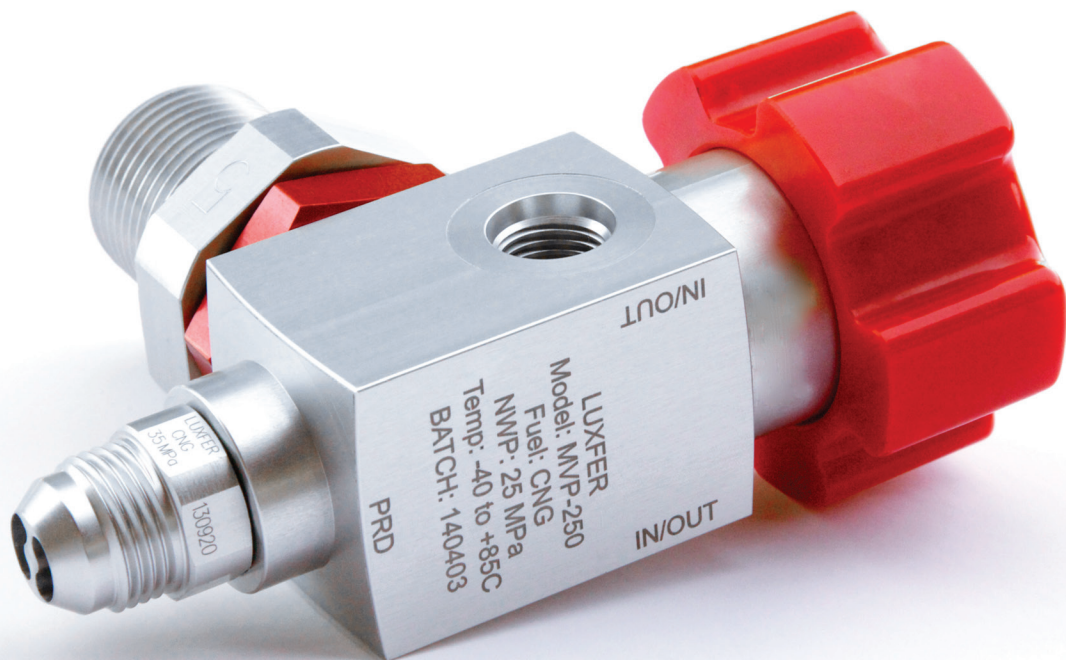


# Operation Manual

# **S-OP-MPV**



MVP SERIES 1-TURN VALVES

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## 1. Overview: MPV Series

- a. **High flow indexable valve** The Luxfer MPV series is a family of high-flow manual cylinder valves. The valve has two inlet ports ( $\frac{3}{4}$ "-16 ORB), two live ports (9/16"-18 ORB), an indexable stud and a proprietary PRD port. There are interchangeable studs for all Luxfer cylinder neck sizes. The PRD port may be plugged or equipped with a Luxfer high-flow PRD.
- b. **Design variants** This manual covers 3 design variants. They differ by the over-torque tolerance of the manual valve. The variants are:
- Original valve
  - Original valve with field upgrade
  - Current valve with factory upgrade

Their external appearances are identical except for ① the knob's height above the valve, ② a shoulder washer's presence on the top of the knob and ③ small engraving differences. They are depicted below (shown with no PRD) and summarized in Table 1 (also see Table 3 below).

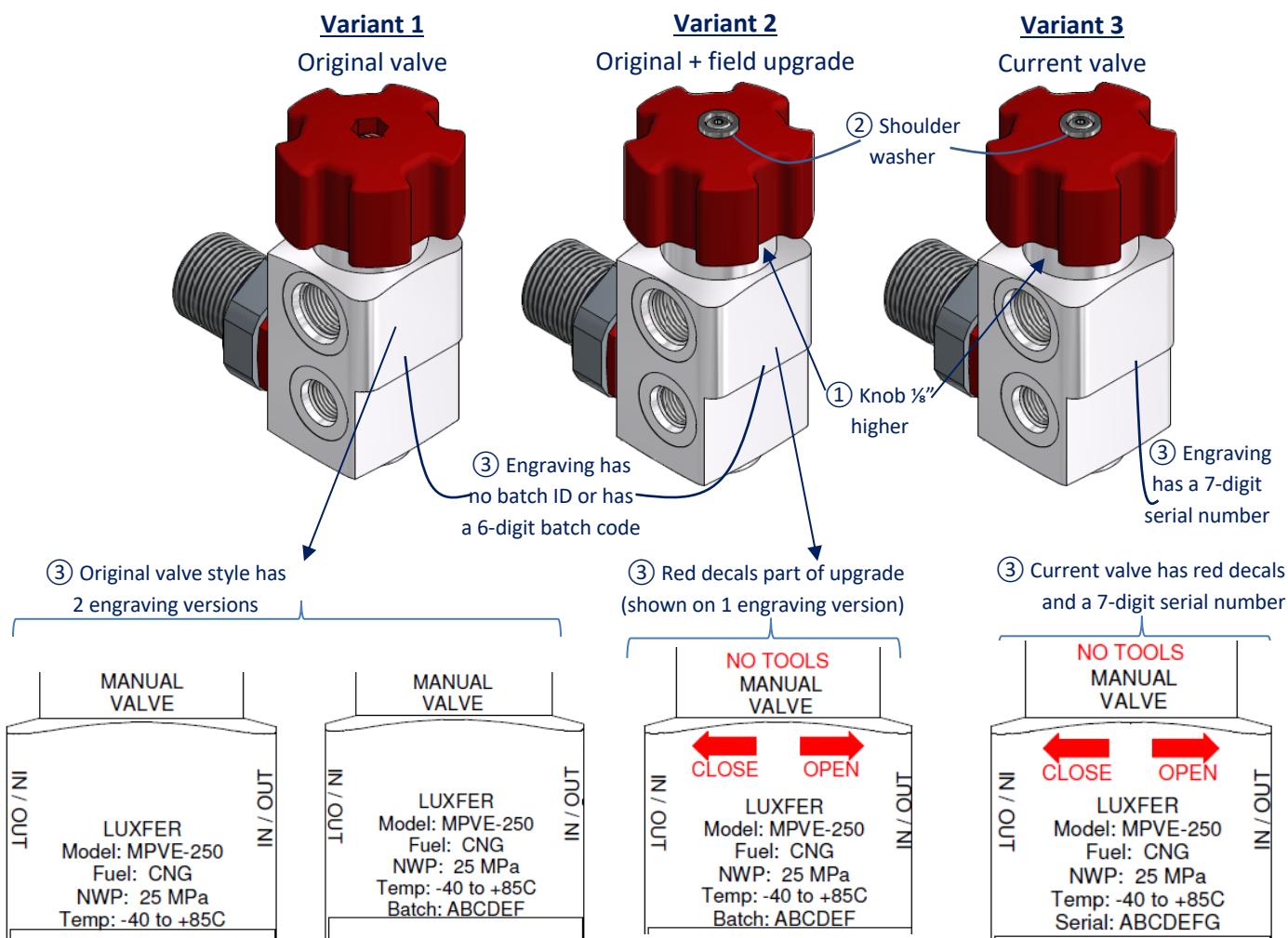


TABLE 1: MPVE-250 Design variants						
Design Variant	Unique engraving	Knob upgrade	Packing nut	Relative over torque limit	Knob height	Knob gap (closed/open)
1	No batch no. or 6-digit batch no.	No	n/a	100%	Base-line	0.40"/0.54"
2		Yes		200%	+1/8"	0.52"/0.64"
3	7-digit serial no.	Yes	Yes	> 400%		0.52"/0.67"

## 2. Safety & Proper Use

### a. Valve use



**WARNING:** HAND OPERATE ONLY. DO NOT USE TOOLS ON THE KNOB.

Valve is **OPEN** by turning counterclockwise (CCW) **1-TURN ONLY**. Valve is **CLOSED** by turning clockwise (CW) **1-TURN ONLY**.



**WARNING:** DO NOT APPLY EXCESSIVE TORQUE. For reference, maximum allowed torque is 45 in.-lbs.

Valve will open and close with hand torque **ONLY** and will be confirmed by positive stop of the handle. If in doubt, the valve's opened/closed state can be confirmed by measurement (see Table 3, below).



**WARNING:** DO NOT force knob past its positive stops (~1 turn between the open and closed positions). This can create unsafe conditions.

### b. Over-Torque & Knob Damage



**WARNING:** Torques greater than the maximum specified are unnecessary and can damage the valve and in extreme over-torque cases might create unsafe conditions.

High over-torques can split the knob into 2 or 3 pieces. A cracked or split knob does not affect valve sealing; however, it indicates excessive torque applied to the knob. Replace a cracked or split knob immediately.



## 3. Proprietary statement

This product is produced by Luxfer. The information disclosed in this document is proprietary to Luxfer. The rights, obligations and duties of the installer, customer are controlled exclusively by the original purchase agreement and warranty. Luxfer assumes no liability for errors or for any damage that result from the use of this document.

#### 4. Limited warranty

Refer to the Luxfer limited warranty section in the standard terms and conditions of sale.

#### 5. General description

The MPV series is a family of high flow, lightweight, aluminum cylinder valves (manual valves). They mount in the cylinder neck and isolate the cylinder from the rest of the fuel system. They may optionally include a PRD and/or an excess flow valve (EFV). The MPVE-250 valve is shown in cross-section in Figure 2.

- a. **Manual valve operator** the manual valve operator is the valve's flow control device. It has a life expectancy >2,000 cycles. It is the yellow feature in the cross-section below (Figure 2) and is shown closed. It may be opened or closed at any pressure. The operator moves ~1 turn between opened to closed.

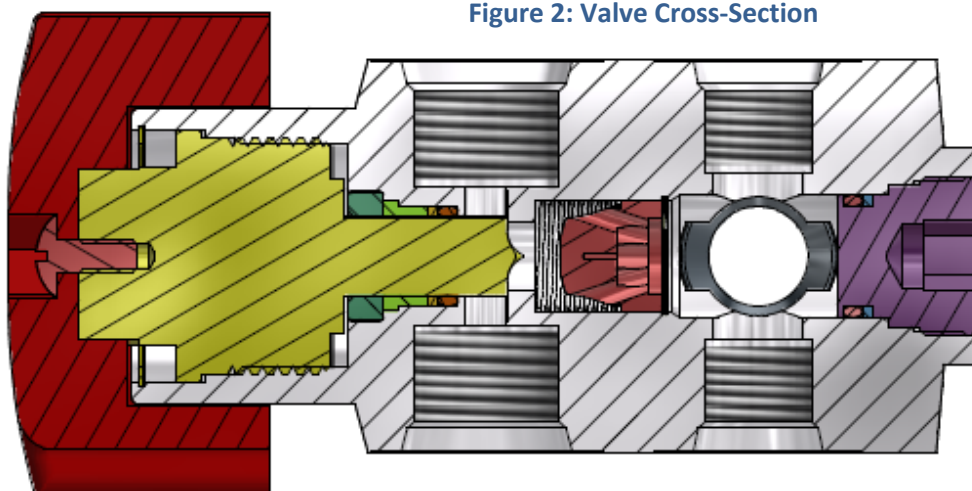
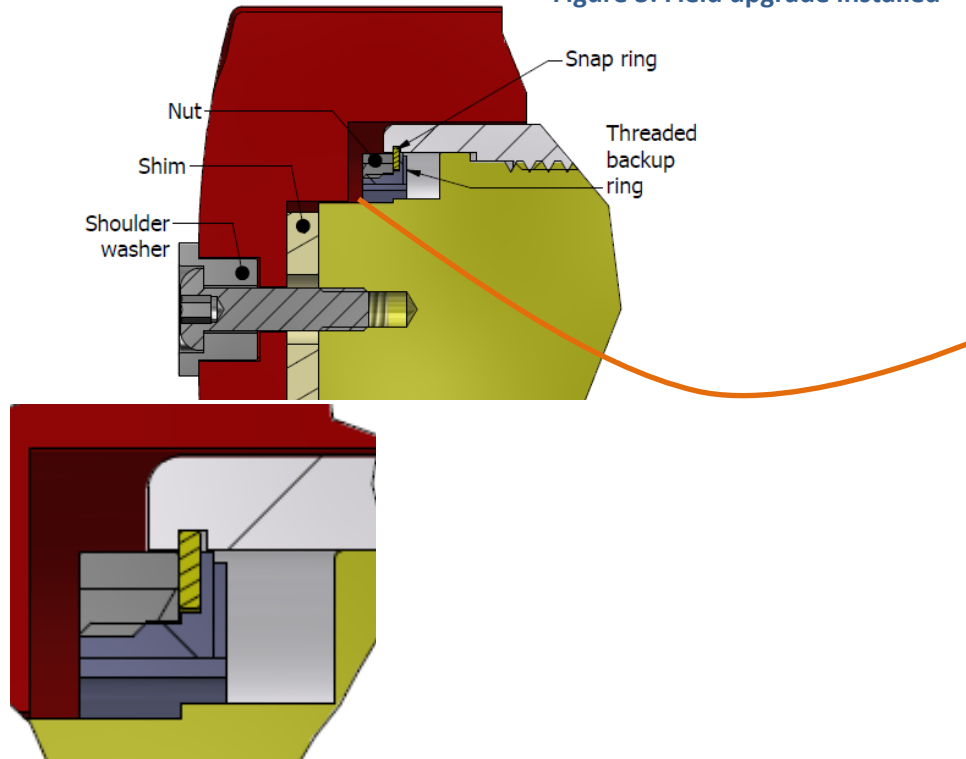


Figure 2: Valve Cross-Section

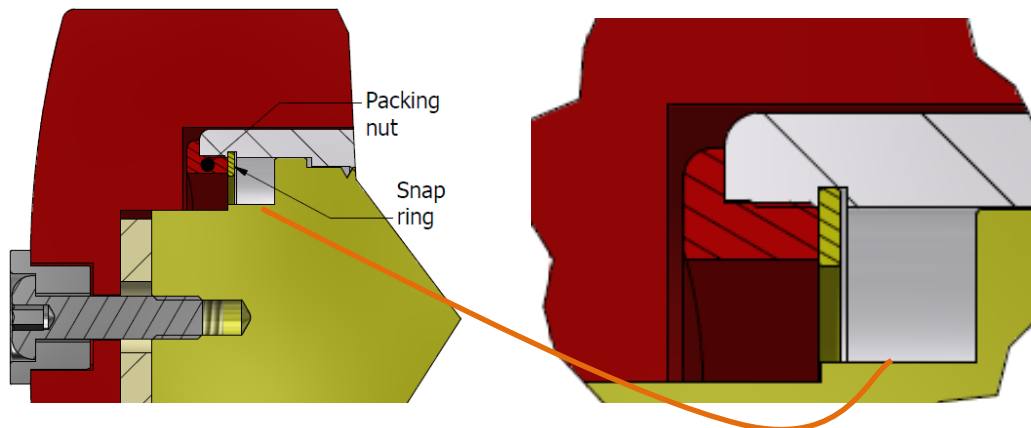
- i. **Field upgrade** Valves made before July 2018 can be fitted with a complimentary upgrade kit which doubles the valve's over-torque tolerance. That kit includes knob enhancements and a threaded back-up ring /nut for the valve's snap ring. The installed kit is depicted in Figure 3's cross-section.

**Figure 3: Field upgrade installed**



- ii. **Factory upgrade** All valves made since July 2018 have a design upgrade that increases the valve's over-torque tolerance to  $>4\times$  the original valve's limit. That version has the same knob enhancements as shown above plus a packing nut located above the snap ring. That factory installed upgrade is depicted in Figure 4's cross-section, below. It cannot be installed in valves made before July 2018.

**Figure 4: Factory installed upgrade**





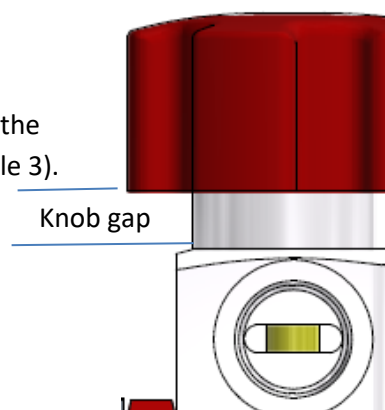
- iii. **Flow vs opening** the MPVE-250 series has a very high flow capacity. Its rated CV is 2.0. That flow is delivered at openings of  $\frac{5}{8}$  turn (225°) or more. There is no performance benefit to torqueing the valve hard against its full-open stop. That is, the vehicle won't fill faster; full flow will not occur at a lower tank pressures; higher horsepowers will not be supported.

Very few systems utilize the valve's full capacity. That is, both the filling and withdrawal systems have appreciably less capacity than the valve. The following example portrays this. Consider a 1-tank system with only 200 psi in the tank and operating at 400 horsepower output. The pressure drop across the valve would change by 0.27 psi between 5/8 turn and the maximum-open position (~1.07 turns).

<b>TABLE 2: Pressure drop across valve at 400 BHP: Valve openings of 5/8 turn and ~1.07 turns</b>	
Factor	Value
Engine output:	400 horsepower
Tank pressure:	200 psi
CNG flow rate	17 grams/sec
Active valves:	1 (i.e. a 1 tank system)
Valve pressure drop @ 400 BHP/200 psi in	0.88 psi @ max opening
	1.15 psi @ 5/8 turn open
<b>Pressure difference</b>	<b>0.27 psi (5/8 vs 1.07 turns)</b>

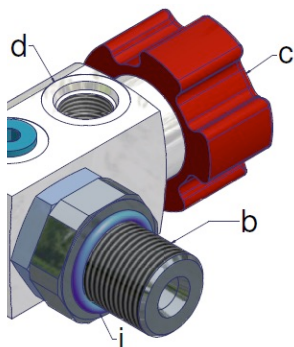
- iv. **Gage-able valve** the open/closed status of the MPVE-250 series can be determined by the gap between the the bottom of the knob and the valve's shoulder (see Table 3).

<b>Table 3: Knob Gap</b>			
State	Variant 1	Variant 2	Variant 3
Open	0.54"	0.64"	0.67"
Closed	0.40"	0.52"	0.52"



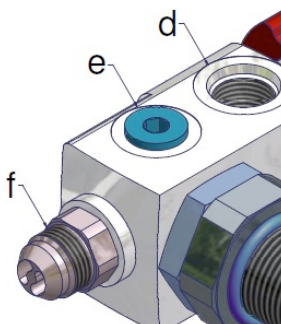
- b. **Indexable studs** the MPV series has interchangeable studs for 3-cylinder neck sizes: 1 $\frac{1}{8}$ "-12; 1 $\frac{1}{2}$ "-12; 2"-12. All are O-ring sealed. A jam nut permits indexing /clocking the valve within a 370° adjustment window for optimum plumbing alignment.

- c. **Hand wheel** the operator requires ~1 turn from opened to closed and is turned by a red hand wheel. As discussed above, the optimum operating range is anywhere from 5/8 turn to 1 turn from the closed position. There is no benefit from torqueing the handwheel hard against the fully-opened stop. **ONLY TURN HANDWHEEL BY HAND. DO NOT USE TOOLS ON THE HANDWHEEL.**

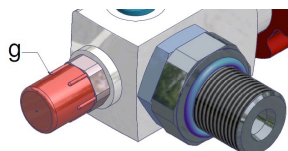


- d. **Inlet ports** the MPV series has 2 inlet ports (left & right). They are in the SAE J1926 form. Those are also known as ORB ports (O-Ring sealed Boss). These high flow ports are bi-directional: gas enters and exits the cylinder through them. They accept light-duty and heavy-duty fittings. They are isolated from cylinder pressure when the manual valve is closed. These ports can facilitate series plumbing of valves (daisy-chaining). Any unused inlet ports must be plugged.

- e. **Live ports** the MPV series has 2 high flow Live Ports (left & right), also in the SAE J1926 form (i.e. ORB ports). Live ports can be used to mount gauges/sensors or to source gas to remote PRD's. Live Ports CANNOT be isolated from cylinder pressure. Never loosen a device or fitting in a Live Port when the cylinder is pressurized (unsafe). Unused Live Ports must be plugged. The basic port has a very high Cv (4.57) for sourcing remote PRD's. However, common 9/16"-18 fittings have much smaller bores (~0.280") and will typically reduce the effective Cv to  $\leq 2.0$ .

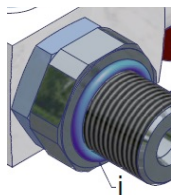
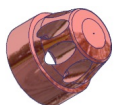


- f. **PRD** the MPV series can accept a Luxfer-proprietary PRD port. The PRD port cannot be isolated from tank pressure. It may be either plugged or be populated with Luxfer's self-venting PRD. The plug or PRD should never be loosened when the cylinder is pressurized (unsafe). Commercial PRD's do not fit in the PRD port. Luxfer's PRD uses a glass thermobulb trigger (102°C, 110°C options). When triggered, gas vents thru 2 kidney-bean shaped holes in the PRD. The outlet end of the PRD is formed as a 37° flare fitting for 1/2" tube (3/4"-16 threads). The PRD may vent directly to atmosphere or be plumbed away. A vent tube, if used, mounts to the PRD with a 37°-flare tubing nut.



- g. **PRD Dust Cap** the PRD must be protected from foreign contaminants always. The release point, whether direct venting or plumbed away, must have a vented dust cap installed. The PRD is supplied with a vented, threaded, plastic dust cap. Its vent feature (weep hole) allows permeation gas to escape while keeping contaminants out of the PRD. The cap blows off if the PRD vents.

- h. **EFV** The MPV series may be equipped with an optional excess flow valve (EFV). The EFV is internal (not visible; located behind the PRD). It is not field serviceable. The EFV is calibrated to customer specific selections for tubing ID, minimum pressure and mass flow rates. The EFV has a small reset orifice (0.15mm) which creates a very low, continuous, "by-pass" flow. That flow resets the EFV once the leak has been corrected. The EFV has a life > 1000 triggering events.



- i. **O-Ring** The stud O-ring on the MPV series uses an ultra-low temperature compound and has special processing for high pressure gas usage. Only use the specified Luxfer O-ring. Substituting commercial O-rings voids the warranty.



## 6. Nomenclature

- a. **37° flare** a hydraulic tube-end format per SAE J533b. The inside of tube has a conical seating face at a 37° angle. Mating fittings are per SAE J514 fittings (also known as JIC fittings). The 37° flared tube seals against a 37° conical section on the male part (without O-rings or ferrules).
- b. **EFV** excess flow valve. A normally free flowing safety valve which closes in the event of excess flow (e.g. high-pressure line shear). EFV's minimize loss of contents. Luxfer's EFV has a small bleed orifice (0.15mm) to automatically reset the EFV once the excess flow condition has stopped.
- c. **Hand wheel** the plastic knob used to open/close the manual valve operator.
- d. **Inlet port** a bidirectional, threaded port thru which gas enters/exits the cylinder. The inlet ports can be isolated from cylinder pressure by closing the manual valve operator.
- e. **Jam nut** a 1½" hex lock nut located between the stud's hex and the valve head. It is loosened to position the valve ahead, then tightened against the valve head to lock it in position.
- f. **Live port** a threaded port connected directly to cylinder pressure. This port cannot be isolated. It is used for gauges, sensors, and to source gas to remote PRD's. It is not for filling.
- g. **Manual valve operator** the valve's internal flow control device which allows or prevents flow to/from the cylinder. It is operated by the hand wheel.
- h. **MPV series** the model designator for this valve series (i.e. MPV).
- i. **PRD** a thermal pressure relief device. In the event of a fire the PRD permanently triggers, releasing a piston to vent the cylinder. Luxfer's PRD uses a fluid filled glass thermobulb as the trigger element. It shatters at the trigger temperature, releasing the vent piston. The PRD cannot be isolated from cylinder pressure.
- j. **Stud** the male threaded valve part which mounts the valve to cylinder neck. The stud includes threads, an O-ring gland, and an O-ring.
- k. **Thermobulb** a fluid filled glass bulb which shatters at a predetermined temperature (102°C or 110°C). The thermobulb is very strong in axial compression.
- l. **Valve** the complete MPV assembly
- m. **Valve body** the rectangular aluminum body which houses the ports, stud, manual valve operator, PRD and excess flow valve.
- n. **Vent cap** a ¾"-16 threaded plastic cap with Ø0.25mm weep hole used to keep contaminants out of the PRD's outlet chamber.
- o. **Vent tube** a ½" OD tube attached to the PRD outlet to pipe away vented gas. The tube end is flared 37° per SAE J533b and attached to the PRD by a tubing nut (DAL1444).

## 7. Model Number Key

The MPV series model numbers contains user information, as decoded in the following table. The table uses the model number **MPVE-350-5-04-1** as an example.

TABLE 1: MPV Series Model Number Key		
Symbol	Factor	Optional choices
<b>M</b>	Valve type	M = manual cylinder valve
<b>P</b>	Safety 1	P = thermobulb type PRD
<b>V</b>	Control	V= 1 turn; P= ¼ turn
<b>E</b>	Safety 2	E= excess flow valve
<b>-350</b>	NWP (bar)	250; 350; 450
<b>-5</b>	Stud class	5= 1½"-12; 6= 1½"-12; 8= 2"-12
<b>-0</b>	Live port class	0=SAE heavy duty; 1= SAE light duty
<b>4</b>	Live port place	1= none; 2= left; 3= right; 4= left & right
<b>-1</b>	PRD trigger	0= 110°C; 1= 102°C

## 8. Specifications

TABLE 2: MPV Series SPECIFICATIONS		
Factor	Units	MPV-250-5
Stud thread (ANSI size)		1½"-12
Stud torque	N•m / (Lb.-ft)	230 – 260 / (170-190)
Jam nut torque	N•m / (Lb.-ft)	120 / (88½)
Hand wheel torque	N•m / (lb. • in)	≤ 5.1 / (≤ 45.1) at all temperatures, pressures
NWP / MWP	bar	250 / 312
	psi	3625 / 4530
Overpressure (burst)	bar	1380
	psi	20,000
Operating temperature	°C	-40° to +85°
	°F	-40° to +185°
Valve Cv		2.0
Live port Cv		4.57 (lower with a fitting installed)
PRD trigger	°C	102°C or 110°C (user options)
PRD vent flow: scfm of air	@100 psia	79
	@100 psig	90
Leakage	Ncc/hr.	< 10 per potential leak site

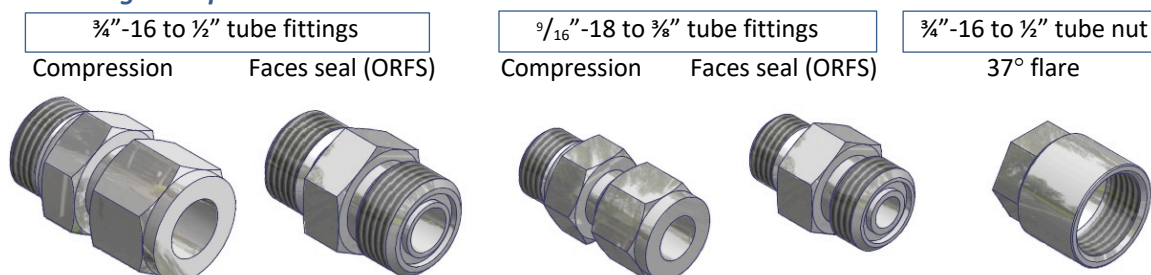
## 9. Ports / Mating fittings

- Inlet** the inlet ports are ¾"-16 UNF SAE ports (ORB ports) and accept standard fittings.
- Live Ports** the Live Ports are 9/16"-18 UNF SAE ports (ORB ports) and accept standard fittings.
- PRD vent** the PRD is a 37° flare fitting for ½" OD tubing (¾"-16 UNF male threads). Luxfer' s tubing nut DAL1444 is preferred for attaching flared tubing.

d. **Standard fitting torques**

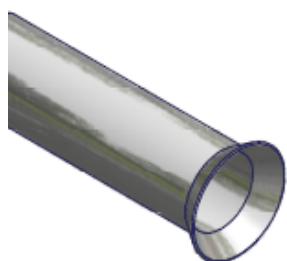
TABLE 3: Standard Fitting Torques					
Valve Feature	Thread size	Thread type	Compatible fitting types	Fitting torque	
				N•m	Lb.-ft
Inlet port	¾"-16 UNF	Female (ORB)	Commercial & SAE (ferrule, ORFS)	68-78	50-60
Live port	9/16"-18 UNF			33-35	24-26
PRD vent	¾"-16 UNF	Male	Luxfer flare nut	30	22
			J514 37° flare nut	49-53 <sup>1,2</sup>	36-39 <sup>1,2</sup>
Note 1: some SAE/JIC adapters and/or nuts may require DAL1844 flare insert due to their extra thread depths					
Note 2: commercial 37° SAE/JIC nuts or adapters may be used. If torques >30 Nm /22 lb.-ft are applied care must be taken if/when loosening such parts. A loosening torque ≥ 35 Nm will loosen the PRD, which will then leak and need repair (not covered by warranty). To avoid that use a 13/16" wrench on the PRD's wrench flats to absorb the torque reaction.					

e. **Fitting examples**

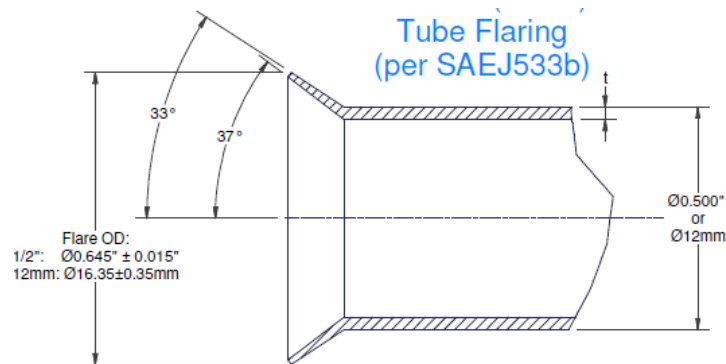


## 10. PRD venting

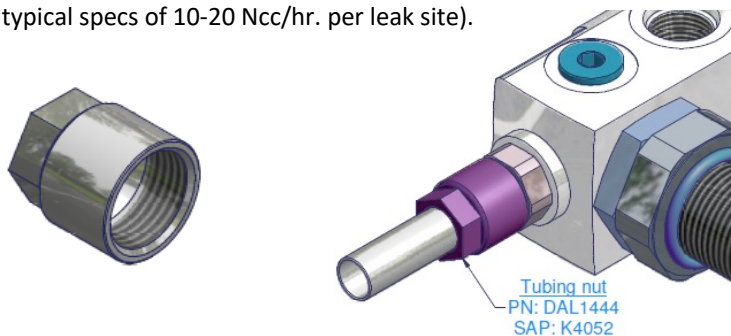
- a. **Tubing size** a vent tube, if used, may be either 12mm OD or 1/2" OD (the preferred size). Their walls may not exceed 1.5mm / 0.065" respectively. Smaller tube OD's are not permitted as they may make the PRD sub-sonic and thus reduce its vent flow. With the specified tube sizes, the PRD is sonic. In that state, the number of tubing bends and vent line length CANNOT impact flow.
- b. **Tube material** 316 stainless tubing is recommended.
- c. **Wall thickness** relatively thin walls have adequate burst strength for this application. With a sonic PRD, the vent tube pressure is  $\approx 50\% \cdot P_{\text{tank abs}}$ . For example: if venting at 4500 psig, the vent pressure would be  $\leq 2243$  psig ( $4514.5 \text{ psia} \div 2 = 2257 \text{ psia} = 2243 \text{ psig}$ ). The 2243 psi would exist only briefly, as tank pressure drops quickly during venting. A 1/2"x 0.035" tube would suffice for most applications (1/2"x 0.035"  $\rightarrow$  10,400 psi burst). For many applications, 1/2"x 0.028" may suffice.



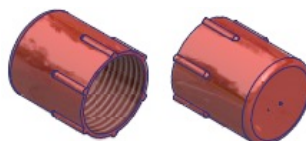
- d. **Flare details** standards do not dictate gas tight seals for vent line connections. However, gastight is feasible, if desired. Gas tight joints require vent tubes to be flared properly and to be of high quality. SAE J533b specifies the flaring process and requirements (concentricity, workmanship, surface quality). Note: the inside and outside of the flared zone have slightly different angles: 37° and 33° (see below). The seating surface must be free of scratches, flaws and contaminants.



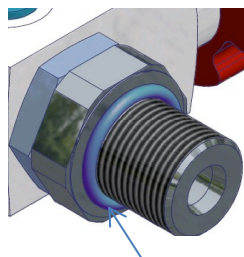
- e. **Tubing nut** PRD's that are plumbed away use a tubing nut to attach the 37° flared vent tube to the PRD. An example is shown below, with Luxfer's 1-piece tubing nut DAL1444. As noted in the table above, the recommended torque is 30 Nm (22lb-ft).
- f. **Torque vs tube quality** Excessive torque will not create a gas tight seal with a poorly formed stainless steel tube. As a 316 tube is stiffer/stronger than the aluminum PRD, excess torque usually just deforms the PRD's seating face. Luxfer recommends tubing nut DAL1444 and 30 Nm of torque. Testing shows that a well-formed tube seals gas tight at 2250 psi backpressure at 30 Nm (i.e. <0.005 ncc/hr. of leakage vs typical specs of 10-20 Ncc/hr. per leak site).



- g. **Dust protection** water, dust, wheel toss and other contaminants are not allowed inside the PRD. Thus, the release point must be capped. The cap needs a 0.25mm weep hole to allow permeation gases to escape. The cap must blow off at ≤ 10 psi internal pressure. Luxfer's vent cap is a ribbed plastic cap with 3/4"-16 threads. It blows off at ~3 psi. Luxfer's cap survives direct application of high pressure carwash water-jets without loosening (if installed 60° past finger tight).



## 11. Installation instructions: VALVE



Apply Krytox  
GPL102 oil

- a. **Cleanliness** ensure the cylinder neck threads, cylinder neck O-ring gland, and valve stud threads are clean and undamaged. Do not install a stud with damaged threads. A stud with damaged threads must be replaced. Damaged threads cannot be repaired. Any repair action would remove the anodized layer and the stud could then gall in the neck of an aluminum cylinder, ruining the cylinder. Remove any visible contaminants from the threads.
- b. **Lube O-ring** Ensure the stud's O-ring (shown blue in image at the right; actual part is black) is clean and undamaged. A damaged O-ring must be replaced with a new Luxfer -50°C O-ring. Apply a light coating of Krytox GPL102 oil to the OD of the O-ring immediately before installing the valve.

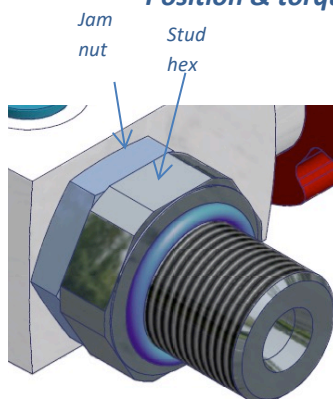
TABLE 4: O-ring Service Parts (-50°C rated)			
Stud thread	1½"-12	1½"-12	2"-12
O-ring size	-216	-025	-226
Luxfer P/N	DAL1425	DAL1571	DAL1381

- c. **Lube threads** refer to the cylinder's instructions. If a lube or anti-seize is required apply it per the cylinder manual's directions. However, in no case is lube or anti-seize to reach the O-ring during installation. Many such compounds will attack the O-ring long term and can cause subsequent leaks. The only lubes which are allowed to reach the O-ring are Krytox GPL 102 oil and Molykote HP300 grease.
- d. **Install valve hand tight** carefully insert the valve into the cylinder neck, engage the threads and turn valve CW (↻) all the way in by hand. Stop when it is hand tight (~12 turns). Do not use a power tool to spin the valve faster.
- e. **Torque valve** use a crowfoot wrench and torque wrench to tighten the valve to the specified torque level (see table). Extra-wide crowfoot wrenches may not fit in the gap between the cylinder neck and jam nut. The table has limits for wrench thicknesses. Do not use wrenches with undersized square drives as the wrench and/or socket extension may shear off at high torque, creating a hazardous condition for the installer. High quality crowfoot wrenches are increasingly difficult to find. Quite often their jaw openings exceed the ANSI limits. Modestly oversized jaw openings may result in unsightly rounding of the stud's hex-corners. That cosmetic situation can be avoided by using brass shim stock (0.001" to 0.010") to minimize any jaw-to-hex-flat gap.



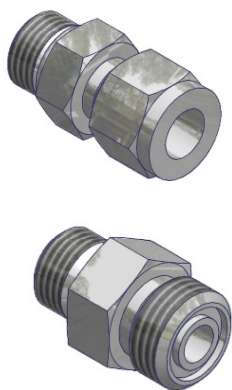
Stud size		1 1/2"-12	2"-12
NWP	Bar	250	250
	Psi	3625	3625
Torque	N•m	230-260	270-340
	Lb.-ft	170-190	200-250
Wrench size		1 1/2"	65mm
Wrench thickness		0.511" (13mm)	0.590" (15mm)

### Position & torque the valve



- use a 1 1/2" crowfoot wrench to loosen stud's **jam nut**: turn the nut CW (↻, tighten direction)
- turn the **jam nut** CW (↻) by hand until it stops against the stud's hex.
- Slowly turn the **valve** CW (↻) until it stops against the 1 1/2" jam nut
- Note the valve's angular location. **You cannot turn the valve more than 370° from here. It may leak if turned farther than 370° (e.g. 1 turn + 10°). Internal O-rings would have to be replaced.**
- Slowly turn the **valve** CCW (↺) to the preferred position; but not more than 370°. If in doubt, check the **jam-nut to valve-head gap** with a feeler gauge. The gap must be ≤ 0.042".
- Hold the valve, turn the **jam nut** CCW (↺) by hand until it abuts the back of the valve head.
- Hold the valve in place and use a 1 1/2" crowfoot wrench to torque the **jam nut** in the CCW (↺) direction to 120 Nm / 88 1/2 lb.-ft (e.g. against the valve head).
- Check with a feeler gauge that the gap between the jam nut and stud hex is ≤ 0.042".

## 12. Installation instructions: FITTINGS

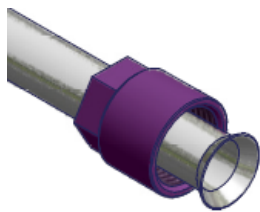


- Cleanliness** ensure the port, fitting, plug, sensor or gauge and the associated O-ring are clean and undamaged. Remove any visible contaminants
- Lube** Apply Krytox GPL 102 to the OD of the O-ring immediately before installation
- Install hand tight** carefully insert the fitting, sensor or gauge in its port, engage the threads and turn CW (↻) by hand until hand tight (typically 4-5 turns). Do not use a power tool or nut driver to turn the part faster.
- Torque the fitting** use either a 6-point socket (preferred) or crowfoot wrench and tighten the fitting / sensor / gauge to the appropriate torque. If the part does not come with a recommended torque, use the values specified in Table 3 (Recommended Fitting Torques).

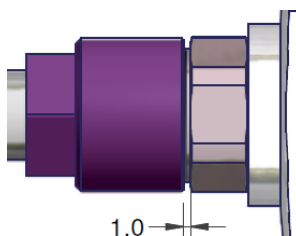
## 13. Installation instructions: PRD VENT

- Remove dust cap** the PRD was factory shipped with a red plastic dust cap installed on the PRD. Remove the dust cap (~ 4 full turns CCW, ↺).

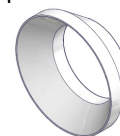




- b. **Cleanliness, tube quality** ensures the PRD's conical sealing end, the PRD's 3/4" threads, the tube's conical sealing face (inside) and tubing nut threads are all clean and undamaged. If the conical sealing surface of either the PRD or the flared tube have scratches, dents, voids or gouges a perfect seal will not be attained. If that is not acceptable, the "damaged" part must be replaced.
- c. **Lube** No lube is used.
- d. **Place tube & nut** carefully bring the tube towards the PRD until the tube and PRD are axially aligned. They should be  $\geq 4$  mm (0.156") apart so that the 2 flares can mate. Bring the tube against the PRD face, then engage the tubing nut. Turn the tubing nut CW (↻) until it is finger tight.

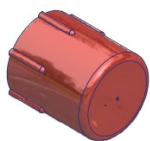


- e. **Check nut clearance ( $\geq 1\text{mm}$ )** If using a commercial SAE/JIC tubing nut or adapter, check that the engagement depth is correct. Some commercial parts are too deep for this PRD and require a conical flare adapter DAL1844. If the face of the nut/adapter is closer than 1mm (0.039") to the PRD's hex the flare adapter is required (see image below right). The flare adaptor is placed between the PRD and flared tube, spacing the tube outwards a small amount.



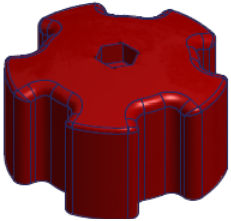
- f. **Torque tubing nut** use a crowfoot wrench and torque the nut (or adapter) to 30 Nm (22 lb.-ft). Restrain/support the tube so that it does not rotate as the torque is applied.

#### 14. Installation instructions: PRD CAP



- a. **Install dust cap** direct vent PRD's (i.e. ones with no vent tube) must have a dust cap installed on the PRD. If one is missing, install it (DAL1444). Place the red dust cap over the PRD and engage the threads. Turn CW (↻) until lightly hand tight (~ 4 turns).
- b. **Tighten dust cap** the dust cap has 6 ribs. Thus, they are 60° apart. With the cap finger tight, note the angular location of the most convenient trib. Tighten the cap an additional 60° CW (↻), by hand. This extra engagement ensures the cap will resist high pressure sprays from car washes and similar cleaning apparatus.

## 15. Operating instructions



- a. **Summary** the manual valve feature allows flow into and out of the cylinder. The handwheel is turned 1 revolution (or less) from fully opened to fully closed. An internal snap ring provides a positive stop in the opening direction. In the closing direction the valve's seating provides a less positive, but still noticeable stop. Increasing the hand wheel torque improves sealing quality (closed). A gas tight seal is achievable by hand with a modest torque. If the valve's position is unknown it can be measured (see 5.a. iv. and Table 3). **ONLY TURN HANDWHEEL BY HAND. DO NOT USE TOOLS ON THE HANDWHEEL.**



- b. **Opening the Valve** Turn the hand wheel 1 turn (or less) in the CCW direction (↺). Stop anywhere from 5/8 turn to ~ 1 turn (when the operator hits its internal positive stop).



- c. **Closing the Valve** Turn the hand wheel ~1 turn in the CW direction (↻). Stop when the operator hits its seat. Apply a reasonable amount of torque to seal.