounting Pad Details

7 Roof-Top Installation

Roof Top Installation Requirements
<ul style="list-style-type: none"> The <i>Green Machine</i> must be protected from damage.
<ul style="list-style-type: none"> VST recommends an 18" perimeter around the <i>Green Machine</i> for maintenance and testing.
<ul style="list-style-type: none"> The <i>Green Machine</i> must be located at least 10' from the property line unless a variance is obtained from the local authority.
<ul style="list-style-type: none"> The <i>Green Machine</i> must be located within 100' of the vent risers.
<ul style="list-style-type: none"> The local jurisdiction must allow the <i>Green Machine</i> to be placed on the roof.
<ul style="list-style-type: none"> The <i>Green Machine</i> may be installed on a station's roof provided the structure can support the weight of the <i>Green Machine</i>.
<ul style="list-style-type: none"> The height of the <i>Green Machine</i> must allow for the proper vapor-piping slope.
<ul style="list-style-type: none"> Due to a variety of roof construction designs, VST cannot recommend how the <i>Green Machine</i> should be mounted on the roof; however, the <i>Green Machine</i> must be installed at a height allowing the piping inlet and outlets to be above or through the building parapet.
<ul style="list-style-type: none"> The <i>Green Machine</i> may be secured to a steel structure attached to the roof.
<ul style="list-style-type: none"> A new air outlet vent riser connected to the <i>Green Machine</i> must be installed to release air to the atmosphere.
<ul style="list-style-type: none"> All safety and code concerns should be taken into consideration prior to a rooftop installation.
<ul style="list-style-type: none"> VST CANNOT BE RESPONSIBLE FOR DAMAGE CAUSED BY IMPROPER <i>GREEN MACHINE</i> FOUNDATION SUPPORT.

8 Canopy-Top Installation

Canopy Top Installation Requirements
<ul style="list-style-type: none"> The <i>Green Machine</i> must be protected from damage.
<ul style="list-style-type: none"> VST recommends an 18" perimeter around the <i>Green Machine</i> for maintenance and testing.
<ul style="list-style-type: none"> The <i>Green Machine</i> must be located at least 10' from the property line unless a variance is obtained from the local authority.
<ul style="list-style-type: none"> The <i>Green Machine</i> must be located within 100' of the vent risers.
<ul style="list-style-type: none"> The local jurisdiction must allow the <i>Green Machine</i> to be placed on the canopy.
<ul style="list-style-type: none"> The <i>Green Machine</i> may be installed on a station's roof provided the structure can support the weight of the <i>Green Machine</i>.
<ul style="list-style-type: none"> The height of the <i>Green Machine</i> must allow for the proper vapor-piping slope.
<ul style="list-style-type: none"> Due to a variety of canopy construction designs, VST cannot recommend how the <i>Green Machine</i> should be mounted on the canopy.
<ul style="list-style-type: none"> The <i>Green Machine</i> may be secured to a steel structure attached to the roof.
<ul style="list-style-type: none"> A new air outlet vent riser connected to the <i>Green Machine</i> must be installed to release air to the atmosphere.
<ul style="list-style-type: none"> All safety and code concerns should be taken into consideration prior to a canopy installation.
<ul style="list-style-type: none"> VST CANNOT BE RESPONSIBLE FOR DAMAGE CAUSED BY IMPROPER <i>GREEN MACHINE</i> FOUNDATION SUPPORT.

9 Vent-Stack Mount Installation

Vent Stack Installation Requirements
<ul style="list-style-type: none"> The <i>Green Machine</i> must be protected from damage.
<ul style="list-style-type: none"> VST recommends an 18" perimeter around the <i>Green Machine</i> for maintenance and testing.
<ul style="list-style-type: none"> The <i>Green Machine</i> must be located at least 10' from the property line unless a variance is obtained from the local authority.
<ul style="list-style-type: none"> The <i>Green Machine</i> must be located within 100' of the vent risers.
<ul style="list-style-type: none"> The local jurisdiction must allow the <i>Green Machine</i> to be placed on the canopy.
<ul style="list-style-type: none"> The <i>Green Machine</i> may be installed elevated next to existing vent risers provided there is an existing structure that can support the weight of the <i>Green Machine</i>, or a structure can be installed to support the weight of the <i>Green Machine</i>.
<ul style="list-style-type: none"> Due to a variety of construction designs, VST cannot recommend how the <i>Green Machine</i> should be installed or mounted on vent riser supports; however, the structure that supports the <i>Green Machine</i> must be designed and installed at a height allowing the piping inlet and outlets to connect to the existing vent risers.
<ul style="list-style-type: none"> A new air outlet vent riser connected to the <i>Green Machine</i> must be installed to release air to the atmosphere.
<ul style="list-style-type: none"> The <i>Green Machine</i> must not be installed within 5' of a P/V valve opening.
<ul style="list-style-type: none"> A Registered Design Engineer is responsible for designing the support structure, support base, all required hardware and bolting connections, and the support structure foundation to meet seismic specifications that may be required by local jurisdictions.
<ul style="list-style-type: none"> VST CANNOT BE RESPONSIBLE FOR DAMAGE CAUSED BY IMPROPER <i>GREEN MACHINE</i> FOUNDATION SUPPORT.

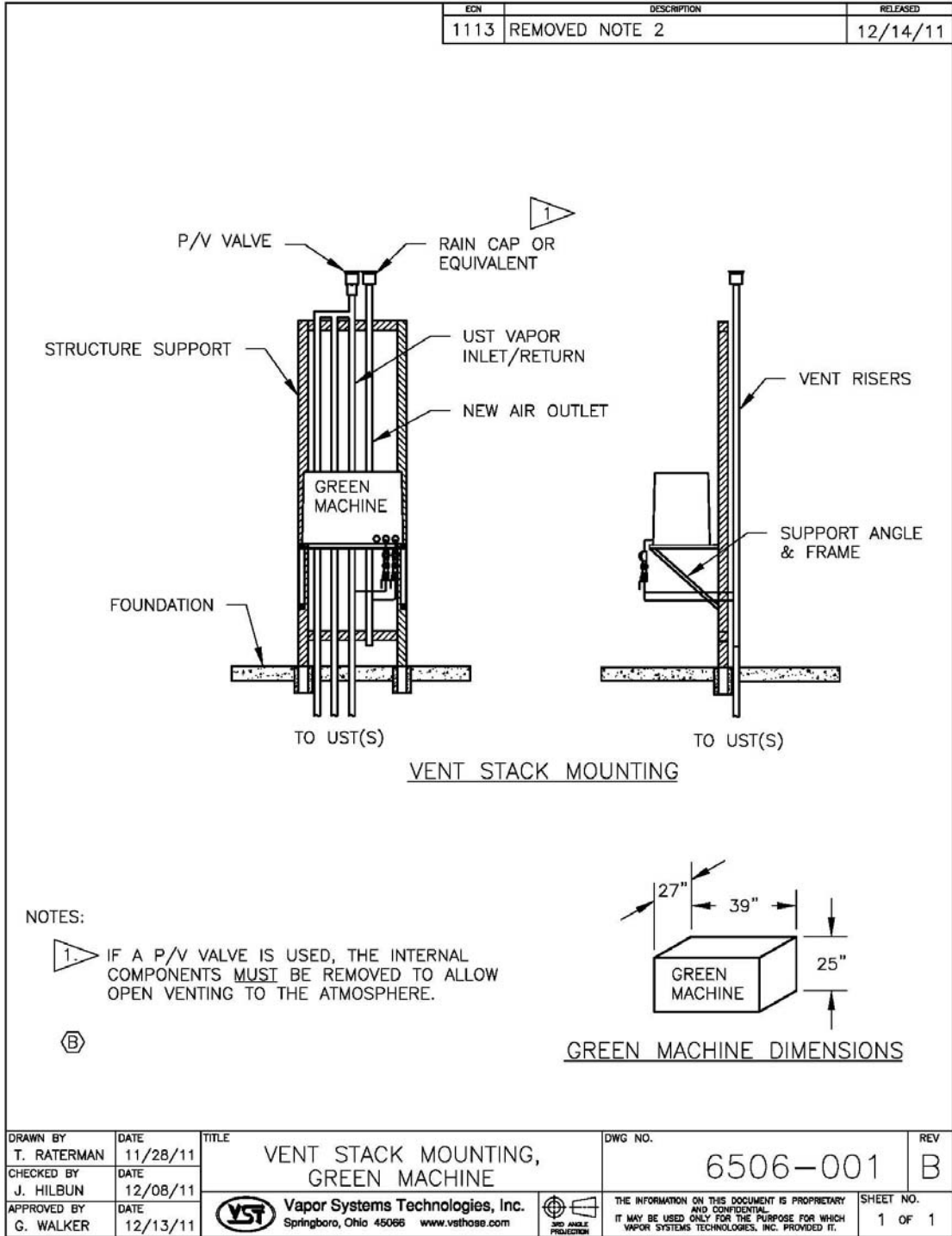


Figure 7: Vent Stack Installation

10 Vapor Piping

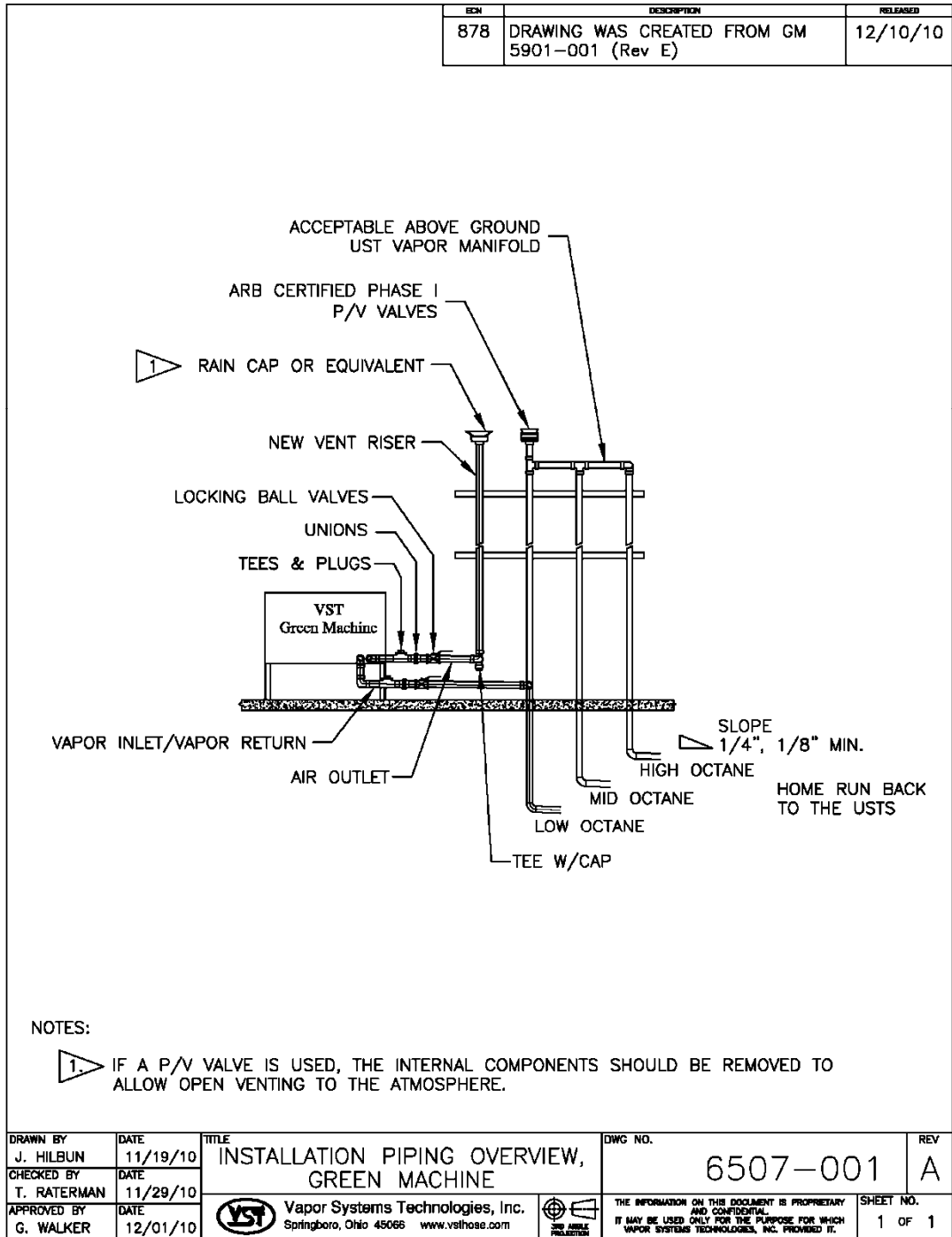


Figure 8: Vapor Piping Overview

Vapor Piping (continued)

- There are 2 piping connections to be made to the *Green Machine*:
 - Vapor inlet/return to the UST vapor-piping system.
 - Air outlet to atmosphere.
- The *Green Machine* piping connections are 1" diameter National Pipe Thread (NPT).

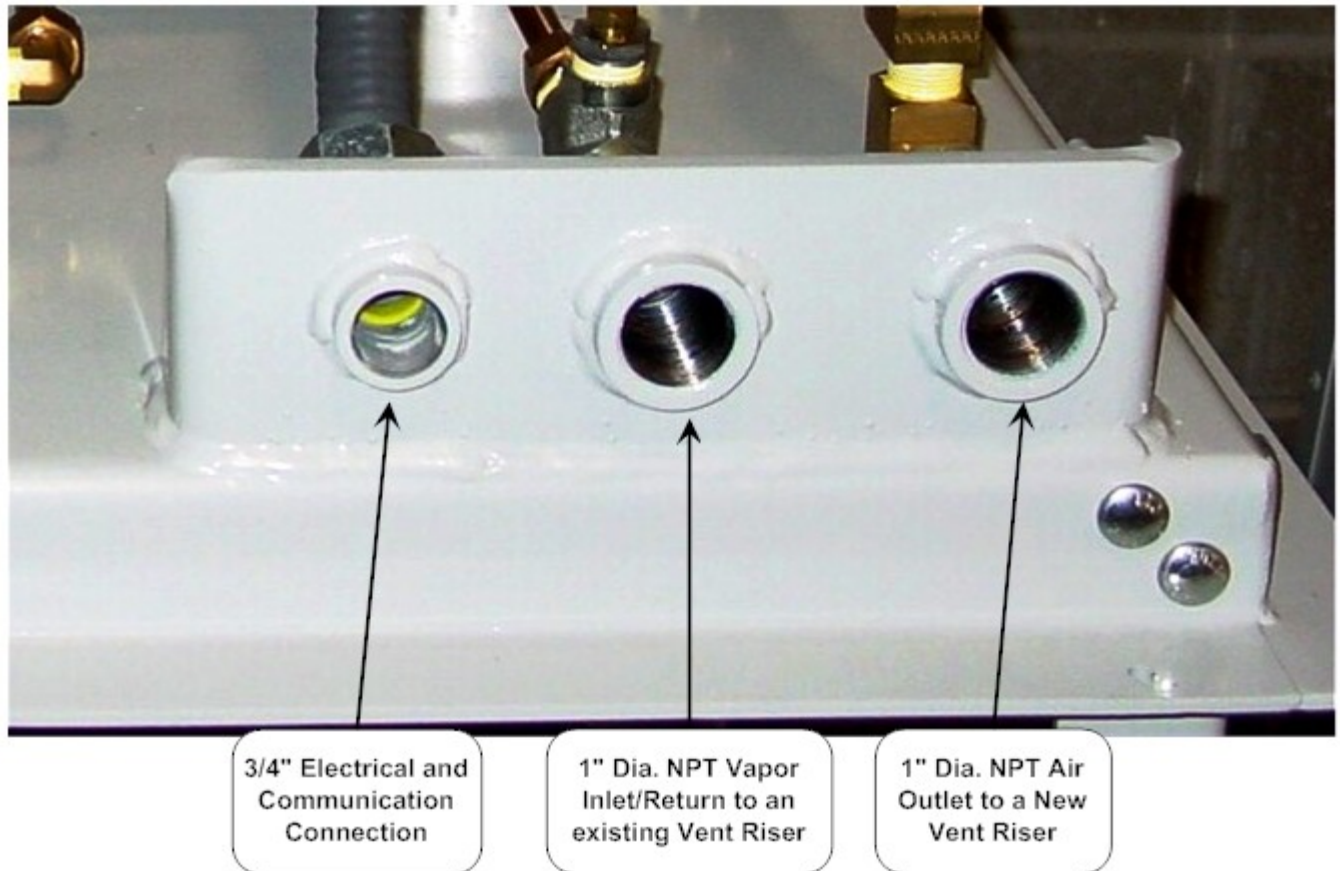


Figure 9: *Green Machine* Connections

10.1 Vapor Piping Installation Instructions

1. Install the vapor air inlet/return piping as shown in **Figure 9** from the vapor inlet/return connections on the *Green Machine* to an existing vent riser.
 - The existing vent riser must be modified by adding a tee for connecting the existing vent riser to the *Green Machine*.
 - The new tee must be installed to allow for slope from the *Green Machine* to the existing vent riser.
 - If there are multiple-grade UST's and multiple vent risers, VST recommends connecting the *Green Machine* to the lowest octane vent riser.

2. Install piping as shown in **Figure 9** from the vapor air outlet to a new vent riser.
 - The new vent riser may be installed next to the existing vent riser.
 - The piping from the *Green Machine* to the new vent riser MUST slope AWAY from the *Green Machine*.
 - Install the new dedicated vent riser so that the discharge opening is a minimum of 12-feet above grade and a minimum of 1" diameter.
 - A rain cap or equivalent must be installed on the new air outlet vent riser. Equivalent: If a PV vent valve is used the internal components must be removed to allow open venting to the atmosphere.
 - Install a tee with a cap at the bottom of the new air outlet vent riser to provide for drainage.

3. If flexible piping is required by the local authority to meet seismic requirements, install the flexible piping between the *Green Machine* locking ball and the vent riser(s).
 - The slope of the flex connection from the *Green Machine* back to the vent riser must be greater than 1/8" per foot slope.
 - The flexible connector must be UL approved for a service station above-ground application.
 - Support the flexible piping per manufacturer's recommendation.
 - The local contractor is responsible for providing all necessary galvanized piping, non-hardening pipe-joint compound, and plumbing fittings.

4. Make sure the gasoline UST tanks vapor piping is manifolded either above ground or below ground.

5. Local jurisdictions require that locks be installed on the cover of the *Green Machine*, on the Safety Disconnect Switch, and on the valves to prevent unauthorized tampering of the equipment.
 - Under normal operation, the valves must be locked in the open position.

10.2 Vapor Piping Post Installation

- After all piping has been installed; make sure the 2 lockable ball valves are in the closed position.
- Make sure all the pipe connections are tight.
- Make sure there is proper slope from the *Green Machine* to the vent risers.
- Make sure there are no traps between the *Green Machine* and the vent risers.
- If flex piping is used, make sure the flexible piping is adequately supported.
- All connections to the *Green Machine* must be galvanized pipe.

10.3 Vapor Piping Bill of Material - Contractor Supplied

Quantity	Component(s)
2	1" diameter straight tee's with caps
2	1" diameter unions
2	1" diameter locking ball valves
1	Straight tee (sized to match existing vent riser)
1	1" x 2" galvanized reducer bushing
1	Straight tee with cap (sized to match new vent riser)
1	Rain cap (on new vent riser)
As required	1" diameter pipe, elbows, and misc. pipe fittings
5	<u>Locks:</u> 2- cover, 2-locking ball vales, 1-control cabinet

11 Electrical

- The VST Control Panel and the electrical junction box inside the *Green Machine* arrive from the factory pre-wired.
- The contractor is responsible for supplying all wires, conduits, fittings, seal-offs, and the safety disconnect-switch.
- Lockable safety disconnect-switch as required by the NEC:
 - Must include an interlock device and wired per included drawings.
 - Must be installed within eye-sight of the *Green Machine*.
 - Must not be installed within 3-feet of the *Green Machine*.
 - Consult the NEC for restrictions, location, and type of disconnect.
 - Not provided by VST.
- The *Green Machine* is installed in a Class I, Division 2 hazardous location and therefore requires electrical seal-offs when connecting to ordinary, non-hazardous electrical locations. Consult the NEC and NFPA for installation instructions.
- All wiring (115 VAC and 24VDC) to be TFFN or THHN with 600V insulation.
- All wiring must be gasoline and oil resistant.
- The contractor is responsible for sizing the wire, cable, and conduit according to the NEC.
- All power (115 VAC and 24VDC), the neutral, and the ground wires connected to the *Green Machine* will be disconnected when:
 - The Emergency Shut-Off (ESO) is activated.
 - The safety disconnect-switch is opened.
 - The VST Control Panel breaker is switched OFF at the main distribution panel breaker.
 - The disconnect switch on the VST Control Panel is turned OFF.

11.1 Electrical Requirements

VST Control Panel Power Requirements					
Equipment	Phase	Voltage	Amperage	Frequency	Fuse/Breaker Size
Main power	1-Phase	115 VAC	20	60-Hz	20 amp breaker
Vacuum Pump Motor	1-Phase	115 VAC	8.8 (See note 1)	60-Hz	10 amp breaker
Control Valves	1-Phase	115 VAC	1.0	60-Hz	5 amp fuse (3 each)
24VDC Power supply	1-Phase	115 VAC	4.0	60-Hz	4 amp fuse
HC Sentry Module	1-Phase	115 VAC	<1.0	60-Hz	
<i>Green Machine</i> Controller		24VDC			Protected by 24VDC power supply

NOTE 1: The 8.8 amp listed is only for the ½ HP, 115 VAC, 1-PH Leeson motor

11.2 Electrical Safety



- The *Green Machine* uses lethal voltages and operates in areas where gasoline vapor may be present.
- Serious injury or death from electrical shock, fire, or explosion may result if the power is ON during installation, testing, or maintenance.
- Be sure to use Lockout/Tag-Out procedures when working on or installing the *Green Machine* or while working on electrical components.
- Always power OFF any electrical components connected to the *Green Machine*. **The *Green Machine* can start automatically.**
- Do not use tools that can generate sparks if there is risk of flammable or explosive vapors being present.
- Read and understand all materials related to installing, testing, and operating the *Green Machine* prior to installation.

11.3 Electrical Installation Code Requirements

- According to NFPA 30:
 - “Electrical wiring and electrical utilization equipment shall be a type specified by and be installed in accordance with NFPA 70. Electrical wiring and electrical utilization equipment shall be approved for the locations in which they are installed.”
- All electrical wiring and electrical utilization equipment must be installed to meet federal, state, and local codes.
- Flexible electrical conduit connections to the *Green Machine* may be required by local jurisdictions to meet seismic code requirements.
- Following such procedures may be required by local, state, and national authorities.
 - The *Green Machine must be installed* in accordance with the National Electric Code (NEC), NFPA 70, and with the Automotive and Marine Service Station Code (NFPA 30A).
 - Intrinsically safe devices must be installed in accordance with Article 504 of the National Electrical Code, ANSI/NFPA 70, for installation in the United States.
 - According to NFPA 30A and the California Fire Code:
“Electrically energized vapor-recovery equipment shall be directly connected to and controlled by the emergency pump shut off in Section 5202.4.7.”

11.4 Electrical Components

Existing Components	VST Supplied Components	Contractor Supplied Components
<ul style="list-style-type: none"> • 115 VAC Main Electrical Panel 	<ul style="list-style-type: none"> • VST Control Panel 	<ul style="list-style-type: none"> • Safety Disconnect Switch with an Interlock
<ul style="list-style-type: none"> • TLS-350 with: <ul style="list-style-type: none"> • Comm Board • Relay Board • I.S. Interstitial Module 	<ul style="list-style-type: none"> • <i>Green Machine:</i> <ul style="list-style-type: none"> • Pre-wired Internal Junction Box 	<ul style="list-style-type: none"> • All conduit
<ul style="list-style-type: none"> • Emergency Shut Off 	<ul style="list-style-type: none"> • HC Sentry 	<ul style="list-style-type: none"> • Electrical Seal-Offs • Wire and Cable
	<ul style="list-style-type: none"> • HC Sentry Interface Cable 	<ul style="list-style-type: none"> • 115VAC relay

11.5 Electrical Installation Procedures

SAFETY PRECAUTION:
PRIOR TO STARTING ANY ELECTRICAL WORK, VERIFY THE BREAKER INSIDE THE PANEL AND THE VST CONTROL PANEL IS LOCKED OUT/ TAGGED OUT, AND VERIFY THAT THE TLS-350 IS IN THE MANUAL OFF MODE.

11.5.1 VST Control Panel Field Wiring Procedure

- See Figures 16 & 17
- Drill holes in the VST Control Panel for all wiring connections.
- Install the VST Control Panel **only inside** the GDF per NEC regulations. The location may vary within the GDF given the allowable space. When possible, place the VST Control Panel as close to the TLS-350 as possible.
- Install or have available a 115 VAC, 20-amp, single-phase breaker in the main distribution panel.
- Make sure the 20-amp breaker inside the distribution panel is turned **OFF** and follow lockout/tagout safety procedures.
- Install the 115 VAC power, the neutral, and the ground from the main distribution panel to the VST Control Panel.
 - The wire labels are:
 - Terminal block 02011 – 115 VAC (hot)
 - Terminal block 02012 – 115 VAC (neutral)
 - Terminal block GND - Ground (Gnd)

11.5.2 VST Control Panel Terminal Block Wire Numbers & Descriptions

Use the terminal blocks and description to field wire the VST Control Panel to the Green Machine and supporting electrical equipment.

CAUTION: Power to the VST Control Panel maybe supplied by multiple 115 VAC external power sources.

External power may exist inside the VST Control Panel when:

1. The main 115 VAC power to the panel is turned OFF.
2. The panel ON/OFF switch is turned OFF.
3. The Safety Disconnect is turned OFF.
4. The ESO is activated or not activated.

Terminal Block 02032 - ESO (115 VAC IN)

Terminal Block 02032 - 4-RELAY MODULE (115 VAC OUT)

Terminal Block 02032 - INTERLOCK (115 VAC OUT)

Terminal Block 02023 - INTERLOCK (115 VAC IN)

Terminal Block 02043 - TLS-350 (115 VAC IN)

Terminal block 02044 – OVERFILL (115 VAC IN)

11.5.3 TLS-350 4-Relay Module: *Machine* RUN and Overfill Alarm Output Relay Wiring Procedure

CAUTION: The GM Run and OVERFILL ALARM output relays inside the TLS-350 4-Relay Module can be powered by a 115 VAC power source inside the VST Control Panel or from an external 115 VAC power source. Refer to the TLS-350 installation manual for connecting to and configuring the correct output relays.

GM Run Output Relay:

- See Figures: 16 & 17 for Option 1, and 18 & 19 for Option 2
- GM Run output relay (N.O.) closes and turns on the Green Machine when the UST pressure increases to 0.2" WC.
- The GM Run output relay can be powered from the VST Control Panel as OPTION 1. or from an external 115 VAC power source as OPTION 2.
- **OPTION 1:** If the GM Run output relay is powered from the VST Control Panel, install two wires from the VST Control Panel to the 4-Relay Module.
 - The wire labels are:
 - Terminal block 02032 – 115 VAC IN
 - Terminal block 02043 – 115 VAC OUT
- **OPTION 2:** Install one wire from the VST Control Panel to the 4-Relay Module if the GM Run output relay is powered from an external 115 VAC power source. The external power source may be from the ESO or another external power source.
 - The wire label is:
 - Terminal block 02043 – 115 VAC OUT

OVERFILL ALARM Run Output Relay:

- See Figures: 16 & 17 for Option 1, and 18 & 19 for Option 2
- The OVERFILL ALARM output relay (N.O.) shuts down the *Green Machine* when a UST reaches max volume level during a fuel drop.
- The OVERFILL ALARM output relay can be powered from the VST Control Panel as OPTION 1. Or from an external 115 VAC power source as OPTION 2.
- **OPTION 1.** If the OVERFILL ALARM output relay is powered from the VST Control Panel, install two wires from the VST Control Panel to the 4-Relay Module
 - The wire labels are:
 - Terminal block 02032 – 115 VAC IN (May not be required if the 03023 - 115 VAC wire was used in the GM Run output relay circuit as described above).
 - Terminal block 02043 – 115 VAC OUT.
- **OPTION 2.** If the OVERFILL ALARM output relay is powered from an external 115 VAC power source, install one wire from the VST Control Panel to the 4-Relay Module. The external power source may be from the ESO or another external power source.
 - The wire label is:
 - Terminal block 02043 – 115 VAC OUT

11.5.4 VST Control Panel to the TLS-350 Intrinsically Safe (I.S.) Bay Wiring Procedure

- **See Figures: 15 & 24**
 - The VST Control Panel uses a current transducer to monitor the vacuum pump motor amperage when the Green Machine is running.
 - If the motor amperage falls below a certain value, a relay closes inside the VST Control Panel, which energizes a relay in the I.S. Bay of the TLS-350.
 - Do not run the wire in any conduit where high voltage is present.
 - Connect the wire to an open liquid sensor channel. If there are not any open channels, an additional module will be required.
 - Program the TLS-350 liquid sensor channel as NORMALLY CLOSED for the channel used (ex. L 8).
 - Give the channel that was used a custom label to identify it as the Green Machine Motor Fault input: “GM Motor Fault.”
 - The TLS will display: “LX: Fuel Alarm” when the GM is in a Motor Fault condition, with “X” being the channel used for the sensor.
 - After the Motor Fault alarm occurs, the printer will show the “GM Motor Fault” label on the automatic printout.
- Install a 2-conductor, shielded, 18 gauge, twisted pair, with a drain wire, cable from the VST Control Panel I.S Bay.
 - Terminate field wiring into TLS Console and connect to Interstitial Sensor Interface Module located in the intrinsically safe wiring compartment of the TLS as shown in Figure 4.
Note: observe polarity! The cable length between the console and sensor must not exceed 1000 feet.
 - Attach the cable shield to the ground lug closest to the conduit entry inside the I.S. Bay.
Do not ground both ends of the shield.
 - Terminal block 07022 – (+)
 - Terminal block 07032 – (-)

CAUTION: Refer to the TLS-350 installation manual for connecting to and configuring the correct output relays.

Note: Intrinsically safe devices must be installed in accordance with Article 504 of the National Electrical

11.5.5 RS422 to RS232 Adapter to TLS-350 RS32 Port Connections

- See Figures 11 - 15
- Per ARB Advisory 355, there must be an available RS232 port for the district inspector to use for downloading data from the TLS-350. Check the TLS-350 to see if there are 2 or more available RS232 serial ports. One DB9 female RS232 port will be found on the required Multi-port MODBUS communication card in the TLS-350. Check to see if there is an additional port on another card available. If there are two or more ports available, use Option A for the connections. This is a direct connection from the Adapter to the TLS-350. If there is only one port available, use Option B for the connections. This connection method uses an RS232 Port Combiner to allow sharing of a serial port.
- The RS422 to RS232 adapter is attached to the top of the VST Control Panel. See figures 12 & 13.
- **OPTION A:** Using the 6 foot RS232 (DB9 Male to Male) serial cable supplied with the VST *Green Machine*, connect one end of the serial cable into the RS232 port on the Adapter located on top of the VST Green Machine Control Panel and the other directly to the TLS-350 Multi-port MODBUS card. Secure these connections. If a longer cable is needed it may be ordered, however the cable length should not exceed 50 feet. Finally set the communications setting for the COM 6 in the TLS-350 to 9600 BPS, 8 data bits, 1 stop bit, No parity. See figure 11.

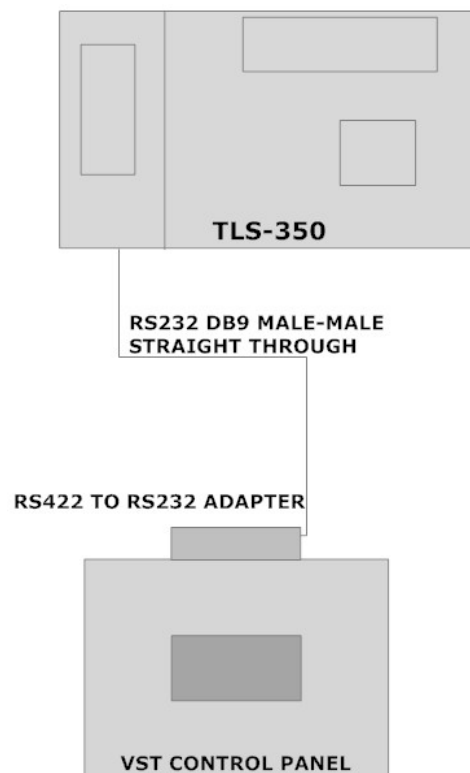


Figure 11: RS422 to RS232 Adapter to TLS-350 Connection - Option A Direct Connection

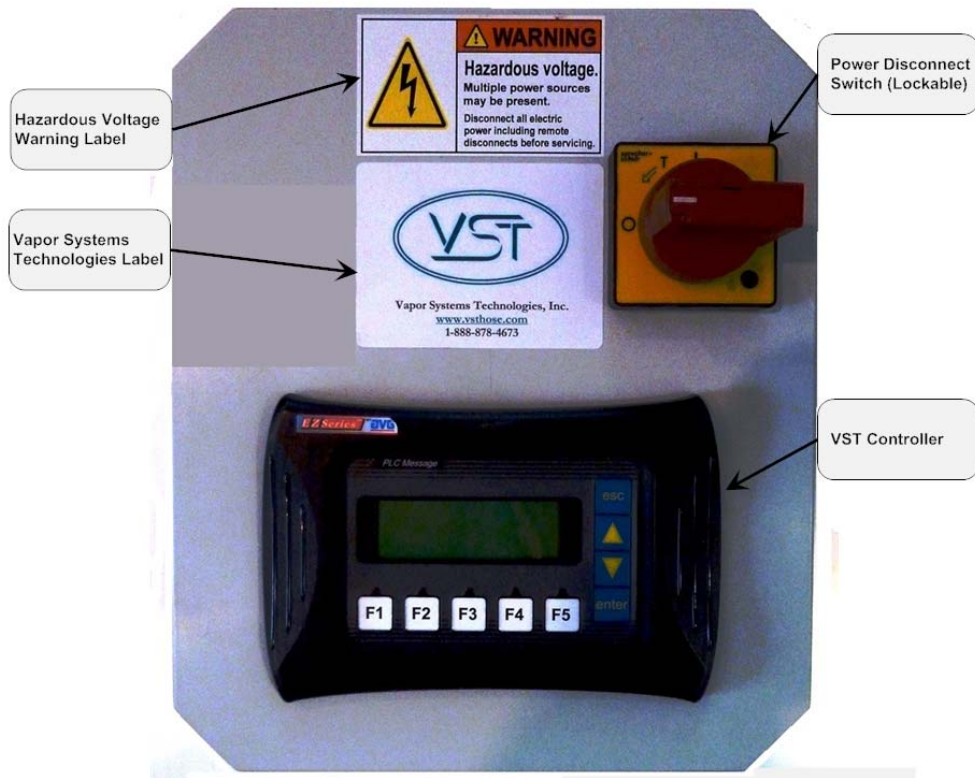


Figure 12: VST Green Machine Control Panel Front View

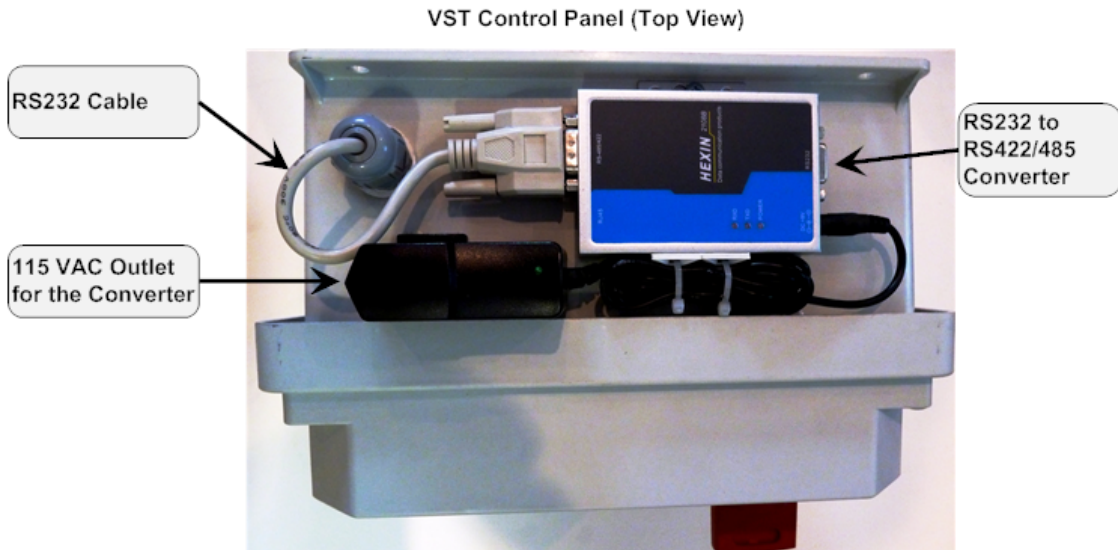


Figure 13: VST Green Machine Control Panel Top View of Adapter

- OPTION B:** If there is not an available communications port for the inspector to use, an RS232 Port Combiner must be used to allow sharing of the serial port. This optional TLS-350 Inspector Port Communications Kit, GM-032, containing an RS232 Port Combiner, an RS232 Null Modem DB9 Male to Male cable, an RS232 Straight Through DB9 Male to Male cable and AC adapter for the Port Combiner must be purchased through VST. The inspector may gain access to the TLS-350 through the Port Combiner's open port.
- Using the 6 foot RS232 Null Modem (DB9 Male to Male) serial cable supplied with the VST *Green Machine*, connect one end of the serial cable into the RS232 port on the Adapter located on top of the VST Green Machine Control Panel and the other into the slave connection on the Port Combiner. If a longer cable is needed it may be ordered, however the cable length should not exceed 50 feet. Connect one end of the RS232 Straight Through DB9 Male to Male cable to the Master port on the Port Combiner and the other end directly to the TLS-350 Multi-port MODBUS card. Secure these connections. This leaves the second slave port open for the inspector's use. Install the Null Modem adapter to this port. Finally set the communications setting for the COM 6 in the TLS-350 to: 9600 BPS, 8 data bits, 1 stop bit, No parity. **See figure 14.**
- Attach the port combiner and its power source next to an available outlet close to the TLS-350. Having the port combiner next to the TLS-350 will be a convenience for the inspector.

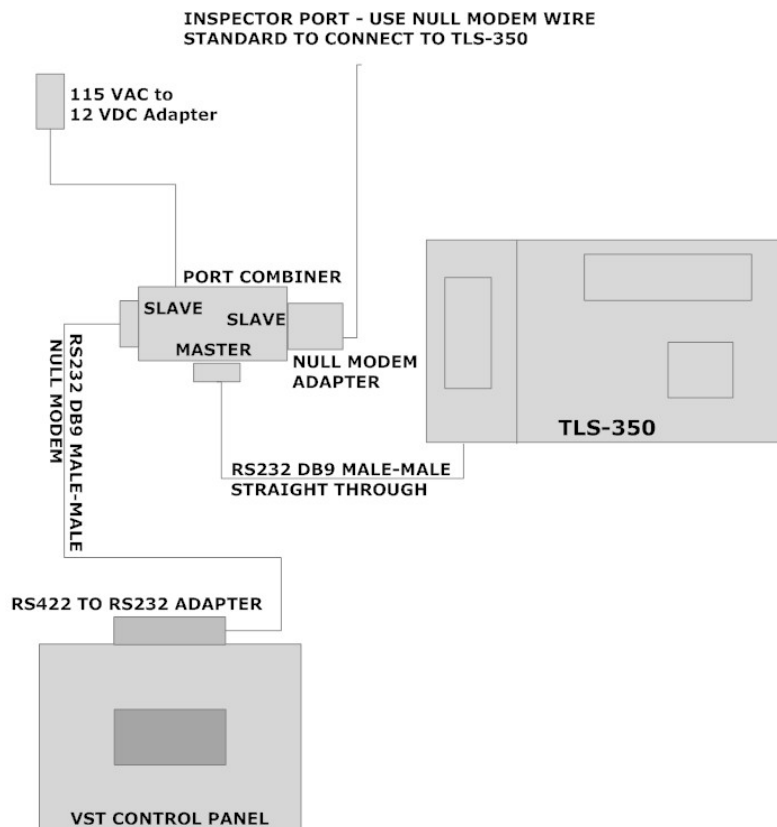


Figure 14: RS422 to RS232 Adapter to TLS-350 Connection - Option B Using a Port Combiner

11.5.6 GDF ESO to the VST Control Panel Wiring Procedure

- **See Figures: 16 & 17 for Option 1, and 18 & 19 for Option 2**
 - The ESO (N.C.), when activated, will turn OFF all power and disconnect the neutral and the ground wires to the *Green Machine*.
 - The ESO wire connecting to the VST Control Panel will be 115 VAC HOT as an external power source.
- Install one wire from the VST Control Panel to the ESO control system output relay.
- The wire label is:
 - Terminal block 02032 - ESO (115 VAC HOT).

CAUTION: “Electrically energized vapor-recovery equipment shall be directly connected to and controlled by the emergency pump shut off in Section 5202.4.7”.

NOTE: The Green Machine will not operate if the ESO is not connected to the VST Control Panel.

11.5.7 VST Control Panel to Safety Disconnect Switch Wiring Procedure

- **See Figures 15 & 20**
- Install 8 wires from the VST Control Panel to the Safety Disconnect Switch
 - 2 wires connect to the interlock switch located in the Safety Disconnect Switch
 - The terminal block label is:
 - Terminal block 02032 - INTERLOCK (+) 115VAC
 - Terminal block 02023 - INTERLOCK (-) 115 VAC
 - Note: The Green Machine will not operate if this circuit is not complete.
 - 5 wires connect to the Safety Disconnect Switch:
 - L1 is for the Vacuum Pump power:
 - Wire number 02052 - VAC PUMP MOTOR (115 VAC HOT).
 - Requires a 10 amp fast acting fuse.
 - L2 is for the V1 Control Valves:
 - Wire number 02062 - V1 VALVES (115 VAC HOT).
 - Requires a 5 amp fast acting fuse.
 - L3 is for the V2 Control Valves:
 - Wire number 02072 - V2 VALVES (115 VAC HOT).
 - Requires a 5 amp fast acting fuse.
 - L4 is for the V5 Control Valves:
 - Wire number 02074 - V5 VALVES (115 VAC HOT).
 - Requires a 5-amp, fast-acting fuse.
 - One ground wire: GND.
 - 1 wire passes through the safety-disconnect switch without any connections:
 - 1 neutral wire.

11.5.8 Safety Disconnect Switch to Internal Junction Box Wiring Procedure

- **See Figures 15 & 21**
- Install 6 wires
 - 6 wires connect to the *Green Machine* Internal Junction Box.
 - L1 is for the Vacuum Pump power:
 - Wire number 02052 - VAC PUMP MOTOR (115 VAC HOT).
 - L2 is for the V1 Control Valves:
 - Wire number 02062 - V1 VALVES (115 VAC HOT).
 - L3 is for the V2 Control Valves:
 - Wire number 02072 - V2 VALVES (115 VAC HOT).
 - L4 is for the V5 Control Valves:
 - Wire number 02074 - V5 VALVES (115 VAC HOT).
 - One neutral wire: 02042 - Neutral.
 - One ground wire: Gnd.

11.5.9 HC Sentry Wiring Procedure

- Install a 2-conductor, 24 gauge (minimum), twisted pair, with a drain wire, shielded cable from the VST Control Panel to the HC Sentry Interface Module.
 - **See Figures 15 & 23**
- Install the HC Sentry Interface Cable from the HC Sentry to the TLS-350 Multiport Card/Communication Port.
 - **See Figures 15 & 23**

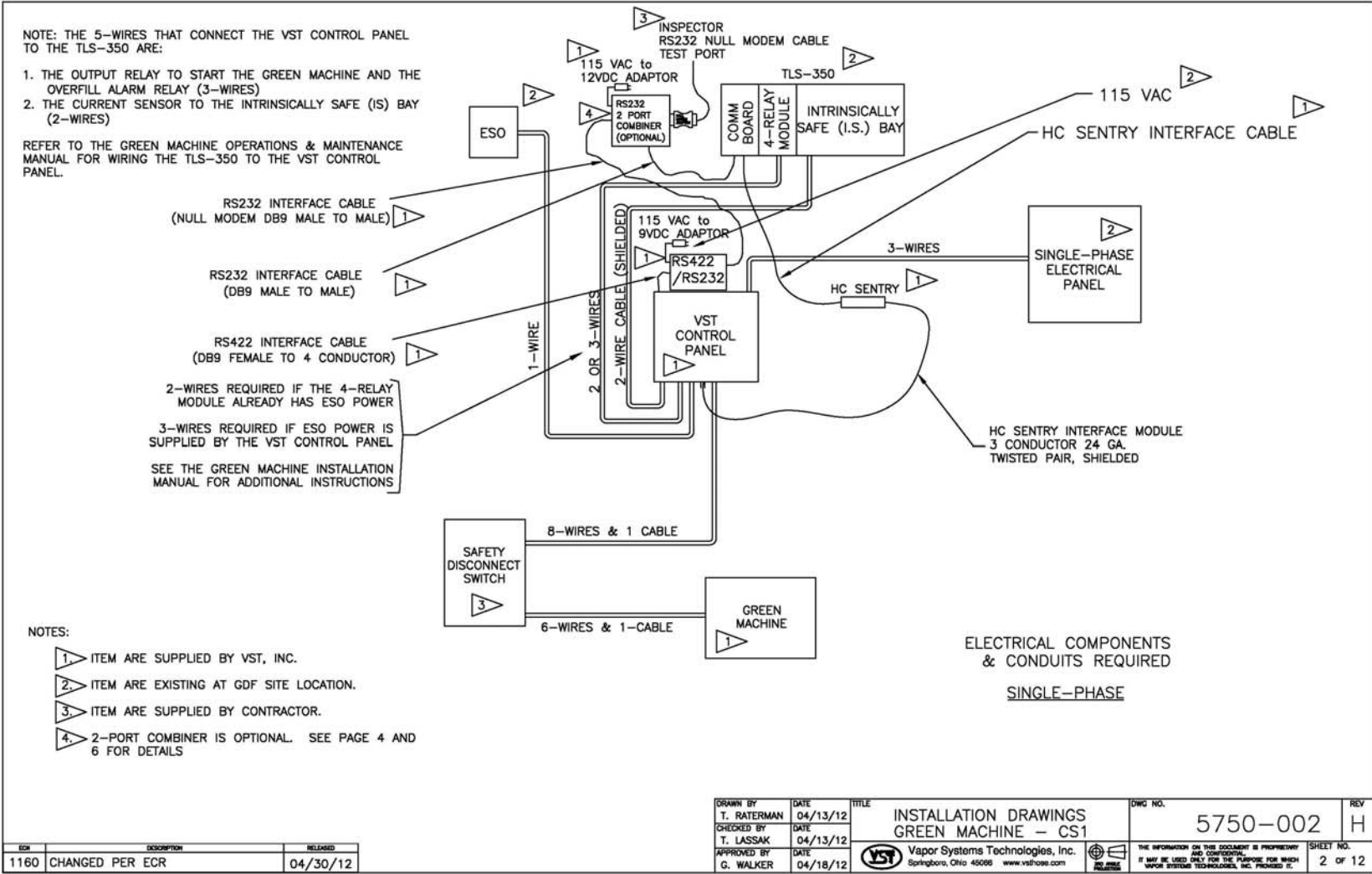


Figure 15: VST Control Panel Wiring Diagram

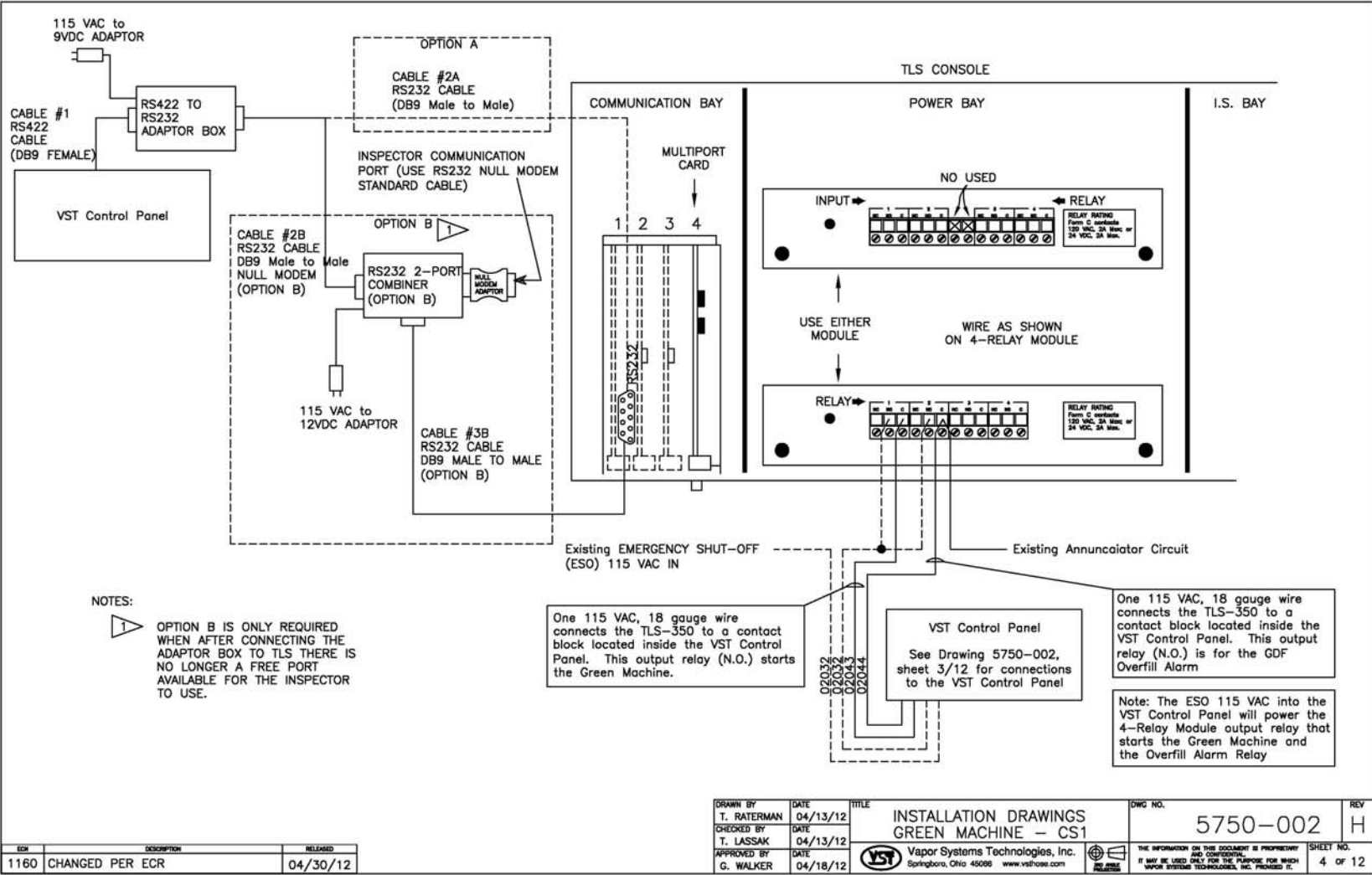


Figure 17: Field Wiring the TLS-350 4-Relay Module for the ESO, GM Run, and Overfill Alarm, Option 1

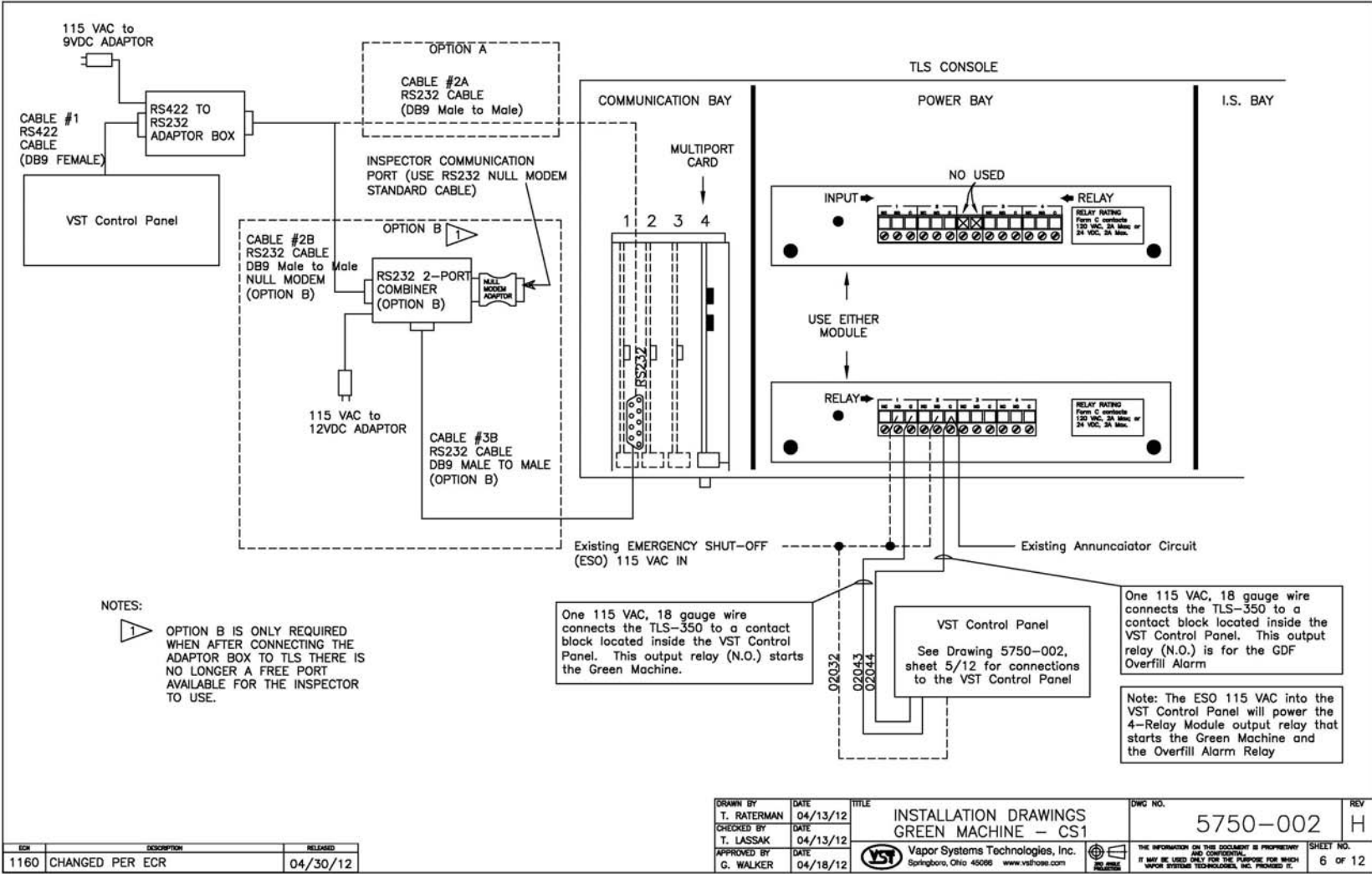


Figure 19: Field Wiring the TLS-350 4-Relay Module for the ESO, GM Run, and Overfill Alarm, Option 2

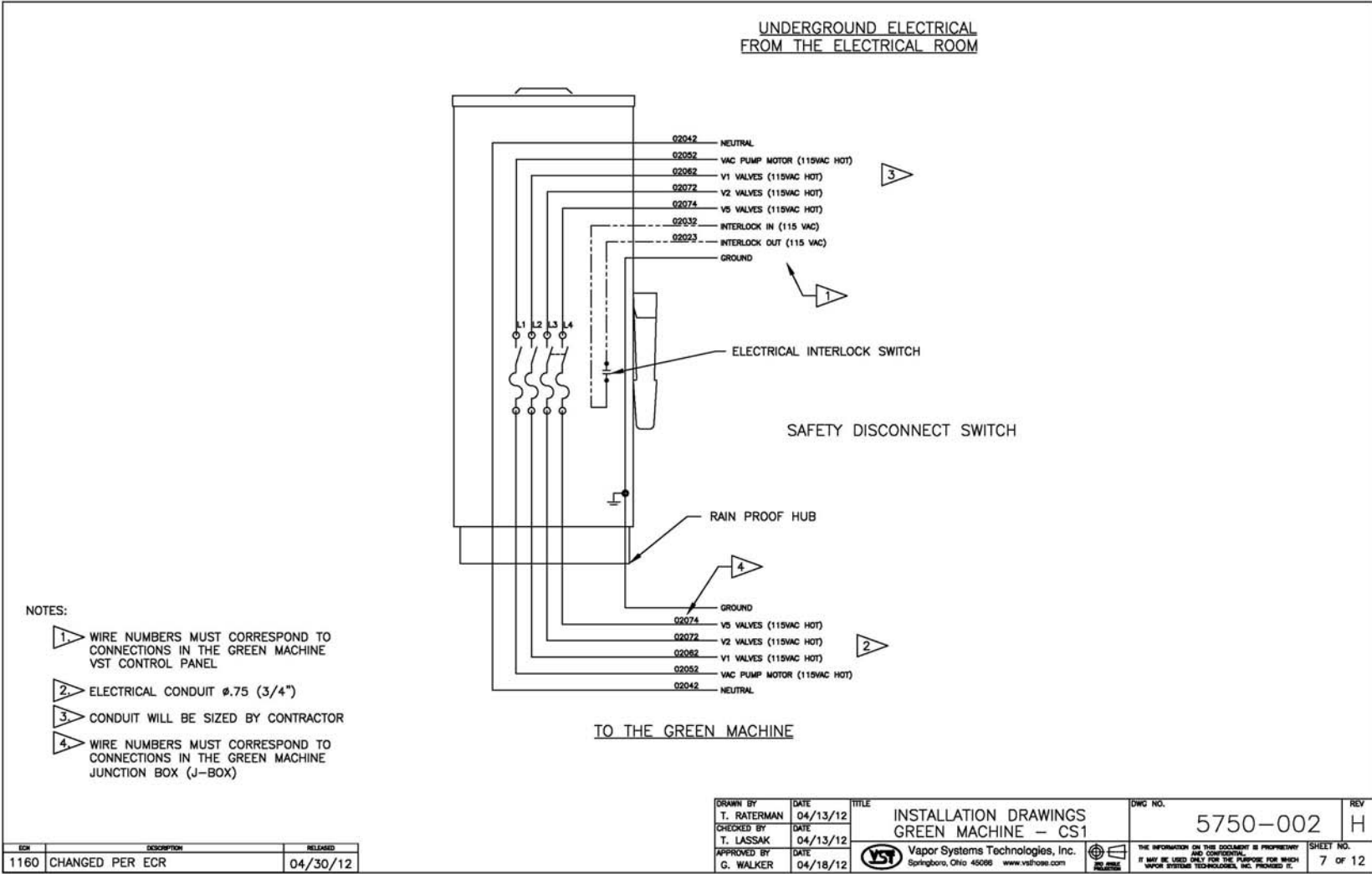


Figure 20: Safety Disconnect Switch Field Wiring Diagram

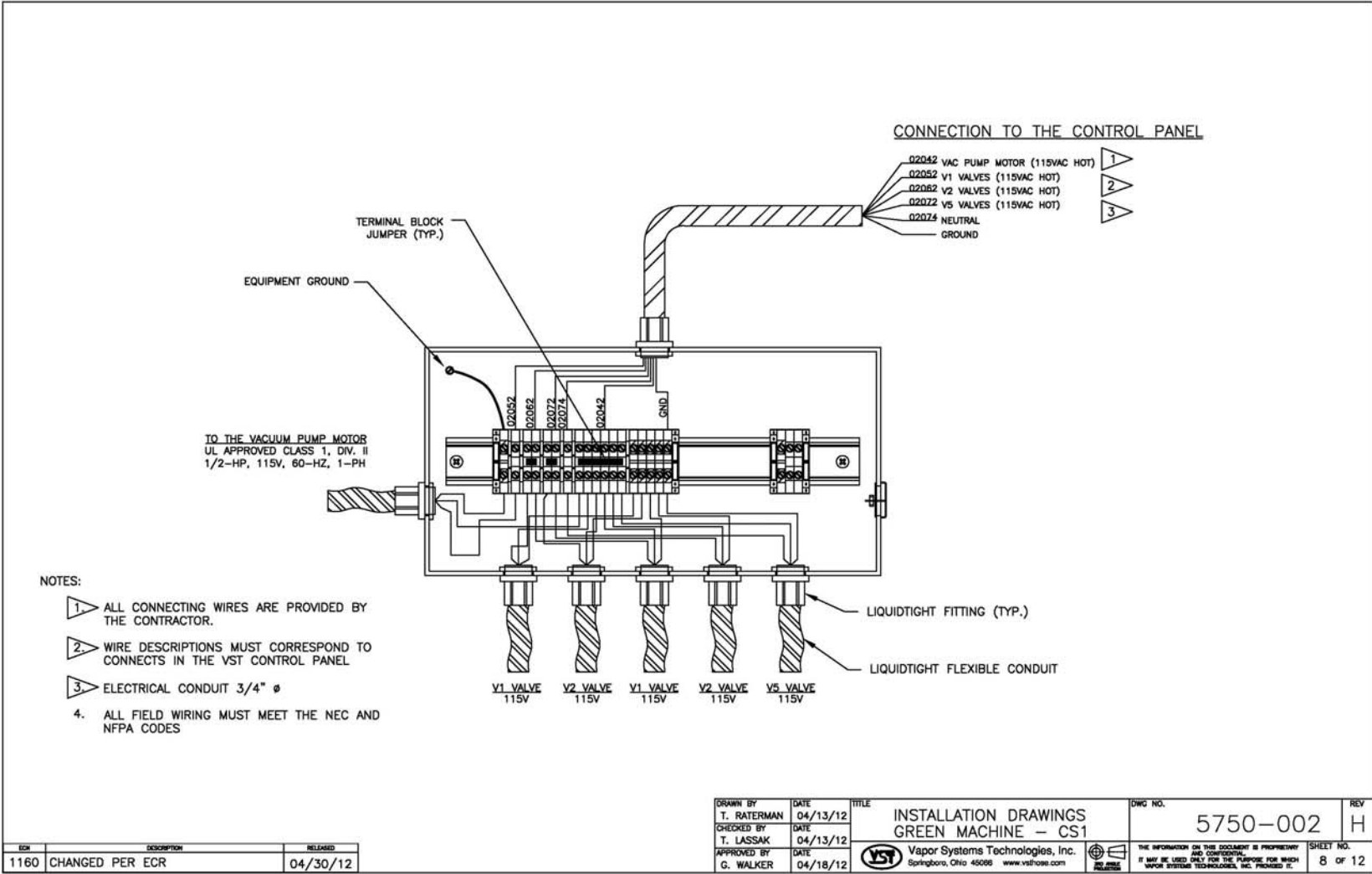


Figure 21: Green Machine Junction Box Field Wiring Diagram

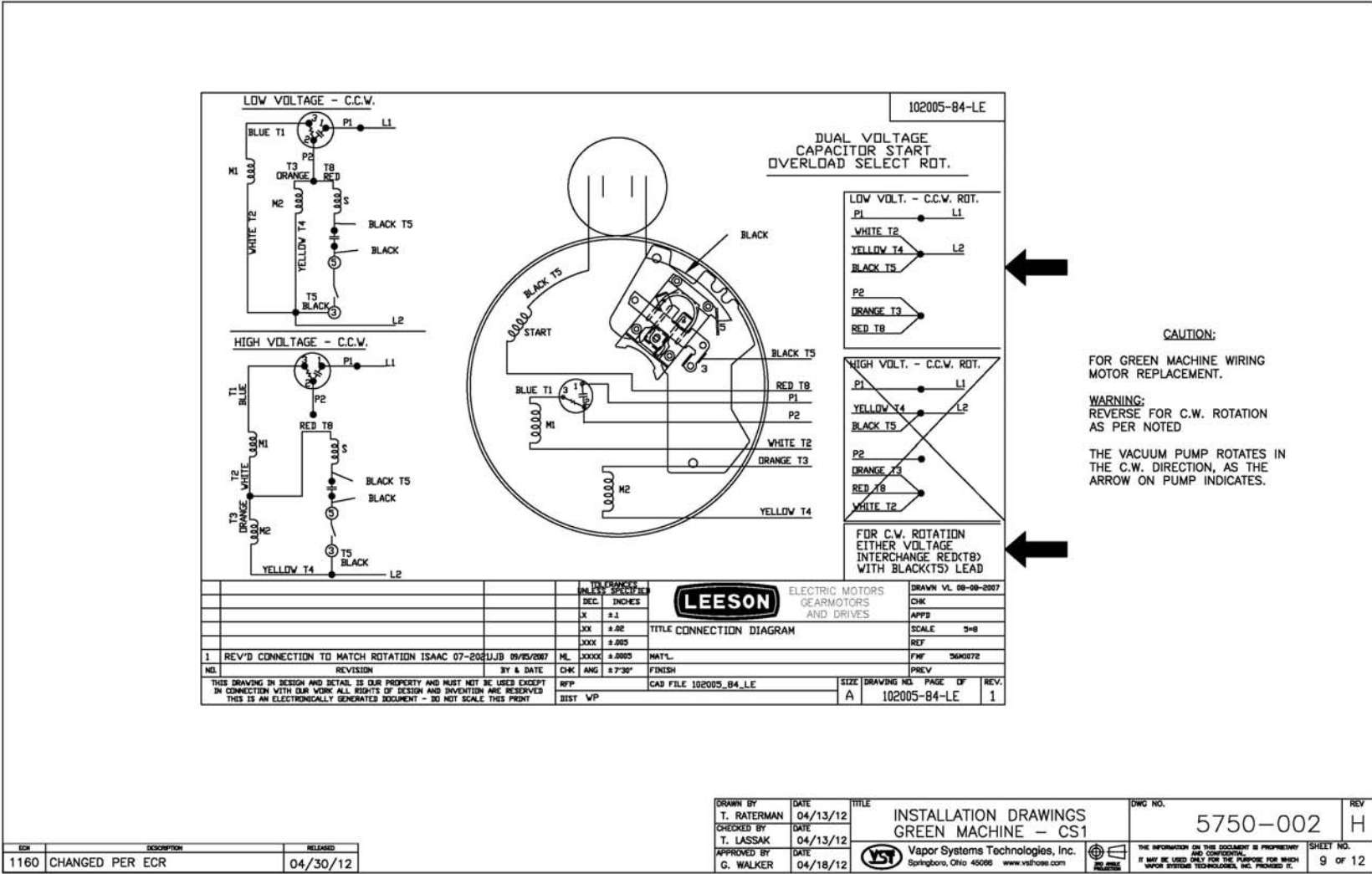


Figure 22: Vacuum Pump Motor Wiring Diagram

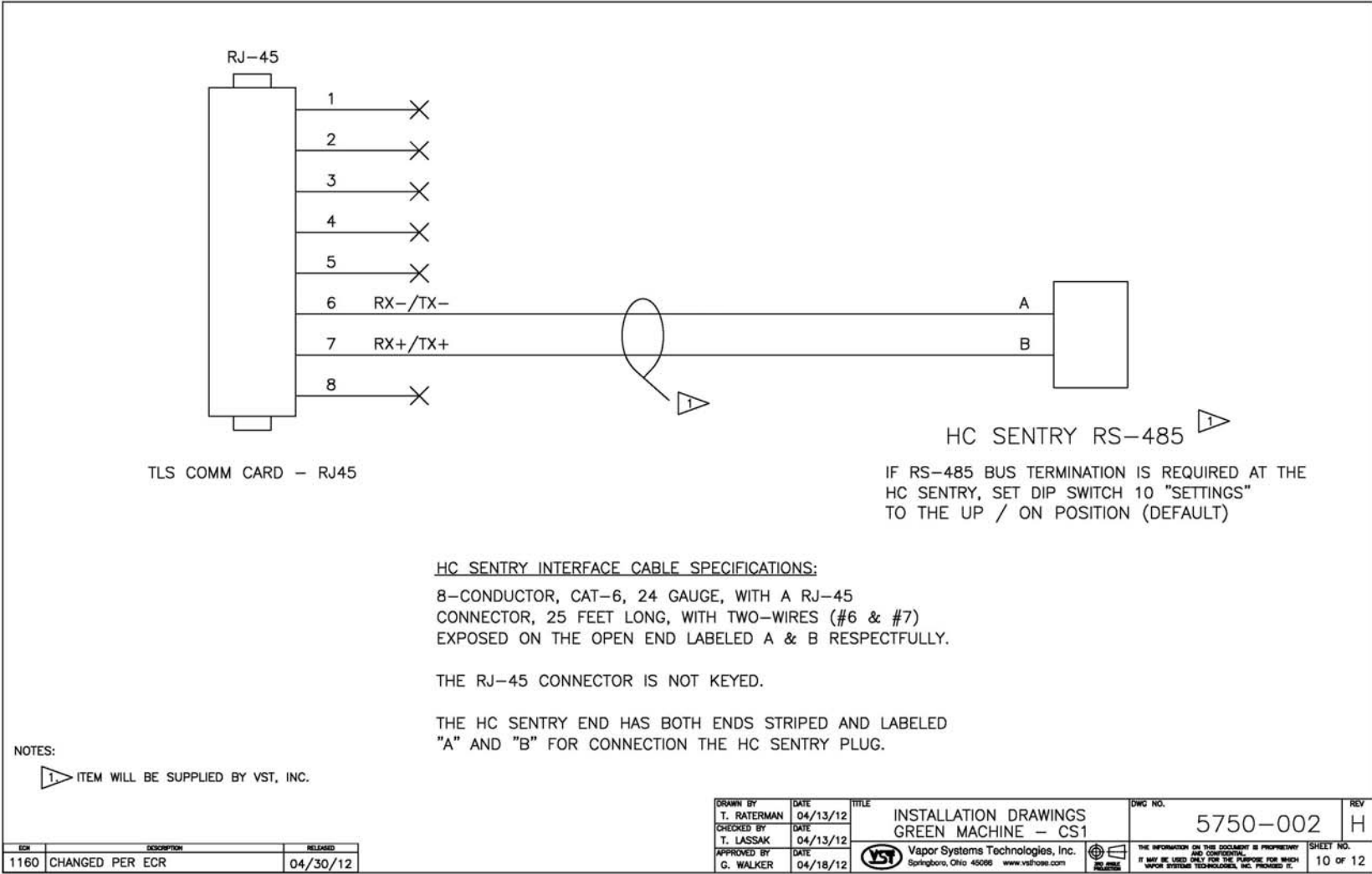


Figure 23: HC Sentry Interface Cable Connections

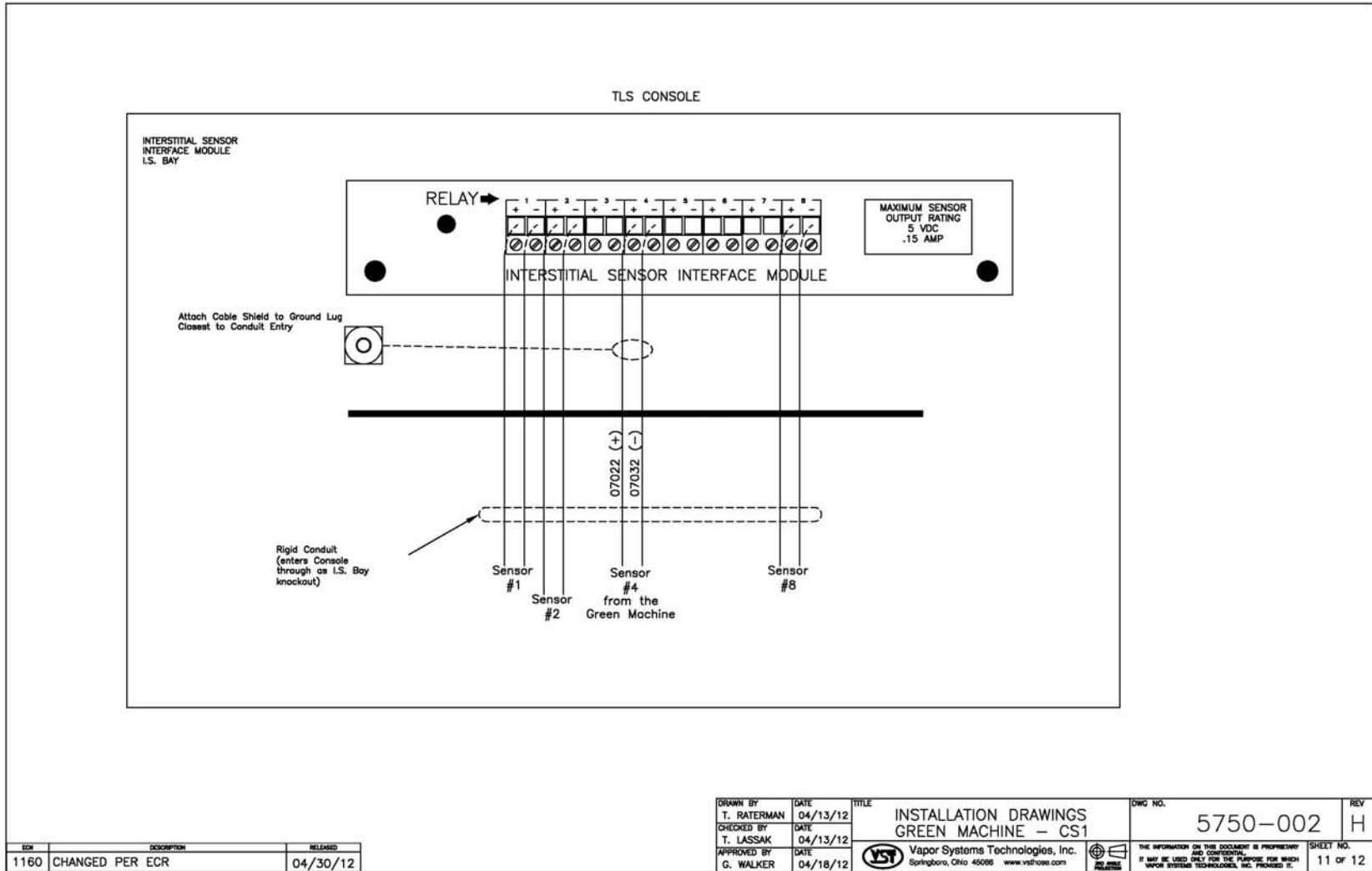


Figure 24: Field Wiring the TLS-350 Interstitial Sensor Interface Module – I.S. Bay

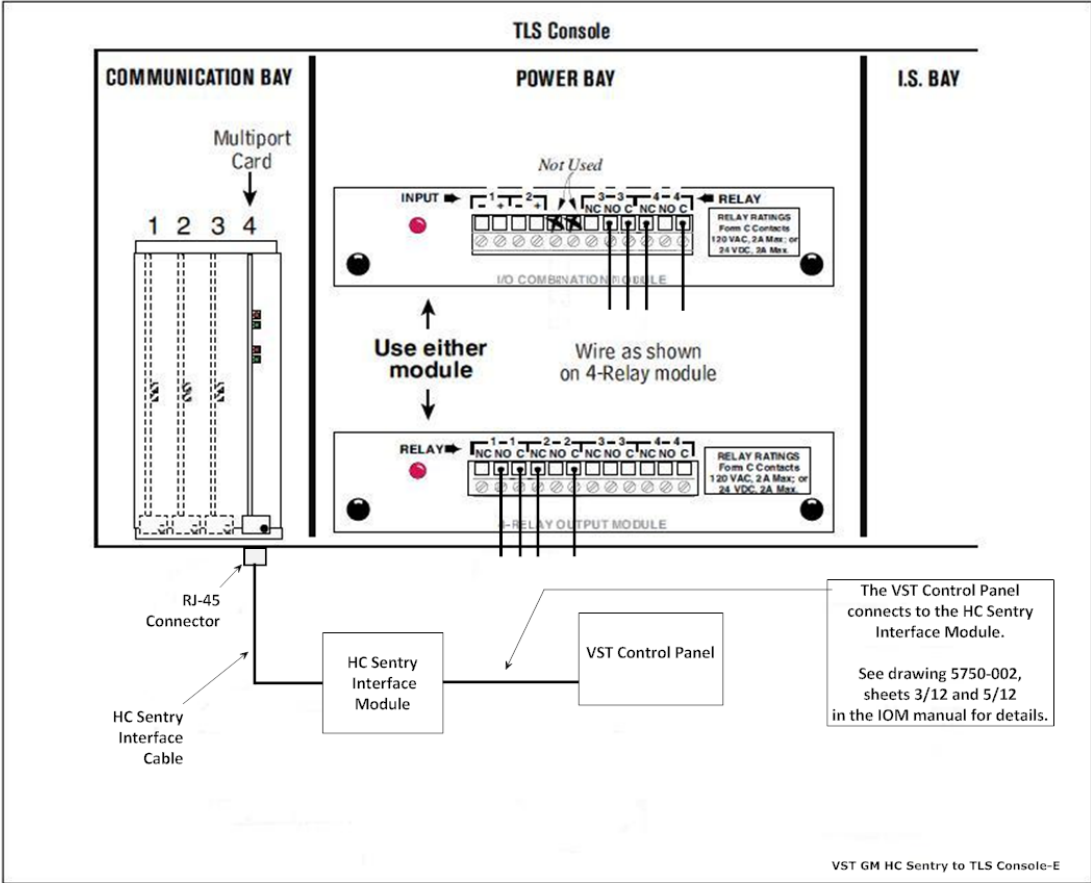


Figure 25: HC Sentry to TLS-350 Connections

12 VST Control Panel

The VST Control Panel is designed to manage the operation of the *Green Machine* based on input from the TLS-350, which is managing the UST vapor pressure. **Figure 26** shows the front of the Control Panel with the following items:

- The *Green Machine* controller:
 - Operates the *Green Machine* based on UST vapor pressure
- The electrical Power ON/OFF disconnect switch:
 - The electrical switch provides a means to turn OFF and disconnect the “main” power from the Control Panel.
 - CAUTION: THIS CONTROL PANEL MAY HAVE FOUR (4) 115 VAC POWER SUPPLY CONNECTION POINTS IDENTIFIED BY YELLOW TERMINAL BLOCK AND HOT WIRES INSIDE THE CONTROL PANEL. FAILURE TO DISCONNECT THE FOUR POWER SUPPLY CONNECTION POINTS BEFORE SERVICING COULD RESULT IN DEATH OR SERIOUS INJURY.
 - Can be locked in the OPEN or CLOSED position (lockout/tagout procedures).

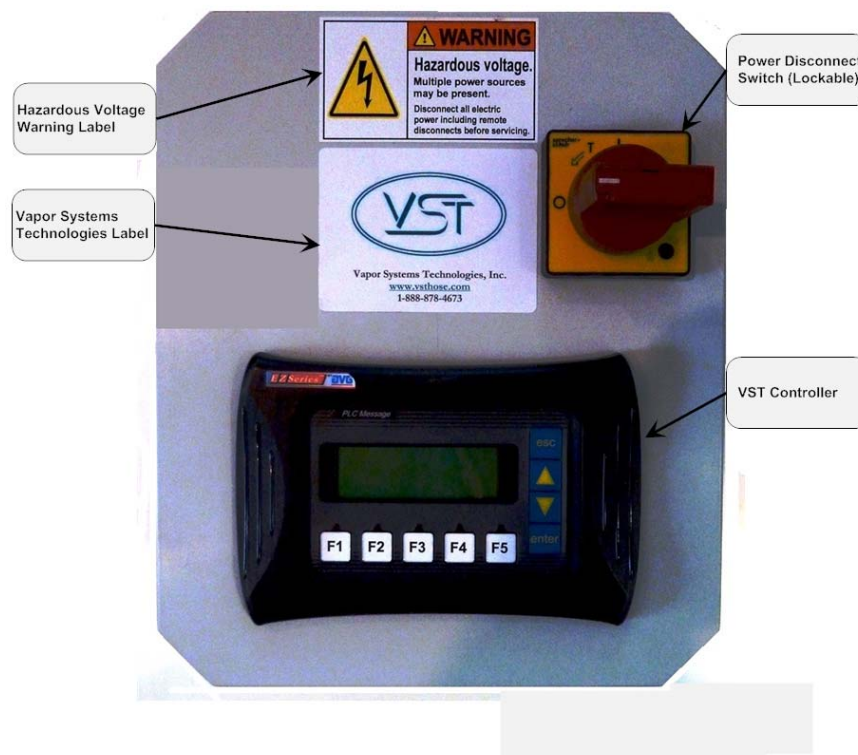


Figure 26: VST *Green Machine* Control Panel, Front View

12.1 Start up Screen and Function Buttons

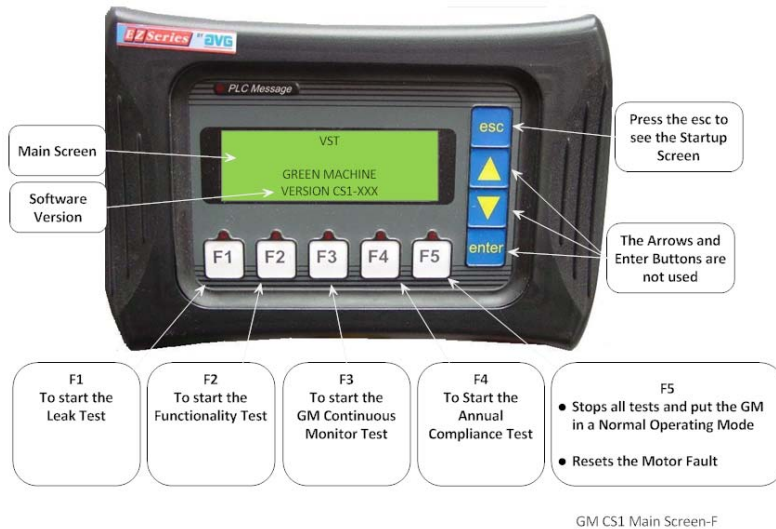


Figure 27: Startup Screen and Function Buttons

12.1.1 Main Screen Overview

- The *Green Machine* will always power up in the Main Screen
- The *Green Machine* will always be in the NORMAL OPERATING mode unless there is an Overfill Alarm or a test is being conducted.
- The *Green Machine* Modes:

ON Mode	Screen display: <i>Green Machine</i> ON
PURGE Mode	Screen display: <i>Green Machine</i> ON
As required, the OFF Mode	Screen display: <i>Green Machine</i> OFF

- Function Buttons

F1	To start the Leak Test
F2	To start the Functionality Test
F3	To start the GM Continuous Monitor Test
F4	To start the <i>Green Machine</i> Annual Compliance Test
F5	<ul style="list-style-type: none"> • To terminate testing & return the <i>Green Machine</i> to a NORMAL OPERATING mode • Reset the Motor Fault

- The esc button:
 - Push the esc button the first time to access the Startup screen.
 - Push the esc button a second time to return to the previous screen.
 - The esc button can be used at any time.

12.2 The Green Machine ON Screen



Figure 28: Green Machine ON Screen

- The *Green Machine* ON screen indicates the *Green Machine* is in either a ON mode or a PURGE mode. The *Green Machine* ON screen will be shown when the TLS-350 Output Relay (that starts the *Green Machine*) is closed.

12.2.1 Green Machine in the ON Mode

The VST Controller is programmed to start the *Green Machine* when the TLS output relay closes. The TLS-350 output relay closes when:

- The *Green Machine* is in the Automatic mode at the TLS-350 and the UST pressure is above 0.2" WC.
- The *Green Machine* is in the Manual ON mode at the TLS-350.

When the *Green Machine* is in the ON mode:

- Gasoline vapors are being pulled into the *Green Machine* from the USTs.
- The UST pressure is decreasing.
- The Vapor Filtration Cartridge is collecting hydrocarbons.
- Clean air is venting to atmosphere.
- There is not an Overfill Alarm condition.
- There is not a Motor Fault.
- Tests are not being conducted.
- After the ON mode is completed, the *Green Machine* will go into the PURGE mode.

12.2.2 Green Machine in the PURGE Mode:

The PURGE Mode will be active regardless of the TLS-350 output relay being opened or closed.

- The PURGE mode is controlled by the *Green Machine* VST Controller.

When the *Green Machine* is in the PURGE mode:

- Hydrocarbons are being returned to the UST.
- Zero airflow to atmosphere out of the Clean Air Outlet.
- There is not an Overfill Alarm condition.
- There is not a Motor Fault.
- Tests are not being conducted.
- Normally, when the PURGE mode is completed, the *Green Machine* will return to the Off Mode.

12.3 Green Machine OFF Screen



Figure 29: *Green Machine OFF* screen

- The OFF mode screen will be shown after the PURGE mode is completed, and when the TLS-350 output relay is open.

The TLS-350 output relay is open when:

- The *Green Machine* is in the Automatic mode at the TLS-350 and the UST pressure is below 0.2" WC.
- The *Green Machine* is in the Manual OFF mode at the TLS-350.
- If there is an Overfill Alarm condition:
 - The *Green Machine* will not operate and will remain OFF for 2-hours after the Overfill Alarm clears.

When the *Green Machine* is OFF:

- The Vacuum Pump is not running.
- All valves are closed.
- Clean air is not being vented to atmosphere.
- UST pressure is not reducing.
- Testing can be performed.
- An Overfill Alarm condition may exist.
- A Motor Fault condition may be active.

12.4 TLS-350 Operations Overview

- A NORMAL OPERATING mode is when the *Green Machine* is in the Automatic mode at the TLS-350.
- The *Green Machine* cycles through the ON and PURGE modes to reduce UST pressure.

12.4.1 TLS-350 4-Relay Module Information

- The TLS-350 has two sets of output relays that connect to the VST Control Panel:
 1. The output relay that starts the *Green Machine*.
 2. The OVERFILL ALARM output relay.

- Output relay that starts the *Green Machine*
 - The *Green Machine* is in the Automatic mode or the Manual ON mode at the TLS-350.
 - In the Automatic mode: This output relay is open when the UST pressure is below 0.2” WC and closed when the UST pressure is above 0.2” WC.
 - In the Manual ON mode: This relay will remain closed.
 - In the Manual OFF mode: This relay will remain open.

- OVERFILL ALARM output relay
 - The OVERFILL ALARM output relay is normally open when there is not an OVERFILL ALARM condition.
 - If there is an OVERFILL ALARM, the OVERFILL ALARM output relay closes which will keep the *Green Machine* from operating.
 - In an OVERFILL ALARM condition, the *Green Machine* will not operate in the AUTOMATIC mode, MANUAL ON mode, or in any test conditions.
 - The *Green Machine* will remain OFF for 2-hours after the OVERFILL ALARM clears.
 - See the OVERFILL ALARM summary in this document for more information.

12.4.2 TLS Intrinsically Safe (I.S.) Bay Information

- The TLS-350 Intrinsically Safe (I.S.) Bay should have an Interstitial Sensor Interface Module installed with an open channel/port for use with the *Green Machine*. If an open channel/port is not available, an interstitial sensor interface module will need to be purchased and installed in the Intrinsically Safe Bay per Veeder-Root instructions in Section 12 – “Installing TLS Console Modules”.
- The Current Sensor will connect the open relay through an intrinsically safe barrier located in the VST control panel.
- When the Vacuum Pump Motor Faults:
 - The relay will close and post an ALARM to the TLS.
 - Will not shutdown the GDF.
 - Will not have to Clear Test After Repair.

12.5 Overfill Alarm



Figure 30: Overfill Alarm Screen

Whenever there is a UST gasoline Overfill Alarm at the station, the TLS-350 is configured to alarm.

1. The Veeder Root TLS-350 Fuel Management System has a Tank Overfill Alarm output relay wired to the VST Control Panel.
 - An overfill condition exists when during a fuel drop, the gasoline level in the UST exceeds the Overfill Alarm setting, which is usually between 90-95% capacity of the UST.
2. When an overfill occurs, the OVERFILL ALARM output relay closes at the TLS-350.
3. The VST Control Panel Controller senses when the Overfill Alarm output relay closes:
 - The *Green Machine* will turn OFF if it is running.
 - Prevents the *Green Machine* from starting if it is not running.
4. When the gasoline level drops below the Overfill Alarm level:
 - The TLS-350 Overfill Alarm output relay opens and the alarm clears.
 - A VST Control Panel 2-hour overfill timer starts to countdown.
5. When the 2-hour overfill time elapses, the *Green Machine* will PURGE for 15-minutes
6. When the PURGE mode ends, the *Green Machine* goes into a NORMAL OPERATING mode provided the *Green Machine* is in the Automatic mode at the TLS-350.

An Overfill Alarm condition:

- Blocks the testing function buttons.
- Ends any tests that may be running.
- Ends the ON mode or PURGE mode during a NORMAL OPERATING cycle.

12.6 Motor Fault

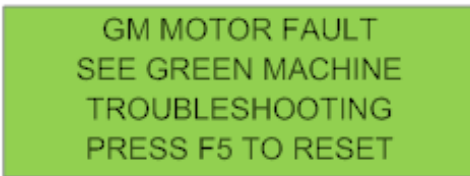


Figure 31: Motor Fault Screen

The VST Control Panel is equipped with a current transducer that samples the vacuum pump motor current during the Purge cycle.

1. If the motor current is below set a value for at least 60 seconds a motor fault is created.
 - The motor fault closes an intrinsically safe relay contact inside the VST Control Panel that is connected to the TLS-350 intrinsically safe (I.S.) bay via an intrinsically safe circuit.
 - The Green Machine will turn OFF and remain OFF until the F5 button is pushed.
 - A Motor Fault is then displayed on the controller.
2. Once a motor fault has occurred, the fault can be cleared by pressing F5 on the VST Control Panel controller.
3. When the motor fault is reset via F5, the Green Machine will automatically go into the purge cycle.
4. After the purge cycle is successfully completed without a motor current fault, the Green Machine is now able to go into the Run cycle if the TLS is providing the signal to do so.

CAUTION: With the motor fault active, the Green Machine will remain OFF until the F5 button is pushed.

12.7 VST Control Panel Test Buttons

- **F1 - Leak Test**
 - Refer to this manual for the testing procedure.
- **F2 - Functionality Test**
 - Refer to this manual for the test procedure.
- **F3 - GM Continuous Monitor Test**
 - Refer to the VR-203 and VR-204 Exhibit 15 for the testing procedure.
- **F4 - Annual Compliance Test (GM Bag Test)**
 - Refer to the VR-203 and VR-204 Exhibit 15 for the testing procedure.

13 Green Machine Pre Start-Up Testing

13.1 Check PMC/ISD Settings on the TLS-350

- Prior to starting the *Green Machine*, make sure the proper Veeder-Root software for the *Green Machine* has been installed on the TLS-350: PMC = 1.04 or higher; ISD = 1.05 or higher.
- See **PMC only** parameter settings in Veeder-Root manual:
 - Smart sensor setup
 - Output relay setup
 - PMC setup
- See **ISD** parameter settings in Veeder-Root manual:
 - Smart sensor setup
 - EVR/ISD setup
 - Output relay setup
 - PMC setup

13.2 Green Machine Post-Installation Start-Up Tests

- During post-installation testing, the *Green Machine* will use outside air, not gasoline vapor from the USTs, to conduct these tests.
 - Functionality Test
 - Leak Test
- VST *Green Machine* Annual Compliance Tests, Exhibit 15:
 - GM Bag Test - uses gasoline vapor from the USTs
 - Continuous Monitor Test
- During post-installation testing, the *Green Machine* will use gasoline vapor from the USTs to conduct this test.
 - Determination of VST *Green Machine* Activation Pressure - VR-203/204, Exhibit 9.

13.3 Functionality Test

Purpose of the Test

- To verify that the valves and the Vacuum Pump are operating properly.

Preparation

- Put the *Green Machine* in the Manual OFF mode at the TLS-350.
- Push the F5 button to make sure no other tests are running.
- The *Green Machine* is now OFF and will not operate.
- Make sure power is **ON** to the VST Control Panel.
- Close the two valves between the *Green Machine* and the vent risers, and remove the caps from both of the tees.

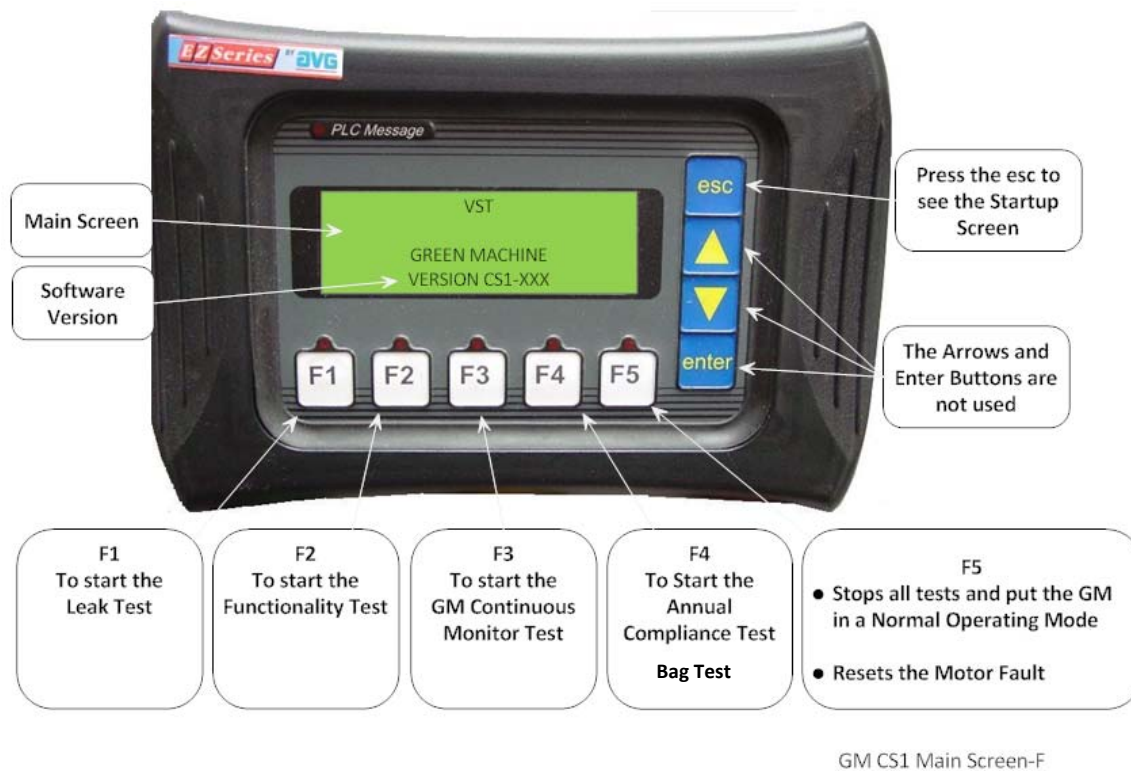


Figure 32: Functionality Test Screen

Testing Procedures

- Push the F2 button to start the Functionality Test (**See Figure 32**)
 - The *Green Machine* will RUN for 60-seconds then PURGE for 60-seconds, (this is one cycle).
 - The *Green Machine* will continue to cycle 5-times or until the F5 button is pushed to end the test.
 - There are 5-cycles to provide enough time to conduct the test.
 - Pushing the F5 button will cancel the test and the screen will show *Green Machine OFF*.

2. During the 60-second RUN mode: **(See Figure 33)**
 - Place your hand over the tee opening at the vapor inlet and feel for suction
 - Next, place your hand over the tee opening at the air outlet and feel for air blowing
3. During the 60-second PURGE cycle: **(See Figure 33)**
 - After the PURGE cycle has begun, place your hand over the tee opening at the vapor inlet and feel for air blowing. The blowing air will reduce to zero flow soon after the PURGE cycle begins.
 - Next, place your hand over the tee opening at the air outlet and feel for zero airflow.
4. If all the conditions hold true for the above test, the valves and the Vacuum Pump are working as expected.
5. Continuous airflow during the PURGE cycle would indicate a leak in the *Green Machine* internal system:
 - Push the F5 button to end the Functionality Test and the screen will show *Green Machine OFF*.
 - Conduct a Leak Test, as shown in this IOM, to find where the leak is occurring.
6. After 5-cycles are complete, the Functionality Test has ended:
 - The *Green Machine* Controller will automatically go back to the *Green Machine OFF* screen.
 - Open the two ball valves between the *Green Machine* and the vent risers, and replace the caps on the two tees.
 - Put the *Green Machine* in the Manual ON mode at the TLS-350.

CAUTION: DO NOT PUT THE GREEN MACHINE IN THE MANUAL ON MODE AT THE TLS-350 UNTIL THE VALVES BETWEEN THE GREEN MACHINE AND THE VENT RISERS ARE OPENED. PUTTING THE GREEN MACHINE IN THE MANUAL ON MODE, WHEN THE VALVES ARE CLOSED, WILL NOT ALLOW THE GREEN MACHINE TO OPERATE PROPERLY AND MAY CAUSE DAMAGE TO INTERNAL COMPONENTS.

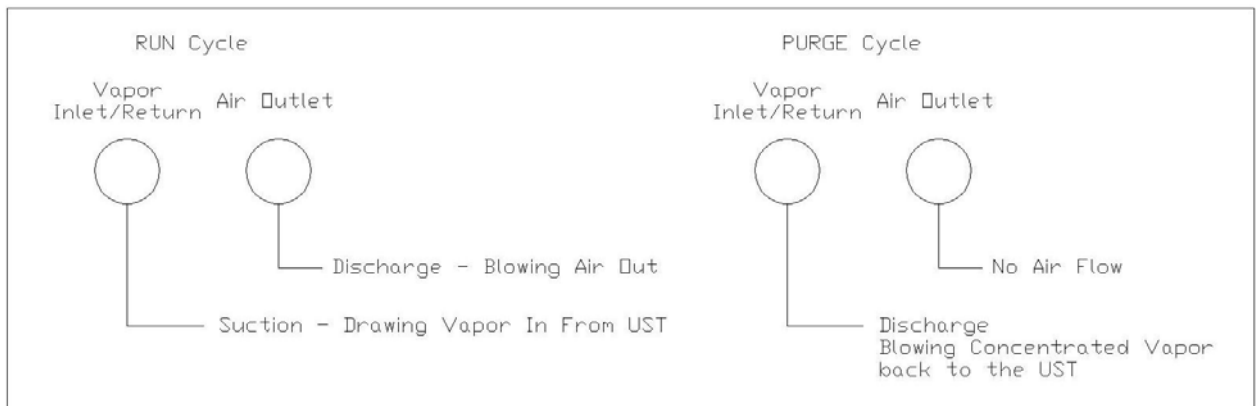


Figure 33: *Green Machine* Operation Diagram

14 Leak Test

Purpose and Applicability

- The purpose of the Leak Test is to insure that all of the tubing fittings and tubes located inside the VST *Green Machine* are leak free.
- The leak test will be required only at installation, during certain troubleshooting, and any time after the *Green Machine* plumbing, fittings, or connections have been loosened or adjusted.

Principle and Summary of Test Procedure

- The *Green Machine* is configured in the MANUAL OFF operating mode and the solenoid valves are set such that all internal *Green Machine* piping and connections can be pressurized with nitrogen. Once pressurized, all piping and connections are checked by applying a soapy solution. Any nitrogen escaping from leaks will cause the soapy solution to bubble. The absence of bubbles indicates that the piping and connections are free of leaks.

Equipment and Supplies

- Cylinder of compressed nitrogen gas with regulator capable of establishing an outlet pressure of less than 20 psi.
- VST Leak Test Fixture (See **Figure 34**).
- Soapy solution that will produce visible bubbles when exposed to nitrogen gas leaking from piping and connections.

Pre-Test Requirements

- Close the manual inlet and outlet valves at the *Green Machine*, and remove a cap from one of the tees (See **Figure 35**). Only one open tee is required for this test.
- Install the Leak Test Fixture in the empty 1" pipe tee on the *Green Machine* as shown in **Figure 35**.
- Ensure that the shut-off valve on the VST Leak Test Fixture is closed, and then connect the nitrogen source. Set the nitrogen regulator to approximately 5 psi outlet pressure, making sure that it does not exceed a maximum of 20 psi outlet pressure.
- The leak check is conducted with 1.0 to 2.0 PSI nitrogen.

Test Procedure

1. Manually turn off the VST *Green Machine* as follows:
 - On the TLS Console front panel, use the 'mode key' to scroll to 'DIAG MODE' and then use the function and step keys to view the 'VAPOR PROCESSOR MODE' menu.
2. From the 'VAPOR PROCESSOR MODE' menu, change the vapor processor mode of operation from automatic to manual mode. From the 'VAPOR PROCESSOR STATE' menu, verify the VP STATE is in the "off" mode. The processor shall be in the off mode for the duration of the test.

CAUTION:

If by chance the TLS is in the Auto Mode during the Leak Check Test, the PLC, after the F1 button is pushed, will control the *Green Machine* as indicated in Step 1 above. After the F5 button is pushed or the 30-minute timer times out, the PLC will convert back to a Normal Operating Mode and the *Green Machine* will start automatically if the UST pressure is above + 0.2"WC. Since this test is conducted with either the *Green Machine* inlet and outlet valve closed, starting the *Green Machine* automatically will NOT ALLOW THE GREEN MACHINE TO OPERATE PROPERLY AND MAY CAUSE DAMAGE TO INTERNAL EQUIPMENT.

3. Make sure power is ON to the VST Control Panel

4. At the VST Control Panel (**See Figure 36**), press the F1 button to disable running the vacuum pump and to open all of the control valves. The vacuum pump will remain off until one of the following conditions is met:
 - The F5 button is pushed OR
 - The PLC internal timer times out at 30 minutes
 - If additional time is needed to conduct the Leak Test, push the F1 button again to re-start the 30 minute timer.

5. Slowly and carefully pressurize the *Green Machine* to between 1.0 and 2.0 psi as follows:
 - Make sure the shut-off valve on the Leak Test Fixture is fully closed.
 - Make sure the Leak Test Fixture pressure regulator is fully closed.
 - Slowly open the valve on the test fixture to pressurize the *Green Machine* at 1.0 to 2.0 PSI nitrogen.

CAUTION:

PRESSURIZING THE *Green Machine* OVER A MAXIMUM OF 5.0 PSI MAY CAUSE DAMAGE TO THE *Green Machine* O-RINGS AND/OR PUMP SEALS, WHICH WILL VOID ALL WARRANTIES OF THE *Green Machine*.

6. With the *Green Machine* pressurized between 1.0 to 2.0 PSI nitrogen, spray a soapy solution on each fitting to check for bubbles:
 - If bubbles do not appear, the connection is tight.
 - If bubbles do appear, tighten the leaking fitting 1/8" turn (maximum) and re-check for leaks.
 - If the fitting cannot be tightened so that the connection is leak free, replace the 45° flare tube assembly that is leaking with a new tube assembly.

7. Continue this process until all the internal tube fittings have been checked and found leak free.

8. Once this test is complete and all the piping fittings are leak free, remove the compressed nitrogen connection to the Leak Test Fixture.

9. Remove the Leak Test Fixture and Re-install the 1" pipe plug.
10. Open the manual inlet and outlet valves at the *Green Machine*.
11. After the testing is completed, push the F5 button on the VST Control Panel to put the PLC back to normal operating mode. If the F5 button is not pushed, the PLC will convert back to normal operating mode 30 minutes after the F1 button was pushed.
12. Use the TLS-350 to put the *Green Machine* back into the **Automatic** mode.

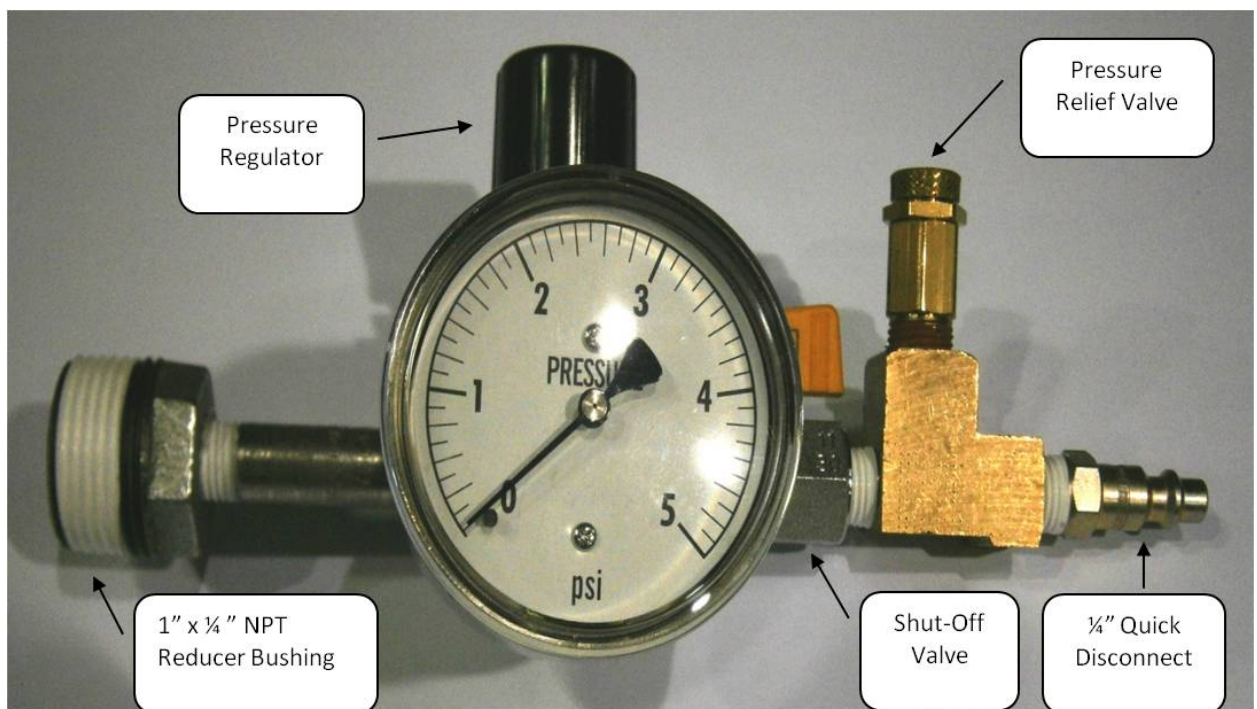
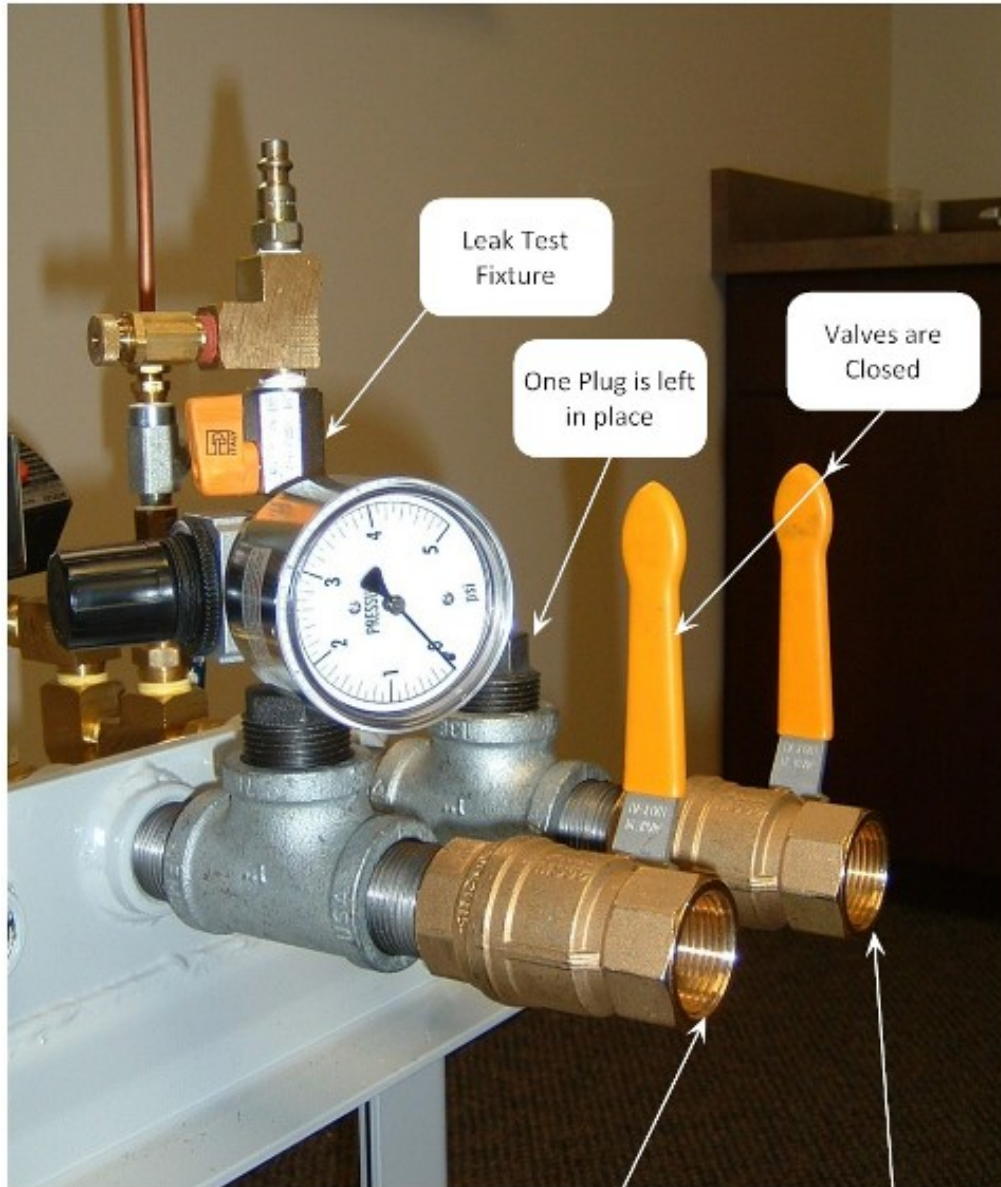


Figure 34: Leak Check Fixture



GM Installed Leak Test Fixture-A

Vapor Inlet/Return
1" Piping

Air Outlet
1" Piping

Figure 35: Green Machine Inlet and Outlet Valves Closed, and Leak Check Fixture Attached



GM CS1 Main Screen-F

Figure 36: Green Machine Controller

Alternative Test Procedures

This procedure shall be conducted as specified. Modifications to this test procedure shall not be used to determine compliance unless prior written approval has been obtained from the ARB Executive Officer, pursuant to Section 14 of Certification Procedure CP-201.

**Data Form for Recording Results of
VST Green Machine Leak Check Test**

Site Information	
GDF Name:	
GDF Address:	
District Permit #:	
Pre-Test Procedures	
Inlet and outlet valves closed for test?	<i>Comments</i>
	<input type="checkbox"/> Yes <input type="checkbox"/> No
Processor set to MANUAL OFF mode for test?	<input type="checkbox"/> Yes <input type="checkbox"/> No
VST Controller set to TEST mode (F1) for test?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Test Results	
Test conducted at a pressure between 1.0 and 2.0 psi?	<i>Comments</i>
	<input type="checkbox"/> Yes <input type="checkbox"/> No
Leaks identified during test? <i>If yes, describe leak location and corrective action taken.</i>	<input type="checkbox"/> Yes <input type="checkbox"/> No
Leaks present at conclusion of test?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Post-Test Procedures	
Inlet and outlet valves opened after test?	<i>Comments</i>
	<input type="checkbox"/> Yes <input type="checkbox"/> No
Pipe plug replaced after test?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Processor returned to AUTOMATIC mode after test?	<input type="checkbox"/> Yes <input type="checkbox"/> No
VST Controller set to NORMAL mode (F5) after test?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Technician Information	
VST Certified Technician Name:	
VST Certification Number:	
Certification Expiration Date:	
Test Company:	
Date Test Conducted:	

14.1 Determination of VST Green Machine Activation Pressure-Exhibit 9

- See VR-203 and VR-204 Exhibit 9 and follow instructions.

14.2 VST Green Machine Annual Compliance Test – Exhibit 15

- Emissions Compliance Test (GM Bag Test)
- VST Continuous Monitor Test

15 Green Machine Start-Up Procedure

- Use the following start-up procedure when initially starting or re-starting after maintenance or testing.

START-UP PROCEDURE	
1.	<ul style="list-style-type: none"> • Make sure the plugs are installed on the 2 tees at the <i>Green Machine</i>.
2.	<ul style="list-style-type: none"> • Make sure the 2 valves are locked in the OPEN position at the <i>Green Machine</i>.
3.	<ul style="list-style-type: none"> • Make sure power is on to the VST Control Panel.
4.	<ul style="list-style-type: none"> • Make sure the pressure sensor in the dispenser is operational.
5.	<ul style="list-style-type: none"> • Make sure that the GDF is vapor tight. (TP 201.3 and Exhibit 4).
6.	<ul style="list-style-type: none"> • After the TLS is installed and configured for the <i>Green Machine</i> and all EVR equipment has been installed, the <i>Green Machine</i> can become operational. • Put the TLS in the AUTOMATIC MODE. • Make sure the VST Control Panel is operational. • If the pressure is above +0.2" WC, the TLS Auxiliary relays will close and the <i>Green Machine</i> will start. • If the pressure is below +0.2" WC, the <i>Green Machine</i> will not start because the UST system-pressure is below the high-pressure threshold.
7.	<ul style="list-style-type: none"> • If the pressure is above 0.2"WC and the Green Machine does not start automatically, see the Green Machine Troubleshooting Manual.
<p>NOTE: All exhibits can be found in Executive Order VR-203 and VR-204</p>	

CAUTION: Locking ball valve handles at the *Green Machine* inlet and outlet must not be removed.

16 Green Machine Operation

16.1 Veeder-Root TLS-350

- The *Green Machine* is controlled by a Veeder-Root (VR) TLS-350.
- VST does not provide the TLS-350 controller or the software required by the TLS-350.
- The TLS-350 operates the *Green Machine* using 3 Modes:
 1. Automatic Mode - Used for normal operation.
 2. Manual OFF Mode - The *Green Machine* is OFF and will not run regardless of UST pressure.
 3. Manual ON Mode:
 - CAUTION: Used for maintenance and testing only.
 - The *Green Machine* will continue to cycle and PURGE regardless of UST pressure.

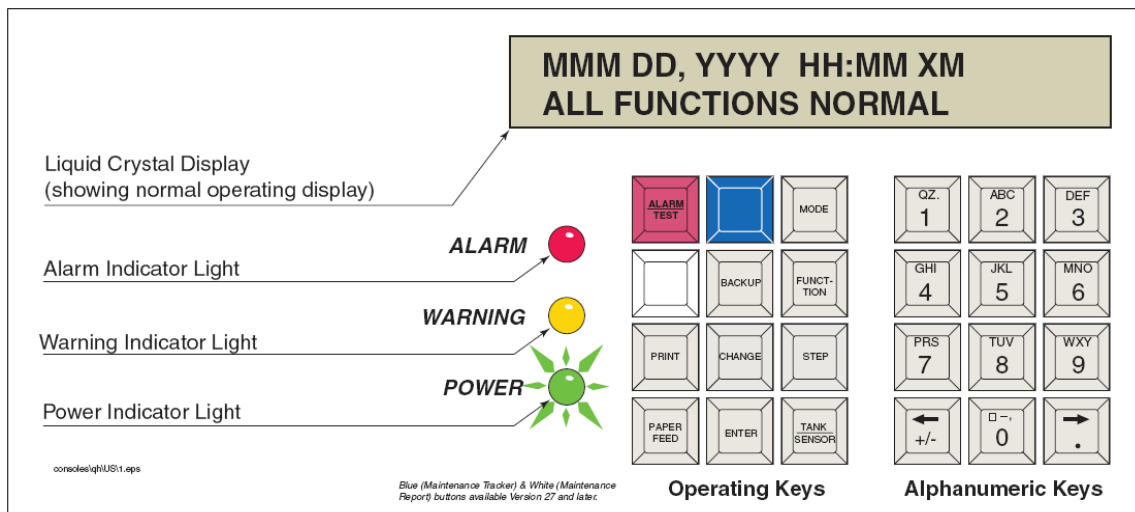


Figure 37: TLS-350 Front Panel

TLS-350 Troubleshooting

17 TLS Warnings and Alarms (PMC & ISD)

- During normal operation when the system is functioning properly and no warning or alarm conditions exist, the “**ALL FUNCTIONS NORMAL**” message will appear in the system status (bottom) line of the console display.
- If a warning or alarm condition occurs, the system displays the condition type and its location.
- If more than one warning or alarm condition exists, the display will alternately flash the appropriate messages.
- The system automatically prints an alarm report showing the warning or alarm type, its location, and the date and time the warning or alarm condition occurred.
- Warning and alarm posting causes the TLS-350 to activate:
 - Warning lights
 - Failure-Alarm indicator lights
 - Audible alarm
 - Automatic strip paper printout documenting the warning or alarm

17.1 TLS-350 PMC Alarms - Troubleshooting Summary

Displayed Message	Description	Light Indicator	Suggested Troubleshooting
VP EMISSION WARN	Mass emission exceeded the certified daily threshold.	Yellow	<ul style="list-style-type: none"> • Troubleshooting Manual www.vsthose.com. • Exhibit 9
VP EMISSION FAIL	2 nd Consecutive mass emission failure.	Red	
PMC SETUP FAIL	PMC is not configured or missing components.	Red	<ul style="list-style-type: none"> • See ISD Troubleshooting Manual, P/N 577013-819
PMC SENSOR FAULT	Component used by PMC has failed or reported an error condition. See Troubleshooting section for complete description of sensors and associated conditions that can cause a sensor fault.	Red	<ul style="list-style-type: none"> • Troubleshooting Manual www.vsthose.com. • Exhibit 9

17.2 TLS-350 ISD Alarms - Troubleshooting Summary

Displayed Message	ISD Monitoring Category	Light Indicator	Description	Suggested Troubleshooting ¹
ISD VAPOR LEAKAGE WARN	Containment	Yellow	Containment system leaks at 2 times the TP-201.3 standard.	<ul style="list-style-type: none"> Exhibit 4 TP-201.3 (or equivalent test procedure)
ISD VAPOR LEAKAGE FAIL ²	Containment	Red	8 th Consecutive Failure of Pressure Integrity (Vapor Leak) Test	
ISD GROSS PRESSURE WARN	Containment	Yellow	95 th percentile of 7-days' ullage pressure exceeds 1.3 IWC.	<ul style="list-style-type: none"> Exhibit 9 Exhibit 10
ISD GROSS PRESSURE FAIL ²	Containment	Red	8 th Consecutive Failure of Gross Containment Pressure Test	
ISD DEGRD PRESSURE WARN	Containment	Yellow	75 th percentile of 30-days' ullage pressure exceeds 0.3 IWC.	
ISD DEGRD PRESSURE FAIL ²	Containment	Red	31 st Consecutive Failure of Degradation Pressure Test	
FLOW COLLECT WARN	Collection	Yellow	Vapor collection flow performance is less than 50%.	<ul style="list-style-type: none"> Exhibit 5 Exhibit 6 Exhibit 17 TP-201.4 (or equivalent test procedure)
FLOW COLLECT FAIL ²	Collection	Red	2 nd Consecutive Failure of Vapor Collection Flow Performance Monitoring Test	
VP EMISSION WARN ^{3,4}	Processor	Yellow	Mass emission exceeded the certified threshold.	<ul style="list-style-type: none"> Troubleshooting Manual www.vsthose.com. Exhibit 9
VP EMISSION FAIL ^{3,4}	Processor	Red	2 nd Consecutive Mass emission test failure.	

Displayed Message	ISD Monitoring Category	Light Indicator	Description	Suggested Troubleshooting ¹
ISD SENSOR OUT WARN	Self-Test	Yellow	Failure of Sensor Self-Test	<ul style="list-style-type: none"> Confirm ISD sensor & module installation / communication per VR 204 IOM Section 12, Chapter 2
ISD SENSOR OUT FAIL	Self-Test	Red	8 th Consecutive Failure of Sensor Self-Test	
ISD SETUP WARN	Self-Test	Yellow	Failure of Setup Test	<ul style="list-style-type: none"> Confirm EVR/ISD programming per VR 204 IOM Section 12
ISD SETUP FAIL ²	Self-Test	Red	8 th Consecutive Failure of Setup Test	

Note: The alarms listed in above table will also activate an audible alarm

¹See ISD Troubleshooting Manual P/N 577013-819 found at <http://www.veeder.com/object/577013-819.html> and the VST ISD Troubleshooting Manual found at http://www.vsthose.com/pdf/Troubleshooting_Manual_Green_Machine.pdf

²ISD Shut Down Alarms – see Figure 48 of IOM Section 12

³This warning will result in an ISD VP Status Warn

⁴This failure will result in an ISD VP Status Fail

Maintenance

18 Overview

- The Vacuum Pump and Control Valves are the only components with moving parts in the *Green Machine*; therefore it requires very little maintenance.
- Because the system continually monitors itself and notifies you of any problems or situations, it requires very little attention.
- VST recommends annually inspecting the Vacuum Pump Rubber Flange Sleeve.
- If the *Green Machine* is not functioning properly consult the VST *Green Machine* Troubleshooting Manual to determine which component may need to be repaired or replaced.
- Exhibit 15 (*Green Machine* Annual Compliance test) may be used as an indicator of performance.
 - GM Bag Test
 - Continuous Monitoring Test

19 Rubber Flange Sleeve Replacement

NOTE: The Rubber Flange Sleeve replacement is done with the motor still attached to the *Green Machine* base.

Safety



Use lockout / tagout procedures prior to starting work.

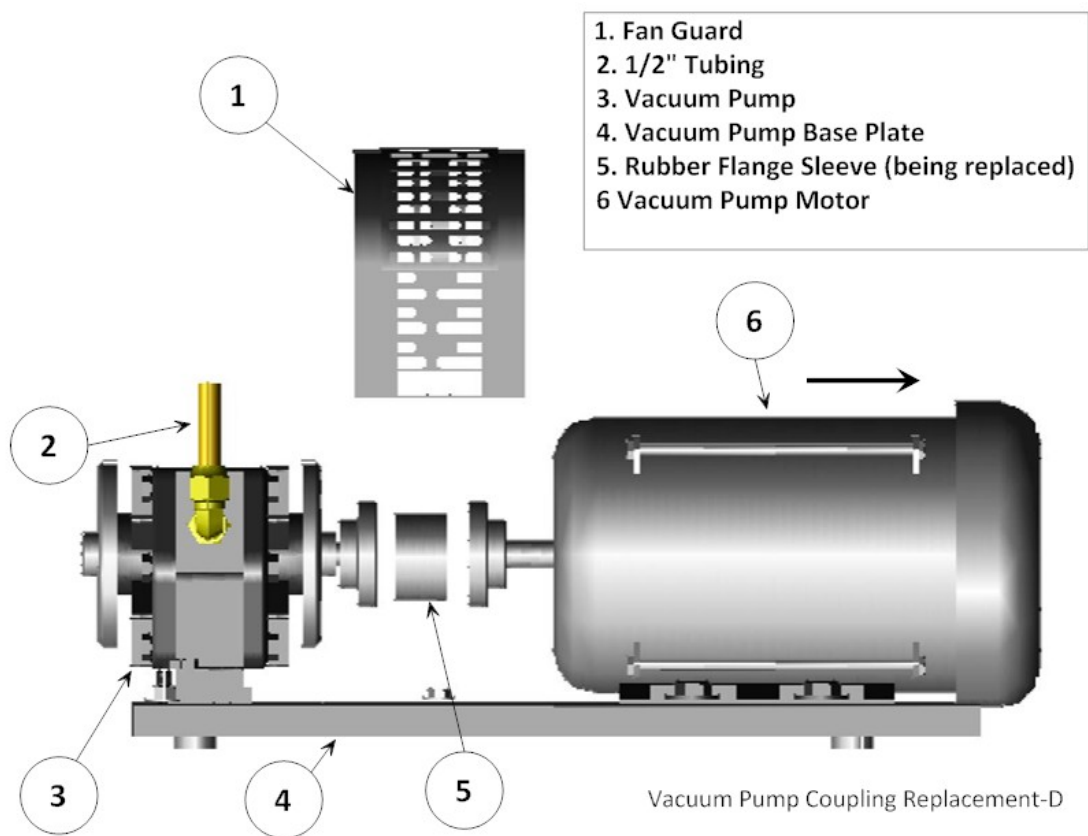


Figure 38: Vacuum Pump Coupling Replacement

19.1 Removing the Rubber Flange Sleeve

Figure 38	
1.	Disconnect power to the VST Control Panel. (The power, ground, and neutral will be completely disconnected from the <i>Green Machine</i>).
2.	Follow lockout/tagout procedures.
3.	Unlock the hasps and remove the cover from the <i>Green Machine</i> NOTE: The Vacuum Pump and tubing will not be affected by moving the Motor.
4.	Remove the Fan Guard over the Coupling Flanges.
5.	Remove 4 motor mounting bolts from the base plate.
6.	Without removing the electrical service from the Motor, slide the Motor away from the Vacuum Pump so the Rubber Flange Sleeve can be removed.

19.2 Replacing the Rubber Flange Sleeve

Figure 38	
1.	Insert a new coupling sleeve P/N GM-004 and slide the Motor towards the Vacuum Pump so the sleeve is tight between the coupling flanges.
2.	Re-install and tighten the 4 motor mounting bolts to the base plate.
3.	Re-install the fan guard over the coupling flanges.
4.	Remove the lock(s) and tags from the lockout/tagout.
5.	After the work is completed, turn ON power to the VST Control Panel. The <i>Green Machine</i> is now operational.
6.	At the <i>Green Machine</i> , check to make sure the Vacuum Pump and Motor are running without excessive vibration or noise.
7.	Put the cover on the <i>Green Machine</i> and lock the hasps.

Annual Green Machine Inspections and Replacements

Annual Green Machine Inspections					
Component	Procedure	Fail Criteria	Corrective Action	Reference Manuals	Authorized Personnel
Vacuum Pump Rubber Flange Sleeve	Visually inspect the Drive Coupling between the Vacuum Pump and the Motor for wear	Rubber debris is found on or around the Vacuum Pump base.	Replace the Rubber Flange Sleeve	IOM – 18	VST ASC Level D
Vacuum Pump	Replace pump every 10 years or 15,000 hours			IOM-18	
VST Green Machine Annual Compliance Testing	Exhibit 15	<p><u>Compliance Bag Test:</u> If the value of the NOVA reading is $\geq 17\%$, the <i>Green Machine</i> is not in compliance.</p> <p><u>Continuous Monitoring Test:</u> If a motor fault is not found then the <i>Green Machine</i> is not in compliance</p>	Refer to the Green Machine Troubleshooting Manual for maintenance	Exhibit 15	