

Proposal to amend UN Regulation No. 110 Shut off Valve

GRSG-119 / October 2020



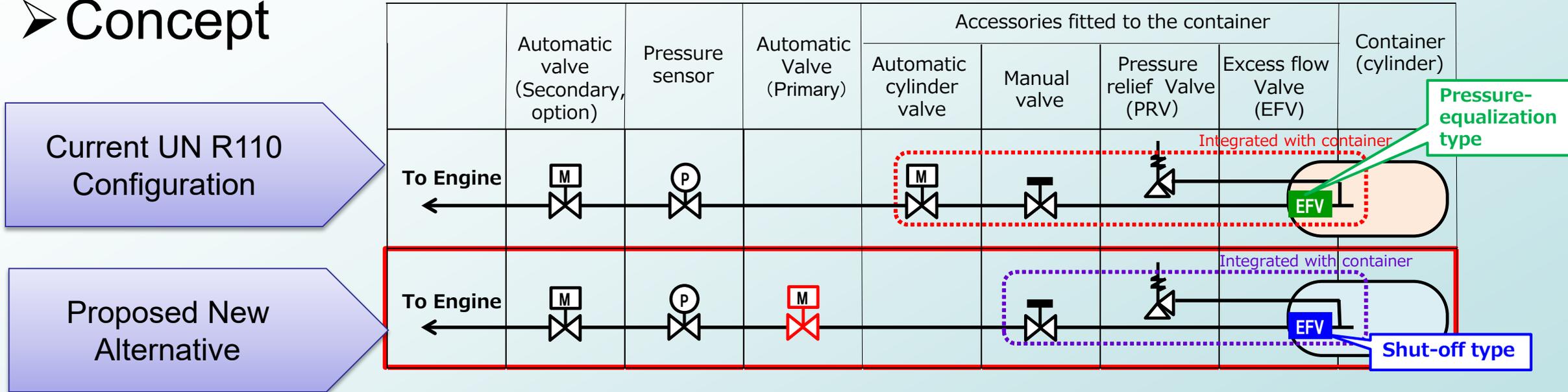
Background

- ISO 15500-14 Road vehicles — Compressed natural gas (CNG) fuel system components — Part 14: Excess flow valve defines “shut-off type excess flow valve”
- ISO 15501-1 Road vehicles — Compressed natural gas (CNG) fuel systems — Part 1: Safety requirements does not restrict the used of such an excess flow valve
- UN R110 currently only recognizes “pressure-equalization type excess flow valve” as excess flow limiting devices
- In Japan current systems use configurations with “shut-off type excess flow valves”
- UN R110 coming into effect in Japan in March 2022



Proposal: Add alternative configuration with a «shut-off type excess flow valve» to UN R110

➤ Concept



The proposal amends the definition of the excess flow valve (EFV) in the sub group of pressure-equalization type and shut-off type excess flow valves to enable a configuration which uses an automatic valve separated with piping from the cylinder but close by the container, instead of an automatic cylinder valve fitted to the container.



Proposal

Amend definition of “Excess flow valve” to differentiate between pressure-equalization type and shut-off type excess flow valves:

4.21. "*Excess flow valve*" (excess flow limiting device) means a device that automatically shuts off, or limits, the gas or liquid flow when the flow exceeds a set design value.

4.21.1 “Pressure-equalization type excess flow valve” means an excess flow valve which automatically resets when the excess flow condition is no longer present.

4.21.2 “Shut-off type excess flow valve” means an excess flow valve that stops flow when in the closed position, which has to be reset by manual operation.



Proposal (2)

Amend the CNG system requirements in paragraphs 18.3.1.4. and 18.5.1.1. such that the automatic cylinder valve can be substituted in case a Shut-Off Type Excess flow valve is used:

18.3.1.4. Automatic cylinder valve **or automatic valve**;

18.5.1.1. An automatic cylinder valve shall be installed directly on each CNG container and to each CNG accumulator.

The automatic cylinder valve can be substituted by an automatic valve attached close to the CNG container, if the excess flow valve attached to the container is a shut-off type excess flow valve.



Proposal (3)

Correct paragraph 18.5.3.1. to reflect that the Excess flow limiting device must be fitted in the CNG fuel container the automatic cylinder valve might have been substituted by an automatic valve:

18.5.3.1. The excess flow limiting device shall be fitted in the CNG fuel container(s) and on each CNG accumulator ~~on the automatic cylinder valve~~.

Update Annex 1A, Paragraph 1.2.4.5.8.3 accordingly:

1.2.4.5.8.3. Automatic cylinder valve / **Automatic valve**



Proposal (4)

Identify in Annex 4, paragraphs 5.4. and 5.6. the applicable requirements based on the excess flow valve type:

5.4. The **pressure-equalization type** excess flow valve shall be designed with a bypass to allow for equalization pressures.

The shut-off type excess flow valve shall have a function to reset actuation.”

5.6. When the **pressure-equalization type** excess flow valve is at cut-off position, the by-pass flow through the valve shall not exceed 0.05 normal m³/minute at a differential pressure of 10,000 kPa.

When the shut-off type excess flow valve is at cut-off position, the amount of leakage from the valve shall not exceed 2.5×10^{-7} normal m³/minute during operation.



Justification

In the UN Regulation No.110 an excess flow valve (EFV) is admitted only for the pressure-equalization type.

At the time of operation, the pressure-equalization type EFV does not completely shut off the fuel gas.

In the UN Regulation No.110, the pressure-equalization type EFV plays a role of limiting the gas flow rate at the time of actuation. In the event of accident such as fuel outflow, the automatic cylinder valve attached to the container shuts completely off the fuel.

In this document, OICA proposes an alternative type of EFV which **can shut off the fuel**, different from the pressure-equalization type. This shut-off type EFV makes it possible for the EFV to play the role of fuel shut-off instead of the automatic cylinder valve attached to the container. Therefore, the same effect can be obtained without providing the automatic valve integrally with the container. The actuation of such shut-off type EFV can be cancelled by operating the manual valve (Manual Reset).



Please consider positively these proposed amendments, which we believe contribute to the improved safety of the entire CNG fuel system.



Backup Material

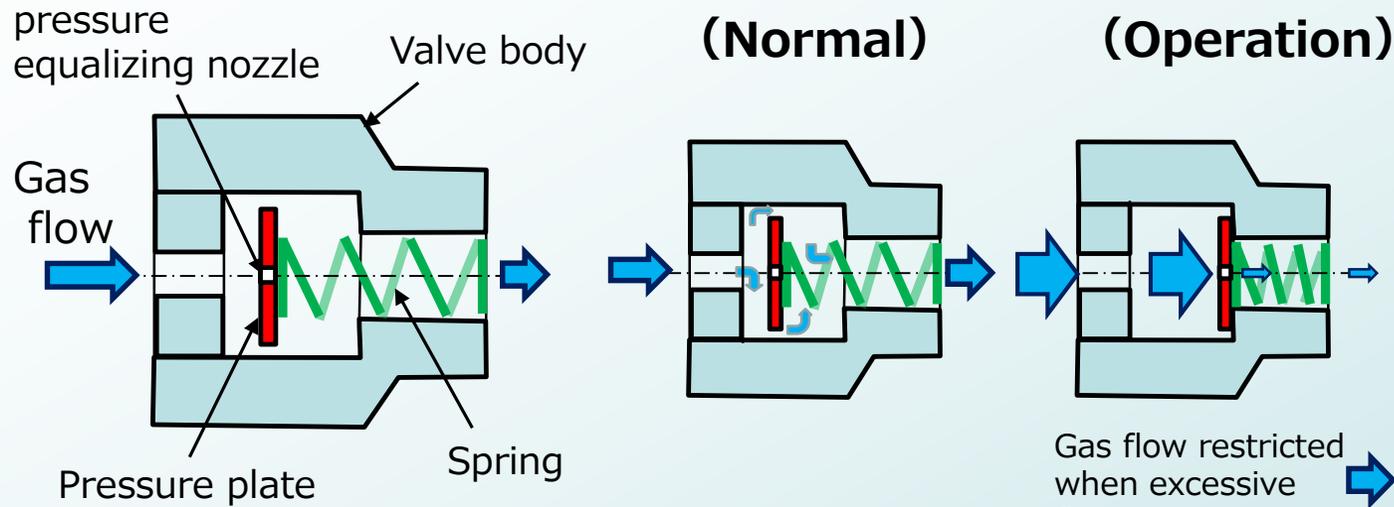
The following slides document considerations which have been taken into account, when creating the proposal:

- Excess flow valve (EFV):
 - Structure and Operation (Comparison of both types)
 - Operational Performance (shut-off type)
 - Current configuration under UN R110
- Assessment of proposed alternative configuration compared to current UN R110 configuration
- Example of accident in Japan with shut-off type valve configuration



Excess flow valve (EFV) - Structure and Operation

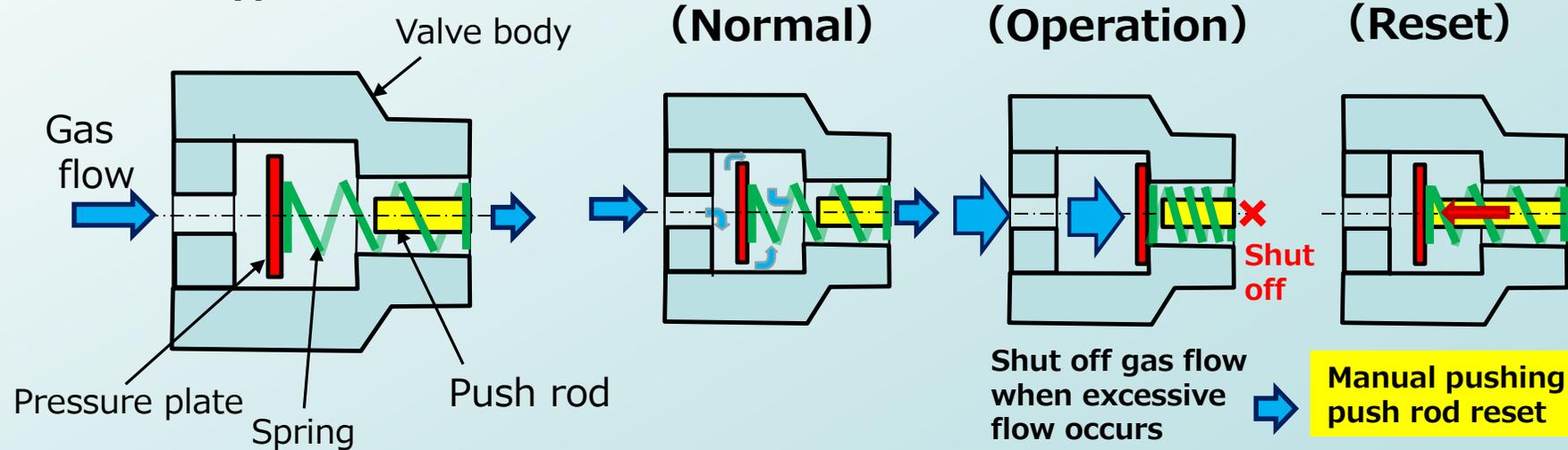
【 Pressure-equalization type 】



Gas flow restricted when excessive flow rate occurs

Small amount of gas is allowed to flow, and when it is equalized, automatic return

【 Shut-off type 】

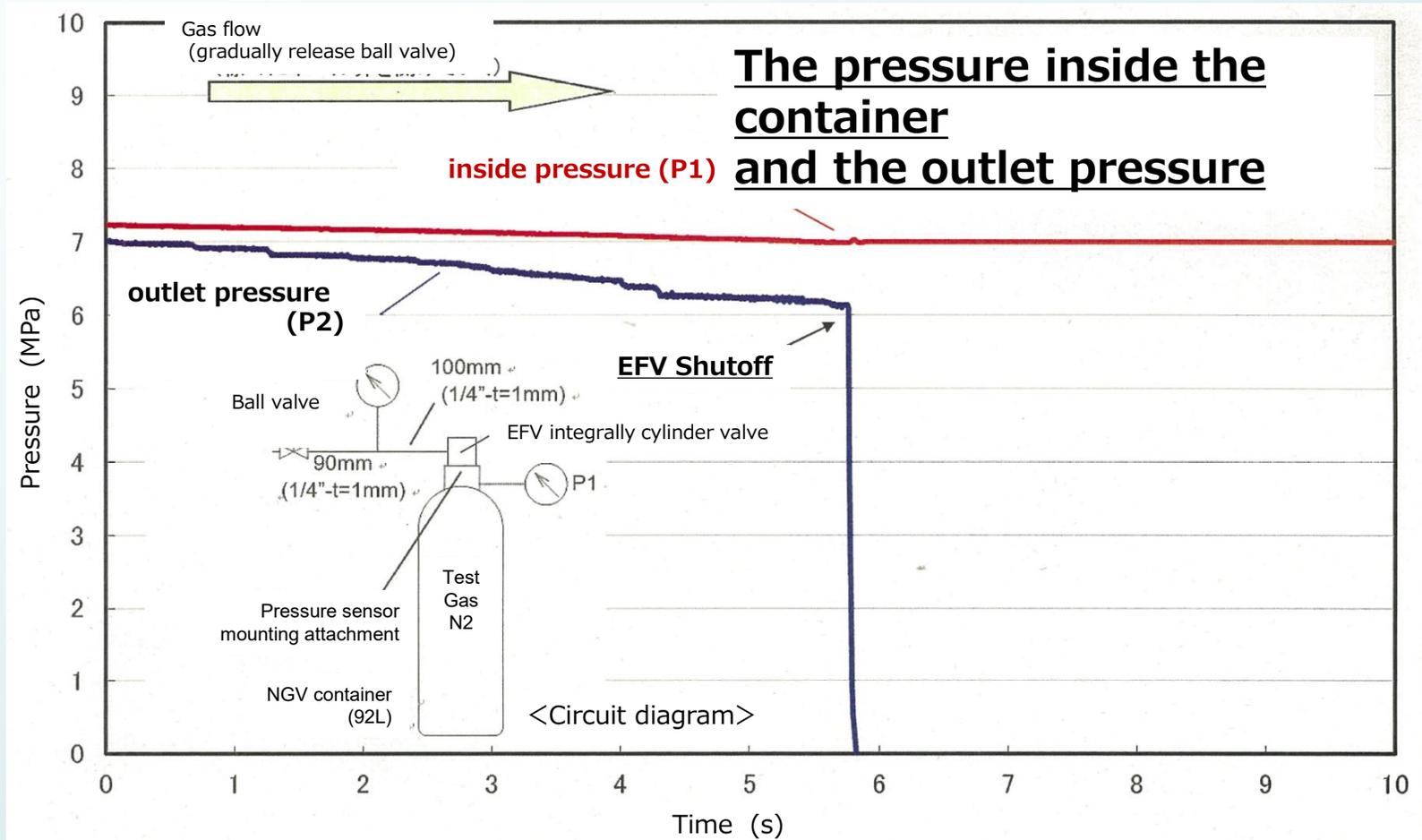


Shut off gas flow when excessive flow occurs

Manual pushing push rod reset



Operation performance of fuel shutoff type EFV



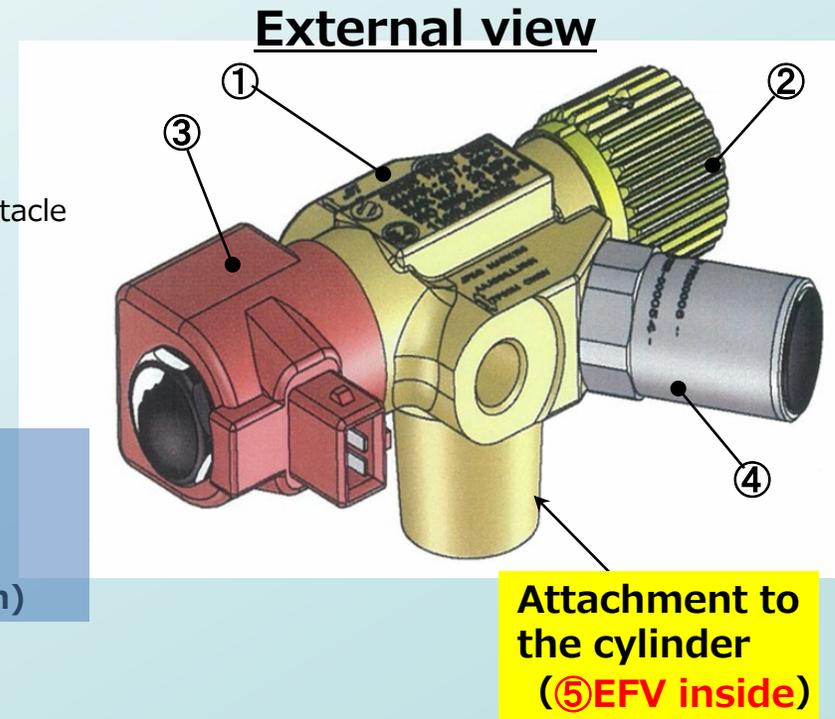
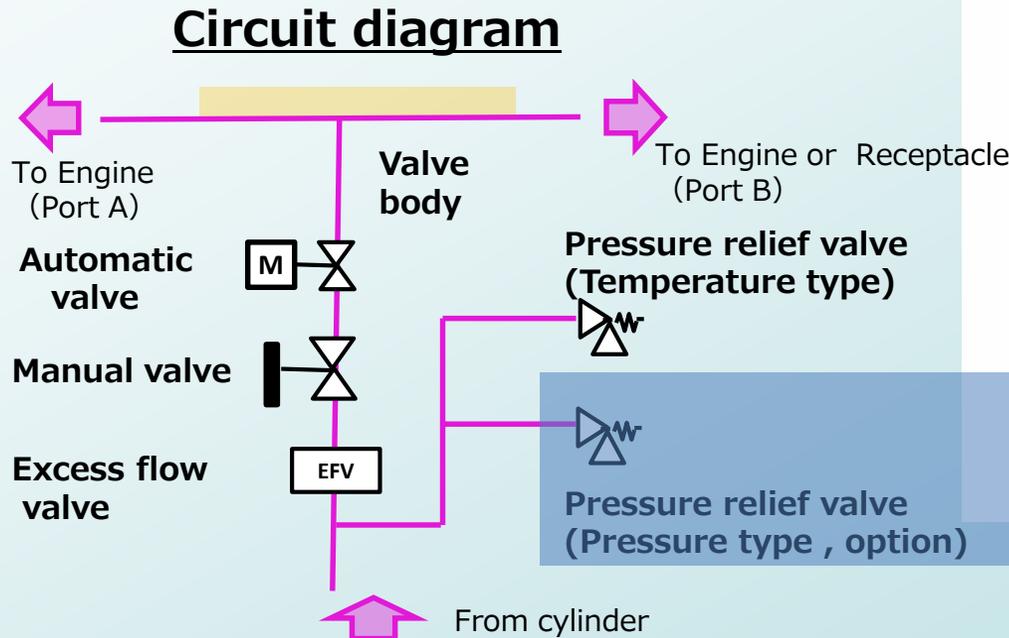


Example of a cylinder valve according to the current UN regulation No. 110 (made by EMER)

- ① Valve body
- ② Manual valve handle
- ③ Automatic valve coil
- ④ Pressure relief valve
- ⑤ Excess flow valve

Since the Excess flow valve is inserted in the threaded portion for attachment to the cylinder, it is difficult to break. On the other hand, the automatic valve is exposed to the outside.

Excess flow valves are more suitable than automatic valves, for preventing fuel outflow during accidents.





Assessment of Proposal

During discussion with experts following concerns have been raised on

(1) Setup of automatic valve (AV)

- adds potential leaking points upstream of the AV
- slow leaks cannot be avoided because they are not detected by EFVs

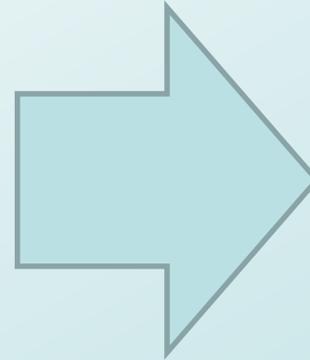
(2) Malfunction of EFV

- access to reset EFV
- how to detect if there is gas inside the cylinder

(3) Harmonization with ISO

Concerns seem to come from reflecting partial points of view.

Risk assessment was made considering both configuration (with/without shut off type EFB) and various cases of possible accidents, events/operations and the risks in each case.



Risk Assessment (next slides):

- Case 1 Malfunction of EFV
- Case 2 Slow leak in enclosed parking places
- Case 3 Pipe break (just after AV)
- Case 4 Pipe break (just after AV) with malfunction of AV or pressure switch (AV open)
- Case 5 Cylinder dropout (cylinder valve survive)
- Case 6 Cylinder dropout (only PRD and EFV survive)



Risk Assessment: Concerns about potential leak points upstream of the Automatic Valve

Connection points upstream of AV exist and are allowed in UNR and ISO.

PRDs for cylinders of long length are assembled by extending from the opposite end of the cylinder with piping connection.

UNR110 provides methods of bonfire test.

UNR110 Annex 3A – Appendix A

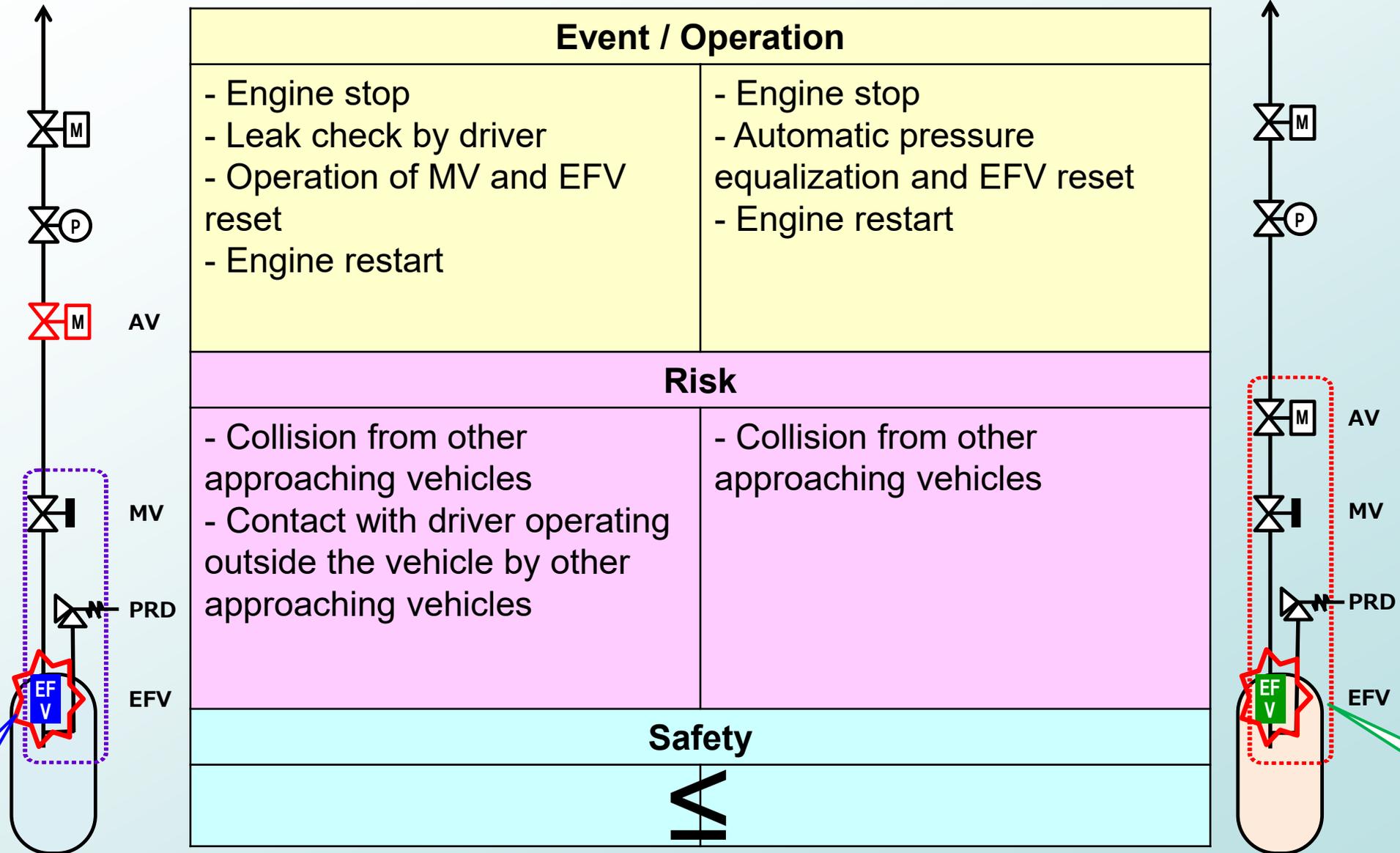
A.15.7. Cylinders greater than 1.65 m length

If the cylinder is fitted with a pressure relief device at one end, the fire source shall commence at the opposite end of the cylinder. If **the cylinder is fitted with pressure relief devices at both ends, or at more than one location along the length of the cylinder**, the centre of the fire source shall be centred midway between the pressure relief devices that are separated by the greatest horizontal distance.

If the cylinder is additionally protected using thermal insulation, then two fire tests at service pressure shall be performed, one with the fire centred midway along the cylinder length, and the other with the fire commencing at one of the cylinder ends.



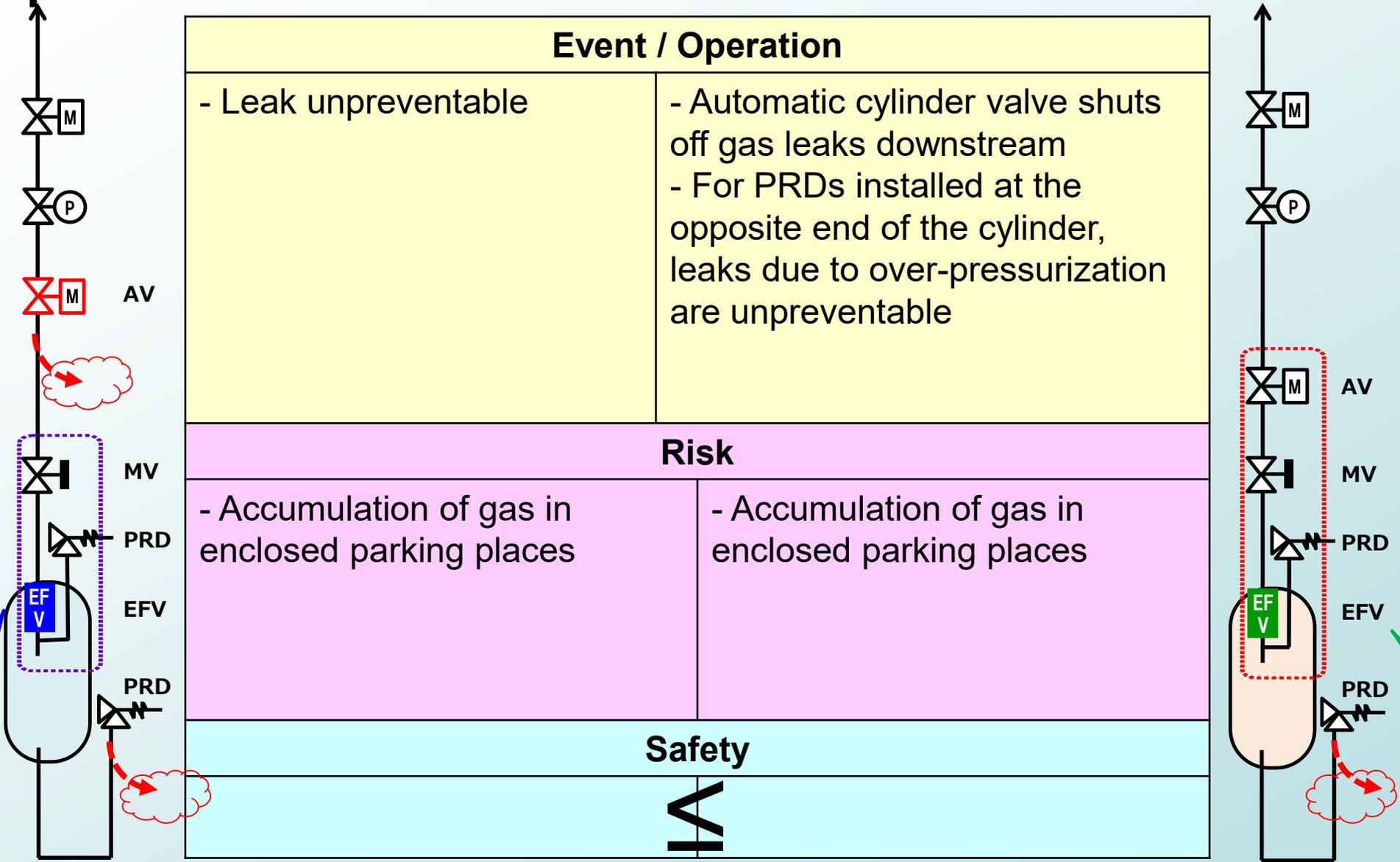
Risk Assessment Case 1 Malfunction of EFV



Shut-off type

Pressure-equalization type

Risk Assessment Case 2 Slow leak in enclosed parking places

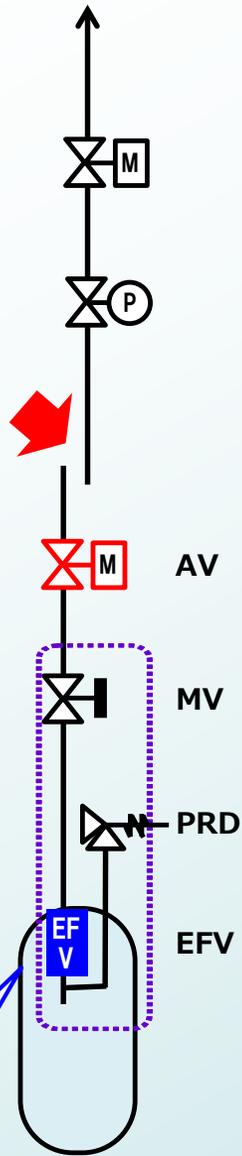


Shut-off type

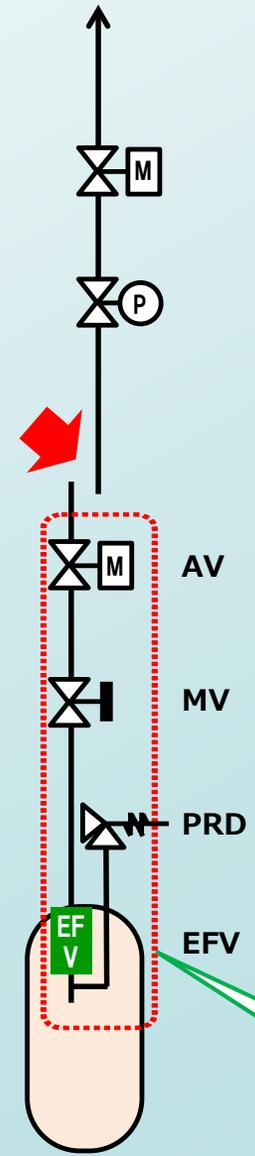
Pressure-equalization type



Risk Assessment Case 3 Pipe break (just after AV)



Event / Operation	
<ul style="list-style-type: none">- Engine stop- Shut-off by EFV or manual reset- Confirmation by driver and proceed to accident handling	<ul style="list-style-type: none">- Engine stop- Automatic pressure equalization and EFV reset- Confirmation by driver and proceed to accident handling
Risk	
<ul style="list-style-type: none">- Less possibility of misjudging EFV malfunction, by visual observation- Engine restart only occurs when misjudges malfunction	<ul style="list-style-type: none">- Driver misjudges malfunction of EFV and repeat trying engine restart
Safety	
=	

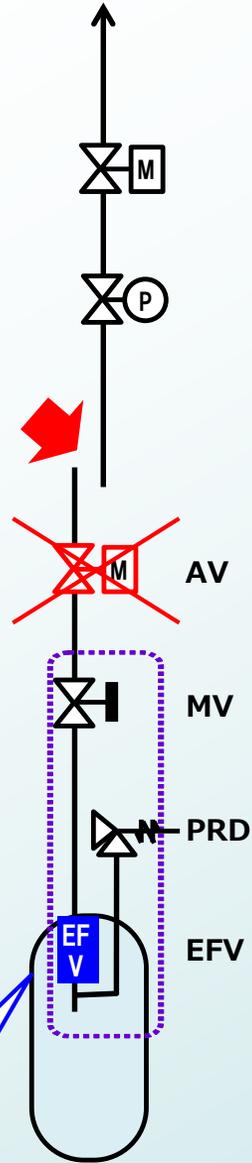


Shut-off type

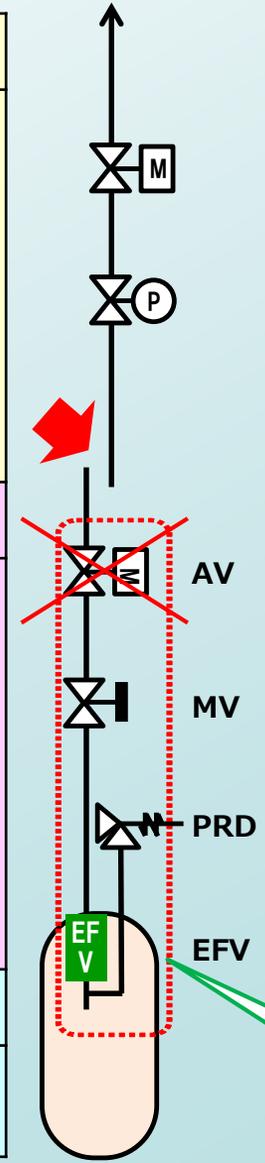
Pressure-equalization type



Risk Assessment Case 4 Pipe break (just after AV) with malfunction of AV or pressure switch (AV open)



Event / Operation	
<ul style="list-style-type: none">- Engine stops- Continuous shut-off by EFV- Driver proceeds to accident handling	<ul style="list-style-type: none">- Engine stops, continuous leak- Driver evacuates or operates MV- When MV is shut, driver proceeds to accident handling
Risk	
<ul style="list-style-type: none">- Small gas leak by fast response of EFV	<ul style="list-style-type: none">- Ignition of leaking gas (Driver injury when operating MV)
Safety	

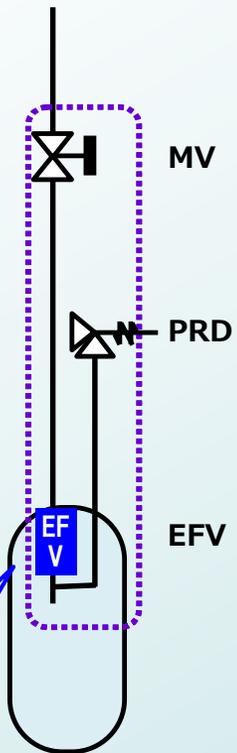


Shut-off type

Pressure-equalization type

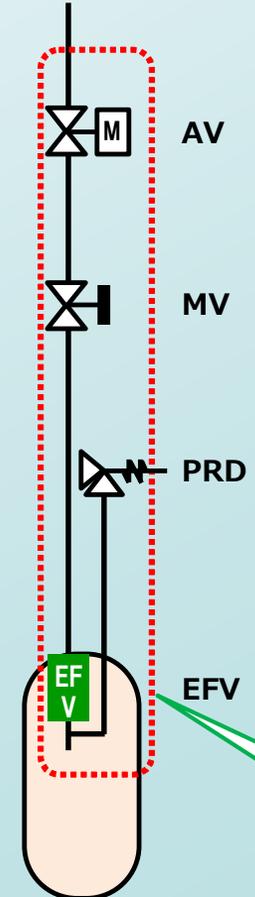


Risk Assessment Case 5 Cylinder dropout (cylinder valve survive)



Shut-off type

Event / Operation	
<ul style="list-style-type: none">- EFV activated- Continuous shut-off by EFV- Gas residual found by close MV -> open MV	<ul style="list-style-type: none">- EFV activated- Pressure equalization to AV and reset EFV (AV shut off gas leakage)- Gas residual found by close MV -> open AV -> open MV
Risk	
Safety	
=	

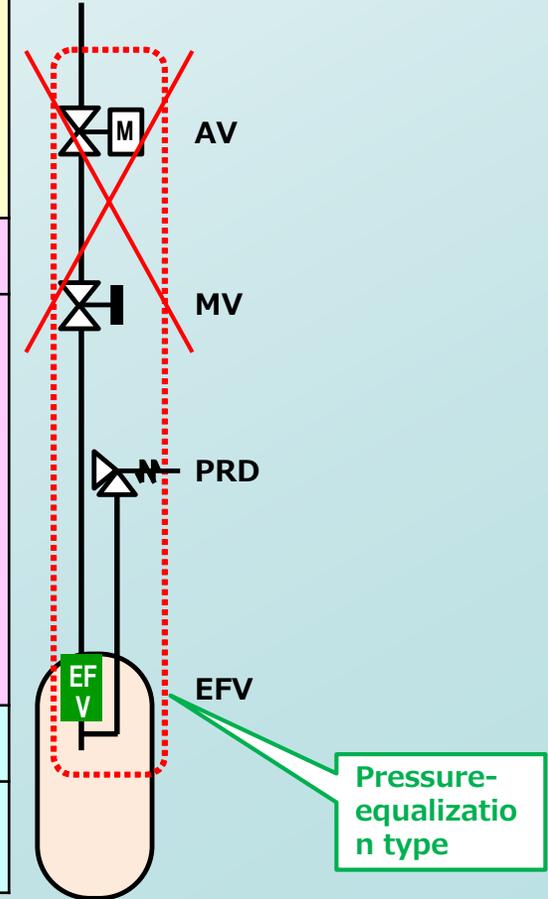
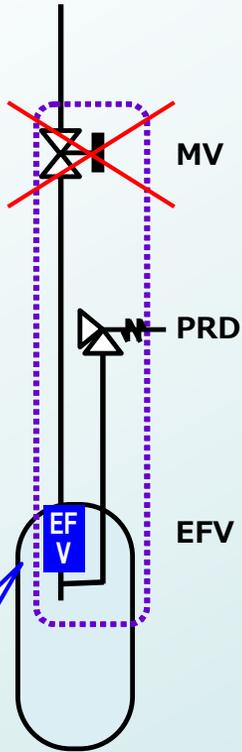


Pressure-equalization type



Risk Assessment Case 6 Cylinder dropout (only PRD and EFV survive)

Event / Operation	
<ul style="list-style-type: none"> - No gas leakage - Professional skill necessary to treat 	<ul style="list-style-type: none"> - Continuous gas leak until the cylinder becomes empty, and no way to shut off - Prevent fire spread, and evacuate
Risk	
<ul style="list-style-type: none"> - Gas eruption or cylinder rupture when disposing cylinder (but just at specialized sites) 	<ul style="list-style-type: none"> - Ignition of leaking gas
Safety	



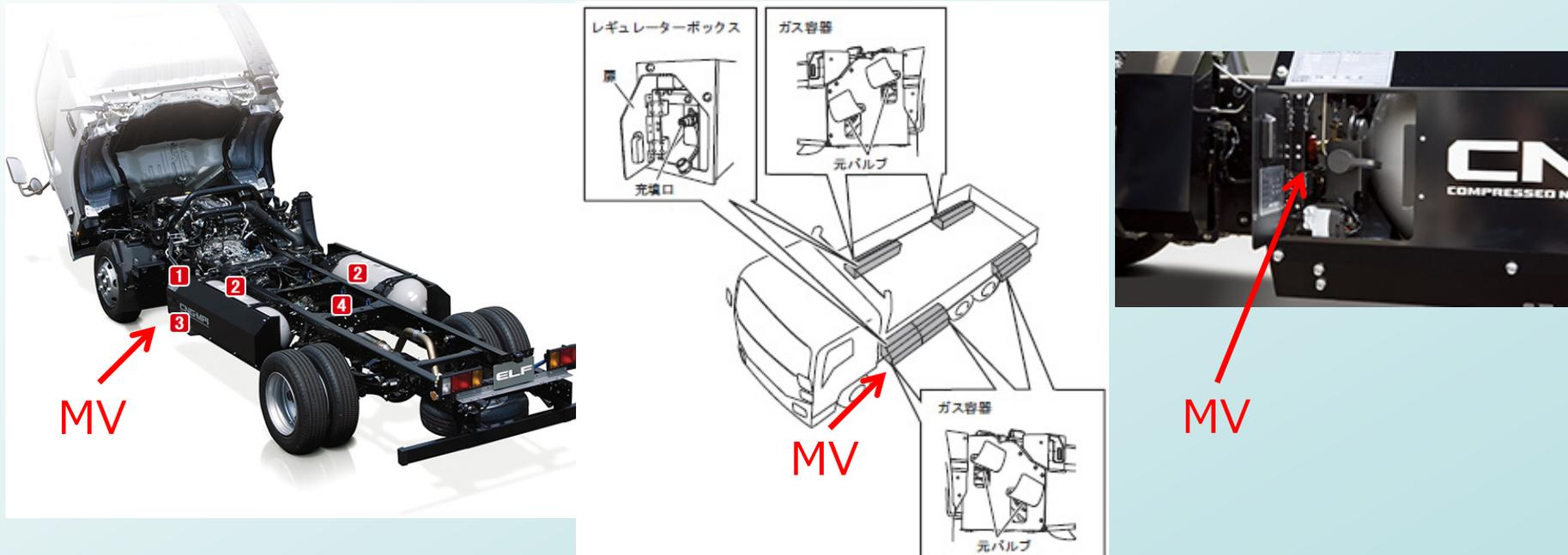


Assessment: Accessibility to reset shut-off type EFVs

EFVs

For some vehicles it is actually easy to access and operate manual valves.

Shut-off type EFVs should be allowed based on the ease of access by the configuration of assembly.





Assessment on Harmonization with ISO

ISO15501-1 requires Automatic Valves installed “directly” on cylinder, not “rigidly”.

“Directly” should be interpreted “without other components in between (just piping allowed)”.

4 Requirements

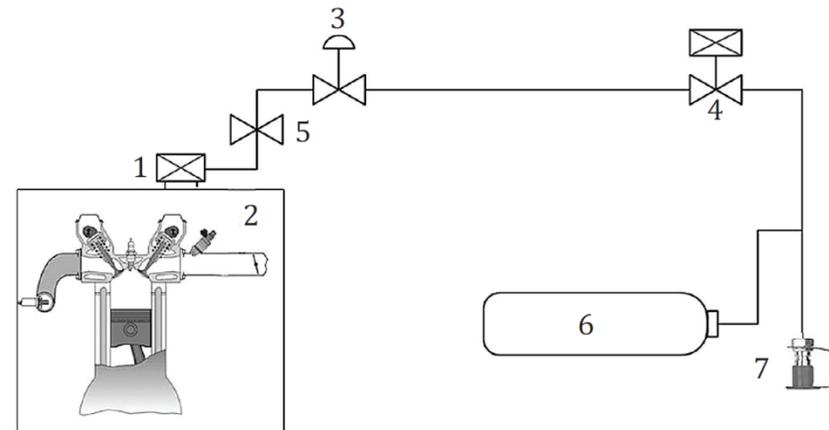
4.1 Design

4.1.1 General

The CNG on-board fuel system shall include the following:

— an automatic valve to be installed directly on every CNG cylinder with a manual valve rigidly fixed to the CNG cylinder, which may be integrated into the automatic valve.

Annex B



Key

- 1 gas/air mixer (or gas injection system)
- 2 engine
- 3 pressure regulator
- 4 main shut-off valve
- 5 PRV (safety device to prevent overpressure)
- 6 gas cylinder + cylinder valve + PRD
- 7 refuelling receptacle



Risk Assessment Conclusion

Safety depends on accident case.

“Separated AV and Shut-off type EFV” are judged generally safe.

The proposal harmonizes with the ISO provisions.

The potential risks can be limited by:

- Length of connection piping
- Number of connection points



Example of an accident in Japan proves safety of the valve configuration with shutoff type EFV.

- A truck caused the metal cover of a roadside gutter to come loose and strike a cylinder valve, causing it to break.
- One of the two fuel pipe fittings dropped, and another deformed.



- Nevertheless, an outflow of fuel was blocked thanks to the shutoff type EFV.