TEL: 780-665-2863
www.enefen.com

Why do Gas Engines require a CSA B149.3 Field Approval and what has changed in the 2020 version of the B149.1 and B149.3 codes?

In general, the CSA B149.1 code is only applicable to the fuel gas supply piping up to the certified or field approved appliance and the overall installation of the appliance. The B149.1 code generally does not include the design of the appliance itself or the configuration of the fuel gas valve train components. The fuel gas valve train configuration and the safety limits of the appliance are generally dictated by the accepted certification standard, or by the B149.3 Field Approval code for non-certified appliances. For this reason, Section 7.2.4 of the B149.1 code that describes the detailed design of Stationary Engines and Turbines has always been somewhat out of place in this code.
In addition, grouping Gas Engines with Gas Turbines has also been problematic because Gas Turbines include a wide range of products with some of them being the size of an entire building with far greater complexity than a relatively simple Gas Engine.

Small gas engines less than 500HP are often purchased off-the-shelf as the engine only and then a mechanical fabricator will mount the engine on a custom skid and couple it to the end device such as a hydraulic pump, generator, etc. These custom configurations will rarely have any kind of documentation for the overall assembly because it was built by a small mechanical fabricator. The engine manufacturer does not provide any product support for such an installation. It is often difficult to approve this type of installation with no supporting documentation, which is why it is necessary to have a professional engineer involved.

Larger turbocharged gas engines from international corporations like Caterpillar will have the engine pre-installed on a skid with the zero-governor pressure regulator and a single solenoid valve (often not CSA certified) without the rest of the fuel gas valve train and often without the end device such as a compressor, generator, etc. The engine manufacturer will often provide a proprietary engine controller and they will generally not release any specifications or electrical drawings for their proprietary equipment, which makes it quite difficult to assess the functionality of the system. The vendor of the final system will often have their own P&ID and electrical drawings that simply show a blank spot where their equipment connects to the engine equipment. These drawings can often become quite complex, which is why it is necessary to have a professional engineer involved.

After several years of the industry trying to deal with this issue, it was finally decided in the 2020 version of these codes to move the design requirements of Gas Engines and Turbines from the B149.1 code to the B149.3 code, which would trigger the requirement for a professional engineer to become involved as per the provincial Safety Act in regards to how non-certified gas appliances are approved. This follows the same methodology used for all other types of gas appliances. In the 2020 version of the B149.1 code, the overall installation requirements are still there in sections 7.2.4 and 7.2.5, but the section title has changed slightly and a new clause has been added:

7.2.4 Non-motive engines and turbines

7.2.4.1

An engine or turbine shall be certified or comply with Clause 17.3 of CSA B149.3.

For Industrial installations, it is very rare for engines or turbines to be a certified assembly, which means the Field Approval via the B149.3 code will be far more common. This follows the same methodology used for all gas-fired appliances.

For a B149.3 Field Approval of an appliance, it is necessary to have a professional engineer involved, which is not a requirement of the B149.1 code. Under the B149.1 code, only a safety codes officer is required to approve the installation and they are not generally trained to assess the safe design of the internal workings of an appliance.

When the design requirements from the B149.1-2015 code were moved to the B149.3-2020 code, there were also several changes made to the design requirements. These changes represent a significant difference between the two codes and this will have an impact on the industry as it adapts.

Summary of design requirements in sections 7.2.4 and 7.2.5 of the B149.1-2015 code that have been removed from the 2020 version of the code:

- One CSA 6.5-C/I certified safety shut-off valve (SSV) installed upstream of the flexible gas hose (7.2.4.2).
- A second certified SSV installed when the fuel input is in excess of 1.0 MMBtuh (~80-100HP - 7.2.4.3) or on all engines of any capacity using propane fuel gas installed inside a building (7.2.5.8).
- SSV(s) to be interlocked with a safety limit control circuit (7.2.4.2) to automatically shut-off the flow of gas when the engine is not in operation (eg. vacuum switch, oil pressure switch, etc).
- Automated speed governor to prevent overspeed operation (7.2.4.2).
- Overcrank protection for engines with an automated start function (7.2.4.5).
- Zero-governor type pressure regulator to link the fuel gas pressure/flow to the air supply pressure/flow (7.2.4.2). This provides fuel/air ratio control.
- CGA 8.1 certified flexible gas hose less than 3ft long connected to the engine to prevent transmission of engine vibration to the fuel gas valve train (7.2.4.9).
- A positive lock-up pressure regulator (7.2.4.6) and overpressure protection if necessary (7.2.4.7).
- A permanent rating plate (7.2.4.10).

Summary of design requirements in the new sections 17.3 and 17.5 of the B149.3-2020 code that replace the above requirements from the B149.1-2015 code:

- Up to an including 2.5 MMBtuh (~200-250HP):
  One CSA 6.5-C/I certified safety shut-off valve (SSV), or two CSA 6.5 certified SSV's (17.3.3).
  Except for a propane fuel supply, which requires a minimum of two valves (17.3.3).
- Over 2.5 MMBtuh and up to an including 5.0 MMBtuh (~400-500HP):
  Two CSA 6.5-C/I certified safety shut-off valve (SSV – 17.3.3).
- Over 5.0 MMBtuh and up to an including 12.5 MMBtuh (~1000-1250HP):
  Two CSA 6.5-C/I SSV's plus at least one of them needs to have a proof of closure switch that is integrated with the start-up circuit (17.3.3).
- Over 12.5 MMBtuh (~1000-1250HP):
  Two CSA 6.5-C/I SSV's plus both of them need to have a proof of closure switch that is integrated with the start-up circuit. Plus they need to be configured with a Valve Proving System (VPS), or there needs to be a CSA 6.5 certified vent valve installed between the two SSV's (17.3.3).
- SSV(s) to be interlocked with a safety limit control circuit (17.3.2) to automatically shut-off the flow of gas when the engine is not in operation (eg. vacuum switch, oil pressure switch, etc).
- For a fuel input greater than 2.5 MMBtuh (~200-250HP), a fuel gas low and high pressure safety device is required to detect incorrect pressure being supplied from the regulator (17.3.4).
- Automated speed governor to prevent overspeed operation (17.3.2).
- Overcrank protection for engines with an automated start function (17.3.6).
- Zero-governor type pressure regulator to link the fuel gas pressure/flow to the air supply pressure/flow (17.3.2). This provides fuel/air ratio control.
- CSA 8.1, CSA 8.3, ULC C536, or CGA CR96 certified flexible gas hose less than 6ft long connected to the engine to prevent transmission of engine vibration to the fuel gas valve train (17.3.2).
- A positive lock-up pressure regulator (17.3.7) and overpressure protection if necessary (17.3.8).
- A permanent rating plate (17.5).
- When installed inside a building or enclosure (ie. almost all of them), it shall be equipped with a gas leak detector set at 20% LEL to activate an audible/visual alarm, interlocked with the mechanical ventilation system, and interlocked to shut down the appliance (17.4.2).

New requirements for large Gas Turbines (17.3.5):

A Gas Turbine with a capacity greater than 12.5 MMBtuh (~1000-1250HP) and an inlet pressure greater than 150psig (17.3.5):
Two safety shut-off valves with a vent valve between them and the valves must be approved for use in the application (refer to Annex K). Most of these large turbines do not have CSA 6.5 certified valves, so this new clause recognizes they require special approval.
In addition, some type of turbine control system, gas flow control valve, and gas hose is required. But it leaves the specification and configuration of these components up to the manufacturer to decide.

The new safety shut-off valve and low/high pressure safety device requirements were added to make the gas engine and turbine requirements similar to the requirements for all other gas appliances covered by the B149.3 code. In the past, they were being given special permission to have fewer safety devices for some unknown reason.
One major practical issue with the new valve requirements is most engine control systems will not have the required functionality to connect the required proof of closure switches. That means there will need to be some kind of custom external control that checks the proof of closure switches before allowing the operator start command to proceed to the engine controller. This is an extra layer of complexity that was not required in the past.

Overall, the new changes found in the B149.3-2020 code will make the operation of gas engines more safe than the current requirements in the B149.1-2015 code and it will bring gas engines into line with the existing approval methods used for all other types of gas-fired appliances. It is unclear what reasoning was used to allow gas engines to follow a different set of approval rules and a lower level of safety in the past, but this issue has been removed from the 2020 codes.

Note about calculation of fuel input ratings based on horsepower ratings…

All of the requirements are recorded in the code based on the fuel input rating of the appliance. However, most gas engines are rated based on the horsepower. A simple conversion using the horsepower rating of the engine to Btuh or kW values will provide a false result. For this reason, the manufacturer fuel consumption values and the fuel gas heating value should be used to determine the true fuel input rating or the calculation provided in the B149.1 code should be used when the fuel consumption values are not available.

From the B149.1 2015 and 2020 codes:

7.2.4.2

Supply piping to a non-motive engine or turbine shall be sized according to both the maximum rate of gas consumption and the requirements of Clause 6. When precise information regarding the maximum rate of gas consumption is not available from the manufacturer, the size of piping shall be computed for normal operation. Normal operation shall be considered the provision of 10 000 Btu/h (3 kW) per brake horsepower for 4-cycle engines and 13 000 Btu/h (4 kW) per brake horsepower for 2-cycle engines.

When either overloads or high starting loads are likely to be encountered, the size of piping shall be computed on a basis proportional to the increased input required.

For example:

2.5 MMBtuh = 732 kW = 980 HP (mechanical) using standard conversion factors

2.5 MMBtuh / 10,000 Btuh/HP = 250 HP using the above calculation for a 4-cycle engine

2.5 MMBtuh / 13,000 Btuh/HP = 200 HP using the above calculation for a 2-cycle engine

2.5 MMBtuh / 1000 Btu/SCF (typical natural gas) = 2500 SCFH natural gas flow rate