

## Overview: EVR Balance Total System

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### 1 VST ENVIRO-LOC Balance Vapor Recovery Hose Assembly

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- The balance type hose assembly consists of two different hoses of two different sizes and constructions, with one (the fluid carrying hose) placed inside of the second hose (the vapor carrying hose). The fluid hose has a nominal ID of 5/8" and is made with a rubber tube, wire braid reinforcement, and rubber outer cover. The vapor hose has a nominal ID of approximately 1 1/2" and is made of a polyurethane material, which is extruded over a spring wire helix. The hoses have been sized to meet the performance requirements of pressure drop that apply to each.
- Typically the hose assembly will consist of two separate hose assemblies with a breakaway device located between them. Usually a shorter length, the hose attached to the dispenser is often referred to as the whip hose. A longer hose is attached to the nozzle and this is often referred to as the curb hose.
- For a typical installation, the overall length of the hose assembly including the breakaway will be 9-15 feet. This length will accommodate the refueling of a vehicle in some proximity of the dispenser, and it will typically create a drape or low spot in the hose during normal use. This low spot in the hose will tend to accumulate fluid in the vapor hose due to condensation in the hose being ingested into the hose when the vehicle tank is topped off. This is a very common occurrence. The VST balance hose assembly includes a liquid removal device (VDV series), which is used to remove fluids that may accumulate in the vapor hose to maintain a clear vapor path.

### 2 Variable Dimension Venturi

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- The VST liquid removal device, which VST refers to as the VDV (Variable Dimension Venturi), is based on the principle of a venturi.

A venturi-type liquid-removal device has been used for some time, about 20 years, starting with the Co-Vent produced by Gilbarco. Other hose manufacturers at the time produced similar devices, all based on the principle of a fixed dimension venturi.

The amount of vacuum produced by the venturi, at a particular flow rate, is determined directly by the dimension of the throat of the venturi, and this directly impacts the ability of the venturi to remove fluid from the vapor hose. At the time that these devices were certified there was no minimum flow-rate performance standard that applied, so this performance threshold was left up to the manufacturer. Therefore, the current fixed dimension venturies in use have a functional flow rate threshold of 6 gpm. The maximum product flow rate for the system is 10 gpm, according to federal mandate.

- VST came into existence following the initial certification of these venturi devices, and by this time, CARB had identified the deficiencies in the low flow-rate performance of the fixed venturi designs. At the time VST certified the VDV, the performance standards required a minimum evacuation rate of 10ml/gal dispensed at a minimum of 5 gpm.
- The VDV utilizes a fixed venturi with a very small throat diameter, which is surrounded by a spring-loaded outer venturi. At lower flow-rates, all or most of the flow passes through the small venturi throat so that enough vacuum is generated to evacuate fluid from the vapor hose at a minimum of 6 gpm. As the flow-rate increases, the spring-loaded outer venturi moves and allows more of the flow to bypass the small inner venturi. This allows the venturi to produce adequate vacuum for the liquid-evacuation throughout the range of flow rates, with the benefit of reducing the pressure drop through the venturi at the higher flow rates.

### 3 VST ENVIRO-LOC Balance Safety Breakaway

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- The purpose of the breakaway device is to prevent substantial damage from occurring, particularly to the dispenser, when a drive-off occurs with the nozzle still in the vehicle filler neck. The VST breakaway design has two separating halves, with one half attached to the whip hose and one half attached to the curb hose. Two fracturable rings hold the two separating halves together. These rings are designed to break at a 350 lb load maximum.
- Each breakaway half has both a fluid passage and a vapor passage, and each passage has a spring-loaded poppet. Upon fracture of the rings and separation of the two halves, all of the spring-loaded poppets move to a seated position, which closes off both the liquid and vapor paths in both directions. The breakaway is not intended to be field serviceable, so once it has been used it must be replaced with a new unit.

### 4 VST ENVIRO-LOC Balance Nozzle

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- The VST balance nozzle is similar in many aspects to balance nozzles that are currently in use. The nozzle incorporates both fluid and vapor passages. A boot and face seal are used to seal the vapor passage of the nozzle to the filler pipe of the vehicle. The nozzle incorporates an interlock device so that the nozzle cannot be used without the vapor boot being sealed to the vehicle filler pipe. The nozzle has an automatic shutoff device to stop the liquid flow once the filler pipe is full of liquid.

There are two areas in particular that have been modified from current practice to meet CARB's performance specifications, one related to the nozzle vapor valve, and the second to the nozzle spout that is designed with special features so as to be substantially dripless.

- To control the flow of liquid through the nozzle, a liquid flow-valve is operated using the nozzle lever. With the VST nozzle, the lever simultaneously operates the vapor flow-valve. The vapor path is only opened when fluid is being discharged from the nozzle. In this way, the nozzle vapor-valve provides a very positive seal when the nozzle is not in use.

- The VST nozzle incorporates an interlock mechanism that interacts with the boot assembly. The interlock device prevents the nozzle lever from being engaged unless the vapor boot has been compressed, such as when it is inserted into the filler pipe of a vehicle. The interlock device provides this feature by an interaction with the automatic shutoff mechanism in the nozzle; it prevents the automatic shutoff mechanism from engaging the lever until the boot has been compressed.
- The automatic shutoff mechanism is similar in design to those used in all current dispensing nozzles.

A spring-biased poppet valve is located at the junction of the nozzle body and the spout assembly. This poppet serves to prevent fluid in the nozzle from draining out when the nozzle is not being used. In addition, it serves to generate a vacuum via a venturi action when liquid is flowing through the nozzle. This vacuum source is connected by a passage to a rubber diaphragm that is part of the latching mechanism, and it is also connected to a passage that extends to the open end of the spout. As long as there is no fluid around the end of the spout, the vacuum being generated will be bled off to the passage-opening in the spout. When fluid reaches the end of the spout and covers up the passage-opening at the end of the spout, the vacuum being generated will act on the rubber diaphragm and will release the pins that hold the lever pivot in place.

With the lever movement, this action closes the liquid and vapor valves in the nozzle and stops the liquid flow. To meet UL requirements, the automatic shutoff feature must operate at a minimum flow-rate, which corresponds to a fluid inlet pressure of 8 psi. This equates to a flow-rate of approximately 3 gpm.

## 5 VST ENVIRO-LOC Balance System ECS Membrane Processor

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- The VST ECS membrane *Processor* does not interact directly with the other balance system hardware. It is in place to monitor and 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 ECS membrane *Processor* will typically not need to operate.

During periods of less activity, the GDF being shut down overnight, winter fuels being present, or other conditions that promote the pressurization of the ullage space, the ECS membrane *Processor* will operate as needed to control the pressure in the ullage space to an accepted level. The ECS membrane *Processor* will turn on at an ullage pressure of +0.20 inches of water and turn it off at a pressure of -0.20 inches of water. Currently, the ECS membrane *Processor* unit is monitored and controlled through the PMC system.

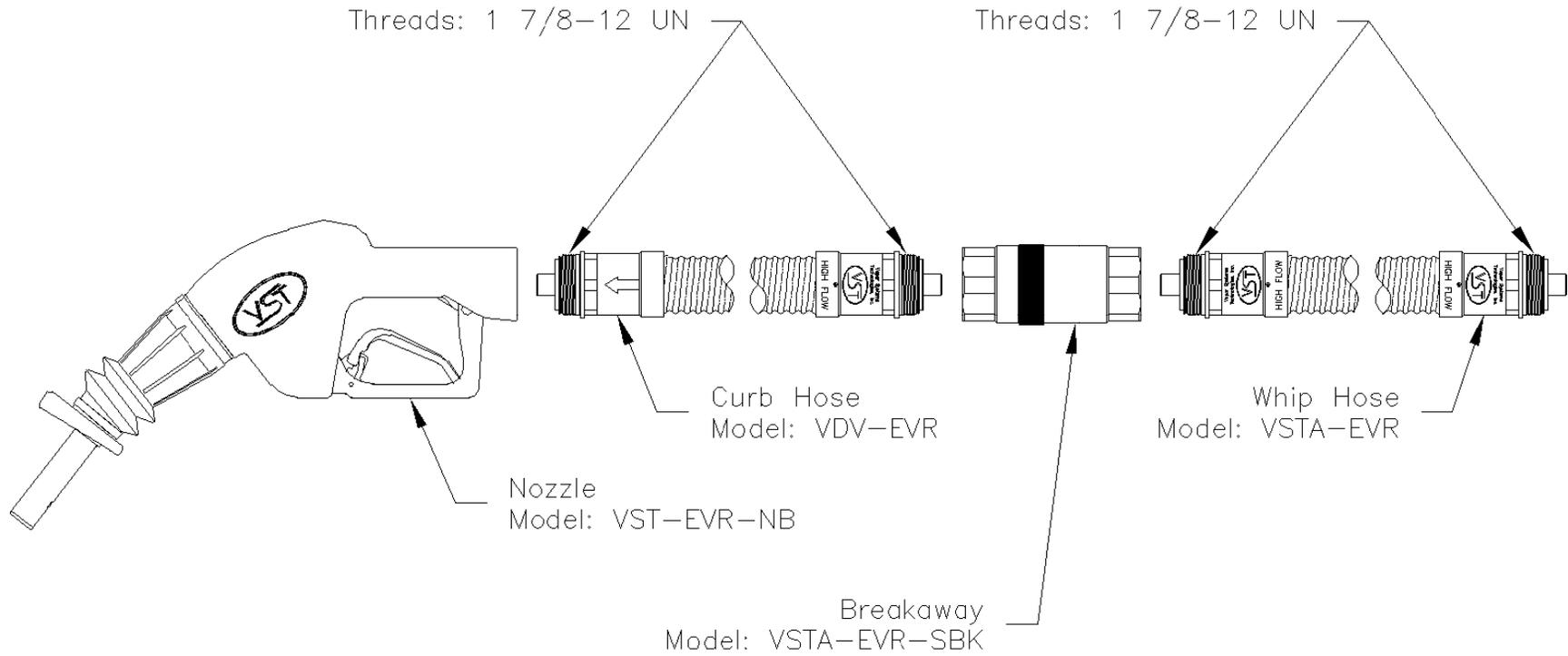
- The ECS membrane *Processor* uses a type of membrane technology to enable it to selectively separate the components in the ullage vapor mixture.

Through a somewhat complex transport means, certain molecules will selectively travel in a stream from one side of the membrane to the other. This stream is referred to as the permeate stream.

In this case, the predominate molecules transported across the membrane will be the primary constituents of air, which are oxygen, nitrogen, and water vapor. A small amount of the hydrocarbons present in the ullage mixture will also migrate across the membrane. Typically, the permeate will contain less than 3.0% hydrocarbons. The result of this activity includes, fresh air vented to atmosphere, saturated hydrocarbon vapors returned to the UST, and UST pressurization controlled to an acceptable level.

- The process of separation by the membrane is made possible by using two pumps, one low-pressure pump which circulates the ullage vapor mixture along one side of the membrane, and one high-vacuum pump, which creates the pressure differential needed to cause the permeate transport across the membrane. These are the only moving parts in the system.

A low-temperature self-regulating heating coil is incorporated around the membrane housing to keep the membrane free from condensate.



**Figure 1: VST Hanging Hardware**  
(Nozzle, Coaxial Curb Hose, Breakaway, and Coaxial Whip Hose)

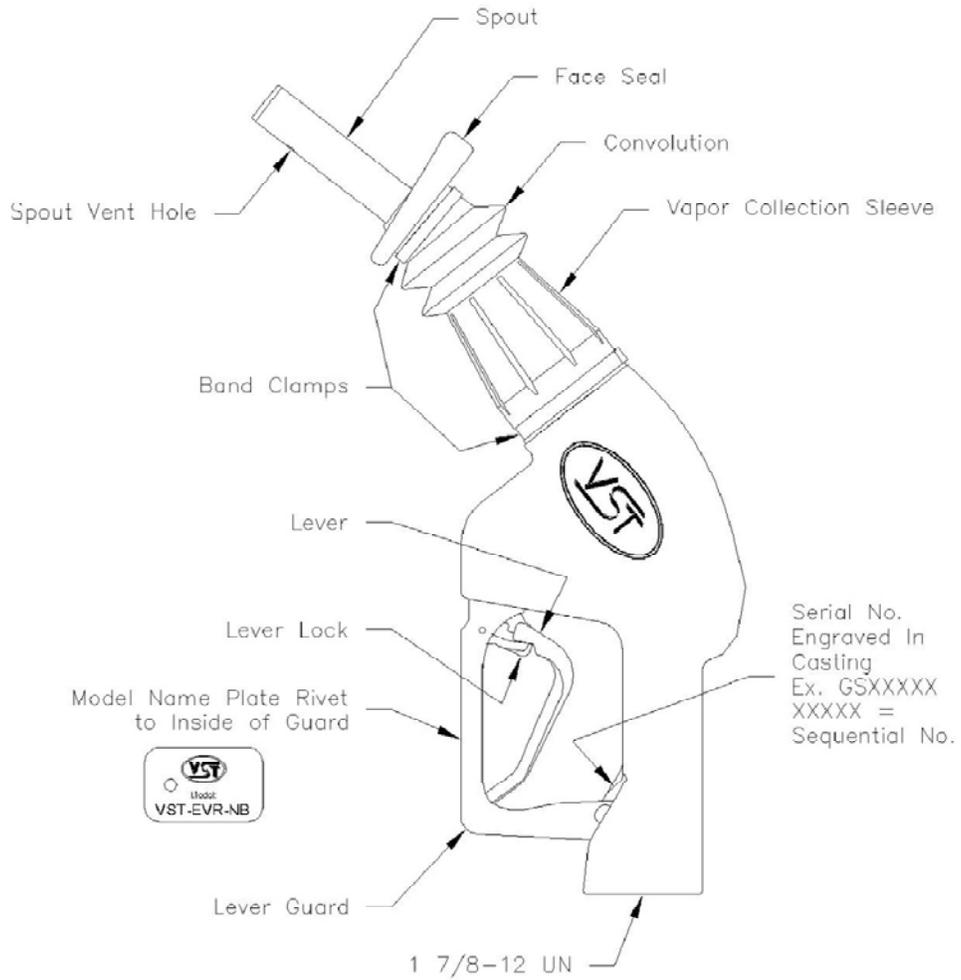
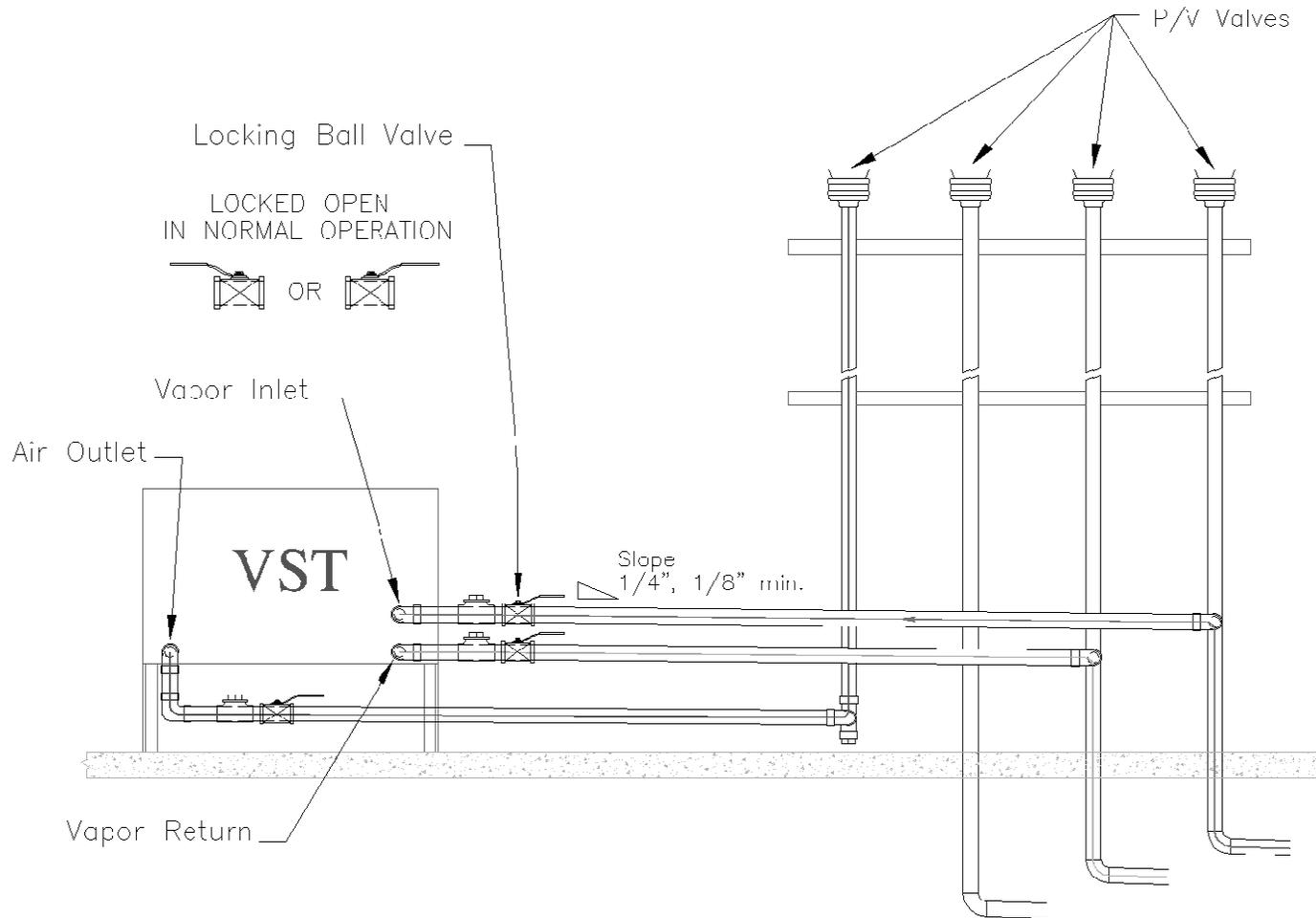


Figure 2: Model VST-EVR-NB Nozzle



CAUTION: THE HANDLES ON THE LOCKING BALL VALVES MUST NOT BE REMOVED.

Figure 3: Model VST-ECS-CS3 Membrane Processor