

# Technical Report on LNG Tank Shutoff Valves

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## **Scope:**

The report screens four international LNG standards: ISO 12991-2012, NFPA 52-2013, SAE J2343-2008 and AS 2739-2009 for requirements related to LNG tank shut-off devices.

The report discusses specific aspects and challenges of mounting two valves in series on same LNG line.

The emphasis is on using two components, a manual valve and an automatic valve mounted in series on the LNG supply line to shutoff the flow.

## **Executive summary:**

Four international standards for LNG vehicles and their fuel systems were screened for requirements for shut-off devices for LNG supply line. All the standards (using different wording) require the function of shutoff/isolation of LNG tank from the rest of the fuel system. None of the searched LNG standards requires two valves in series on the LNG fuel supply line.

Introducing an over-constraining requirement, for the type of component and the function, such as two valves in series one manual the other one automatic for shutting off the LNG supply line, leads to increased system complexity and may affect vehicle safety or first responder safety in case of an emergency. This also prevents the introduction of new technologies.

A manual valve is subject to operator error. Leaving the manual valve closed can create scenarios where the vehicle start moving and then becomes disabled. If it was in the process of merging onto a highway, or crossing a railway, this could become a safety issue.

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## **Discussion:**

Mounting two valves in series on an LNG line creates the danger of trapping LNG. (The LNG trapping is the confinement of LNG in an enclosed space of constant volume). When subject to ambient heat the trapped LNG expands and creates very high pressures that can lead to rupture of the component(s) that trapped LNG. To avoid this danger, the designer of the system must take special measures. This increases the complexity and may actually affect system safety.

Importing requirements from adjacent domains such as CNG may lead to introducing dangerous situations or to complicating the LNG fuel system construction without increasing system safety. The presence of two valves in series on a CNG discharge line does not create such danger (fluid trapping).

In the case of an emergency, a manual valve requires the action of the operator to shut-off the flow. Due to location of the manual valve, on the LNG tank, it exposes the operator to the risk of injury. An automatic shut-off valve shuts-off the flow when de-energized. This does not require the operator intervention, therefore is safer than the manual shut-off.

A manual valve is subject to operator error. Leaving the manual valve closed can create scenarios where the vehicle start moving and then becomes disabled. If it was in the process of merging onto a highway, or crossing a railway, this could become a safety issue.

Prescribing specific type of components for certain function (double constraint) for LNG shut-off, does not allow the introduction of new technologies that can be safer for vehicle or first responders.

## **Current status in the LNG vehicle codes and standards:**

### **ISO 12991-2012**

*Liquefied natural gas (LNG) -- Tanks for on-board storage as a fuel for automotive vehicles*

Paragraph 4.7.5 sets requirements for Shut-off valves and non-return valves:

*“ The fuel tank shall be provided with shut-off valves for the purpose of securing the fuelling lines and the fuel supply lines to the LNG conversion system(s).*

*In addition, all LNG fuel supply lines to the LNG conversion system(s), except the lines to the boil-off management system, shall be secured with automatic shut-off valves or excess flow valves. These valves shall be mounted directly on or within the fuel tank.*

*The fuelling line shall be secured by either a manually or an automatically operated shut-off valve, which shall always be closed except during the fuelling process. If the fuelling connector receptacle is not mounted directly on the fuel tank, a second isolation valve shall be used. This valve may be a manual shut-off valve, an automatic shut-off valve or a non-return valve. When two isolation valves are required, one shall be mounted directly on or within the fuel tank.*

*The automatic shut-off valves shall close with loss of motive power.”*

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The standard requires shut-off valves for the purpose of securing the fueling lines and the fuel supply lines.

- For the fuel supply lines, the standard requires automatic shut-off valves or excess flow valves.
- For the fuelling lines the standard requires a second isolation valve, if the fueling receptacle is not mounted directly on the fuel tank.

The standard uses plural of the nouns to indicate multiple lines of the LNG tank that need to be isolated/secured from the rest of the system.

There is no requirement for two valve mounted on the fuel supply line.

An automatic shut-off valve or excess flow valve is required on the fuel supply line.

### **NFPA 52-2013**

*Vehicular Gaseous Fuel Systems Code*

Relevant to the topic of the report is paragraph 9.12.1.12:

[9.12.1.12 Vehicular fuel systems shall be equipped with at least one manual or automatic fuel shutoff valve.](#)

This standard allows for use of one device (manual valve or automatic) valve for the isolation of the LNG fuel tank from the engine fuel supply system.

### **AS/NZS 2739 – 2009**

*Natural gas (NG) fuel systems for vehicle engines*

The standard requires two types of valves (Reference paragraph 4.1.2):

(f) [Service isolation valve.](#)

(h) [Fuel shut-off device \(solenoid lock off\).](#)

They may be combined (excerpts from paragraph 2.1.1): [“into multifunction units, provided that such units comply with the requirements for each function.”](#)

The standard makes the difference between the function (and by default location) of each device/valve. It does not request a specific type of component.

### **SAE J2343 – 2008**

*Recommended Practice for LNG Medium and Heavy-Duty Powered Vehicles*

The standard requires Container Shutoff Devices (Ref: 4.2.1.8.1):

[“Each container shall be equipped with accessible shut-off devices that allow for its complete isolation from the rest of the engine fuel supply system.](#)

...

[Normally closed automatically shutoff devices that are held open by electric current, pneumatic or hydraulic pressure, or a combination thereof, or manually operated shutoff devices shall be permitted to be used to meet this requirement.”](#)

The standard has specific requirements for Manual Vent Valve (Ref: 4.2.6) and for Automatic Shutoff Devices (Ref: 4.5)

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The standard requires the function of complete isolation of the LNG tank from the rest of the fuel system. It enumerates two types of components “normally closed automatic shutoff devices” or “manually operated shutoff devices” that are permitted to be used. It does not limit the manufacturer’s choice to use other types of components that can perform the same function.

### **Conclusions on standards:**

- ISO 12991-2012 For the fuel supply lines, the standard requires automatic shut-off valves or excess flow valves.
- NFPA 52 -2013 Requires at least one manual or automatic fuel shutoff valve.
- AS 2739 – 2009 Requires two types of valves: Service isolation valve and Fuel shut-off device (solenoid lock off). The function of the two is different, one is meant for service the other one for shutoff.
- SAE J2343 – 2008 Requires LNG tank to be equipped with shutoff devices to allow complete isolation from the rest of the system. Normally closed automatic shutoff devices or manually operated shutoff devices are permitted to be used.

All the standards (using different wording) require the function of shutoff/isolation of LNG tank from the rest of the fuel system.

None of the searched LNG codes requires two valves in series on the LNG supply line.

### **Recommendations:**

Align the requirements in R110 with the requirements in the existing LNG standards:

- Require the function of shut-off of the LNG supply line.
  - Allow/require the use of automatic valves, **or** manually operated valves, **or** other devices or methods that can perform the function.
  - Avoid requiring two shutoff valves in series on the LNG discharge line

Allow the certification agency to accept new technologies that prove equivalent safety.