Technologies

Gas Trains: FM, DBB, VPS, & Dual Fuel

Factory Mutual / Double-Block and Bleed / Valve Proving System

Commercial boiler gas train requirements are specified by many codes, including ASME CSD-1, NFPA, B149, several UL and ANSI codes, as well as insurance companies.

Main Gas Train Components

Pressure Switch

Low- and high- pressure gas switches are placed at the entrance and exit of the gas train, respectively. These gas switches are designed to measure the gas pressure entering and exiting the gas train. The high-pressure gas switch shuts down the unit if pressure exceeds maximum conditions. These pressures are subject to each unit and can be found on the AERCO website.

Safety Shut Off Valve (SSOV)

The Safety Shut Off Valve is an actuated valve designed to stop the flow of gas if a hazardous condition is detected. SSOVs are required to close in less than one second and are placed in between the high- and low- pressure switches. The SSOV is factory piped and does not require vent piping. Some codes may allow a single gas valve to be used. In many cases, a Safety Shut Off Valve (SSOV) comprised of two valves in series is required. There is a proof of closure switch internal to the SSOV. ASME CSD-1 states that “Provisions shall be made to test independently each SSOV for seal leakage.” There are two strategies for this test, which are required annually by trained personnel.

Manual Shut Off Valve (MSOV)

The Manual Shut Off Valve is a manually operated valve designed to stop the flow of gas to the unit.

External Pressure Regulator

Although external pressure regulators are not internal to the gas train, they are very important for the unit’s operation. External pressure regulators are self-contained with tapped diaphragm vent ports allowing the diaphragm to change its position as required. These vents typically require piping to the outside. The regulator is to be placed on the gas inlet piping. An external lock-up style regulator is required when supply gas pressures can be greater than the maximum acceptable inlet gas pressure defined by the manufacturer.

It is important to note the maximum pressure rating for the unit’s pressure switches and SSOV. If these components receive any pressure higher than for what they are rated, they will need to be replaced.

Insurance

It is important to ensure that the chosen gas train complies with your insurance company's requirements. Three of the biggest insurance companies dealt with are FM Global, IRI (former), and GE GAP. These companies work to mitigate risk and protect property against damage from a wide variety of risks.

FM Global

The Factory Mutual (FM) gas train is used as the standard gas train. FM aligned their requirements with those of CSD-1. A standard UL or ETL listed boiler up to 2,500 MBH complying with CSD-1 is accepted; however, boilers up to 12,500 MBH must not only align with CSD-1 but also require FM approved components. All components listed in the Main Gas Train Components section of this paper must be FM approved when available.

IRI (former)

Former Industrial Risk Insurers (IRI) requirements include a double block and bleed (DBB) gas train. This insurance requirement has been replaced by GE GAP.

GE Gap

In 2007, IRI changed hands and became GE Global Asset Protection Services (GE GAP), sometimes referred to as XL GAP. GE GAP requires ANSI / ASME CSD-1 compliance for boiler sizes up to 12,500 MBH. It is important to note that CSD-1 2010 and later does not mention DBB. Therefore, there is no longer a DBB or VPS gas train requirement for compliance with GE GAP in North America.

Factory Mutual (FM)

The FM gas train, shown in Figure 1, consists of the basic components. The first component of the gas train is the "drip leg", which catches any debris in the fuel. The fuel then travels through the low-pressure switch, PS1, and enters the SSOV, V1. Once it passes V1, it travels through the high-pressure switch, PS2, and passes the Manual Shut Off Valve, MV. The gas then exits the gas train and enters the air/fuel valve.

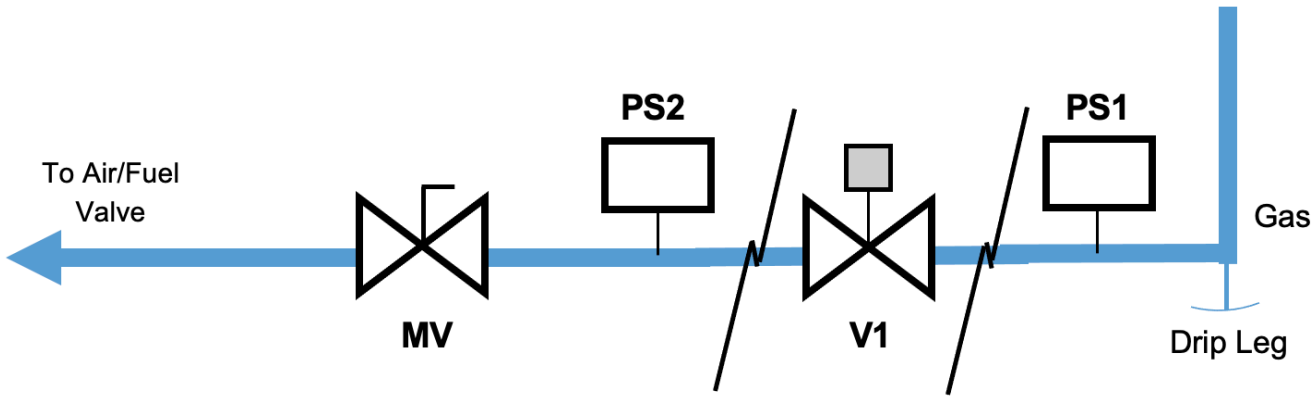

Figure 1: FM Gas Train

Advantages:

Due to the simplicity of its design, the FM gas train has few modes of failure.

Disadvantages:

One disadvantage to the FM gas train is that it has no leak detection. If the fuel in the gas train is over pressure, the gas train must be replaced.

Double-Block and Bleed (DBB)

Double Block and Bleed (DBB) refers to the practice of closing two normally closed SSOVs in series, V1 and V2, to check for leaks, shown in Figure 2. A third, normally open valve, V3, positioned in between V1 and V2, is piped to the outside of the building to relieve any gas pressure that remains in the pipes. This happens in the case of V1 failure or leakage.

Since the bleed line consists of pipe and a solenoid valve, it is easy to incorporate into the system. These typically have the bleed valve wired in series with the main valve to ensure the bleed line valve, V3, is powered closed when the SSOVs are powered open.

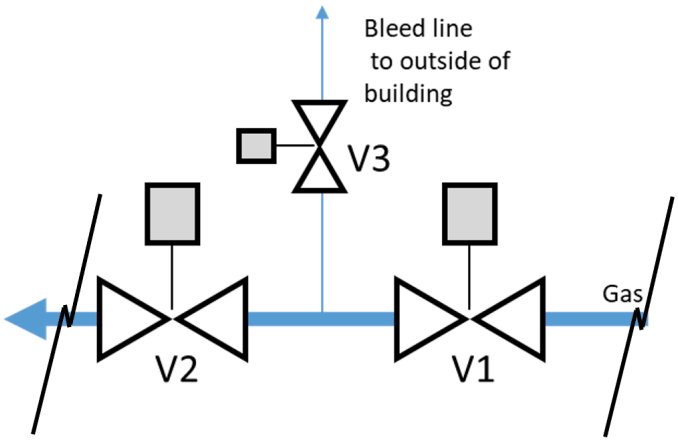

Figure 2: DBB Gas Train

Advantages:
An advantage of DBB is the second SSOV available to prevent overpressure from occurring in the combustion chamber. This is a redundant safety that goes beyond the FM compliant gas train, which is widely accepted by underwriters as a very safe gas train.

Disadvantages:
One drawback to this design is that any potential leaks due to a V1 failure scenario will likely not be detected until annual boiler safety testing.

Another drawback to this design is that the vent must be piped to the exterior of the building. This can add significant cost to an installation, particularly if there are many boilers or if the mechanical room is far from the building exterior. This may increase installation time and cost and may cause a nuisance to people who are near termination when a leak occurs.

A third disadvantage occurs when multiple units are in a single mechanical room. Some jurisdictions do not allow vent pipes to be commonly vented but, rather, must be individually run outside of the building. Other jurisdictions allow vent lines to be commonly vented, but the vent line must be sized large enough to relieve gas from all the boilers to the atmosphere.

Valve Proving System (VPS)

Like FM and DBB, Valve Proving System (VPS) has been listed as an approved method in CSD-1.

The VPS replaces the vent valve and/or proof of closure. Similar to DBB, VPS also has two normally closed valves. VPS-1 and VPS-2 are ways to implement leak detection.

VPS-1: VPS-1, depicted in Figure 3, uses a flame safeguard control for leak detection. The flame safeguard controls the two valves separately. During the standby period, the downstream valve, V2, opens, pushing any gas between the two valves downstream, then proceeds to close. The control then monitors a pressure switch between the two gas valves to determine if valve V1 is leaking. If V1 leaks, the pressure between V1 and V2 will rise. If the flame safeguard control recognizes this condition, it indicates a fault and prohibits the boiler from starting.

If V1 is not leaking, the flame safeguard control opens V1 and allows the space between the two valves to pressurize incoming line pressure. The flame safeguard control then closes V1. It again monitors the gas pressure switch to determine if there is a leak in valve V2. If valve V2 is leaking, a decrease in pressure between valve V1 and V2 will occur so that it is below the inline pressure. If the flame safeguard control recognizes this condition, it indicates a fault and does not allow the boiler to start. If there is no change in pressure, the unit will start.

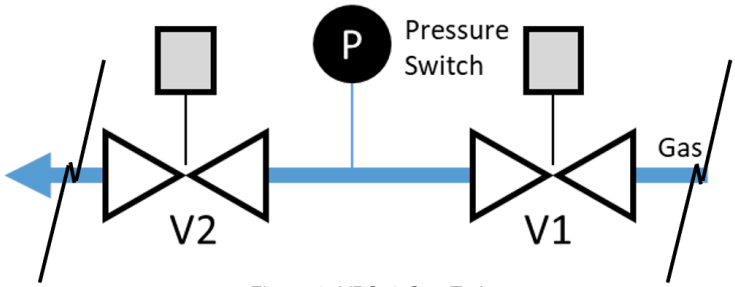

Figure 3: VPS-1 Gas Train

VPS-2: An alternative leak detection method is to use an approved external device instead of the flame safeguard itself. The VPS device has one connection to the gas line upstream of V1 and a second connection to a port found between the two valves V1 and V2, shown in Figure 4. When the boiler is ready to fire, the boiler sends a signal to the VPS device. The VPS then uses an internal pump to force gas between the two valves, increasing the pressure between them. If the VPS device determines that the pressure setpoint was reached between the two valves within a set time period, it sends a signal back to the boiler that the unit is safe to startup. If the VPS cannot build up the pressure between the two valves within that set time, indicating a leak in either V1 or V2, it will not allow the boiler to start. Without a gas vent line, the possibility of a gas leak to the atmosphere is reduced. VPS is environmentally friendly. Since there is no gas line, a V1 leak does not produce gas accumulation elsewhere.

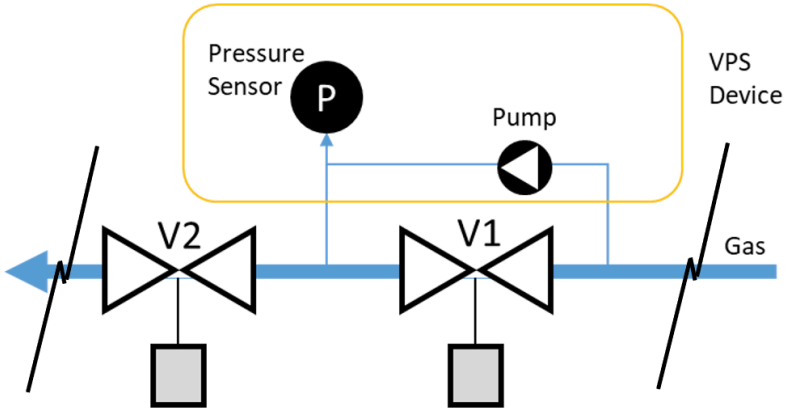

Figure 4: VPS-2 Gas Train

Advantages:
VPS is a self-checking safety component that provides valve automatic leak detection, alarm, and shut off without the need for operator intervention.

Another advantage to the VPS is the elimination of DBB venting line installation to the outside of the building. In many cases, running these lines complicates installation and adds significant costs.

VPS is environmentally friendly. Since there is no gas vent line, a V1 leak does not produce gas accumulation elsewhere.

Disadvantages:
Valve proving systems use more complex controls than the DBB. However, manufacturers who integrate VPS into their system from the factory eliminate this problem. This becomes a complication if the VPS system is retrofitted on site as an external add-on. In this case, the burden of learning, installation, and integration is on the installing contractor.

Dual Fuel

Some gas trains offer dual fuel options. A dual fuel gas train is a gas train comprised of two complete FM compliant gas trains that meet at the flange to the air/fuel valve. This gas train is able to switch between two types of fuel (i.e. natural gas, propane). Each fuel has its own inlet, SSOV, and low- and high- pressure gas switches. The user can manually select which gas to fire using the fuel selector switch.

Advantages:
The dual fuel gas train acts as a precautionary measure. Natural gas being piped from the building is not always reliable, so in the case that no natural gas is available, propane gas can be used to fire the unit.

Disadvantages:
Propane can be difficult to store depending on space constraints and is typically more expensive than Natural Gas. Propane may cause higher NOx emissions.

Which Solution to Use

In most cases, the boiler manufacturer will offer leak detection options for the gas train. National codes do not usually specify one method over another. However, insurance companies may define the leak detection method preferred to them. Due to its safety and reduced installation cost and leak issues, offering VPS to replace DBB can address most insurance companies' requirements.

When selecting equipment, be sure to investigate the available gas train leak detection options that conform to the insurance requirement.

Products by Gas Train

Model	FM	DBB	VPS-2	Dual Fuel	Dual Fuel DBB
BMK750/1000	X	X		X	
BMK1500/2000	X	X		X	X
BMK2500/3000	X	X		X	X
BMK4000/5000N	X	X	X	X	X
BMK5000/6000	X		X	X	
INN600N-1350N	X				
AM all models	X				
MLX all models	X				
MFC* all models	X	X		X	

Table 1: Products by Gas Train

*The MFC Dual Fuel option is only for natural gas and #2 Fuel Oil applications

AERCO International, Inc. • 100 Oritani Drive • Blauvelt, NY 10913
USA: T: (845) 580-8000 • Toll Free: (800) 526-0288 • AERCO.com