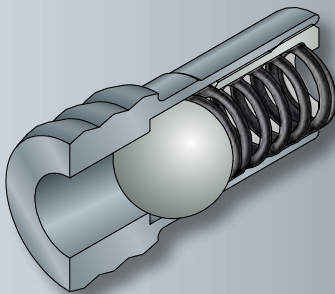


IMH Handbook of Hydraulics and Pneumatics

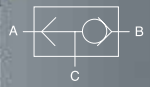


Actual Size

Innovation in Miniature



THE LEE COMPANY
Industrial Microhydraulics Group



The Lee Company

IMH Handbook of Hydraulics and Pneumatics

8th Edition

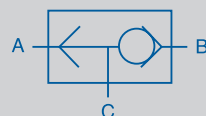
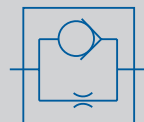
THE LEE COMPANY INDUSTRIAL MICROHYDRAULICS GROUP

82 Pequot Park Road
Westbrook, Connecticut 06498-0424 U.S.A.

Phone: 860 399-6281

Fax: 860 399-7058 (order entry)
860 399-4842 (technical information)

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THE LEE COMPANY

For over 70 years, The Lee Company has pioneered the design and manufacture of miniature precision fluid control components for a wide range of industries such as aerospace, oil production, Formula 1 car racing and medical/scientific instrumentation. To date, more than 100,000,000 Lee Plugs®, Restrictors, Valves and Safety Screens have been delivered to aerospace manufacturers alone, worldwide. A typical commercial jet employs an average of 4,000 such Lee Parts. Lee Products are specifically engineered to enable designers to reduce the size and weight of their designs, while improving quality and manufacturability.

The Lee Company employs over 1,000 people and occupies over 1 million square feet of manufacturing space on several campuses in Westbrook and Essex, Connecticut, U.S.A., as well as Cambridge, U.K. Lee Company sales offices, staffed by degreed sales engineers, are located throughout the United States and Europe, and the company's distribution network spans the entire globe. Lee's unique capabilities in miniaturization and engineering expertise (one of every eight employees is an engineer) keep the company at the forefront of fluid flow technology, and enable it to work effectively with customers to solve difficult fluid control problems.

IMH DIVISION

In 1991, The Lee Company founded the Industrial Microhydraulics (IMH) Division to adapt its proven design concepts to meet the higher volume production, performance and cost requirements of automotive, industrial hydraulic and medical applications. Using design techniques similar to those used for the Lee Plugs, valves, restrictors and safety screens that have logged millions of flight hours in aerospace applications, The IMH Division can now offer products of the

same reliability and consistent performance, in very high quantities. These products are produced in an efficient, automated factory to the exacting standards of IATF 16949. The Lee Company continues to expand the product offerings in The IMH Division. Should you need a product not shown in this handbook, please contact a Lee Sales Engineer to discuss your specific requirements.

MISSION STATEMENT

The Mission of The Lee Company is to design and build state of the art products that exceed customers' expectations for utility, performance and quality. The Lee Company constantly strives to improve the product designs, the manufacturing process and the quality system. The ultimate goal is zero defects and a satisfied customer.

SALES AND SERVICE

The Lee Company is committed to full professional service to our customers through a worldwide sales network of graduate engineers. Lee has sales offices in Huntington Beach, Chicago, Tampa, Dallas, Detroit, Tacoma, and at the corporate headquarters in Westbrook. Lee also has wholly owned sales and service subsidiaries in London (Gerrards Cross), Frankfurt, Paris (Voisins-Le-Bretonneux), Milan and Stockholm, and is represented in over forty countries.

If you have a fluid control problem and would like to talk to an engineer, or would like product information, please visit www.theleeco.com or contact the field sales office (see page C76) nearest you.

IMH HANDBOOK

This handbook is divided into 3 sections: Components intended to be installed into metal, components intended to be installed into plastic and a technical reference section.

Section I – Products For Installation into Metal A1 – A86

Insert Check Valves	A3 – A18
Insert Relief Valves	A19 – A24
Insert Orifices	A25 – A50
Insert Restrictor Check Valves	A51 – A56
Insert Flow Controls	A57 – A62
Insert Shuttle Valves	A63 – A66
Insert Safety Screens	A67 – A78
Lee BetaPlugs	A79 – A88

Section II – Products For Installation into Plastic B1 – B46

Check Valves	B3 – B11
Relief Valves	B12 – B18
Orifices	B19 – B26
Flow Controls	B27 – B30
Restrictor Check Valves	B31 – B32
Safety Screens	B33 – B38
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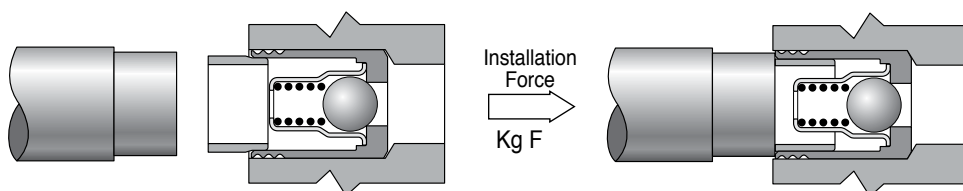
Section III – Engineering Reference..... C1 – C73

General Information C74 – C76



INSERTS

The first section of the Handbook contains products intended for installation into metals (Section Two products are to be installed into plastic). The inserts are designed using the insert principle, which uses a pin to expand a grooved section of the insert's body into the housing wall to effect a seal and retain the component. The pin, which has been pre-installed, is driven into the body. Using friction and penetration, the lands bite into the housing material. The Lee Company does not recommend the use of coatings or surface treatments in the area of the installation hole where the Lee component is to be installed. Do not clean the insert prior to installation. The assembly is prelubricated for proper installation.



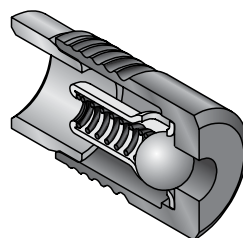
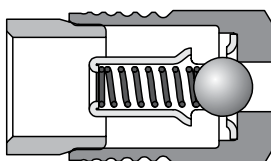
The insert principle eliminates the need for threads and o-rings. Simply insert the component into a drilled hole and drive the expander pin flush to within 0.25mm (0.010") above flush of the insert. The installation tool can bottom on the insert body. Lee Installation Tools are available for each product and part numbers are listed on each page.

Since inserts can only be installed in one direction, most come in forward and reverse flow versions to provide design flexibility.

REVERSE FLOW VALVE

DIRECTION OF
INSTALLATION
→

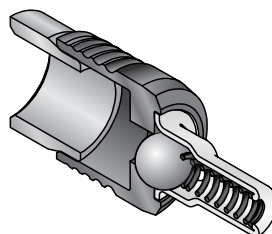
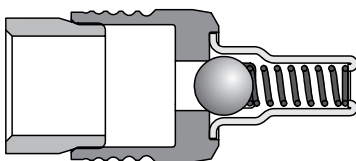
←
REVERSE FLOW
DIRECTION



FORWARD FLOW VALVE

DIRECTION OF
INSTALLATION
→

→
FORWARD FLOW
DIRECTION



Installation forces required to install inserts vary for different model parts and are listed on each page. The force specification may be a maximum or a range.

Features and Benefits

- Compact designs
 - Minimize housing size.
- Integral locking end
 - Long life.
 - No o-rings to fail.
- Pre-assembled
 - Easy to integrate into automated assembly lines.
- 100% Tested
 - Eliminates rework, reducing internal costs.
 - Enhances customers' product quality.
 - Guaranteed performance.
- All metal design
 - Wide operating temperature range.
 - Compatible with most fluids.

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Insert Check Valves A3 – A18

Insert Relief Valves A19 – A24

Insert Orifices A25 – A50

**Insert Restrictor
Check..... A51 – A56**

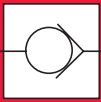
Flow Controls..... A57 – A62

**Insert Shuttle
Valves A63 – A66**

**Insert Safety
Screens A67 – A72**

Cartridge Screens..... A73 – A78

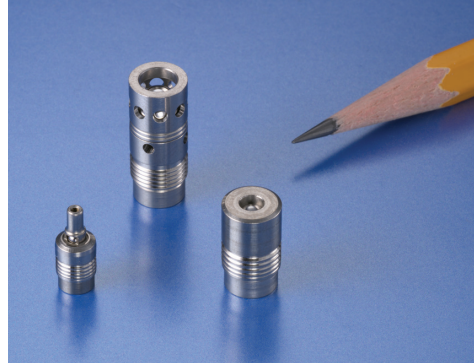
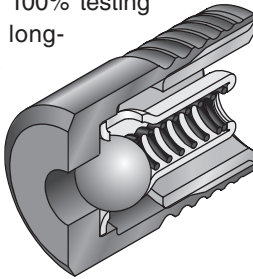
Lee Betaplugs® A79 – A88



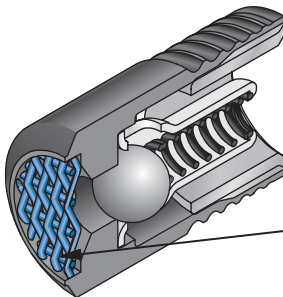
INSERT CHECK VALVES

The IMH Chek is a threadless, cartridge-style insert designed for simple, low cost installation into manifolds, and is based on the same hard seat Lee Chek® designs used in flight control systems of almost every aircraft flying today.

A robust design and 100% testing ensures consistent, long-term performance up to 28 MPa (4060 psid) and 149°C (300°F) or higher depending on specific application requirements.

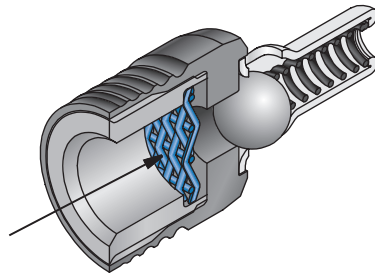


A high quality metal to metal seat limits leakage in the checked direction to no more than 20 sccm of air at 172 kPa (25 psi) differential. The valves are compatible with hydraulic fluids, brake fluids, fuels and oils. Integral safety screen protection is available, (see drawings below).



Screened Reverse

Integral
Safety Screen

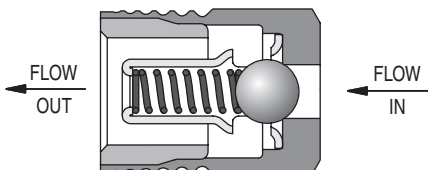


Screened Forward

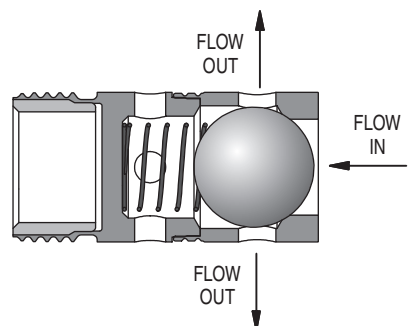
IMH Cheks come in two styles, "axial" and "side exit", (see drawings below). 558, 855 and 400 Bar models are axial flowing and the

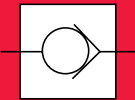
832 models are side exit flowing. Some models are available with a ceramic ball as standard.

Axial Flow



Side Exit Flow





Features and Benefits

- Metal to metal seating
 - Provides high reliability.
 - Long life.
- Leak tight
 - Efficient system performance.
- Guided ball design
 - Fast response.
 - Low hysteresis.
- Positive ball stop
 - Infinite spring life.
 - Stable performance.
- Screened versions
 - Blocks rogue contamination.
- Ceramic ball versions
 - Compatible with aggressive fluids.
- Axial and side exit versions
 - Design flexibility.

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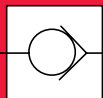
832 Reverse Side ExitA15

832 Forward Side ExitA16

400 BAR CHECK VALVES

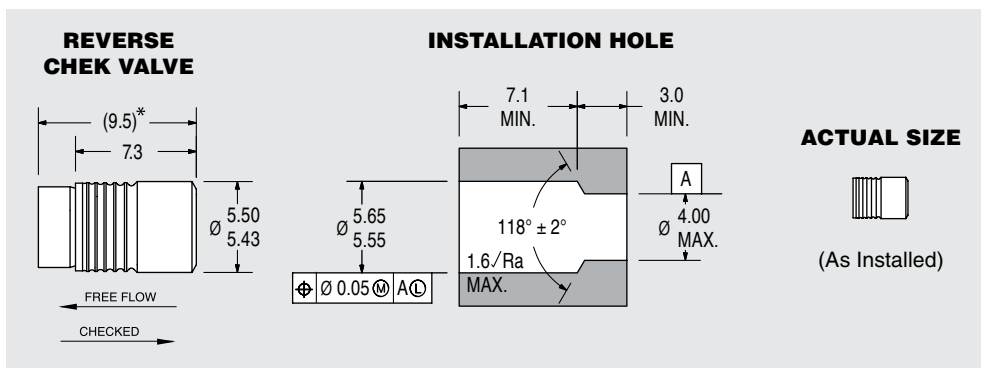
ReverseA17

Forward.....A18



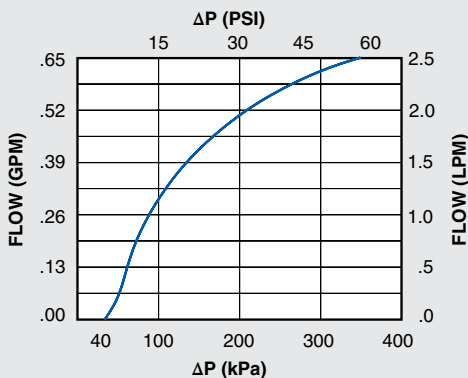
INSERT CHECK VALVES

558 SERIES CHEK VALVE - REVERSE FLOW



* LOA before installation.
All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

PERFORMANCE

Lohm Rate: 250 Lohms

Leakage: 20 sccm/min. (max.) @ 172 kPa (25 psid) on air
1 Drop/min. (max.) on hydraulic fluid

Maximum Working Pressure:
28 MPa (4,060 psid) (Checked Direction)
4 MPa (580 psid) (Flow Direction)

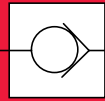
MATERIALS

Body 303 Stainless Steel
Cage 305 Stainless Steel
Pin 416 Stainless Steel
Spring 302 Stainless Steel
Ball..... 440C Stainless Steel

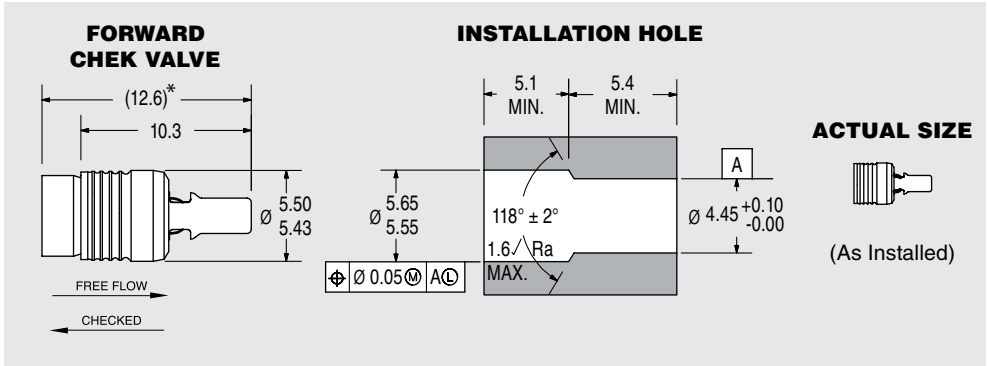
INSTALLATION

Tool Part Number CCRT0900120S
Force 625 Kg F (max.)
For installation procedure [see page A1](#).

LEE PART NO.	CRACKING PRESSURE
CCRM2550200S	0 kPa (No Spring)
CCRM2550204S	4 ± 3 kPa (0.6 ± 0.4 psid)
CCRM2550207S	7 ± 5 kPa (1 ± 0.7 psid)
CCRM2550214S	14 ± 5 kPa (2 ± 0.7 psid)
CCRM2550225S	25 ± 10 kPa (3.6 ± 1.5 psid)
CCRM2550240S	40 ± 30 kPa (6 ± 4.4 psid)
CCRM2550269S	69 ± 17 kPa (10 ± 2.5 psid)

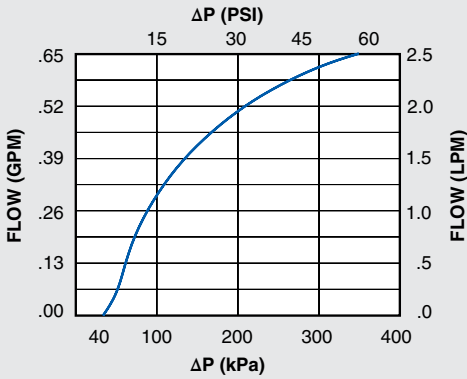


558 SERIES CHEK VALVE - FORWARD FLOW



* LOA before installation.
All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 250 Lohms

Leakage: 20 sccm/min. (max.) @ 172 kPa (25 psid) on air
1 Drop/min. (max.) on hydraulic fluid

Maximum Working Pressure:
28 MPa (4,060 psid) (Checked Direction)
4 MPa (580 psid) (Flow Direction)

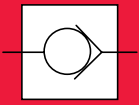
MATERIALS

Body 303 Stainless Steel
Cage 305 Stainless Steel
Pin 416 Stainless Steel
Spring 302 Stainless Steel
Ball 440C Stainless Steel

INSTALLATION

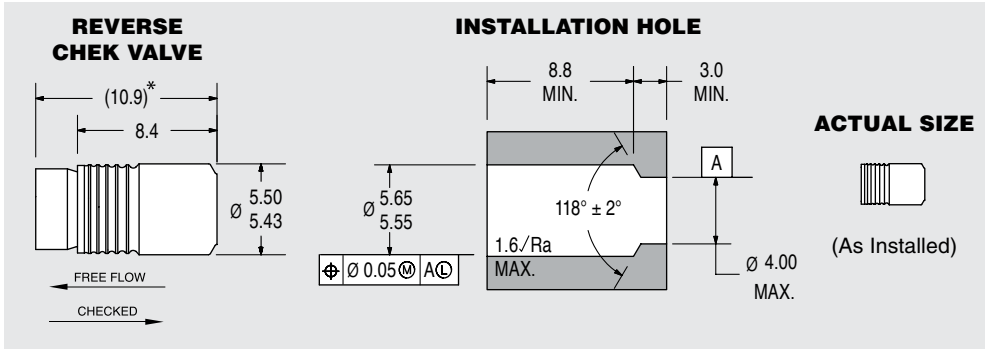
Tool Part Number CCRT0900120S
Force 625 Kg F (max.)
For installation procedure see page A1.

LEE PART NO.	CRACKING PRESSURE
CCFM2550200S	0 kPa (No Spring)
CCFM2550204S	4 ± 3 kPa (0.6 ± 0.4 psid)
CCFM2550207S	7 ± 5 kPa (1 ± 0.7 psid)
CCFM2550214S	14 ± 5 kPa (2 ± 0.7 psid)
CCFM2550225S	25 ± 10 kPa (3.6 ± 1.5 psid)
CCFM2550240S	40 ± 30 kPa (6 ± 4.4 psid)
CCFM2550269S	69 ± 17 kPa (10 ± 2.5 psid)



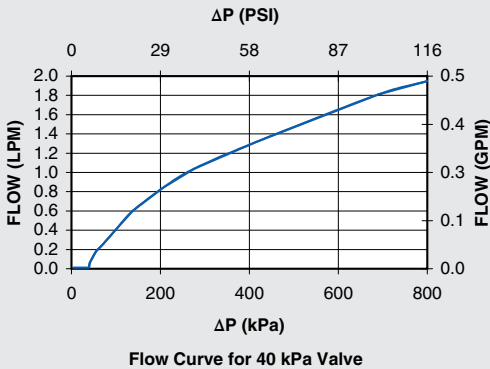
INSERT CHECK VALVES

558 SERIES CHEK VALVE - SCREENED REVERSE FLOW



* LOA before installation.
All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 400 Lohms

Leakage: 20 sccm/min. (max.) @ 172 kPa (25 psid) on air
1 Drop/min. (max.) on hydraulic fluid

Screen Size: 125 Micron Absolute

Maximum Working Pressure:
28 MPa (4,060 psid)
(Checked Direction)
4 MPa (580 psid)
(Flow Direction)

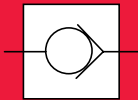
MATERIALS

Body 303 Stainless Steel
Cage 305 Stainless Steel
Pin 416 Stainless Steel
Spring 302 Stainless Steel
Ball..... 440C Stainless Steel
Screen 316 Stainless Steel

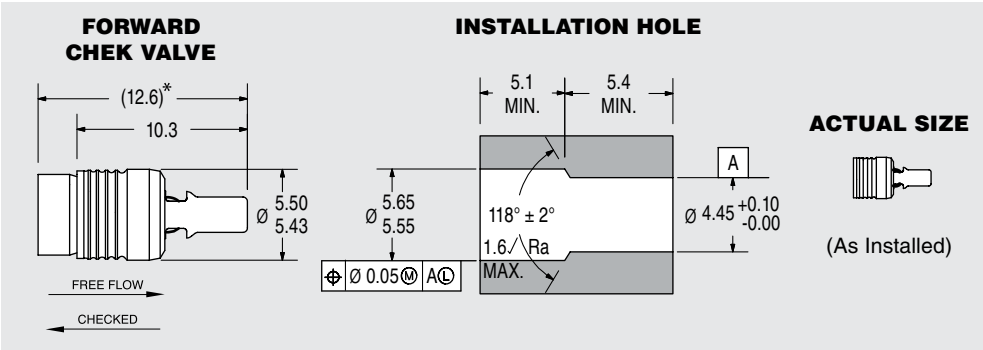
INSTALLATION

Tool Part Number CCRT0900120S
Force 625 Kg F (max.)
For installation procedure [see page A1](#).

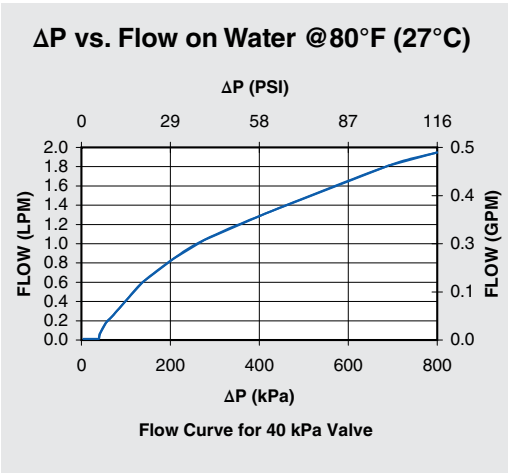
LEE PART NO.	CRACKING PRESSURE
CCRM2553000S	0 kPa (No Spring)
CCRM2553014S	14 ± 5 kPa (2 ± 0.7 psid)
CCRM2553040S	40 ± 30 kPa (6 ± 4.4 psid)
CCRM2553069S	69 ± 17 kPa (10 ± 2.5 psid)



558 SERIES CHEK VALVE - SCREENED
FORWARD FLOW



* LOA before installation.
All dimensions in millimeters.

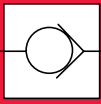


PERFORMANCE
Lohm Rate: 400 Lohms
Leakage: 20 sccm/min. (max.) @ 172 kPa (25 psid) on air 1 Drop/min. (max.) on hydraulic fluid
Screen Size: 125 Micron Absolute
Maximum Working Pressure: 28 MPa (4,060 psid) (Checked Direction) 4 MPa (580 psid) (Flow Direction)

MATERIALS
Body 303 Stainless Steel
Cage 305 Stainless Steel
Pin 303 Stainless Steel
Spring 302 Stainless Steel
Ball..... 440C Stainless Steel
Screen 316 Stainless Steel

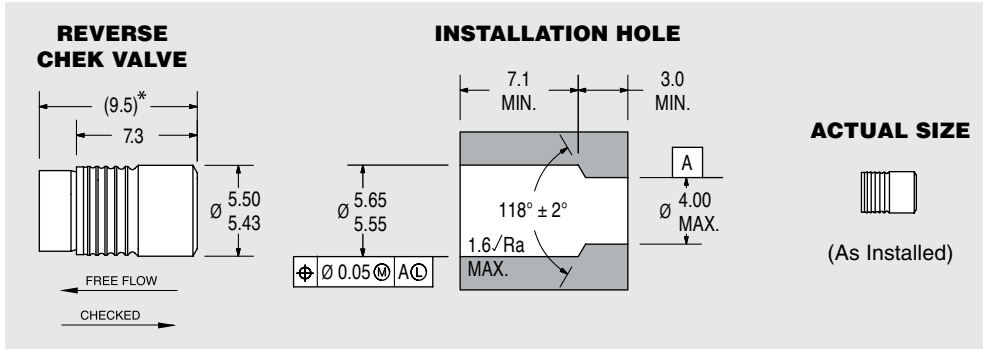
LEE PART NO.	CRACKING PRESSURE
CCFM2553000S	0 kPa (No Spring)
CCFM2553014S	14 ± 5 kPa (2 ± 0.7 psid)
CCFM2553040S	40 ± 30 kPa (6 ± 4.4 psid)
CCFM2553069S	69 ± 17 kPa (10 ± 2.5 psid)

INSTALLATION
Tool Part Number CCRT0900120S
Force 625 Kg F (max.)
For installation procedure see page A1 .



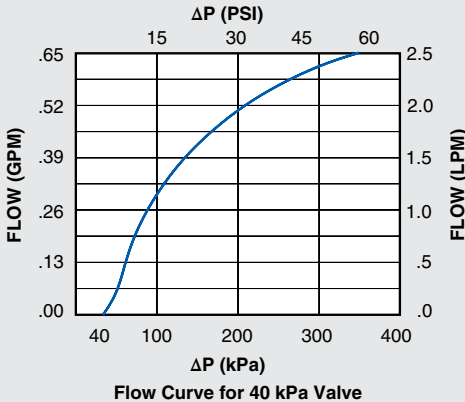
INSERT CHECK VALVES

558 SERIES CHEK VALVE - CERAMIC BALL REVERSE FLOW



* LOA before installation.
All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 250 Lohms

Leakage: 20 sccm/min. (max.) @ 172 kPa (25 psid) on air
1 Drop/min. (max.) on hydraulic fluid

Maximum Working Pressure:
28 MPa (4,060 psid) (Checked Direction)
4 MPa (580 psid) (Flow Direction)

MATERIALS

Body 303 Stainless Steel
Cage 305 Stainless Steel
Pin 416 Stainless Steel
Spring 302 Stainless Steel
Ball..... Ceramic

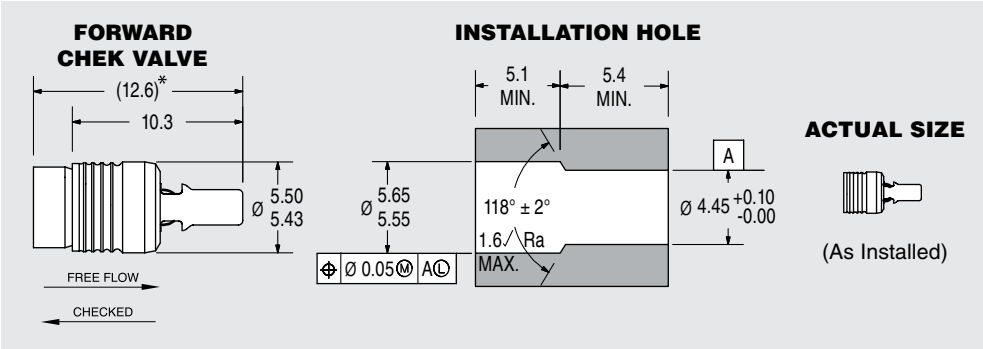
INSTALLATION

Tool Part Number CCRT0900120S
Force 625 Kg F (max.)
For installation procedure [see page A1](#).

LEE PART NO.	CRACKING PRESSURE
CCRM2550800S	0 kPa (No Spring)
CCRM2550814S	14 ± 5 kPa (2 ± 0.7 psid)
CCRM2550840S	40 ± 30 kPa (6 ± 4.4 psid)

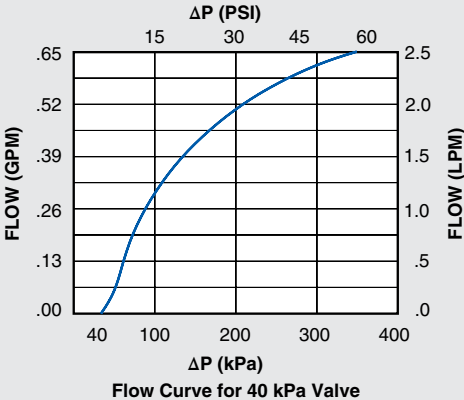


558 SERIES CHEK VALVE - CERAMIC BALL
FORWARD FLOW



* LOA before installation.
All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 250 Lohms

Leakage: 20 sccm/min. (max.) @ 172 kPa (25 psid) on air
1 Drop/min. (max.) on hydraulic fluid

Maximum Working Pressure:
28 MPa (4,060 psid) (Checked Direction)
4 MPa (580 psid) (Flow Direction)

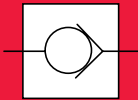
MATERIALS

Body 303 Stainless Steel
Cage 305 Stainless Steel
Pin 416 Stainless Steel
Spring 302 Stainless Steel
Ball..... Ceramic

INSTALLATION

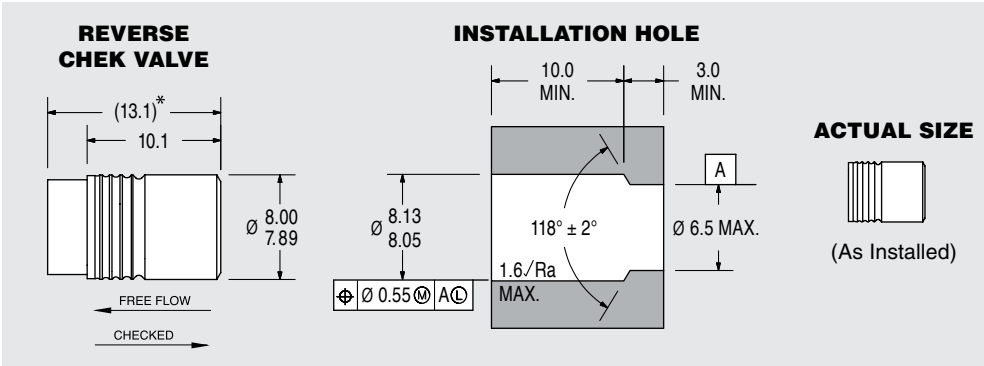
Tool Part Number CCRT0900120S
Force 625 Kg F (max.)
For installation procedure see page A1.

LEE PART NO.	CRACKING PRESSURE
CCFM2550800S	0 kPa (No Spring)
CCFM2550814S	14 ± 5 kPa (2 ± 0.7 psid)
CCFM2550840S	40 ± 30 kPa (6 ± 4.4 psid)

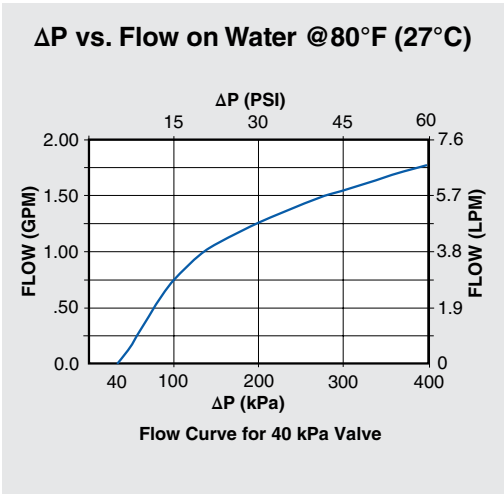


INSERT CHECK VALVES

855 SERIES CHEK VALVE - REVERSE FLOW



* LOA before installation.
All dimensions in millimeters.



LEE PART NO.	CRACKING PRESSURE
CCRM2800200S	0 kPa (No Spring)
CCRM2800204S	4 ± 3 kPa (0.6 ± 0.4 psid)
CCRM2800207S	7 ± 5 kPa (1 ± 0.7 psid)
CCRM2800214S	14 ± 5 kPa (2 ± 0.7 psid)
CCRM2800240S	40 ± 30 kPa (6 ± 4.4 psid)
CCRM2800269S	69 ± 30 kPa (10 ± 4.4 psid)

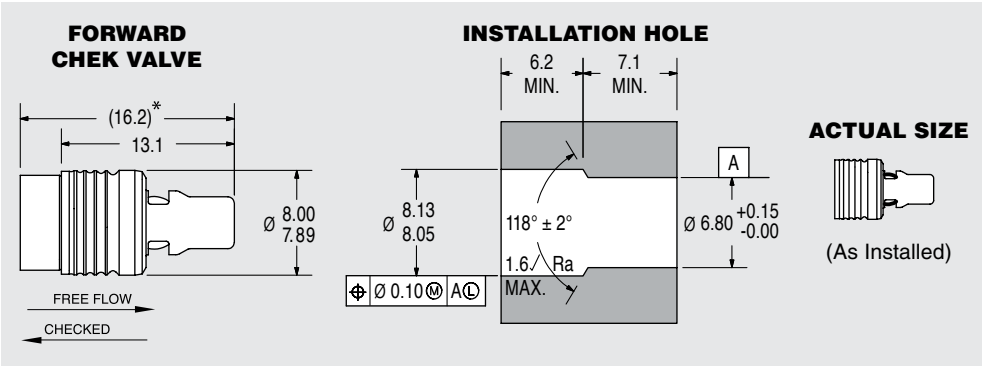
PERFORMANCE
Lohm Rate: 75 Lohms
Leakage: 20 sccm/min. (max.)@172 kPa (25 psid) on air 1 Drop/min. (max.) on hydraulic fluid
Maximum Working Pressure: 28 MPa (4,060 psid) (Checked Direction) 4 MPa (580 psid) (Flow Direction)

MATERIALS
Body 303 Stainless Steel
Cage 305 Stainless Steel
Pin 416 Stainless Steel
Spring 302 Stainless Steel
Ball..... 440C Stainless Steel

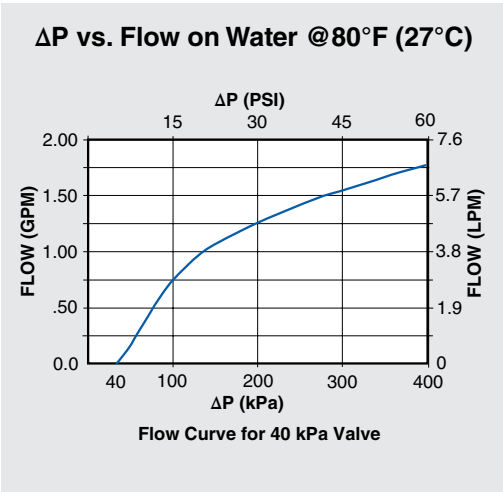
INSTALLATION
Tool Part Number CCRT0900150S
Force 680 Kg F (max.)
For installation procedure see page A1 .



855 SERIES CHEK VALVE - FORWARD FLOW



* LOA before installation.
All dimensions in millimeters.

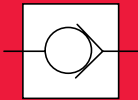


PERFORMANCE
Lohm Rate: 75 Lohms
Leakage: 20 sccm/min. (max.) @ 172 kPa (25 psid) on air
1 Drop/min. (max.) on hydraulic fluid
Maximum Working Pressure: 28 MPa (4,060 psid) (Checked Direction)
4 MPa (580 psid) (Flow Direction)

MATERIALS
Body 303 Stainless Steel
Cage 305 Stainless Steel
Pin 416 Stainless Steel
Spring 302 Stainless Steel
Ball..... 440C Stainless Steel

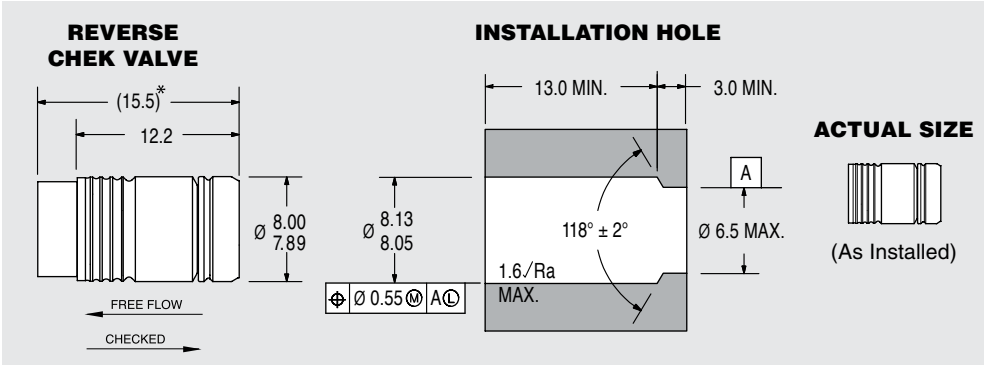
LEE PART NO.	CRACKING PRESSURE
CCFM2800200S	0 kPa (No Spring)
CCFM2800204S	4 ± 3 kPa (0.6 ± 0.4 psid)
CCFM2800207S	7 ± 5 kPa (1 ± 0.7 psid)
CCFM2800214S	14 ± 5 kPa (2 ± 0.7 psid)
CCFM2800240S	40 ± 30 kPa (6 ± 4.4 psid)
CCFM2800269S	69 ± 30 kPa (10 ± 4.4 psid)

INSTALLATION
Tool Part Number CCRT0900150S
Force 680 Kg F (max.)
For installation procedure see page A1.

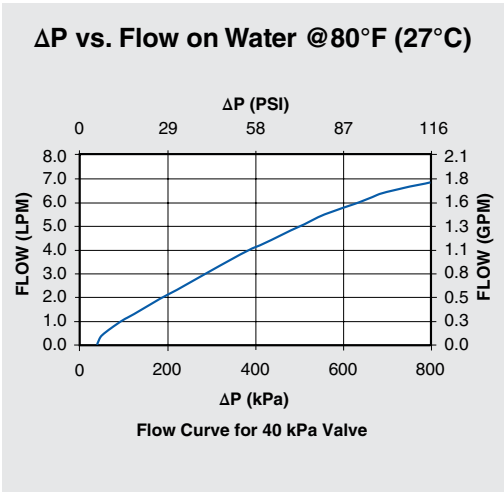


INSERT CHECK VALVES

855 SERIES CHEK VALVE - SCREENED REVERSE FLOW



* LOA before installation.
All dimensions in millimeters.

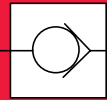


PERFORMANCE
Lohm Rate: 130 Lohms
Leakage: 20 sccm/min. (max.) @ 172 kPa (25 psid) on air
1 Drop/min. (max.) on hydraulic fluid
Screen Size: 125 Micron Absolute
Maximum Working Pressure:
28 MPa (4,060 psid) (Checked Direction)
4 MPa (580 psid) (Flow Direction)

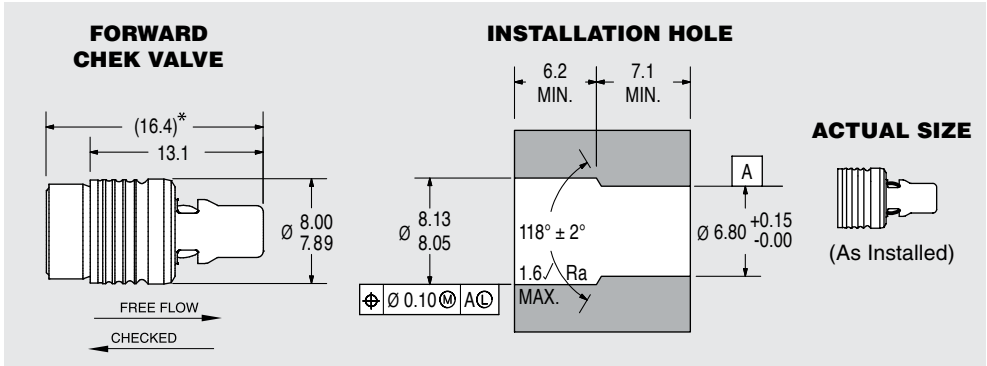
MATERIALS
Body 303 Stainless Steel
Cage 305 Stainless Steel
Pin 416 Stainless Steel
Spring 302 Stainless Steel
Ball..... 440C Stainless Steel
Screen 316 Stainless Steel

LEE PART NO.	CRACKING PRESSURE
CCRM2803000S	0 kPa (No Spring)
CCRM2803014S	14 ± 5 kPa (2 ± 0.7 psid)
CCRM2803040S	40 ± 30 kPa (6 ± 4.4 psid)
CCRM2803069S	69 ± 30 kPa (10 ± 4.4 psid)

INSTALLATION
Tool Part Number CCRT0900150S
Force 680 Kg F (max.)
For installation procedure see page A1 .



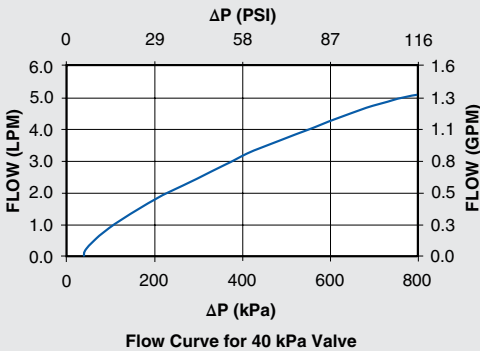
855 SERIES CHEK VALVE - SCREENED FORWARD FLOW



* LOA before installation.

All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 170 Lohms

Leakage: 20 sccm/min. (max.) @ 172 kPa (25 psid) on air
1 Drop/min. (max.) on hydraulic fluid

Screen Size: 125 Micron Absolute

Maximum Working Pressure:
28 MPa (4,060 psid) (Checked Direction)
4 MPa (580 psid) (Flow Direction)

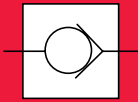
MATERIALS

Body 303 Stainless Steel
Cage 305 Stainless Steel
Pin 303 Stainless Steel
Spring 302 Stainless Steel
Ball..... 440C Stainless Steel
Screen 316 Stainless Steel

INSTALLATION

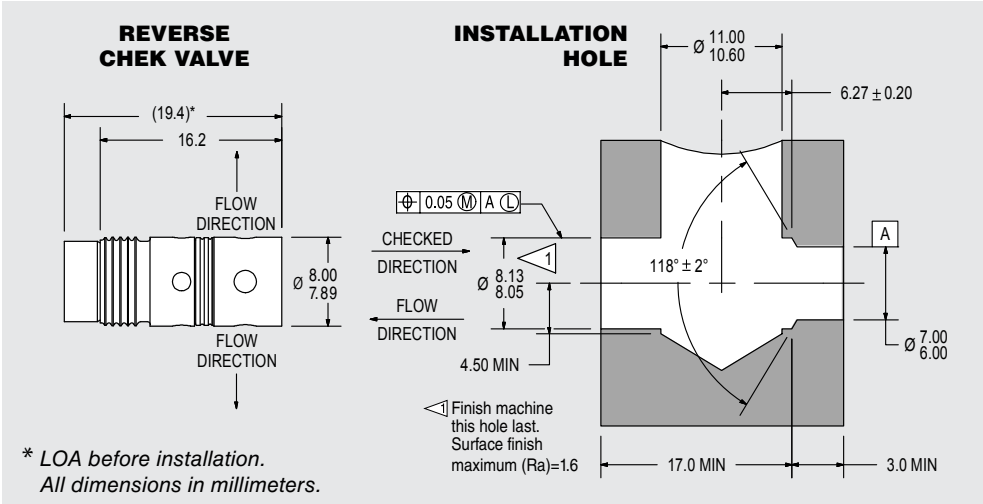
Tool Part Number CCRT0900150S
Force 680 Kg F (max.)
For installation procedure see [page A1](#).

LEE PART NO.	CRACKING PRESSURE
CCFM2803000S	0 kPa (No Spring)
CCFM2803014S	14 ± 5 kPa (2 ± 0.7 psid)
CCFM2803040S	40 ± 30 kPa (6 ± 4.4 psid)
CCFM2803069S	69 ± 30 kPa (10 ± 4.4 psid)

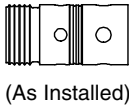


INSERT CHECK VALVES

832 SERIES SIDE EXIT CHEK VALVE REVERSE FLOW



ACTUAL SIZE



(As Installed)

PERFORMANCE

Flow Rate: 55 Lohms max. (3.6 GPM @ 100 psid)

Leakage: 1 Drop/min. (max.) after 2 minute wait on hydraulic fluid in checked direction at 6.9-27.6 MPa (1,000 - 4,000 psid)

Maximum Working Pressure: 28 MPa (4,060 psid)

MATERIALS

Upper Body.....303 Stainless Steel

Lower Body.....303 Stainless Steel

Pin416 Stainless Steel

Spring302 Stainless Steel

Ball.....440C Stainless Steel

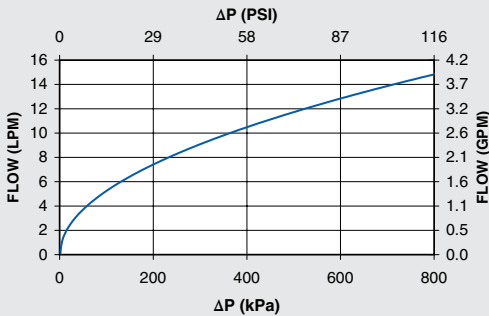
INSTALLATION

Tool Part Number CCRT0900150S

Force 545 Kg F (min.)
635 Kg F (max.)

For installation procedure [see page A1](#).

ΔP vs. Flow on Water @80°F (27°C)

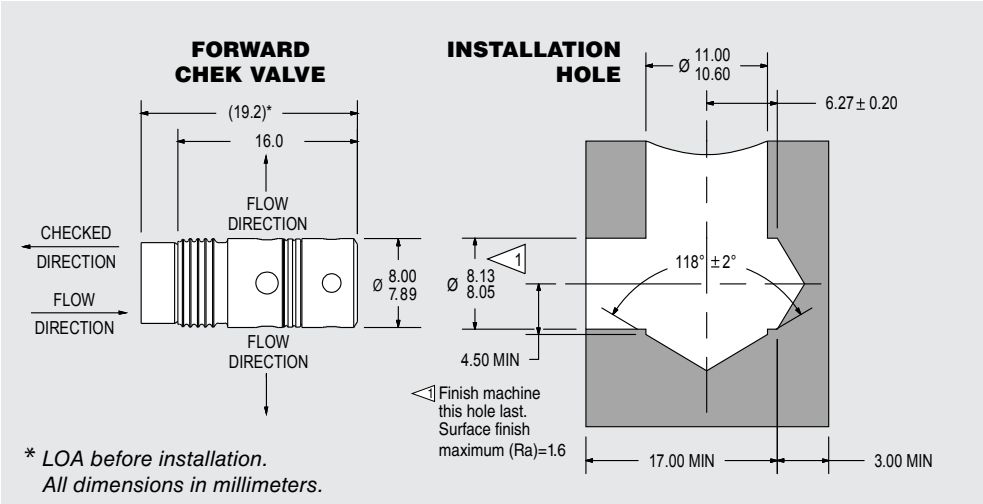


Flow Curve for 0 kPa Valve

LEE PART NO.	CRACKING PRESSURE
CCRM8321000S	0 kPa (No Spring)
CCRM8321014S	14 ± 5 kPa (2 ± 0.7 psid)
CCRM8321040S	40 ± 30 kPa (6 ± 4.4 psid)



832 SERIES SIDE EXIT CHEK VALVE
FORWARD FLOW

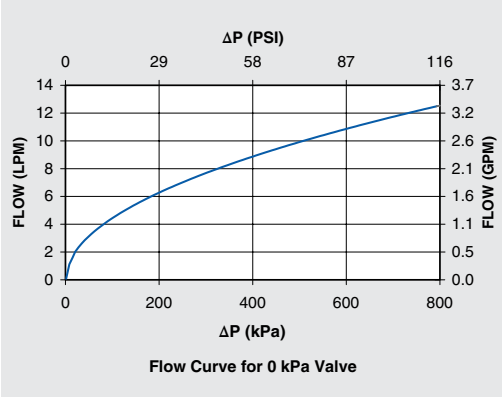


ACTUAL SIZE



(As Installed)

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Flow Rate: 65 Lohms max. (3.1 GPM @ 100 psid)

Leakage: 1 Drop/min. (max.) after 2 minute wait on hydraulic fluid in checked direction at 6.9-27.6 MPa (1,000 - 4,000 psid)

Maximum Working Pressure: 28 MPa (4,060 psid)

MATERIALS

Upper Body.....303 Stainless Steel

Lower Body.....303 Stainless Steel

Pin416 Stainless Steel

Spring302 Stainless Steel

Ball.....440C Stainless Steel

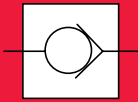
INSTALLATION

Tool Part Number CCRT0900150S

Force 545 Kg F (min.)
635 Kg F (max.)

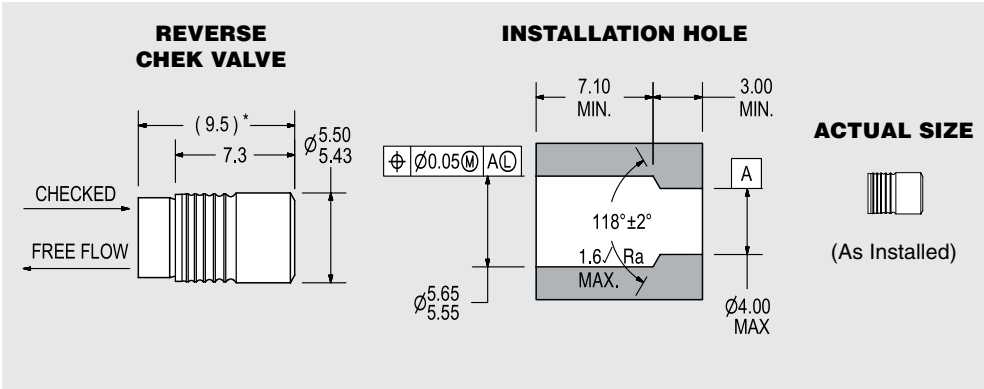
For installation procedure [see page A1](#).

LEE PART NO.	CRACKING PRESSURE
CCFM8321000S	0 kPa (No Spring)
CCFM8321014S	14 ± 5 kPa (2 ± 0.7 psid)
CCFM8321040S	40 ± 30 kPa (6 ± 4.4 psid)

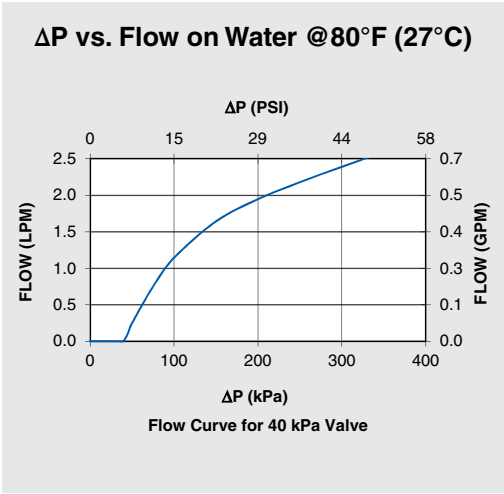


INSERT CHECK VALVES

400 BAR CHEK VALVE REVERSE FLOW



* LOA before installation.
All dimensions in millimeters.

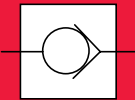


PERFORMANCE
Lohm Rate: 250 Lohms
Leakage: 20 sccm/min. (max.) @ 172 kPa (25 psid) on air
1 Drop/min. (max.) on hydraulic fluid
Maximum Working Pressure:
400 Bar (5,800 psid) (Checked Direction)
40 Bar (580 psid) (Flow Direction)

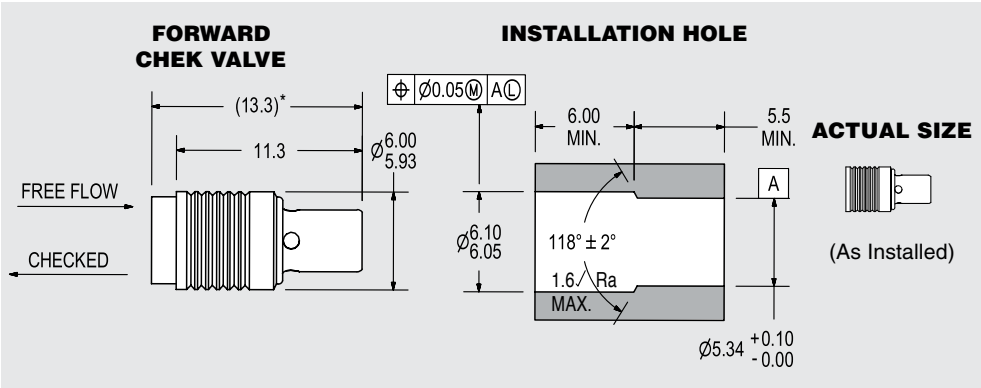
MATERIALS
Body 303 Stainless Steel
Cage 416 Stainless Steel
Pin 416 Stainless Steel
Spring 302 Stainless Steel
Ball..... 440C Stainless Steel

LEE PART NO.	CRACKING PRESSURE
CCHR5510000S	0 kPa (No Spring)
CCHR5510014S	14 ± 5 kPa (2 ± 0.7 psid)
CCHR5510040S	40 ± 30 kPa (6 ± 4.4 psid)

INSTALLATION
Tool Part Number CCRT0900120S
Force 625 Kg F (max.)
For installation procedure see page A1.

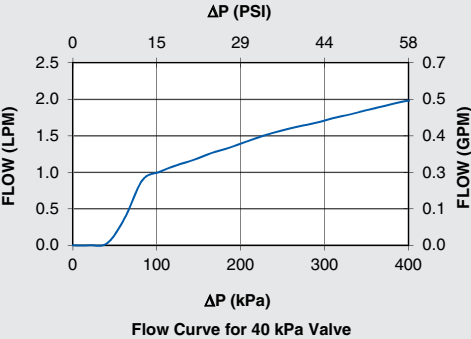


400 BAR CHEK VALVE
FORWARD FLOW



* LOA before installation.
All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 320 Lohms
Leakage: 20 sccm/min. (max.) @172 kPa (25 psid) on air
1 Drop/min. (max.) on hydraulic fluid
Maximum Working Pressure:
400 Bar (5,800 psid) (Checked Direction)
40 Bar (580 psid) (Flow Direction)

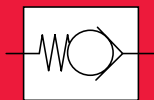
MATERIALS

Body 303 Stainless Steel
Cage 416 Stainless Steel
Pin 416 Stainless Steel
Spring 302 Stainless Steel
Ball..... 440C Stainless Steel

INSTALLATION

Tool Part Number CCRT0051078S
Force 910 Kg F (max.)
For installation procedure see page A1.

LEE PART NO.	CRACKING PRESSURE
CCHF6010000S	0 kPa (No Spring)
CCHF6010014S	14 ± 5 kPa (2 ± 0.7 psid)
CCHF6010040S	40 ± 30 kPa (6 ± 4.4 psid)



INSERT RELIEF VALVES

IMH Relief Valves are designed to protect systems from over pressurization or to attenuate pressure spikes. These valves are not suited for upstream pressure regulation.

As with the IMH Chek, the relief valve is a threadless, cartridge style insert designed for simple, low cost installation into manifolds, in the most compact package available anywhere.



A high quality, metal-to-metal seat provides long life and extremely low leakage, as well as compatibility with a wide range of fluids.

The Relief Valve is available in a 5.5mm size and an 8.0mm for more flow.



Features and Benefits

- Metal to metal seat
 - Provides high reliability.
 - Long life.
 - Repeatable crack.
- Leak tight
 - Efficient system performance.
- Guided ball design
 - Fast response.
 - Low hysteresis.
- 100% tested
 - Eliminates rework.

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5.5mm RELIEF VALVES

558 Reverse A21

558 Forward..... A22

8.0mm RELIEF VALVES

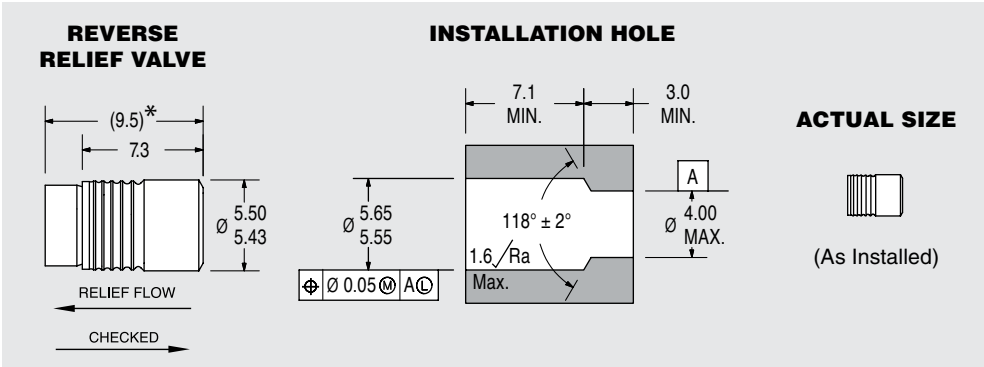
855 Reverse A23

855 Forward..... A24

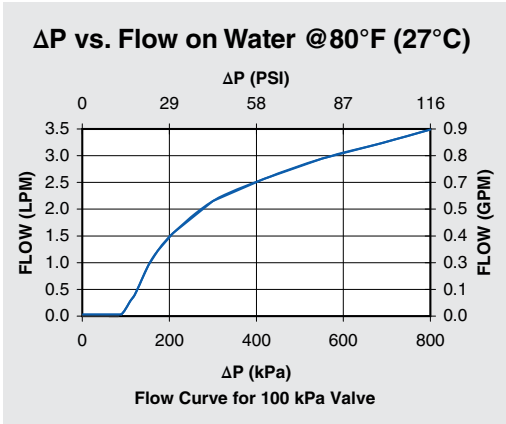


INSERT RELIEF VALVES

558 SERIES RELIEF VALVE - REVERSE FLOW



All dimensions are in millimeters.
* LOA before installation

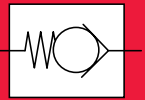


PERFORMANCE	
Lohm Rate:	250 Lohms
Leakage:	20sccm/min. (max.) @ 172 kPa (25 psid) on air 1 Drop/min. (max.) on hydraulic fluid
Maximum Working Pressure:	28 MPa (4,060 psid) Checked Direction 4 MPa (580 psid) Flow Direction
Cracking Pressure Tolerance:	±15%

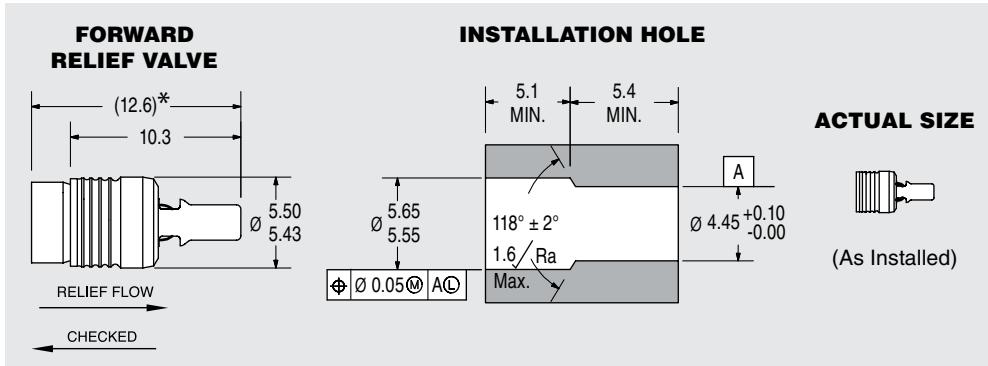
LEE PART NO.	CRACKING PRESSURE
PCRM2550210S	100 kPa (14.5 psid)
PCRM2550215S	150 kPa (21.8 psid)
PCRM2550220S	200 kPa (29 psid)
PCRM2550225S	250 kPa (36.6 psid)
PCRM2550230S	300 kPa (43.5 psid)
PCRM2550235S	350 kPa (50.8 psid)
PCRM2550240S	400 kPa (58 psid)
PCRM2550250S	500 kPa (72.5 psid)
PCRM2550255S	550 kPa (79.8 psid)

MATERIALS	
Body	303 Stainless Steel
Cage	305 Stainless Steel
Pin	416 Stainless Steel
Spring	302 Stainless Steel
Ball.....	440C Stainless Steel

INSTALLATION	
Tool Part Number	CCRT0900120S
Force	625 Kg F (max.)
For installation procedure see page A1 .	



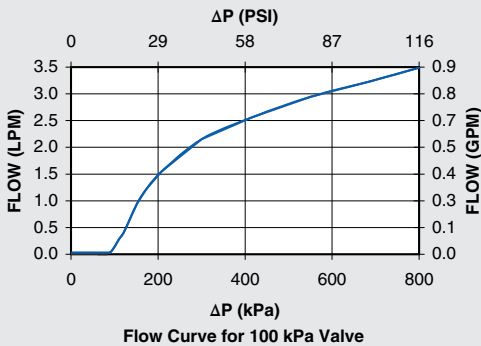
558 SERIES RELIEF VALVE - FORWARD FLOW



All dimensions are in millimeters.

* LOA before installation

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 250 Lohms

Leakage: 20sccm/min. (max.)
@ 172 kPa (25 psid) on air
1 Drop/min. (max.) on
hydraulic fluid

Maximum Working Pressure:
28 MPa (4,060 psid)
Checked Direction
4 MPa (580 psid)
Flow Direction

Cracking Pressure Tolerance: ±15%

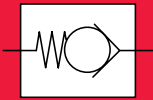
LEE PART NO.	CRACKING PRESSURE
PCFM2550210S	100 kPa (14.5 psid)
PCFM2550215S	150 kPa (21.8 psid)
PCFM2550220S	200 kPa (29 psid)
PCFM2550225S	250 kPa (36.6 psid)
PCFM2550230S	300 kPa (43.5 psid)
PCFM2550235S	350 kPa (50.8 psid)
PCFM2550240S	400 kPa (58 psid)
PCFM2550250S	500 kPa (72.5 psid)
PCFM2550255S	550 kPa (79.8 psid)

MATERIALS

Body 303 Stainless Steel
Cage 305 Stainless Steel
Pin 416 Stainless Steel
Spring 302 Stainless Steel
Ball..... 440C Stainless Steel

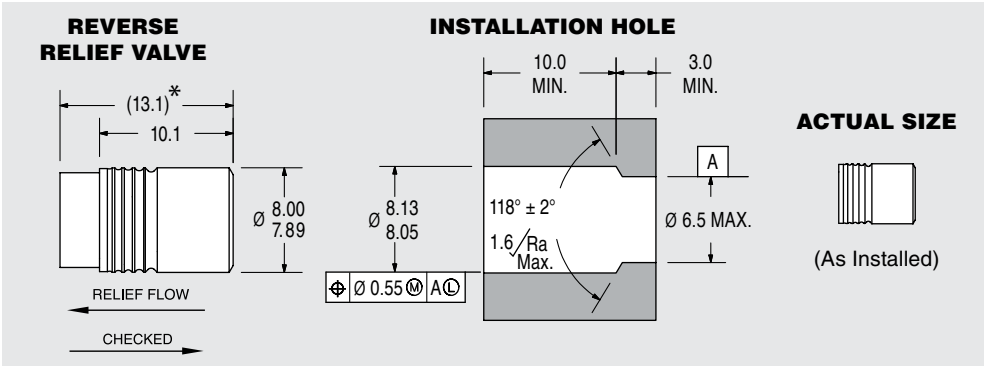
INSTALLATION

Tool Part Number CCRT0900120S
Force 625 Kg F (max.)
For installation procedure [see page A1](#).

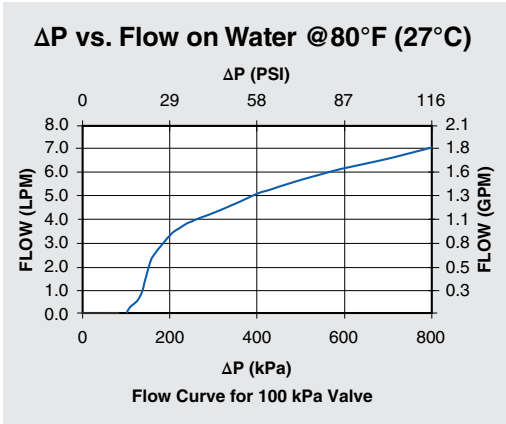


INSERT RELIEF VALVES

855 SERIES RELIEF VALVE - REVERSE FLOW



All dimensions are in millimeters.
* LOA before installation

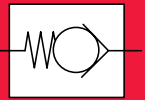


PERFORMANCE
Lohm Rate: 120 Lohms
Leakage: 20sccm/min. (max.) @ 172 kPa (25 psid) on air 1 Drop/min. (max.) on hydraulic fluid
Maximum Working Pressure: 28 MPa (4,060 psid) Checked Direction 4 MPa (580 psid) Flow Direction
Cracking Pressure Tolerance: ±15%

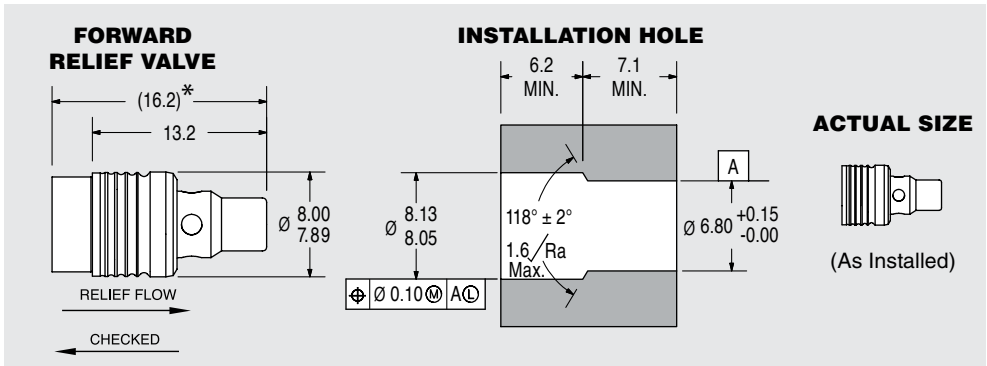
LEE PART NO.	CRACKING PRESSURE
PCRM3800210S	100 kPa (14.5 psid)
PCRM3800215S	150 kPa (21.8 psid)
PCRM3800220S	200 kPa (29 psid)
PCRM3800225S	250 kPa (36.6 psid)
PCRM3800230S	300 kPa (43.5 psid)
PCRM3800235S	350 kPa (50.8 psid)
PCRM3800240S	400 kPa (58 psid)
PCRM3800250S	500 kPa (72.5 psid)
PCRM3800255S*	550 kPa (79.8 psid)

MATERIALS
Body 303 Stainless Steel
Cage 416 Stainless Steel
Pin 416 Stainless Steel
Spring 302/17-7* Stainless Steel
Ball 440C Stainless Steel

INSTALLATION
Tool Part Number CCRT0900150S
Force 680 Kg F (max.)
For installation procedure see page A1 .



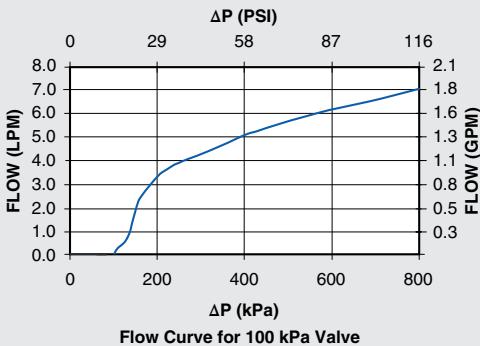
855 SERIES RELIEF VALVE - FORWARD FLOW



All dimensions are in millimeters.

* LOA before installation

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 120 Lohms

Leakage: 20sccm/min. (max.)
@ 172 kPa (25 psid) on air
1 Drop/min. (max.) on
hydraulic fluid

Maximum Working Pressure:
28 MPa (4,060 psid)
Checked Direction
4 MPa (580 psid)
Flow Direction

Cracking Pressure Tolerance: ±15%

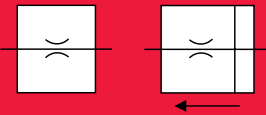
MATERIALS

Body 303 Stainless Steel
Cage 416 Stainless Steel
Pin 416 Stainless Steel
Spring 302/17-7* Stainless Steel
Ball..... 440C Stainless Steel

INSTALLATION

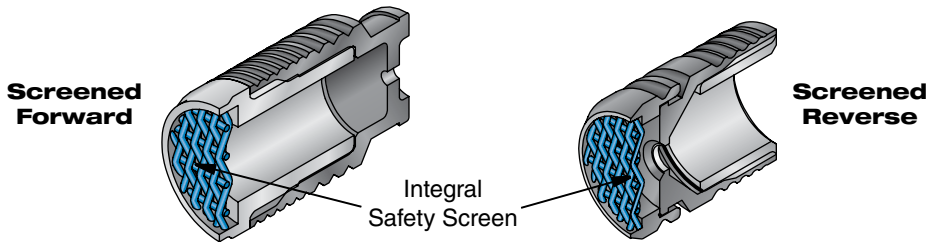
Tool Part Number CCRT0900150S
Force 680 Kg F (max.)
For installation procedure [see page A1](#).

LEE PART NO.	CRACKING PRESSURE
PCFM3800210S	100 kPa (14.5 psid)
PCFM3800215S	150 kPa (21.8 psid)
PCFM3800220S	200 kPa (29 psid)
PCFM3800225S	250 kPa (36.6 psid)
PCFM3800230S	300 kPa (43.5 psid)
PCFM3800235S	350 kPa (50.8 psid)
PCFM3800240S	400 kPa (58 psid)
PCFM3800250S	500 kPa (72.5 psid)
PCFM3800255S*	550 kPa (79.8 psid)



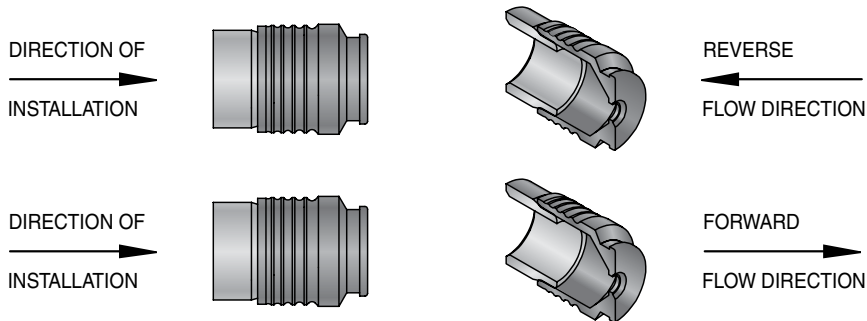
INSERT ORIFICES

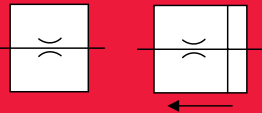
IMH Orifices are economical, reliable, highly accurate miniature restrictors. These orifices are 100% flow tested to ensure that every part is within $\pm 5\%$ of its nominal flow rate. Tighter flow tolerances are available as specials. Tight flow tolerances are only possible if entrance and exit conditions are closely controlled. This provides far more accuracy than an orifice specified by hole tolerance. An ordinary hole held to a very tight hole tolerance will not result in a tight flow tolerance. IMH orifices are so consistent because they are produced in high volume by automated processes. Installation is simple using the field proven controlled expansion principle which provides retention up to 21 mPa (3,045 psid) and creates a leak tight seal. Constructed entirely of stainless steel, these orifices will not change flow rate over time due either to corrosion or erosion. Integral safety screens are incorporated where the orifice diameter is 0.5mm (.020") or below.



Orifices come in three body diameters; 2.5mm, 5.5mm and 8.0mm to offer choices in size and screen capacity. The 2.5mm model is the smallest self retained, screened restrictor in the world, allowing designers to save space and weight, while reducing overall design and assembly time.

All three sizes are available in gas and liquid versions. Gas orifices are tested on clean dry nitrogen and liquid orifices on distilled water. Great care is taken to ensure the accuracy of the automated test systems. To further increase accuracy, orifices are tested in the direction of use. Simply refer to the diagram illustrating forward and reverse flow.





Features and Benefits

- Accurate flow
 - Eliminate expensive alternative components.
 - More consistent system performance.
- Self retained
 - Easy installation.
 - Maintains flow accuracy.
- Integral safety screens
 - Saves space and weight.
 - Simplifies assembly.
 - Ensures reliability.
- 100% flow tested
 - All parts within flow tolerance.
 - Consistent batch to batch performance.

TABLE OF CONTENTS

2.5mm ORIFICES FOR LIQUIDS

Screened Reverse A27

Screened Forward A28

Unscreened Reverse A29

Unscreened Forward A30

2.5mm ORIFICES FOR GASES

Screened Reverse A31

Screened Forward A32

Unscreened Reverse A33

Unscreened Forward A34

5.5mm ORIFICES FOR LIQUIDS

Screened Reverse A35

Screened Forward A36

Unscreened Reverse A37

Unscreened Forward A38

5.5mm ORIFICES FOR GASES

Screened Reverse A39

Screened Forward A40

Unscreened Reverse A41

Unscreened Forward A42

8.0mm ORIFICES FOR LIQUIDS

Screened Reverse A43

Screened Forward A44

Unscreened Reverse A45

Unscreened Forward A46

8.0mm ORIFICES FOR GASES

Screened Reverse A47

Screened Forward A48

Unscreened Reverse A49

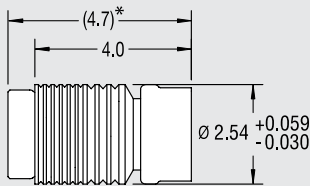
Unscreened Forward A50



INSERT ORIFICES

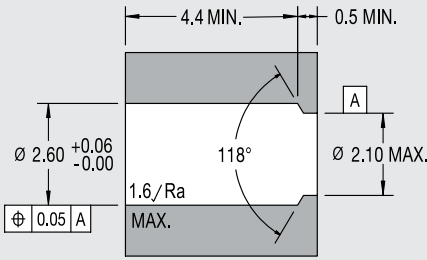
2.5mm INSERT ORIFICE FOR LIQUIDS SCREENED - REVERSE FLOW

IMH ORIFICE SCREENED



METERED FLOW
←
REVERSE

INSTALLATION HOLE SCREENED REVERSE



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



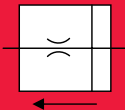
(As Installed)

LEE PART NUMBER	LOHM RATE	SCREEN MICRON RATING
RILR2553080S	8,000	40
RILR2553100S	10,000	40
RILR2553120S	12,000	40
RILR2553150S	15,000	40
RILR2553200S	20,000	40
RILR2553250S	25,000	40
RILR2553300S	30,000	40
RILR2553400S	40,000	40
RILR2553450S	45,000	40

PERFORMANCE
Metered Flow Lohm Rate Tolerance: ± 5% Test Fluid: Distilled Water Maximum Working Pressure: 21 MPa (3,045 psid) (In Aluminum)

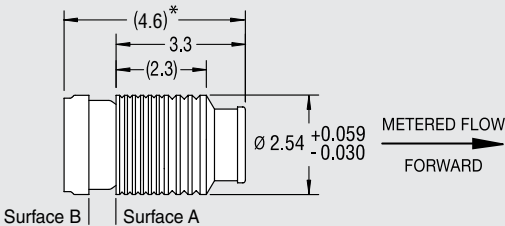
MATERIALS
Body 303 Stainless Steel Pin 416 Stainless Steel Screen 316 Stainless Steel

INSTALLATION
Tool Part Number..... CCRT0029354S Force..... 178 Kg F (max.) For installation procedure see page A1 .

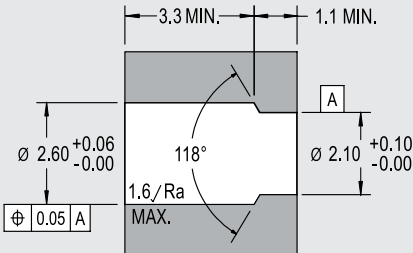


2.5mm INSERT ORIFICE FOR LIQUIDS SCREENED - FORWARD FLOW

IMH ORIFICE SCREENED



INSTALLATION HOLE SCREENED FORWARD



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

LEE PART NUMBER	LOHM RATE	SCREEN MICRON RATING
RILF2553080S	8,000	40
RILF2553100S	10,000	40
RILF2553120S	12,000	40
RILF2553150S	15,000	40
RILF2553200S	20,000	40
RILF2553250S	25,000	40
RILF2553300S	30,000	40
RILF2553400S	40,000	40
RILF2553450S	45,000	40

PERFORMANCE
Metered Flow
Lohm Rate Tolerance: $\pm 5\%$
Test Fluid: Distilled Water
Maximum Working Pressure: 21 MPa (3,045 psid) (In Aluminum)

MATERIALS
Body 303 Stainless Steel
Pin 303 Stainless Steel
Screen 316 Stainless Steel

INSTALLATION PROCEDURE

Insert the IMH orifice into a drilled installation hole. Seal and lock in place by driving in the screened expander pin. Surface A and B will be flush within +0.25mm (+0.010") of each other.

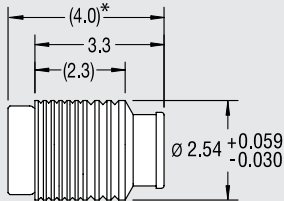
INSTALLATION
Tool Part Number..... CCRT0029354S
Force..... 178 Kg F (max.)
For installation procedure see left.



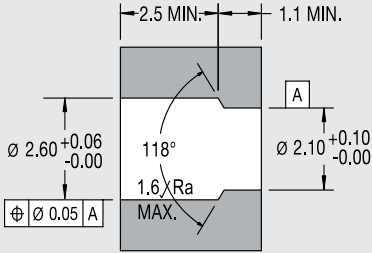
INSERT ORIFICES

2.5mm INSERT ORIFICE FOR LIQUIDS UNSCREENED - REVERSE FLOW

**IMH ORIFICE
UNSCREENED**



**INSTALLATION HOLE
UNSCREENED**



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

LEE PART NUMBER	LOHM RATE
RILR2551012S	1,200
RILR2551015S	1,500
RILR2551020S	2,000
RILR2551025S	2,500
RILR2551030S	3,000
RILR2551040S	4,000
RILR2551050S	5,000
RILR2551060S	6,000

PERFORMANCE
Metered Flow Lohm Rate Tolerance: ± 5% Test Fluid: Distilled Water Maximum Working Pressure: 21 MPa (3,045 psid) (In Aluminum)

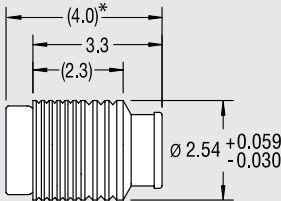
MATERIALS
Body 303 Stainless Steel Pin 416 Stainless Steel

INSTALLATION
Tool Part Number..... CCRT0029354S Force..... 178 Kg F (max.) For installation procedure see page A1 .



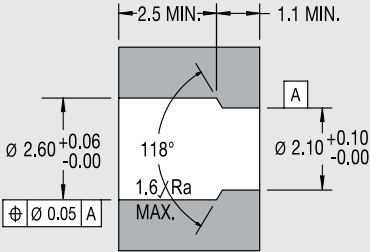
2.5mm INSERT ORIFICE FOR LIQUIDS UNSCREENED - FORWARD FLOW

IMH ORIFICE UNSCREENED



METERED FLOW
FORWARD

INSTALLATION HOLE UNSCREENED



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

LEE PART NUMBER	LOHM RATE
RILF2551012S	1,200
RILF2551015S	1,500
RILF2551020S	2,000
RILF2551025S	2,500
RILF2551030S	3,000
RILF2551040S	4,000
RILF2551050S	5,000
RILF2551060S	6,000

PERFORMANCE

Metered Flow
Lohm Rate Tolerance: $\pm 5\%$
Test Fluid: Distilled Water
Maximum Working Pressure:
21 MPa (3,045 psid)
(In Aluminum)

MATERIALS

Body 303 Stainless Steel
Pin 416 Stainless Steel

INSTALLATION

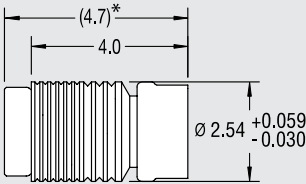
Tool Part Number..... CCRT0029354S
Force..... 178 Kg F (max.)
For installation procedure [see page A1](#).



INSERT ORIFICES

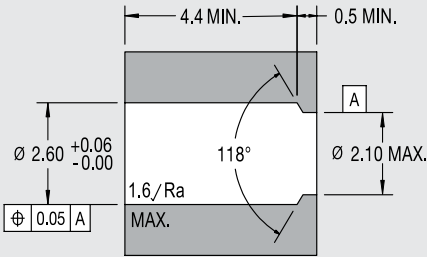
2.5mm INSERT ORIFICE FOR GASES SCREENED - REVERSE FLOW

IMH ORIFICE SCREENED



METERED FLOW
←
REVERSE

INSTALLATION HOLE SCREENED REVERSE



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



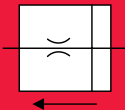
(As Installed)

LEE PART NUMBER	LOHM RATE	SCREEN MICRON RATING
RIGR2553080S	8,000	40
RIGR2553100S	10,000	40
RIGR2553120S	12,000	40
RIGR2553150S	15,000	40
RIGR2553200S	20,000	40
RIGR2553250S	25,000	40
RIGR2553300S	30,000	40
RIGR2553400S	40,000	40
RIGR2553450S	45,000	40

PERFORMANCE
Metered Flow Lohm Rate Tolerance: ± 5% Test Fluid: Clean & Dry Nitrogen Maximum Working Pressure: 21 MPa (3,045 psid) (In Aluminum)

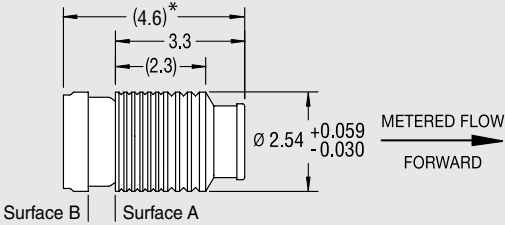
MATERIALS
Body 303 Stainless Steel Pin 416 Stainless Steel Screen 316 Stainless Steel

INSTALLATION
Tool Part Number..... CCRT0029354S Force..... 178 Kg F (max.) For installation procedure see page A1 .

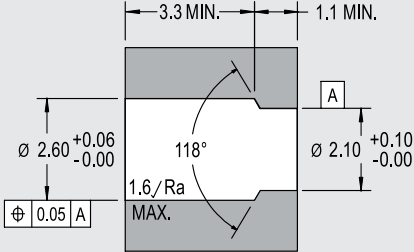


2.5mm INSERT ORIFICE FOR GASES SCREENED - FORWARD FLOW

IMH ORIFICE SCREENED



INSTALLATION HOLE SCREENED FORWARD



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

LEE PART NUMBER	LOHM RATE	SCREEN MICRON RATING
RIGF2553080S	8,000	40
RIGF2553100S	10,000	40
RIGF2553120S	12,000	40
RIGF2553150S	15,000	40
RIGF2553200S	20,000	40
RIGF2553250S	25,000	40
RIGF2553300S	30,000	40
RIGF2553400S	40,000	40
RIGF2553450S	45,000	40

PERFORMANCE
Metered Flow
Lohm Rate Tolerance: $\pm 5\%$
Test Fluid: Clean & Dry Nitrogen
Maximum Working Pressure: 21 MPa (3,045 psid) (In Aluminum)

MATERIALS
Body 303 Stainless Steel
Pin 303 Stainless Steel
Screen 316 Stainless Steel

INSTALLATION PROCEDURE

Insert the IMH orifice into a drilled installation hole. Seal and lock in place by driving in the screened expander pin. Surface A and B will be flush within $+0.25\text{mm}$ ($+0.010''$) of each other.

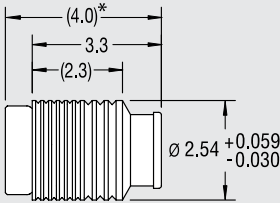
INSTALLATION
Tool Part Number..... CCRT0029354S
Force..... 178 Kg F (max.)
For installation procedure see left.



INSERT ORIFICES

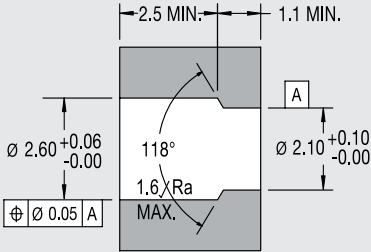
2.5mm INSERT ORIFICE FOR GASES UNSCREENED - REVERSE FLOW

IMH ORIFICE UNSCREENED



METERED FLOW
←
REVERSE

INSTALLATION HOLE UNSCREENED



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

LEE PART NUMBER	LOHM RATE
RIGR2551012S	1,200
RIGR2551015S	1,500
RIGR2551020S	2,000
RIGR2551025S	2,500
RIGR2551030S	3,000
RIGR2551040S	4,000
RIGR2551050S	5,000
RIGR2551060S	6,000

PERFORMANCE
Metered Flow Lohm Rate Tolerance: ± 5% Test Fluid: Clean & Dry Nitrogen Maximum Working Pressure: 21 MPa (3,045 psid) (In Aluminum)

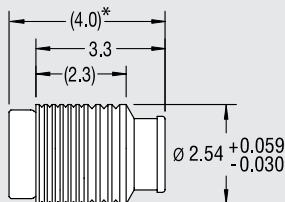
MATERIALS
Body 303 Stainless Steel Pin 416 Stainless Steel

INSTALLATION
Tool Part Number..... CCRT0029354S Force..... 178 Kg F (max.) For installation procedure see page A1 .



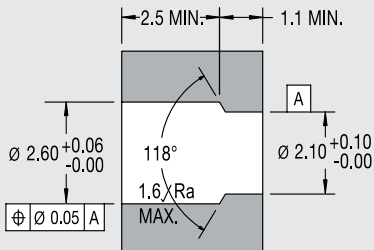
2.5mm INSERT ORIFICE FOR GASES UNSCREENED - FORWARD FLOW

IMH ORIFICE UNSCREENED



METERED FLOW
FORWARD

INSTALLATION HOLE UNSCREENED



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

LEE PART NUMBER	LOHM RATE
RIGF2551012S	1,200
RIGF2551015S	1,500
RIGF2551020S	2,000
RIGF2551025S	2,500
RIGF2551030S	3,000
RIGF2551040S	4,000
RIGF2551050S	5,000
RIGF2551060S	6,000

PERFORMANCE

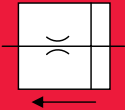
Metered Flow
Lohm Rate Tolerance: $\pm 5\%$
Test Fluid: Clean & Dry Nitrogen
Maximum Working Pressure:
21 MPa (3,045 psid)
(In Aluminum)

MATERIALS

Body 303 Stainless Steel
Pin 416 Stainless Steel

INSTALLATION

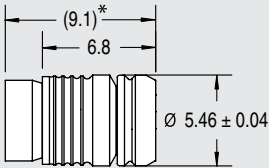
Tool Part Number..... CCRT0029354S
Force..... 178 Kg F (max.)
For installation procedure [see page A1](#).



INSERT ORIFICES

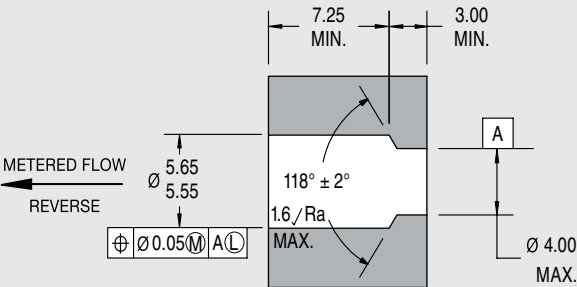
5.5mm INSERT ORIFICE FOR LIQUIDS SCREENED - REVERSE FLOW

IMH ORIFICE SCREENED



* LOA before installation.
All dimensions in millimeters.

INSTALLATION HOLE SCREENED REVERSE



ACTUAL SIZE



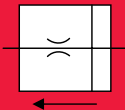
(As Installed)

LEE PART NUMBER	LOHM RATE	SCREEN MICRON RATING
RILR5553020S	2,000	125
RILR5553025S	2,500	125
RILR5553030S	3,000	125
RILR5553040S	4,000	125
RILR5553050S	5,000	125
RILR5553060S	6,000	75
RILR5553080S	8,000	75
RILR5553100S	10,000	75
RILR5553120S	12,000	75
RILR5553150S	15,000	75
RILR5553200S	20,000	40
RILR5553250S	25,000	40
RILR5553300S	30,000	40
RILR5553400S	40,000	40
RILR5553450S	45,000	40

PERFORMANCE
Metered Flow Lohm Rate Tolerance: ± 5%
Test Fluid: Distilled Water
Maximum Working Pressure: 21 MPa (3,045 psid)

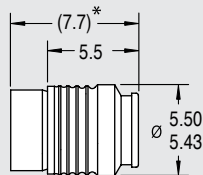
MATERIALS
Body 303 Stainless Steel
Pin 416 Stainless Steel
Screen 316 Stainless Steel

INSTALLATION
Tool Part Number..... CCRT0900120S
Force..... 625 Kg F (max.)
For installation procedure see page A1 .



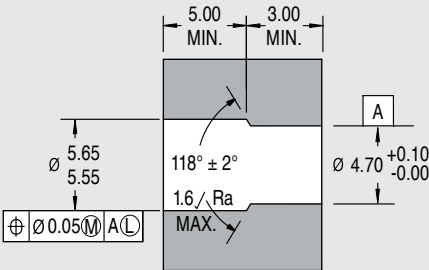
5.5mm INSERT ORIFICE FOR LIQUIDS SCREENED - FORWARD FLOW

IMH ORIFICE SCREENED



METERED FLOW
→
FORWARD

INSTALLATION HOLE SCREENED FORWARD



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

LEE PART NUMBER	LOHM RATE	SCREEN MICRON RATING
RILF5553020S	2,000	125
RILF5553025S	2,500	125
RILF5553030S	3,000	125
RILF5553040S	4,000	125
RILF5553050S	5,000	125
RILF5553060S	6,000	75
RILF5553080S	8,000	75
RILF5553100S	10,000	75
RILF5553120S	12,000	75
RILF5553150S	15,000	75
RILF5553200S	20,000	40
RILF5553250S	25,000	40
RILF5553300S	30,000	40
RILF5553400S	40,000	40
RILF5553450S	45,000	40

PERFORMANCE
Metered Flow Lohm Rate Tolerance: $\pm 5\%$ Test Fluid: Distilled Water Maximum Working Pressure: 21 MPa (3,045 psid)

MATERIALS
Body 303 Stainless Steel Pin 303 Stainless Steel Screen 316 Stainless Steel

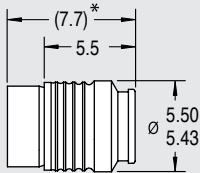
INSTALLATION
Tool Part Number..... CCRT0900120S Force..... 625 Kg F (max.) For installation procedure see page A1 .



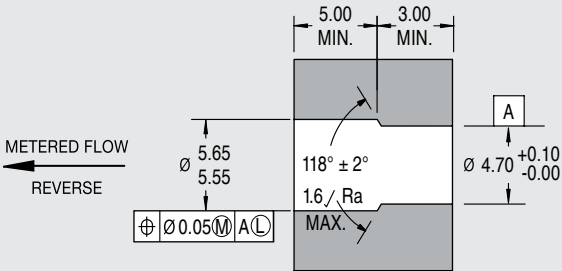
INSERT ORIFICES

5.5mm INSERT ORIFICE FOR LIQUIDS UNSCREENED - REVERSE FLOW

IMH ORIFICE UNSCREENED



INSTALLATION HOLE UNSCREENED



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

LEE PART NUMBER	LOHM RATE
RILR5551005S	500
RILR5551006S	600
RILR5551008S	800
RILR5551010S	1,000
RILR5551012S	1,200
RILR5551015S	1,500

PERFORMANCE
Metered Flow Lohm Rate Tolerance: ± 5%
Test Fluid: Distilled Water
Maximum Working Pressure: 21 MPa (3,045 psid)

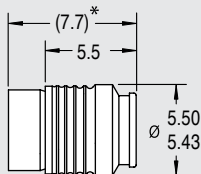
MATERIALS
Body 303 Stainless Steel
Pin 416 Stainless Steel

INSTALLATION
Tool Part Number..... CCRT0900120S
Force..... 625 Kg F (max.)
For installation procedure see page A1 .



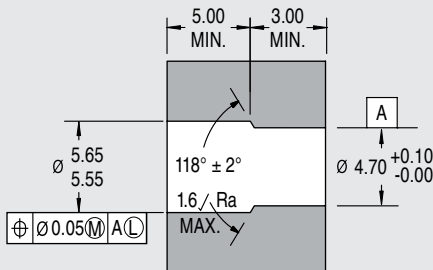
5.5mm INSERT ORIFICE FOR LIQUIDS UNSCREENED - FORWARD FLOW

IMH ORIFICE UNSCREENED



METERED FLOW
→
FORWARD

INSTALLATION HOLE UNSCREENED



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

LEE PART NUMBER	LOHM RATE
RILF5551005S	500
RILF5551006S	600
RILF5551008S	800
RILF5551010S	1,000
RILF5551012S	1,200
RILF5551015S	1,500

PERFORMANCE

Metered Flow
Lohm Rate Tolerance: $\pm 5\%$

Test Fluid: Distilled Water

Maximum Working Pressure:
21 MPa (3,045 psid)

MATERIALS

Body 303 Stainless Steel
Pin 416 Stainless Steel

INSTALLATION

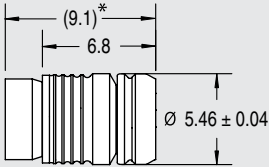
Tool Part Number..... CCRT0900120S
Force..... 625 Kg F (max.)
For installation procedure [see page A1](#).



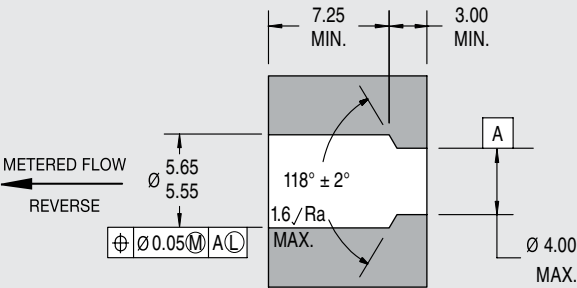
INSERT ORIFICES

5.5mm INSERT ORIFICE FOR GASES SCREENED - REVERSE FLOW

IMH ORIFICE SCREENED



INSTALLATION HOLE SCREENED REVERSE



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



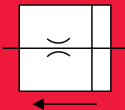
(As Installed)

LEE PART NUMBER	LOHM RATE	SCREEN MICRON RATING
RIGR5553020S	2,000	125
RIGR5553025S	2,500	125
RIGR5553030S	3,000	125
RIGR5553040S	4,000	125
RIGR5553050S	5,000	125
RIGR5553060S	6,000	75
RIGR5553080S	8,000	75
RIGR5553100S	10,000	75
RIGR5553120S	12,000	75
RIGR5553150S	15,000	75
RIGR5553200S	20,000	40
RIGR5553250S	25,000	40
RIGR5553300S	30,000	40
RIGR5553400S	40,000	40
RIGR5553450S	45,000	40

PERFORMANCE
Metered Flow Lohm Rate Tolerance: ± 5%
Test Fluid: Clean & Dry Nitrogen
Maximum Working Pressure: 21 MPa (3,045 psid)

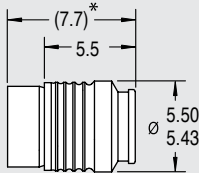
MATERIALS
Body 303 Stainless Steel
Pin 416 Stainless Steel
Screen 316 Stainless Steel

INSTALLATION
Tool Part Number..... CCRT0900120S
Force..... 625 Kg F (max.)
For installation procedure see page A1 .



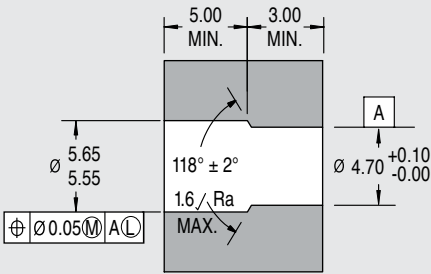
5.5mm INSERT ORIFICE FOR GASES SCREENED - FORWARD FLOW

IMH ORIFICE SCREENED



METERED FLOW
FORWARD

INSTALLATION HOLE SCREENED



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

LEE PART NUMBER	LOHM RATE	SCREEN MICRON RATING
RIGF5553020S	2,000	125
RIGF5553025S	2,500	125
RIGF5553030S	3,000	125
RIGF5553040S	4,000	125
RIGF5553050S	5,000	125
RIGF5553060S	6,000	75
RIGF5553080S	8,000	75
RIGF5553100S	10,000	75
RIGF5553120S	12,000	75
RIGF5553150S	15,000	75
RIGF5553200S	20,000	40
RIGF5553250S	25,000	40
RIGF5553300S	30,000	40
RIGF5553400S	40,000	40
RIGF5553450S	45,000	40

PERFORMANCE
Metered Flow Lohm Rate Tolerance: $\pm 5\%$ Test Fluid: Clean & Dry Nitrogen Maximum Working Pressure: 21 MPa (3,045 psid)

MATERIALS
Body 303 Stainless Steel Pin 303 Stainless Steel Screen 316 Stainless Steel

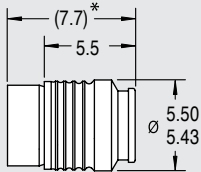
INSTALLATION
Tool Part Number..... CCRT0900120S Force..... 625 Kg F (max.) For installation procedure see page A1 .



INSERT ORIFICES

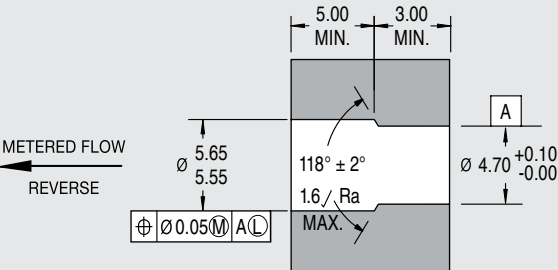
5.5mm INSERT ORIFICE FOR GASES UNSCREENED - REVERSE FLOW

IMH ORIFICE UNSCREENED



* LOA before installation.
All dimensions in millimeters.

INSTALLATION HOLE UNSCREENED



ACTUAL SIZE



(As Installed)

LEE PART NUMBER	LOHM RATE
RIGR5551005S	500
RIGR5551006S	600
RIGR5551008S	800
RIGR5551010S	1,000
RIGR5551012S	1,200
RIGR5551015S	1,500

PERFORMANCE
Metered Flow Lohm Rate Tolerance: ± 5%
Test Fluid: Clean & Dry Nitrogen
Maximum Working Pressure: 21 MPa (3,045 psid)

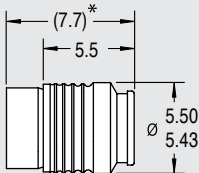
MATERIALS
Body 303 Stainless Steel
Pin 416 Stainless Steel

INSTALLATION
Tool Part Number..... CCRT0900120S
Force..... 625 Kg F (max.)
For installation procedure see page A1 .



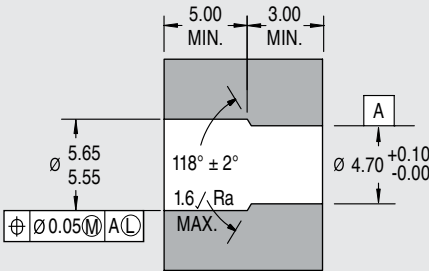
5.5mm INSERT ORIFICE FOR GASES UNSCREENED - FORWARD FLOW

IMH ORIFICE UNSCREENED



METERED FLOW
FORWARD

INSTALLATION HOLE UNSCREENED



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

LEE PART NUMBER	LOHM RATE
RIGF5551005S	500
RIGF5551006S	600
RIGF5551008S	800
RIGF5551010S	1,000
RIGF5551012S	1,200
RIGF5551015S	1,500

PERFORMANCE

Metered Flow
Lohm Rate Tolerance: $\pm 5\%$

Test Fluid: Clean & Dry Nitrogen

Maximum Working Pressure:
21 MPa (3,045 psid)

MATERIALS

Body 303 Stainless Steel
Pin 416 Stainless Steel

INSTALLATION

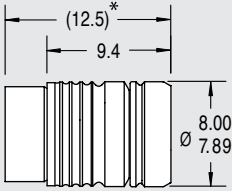
Tool Part Number..... CCRT0900120S
Force..... 625 Kg F (max.)
For installation procedure [see page A1](#).



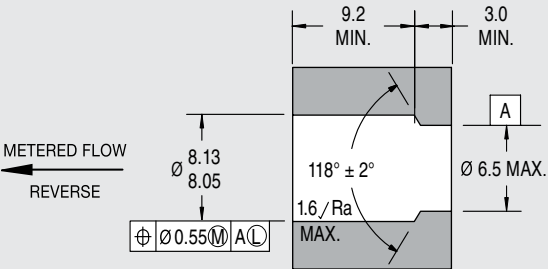
INSERT ORIFICES

8.0mm INSERT ORIFICE FOR LIQUIDS SCREENED - REVERSE FLOW

IMH ORIFICE
SCREENED



INSTALLATION HOLE
SCREENED REVERSE



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



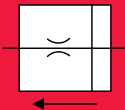
(As Installed)

LEE PART NUMBER	LOHM RATE	SCREEN MICRON RATING
RILR8053020S	2,000	125
RILR8053025S	2,500	125
RILR8053030S	3,000	125
RILR8053040S	4,000	125
RILR8053050S	5,000	125
RILR8053060S	6,000	75
RILR8053080S	8,000	75
RILR8053100S	10,000	75
RILR8053120S	12,000	75
RILR8053150S	15,000	75
RILR8053200S	20,000	40
RILR8053250S	25,000	40
RILR8053300S	30,000	40
RILR8053400S	40,000	40
RILR8053450S	45,000	40

PERFORMANCE
Metered Flow Lohm Rate Tolerance: ± 5%
Test Fluid: Distilled Water
Maximum Working Pressure: 21 MPa (3,045 psid)

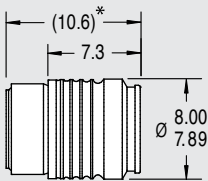
MATERIALS
Body 303 Stainless Steel
Pin 416 Stainless Steel
Screen 316 Stainless Steel

INSTALLATION
Tool Part Number..... CCRT0900150S
Force..... 680 Kg F (max.)
For installation procedure see page A1 .



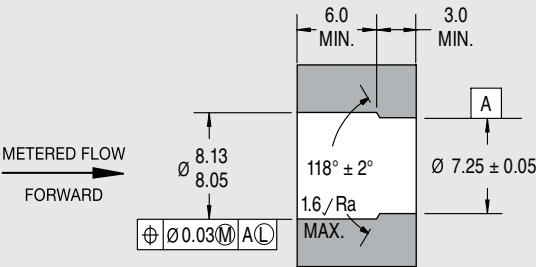
8.0mm INSERT ORIFICE FOR LIQUIDS SCREENED - FORWARD FLOW

IMH ORIFICE SCREENED



* LOA before installation.
All dimensions in millimeters.

INSTALLATION HOLE SCREENED FORWARD



ACTUAL SIZE



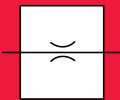
(As Installed)

LEE PART NUMBER	LOHM RATE	SCREEN MICRON RATING
RILF8053020S	2,000	125
RILF8053025S	2,500	125
RILF8053030S	3,000	125
RILF8053040S	4,000	125
RILF8053050S	5,000	125
RILF8053060S	6,000	75
RILF8053080S	8,000	75
RILF8053100S	10,000	75
RILF8053120S	12,000	75
RILF8053150S	15,000	75
RILF8053200S	20,000	40
RILF8053250S	25,000	40
RILF8053300S	30,000	40
RILF8053400S	40,000	40
RILF8053450S	45,000	40

PERFORMANCE
Metered Flow
Lohm Rate Tolerance: $\pm 5\%$
Test Fluid: Distilled Water
Maximum Working Pressure: 21 MPa (3,045 psid)

MATERIALS
Body 303 Stainless Steel
Pin 303 Stainless Steel
Screen 316 Stainless Steel

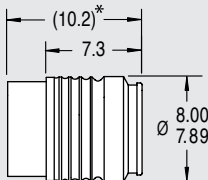
INSTALLATION
Tool Part Number..... CCRT0900150S
Force..... 680 Kg F (max.)
For installation procedure see page A1 .



INSERT ORIFICES

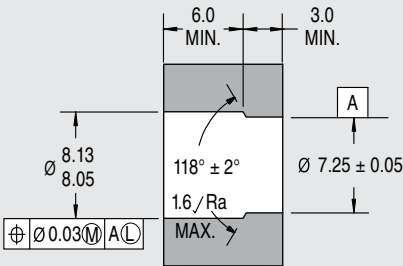
8.0mm INSERT ORIFICE FOR LIQUIDS UNSCREENED - REVERSE FLOW

IMH ORIFICE UNSCREENED



METERED FLOW
←
REVERSE

INSTALLATION HOLE UNSCREENED



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



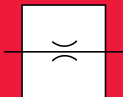
(As Installed)

LEE PART NUMBER	LOHM RATE
RILR8051005S	500
RILR8051006S	600
RILR8051008S	800
RILR8051010S	1,000
RILR8051012S	1,200
RILR8051015S	1,500

PERFORMANCE
Metered Flow Lohm Rate Tolerance: ± 5%
Test Fluid: Distilled Water
Maximum Working Pressure: 21 MPa (3,045 psid)

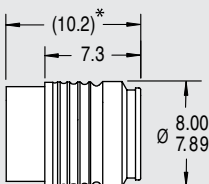
MATERIALS
Body 303 Stainless Steel
Pin 416 Stainless Steel

INSTALLATION
Tool Part Number..... CCRT0900150S
Force..... 680 Kg F (max.)
For installation procedure see page A1 .



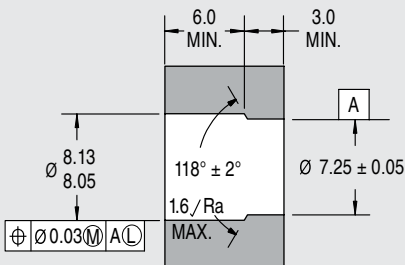
8.0mm INSERT ORIFICE FOR LIQUIDS UNSCREENED - FORWARD FLOW

IMH ORIFICE UNSCREENED



METERED FLOW
→
FORWARD

INSTALLATION HOLE UNSCREENED



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



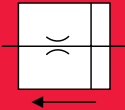
(As Installed)

LEE PART NUMBER	LOHM RATE
RILF8051005S	500
RILF8051006S	600
RILF8051008S	800
RILF8051010S	1,000
RILF8051012S	1,200
RILF8051015S	1,500

PERFORMANCE
Metered Flow Lohm Rate Tolerance: $\pm 5\%$ Test Fluid: Distilled Water Maximum Working Pressure: 21 MPa (3,045 psid)

MATERIALS
Body 303 Stainless Steel Pin 416 Stainless Steel

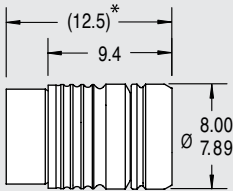
INSTALLATION
Tool Part Number..... CCRT0900150S Force..... 680 Kg F (max.) For installation procedure see page A1 .



INSERT ORIFICES

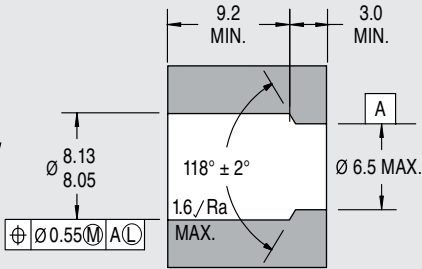
8.0mm INSERT ORIFICE FOR GASES SCREENED - REVERSE FLOW

IMH ORIFICE SCREENED



METERED FLOW
← REVERSE

INSTALLATION HOLE SCREENED REVERSE



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



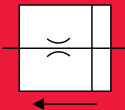
(As Installed)

LEE PART NUMBER	LOHM RATE	SCREEN MICRON RATING
RIGR8053020S	2,000	125
RIGR8053025S	2,500	125
RIGR8053030S	3,000	125
RIGR8053040S	4,000	125
RIGR8053050S	5,000	125
RIGR8053060S	6,000	75
RIGR8053080S	8,000	75
RIGR8053100S	10,000	75
RIGR8053120S	12,000	75
RIGR8053150S	15,000	75
RIGR8053200S	20,000	40
RIGR8053250S	25,000	40
RIGR8053300S	30,000	40
RIGR8053400S	40,000	40
RIGR8053450S	45,000	40

PERFORMANCE
Metered Flow Lohm Rate Tolerance: ± 5%
Test Fluid: Clean & Dry Nitrogen
Maximum Working Pressure: 21 MPa (3,045 psid)

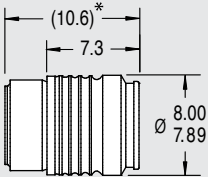
MATERIALS
Body 303 Stainless Steel
Pin 416 Stainless Steel
Screen 316 Stainless Steel

INSTALLATION
Tool Part Number..... CCRT0900150S
Force..... 680 Kg F (max.)
For installation procedure see page A1 .



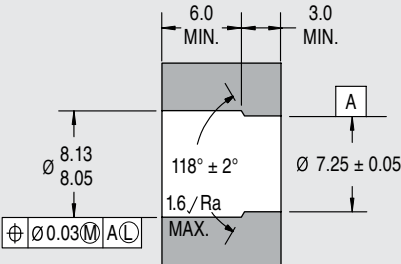
8.0mm INSERT ORIFICE FOR GASES SCREENED - FORWARD FLOW

IMH ORIFICE SCREENED



METERED FLOW
→
FORWARD

INSTALLATION HOLE SCREENED FORWARD



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

LEE PART NUMBER	LOHM RATE	SCREEN MICRON RATING
RIGF8053020S	2,000	125
RIGF8053025S	2,500	125
RIGF8053030S	3,000	125
RIGF8053040S	4,000	125
RIGF8053050S	5,000	125
RIGF8053060S	6,000	75
RIGF8053080S	8,000	75
RIGF8053100S	10,000	75
RIGF8053120S	12,000	75
RIGF8053150S	15,000	75
RIGF8053200S	20,000	40
RIGF8053250S	25,000	40
RIGF8053300S	30,000	40
RIGF8053400S	40,000	40
RIGF8053450S	45,000	40

PERFORMANCE
Metered Flow Lohm Rate Tolerance: $\pm 5\%$ Test Fluid: Clean & Dry Nitrogen Maximum Working Pressure: 21 MPa (3,045 psid)

MATERIALS
Body 303 Stainless Steel Pin 303 Stainless Steel Screen 316 Stainless Steel

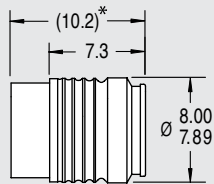
INSTALLATION
Tool Part Number..... CCRT0900150S Force..... 680 Kg F (max.) For installation procedure see page A1 .



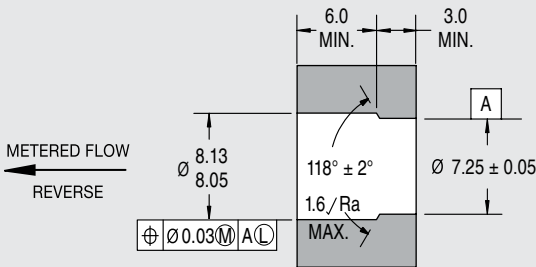
INSERT ORIFICES

8.0mm INSERT ORIFICE FOR GASES UNSCREENED - REVERSE FLOW

IMH ORIFICE UNSCREENED



INSTALLATION HOLE UNSCREENED



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

LEE PART NUMBER	LOHM RATE
RIGR8051005S	500
RIGR8051006S	600
RIGR8051008S	800
RIGR8051010S	1,000
RIGR8051012S	1,200
RIGR8051015S	1,500

PERFORMANCE
Metered Flow Lohm Rate Tolerance: ± 5%
Test Fluid: Clean & Dry Nitrogen
Maximum Working Pressure: 21 MPa (3,045 psid)

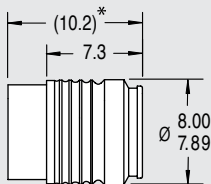
MATERIALS
Body 303 Stainless Steel
Pin 416 Stainless Steel

INSTALLATION
Tool Part Number..... CCRT0900150S
Force..... 680 Kg F (max.)
For installation procedure see page A1 .



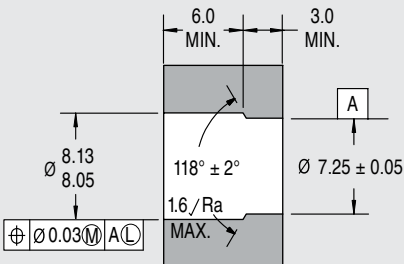
8.0mm INSERT ORIFICE FOR GASES UNSCREENED - FORWARD FLOW

IMH ORIFICE UNSCREENED



METERED FLOW
→
FORWARD

INSTALLATION HOLE UNSCREENED



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

LEE PART NUMBER	LOHM RATE
RIGF8051005S	500
RIGF8051006S	600
RIGF8051008S	800
RIGF8051010S	1,000
RIGF8051012S	1,200
RIGF8051015S	1,500

PERFORMANCE

Metered Flow
Lohm Rate Tolerance: $\pm 5\%$

Test Fluid: Clean & Dry Nitrogen

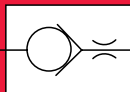
Maximum Working Pressure:
21 MPa (3,045 psid)

MATERIALS

Body 303 Stainless Steel
Pin 416 Stainless Steel

INSTALLATION

Tool Part Number..... CCRT0900150S
Force..... 680 Kg F (max.)
For installation procedure [see page A1](#).



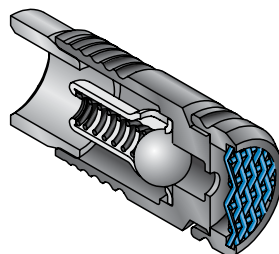
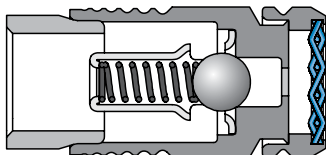
INSERT RESTRICTOR CHECKS

Restrictor checks are functionally an orifice in series with a check valve, all in one package. IMH Restrictor Checks are the same size as their equivalent check valves. These valves come in forward and reverse flow directions and incorporate a screen of an appropriate filtration size for orifice diameters below 0.5mm (0.020").



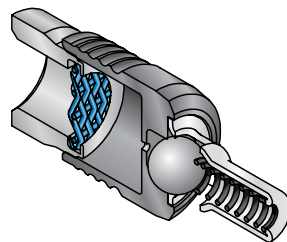
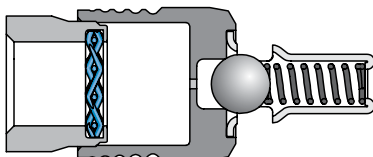
Reverse Flow Direction

DIRECTION OF
INSTALLATION →
REVERSE FLOW ←
DIRECTION

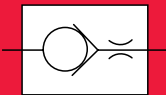


Forward Flow Direction

DIRECTION OF
INSTALLATION →
FORWARD FLOW →
DIRECTION



Large orifice diameters do not come with screens as standards. IMH Restrictor Checks are available in a wide range of metered lohm rates; 40,000 lohms [0.1mm (0.004")] to 400 lohms [1.1mm (0.044")] equivalent orifice.



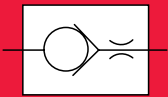
Features and Benefits

- Combines hydraulic functions
 - Simplifies manifold.
- Accurate flow
 - Eliminate expensive alternative components.
 - More consistent system performance.
- Integral screened versions
 - Protects the orifice.
 - Saves space and weight.
 - Simplifies assembly.
 - Ensures reliability.
- 100% flow tested
 - Eliminates rework.
 - All parts within flow tolerance.
 - Consistent batch to batch performance.

TABLE OF CONTENTS

5.5mm RESTRICTOR CHECKS

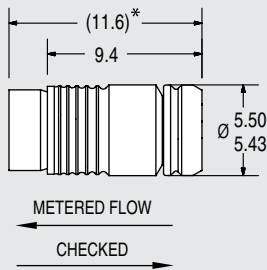
Reverse Screened	A53
Reverse Unscreened	A54
Forward Screened	A55
Forward Unscreened	A56



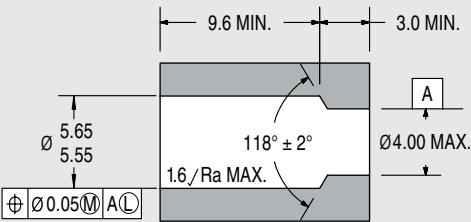
INSERT RESTRICTOR CHECKS

RESTRICTOR CHEK - SCREENED REVERSE FLOW

REVERSE RESTRICTOR CHEK



INSTALLATION HOLE



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

PERFORMANCE

Metered Flow Lohm Rate Tolerance: $\pm 5\%$
Leakage: 20sccm/min. (max.) @ 172 kPa (25 psid) on air
1 Drop/min. (max.) on hydraulic fluid
Maximum Working Pressure:
28 MPa (4,060 psid)
Checked Direction
4 MPa (580 psid)
Metered Flow Direction
Cracking Pressure: 40 ± 30 kPa
(6 ± 4.4 psid)

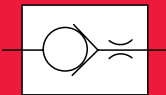
MATERIALS

Body 303 Stainless Steel
Pin 416 Stainless Steel
Cage 305 Stainless Steel
Spring 302 Stainless Steel
Ball 440C Stainless Steel
Screen 316 Stainless Steel

INSTALLATION

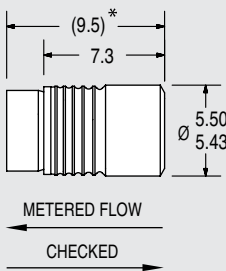
Tool Part Number CCRT0900120S
Force 625 Kg F (max.)
For installation procedure [see page A1](#).

LEE PART NUMBER	LOHM RATE	SCREEN MICRON RATING
CORM5521025S	2,500	125
CORM5521030S	3,000	125
CORM5521040S	4,000	125
CORM5521050S	5,000	125
CORM5571060S	6,000	75
CORM5571080S	8,000	75
CORM5571100S	10,000	75
CORM5571120S	12,000	75
CORM5571150S	15,000	75
CORM5541200S	20,000	40
CORM5541300S	30,000	40
CORM5541400S	40,000	40

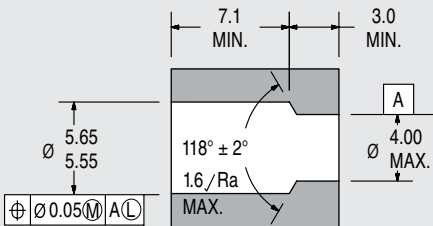


RESTRICTOR CHEK - REVERSE FLOW

REVERSE RESTRICTOR CHEK

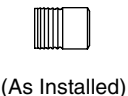


INSTALLATION HOLE



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

PERFORMANCE

Metered Flow Lohm Rate Tolerance: $\pm 5\%$
Leakage: 20sccm/min. (max.) @ 172 kPa (25 psid) on air
1 Drop/min. (max.) on hydraulic fluid
Maximum Working Pressure:
28 MPa (4,060 psid)
Checked Direction
4 MPa (580 psid)
Metered Flow Direction
Cracking Pressure: 40 ± 30 kPa (6 ± 4.4 psid)

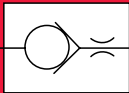
MATERIALS

Body 303 Stainless Steel
Pin 416 Stainless Steel
Cage 305 Stainless Steel
Spring 302 Stainless Steel
Ball 440C Stainless Steel

INSTALLATION

Tool Part Number CCRT0900120S
Force 625 Kg F (max.)
For installation procedure see page A1.

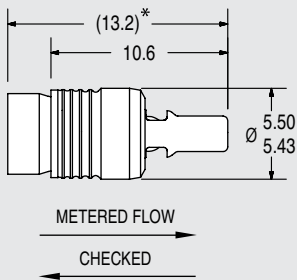
LEE PART NUMBER	LOHM RATE
CORM5501004S	400
CORM5501005S	500
CORM5501006S	600
CORM5501008S	800
CORM5501010S	1,000
CORM5501012S	1,200
CORM5501015S	1,500
CORM5501020S	2,000



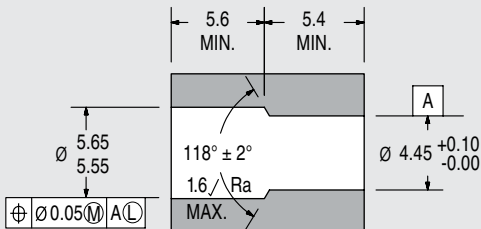
INSERT RESTRICTOR CHECKS

RESTRICTOR CHEK - SCREENED FORWARD FLOW

FORWARD RESTRICTOR CHEK



INSTALLATION HOLE



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

PERFORMANCE

Metered Flow Lohm Rate Tolerance: $\pm 5\%$
Leakage: 20sccm/min. (max.) @ 172 kPa (25 psid) on air
1 Drop/min. (max.) on hydraulic fluid
Maximum Working Pressure:
28 MPa (4,060 psid) Checked Direction
4 MPa (580 psid) Metered Flow Direction
Cracking Pressure: 40 ± 30 kPa (6 ± 4.4 psid)

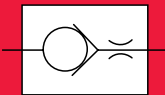
MATERIALS

Body 303 Stainless Steel
Pin 303 Stainless Steel
Cage 305 Stainless Steel
Spring 302 Stainless Steel
Ball 440C Stainless Steel
Screen 316 Stainless Steel

INSTALLATION

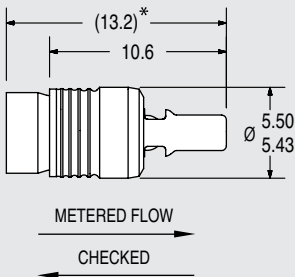
Tool Part Number CCRT0900120S
Force 625 Kg F (max.)
For installation procedure [see page A1](#).

LEE PART NUMBER	LOHM RATE	SCREEN MICRON RATING
COFM5521025S	2,500	125
COFM5521030S	3,000	125
COFM5521040S	4,000	125
COFM5521050S	5,000	125
COFM5571060S	6,000	75
COFM5571080S	8,000	75
COFM5571100S	10,000	75
COFM5571120S	12,000	75
COFM5571150S	15,000	75

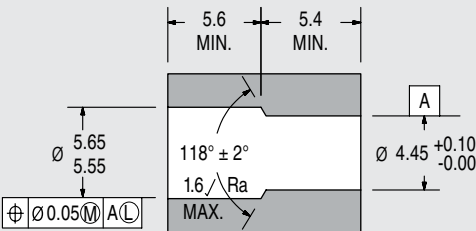


RESTRICTOR CHEK - FORWARD FLOW

FORWARD RESTRICTOR CHEK



INSTALLATION HOLE



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

PERFORMANCE

Metered Flow Lohm Rate Tolerance: $\pm 5\%$
Leakage: 20sccm/min. (max.) @ 172 kPa (25 psid) on air
1 Drop/min. (max.) on hydraulic fluid
Maximum Working Pressure:
28 MPa (4,060 psid)
Checked Direction
4 MPa (580 psid)
Metered Flow Direction
Cracking Pressure: 40 ± 30 kPa
(6 ± 4.4 psid)

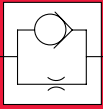
MATERIALS

Body 303 Stainless Steel
Pin 416 Stainless Steel
Cage 305 Stainless Steel
Spring 302 Stainless Steel
Ball 440C Stainless Steel

INSTALLATION

Tool Part Number CCRT0900120S
Force 625 Kg F (max.)
For installation procedure see page A1.

LEE PART NUMBER	LOHM RATE
COFM5501004S	400
COFM5501005S	500
COFM5501006S	600
COFM5501008S	800
COFM5501010S	1,000
COFM5501012S	1,200
COFM5501015S	1,500
COFM5501020S	2,000

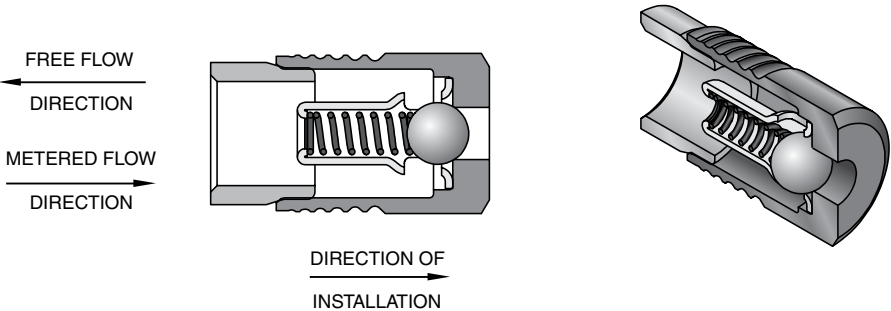


INSERT FLOW CONTROLS

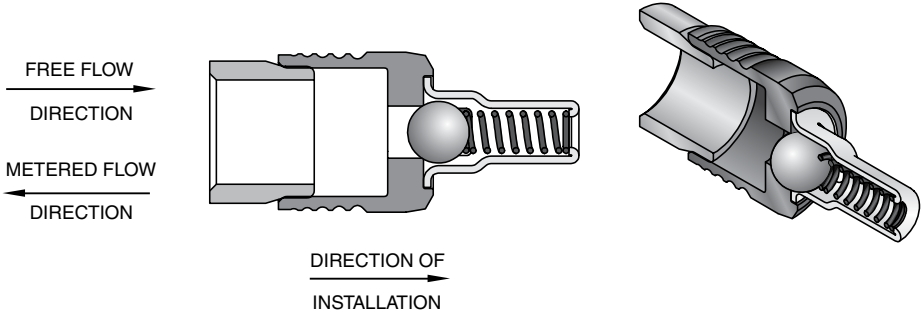
Flow Controls are functionally an orifice in parallel with a check valve — all in one package. IMH Flow Controls are the same size as the equivalent IMH check valve. Flow Controls are available in two diameters; 5.5mm and 8.0mm. The 5.5mm version covers lohm rates from 2,000 lohms [0.5mm (0.020")] to 10,000 lohms [0.22mm (0.009")] equivalent orifice diameters. The 8.0mm Flow Control covers 500 lohms [0.99mm (0.039")] to 2,000 lohms [0.5mm (0.020")] equivalent orifice diameters. Both sizes are available in forward and reverse configurations.

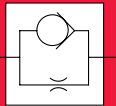


Reverse Flow Valve



Forward Flow Valve





Features and Benefits

- Combines hydraulic functions
 - Simplifies manifold.
- Accurate flow
 - Eliminate expensive alternative components.
 - More consistent system performance.
- 100% flow tested
 - Eliminates rework.
 - All parts within flow tolerance.
 - Consistent batch to batch performance.

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5.5mm FLOW CONTROLS

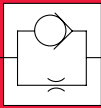
Reverse A59

Forward A60

8.0mm FLOW CONTROLS

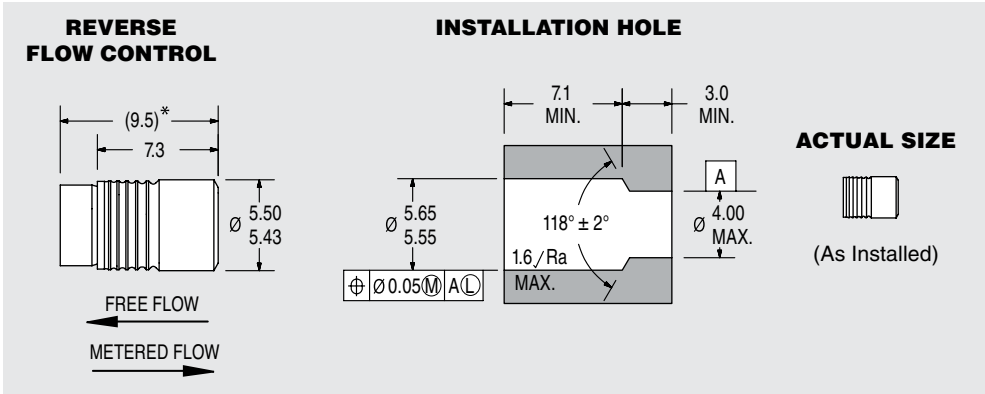
Reverse A61

Forward A62

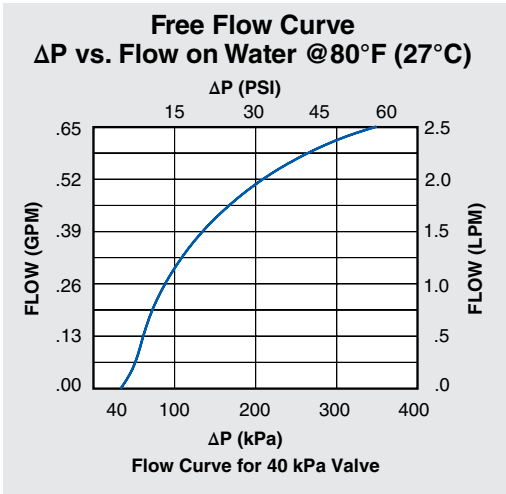


INSERT FLOW CONTROLS

5.5mm FLOW CONTROL - REVERSE FLOW



* LOA before installation.
All dimensions in millimeters.

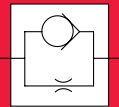


PERFORMANCE
Metered Flow
Lohm Rate Tolerance: ± 15%
Free Flow Lohm Rate: 250 Lohms
Cracking Pressure: 40 ± 30 kPa (6 ± 4.4 psid)
Maximum Working Pressure:
28 MPa (4,060 psid)
Metered Flow Direction
4 MPa (580 psid)
Free Flow Direction

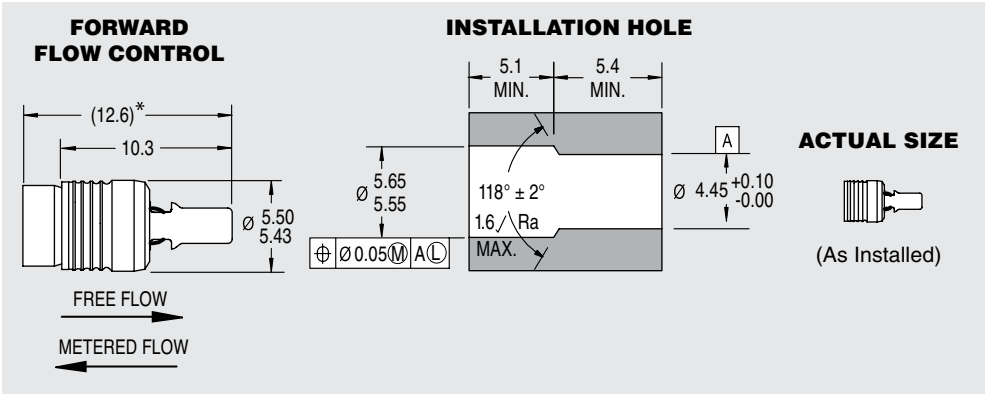
MATERIALS
Body303 Stainless Steel
Pin416 Stainless Steel
Cage.....305 Stainless Steel
Spring.....302 Stainless Steel
Ball440C Stainless Steel

LEE PART NUMBER	LOHM RATE
CFRM5501020S	2,000
CFRM5501025S	2,500
CFRM5501030S	3,000
CFRM5501040S	4,000
CFRM5501050S	5,000
CFRM5501060S	6,000
CFRM5501080S	8,000
CFRM5501100S	10,000

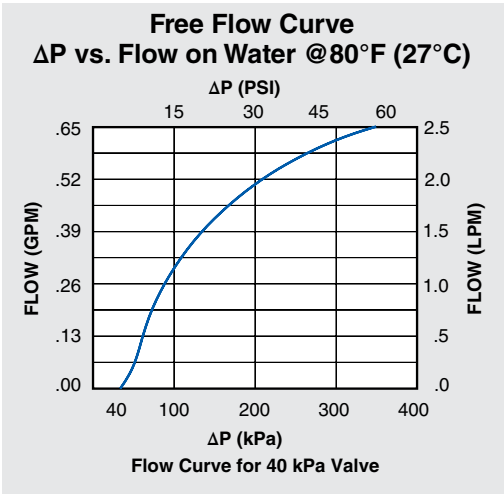
INSTALLATION
Tool Part Number CCRT0900120S
Force 625 Kg F (max.)
For installation procedure see page A1.



5.5mm FLOW CONTROL - FORWARD FLOW



* LOA before installation.
All dimensions in millimeters.

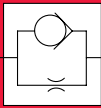


PERFORMANCE
Metered Flow
Lohm Rate Tolerance: ± 15%
Free Flow Lohm Rate: 250 Lohms
Cracking Pressure: 40 ± 30 kPa (6 ± 4.4 psid)
Maximum Working Pressure:
28 MPa (4,060 psid)
Metered Flow Direction
4 MPa (580 psid)
Free Flow Direction

MATERIALS
Body303 Stainless Steel
Pin416 Stainless Steel
Cage.....305 Stainless Steel
Spring.....302 Stainless Steel
Ball440C Stainless Steel

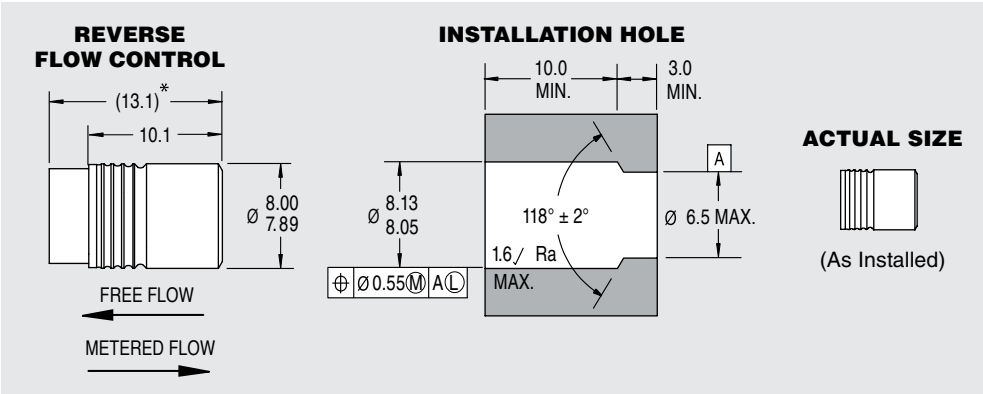
LEE PART NUMBER	LOHM RATE
CFFM5501020S	2,000
CFFM5501025S	2,500
CFFM5501030S	3,000
CFFM5501040S	4,000
CFFM5501050S	5,000
CFFM5501060S	6,000
CFFM5501080S	8,000
CFFM5501100S	10,000

INSTALLATION
Tool Part Number CCRT0900120S
Force 625 Kg F (max.)
For installation procedure see page A1.

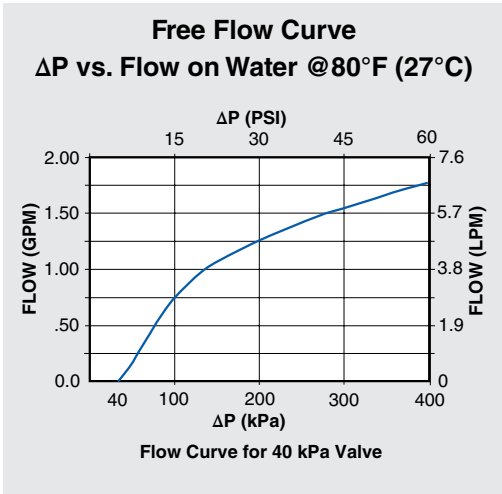


INSERT FLOW CONTROLS

8.0mm FLOW CONTROL - REVERSE



* LOA before installation.
All dimensions in millimeters.

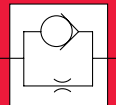


PERFORMANCE
Metered Flow Lohm Rate Tolerance: ± 15%
Free Flow Lohm Rate: 75 Lohms
Cracking Pressure: 40 ± 30 kPa (6 ± 4.4 psid)
Maximum Working Pressure: 28 MPa (4,060 psid)
Metered Flow Direction 4 MPa (580 psid)
Free Flow Direction

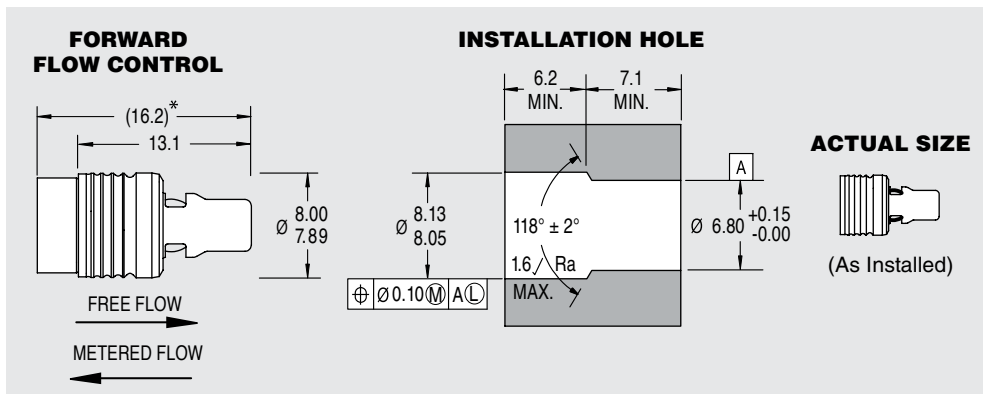
MATERIALS
Body 303 Stainless Steel
Pin 416 Stainless Steel
Cage 305 Stainless Steel
Spring 302 Stainless Steel
Ball..... 440C Stainless Steel

LEE PART NUMBER	LOHM RATE
CFRM8001005S	500
CFRM8001006S	600
CFRM8001008S	800
CFRM8001010S	1,000
CFRM8001012S	1,200
CFRM8001015S	1,500
CFRM8001020S	2,000

INSTALLATION
Tool Part Number CCRT0900150S
Force 680 Kg F (max.)
For installation procedure see page A1.

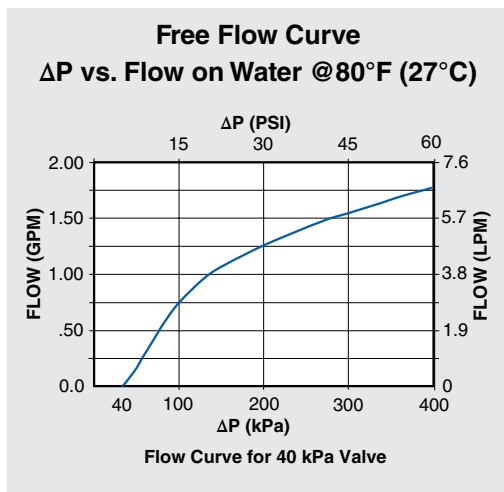


8.0mm FLOW CONTROL - FORWARD



* LOA before installation.

All dimensions in millimeters.

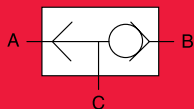


PERFORMANCE
Metered Flow Lohm Rate Tolerance: $\pm 15\%$
Free Flow Lohm Rate: 75 Lohms
Cracking Pressure: 40 ± 30 kPa (6 ± 4.4 psid)
Maximum Working Pressure: 28 MPa (4,060 psid)
Metered Flow Direction 4 MPa (580 psid)
Free Flow Direction

MATERIALS
Body 303 Stainless Steel
Pin 416 Stainless Steel
Cage 305 Stainless Steel
Spring 302 Stainless Steel
Ball..... 440C Stainless Steel

LEE PART NUMBER	LOHM RATE
CFFM8001005S	500
CFFM8001006S	600
CFFM8001008S	800
CFFM8001010S	1,000
CFFM8001012S	1,200
CFFM8001015S	1,500
CFFM8001020S	2,000

INSTALLATION
Tool Part Number CCRT0900150S
Force 680 Kg F (max.)
For installation procedure see page A1 .



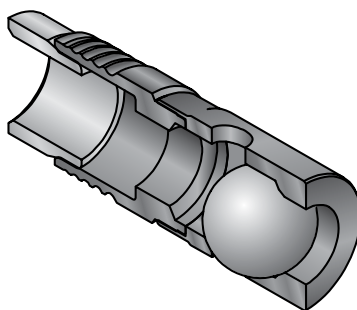
INSERT SHUTTLE VALVES

The IMH Shuttle valve is a miniature, economical and reliable solution to the problem of hydraulic isolation in manifolds. This valve features a compact, non-detented, selective design that is ideal as a signal for auxiliary functions, such as hydraulically released, spring applied brakes as well as load sensing applications.

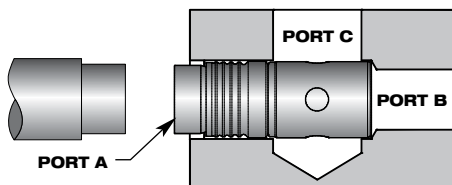
The IMH Shuttle valve is available in two sizes; a 5.5mm 2.1 GPM* model and a 8.0mm 4.8 GPM* version. These valves are the smallest in their class, often one third the size of existing shuttle valves with comparable flow rates.

The all metal construction provides high reliability, yet leakage is drip tight. Each valve is 100% factory tested for flow and leakage to ensure consistent, long term performance.

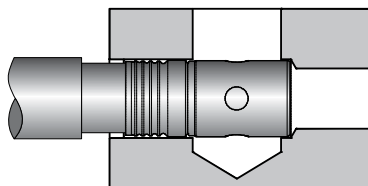
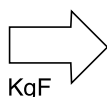
This cartridge-style valve installs easily into a drilled hole, eliminating the need for threads or o-rings. The Lee Company does not recommend the use of coatings or surface treatments in the area of the installation hole where the Lee component is to be installed. Do not clean the insert prior to installation. The assembly is prelubricated for proper installation. To install, simply insert the shuttle valve into a drilled hole and drive the expansion pin into the valve body with a minimum of 545 KgF



(1,200 lbs. force) and a maximum of 635 KgF (1,400 lbs. force). The ends of the expansion pin and insert will be flush to within $\pm 0.25\text{mm}$ ($\pm 0.010"$) above flush of each other. The installation tool can bottom on the insert body. Lee Installation Tools are available for each valve and part numbers are listed on each page. The locking end seals Port A from Port C and retains the valve. During installation, the edge seal at the opposite end is driven into the housing, sealing Port B from Port C.



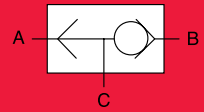
545-635



This valve is constructed entirely of stainless steel for long term, trouble free life.

* at 50 psid

INSERT SHUTTLE VALVES



A64

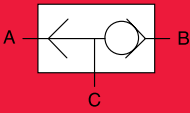
Features and Benefits

- Smallest in their flow class
 - Minimize housing size.
- Leak tight
 - No system drift.
 - No system losses.
- Low shuttling pressure
 - Fast system response.
- All metal retention and sealing
 - No threads necessary.
 - No o-rings to fail.

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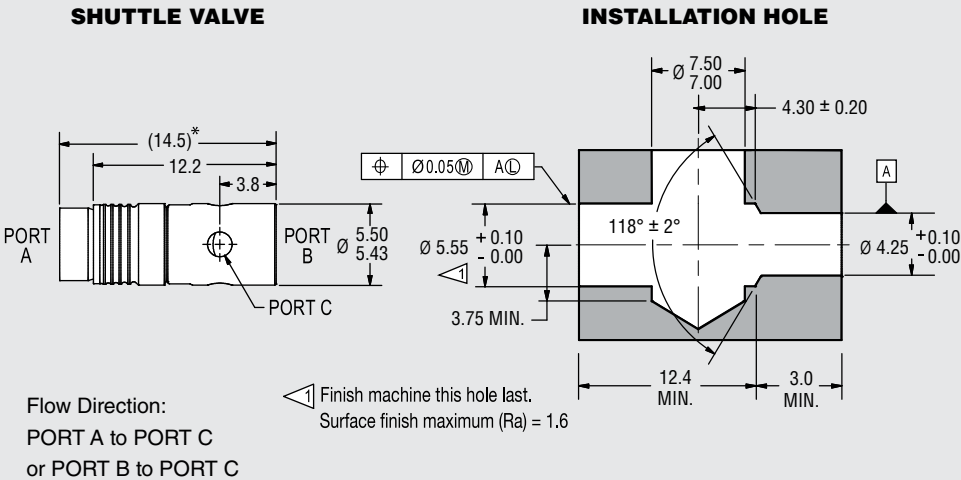
5.5mm Shuttle ValveA65

8.0mm Shuttle ValveA66



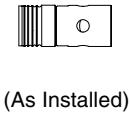
INSERT SHUTTLE VALVES

5.5mm SHUTTLE VALVE



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



PERFORMANCE

Flow Rate: (A to C or B to C) 75 Lohms
max. (2.1 GPM @50 psid
on hydraulic fluid)

Shuttling
Pressure: 7 kPa (1 psi) maximum

Leakage: A to B or B to A, 1 Drop/min.
(max.) after 2 minute wait
on hydraulic fluid at
6.9-27.6 MPa (1,000 -
4,000 psid)

Maximum Working Pressure:
28 MPa (4,060 psid)

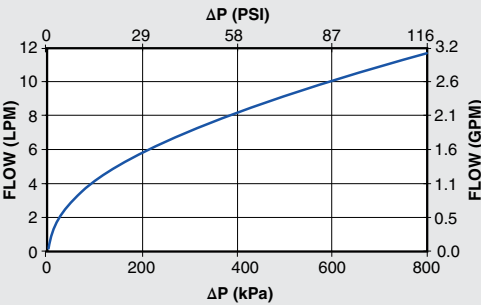
MATERIALS

Upper Body.....303 Stainless Steel
Lower Body.....303 Stainless Steel
Pin416 Stainless Steel
Ball.....440C Stainless Steel

INSTALLATION

Tool Part Number CCRT0900120S
Force 545 Kg F (min.)
635 Kg F (max.)
For installation procedure [see page A63](#).

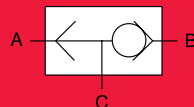
ΔP vs. Flow on Water @80°F (27°C)



LEE PART NUMBER

CCSV5510000S

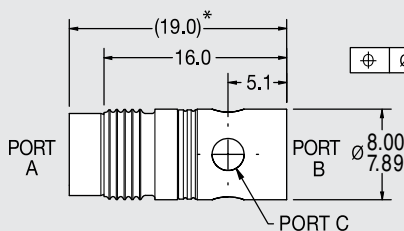
INSERT SHUTTLE VALVES



A66

8.0mm SHUTTLE VALVE

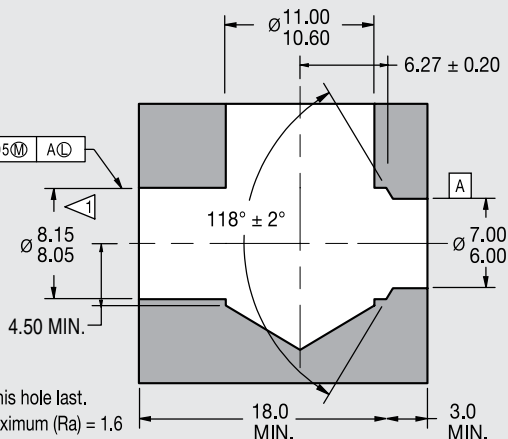
SHUTTLE VALVE



Flow Direction:
PORT A to PORT C
or PORT B to PORT C

1 Finish machine this hole last.
Surface finish maximum (Ra) = 1.6

INSTALLATION HOLE



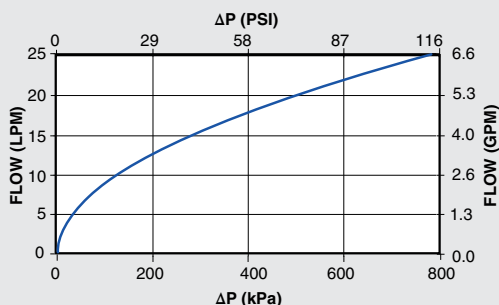
* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Flow Rate: (A to C or B to C) 32 Lohms
max. (4.8 GPM @50 psid
on hydraulic fluid)

Shuttling

Pressure: 7 kPa (1 psi) maximum

Leakage: A to B or B to A, 1 Drop/min.
(max.) after 2 minute wait
on hydraulic fluid at
6.9-27.6 MPa (1,000 -
4,000 psid)

Maximum Working Pressure:
28 MPa (4,060 psid)

MATERIALS

Upper Body.....303 Stainless Steel
Lower Body.....303 Stainless Steel
Pin416 Stainless Steel
Ball.....440C Stainless Steel

INSTALLATION

Tool Part Number CCRT0900150S

Force 545 Kg F (min.)
635 Kg F (max.)

For installation procedure [see page A63](#).

LEE PART NUMBER

CCSV8010000S



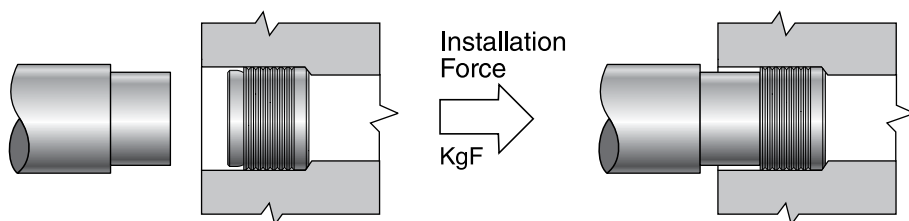
INSERT SAFETY SCREENS

IMH Screens are “last chance” safety screens designed to protect critical fluid control components against rogue contamination. They are *not* intended to serve as system filters. The screens are constructed of stainless steel woven wire mesh, bonded together using a proprietary process that offers superior integrity and life.

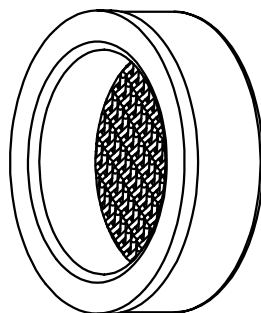
IMH Screens are available in Insert or Cartridge styles. Insert Screens feature an integral locking end, while Cartridge Screens are designed to be retained by the customer, or for 5.5 and 8mm sizes, retained by a separate locking end.

IMH Insert Style Screens use the proven *Lee Insert Principle* of controlled expansion during installation to lock the screen in place.

A preinstalled expander pin is simply pressed flush to within 0.25mm (0.010") above flush with the screen body, expanding the locking grooves into the wall of the installation hole to effect a seal and retain the part. The installation force required to install Insert Screens varies for different screen models, and is listed on each page. The Lee Company does not recommend the use of coatings or surface treatments in the area of the installation hole where the Lee component is to be installed. Do not clean the insert prior to installation. The assembly is prelubricated for proper installation.



IMH Cartridge Screens use proprietary high strength bonded mesh to provide additional strength and integrity for applications where higher pressures could cause rupture due to the effects of clogging, possibly with catastrophic consequences. The unique design of the Lee Cartridge Screen is engineered to prevent a rupture and instead allow a gradual reduction in flow performance.





Features and Benefits

- Self retained
 - Retrofits into drilled hole.
 - Easy to install.
 - No threads necessary.
- Proprietary bonded mesh
 - Superior integrity and life.
- High pressure capability
 - Won't fail when clogged.
 - No catastrophic failure.
 - Ensures reliability.

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5.5mm
Insert Screen..... A69

8.0mm
Insert Screen..... A70

10.0mm
Insert Screen..... A71

12.0mm
Insert Screen..... A72

5.5mm
Cartridge
Screen A73

5.5mm
Insert Retainer.....A74

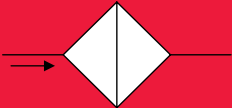
8.0mm
Cartridge Screen A75

8.0mm
Insert Retainer.....A76

10.0mm
Cartridge Screen A77-A78

12.0mm
Cartridge Screen A77-A78

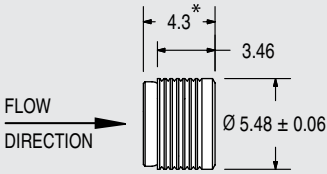
16.0mm
Cartridge Screen A77-A78



INSERT SAFETY SCREENS

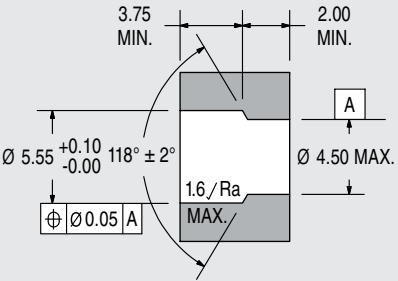
5.5mm INSERT SAFETY SCREEN

INSERT SCREEN



* LOA before installation.
All dimensions in millimeters.

INSTALLATION HOLE



ACTUAL SIZE



(As Installed)

LEE PART NUMBER	MICRON RATING	LOHM RATE	MAXIMUM FLOW RATE (LPM)	OPEN AREA (mm²)	ROB NUMBER
SCRM2553040S	40	275	15.1 (4.0 GPM)	2.4	0.04
SCRM2552075S	75	240	16.3 (4.3 GPM)	2.1	0.08
SCRM2551125S	125	290	9.5 (2.5 GPM)	1.8	0.16
SCRM2551170S	170	180	21.7 (5.7 GPM)	2.4	0.43

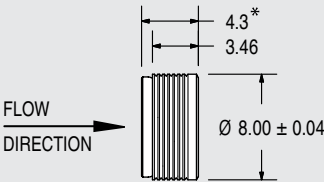
MATERIALS
Body 303 Stainless Steel
Pin 416 Stainless Steel
Screen 316 Stainless Steel

INSTALLATION
Tool Part Number CCRT0901034S
Force 510 Kg F (max.)
For installation procedure see page A67 .



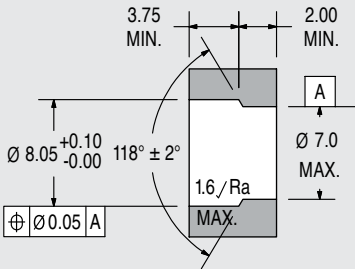
8.0mm INSERT SAFETY SCREEN

INSERT SCREEN



* LOA before installation.
All dimensions in millimeters.

INSTALLATION HOLE



ACTUAL SIZE



(As Installed)

LEE PART NUMBER	MICRON RATING	LOHM RATE	MAXIMUM FLOW RATE (LPM)	OPEN AREA (mm ²)	ROB NUMBER
SCRM2803040S	40	105	24.6 (6.5 GPM)	7.0	0.13
SCRM2802075S	75	95	20.6 (5.4 GPM)	6.2	0.25
SCRM2801125S	125	105	24.6 (6.5 GPM)	5.2	0.46
SCRM2801170S	170	65	42.5 (11.2 GPM)	7.1	1.25

MATERIALS

Body 303 Stainless Steel
Pin 416 Stainless Steel
Screen 316 Stainless Steel

INSTALLATION

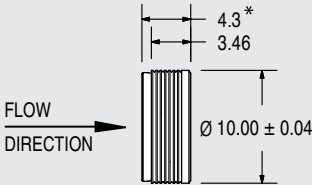
Tool Part Number CCRT0901036S
Force 1118 Kg F (max.)
For installation procedure [see page A67](#).



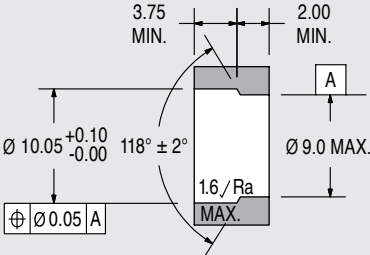
INSERT SAFETY SCREENS

10.0mm INSERT SAFETY SCREEN

INSERT SCREEN



INSTALLATION HOLE



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

LEE PART NUMBER	MICRON RATING	LOHM RATE	MAXIMUM FLOW RATE (LPM)	OPEN AREA (mm ²)	ROB NUMBER
SCRM2103040S	40	65	26.0 (6.9 GPM)	12.5	0.23
SCRM2102075S	75	55	47.0 (12.4 GPM)	11.0	0.44
SCRM2101125S	125	65	36.8 (9.7 GPM)	9.3	0.82
SCRM2101170S	170	40	48.9 (12.9 GPM)	12.6	2.22

MATERIALS

Body 303 Stainless Steel
Pin 416 Stainless Steel
Screen 316 Stainless Steel

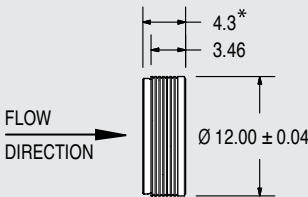
INSTALLATION

Tool Part Number CCRT0901035S
Force 1135 Kg F (max.)
For installation procedure [see page A67](#).

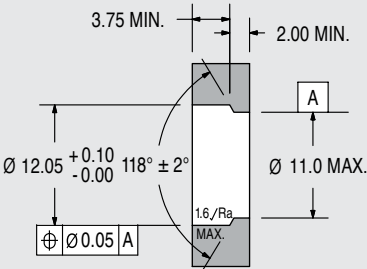


12.0mm INSERT SAFETY SCREEN

INSERT SCREEN



INSTALLATION HOLE



* LOA before installation.
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

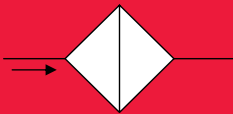
LEE PART NUMBER	MICRON RATING	LOHM RATE	MAXIMUM FLOW RATE (LPM)	OPEN AREA (mm ²)	RoB NUMBER
SCRM2123040S	40	45	30.7 (8.1 GPM)	19.6	0.37
SCRM2122075S	75	40	34.6 (9.1 GPM)	17.2	0.69
SCRM2121125S	125	45	38.9 (10.3 GPM)	14.5	1.28
SCRM2121170S	170	30	41.2 (10.9 GPM)	19.7	3.47

MATERIALS

Body 303 Stainless Steel
Pin 416 Stainless Steel
Screen 316 Stainless Steel

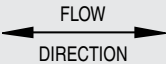
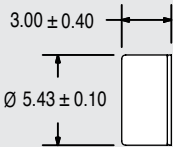
INSTALLATION

Tool Part Number CCRT0900875S
Force 1135 Kg F (max.)
For installation procedure [see page A67](#).



CARTRIDGE SCREENS

5.5mm CARTRIDGE SCREEN



ACTUAL SIZE



(As Installed)

All dimensions in millimeters.

LEE PART NUMBER	MICRON RATING	LOHM RATE	OPEN AREA (mm²)	Rob NUMBER	MIN. BURST PRESSURE (MPa)
SCRM7551040S	40	275	3.2	0.06	24 (3,500 psi)
SCRM7551075S	75	200	2.5	0.10	24 (3,500 psi)
SCRM7551125S	125	275	1.6	0.14	24 (3,500 psi)
SCRM7551170S	170	165	1.8	0.33	24 (3,500 psi)

INSTALLATION

The 5.5mm Cartridge Screen is designed to slip into a drilled flat bottom hole and be retained by a secondary means. The 5.5mm Insert Screen Retainer shown on the following page is available for this purpose.

MATERIALS

- Body 305 Stainless Steel
- Pintal 17-7 Stainless Steel
- Screen 316 Stainless Steel

CARTRIDGE SCREENS

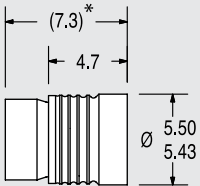


A74

5.5mm INSERT - SCREEN RETAINER

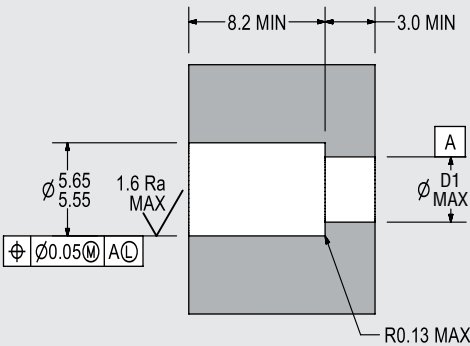
For use in retaining the 5.5mm Cartridge Screen

SCREEN RETAINER

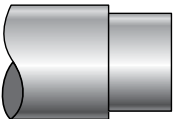


* LOA before installation.
All dimensions in millimeters.

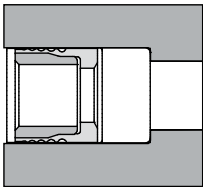
INSTALLATION HOLE



(As Installed)



Installation
Force
662 Kg F
Max.



ACTUAL SIZE



(As Installed)

LEE PART NUMBER

SCRR5510001S

Screen and Retainer sold separately.

MATERIALS

Body 303 Stainless Steel

Pin 416 Stainless Steel

INSTALLATION

Tool Part NumberCCRT0900120S
Force662 Kg F (max.)

To install, insert the 5.5mm Cartridge Screen into the installation hole as shown. Then insert the Screen Retainer into the installation hole and drive the expander pin flush to within 0.25mm (0.010") above flush of the retainer. The installation tool can bottom on the retainer body with no consequence. A Lee Installation tool is available, see part number listed above.

LEE PART NUMBER

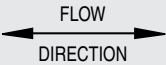
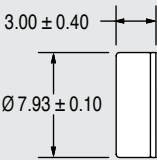
D1 MAX (mm)

SCRM7551040S	3.84
SCRM7551075S	3.66
SCRM7551125S	3.41
SCRM7551170S	2.91



CARTRIDGE SCREENS

8.0mm CARTRIDGE SCREEN



ACTUAL SIZE



(As Installed)

All dimensions in millimeters.

LEE PART NUMBER	MICRON RATING	LOHM RATE	OPEN AREA (mm²)	Rob NUMBER	MIN. BURST PRESSURE (MPa)
SCRM7801040S	40	115	7.7	0.14	24 (3,500 psi)
SCRM7801075S	75	85	7.3	0.29	24 (3,500 psi)
SCRM7801125S	125	105	4.7	0.41	24 (3,500 psi)
SCRM7801170S	170	70	5.4	0.96	24 (3,500 psi)

INSTALLATION

The 8.0mm Cartridge Screen is designed to slip into a drilled flat bottom hole and be retained by a secondary means. The 8.0mm Insert Screen Retainer shown on the following page is available for this purpose.

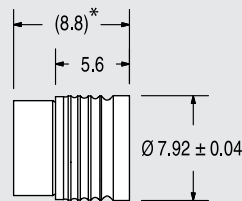
MATERIALS

Body 305 Stainless Steel
Pintal 17-7 Stainless Steel
Screen 316 Stainless Steel

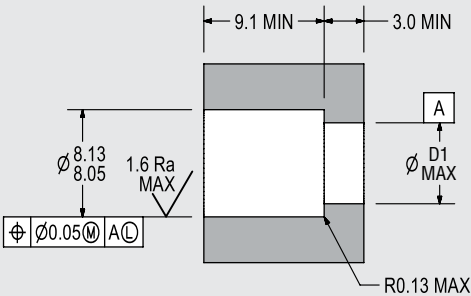


8.0mm INSERT - SCREEN RETAINER
For use in retaining the 8.0mm Cartridge Screen

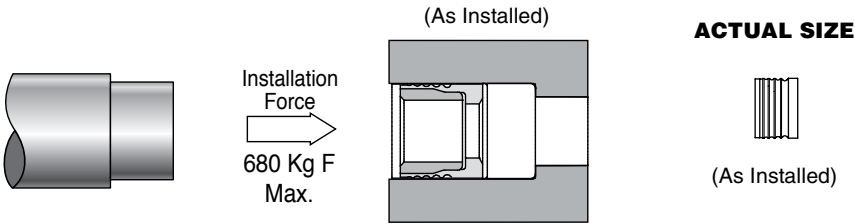
SCREEN RETAINER



INSTALLATION HOLE



* LOA before installation.
All dimensions in millimeters.

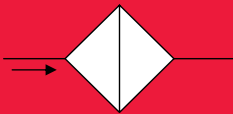


LEE PART NUMBER
SCRR8010001S
Screen and Retainer sold separately.

MATERIALS
Body 303 Stainless Steel
Pin 416 Stainless Steel

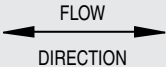
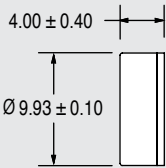
INSTALLATION
Tool Part Number CCRT0900150S
Force 680 Kg F (max.)
To install, insert the 8.0mm Cartridge Screen into the installation hole as shown. Then insert the Screen Retainer into the installation hole and drive the expander pin flush to within 0.25mm (0.010") above flush of the retainer. The installation tool can bottom on the retainer body with no consequence. A Lee Installation tool is available, see part number listed above.

LEE PART NUMBER	D1 MAX (mm)
SCRM7801040S	6.03
SCRM7801075S	5.81
SCRM7801125S	5.54
SCRM7801170S	5.10



CARTRIDGE SCREENS

10mm CARTRIDGE SCREEN

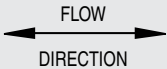
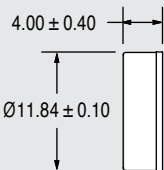


ACTUAL SIZE



(As Installed)

12mm CARTRIDGE SCREEN

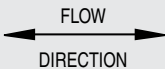
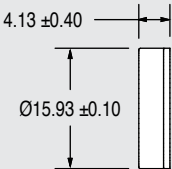


ACTUAL SIZE



(As Installed)

16mm CARTRIDGE SCREEN



ACTUAL SIZE



(As Installed)

All dimensions in millimeters.

INSTALLATION

The Cartridge Screen is designed to slip into a drilled, flat bottom hole and be retained by a secondary means.

MATERIALS

Body 305 Stainless Steel
Pintal 17-7 Stainless Steel
Screen 316 Stainless Steel



10mm CARTRIDGE SCREEN

LEE PART NUMBER	MICRON RATING	LOHM RATE	OPEN AREA (mm ²)	RoB NUMBER	MIN. BURST PRESSURE (MPa)
SCRM7101040S	40	70	11.6	0.22	24 (3,500 psi)
SCRM7101075S	75	60	9.6	0.39	24 (3,500 psi)
SCRM7101125S	125	65	7.4	0.65	24 (3,500 psi)
SCRM7101170S	170	45	8.7	1.53	24 (3,500 psi)
SCRM7101300S	300	35	10.0	6.75	24 (3,500 psi)

12mm CARTRIDGE SCREEN

LEE PART NUMBER	MICRON RATING	LOHM RATE	OPEN AREA (mm ²)	RoB NUMBER	MIN. BURST PRESSURE (MPa)
SCRM7121040S	40	45	18.1	0.34	24 (3,500 psi)
SCRM7121075S	75	35	14.9	0.60	24 (3,500 psi)
SCRM7121125S	125	55	11.6	1.02	24 (3,500 psi)
SCRM7121170S	170	35	14.3	2.52	24 (3,500 psi)
SCRM7121300S	300	25	17.0	11.44	24 (3,500 psi)

16mm CARTRIDGE SCREEN

LEE PART NUMBER	MICRON RATING	LOHM RATE	OPEN AREA (mm ²)	RoB NUMBER	MIN. BURST PRESSURE (MPa)
SCRM7161040S	40	30	34	0.64	24 (3,500 psi)
SCRM7161075S	75	20	29	1.16	24 (3,500 psi)
SCRM7161125S	125	30	23	2.05	24 (3,500 psi)
SCRM7161170S	170	20	28	5.06	24 (3,500 psi)
SCRM7161300S	300	15	35	23.5	24 (3,500 psi)

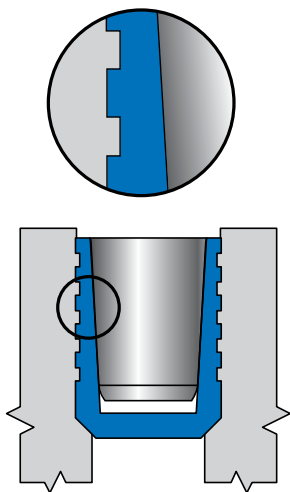


The Lee Company has supplied over 100 million Lee Plugs® to the aerospace industry since 1948. Virtually every military and commercial aircraft in flight today contains Lee Plugs® in hydraulic, fuel, and lube system manifolds. The IMH Division based its commercial Lee Betaplug® designs on the same reliable, field-proven controlled expansion principle.

The Lee Betaplug is a pre-assembled, one-piece, tapered expansion plug specifically engineered to seal fluid passages in metal castings and plastic housings leak-tight, without the use of threads or sealants. Controlled expansion during installation causes the lands and grooves on the O.D. of the plug body to bite into the wall of the fluid passage, creating a leak-tight seal and assuring retention. The unique tapered design eliminates the need for tight manufacturing tolerances, and allows the designer to minimize the wall thickness required around the plug, even for brittle housing materials. **Note: Betaplugs are not recommended for use above 275°F (135°C).**



LEE BETAPLUG ADVANTAGE



KNOWN BOSS STRESS

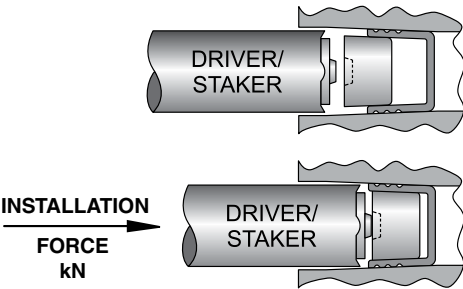
Conventional, cylindrical shaped expansion plugs require additional expansion for the clearance between the plug O.D. and the installation hole.

The matching tapers of the Betaplug and its installation hole create a perfect fit, eliminating the need for additional expansion. Since the Betaplug's expansion is precisely controlled by the size of the tapered pin, the amount of expansion and any resulting boss stress is completely predictable.

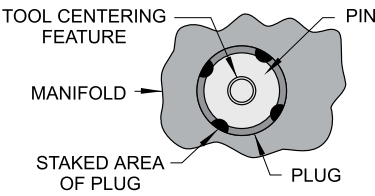
The installation of Lee Betaplugs, whether performed manually or automatically, is very easy and economical. First, the preassembled Betaplug is inserted into the tapered installation hole narrow end first. The pin is then driven into the plug using the recommended Lee Company Installation/Staking Tool until the pin is below flush and the plug is staked. The installation tool is designed to install the pin below flush while staking over the back edge of the plug.



For 6000 Series Betaplugs the pin should be installed 0.38 to 0.46mm (0.015" to 0.018") below flush. The Short Betaplug pin should be installed 0.50 to 0.80mm (0.020" to 0.031") below flush.



Top View of Installed Betaplug



Lee Installation/Staking Tools are available for each Betaplug and part numbers are listed in each section.

The tool contains a centering feature which ensures proper tool alignment during installation. All Betaplug pins are coated with a wax that produces a thin, solid lubricating film that reduces friction, allowing the pin to be driven to its correct position relative to the plug. Do not clean prior to installation.

The installation force required to drive the pin into the Betaplug is a function of boss material, installation hole and boss geometry, and plug size. A boss made of a stronger material or having a larger wall thickness will require a greater installation force than one made of a weaker material or having thinner walls. Typical installation forces for A380 die-cast aluminum are listed for each Betaplug. See Tooling Table in each section.

TABLE OF CONTENTS

BETAPLUGS

6000 Series..... A81 – A84

Short Series A85 – A88

Features and Benefits

- Lee plug experience – maximum reliability
- Ideal for fragile castings – eliminates cracking of brittle materials
- Controlled expansion – ensures consistent performance
- Various diameters available – design flexibility
- One piece design facilitates reliable automated or manual installation
- No threads or sealants required

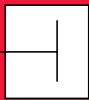
Available Designs

The 6000 Series Betaplug is designed for high pressure systems (up to 7,000 psi), and is available in 4, 5, 6, 7 and 8 mm diameters.

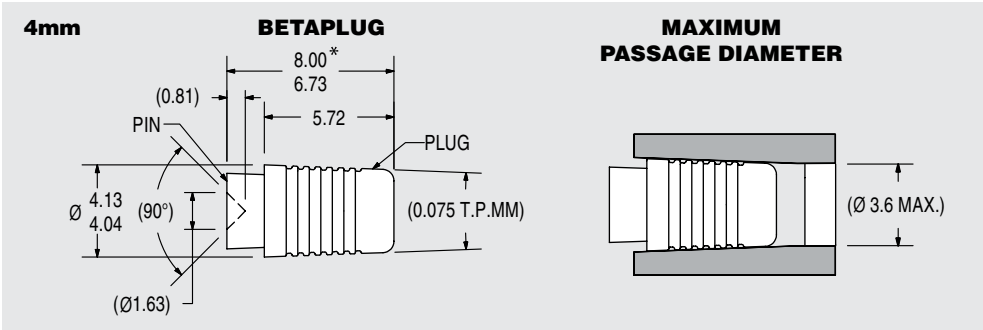
MATERIALS	
Pin	6061 Aluminum
Plug	6061 Aluminum

The Short Betaplug is designed for low pressure systems, up to 500 psi, and is available in 7, 9, 11, 13 and 16 mm diameters.

MATERIALS	
Pin & Plug	6061 Aluminum



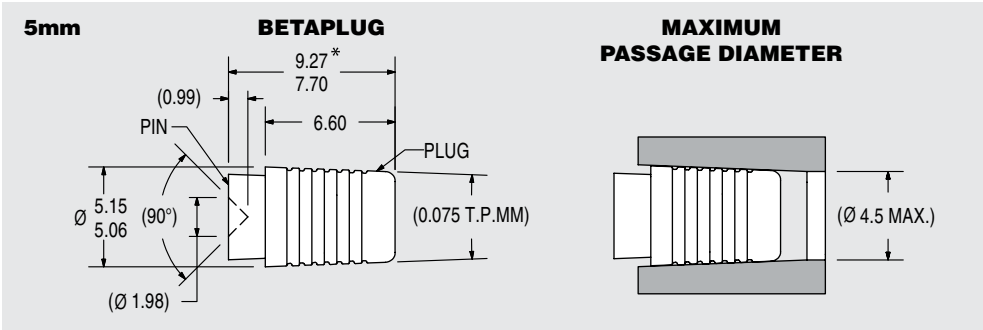
6000 SERIES BETAPLUG



ACTUAL SIZE



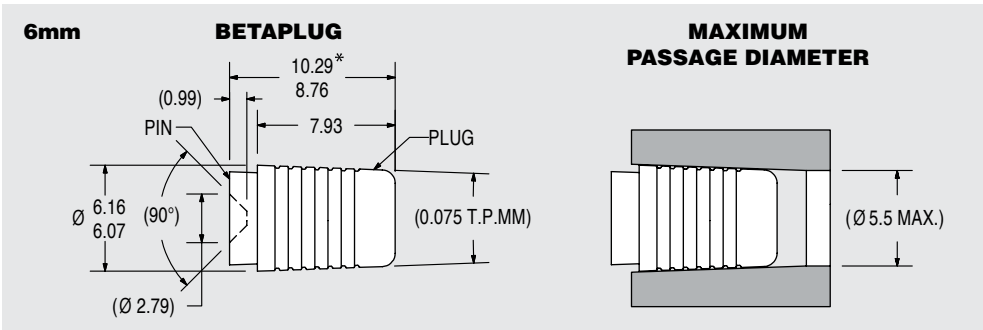
LEE PART NUMBER	BURST PRESSURE †
PLBA0402604S	483 Bar (7,000 psi)



ACTUAL SIZE



LEE PART NUMBER	BURST PRESSURE †
PLBA0502604S	483 Bar (7,000 psi)



ACTUAL SIZE

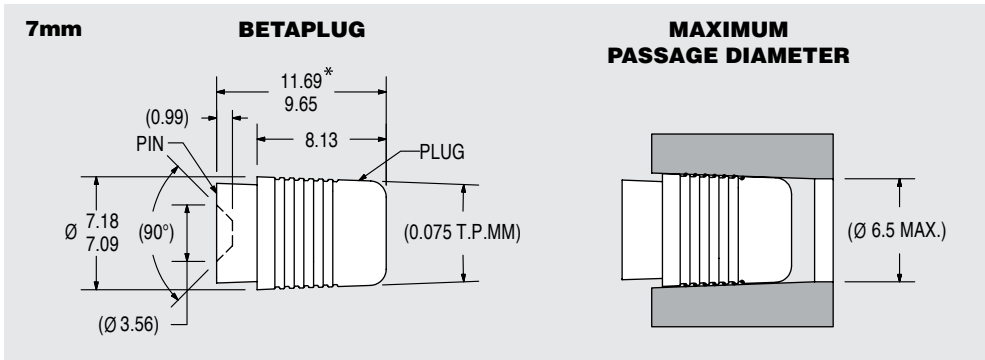


LEE PART NUMBER	BURST PRESSURE †
PLBA0602604S	483 Bar (7,000 psi)

* LOA before installation. All dimensions in millimeters.
† Typical burst pressure for A380 die-cast aluminum



6000 SERIES BETAPLUG (cont.)

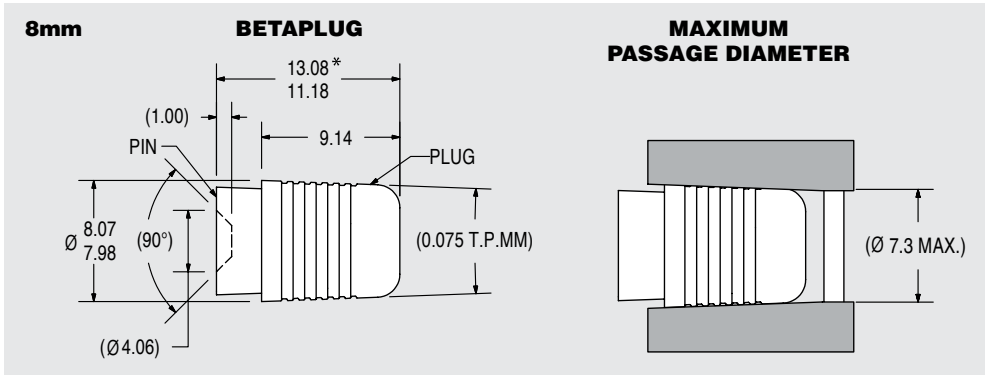


ACTUAL SIZE



(As Installed)

LEE PART NUMBER	BURST PRESSURE †
PLBA0703604S	276 Bar (4,000 psi)



ACTUAL SIZE

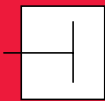


(As Installed)

LEE PART NUMBER	BURST PRESSURE †
PLBA0803604S	276 Bar (4,000 psi)

* LOA before installation. All dimensions in millimeters.

† Typical burst pressure for A380 die-cast aluminum

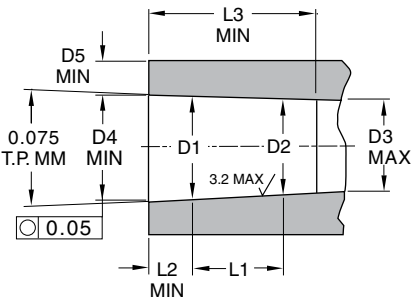


6000 SERIES BETAPLUG HOLE PREPARATION

The installation hole for a 6000 Series Lee Betaplug has an included taper angle, Beta, of 4.3°, which matches the tapered outside diameter of the Betaplug. This included draft angle of 4.3° is very easy to achieve with a core pin in a die-cast or molded part or to machine using a tapered tool.

A tolerance of $\pm 0.3^\circ$ on the taper angle of 4.3° is specified to guarantee that the Betaplug's rated performance is achieved. If the taper angles are out of tolerance, the plug will either wedge first at the top or at the bottom, reducing sealing burst pressure. Tapered reamers are available for each size Betaplug. See the tooling table for applicable part numbers.

The Lee Company recommends that the Betaplug be installed below the surface of the housing to ensure maximum plug retention capability. The use of coatings or surface treatments in the area of the installation hole where the Betaplug is to be installed is not recommended.



GAGE DIMENSIONS AND MAXIMUM PASSAGE DIAMETERS (mm)

BETA- PLUG SIZE	TOP GAGE DIA., D1	BOTTOM GAGE DIA., D2	MAX. PASSAGE DIA., D3	MIN. OPENING, D4	MIN. WALL THICKNESS, D5	GAGE LENGTH, L1	MIN. GAGE DEPTH, L2	MIN. TAPER DEPTH, L3*
4	4.07	3.68	3.60	4.16	1.40	4.88-5.57	1.12	7.54
5	5.08	4.70	4.50	5.19	1.80	4.75-5.43	1.38	8.59
6	6.10	5.60	5.50	6.21	2.20	6.25-7.14	1.38	10.06
7	7.11	6.58	6.50	7.23	2.50	6.63-7.57	1.50	10.26
8	8.00	7.37	7.30	8.13	2.80	7.87-9.00	1.63	11.41

* Depth of tapered hole (L3) from depth of minimum diameter (D4).
All dimensions are in millimeters.

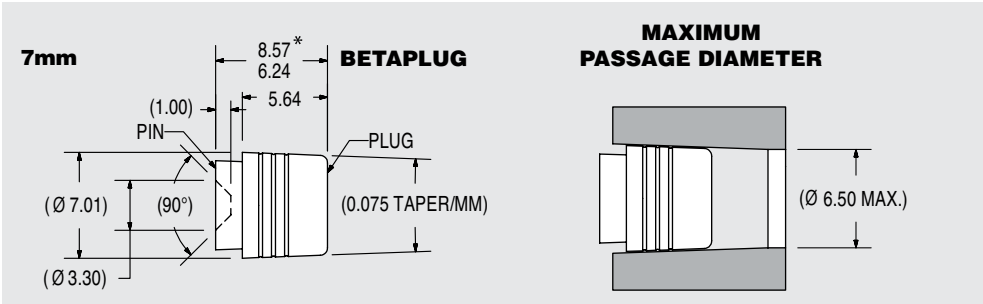


TOOLING

BETAPLUG SIZE	INSTALLATION/STAKING TOOL PART NUMBER	TAPERED REAMER PART NUMBER	TYPICAL INSTALLATION FORCE (kN)
4	PLBT0470030S	PLBT0470020S	2.9 (650 lbf)
5	PLBT0570031S	PLBT0570020S	2.4 (550 lbf)
6	PLBT0670031S	PLBT0670020S	2.6 (600 lbf)
7	PLBT0770030S	PLBT0770020S	4.0 (900 lbf)
8	PLBT0870030S	PLBT0870020S	4.4 (1,000 lbf)



SHORT BETAPLUG

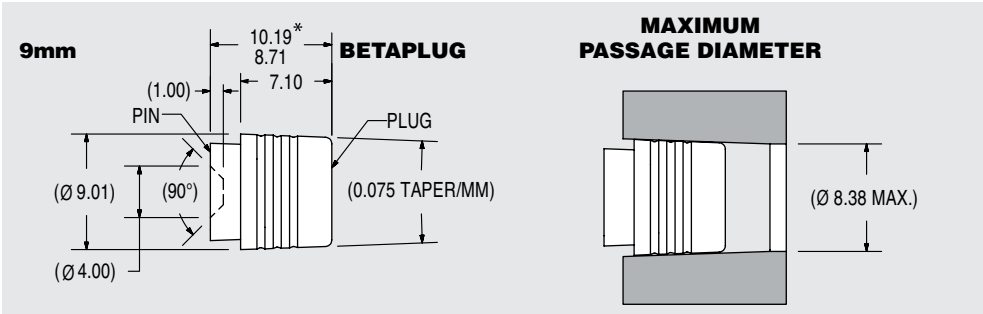


ACTUAL SIZE



(As Installed)

LEE PART NUMBER	RATED PRESSURE †
PLBA0702610S	35 Bar (500 psi)

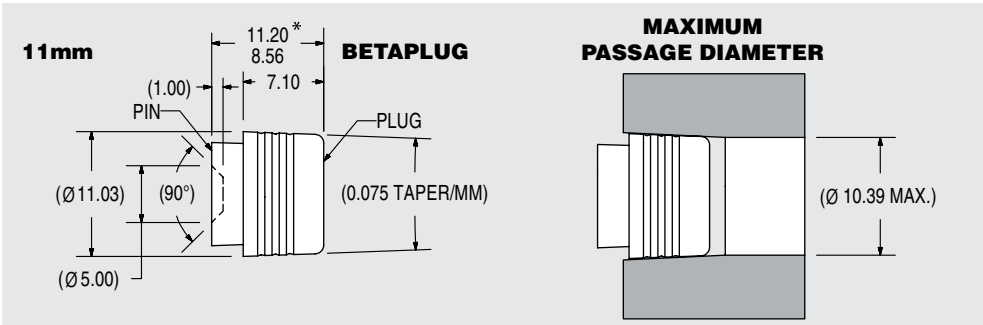


ACTUAL SIZE



(As Installed)

LEE PART NUMBER	RATED PRESSURE †
PLBA0903610S	35 Bar (500 psi)



ACTUAL SIZE



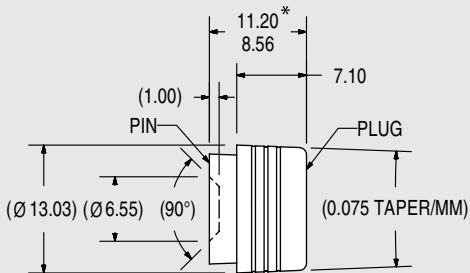
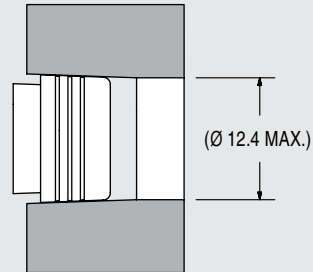
(As Installed)

LEE PART NUMBER	RATED PRESSURE †
PLBA1103610S	35 Bar (500 psi)

* LOA before installation. All dimensions in millimeters.
† Rated pressures may be higher depending upon specific application requirements.
Contact your Lee Sales Engineer for higher pressure requirements.



SHORT BETAPLUG (cont.)

13mm
BETAPLUG

**MAXIMUM
PASSAGE DIAMETER**

ACTUAL SIZE

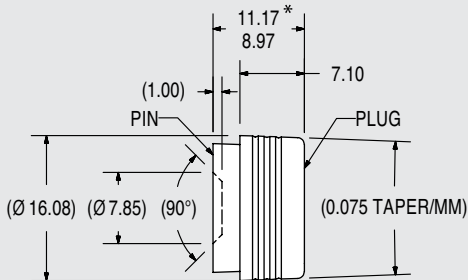
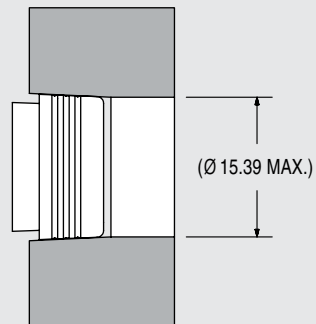

(As Installed)

LEE PART NUMBER

PLBA1304610S

RATED PRESSURE †

35 Bar (500 psi)

16mm
BETAPLUG

**MAXIMUM
PASSAGE DIAMETER**

ACTUAL SIZE


(As Installed)

LEE PART NUMBER

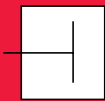
PLBA1604610S

RATED PRESSURE †

35 Bar (500 psi)

* LOA before installation. All dimensions in millimeters.

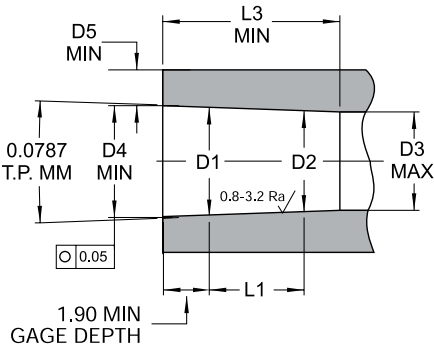
† Rated pressures may be higher depending upon specific application requirements.
Contact your Lee Sales Engineer for higher pressure requirements.



SHORT BETAPLUG HOLE PREPARATION

The Short Betaplug has been qualified to work in generously toleranced installation holes. The taper of the hole can range anywhere from 4°-5°, giving the designer flexibility in satisfying specific application requirements. Tapered Reamers are available for each size Short Betaplug. See the tooling table for applicable part numbers.

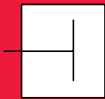
The Lee Company recommends that the Short Betaplug be installed flush or below the surface of the housing to ensure optimum performance. The use of coatings or surface treatments in the area of the installation hole where the Short Betaplug is to be installed is not recommended.



GAGE DIMENSIONS AND MAXIMUM PASSAGE DIAMETERS (mm)

BETA-PLUG SIZE	TOP GAGE DIA., D1	BOTTOM GAGE DIA., D2	MAX. PASSAGE DIA., D3	MIN. OPENING, D4	MIN. WALL THICKNESS, D5	GAGE LENGTH, L1	MIN. TAPER DEPTH, L3*
7	7.01	6.69	6.50	7.16	2.45	3.66-4.58	10.00
9	9.01	8.69	8.38	9.16	3.15	3.66-4.58	12.00
11	11.03	10.71	10.39	11.18	3.85	3.66-4.58	12.00
13	13.03	12.71	12.40	13.18	4.55	3.66-4.58	12.00
16	16.08	15.76	15.39	16.23	5.60	3.66-4.58	12.00

* Depth of tapered hole (L3) from depth of minimum diameter (D4).
All dimensions are in millimeters.

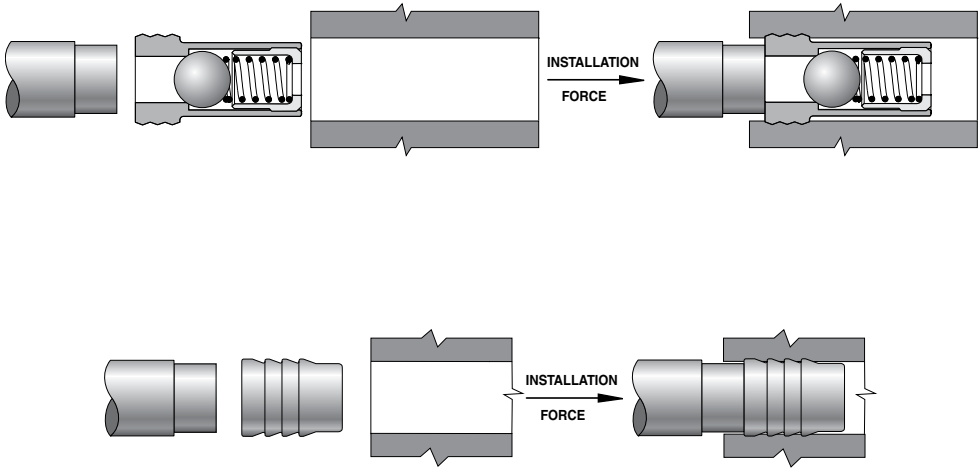


TOOLING

BETAPLUG SIZE	INSTALLATION/ STAKING TOOL PART NUMBER	TAPERED REAMER PART NUMBER	TAPERED REAMER, ROUGH FINISH PART NUMBER	TYPICAL INSTALLATION FORCE (kN)
7	PLBT0070901S	PLBT0700012S	PLBT0700014S	4.9 (1,100 lbf)
9	PLBT0090901S	PLBT0900012S	PLBT0900014S	4.9 (1,100 lbf)
11	PLBT0110901S	PLBT1100012S	PLBT1100014S	6.2 (1,400 lbf)
13	PLBT0130901S	PLBT1300012S	PLBT1300014S	6.2 (1,400 lbf)
16	PLBT0160901S	PLBT1600012S	PLBT1600014S	6.5 (1,460 lbf)

IMH PRODUCTS FOR PLASTIC INSTALLATION

The Industrial Microhydraulics Group offers a line of products intended for installation into plastic manifolds or fittings. A series of smoothly curved lands allow the part to be pressed in while the plastic flows into the adjacent grooves. Some plastics with a lot of elongation, such as Polypropylene, Nylon, Acetal, Polyethylene and PEEK, cold flow into the grooves effecting retention and a seal.



Other plastics, such as acrylic and polycarbonate, are rigid and the part must be heat flowed into the hole. The IMH Group can offer advice on the best methods of installation for each product and plastic. We offer products already installed in plastic fittings, equipment to install our products, as well as the service of installing them for you.

The maximum working pressure for products intended for installation into plastic manifolds or fittings is dependent on housing material, configuration and operating conditions.

Many of the insert products from Section I, such as check valves, relief valves, orifices, restrictor check valves and safety screens, are offered in the plastic installation configuration. They contain many of the same features and offer the same benefits:

Features and Benefits

- Miniature Size
 - Allows designers to save space and weight.
- 100% Testing
 - Eliminates need for system rework.
- Stainless Steel Construction
 - Compatible with most fluids.
- Rugged, Durable Design
 - Provides high reliability and long life.
- Low Leakage Valve Seats
 - More efficient system performance.
- Highly Accurate Orifices
 - Provides more consistent system performance.

TABLE OF CONTENTS

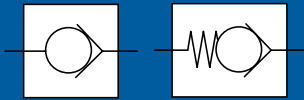
Check and
Relief Valves..... B3 – B18

Orifices B19 – B26

Restrictor Check and
Flow Controls B27 – B32

Safety Screens B33 – B38

Products in Plastic
Fittings..... B39 – B46



CHECK & RELIEF VALVES FOR PLASTIC

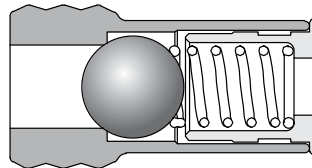
IMH Checks and Relief Valves for plastic installation have the same internal design as the inserts in Section I. A high quality metal to metal seat provides low leakage and highly repeatable cracking pressure. Their all stainless steel design provides compatibility with a wide range of fluids and gases. Some models are available with a ceramic ball as standard. These valves come in three diameters (2.5, 5.5 and 8.0mm) with corresponding flow capabilities. The 2.5mm valve is the smallest cartridge style valve available and is so small it fits in many common plastic fittings (see [“Products in Plastic Fittings”](#) section, pages B39-B46).



2.5mm CHEK

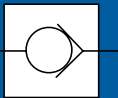
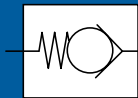


ACTUAL SIZE



Flow
Direction →
← Checked
Direction

CHECK & RELIEF VALVES FOR PLASTIC



Features and Benefits

- Metal to metal seating
 - Provides high reliability.
 - Repeatable crack.
- Press-in design
 - Simple installation.
- Leak tight
 - Efficient system performance.
- Guided ball design
 - Fast response.
 - Low hysteresis.
- Ceramic ball versions
 - Compatible with aggressive fluids.
- 100% tested
 - Eliminates rework.

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Check Valves

2.5mm Check Valve	B5
with Ceramic Ball.....	B6
5.5mm Check Valve	B7
with Ceramic Ball.....	B8
316L Check Valve	B9
8.0mm Check Valve	B10
with Ceramic Ball.....	B11

Relief Valves

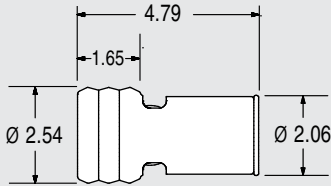
2.5mm Relief Valve	B12
with Ceramic Ball.....	B13
5.5mm Relief Valve	B14
with Ceramic Ball.....	B15
316L Relief Valve	B16
8.0mm Relief Valve	B17
with Ceramic Ball.....	B18



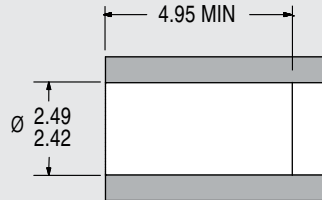
CHECK & RELIEF VALVES FOR PLASTIC

2.5mm CHECK VALVE for PLASTIC INSTALLATION

CHEK VALVE



INSTALLATION HOLE

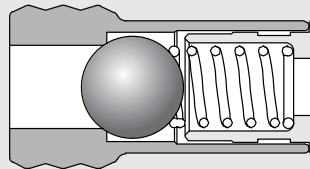


ACTUAL SIZE



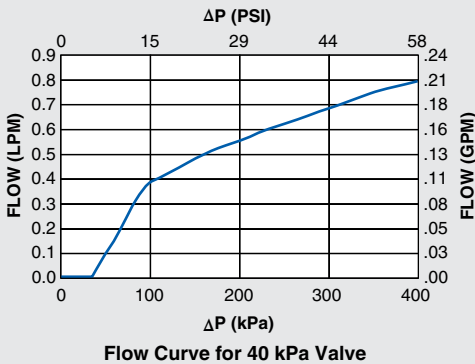
(As Installed)

All dimensions in millimeters.



Flow
Direction →
← Checked
Direction

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 750 Lohms

Leakage: 10 sccm/min. (max.) @500 kPa (72.5 psid) on air
1 Drop/min. (max.) on water

MATERIALS

Body..... 303 Stainless Steel
Ball Stop ... 303 Stainless Steel
Spring 302 Stainless Steel
Ball..... 440C Stainless Steel

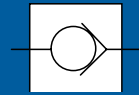
LEE PART NO.	CRACKING PRESSURE
CCPI2510000S	0 kPa (No Spring)
CCPI2510004S	4 ± 3 kPa (0.6 ± 0.4 psid)
CCPI2510007S	7 ± 5 kPa (1 ± 0.7 psid)
CCPI2510014S	14 ± 5 kPa (2 ± 0.7 psid)
CCPI2510040S	40 ± 15 kPa (6 ± 2.2 psid)

INSTALLATION

Tool Part NumberCCRT0024277S

To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities.

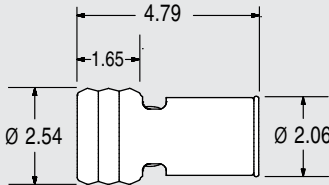
CHECK & RELIEF VALVES FOR PLASTIC



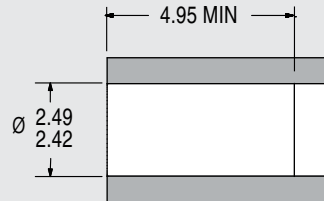
B6

2.5mm CHECK VALVE - CERAMIC BALL for PLASTIC INSTALLATION

CHEK VALVE



INSTALLATION HOLE

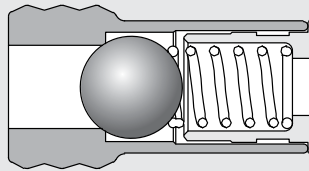


ACTUAL SIZE



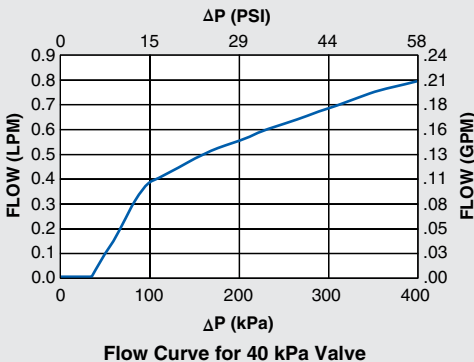
(As Installed)

All dimensions in millimeters.



Flow
Direction →
Checked
Direction ←

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 750 Lohms

Leakage: 10 sccm/min. (max.) @500 kPa (72.5 psid) on air
1 Drop/min. (max.) on water

MATERIALS

Body..... 303 Stainless Steel
Ball Stop ... 303 Stainless Steel
Spring 302 Stainless Steel
Ball..... Ceramic

LEE PART NO.

CRACKING PRESSURE

CCPI2580000S	0 kPa (No Spring)
CCPI2580004S	4 ± 3 kPa (0.6 ± 0.4 psid)
CCPI2580007S	7 ± 5 kPa (1 ± 0.7 psid)
CCPI2580014S	14 ± 5 kPa (2 ± 0.7 psid)
CCPI2580040S	40 ± 15 kPa (6 ± 2.2 psid)

INSTALLATION

Tool Part NumberCCRT0024277S

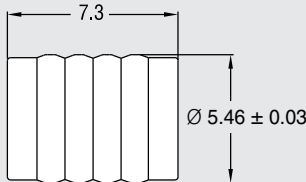
To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities.



CHECK & RELIEF VALVES FOR PLASTIC

5.5mm CHECK VALVE for PLASTIC INSTALLATION

CHEK VALVE

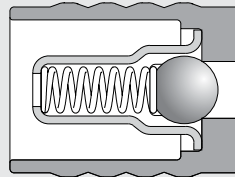
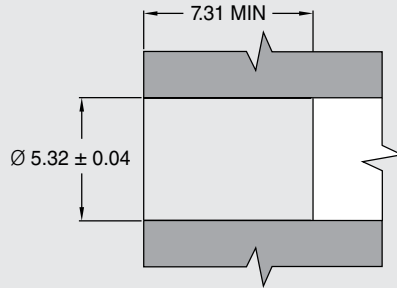


ACTUAL SIZE



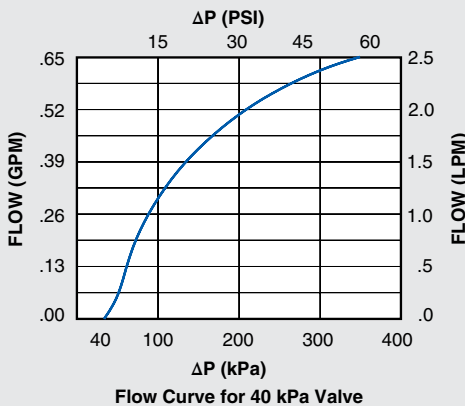
All dimensions in millimeters.

INSTALLATION HOLE



Flow
Direction
→
Checked
→

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 250 Lohms

Leakage: 20 sccm/min. (max.) @172 kPa (25 psid) on air

1 Drop/min. (max.) on water

MATERIALS

Body..... 303 Stainless Steel

Cage 305 Stainless Steel

Spring 302 Stainless Steel

Ball..... 440C Stainless Steel

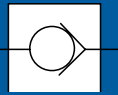
INSTALLATION

Tool Part NumberCCRT0900170S

To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities. See page B27.

LEE PART NO.	CRACKING PRESSURE
CCPI5510000S	0 kPa (No Spring)
CCPI5510004S	4 ± 3 kPa (0.6 ± 0.4 psid)
CCPI5510007S	7 ± 5 kPa (1 ± 0.7 psid)
CCPI5510014S	14 ± 5 kPa (2 ± 0.7 psid)
CCPI5510040S	40 ± 15 kPa (6 ± 2.2 psid)
CCPI5510069S	69 ± 17.3 kPa (10 ± 2.5 psid)

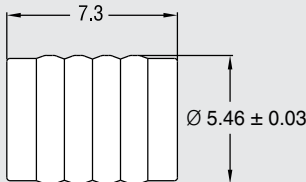
CHECK & RELIEF VALVES FOR PLASTIC



B8

5.5mm CHECK VALVE - CERAMIC BALL for PLASTIC INSTALLATION

CHEK VALVE

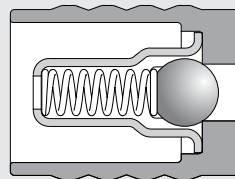
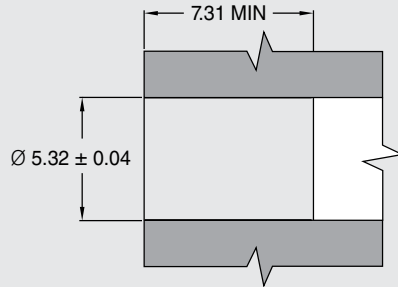


ACTUAL SIZE



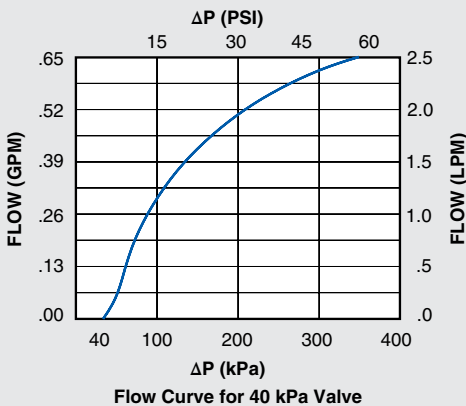
All dimensions in millimeters.

INSTALLATION HOLE



Flow
Direction
Checked →

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 250 Lohms
Leakage: 20 sccm/min. (max.) @ 172 kPa (25 psid) on air
1 Drop/min. (max.) on water

MATERIALS

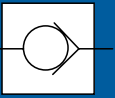
Body..... 303 Stainless Steel
Cage 305 Stainless Steel
Spring 302 Stainless Steel
Ball..... Ceramic

INSTALLATION

Tool Part NumberCCRT0900170S

To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities. See page B27.

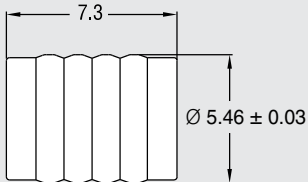
LEE PART NO.	CRACKING PRESSURE
CCPI5580000S	0 kPa (No Spring)
CCPI5580007S	7 ± 5 kPa (1 ± 0.7 psid)
CCPI5580014S	14 ± 5 kPa (2 ± 0.7 psid)
CCPI5580040S	40 ± 30 kPa (6 ± 4.4 psid)
CCPI5580069S	69 ± 17.3 kPa (10 ± 2.5 psid)



CHECK & RELIEF VALVES FOR PLASTIC

5.5mm CHECK VALVE - MEDICAL GRADE 316L for PLASTIC INSTALLATION

CHEK VALVE



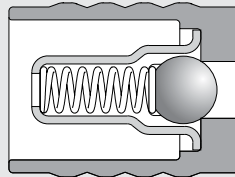
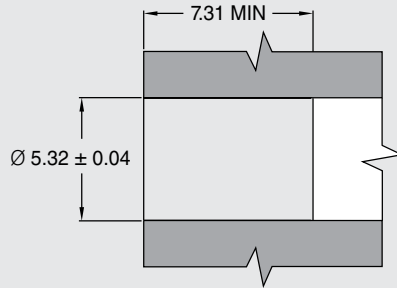
ACTUAL SIZE



(As Installed)

All dimensions in millimeters.

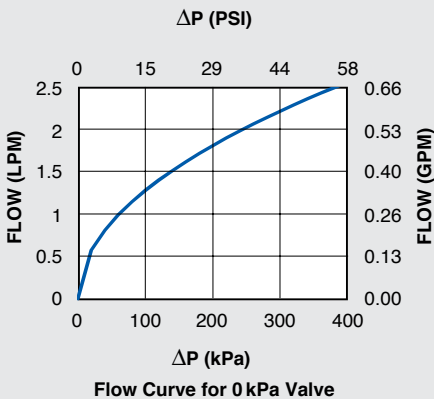
INSTALLATION HOLE



Flow
Direction

Checked

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 250 Lohms

Leakage: 20 sccm/min. (max.) @172 kPa (25 psid) on air

1 Drop/min. (max.) on water

MATERIALS

Body..... 316L Stainless Steel

Cage 316L Stainless Steel

Spring 316L Stainless Steel

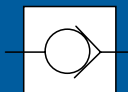
Ball..... Ceramic

INSTALLATION

Tool Part NumberCCRT0900170S

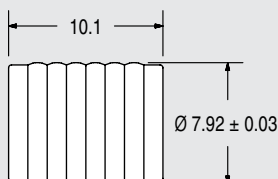
To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities. See page B27.

LEE PART NO.	CRACKING PRESSURE
CCPI5540000S	0 kPa (No Spring)
CCPI5540007S	7 ± 5 kPa (1 ± 0.7 psid)
CCPI5540014S	14 ± 5 kPa (2 ± 0.7 psid)
CCPI5540040S	40 ± 15 kPa (6 ± 2.2 psid)

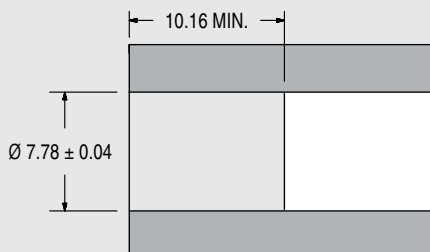


8.0mm CHECK VALVE for PLASTIC INSTALLATION

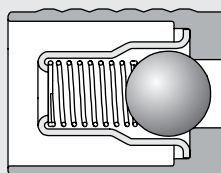
CHEK VALVE



INSTALLATION HOLE



ACTUAL SIZE

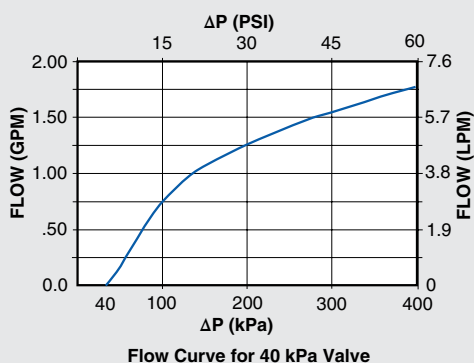


Flow
Direction

Checked

All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 75 Lohms
Leakage: 20 sccm/min. (max.) @172 kPa (25 psid) on air
1 Drop/min. (max.) on water

MATERIALS

Body..... 303 Stainless Steel
Cage 305 Stainless Steel
Spring 302 Stainless Steel
Ball..... 440C Stainless Steel

LEE PART NO.	CRACKING PRESSURE
CCPI8010000S	0 kPa (No Spring)
CCPI8010004S	4 ± 3 kPa (0.6 ± 0.4 psid)
CCPI8010007S	7 ± 5 kPa (1 ± 0.7 psid)
CCPI8010014S	14 ± 5 kPa (2 ± 0.7 psid)
CCPI8010040S	40 ± 30 kPa (6 ± 4.4 psid)
CCPI8010069S	69 ± 17.3 kPa (10 ± 2.5 psid)

INSTALLATION

Tool Part NumberCCRT0900180S

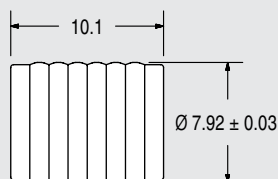
To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities. See page B27.



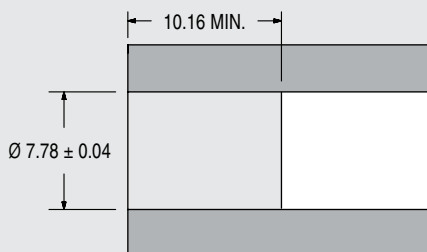
CHECK & RELIEF VALVES FOR PLASTIC

8.0mm CHECK VALVE - CERAMIC BALL for PLASTIC INSTALLATION

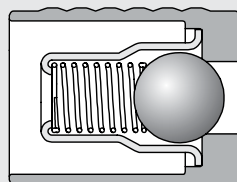
CHEK VALVE



INSTALLATION HOLE



ACTUAL SIZE

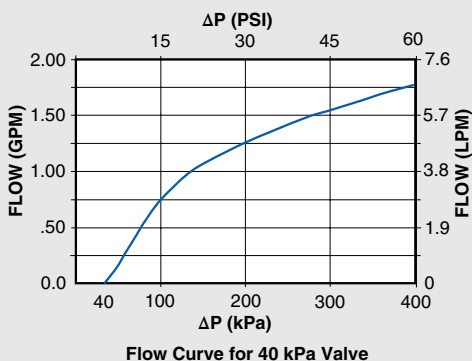


Flow
Direction

Checked

All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 75 Lohms

Leakage: 20 sccm/min. (max.) @ 172 kPa (25 psid) on air
1 Drop/min. (max.) on water

MATERIALS

Body..... 303 Stainless Steel
Cage 305 Stainless Steel
Spring 302 Stainless Steel
Ball..... Ceramic

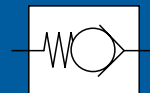
INSTALLATION

Tool Part NumberCCRT0900180S

To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities. See page B27.

LEE PART NO.	CRACKING PRESSURE
CCPI8080000S	0 kPa (No Spring)
CCPI8080007S	7 ± 5 kPa (1 ± 0.7 psid)
CCPI8080014S	14 ± 5 kPa (2 ± 0.7 psid)
CCPI8080040S	40 ± 30 kPa (6 ± 4.4 psid)
CCPI8080069S	69 ± 17.3 kPa (10 ± 2.5 psid)

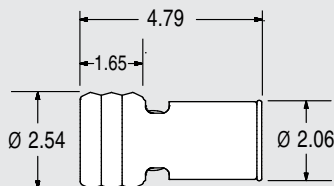
CHECK & RELIEF VALVES FOR PLASTIC



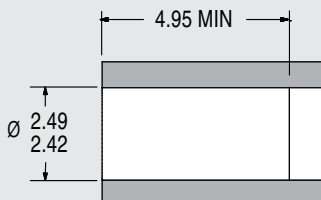
B12

2.5mm RELIEF VALVE for PLASTIC INSTALLATION

RELIEF VALVE



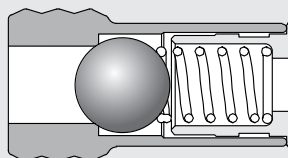
INSTALLATION HOLE



ACTUAL SIZE



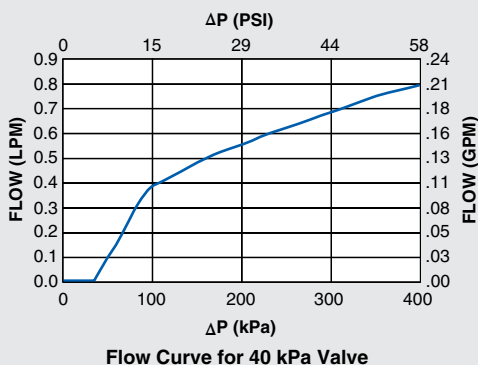
(As Installed)



Flow
Direction →
← Checked
Direction

All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 750 Lohms

Leakage: 10 sccm/min. (max.) @500 kPa (72.5 psid) on air
1 Drop/min. (max.) on water

Cracking Pressure Tolerance: ± 15%

MATERIALS

Body..... 303 Stainless Steel
Ball Stop ... 303 Stainless Steel
Spring 302 Stainless Steel
Ball..... 440C Stainless Steel

LEE PART NO.

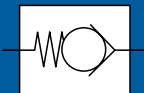
CRACKING PRESSURE

CCPI2510100S	100 kPa (14.5 psid)
CCPI2510150S	150 kPa (21.8 psid)
CCPI2510200S	200 kPa (29 psid)
CCPI2510250S	250 kPa (36.6 psid)
CCPI2510300S	300 kPa (43.5 psid)
CCPI2510345S	345 kPa (50 psid)

INSTALLATION

Tool Part NumberCCRT0024277S

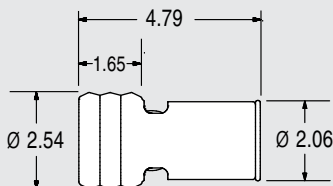
To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities.



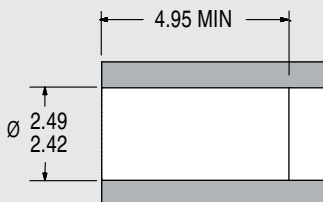
CHECK & RELIEF VALVES FOR PLASTIC

2.5mm RELIEF VALVE - CERAMIC BALL for PLASTIC INSTALLATION

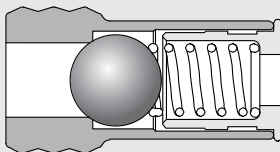
RELIEF VALVE



INSTALLATION HOLE



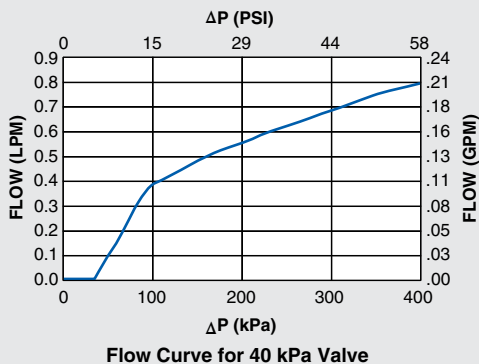
ACTUAL SIZE



Flow
Direction →
← Checked
Direction

All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 750 Lohms

Leakage: 10 sccm/min. (max.) @500
kPa (72.5 psid) on air
1 Drop/min. (max.) on
water

Cracking Pressure Tolerance: ± 15%

MATERIALS

Body..... 303 Stainless Steel
Ball Stop ... 303 Stainless Steel
Spring 302 Stainless Steel
Ball..... Ceramic

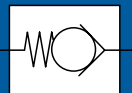
LEE PART NO.	CRACKING PRESSURE
CCPI2580100S	100 kPa (14.5 psid)
CCPI2580150S	150 kPa (21.8 psid)
CCPI2580200S	200 kPa (29 psid)
CCPI2580250S	250 kPa (36.6 psid)
CCPI2580300S	300 kPa (43.5 psid)
CCPI2580345S	345 kPa (50 psid)

INSTALLATION

Tool Part NumberCCRT0024277S

To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities.

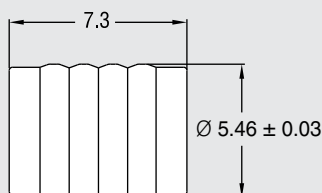
CHECK & RELIEF VALVES FOR PLASTIC



B14

5.5mm RELIEF VALVE for PLASTIC INSTALLATION

RELIEF VALVE

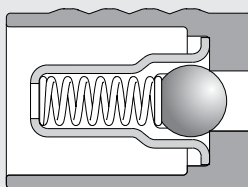


ACTUAL SIZE

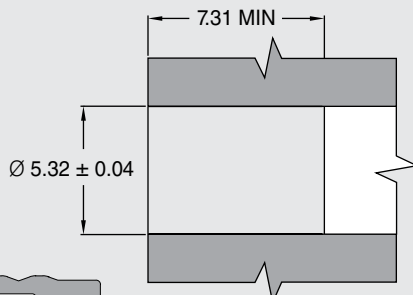


(As Installed)

All dimensions in millimeters.



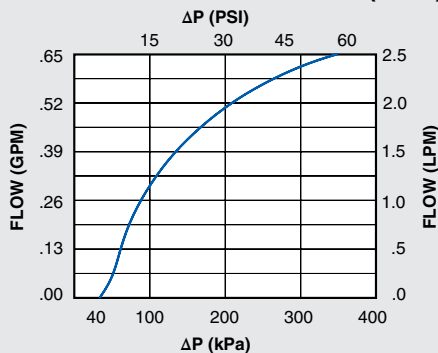
INSTALLATION HOLE



Relief Flow
Direction

Checked

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

PERFORMANCE

Lohm Rate: 250 Lohms

Leakage: 20 sccm/min. (max.) @172 kPa (25 psid) on air
1 Drop/min. (max.) on water

Cracking Pressure Tolerance: ± 15%

MATERIALS

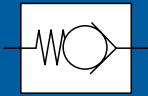
Body..... 303 Stainless Steel
Cage 305 Stainless Steel
Spring 302 Stainless Steel
Ball..... 440C Stainless Steel

INSTALLATION

Tool Part NumberCCRT0900170S

To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities. See page B27.

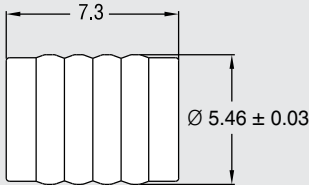
LEE PART NO.	CRACKING PRESSURE
CCPI5510100S	100 kPa (14.5 psid)
CCPI5510150S	150 kPa (21.8 psid)
CCPI5510200S	200 kPa (29 psid)
CCPI5510250S	250 kPa (36.6 psid)
CCPI5510300S	300 kPa (43.5 psid)
CCPI5510350S	350 kPa (50.8 psid)
CCPI5510400S	400 kPa (58 psid)
CCPI5510500S	500 kPa (72.5 psid)
CCPI5510550S	550 kPa (79.8 psid)
CCPI5510625S	625 kPa (90.6 psid)



CHECK & RELIEF VALVES FOR PLASTIC

5.5mm RELIEF VALVE - CERAMIC BALL for PLASTIC INSTALLATION

RELIEF VALVE

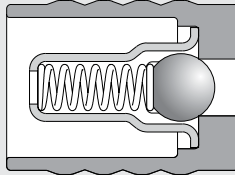


ACTUAL SIZE

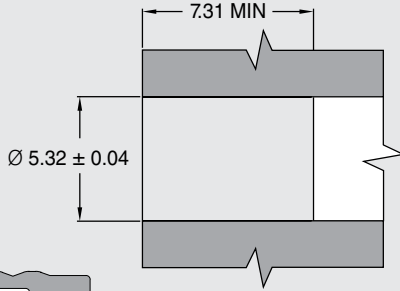


(As Installed)

All dimensions in millimeters.

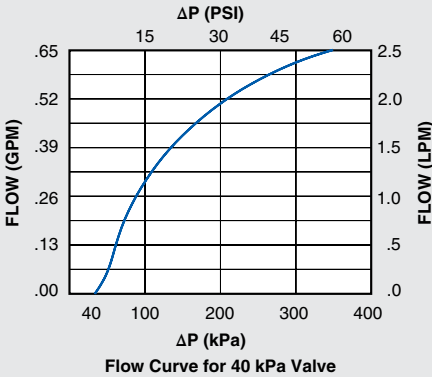


INSTALLATION HOLE



Relief Flow
Direction
Checked

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 250 Lohms
Leakage: 20 sccm/min. (max.) @ 172 kPa (25 psid) on air
1 Drop/min. (max.) on water
Cracking Pressure Tolerance: ± 15%

MATERIALS

Body..... 303 Stainless Steel
Cage 305 Stainless Steel
Spring 302 Stainless Steel
Ball..... Ceramic

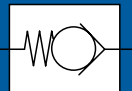
INSTALLATION

Tool Part NumberCCRT0900170S

To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities. See page B27.

LEE PART NO.	CRACKING PRESSURE
CCPI5580100S	100 kPa (14.5 psid)
CCPI5580150S	150 kPa (21.8 psid)
CCPI5580200S	200 kPa (29 psid)
CCPI5580250S	250 kPa (36.6 psid)
CCPI5580300S	300 kPa (43.5 psid)
CCPI5580350S	350 kPa (50.8 psid)
CCPI5580400S	400 kPa (58 psid)
CCPI5580500S	500 kPa (72.5 psid)
CCPI5580550S	550 kPa (79.8 psid)
CCPI5580625S	625 kPa (90.6 psid)

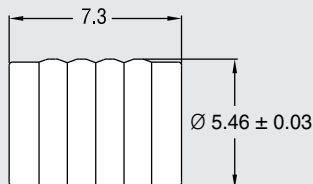
CHECK & RELIEF VALVES FOR PLASTIC



B16

5.5mm RELIEF VALVE - MEDICAL GRADE 316L for PLASTIC INSTALLATION

RELIEF VALVE



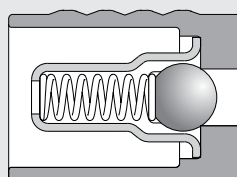
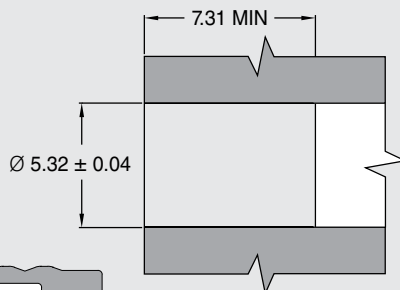
ACTUAL SIZE



(As Installed)

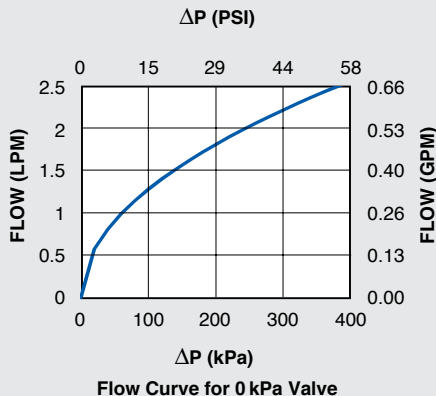
All dimensions in millimeters.

INSTALLATION HOLE



Flow
Direction
←
Checked
→

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 250 Lohms

Leakage: 20 sccm/min. (max.) @ 172 kPa (25 psid) on air
1 Drop/min. (max.) on water

Cracking Pressure Tolerance: ± 15%

MATERIALS

Body..... 316L Stainless Steel
Cage 316L Stainless Steel
Spring 316L Stainless Steel
Ball..... Ceramic

LEE PART NO.

CRACKING PRESSURE

CCPI5540100S 100 kPa (14.5 psid)

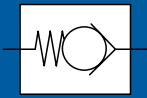
CCPI5540150S 150 kPa (21.8 psid)

CCPI5540200S 200 kPa (29 psid)

INSTALLATION

Tool Part NumberCCRT0900170S

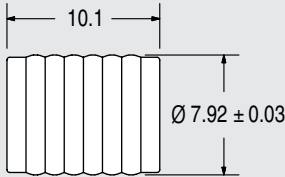
To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities. See page B27.



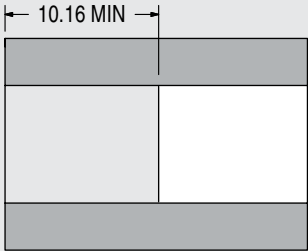
CHECK & RELIEF VALVES FOR PLASTIC

8.0mm RELIEF VALVE for PLASTIC INSTALLATION

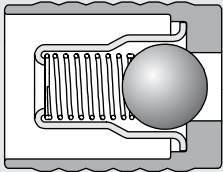
RELIEF VALVE



INSTALLATION HOLE



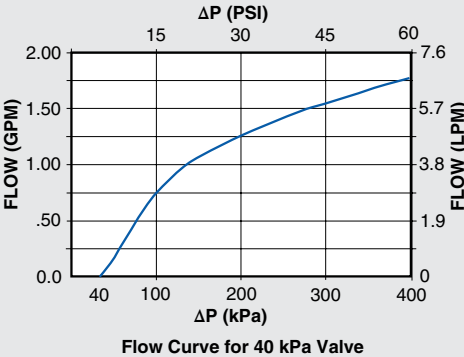
ACTUAL SIZE



Relief Flow
Direction
Checked

All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 75 Lohms
 Leakage: 20 sccm/min. (max.) @172 kPa (25 psid) on air
 1 Drop/min. (max.) on water
 Cracking Pressure Tolerance: ± 15%

MATERIALS

Body..... 303 Stainless Steel
 Cage 305 Stainless Steel
 Spring 302 Stainless Steel
 Ball..... 440C Stainless Steel

INSTALLATION

Tool Part NumberCCRT0900180S

To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities. See page B27.

LEE PART NO.	CRACKING PRESSURE
CCPI8010100S	100 kPa (14.5 psid)
CCPI8010150S	150 kPa (21.8 psid)
CCPI8010200S	200 kPa (29 psid)
CCPI8010250S	250 kPa (36.6 psid)
CCPI8010300S	300 kPa (43.5 psid)
CCPI8010350S	350 kPa (50.8 psid)
CCPI8010400S	400 kPa (58 psid)
CCPI8010500S	500 kPa (72.5 psid)

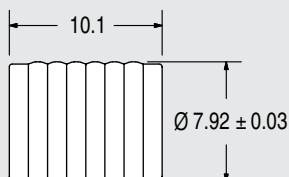
CHECK & RELIEF VALVES FOR PLASTIC



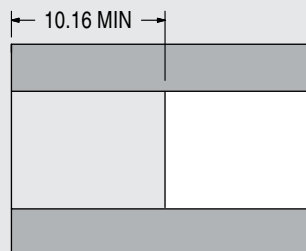
B18

8.0mm RELIEF VALVE - CERAMIC BALL for PLASTIC INSTALLATION

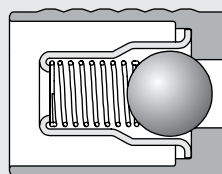
RELIEF VALVE



INSTALLATION HOLE



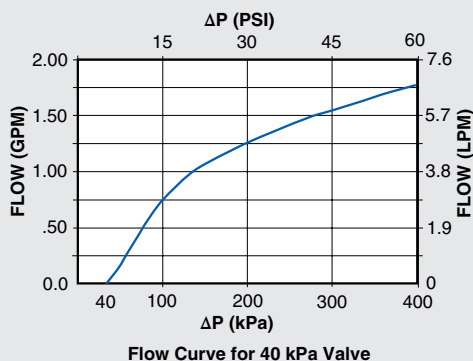
ACTUAL SIZE



Relief Flow
Direction
Checked

All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



PERFORMANCE

Lohm Rate: 75 Lohms
 Leakage: 20 sccm/min. (max.) @ 172 kPa (25 psid) on air
 1 Drop/min. (max.) on water
 Cracking Pressure Tolerance: ± 15%

MATERIALS

Body..... 303 Stainless Steel
 Cage 305 Stainless Steel
 Spring 302 Stainless Steel
 Ball..... Ceramic

INSTALLATION

Tool Part NumberCCRT0900180S

To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities. See page B27.

LEE PART NO.	CRACKING PRESSURE
CCPI8080100S	100 kPa (14.5 psid)
CCPI8080150S	150 kPa (21.8 psid)
CCPI8080200S	200 kPa (29 psid)
CCPI8080250S	250 kPa (36.6 psid)
CCPI8080300S	300 kPa (43.5 psid)
CCPI8080350S	350 kPa (50.8 psid)
CCPI8080400S	400 kPa (58 psid)
CCPI8080500S	500 kPa (72.5 psid)

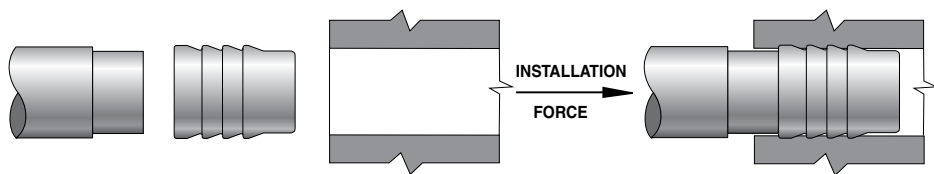


ORIFICES FOR PLASTIC

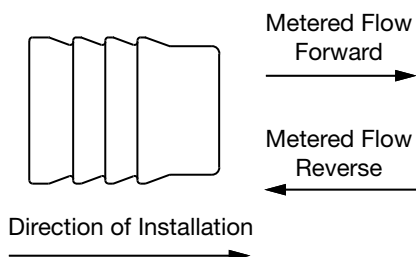
IMH Orifices for plastic are economical, reliable, highly accurate miniature restrictors. These orifices are 100% flow tested to ensure that every part is within $\pm 5\%$ of its nominal flow rate (tighter flow tolerances available as special orders). Tight flow tolerances are only possible if entrance and exit conditions are closely controlled. This provides far more accuracy than an orifice specified by hole tolerance. An ordinary hole held to a very tight hole tolerance will not result in a tight flow tolerance. IMH orifices are so consistent because they are produced in high volume by automated processes.



Installation is simple. Press or heat flow the orifice into a plastic hole, narrow end first, until the orifice is flush minimum with the top of the installation hole. Pressing or heat flowing the restrictors into the manifold or fitting provides retention and creates a leak tight seal.



Orifices are available in Brass, 303 and 316 Stainless Steel. Brass orifices are available in gas versions only and are often used for oxygen service. Stainless steel orifices come in gas and liquid versions and will not change flow rate over time due either to corrosion or erosion. Gas orifices are tested on clean dry nitrogen and liquid orifices on distilled water. Great care is taken to ensure the accuracy of the automated test systems. To further increase accuracy, orifices are tested in the direction of use. Simply refer to the diagram illustrating forward and reverse flow.





Features and Benefits

- Accurate flow
 - Eliminate expensive alternative components.
 - More consistent system performance.
- Press-in design
 - Easy installation.
 - Maintains flow accuracy.
- 100% flow tested
 - All parts within flow tolerance.
 - Consistent batch to batch performance.
- Various material choices
 - Design flexibility.

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2.5mm ORIFICES FOR GASES

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316 Stainless Steel..... B24

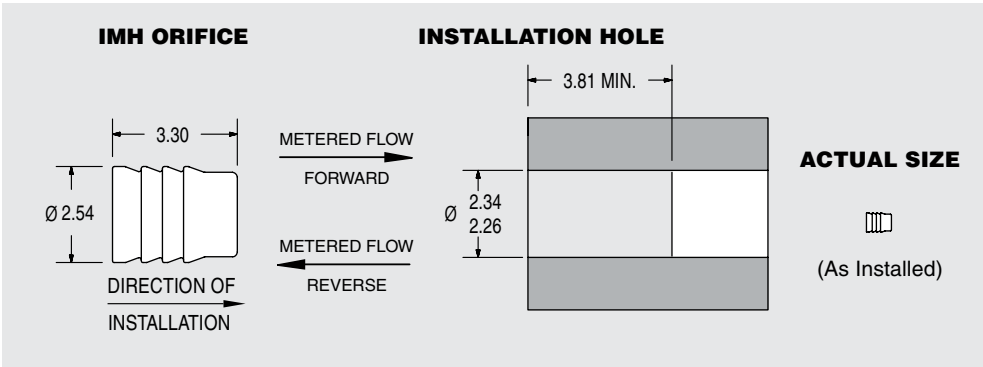
Brass B25

NOTES B26



ORIFICES FOR PLASTIC

2.5mm ORIFICE FOR LIQUIDS 303 STAINLESS STEEL for PLASTIC INSTALLATION



All dimensions in millimeters.

LEE PART NO.		LOHM RATE
METERED FLOW DIRECTION		
FORWARD	REVERSE	
RPLF2551005S	RPLR2551005S	500
RPLF2551006S	RPLR2551006S	600
RPLF2551008S	RPLR2551008S	800
RPLF2551010S	RPLR2551010S	1,000
RPLF2551012S	RPLR2551012S	1,200
RPLF2551015S	RPLR2551015S	1,500
RPLF2551020S	RPLR2551020S	2,000
RPLF2551025S	RPLR2551025S	2,500
RPLF2551030S	RPLR2551030S	3,000
RPLF2551040S	RPLR2551040S	4,000
RPLF2551050S	RPLR2551050S	5,000
RPLF2551060S	RPLR2551060S	6,000
RPLF2551080S	RPLR2551080S	8,000
RPLF2551100S	RPLR2551100S	10,000
RPLF2551120S	RPLR2551120S	12,000
RPLF2551150S	RPLR2551150S	15,000
RPLF2551200S	RPLR2551200S	20,000
RPLF2551250S	RPLR2551250S	25,000
RPLF2551300S	RPLR2551300S	30,000
RPLF2551400S	RPLR2551400S	40,000
RPLF2551450S	RPLR2551450S	45,000

PERFORMANCE
Metered Flow Lohm Rate Tolerance: ± 5%
Test Fluid: Distilled Water

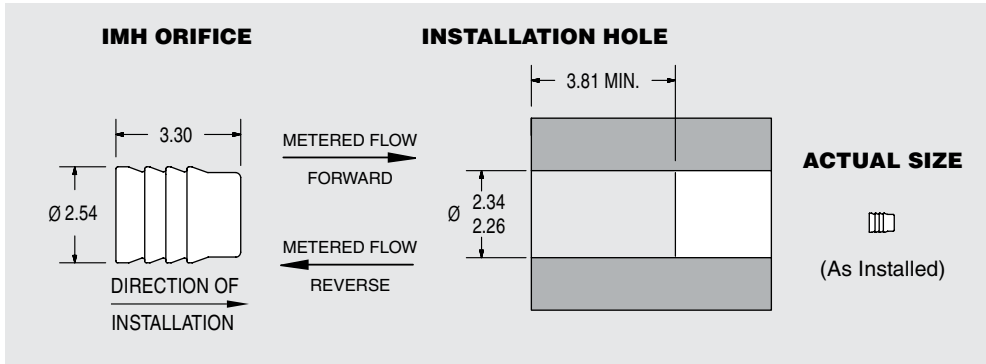
MATERIALS
Body..... 303 Stainless Steel

INSTALLATION
Tool Part Number CCRT0029354S
For installation procedure see page B19.

For companion 2.5mm Safety Screen [see page B35.](#)



2.5mm ORIFICE FOR LIQUIDS 316 STAINLESS STEEL for PLASTIC INSTALLATION



All dimensions in millimeters.

LEE PART NO.		LOHM RATE
METERED FLOW DIRECTION		
FORWARD	REVERSE	
RPLF2552005S	RPLR2552005S	500
RPLF2552006S	RPLR2552006S	600
RPLF2552008S	RPLR2552008S	800
RPLF2552010S	RPLR2552010S	1,000
RPLF2552012S	RPLR2552012S	1,200
RPLF2552015S	RPLR2552015S	1,500
RPLF2552020S	RPLR2552020S	2,000
RPLF2552025S	RPLR2552025S	2,500
RPLF2552030S	RPLR2552030S	3,000
RPLF2552040S	RPLR2552040S	4,000
RPLF2552050S	RPLR2552050S	5,000
RPLF2552060S	RPLR2552060S	6,000
RPLF2552080S	RPLR2552080S	8,000
RPLF2552100S	RPLR2552100S	10,000
RPLF2552120S	RPLR2552120S	12,000
RPLF2552150S	RPLR2552150S	15,000
RPLF2552200S	RPLR2552200S	20,000
RPLF2552250S	RPLR2552250S	25,000
RPLF2552300S	RPLR2552300S	30,000
RPLF2552400S	RPLR2552400S	40,000
RPLF2552450S	RPLR2552450S	45,000

PERFORMANCE
Metered Flow
Lohm Rate Tolerance: $\pm 5\%$
Test Fluid: Distilled Water

MATERIALS
Body.....316 Stainless Steel

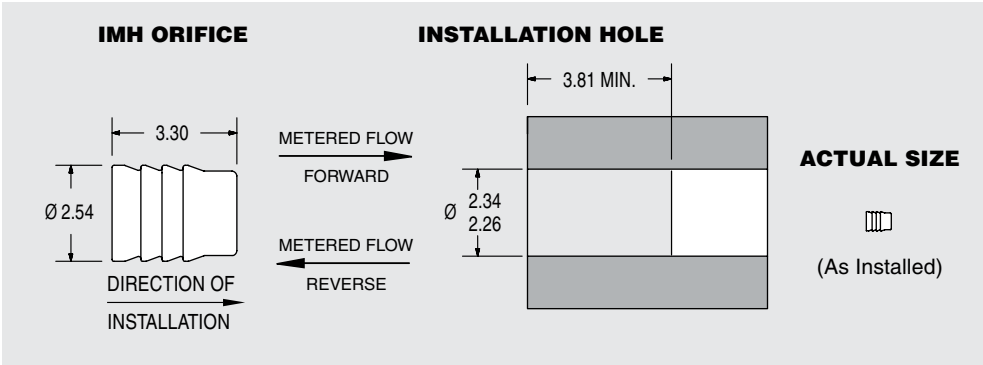
INSTALLATION
Tool Part Number CCRT0029354S
For installation procedure see page B19.

For companion 2.5mm Safety Screen [see page B35.](#)



ORIFICES FOR PLASTIC

2.5mm ORIFICE FOR GASES 303 STAINLESS STEEL for PLASTIC INSTALLATION



All dimensions in millimeters.

LEE PART NO.		LOHM RATE
METERED FLOW DIRECTION		
FORWARD	REVERSE	
RPGF2551005S	RPGR2551005S	500
RPGF2551006S	RPGR2551006S	600
RPGF2551008S	RPGR2551008S	800
RPGF2551010S	RPGR2551010S	1,000
RPGF2551012S	RPGR2551012S	1,200
RPGF2551015S	RPGR2551015S	1,500
RPGF2551020S	RPGR2551020S	2,000
RPGF2551025S	RPGR2551025S	2,500
RPGF2551030S	RPGR2551030S	3,000
RPGF2551040S	RPGR2551040S	4,000
RPGF2551050S	RPGR2551050S	5,000
RPGF2551060S	RPGR2551060S	6,000
RPGF2551080S	RPGR2551080S	8,000
RPGF2551100S	RPGR2551100S	10,000
RPGF2551120S	RPGR2551120S	12,000
RPGF2551150S	RPGR2551150S	15,000
RPGF2551200S	RPGR2551200S	20,000
RPGF2551250S	RPGR2551250S	25,000
RPGF2551300S	RPGR2551300S	30,000
RPGF2551400S	RPGR2551400S	40,000
RPGF2551450S	RPGR2551450S	45,000

PERFORMANCE
Metered Flow Lohm Rate Tolerance: ± 5%
Test Fluid: Clean & Dry Nitrogen

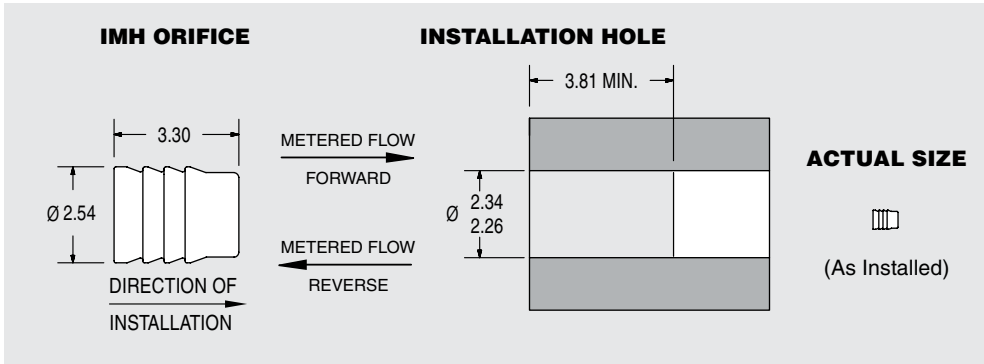
MATERIALS
Body..... 303 Stainless Steel

INSTALLATION
Tool Part Number CCRT0029354S
For installation procedure see page B19 .

For companion 2.5mm Safety Screen [see page B35](#).



2.5mm ORIFICE FOR GASES 316 STAINLESS STEEL for PLASTIC INSTALLATION



All dimensions in millimeters.

LEE PART NO.		LOHM RATE
METERED FLOW DIRECTION		
FORWARD	REVERSE	
RPGF2552005S	RPGR2552005S	500
RPGF2552006S	RPGR2552006S	600
RPGF2552008S	RPGR2552008S	800
RPGF2552010S	RPGR2552010S	1,000
RPGF2552012S	RPGR2552012S	1,200
RPGF2552015S	RPGR2552015S	1,500
RPGF2552020S	RPGR2552020S	2,000
RPGF2552025S	RPGR2552025S	2,500
RPGF2552030S	RPGR2552030S	3,000
RPGF2552040S	RPGR2552040S	4,000
RPGF2552050S	RPGR2552050S	5,000
RPGF2552060S	RPGR2552060S	6,000
RPGF2552080S	RPGR2552080S	8,000
RPGF2552100S	RPGR2552100S	10,000
RPGF2552120S	RPGR2552120S	12,000
RPGF2552150S	RPGR2552150S	15,000
RPGF2552200S	RPGR2552200S	20,000
RPGF2552250S	RPGR2552250S	25,000
RPGF2552300S	RPGR2552300S	30,000
RPGF2552400S	RPGR2552400S	40,000
RPGF2552450S	RPGR2552450S	45,000

PERFORMANCE
Metered Flow Lohm Rate Tolerance: $\pm 5\%$ Test Fluid: Clean & Dry Nitrogen

MATERIALS
Body.....316 Stainless Steel

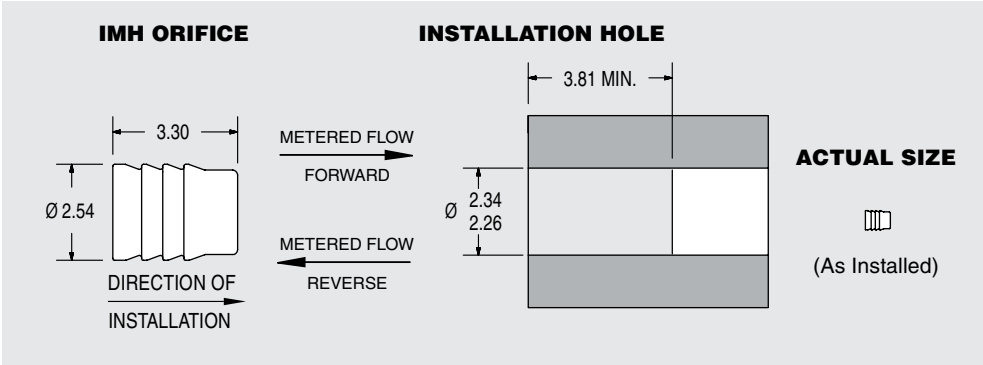
INSTALLATION
Tool Part Number CCRT0029354S For installation procedure see page B19 .

For companion 2.5mm Safety Screen [see page B35](#).



ORIFICES FOR PLASTIC

2.5mm ORIFICE FOR GASES BRASS for PLASTIC INSTALLATION



All dimensions in millimeters.

LEE PART NO.		LOHM RATE
METERED FLOW DIRECTION		
FORWARD	REVERSE	
RPGF2554005S	RPGR2554005S	500
RPGF2554006S	RPGR2554006S	600
RPGF2554008S	RPGR2554008S	800
RPGF2554010S	RPGR2554010S	1,000
RPGF2554012S	RPGR2554012S	1,200
RPGF2554015S	RPGR2554015S	1,500
RPGF2554020S	RPGR2554020S	2,000
RPGF2554025S	RPGR2554025S	2,500
RPGF2554030S	RPGR2554030S	3,000
RPGF2554040S	RPGR2554040S	4,000
RPGF2554050S	RPGR2554050S	5,000
RPGF2554060S	RPGR2554060S	6,000
RPGF2554080S	RPGR2554080S	8,000
RPGF2554100S	RPGR2554100S	10,000
RPGF2554120S	RPGR2554120S	12,000
RPGF2554150S	RPGR2554150S	15,000
RPGF2554200S	RPGR2554200S	20,000
RPGF2554250S	RPGR2554250S	25,000
RPGF2554300S	RPGR2554300S	30,000
RPGF2554400S	RPGR2554400S	40,000
RPGF2554450S	RPGR2554450S	45,000

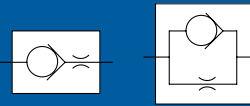
PERFORMANCE
Metered Flow Lohm Rate Tolerance: ± 5% Test Fluid: Clean & Dry Nitrogen

MATERIALS
Body..... Brass C36000

INSTALLATION
Tool Part Number CCRT0029354S For installation procedure see page B19 .

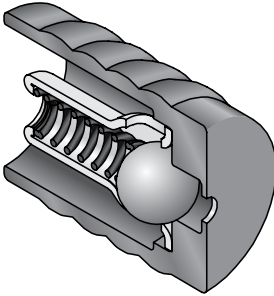
For companion 2.5mm Safety Screen [see page B35](#).





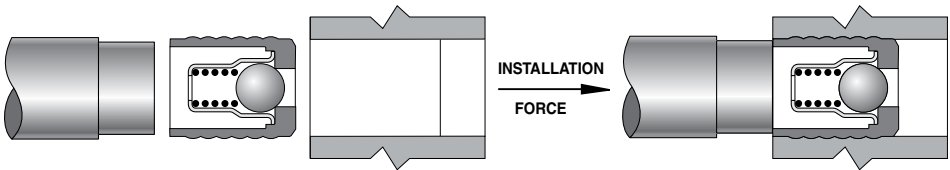
RESTRICTOR CHECKS & FLOW CONTROLS FOR PLASTIC

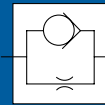
Restrictor Checks are functionally an orifice in series with a check valve, all in one compact package. Flow controls are functionally an orifice in parallel with a check valve, all in one package. Both come in a wide variety of metered lohm rates (orifices sizes).



Where screening is necessary, companion screens for plastic are available in four different micron ratings (see pages B36-B37).

To install, simply press or heat flow the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities. Lee installation tools are available for each product and part numbers are listed on each page.



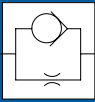


Features and Benefits

- Combines hydraulic functions
 - Simplifies manifold.
- Accurate flow
 - Eliminate expensive alternative components.
 - More consistent system performance.
- 100% flow tested
 - Eliminates rework.
 - All parts within flow tolerance.
 - Consistent batch to batch performance.
- Press-in Design
 - Simple installation.

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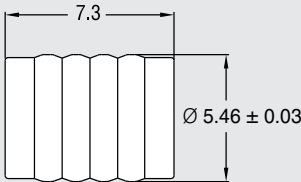
5.5mm Flow Control	B29
8.0mm Flow Control	B30
5.5mm Restrictor Check.....	B31
Notes.....	B32



FLOW CONTROLS FOR PLASTIC

5.5mm FLOW CONTROL for PLASTIC INSTALLATION

FLOW CONTROL

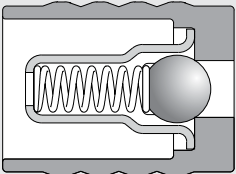
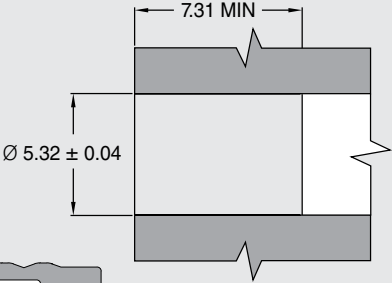


ACTUAL SIZE



(As Installed)

INSTALLATION HOLE

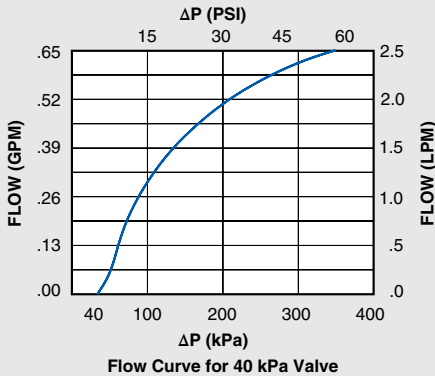


Free Flow
Metered Flow

All dimensions in millimeters.

Free Flow Curve

ΔP vs. Flow on Water @ 80°F (27°C)



PERFORMANCE

Metered Flow
Lohm Rate Tolerance: $\pm 15\%$
Free Flow Lohm Rate: 250 Lohms
Cracking Pressure: 40 ± 30 kPa
(6 ± 4.4 psid)

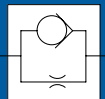
MATERIALS

Body303 Stainless Steel
Cage.....305 Stainless Steel
Spring.....302 Stainless Steel
Ball440C Stainless Steel

INSTALLATION

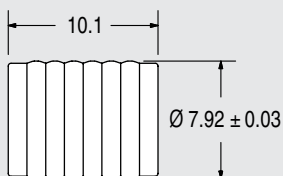
Tool Part Number CCRT0900170S
For installation procedure [see page B27](#).

LEE PART NUMBER	LOHM RATE
CFPM5501020S	2000
CFPM5501025S	2500
CFPM5501030S	3000
CFPM5501040S	4000
CFPM5501050S	5000
CFPM5501060S	6000
CFPM5501080S	8000
CFPM5501100S	10000



8.0mm FLOW CONTROL for PLASTIC INSTALLATION

FLOW CONTROL



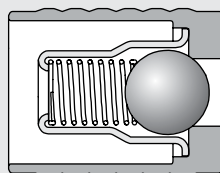
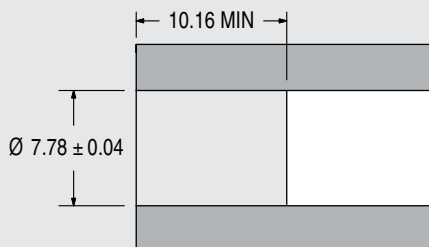
ACTUAL SIZE



(As Installed)

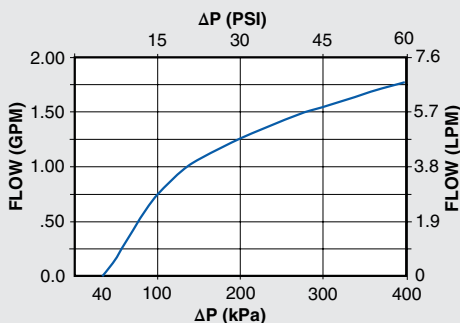
All dimensions in millimeters.

INSTALLATION HOLE



Free Flow
Metered Flow

Free Flow Curve ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

PERFORMANCE

Metered Flow

Lohm Rate Tolerance: $\pm 15\%$

Free Flow Lohm Rate: 75 Lohms

Cracking Pressure: 40 ± 30 kPa
(6 ± 4.4 psid)

MATERIALS

Body303 Stainless Steel
Cage.....305 Stainless Steel
Spring.....302 Stainless Steel
Ball440C Stainless Steel

LEE PART NUMBER

LOHM RATE

CFPM8001005S	500
CFPM8001006S	600
CFPM8001008S	800
CFPM8001010S	1000
CFPM8001012S	1200
CFPM8001015S	1500
CFPM8001020S	2000

INSTALLATION

Tool Part Number CCRT0900180S

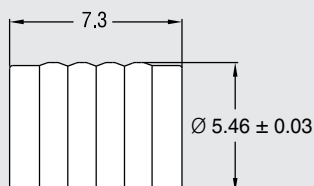
For installation procedure [see](#)
[page B27](#).



RESTRICTOR CHECKS FOR PLASTIC

5.5mm RESTRICTOR CHEK for PLASTIC INSTALLATION

RESTRICTOR CHECK

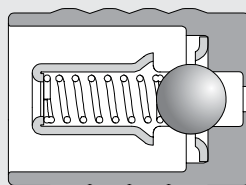
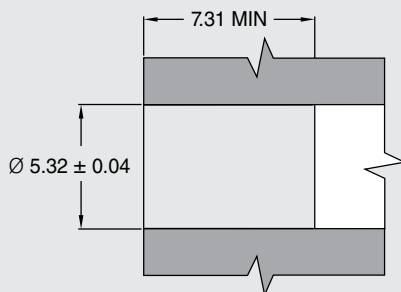


ACTUAL SIZE



All dimensions in millimeters.

INSTALLATION HOLE



Metered
Flow

Checked

LEE PART NUMBER	LOHM RATE
COPM5501004S	400
COPM5501005S	500
COPM5501006S	600
COPM5501008S	800
COPM5501010S	1000
COPM5501012S	1200
COPM5501015S	1500
COPM5501020S	2000

PERFORMANCE

Metered Flow

Lohm Rate Tolerance: $\pm 5\%$

Leakage: 20 sccm/min. (max.) @ 172 kPa (25 psid) on air
1 Drop/min. (max.) on water

Cracking Pressure: 40 ± 30 kPa
(6 ± 4.4 psid)

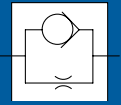
MATERIALS

Body..... 303 Stainless Steel
Cage 305 Stainless Steel
Spring 302 Stainless Steel
Ball..... 440C Stainless Steel

INSTALLATION

Tool Part Number CCRT0900170S

For installation procedure [see page B27](#).





SAFETY SCREENS FOR PLASTIC

IMH Screens are "last chance" safety screens designed to protect critical fluid control components against rogue contamination. They are not intended to serve as system filters. The screens are constructed of stainless steel woven wire mesh, bonded together using a proprietary process that offers superior integrity and life.

IMH Safety Screens for plastic are designed to be companion parts to other products in this section or used as stand alone components.





Features and Benefits

- Press-in design
 - Easy to install.
- Proprietary bonded mesh
 - Superior integrity and life.
- Various diameters
 - Design flexibility.

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2.5mm Safety Screen B35

5.5mm Safety Screen B36

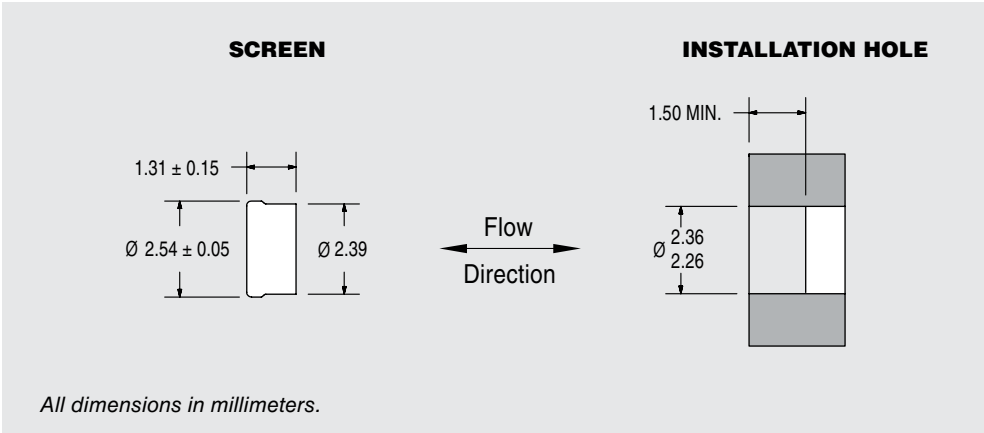
8.0mm Safety Screen B37

Notes..... B38



SAFETY SCREENS FOR PLASTIC

2.5mm SAFETY SCREEN for PLASTIC INSTALLATION



ACTUAL SIZE

□
(As Installed)

MATERIALS

Body303 Stainless Steel
Screen316 Stainless Steel

INSTALLATION

Tool Part NumberCCRT0029354S

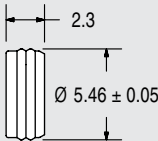
To install, simply press the screen into a plastic installation hole, narrow end first, until the screen is flush minimum with the top of the installation hole.

LEE PART NUMBER	MICRON RATING	LOHM RATE	OPEN AREA (mm²)	ROB#
SCRM4253004S	4	1700	0.2	0.0033
SCRM4252040S	40	850	0.5	0.0097



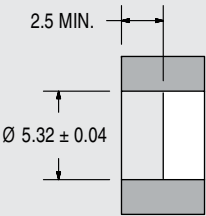
5.5mm SAFETY SCREEN
for PLASTIC INSTALLATION

SCREEN



Flow
Direction

INSTALLATION HOLE



All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

MATERIALS

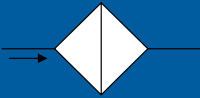
Body303 Stainless Steel
Screen316 Stainless Steel

INSTALLATION

Tool Part NumberCCRT0900170S

To install, simply press the screen into a plastic installation hole until the screen is flush minimum with the top of the installation hole. The screen can be installed in either direction.

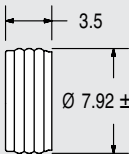
LEE PART NUMBER	MICRON RATING	LOHM RATE	OPEN AREA (mm ²)	ROB#
SCRM4551040S	40	185	2.8	0.05
SCRM4551075S	75	170	2.4	0.10
SCRM4551125S	125	255	2.1	0.18
SCRM4551170S	170	205	2.8	0.49



SAFETY SCREENS FOR PLASTIC

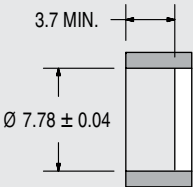
8.0mm SAFETY SCREEN for PLASTIC INSTALLATION

SCREEN



Flow
Direction

INSTALLATION HOLE



All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

MATERIALS

Body303 Stainless Steel
Screen.....316 Stainless Steel

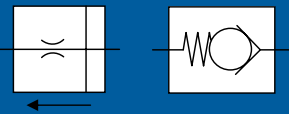
INSTALLATION

Tool Part NumberCCRT0900180S

To install, simply press the screen into a plastic installation hole until the screen is flush minimum with the top of the installation hole. The screen can be installed in either direction.

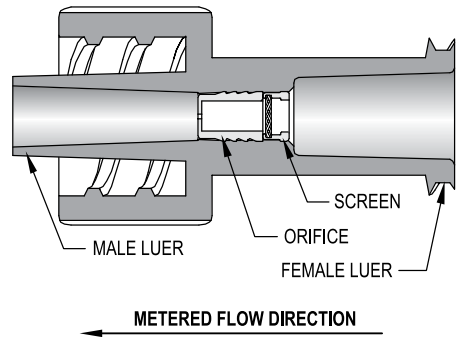
LEE PART NUMBER	MICRON RATING	LOHM RATE	OPEN AREA (mm ²)	ROB#
SCRM4801040S	40	80	7.1	0.13
SCRM4801075S	75	70	6.3	0.25
SCRM4801125S	125	90	5.3	0.47
SCRM4801170S	170	90	7.2	1.27





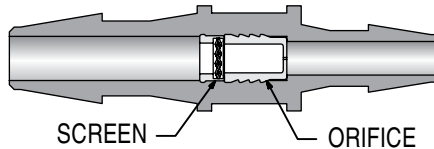
PRODUCTS IN PLASTIC FITTINGS

The Lee Company IMH Group offers our highly accurate Orifice installed into a male to female luer adaptor and features an integral safety screen to protect the orifice from contamination. Ideal for medical applications, the orifice and screen are 300 Series stainless steel and the fitting is made of medical grade polypropylene. Designed for both liquid and gas applications, the orifices are 100% flow tested on either distilled water or nitrogen to ensure that each part is within $\pm 5\%$ of its nominal flow rate. This provides far more accuracy than orifices specified by hole tolerance.

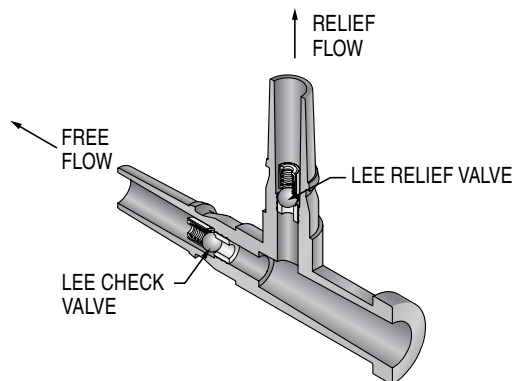
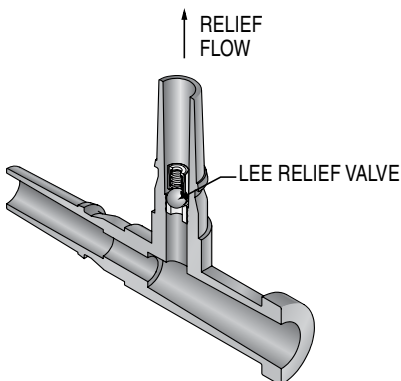


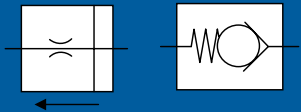
Orifices of very high lohm rates (very small hole diameters) are now available in a barb to barb union as standard. Lohm rates of as high as five million lohms, equivalent to as small as a 0.001mm (0.0004") diameter orifice, come flow tested to tolerances of $\pm 5\%$. This incredible accuracy is simply not available anywhere else. These orifices are protected by a 4 micron screen. The orifice and screen are 300 Series stainless steel and the fitting is medical grade polypropylene. This product is intended for gas applications only.

**METERED FLOW
DIRECTION**



The IMH Group also offers a series of Luer Tee fittings with a relief valve in the branch of the Tee. These are particularly useful for a syringe driven system where a maximum force is required. One version uses a 2.5mm relief valve and another uses a 5.5mm model for higher flow. A third version has a 2.5mm relief valve in the branch and a check valve in the downstream branch to prevent backflow as well as over pressure protection. The check valve has a cracking pressure of 4 kPa and the relief valves range from 100 to 300 kPa. As with all IMH valves, cracking pressure is highly repeatable and valve seat leakage is very low.





IMH products for plastics can be installed in a wide variety of fitting configurations and materials other than those shown as standard in this handbook. For more information on other materials or to discuss alternate fitting configurations please contact a Lee Sales Engineer.

Features and Benefits

- Preassembled
 - Ready to use.
- Numerous configurations
 - Design flexibility.
- Integral safety screens
 - Blocks rogue contamination.
 - Ensures reliability.
- 100% tested
 - Eliminates rework.
 - All parts within performance tolerance.
 - Consistent batch to batch performance.

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**Orifice in Male to Female
Luer for Gases B41**

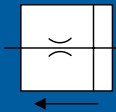
**Orifice in Male to Female
Luer for Liquids B42**

**High Lohm Orifice in
1/8" to 3/32" Barb Union .. B43**

**2.5mm Relief Valve in
Luer Tee B44**

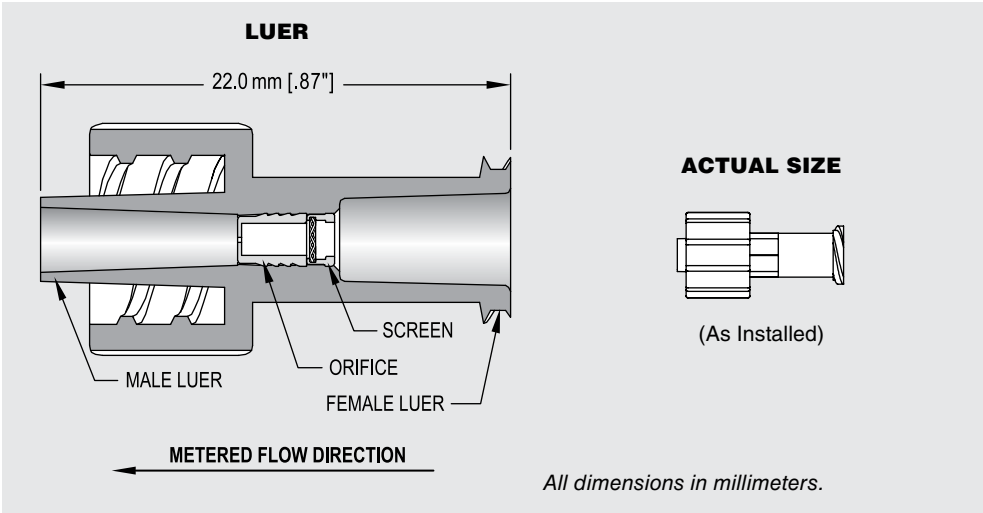
**5.5mm Relief Valve in
Luer Tee B45**

**2.5mm Relief and Check in
Luer Tee B46**



PRODUCTS IN PLASTIC FITTINGS

GAS ORIFICE - LEE IMH SCREENED ORIFICE IN MALE TO FEMALE LUER



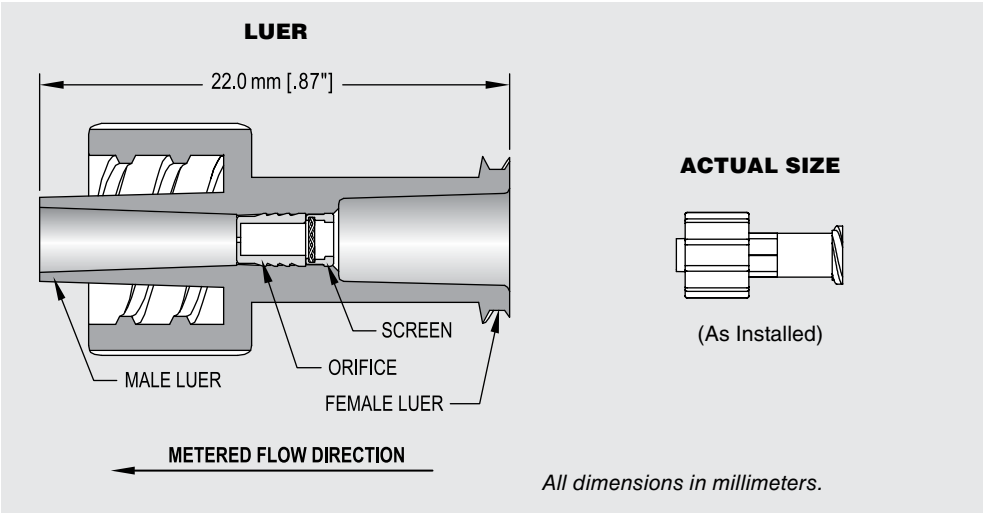
LEE PART NO.	LOHM RATE
RESM1505000S	5,000
RESM1505500S	5,500
RESM1506000S	6,000
RESM1506500S	6,500
RESM1507000S	7,000
RESM1507500S	7,500
RESM1508000S	8,000
RESM1508500S	8,500
RESM1509000S	9,000
RESM1509500S	9,500
RESM1510000S	10,000
RESM1515000S	15,000
RESM1520000S	20,000
RESM1525000S	25,000
RESM1530000S	30,000
RESM1535000S	35,000
RESM1540000S	40,000
RESM1545000S	45,000

PERFORMANCE
Metered Flow
Lohm Rate Tolerance: $\pm 5\%$
Screen Size: 40 Micron
Test Fluid: Clean & Dry Nitrogen

MATERIALS
Fitting..... Polypropylene - Natural
Orifice..... 303 Stainless Steel
Screen Body... 303 Stainless Steel
Screen..... 316 Stainless Steel



LIQUID ORIFICE - LEE IMH SCREENED ORIFICE
IN MALE TO FEMALE LUER



LEE PART NO.	LOHM RATE
RESM0505000S	5,000
RESM0505500S	5,500
RESM0506000S	6,000
RESM0506500S	6,500
RESM0507000S	7,000
RESM0507500S	7,500
RESM0508000S	8,000
RESM0508500S	8,500
RESM0509000S	9,000
RESM0509500S	9,500
RESM0510000S	10,000
RESM0515000S	15,000
RESM0520000S	20,000
RESM0525000S	25,000
RESM0530000S	30,000
RESM0535000S	35,000
RESM0540000S	40,000
RESM0545000S	45,000

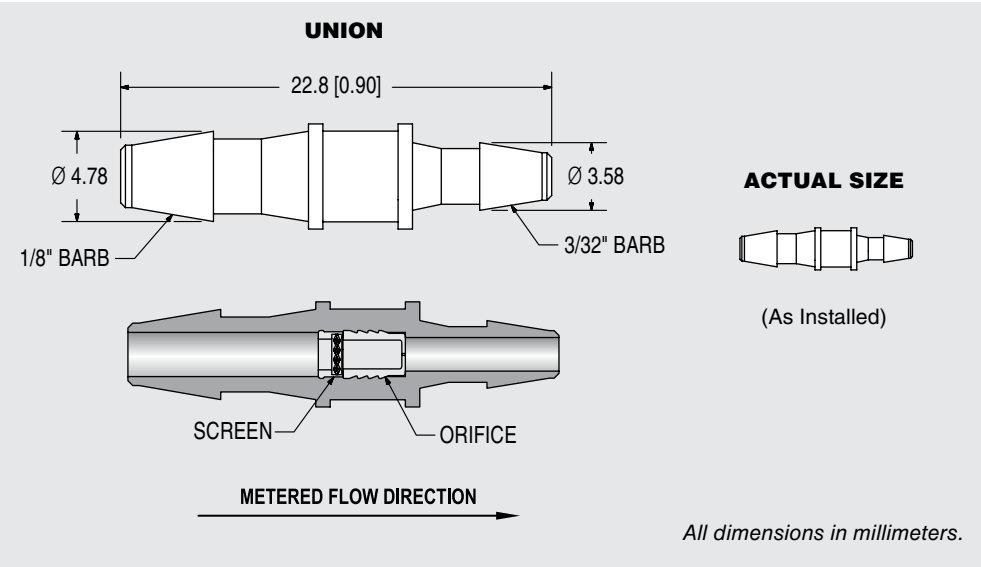
PERFORMANCE
Metered Flow
Lohm Rate Tolerance: $\pm 5\%$
Screen Size: 40 Micron
Test Fluid: Distilled Water

MATERIALS
Fitting..... Polypropylene - Natural
Orifice..... 303 Stainless Steel
Screen Body... 303 Stainless Steel
Screen..... 316 Stainless Steel



PRODUCTS IN PLASTIC FITTINGS

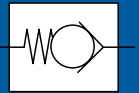
GAS ORIFICE - LEE IMH HIGH LOHM SCREENED ORIFICE IN 1/8" BARB TO 3/32" BARB UNION



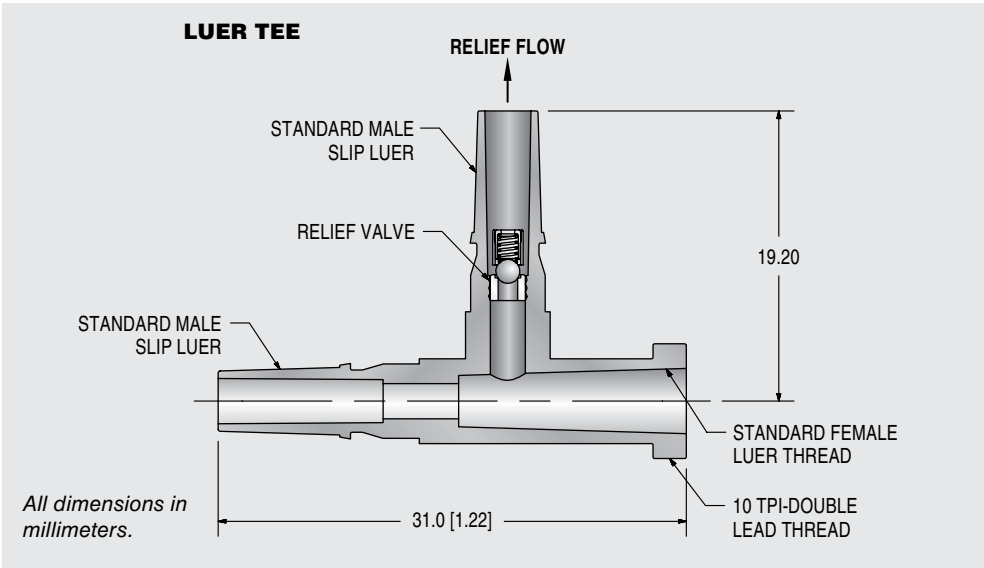
LEE PART NUMBER	LOHM RATE
RHGV1530060S	60,000
RHGV1530075S	75,000
RHGV1530100S	100,000
RHGV1530250S	250,000
RHGV1530500S	500,000
RHGV1530750S	750,000
RHGV1531000S	1,000,000
RHGV1532000S	2,000,000
RHGV1533000S	3,000,000
RHGV1534000S	4,000,000
RHGV1535000S	5,000,000

PERFORMANCE
Metered Flow
Lohm Rate Tolerance: ± 5%
Screen Size: 4 Micron
Test Fluid: Clean & Dry Nitrogen

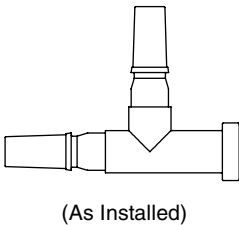
MATERIALS
Fitting..... Polypropylene - Blue
Orifice..... 303 Stainless Steel
Screen Body... 303 Stainless Steel
Screen..... 316 Stainless Steel



2.5mm RELIEF VALVE IN LUER TEE



ACTUAL SIZE



(As Installed)

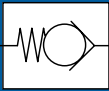
PERFORMANCE

Relief Valve Lohm Rate: 750 Lohms
Leakage: 1 Drop/min. (max.) on water
Cracking Pressure Tolerance: $\pm 15\%$

LEE PART NUMBER	CRACKING PRESSURE
CCPF0100100S	100 kPa (14.5 psid)
CCPF0100200S	200 kPa (29 psid)
CCPF0100300S	300 kPa (43.5 psid)

MATERIALS

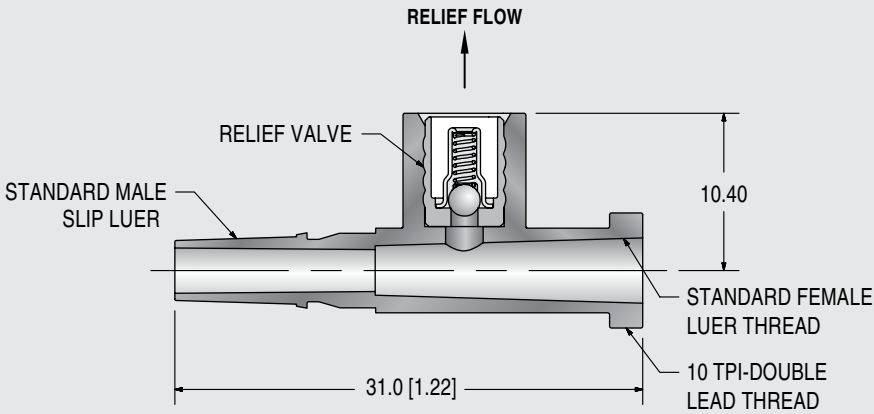
Fitting..... Polypropylene - Blue
Relief Valve
Body 303 Stainless Steel
Ball Stop 303 Stainless Steel
Spring 302 Stainless Steel
Ball 440C Stainless Steel



PRODUCTS IN PLASTIC FITTINGS

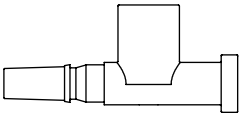
5.5mm RELIEF VALVE IN LUER TEE

LUER TEE



All dimensions in millimeters.

ACTUAL SIZE



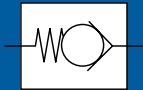
(As Installed)

PERFORMANCE

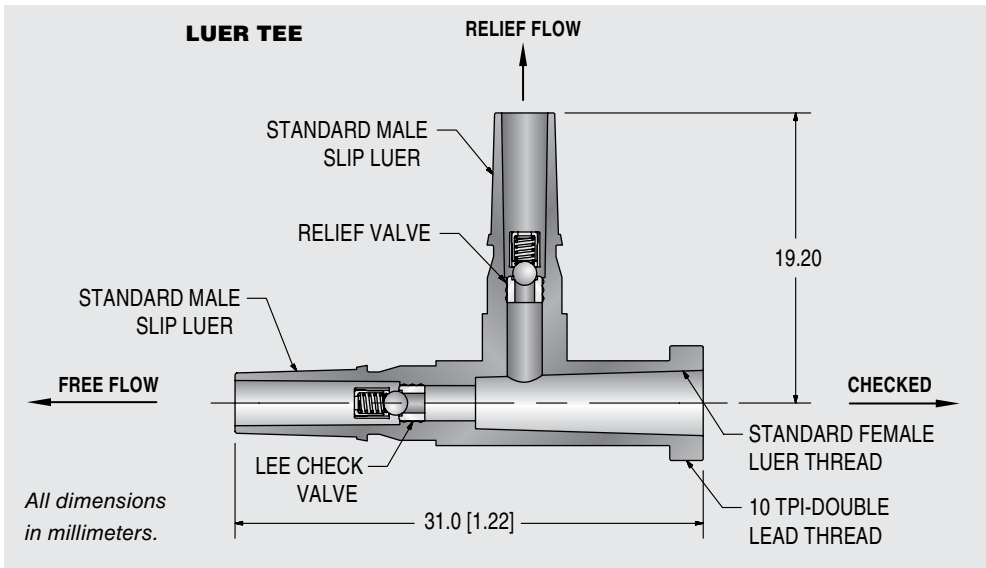
Relief Valve Lohm Rate: 250 Lohms
Leakage: 1 Drop/min. (max.) on water
Cracking Pressure Tolerance: $\pm 15\%$

LEE PART NUMBER	CRACKING PRESSURE
CCPF0300100S	100 kPa (14.5 psid)
CCPF0300200S	200 kPa (29 psid)
CCPF0300300S	300 kPa (43.5 psid)
CCPF0300400S	400 kPa (58 psid)
CCPF0300500S	500 kPa (72.5 psid)

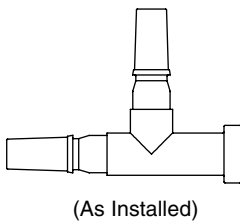
MATERIALS
Fitting.....Polypropylene - Blue
Relief Valve
Body303 Stainless Steel
Cage305 Stainless Steel
Spring302 Stainless Steel
Ball440C Stainless Steel



2.5mm RELIEF AND CHECK VALVE IN LUER TEE



ACTUAL SIZE



PERFORMANCE

- Relief Valve Lohm Rate: 750 Lohms
- Relief Valve Cracking Pressure
Tolerance: $\pm 15\%$
- Relief Valve Leakage: 1 Drop/min.
(max.) on water
- Check Valve Lohm Rate: 750 Lohms
- Check Valve Cracking Pressure:
 $4 \pm 3 \text{ kPa } (0.6 \pm 0.4 \text{ psid})$
- Check Valve Leakage: 1 Drop/min.
(max.) on water

LEE PART NUMBER	CRACKING PRESSURE
CCPF0200100S	100 kPa (14.5 psid)
CCPF0200200S	200 kPa (29 psid)
CCPF0200300S	300 kPa (43.5 psid)

MATERIALS

- Fitting..... Polypropylene - Blue
- Relief and Check Valve
- Body 303 Stainless Steel
- Ball Stop 303 Stainless Steel
- Spring 302 Stainless Steel
- Ball 440C Stainless Steel

The Engineering Reference Section of the IMH Handbook is a handy compilation of facts that every hydraulics engineer can use. It starts with a comprehensive discussion of Lohm Laws which make every hydraulic and pneumatic calculation easy. It includes formulas for comparing the effectiveness of different mesh size safety screens called ROB numbers, and finally, extensive reference material including standards, conversion factors, graphic symbols and definitions.

LOHM LAWS - DEFINITION

Every engineer will be interested in our simple system of defining the fluid resistance of Lee hydraulic components.

Just as the OHM is used in the electrical industry, we find that we can use a liquid OHM or "Lohm" to good advantage on all hydraulic computations.

When using the Lohm system, you can forget about coefficients of discharge and dimensional tolerances on drilled holes. These factors are automatically compensated for in the Lohm calculations, and confirmed by testing each component to establish flow tolerances. The resistance to flow of any fluid component can be expressed in Lohms.

The Lohm has been selected so that a 1 Lohm restriction will permit a flow of 100 gallons per minute of water with a pressure drop of 25 psi at a temperature of 80° F.

The graph on [page C3](#) relates Lohms to hole diameter in inches and millimeters.

LOHM SYSTEM SLIDE RULE

The Lee Company offers a specially designed Hydraulic and Pneumatic Flow Calculator to help in the transition to the Lohm System. This handy, free slide rule can be used to solve basic Lohm calculations.

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Hydraulic Fluids	C19 – C20
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Water Hammer	C22
Bulk Modulus	C23 – C27
Cavitation	C28
Gas Flow	C29 – C43
Momentum Forces –	
Gas Flow	C44
Transient Gas Flow	C45 – C46
Temperature Change in	
Gas Flow	C47 – C48
Pneumatic Power	C49 – C50
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ROB Number

Definition	C52 – C53
Table of Single Orifice	
ROB Numbers	C54 – C55

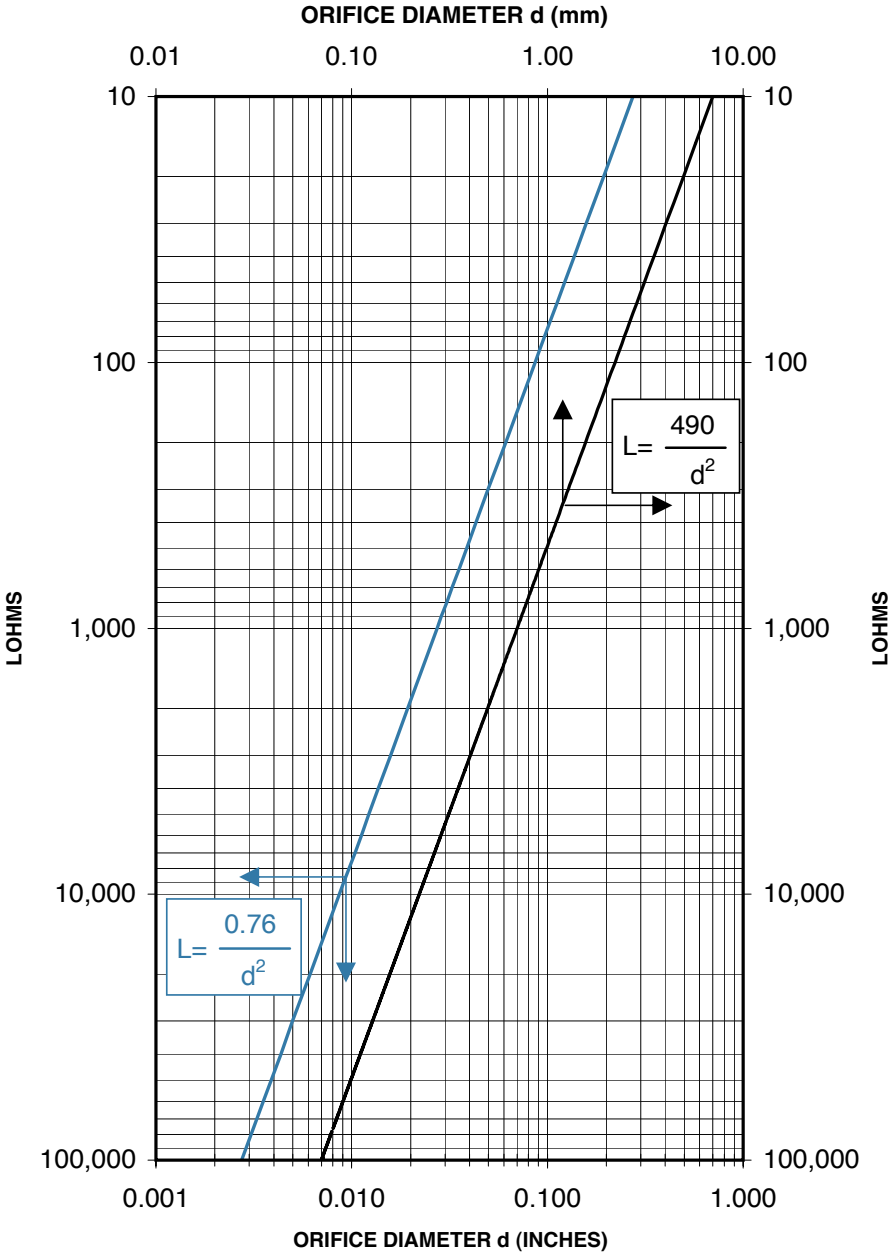
Contamination C56 – C59**Reference Information**

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Graphic Symbols	C69 – C72
Definitions of Viscosity	C73

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LOHM RATE VERSUS ORIFICE DIAMETER



LOHM LAWS

LIQUID FLOW

The Lohm has been selected so that a 1 Lohm restriction will permit a flow of 100 gallons per minute of water with a pressure drop of 25 psi at a temperature of 80°F.

- I = Flow rate (gallons per minute).
 H = Differential pressure (psi).
 L = Lohms, a measure of resistance to liquid flow.
 It includes all density, viscosity, Reynolds number, coefficient of discharge & area units.

$$L = 20 \frac{\sqrt{H}}{I} \quad I = 20 \frac{\sqrt{H}}{L}$$

$$H = \frac{I^2 \times L^2}{400}$$

When testing on water at 25 psi ΔP , $\sqrt{H} = 5$ and the above formulas simplify as follows:

$$L = \frac{100}{I} \quad \text{and} \quad I = \frac{100}{L}$$

Some useful relationships:

- 1000 Lohms will permit a flow of 50 lb/hr water at 25 psi ΔP .

- Flow Coefficient, $C_v = \frac{20}{L}$

- $L = \frac{0.76}{d^2} \quad L = \frac{0.527}{C_d A}$

d = Orifice diameter (inches)

C_d = Coefficient of discharge

A = Orifice area (inches)²

- For metric units $L = \frac{490}{d^2}$

where d = orifice diameter in millimeters

LIQUID FLOW - EXAMPLES

Problem 1. What restriction will permit a flow of 1 gallon of water per hour at 50 psi ΔP ?

$$I = 1/60 = 0.0167 \text{ GPM}$$

$$L = \frac{20 \sqrt{H}}{I} = \frac{20 \sqrt{50}}{0.0167} = 8500 \text{ Lohms}$$

Problem 2. An orifice with a hole diameter of .012" flows 18 lb/hr of water at 100 psi ΔP . How many Lohms?

$$I = \frac{18}{60 \times 8.345} = 0.036 \text{ GPM}$$

$$L = \frac{20 \sqrt{H}}{I} = \frac{20 \sqrt{100}}{0.036} = \frac{200}{0.036} = 5500 \text{ Lohms}$$

Problem 3. What ΔP will be required to flow 20 GPH of water through a 2000 Lohm orifice?

$$I = \frac{20}{60} = 0.333 \text{ GPM}$$

$$H = \frac{I^2 \times L^2}{400} = \frac{0.333^2 \times 2000^2}{400} = \frac{0.111 \times 4,000,000}{400} = 1110 \text{ psi } \Delta P$$

Problem 4. What water flow will result from a restriction of 500 Lohms and a ΔP of 500 psi?

$$I = \frac{20 \sqrt{H}}{L} = \frac{20 \sqrt{500}}{500} = 0.894 \text{ GPM}$$

NOTE: For special flow requirements, The Lee Company can determine the required Lohm rating.

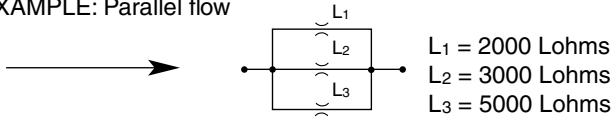
LIQUID FLOW - TWO FORMULAS FOR COMBINATIONS OF RESTRICTORS

PARALLEL FLOW, the total Lohm rating is:

$$\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \dots + \frac{1}{L_N}$$

Please note that this relationship is identical to the electrical equation.

EXAMPLE: Parallel flow



$$\frac{1}{L_T} = \frac{1}{2000} + \frac{1}{3000} + \frac{1}{5000} = 0.00103 \text{ and therefore } L_T = 970 \text{ Lohms}$$

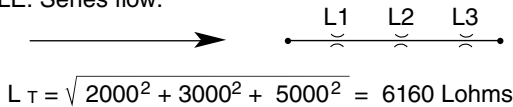
SERIES FLOW, the total Lohm rating is:

$$L_T = \sqrt{L_1^2 + L_2^2 + L_3^2 + \dots + L_N^2}$$

Please note that this relationship is not the same as in electrical problems. The difference is due to the non-linearity of

$$H = \frac{I^2 L^2}{400}$$

EXAMPLE: Series flow:



$$L_T = \sqrt{2000^2 + 3000^2 + 5000^2} = 6160 \text{ Lohms}$$

When $L_1 = L_2 = L_3$, then $L_T = L\sqrt{N}$

N = Number of equal restrictors in series

For passageway size: $D_T = D/N^{1/4}$

D_T = Diameter of a single equivalent orifice, with a Lohm rate = L_T

D = Diameter of the actual orifices, each with a Lohm rate = L_1

LIQUID FLOW - SERIES FLOW

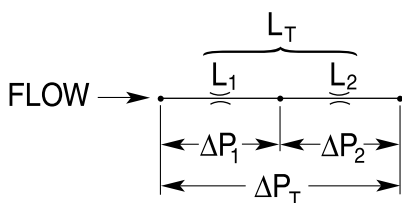
One of the reasons for using two restrictors in series is to allow fine tuning of a total resistance value. If L_1 is known and is more than 90% of L_T , then L_2 may vary by $\pm 5\%$ without altering the value of L_T by more than $\pm 1\%$, even though the value of L_2 may be as high as 40% of L_T . This effect becomes even more pronounced as L_1 approaches L_T .

To determine the intermediate pressure between two resistances in series, the following formulas may be used.

$$\Delta P_1 = \frac{P_T}{1 + (L_2/L_1)^2}$$

$$\Delta P_2 = \frac{P_T}{1 + (L_1/L_2)^2}$$

$$\left(\frac{L_1}{L_2} \right)^2 = \frac{P_1}{P_2}$$



LIQUID FLOW - FLOW FORMULA

The following formulas are presented to extend the use of the Lohm laws to many different liquids, operating over a wide range of pressure conditions.

NOMENCLATURE

- L = Lohms
- H = Differential pressure
- I = Liquid flow rate: Volumetric
- S = Specific gravity* (see pages C15 – C16)
- V = Viscosity compensation factor** (see page C12)
- w = Liquid flow rate: Gravimetric
- K = Units Constant – Liquid (see page C9)

*S = 1.0 for water at 80°F.

**V = 1.0 for water at 80°F.

LIQUID FLOW

These formulas introduce compensation factors for liquid density and viscosity. They are applicable to any liquid of known properties, with minimum restrictions on pressure levels or temperature.

The units constant (K) eliminates the need to convert pressure and flow parameters to special units.

Volumetric Flow Units

$$L = \frac{KV}{I} \sqrt{\frac{H}{S}}$$

Gravimetric Flow Units

$$L = \frac{KV}{w} \sqrt{HS}$$

LIQUID FLOW - UNITS CONSTANT K

Volumetric Flow Units

$$L = \frac{KV}{I} \sqrt{\frac{H}{S}}$$

VOLUMETRIC FLOW UNITS			
Flow Units	Pressure Units		
	psi	bar	kPa
GPM	20	76.2	7.62
L/min	75.7	288	28.8
ml/min	75 700	288 000	28 800
in ³ /min	4 620	17 600	1 760

Gravimetric Flow Units

$$L = \frac{KV}{w} \sqrt{HS}$$

GRAVIMETRIC FLOW UNITS			
Flow Units	Pressure Units		
	psi	bar	kPa
PPH	10 000	38 100	3 810
gm/min	75 700	288 000	28 800

LIQUID FLOW CALCULATIONS - EXAMPLES

Problem 1. An orifice is required to flow 0.15 GPM of MIL-H-83282 hydraulic fluid at 80°F and 100 psi ΔP. What restriction is required?

Solution:

1. Read specific gravity; $S = 0.84$ from chart on [page C15](#).
2. Read viscosity; $\nu = 21\text{cs}$. From chart on [page C13](#).
3. Use viscosity and ΔP to determine viscosity compensation factor $V = 0.95$ from graph on [page C12](#).
4. Select units constant, $K = 20$ from table on [page C9](#).

$$L = \frac{KV}{I} \sqrt{\frac{H}{S}} = \frac{20 (0.95)}{0.15} \sqrt{\frac{100}{0.84}} = 1380 \text{ Lohms}$$

Problem 2. What pressure drop will result from a flow of 5 PPH of SAE #10 lubricating oil at 20°F, flowing through a 1000 Lohm orifice?

Solution:

1. Read specific gravity and viscosity.
 $S = 0.90$, $\nu = 600\text{cs}$.
2. Use knowledge of system to assume solution.
 $H = 50 \text{ psid}$.
3. Use assumed ΔP to determine $V = 0.18$
4. Select units constant, $K = 10,000$ from table on [page C9](#).
5. Compute trial ΔP.

$$H = \frac{w^2 L^2}{S K^2 V^2} = \frac{5^2 (1000)^2}{0.90 (10,000)^2 0.18^2} = 8.6 \text{ psid}$$

6. Make trials as required to find correct solution.
 $H = 26 \text{ psid}$.

LIQUID FLOW - EXAMPLES

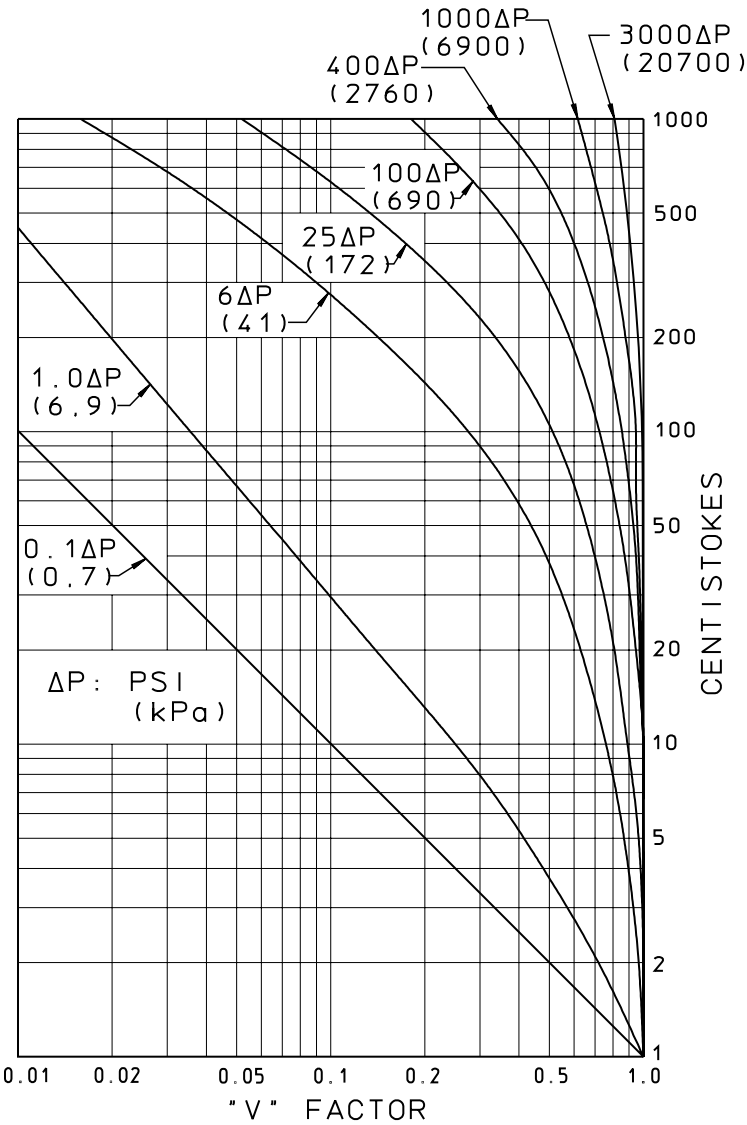
Problem 3. A Safety Screen is required to flow 775 lb/hr of diesel fuel @ 80°F with a maximum pressure drop of 5 psid. What is the maximum Lohm rate allowed for the Safety Screen?

Solution:

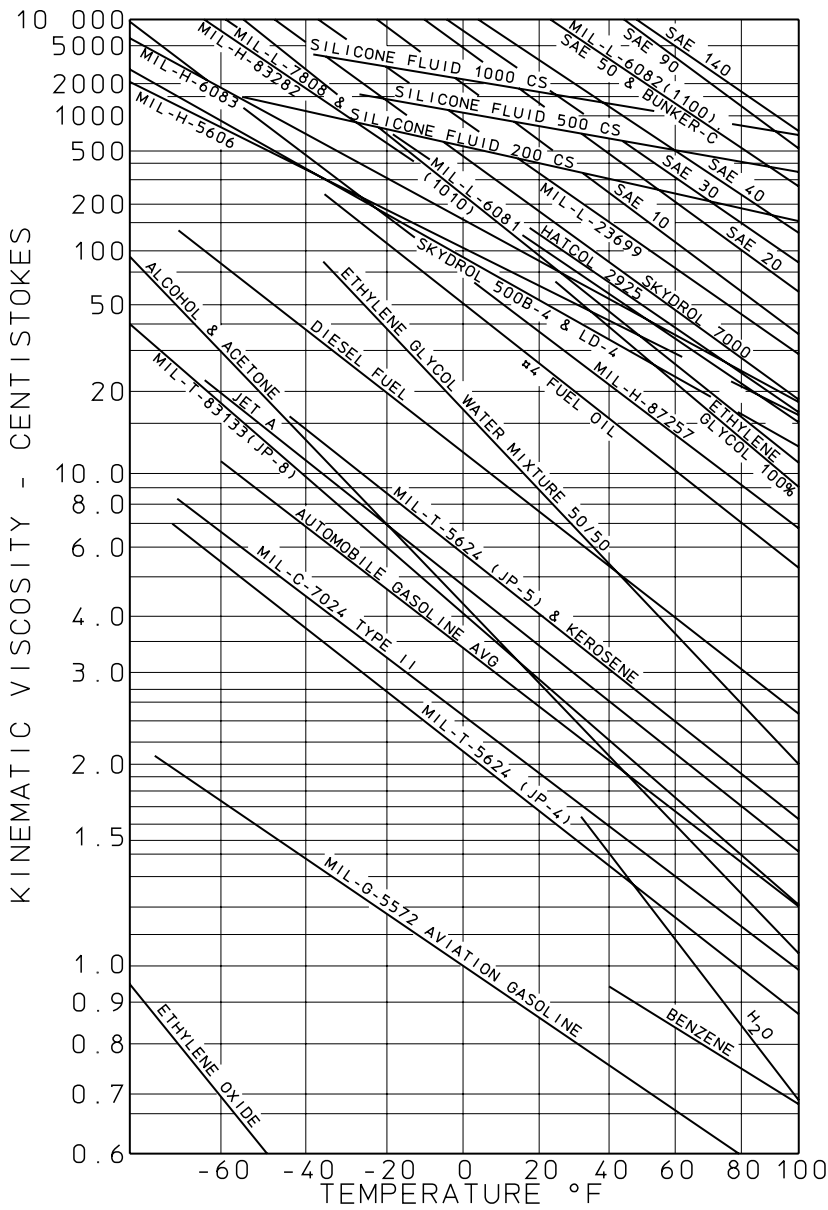
1. Find specific gravity; $S = 0.87$ from curve on page C15.
2. Find viscosity; $\nu = 3.1\text{cs}$ from curve on page C13.
3. Use ν and ΔP to determine viscosity compensation factor, $V = 0.87$ from curve on page C12.
4. Select units constant, $K = 10,000$ from table on page C9.

$$L = \frac{KV}{w} \sqrt{HS} = \frac{10000(0.87)}{775} \sqrt{5(0.87)} = 23 \text{ Lohms Maximum}$$

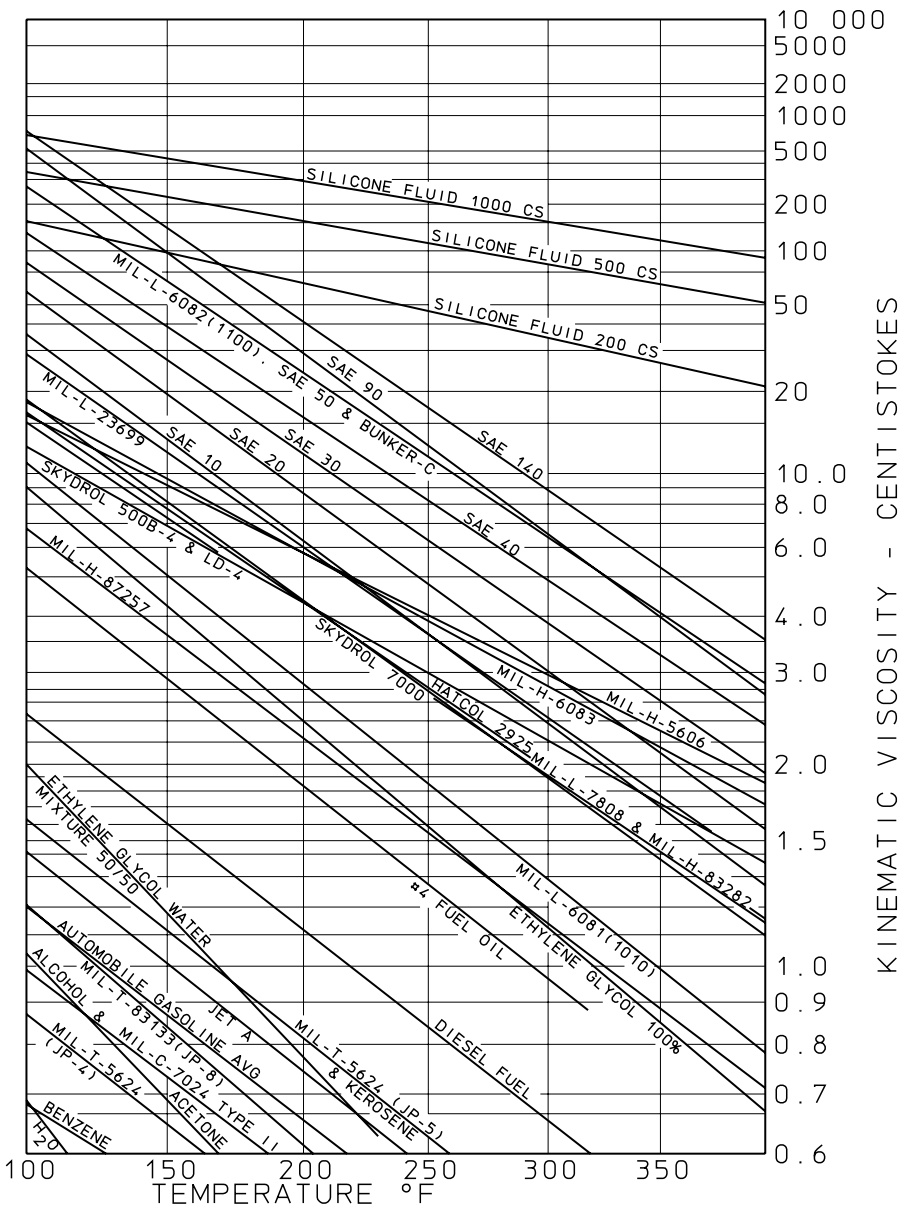
**VISCOSITY COMPENSATION FACTOR
FOR SINGLE ORIFICE**



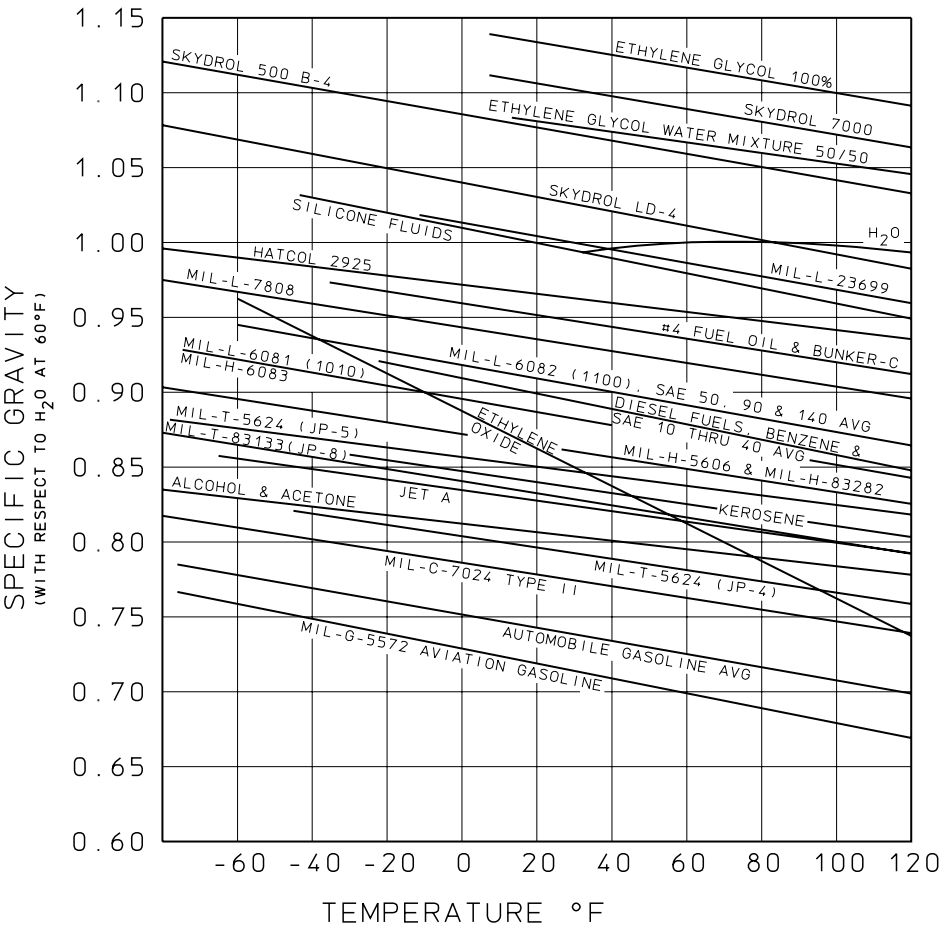
VISCOSITIES OF
TYPICAL FLUIDS vs TEMPERATURE



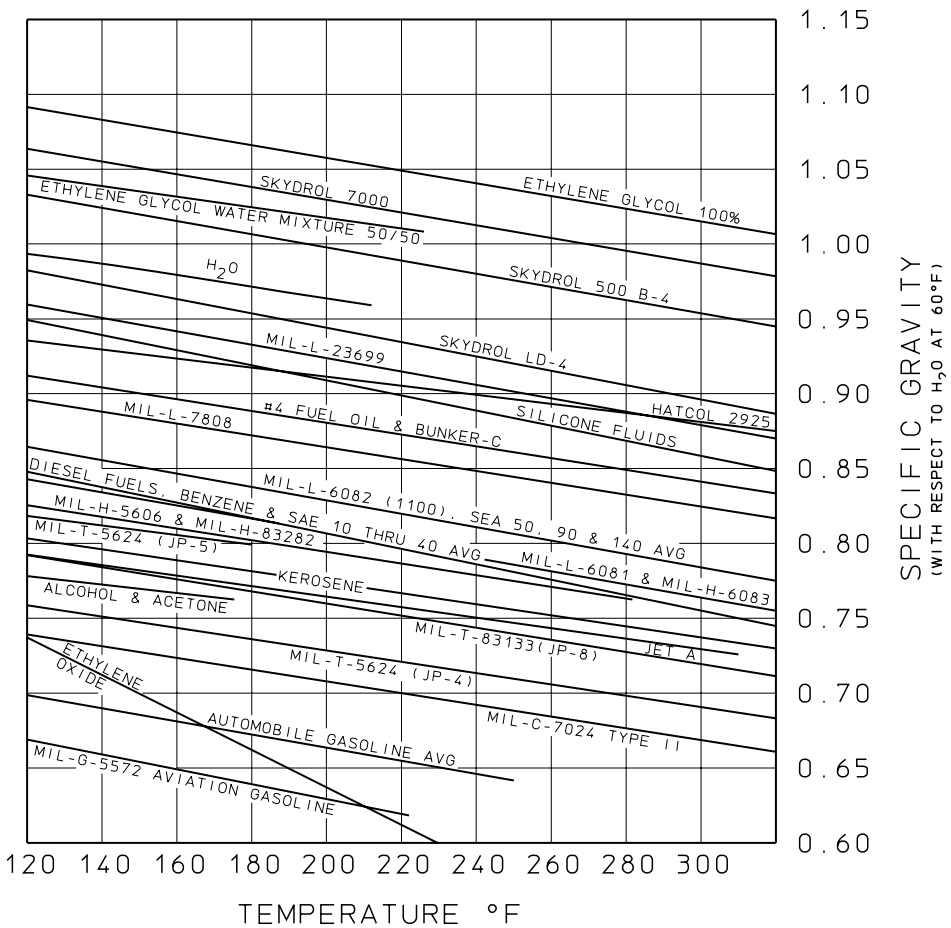
VISCOSITIES OF
TYPICAL FLUIDS vs TEMPERATURE



SPECIFIC GRAVITY OF
TYPICAL FLUIDS vs TEMPERATURE



SPECIFIC GRAVITY OF TYPICAL FLUIDS vs TEMPERATURE



HYDRAULIC POWER

Whenever there is flow through an orifice, there is a power consumption (or loss) which is a function of the pressure drop and the flow rate. The following data is useful in calculating the hydraulic power requirements of a system.

$$\text{H.P.} = \frac{H \times I}{1714} \quad \begin{array}{l} \text{When } H = \text{psi } \Delta P \\ I = \text{GPM flow rate} \end{array}$$

The hydraulic power can also be expressed in another convenient form.

$$\text{H.P.} = \frac{0.0117 H^{3/2}}{L} \quad \text{or} \quad \frac{0.0117 H \sqrt{H}}{L}$$

Since 1 H.P. = 746 watts, the above formula can be:

$$\text{Watts} = \frac{8.70 H^{3/2}}{L} \quad \text{or} \quad \frac{8.70 H \sqrt{H}}{L}$$

The nomogram on the opposite page shows this relationship.

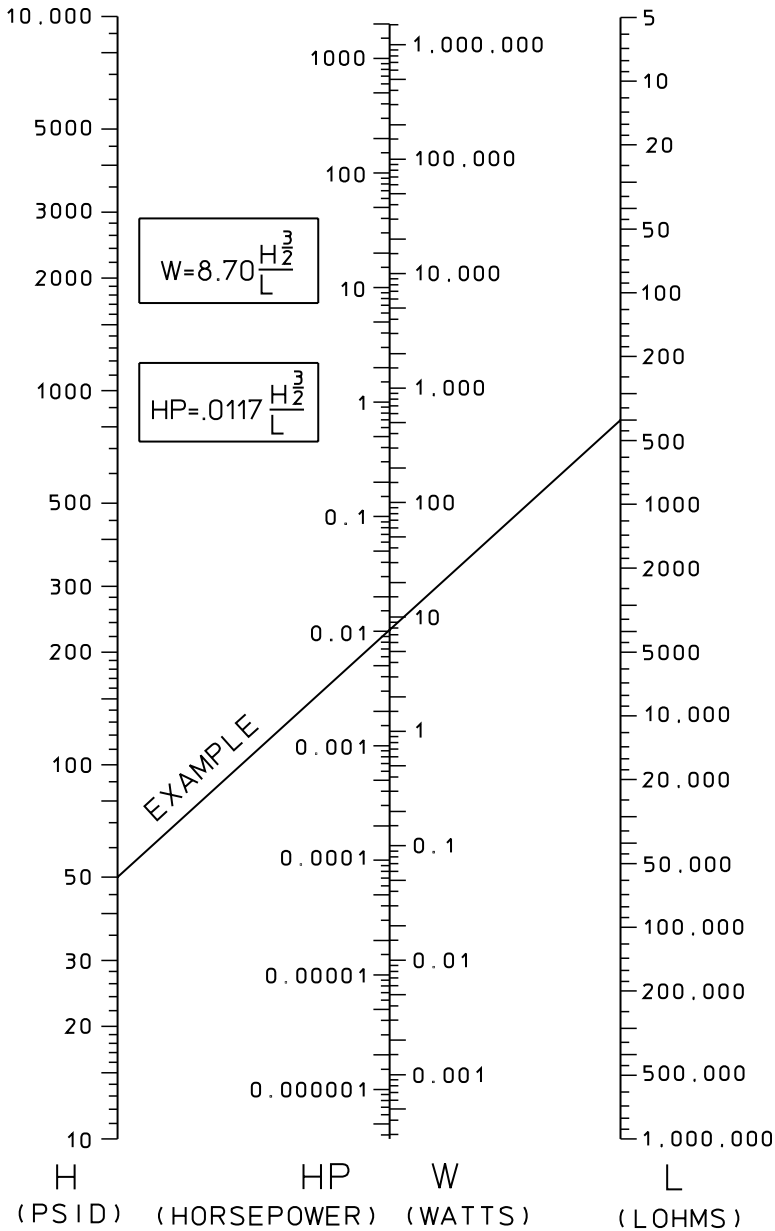
EXAMPLE:

A Lee IMH Chek Valve with 400 Lohms will flow 0.35 GPM at 50 psid. At those conditions, what horsepower is lost?

$$\text{H.P.} = \frac{H \times I}{1714} = \frac{50 \times 0.35}{1714}$$

$$\text{H.P.} = 0.010$$

NOMOGRAM FOR HYDRAULIC POWER



TEMPERATURE RISE IN HYDRAULIC FLUIDS

Hydraulic fluid heats when flowing through a restriction as the pressure energy upstream of the restriction is converted into thermal energy.

$$\Delta T = \frac{0.003 (\Delta P)}{(S) (c)}$$

FLUID	c~BTU/ lb./ °F*
Water	1.00
JP-4	0.50
MIL-H-5606	0.47
MIL-H-83282	0.50
Skydrol 500 B-4	0.39
Silicone 100cs	0.35
Gasoline	0.50

ΔT = Temp. rise in °F

ΔP = Pressure drop
in psi

S = Specific gravity

c = Specific heat

*Specific Heat at 100°F.

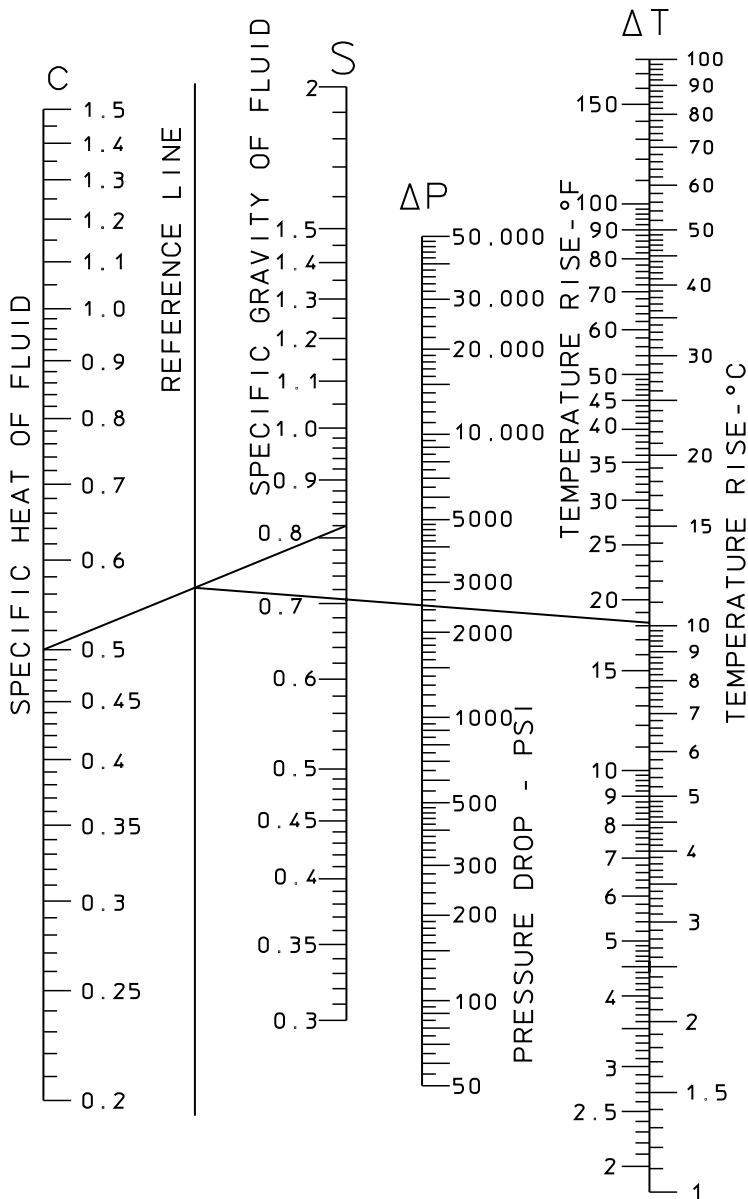
EXAMPLE:

If a Lee orifice is flowing MIL-H-83282 at 120°F and 2500 psid, the temperature rise across the Lee orifice is computed as follows:

For MIL-H-83282 at 120°F, S = 0.82, c = 0.50

$$\Delta T = \frac{(0.003) (2500)}{(0.82) (0.50)} = 18.3^{\circ}\text{F}$$

TEMPERATURE RISE IN HYDRAULIC FLUIDS



1. Connect **c** to **S**
2. From point on reference line, connect **P** and extend to **T**.

MOMENTUM FORCES

The momentum Lohm Laws give the designer simple formulas to determine the forces caused by changes in velocity (either speed or direction) of a liquid.

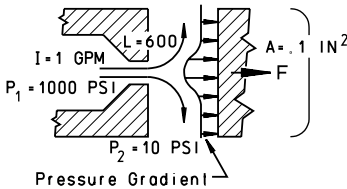
$$F = \frac{SI^2L}{400} \qquad F = \frac{H}{L} \qquad F = \frac{I\sqrt{HS}}{20}$$

F = Force in lbs. H = psid I = GPM S = Spec. gravity

These forces are produced by locally high (or low) pressure gradients, and should be added to the forces produced by the static pressure. It is often useful to sketch these pressure gradients to determine the direction of the momentum forces.

EXAMPLE: Where a liquid changes direction.

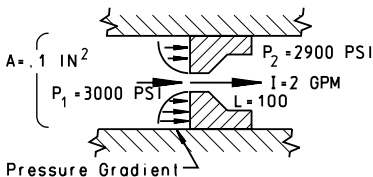
$$F_{\text{momentum}} = \frac{H}{L} = \frac{990}{600} = 1.7 \text{ lbf}$$



The momentum force of 1.6 lbs. in this example must be added to the force produced by static pressure on the plate (of .1 in.² x 10 psi = 1 lb.) to give the total force on the plate.

EXAMPLE: Where a liquid changes speed.

$$F_{\text{momentum}} = \frac{SI^2L}{400} = \frac{1 \times 2^2 \times 100}{400} = 1 \text{ lbf}$$



The momentum force of 1lb. in this example must be subtracted from the force produced by static pressure on the plate (of 0.1 x [3000-2900] = 10 lb.) to give the total force on the piston.

WATER HAMMER

A brief pressure spike, commonly called water hammer, occurs when a high velocity fluid is suddenly stopped. It is often brought on by the fast closing of a valve somewhere in the system. The hydraulic system designer can approximate the magnitude of the pressure spike with the following formula that assumes a “hard” system with non-compliant fluid passages, and will, therefore, yield a worst case value for the peak pressure.

$$\Delta P = \frac{I}{20D^2} \sqrt{S \times B}$$

ΔP = Pressure rise caused by water hammer effects (psi)

I = Flow rate (GPM)

S = Specific gravity, [see pages C15 – C16](#).

B = Bulk modulus (psi)

D = Inside diameter of fluid passageway upstream of the Lee component (in.)

EXAMPLE: An IMH component is flowing 1 GPM of MIL-H-83282 at 80°F with 4000 psi upstream and 3500 psi downstream. The component is being fed through a 0.15 in. dia. passage upstream. If a valve is suddenly shut downstream of the component, the pressure spike will be:

$$\Delta P = \frac{1}{20 (0.15)^2} \sqrt{0.84 (300,000)} = 1,100 \text{ psi}$$

The maximum upstream pressure would then be:

(4000 psi steady state) + (1100 psi spike) = 5100 psi total

BULK MODULUS

Bulk Modulus is a measure of the resistance of a fluid to compression. It is defined as the ratio of pressure stress to volumetric strain. The value of bulk modulus equals the pressure change x 100 required to cause a one percent change in volume.

$$B = - \frac{\Delta P}{\Delta V} \times V$$

EXAMPLE:

MIL-H-83282 oil has a bulk modulus of 3.0×10^5 psi. Thus, a pressure increase of 3000 psi will reduce its volume by 1.0%.

When the value of B is known (see reference table on next page), it is easy to calculate the effect of any pressure change on volume, or of any volume change on pressure.

$$\Delta V = - \frac{V}{B} \times \Delta P \quad \text{or} \quad \Delta P = - \frac{B}{V} \times \Delta V$$

COEFFICIENT OF THERMAL EXPANSION

The Coefficient of Cubical Thermal Expansion is the change in volume per unit volume caused by a change in temperature of 1°F.

$$\Delta V = V \times \gamma \times \Delta T$$

EXAMPLE:

MIL-H-83282 oil has a coefficient of cubical thermal expansion of 0.00046/°F. Thus a temperature rise of 100°F will increase its volume by 4.6%.

The bulk modulus and the coefficient of cubical thermal expansion can be used together to compute the pressure rise in a closed system subjected to an increasing temperature.

$$\text{Pressure Rise: } \Delta P = B \times \gamma \times \Delta T$$

BULK MODULUS

EXAMPLE:

MIL-H-83282 oil at 0 psi is heated from 70°F to 120°F in a closed, constant volume system containing 100 cu. in.

$$\Delta P = 3.0 \times 10^5 \times 0.00046 \times 50 = 6900 \text{ psi}$$

This is the same ΔP which would be caused by adding 2.3 cubic inches of oil with no temperature change. It is also apparent that a constant system pressure could be maintained by bleeding off 2.3 cubic inches of oil while increasing the temperature by 50°F.

REFERENCE TABLE

FLUID	B _{ref.}	γ	FLASH POINT*	POUR POINT
Units	psi	$\Delta V/V/^\circ F$	$^\circ F$, min.	$^\circ F$, max.
Gasoline	150 000	0.00072	-50°	-75°
JP-4	200 000	0.00057	0°	-76°
MIL-H-5606	260 000	0.00046	200°	-75°
MIL-H-83282	300 000	0.00046	400°	-65°
MIL-H-6083	260 000	0.00044	200°	-75°
SKYDROL 500B-4	340 000	0.00047	340°	-80°
Silicone 100cs	150 000	0.00054	575°	-65°
Water	310 000	0.00021	—	+32°

B_{ref.} = Tangent adiabatic bulk modulus psi stated at 100°F, 2500 psi and no entrained air. A reference point.

γ = Coefficient of cubical thermal expansion/ $^\circ F$ at 100°F

ΔP = Pressure rise, psi

ΔT = Temperature rise, $^\circ F$

P₁, P₂ = Initial and final pressures, psi

**Flash point is the lowest temperature at which sufficient combustible vapor is driven off a fuel to flash when ignited in the presence of air.*

BULK MODULUS (ACTUAL)

The previous examples used a constant bulk modulus for simplicity. In actual use, the bulk modulus is affected by the working pressure, temperature and percent of entrained air. Use the next 3 graphs to find the effect of these variables, and you will get a close approximation of actual conditions. The actual bulk modulus, B , of a fluid is the value in the table on [page C24](#) as B_{ref} , modified for the effect of pressure, temperature and percent of entrained air.

The actual bulk modulus $B = E_P \times E_T \times E_A \times B_{ref}$.

EXAMPLE:

500 psi, 60°F, 2% entrained air, MIL-H-83282.

Actual $B = 0.91 \times 1.10 \times 0.8 \times 300,000 = 240,000$ psi

EXAMPLE:

2000 psi, 160°F, 2% entrained air, MIL-H-83282.

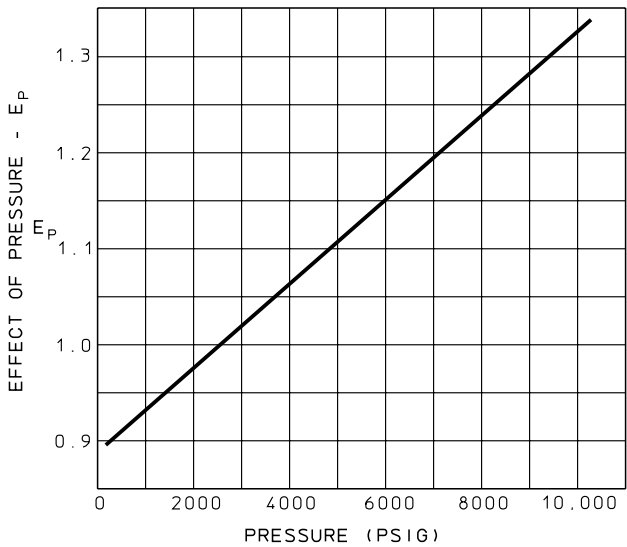
Actual $B = 0.98 \times 0.86 \times 0.98 \times 300,000 = 248,000$ psi

With the corrected bulk moduli for the two end points of a thermal problem, an average bulk modulus can be selected for calculation purposes. We would use 244,000 psi for B .

BULK MODULUS

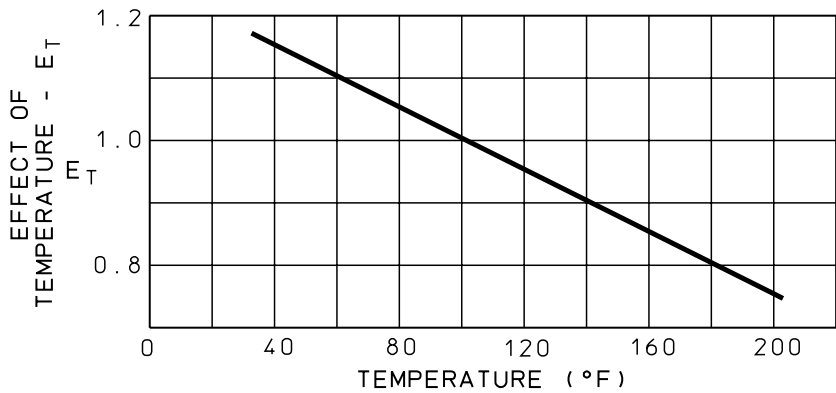
WORKING PRESSURE

The effect of working pressure on bulk modulus for hydrocarbon fluids.



TEMPERATURE

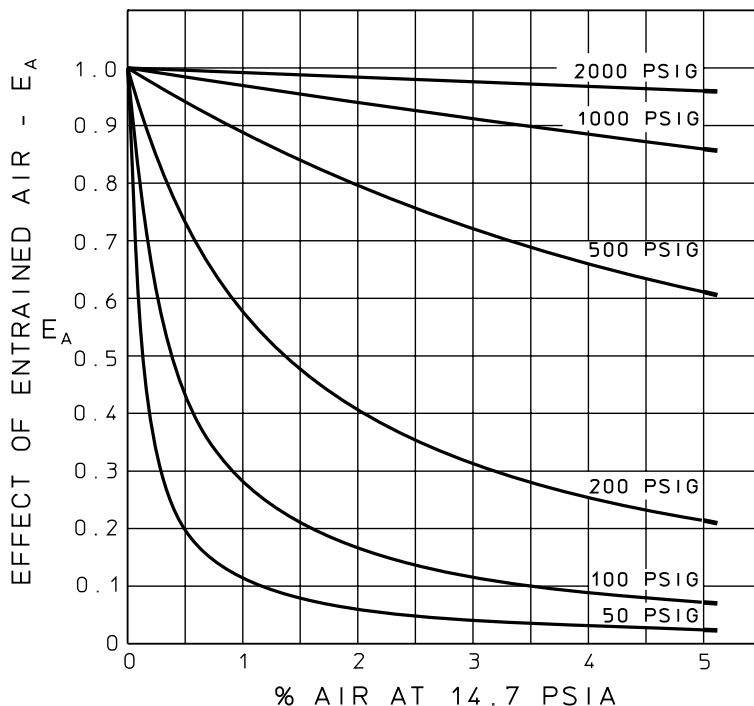
The effect of temperature on bulk modulus for hydrocarbon fluids.



BULK MODULUS

ENTRAINED AIR

The effect of entrained air on bulk modulus in hydrocarbon and other fluids for different working pressures.



To simplify the calculations of thermal problems with entrained air, these curves show the *average* effect on a 230,000 psi bulk modulus for pressure points fairly close together. If a wide change in pressure is encountered in a problem, it would be more accurate to break the changes down into two or more steps, depending on the accuracy desired.

An accurate one step formula for this relationship follows:

(Note that pressure is in units of psia.)

$$E_A = \frac{1}{\frac{0.147 B_{ref.}}{P_1 \times P_2} \times \% \text{ air} + 1}$$

CAVITATION

Liquid flowing through any orifice will cavitate whenever its velocity causes the pressure in the throat of the orifice to drop below the vapor pressure of the flowing liquid. Even though there may be a high supply pressure and a high back pressure on the orifice, if the velocity is high enough there will be a subsequent lowering of the pressure in the throat of the orifice and the possibility of cavitation.

The effects of cavitation are choked flow and erosion – both of which are undesirable. To prevent cavitation, the throat pressure must be maintained, either by:

1. Applying sufficiently high back pressure, or
2. Reducing the velocity of the liquid as it flows through a restrictor.

GAS FLOW

The Lohm Laws extend the definition of Lohms for gas flow at any pressure and temperature, and with any gas. The formulas work well for all gases because they are corrected for the specific gas, and for the flow region and incompressibility of low pressure gases.

A 100 Lohm restriction will permit a flow of 250 standard liters per minute of nitrogen at a temperature of 59°F, and an upstream pressure of 90 psia discharging to atmosphere.

$$L = \frac{K f_T P_1}{Q} \quad \begin{array}{l} \text{(Sonic region)} \\ \text{i.e. } P_1/P_2 \geq 1.9 \end{array}$$

$$L = \frac{2 K f_T \sqrt{\Delta P P_2}}{Q} \quad \begin{array}{l} \text{(Subsonic region)} \\ \text{i.e. } P_1/P_2 < 1.9 \end{array}$$

NOMENCLATURE

L = Lohms

K = Units Constant – Gas (see page C31)

f_T = Temperature correction factor (see page C30)

P_1 = Upstream absolute pressure

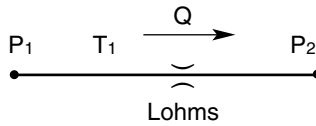
P_2 = Downstream absolute pressure

Q = Gas flow rate

$\Delta P = P_1 - P_2$

1. Compute the P_1/P_2 pressure ratio.
2. Select the correct formula for the flow region.
3. Look up the value of “K” for the gas.
4. Determine the temperature correction factor, “ f_T ”.
5. Use the formula to solve for the unknown.

GAS FLOW



EXAMPLE: What restriction will permit a flow of 1.00 std L/min. of nitrogen at 90°F, with supply pressure at 5 psig, discharging to atmosphere?

$$K = 276 \text{ (see page C31)}$$

$$T_1 = 90^\circ\text{F}, f_T = 0.98 \text{ (see below)}$$

$$P_1 = 5.0 + 14.7 = 19.7 \text{ psia}, P_2 = 14.7 \text{ psia}$$

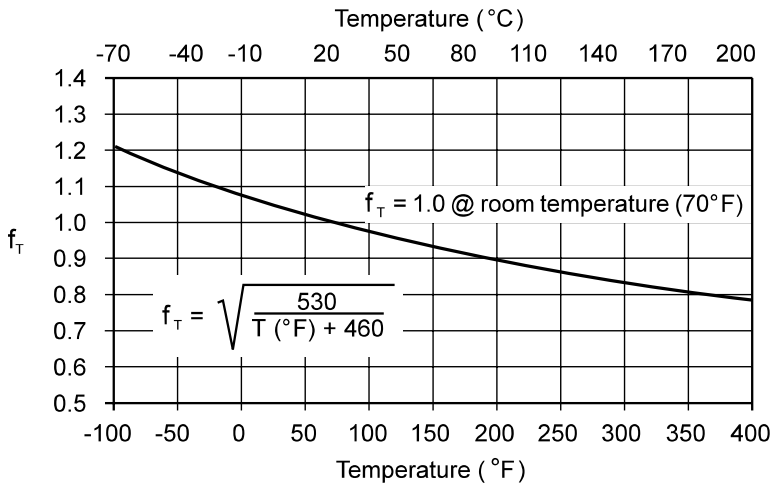
$$P_1/P_2 = 19.7/14.7 = 1.34 \text{ (subsonic)}$$

$$\Delta P = 5.0 \text{ psid}$$

$$Q = 1.00 \text{ std L/min.}$$

$$L = \frac{2 (276) 0.98 \sqrt{5.0 (14.7)}}{1.00} = 4640 \text{ Lohms}$$

TEMPERATURE CORRECTION FACTOR f_T



GAS FLOW - UNITS CONSTANT "K"

To eliminate the need to convert pressure and flow parameters into specific units such as "psia" and "std L/min.," the table below lists values of the Units Constant "K," which is used in the Gas Flow Lohm Formulas:

$$\text{Lohms} = \frac{K \text{ } f_T P_1}{Q} \quad (\text{Sonic: } P_1 / P_2 \geq 1.9)$$

$$\text{Lohms} = \frac{2 K \text{ } f_T \sqrt{\Delta P P_2}}{Q} \quad (\text{Subsonic: } P_1 / P_2 < 1.9)$$

VOLUMETRIC FLOW UNITS							
Abs. Pres	psia			bar		kPa	mm. Hg
Flow	SLPM	SCFM	in ³ /min	SLPM	SCFM	SLPM	mL/min
H ₂	1030	36.3	62 700	14 900	526	149	19 900
He	771	27.2	47 100	11 200	395	112	14 900
Neon	343	12.1	20 900	4 980	176	49.8	6 640
Nat. Gas	319	11.3	19 400	4 620	163	46.2	6 160
N ₂	276	9.73	16 800	4 000	141	40.0	5 330
CO	274	9.69	16 700	3 980	141	39.8	5 300
Air	271	9.56	16 500	3 930	139	39.3	5 230
Ethane	251	8.86	15 300	3 640	129	36.4	4 850
O ₂	257	9.08	15 700	3 730	132	37.3	4 970
Argon	245	8.65	14 900	3 550	125	35.5	4 730
CO ₂	213	7.52	13 000	3 090	109	30.9	4 110
N ₂ O	214	7.56	13 100	3 100	110	31.0	4 140
SO ₂	176	6.21	10 700	2 550	90.1	25.5	3 400
Freon-12	123	4.34	7 510	1 780	63.0	17.8	2 380

GAS FLOW - UNITS CONSTANT “K”

$$\text{Lohms} = \frac{K \text{ ft } P_1}{Q} \quad (\text{Sonic})$$

$$\text{Lohms} = \frac{2 K \text{ ft } \sqrt{\Delta P} P_2}{Q} \quad (\text{Subsonic})$$

GRAVIMETRIC FLOW UNITS							
Abs. Pres	psia			bar		kPa	mm.Hg
Flow	PPH	lb _m /s	kg/min	PPH	kg/min	kg/min	gm/min
H ₂	11.6	0.00322	0.0876	168	1.27	0.0127	1.69
He	17.3	0.00479	0.131	250	1.89	0.0189	2.52
Neon	38.7	0.0108	0.293	561	4.25	0.0425	5.66
Nat. Gas	34.8	0.00966	0.263	505	3.82	0.0382	5.09
N ₂	43.2	0.0120	0.326	626	4.73	0.0473	6.31
CO	43.0	0.0119	0.325	623	4.71	0.0471	6.28
Air	43.8	0.0122	0.331	636	4.81	0.0481	6.41
Ethane	42.2	0.0117	0.319	611	4.62	0.0462	6.16
O ₂	46.0	0.0128	0.348	667	5.04	0.0504	6.72
Argon	54.6	0.0152	0.413	792	5.99	0.0599	7.99
CO ₂	52.4	0.0145	0.396	759	5.74	0.0574	7.65
N ₂ O	52.7	0.0146	0.398	764	5.77	0.0577	7.70
SO ₂	63.0	0.0175	0.476	914	6.91	0.0691	9.21
Freon-12	83.2	0.0231	0.629	1210	9.12	0.0912	12.2

GAS FLOW CHARACTERISTICS

When selecting components for use in a gas system, certain factors must be considered which arise only because of the compressibility of the gaseous medium. The nature of gas compressibility is defined by the following two rules.

Boyle's Law – The pressure and specific volume of a gas are inversely proportional to each other under conditions of constant temperature.

Charles' Law – The pressure and temperature of a gas are directly proportional to each other when the volume is held constant, and the volume and temperature are directly proportional when the pressure is held constant.

Thus, a gas will expand to fill any container, and pressure and temperature will adjust to values consistent with the above rules. Gas flowing through valves and restrictors will be subject to an increasing specific volume as pressure drops take place, and temperatures will change as determined by the Joule-Thompson effect.

The combination of the above rules forms the basis for the “Equation of State” for perfect gases. This allows either pressure, temperature, or volume to be calculated for a known quantity of gas when the other two variables are known.

i.e. $pV = mRT$ (See page C51 for values of the Gas Constant, R)

In general, the following comments apply to gas flow.

1. Gas flow at high pressure ratios ($P_1/P_2 > 1.9$) is directly proportional to the upstream absolute pressure (see page C29).
2. Gas flow at moderate pressure ratios ($P_1/P_2 < 1.9$) is proportional to the downstream absolute pressure, and to the pressure differential (see page C29).

GAS FLOW CHARACTERISTICS

3. Gas flow at low pressure ratios ($P_1/P_2 < 1.1$) is proportional to the pressure differential, similar to hydraulic flow.
4. When restrictions appear in series, the most downstream restrictor dominates in the determination of flow rate.
5. When the absolute pressure ratio across a restrictor is above 1.9, the gas velocity will reach the speed of sound (sonic flow) in the restrictor throat. When restrictors appear in series the overall pressure ratio must be higher to achieve sonic flow.
6. When equal restrictors appear in series, sonic flow can only occur in the most downstream restrictor.
7. Velocity of the gas stream cannot exceed the speed of sound in either a constant area duct, or a converging section.

The Rule of Forbidden Signals:*

“The effect of pressure changes produced by a body moving at a speed faster than the speed of sound cannot reach points ahead of the body.”

This rule can be applied to pneumatic flow restrictors where the body is not moving, but the flow velocity relative to the body can reach, or exceed, the speed of sound. Whenever the downstream pressure is low enough to produce Mach 1 at the restrictor throat, any effect of changes in the downstream pressure cannot reach points upstream of the throat. Thus, flow rate will be independent of downstream pressure. This situation applies to a single orifice restrictor flowing air when the overall pressure ratio exceeds 1.89/1.

*von Kármán, Jour. Aero. Sci., Vol. 14, No. 7 (1947)

GAS FLOW

ABSOLUTE PRESSURE MEASUREMENT

Gas flow is a function of upstream absolute pressure, and of the ratio of upstream to downstream pressures. Lohm testing done at The Lee Company is performed at an upstream pressure which is high enough so that downstream pressure does not affect the flow rate. To accurately determine the upstream absolute pressure, it is necessary to measure atmospheric pressure with a suitable barometer. This measurement will normally be in units of in. Hg, while the gauge pressure reading is in units of psig. Thus, the barometer reading must be converted to psia, and added to the gauge reading to get the value of pressure in psia.

$$\text{Pres. (psia)} = \text{Pres. (psig)} + 0.4912 \times \text{Pres. (in. Hg)}$$

EXAMPLE: What single-orifice restriction will permit a flow of 2.00 std L/min. of nitrogen at 70°F, with supply pressure at 10 psig, discharging to an atmospheric pressure of 29.5 in. Hg?

$$\begin{aligned} K &= 276 \text{ (see page C31)} \\ T_1 &= 70^\circ\text{F, fr} = 1.00 \text{ (see page C30)} \\ P_2 &= 0.4912 \times 29.5 = 14.5 \text{ psia} \\ P_1 &= 10.0 + 14.5 = 24.5 \text{ psia} \\ P_1/P_2 &= 24.5/14.5 = 1.69 \text{ (subsonic)} \\ \Delta P &= 24.5 - 14.5 = 10.0 \text{ psid} \\ Q &= 2.00 \text{ std L/min.} \end{aligned}$$

$$L = \frac{2 (276) 1.0 \sqrt{10.0 (14.5)}}{2.00} = 3320 \text{ Lohms}$$

GAS FLOW**ACFM TO SCFM CONVERSION**

It is frequently convenient to express gas flow in terms of flow at standard conditions. This is useful for calculation purposes, or for application to flow measuring instruments.

$$\text{SCFM} = \text{ACFM} \left(\frac{P}{14.7} \right) \left(\frac{519}{T} \right)$$

UNITS:

T = Gas temperature, °R = 460 + °F

P = Gas pressure, psia

ACFM = Gas flow, actual cubic feet/minute

SCFM = Gas flow, standard cubic feet/minute

EXAMPLE: What is SCFM corresponding to 0.032 ACFM at 300 psia and at 240°F?

SOLUTION:

$$\text{SCFM} = 0.032 \left(\frac{300}{14.7} \right) \left(\frac{519}{700} \right) = 0.48$$

GAS FLOW

FLOW FACTOR (MULTI-ORIFICE)

When multiple orifices appear in series or when a restrictor has several stages, there is a non-uniform distribution of the overall pressure drop through the restrictor. See page C39 for additional discussion of series gas flow.

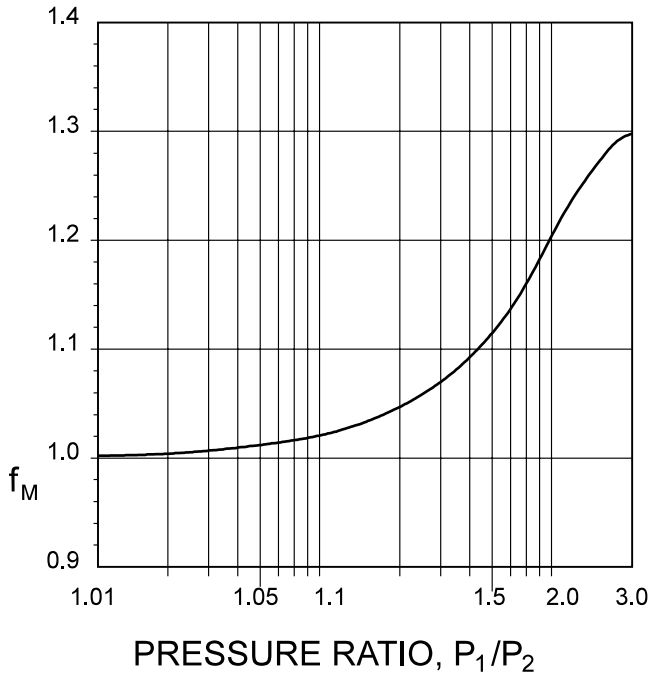
The effect of the above flow behavior is that the gas flow rate of a multi-orifice device is higher than would be expected from a single-orifice device of the same lohm rate, and at the same pressure conditions. This characteristic is reflected in the flow factor, “ f_M ,” which reaches a maximum value of 1.3 at a pressure ratio of 3/1. See the graph on page C38 for values of “ f_M ,” at any pressure ratio for multi-orifice restrictors.

$$\text{Lohms} = \frac{K f_T f_M P_1}{Q} \quad (\text{Sonic region})$$

EXAMPLE: What multi-orifice restriction will permit a flow of 0.5 std L/min. of hydrogen at 70°F, with supply pressure at 40 psig, discharging to atmosphere?

$$\begin{aligned} K &= 1030 \text{ (see page C31)} \\ T_1 &= 70^\circ\text{F}, \quad f_T = 1.0 \text{ (see page C30)} \\ P_1 &= 40.0 + 14.7 = 54.7 \text{ psia} \\ P_2 &= 14.7 \text{ psia} \\ P_1/P_2 &= 54.7 / 14.7 = 3.72 \\ f_M &= 1.30 \text{ (see page C38)} \\ Q &= 0.50 \text{ std L/min} \end{aligned}$$

$$L = \frac{1030 \times 1.0 \times 1.30 \times 54.7}{0.50} = 146,000 \text{ Lohms}$$

GAS FLOW**FLOW FACTOR “ f_M ” (MULTI-ORIFICE)**

Sonic flow:

for $P_1 / P_2 > 3$, use $f_M = 1.3$

GAS FLOW SERIES

When gas flow passes through orifices in series, the pressure drops are not evenly distributed. This is caused by the compressibility of the gas, and generally results in higher pressure drops at the downstream orifices. Thus, it becomes difficult to calculate the intermediate pressure between series restrictors flowing gas without using a trial and error process. To simplify this calculation, the chart on the following page may be used when the Lohm rates of the applicable restrictors are known.

TWO RESTRICTORS

The chart on the adjacent page solves for the absolute pressure between two orifices as a percentage of the supply pressure. To solve a problem, simply follow the graph line corresponding to the Lohm ratio, L_1/L_2 , until it crosses the overall pressure ratio, P_1/P_3 . Then read horizontally across to the left hand scale to obtain the value of P_2 as a percentage of the upstream absolute pressure, P_1 .

EXAMPLE: Find the intermediate pressure between two restrictors with an upstream pressure 72 psia, exhausting to atmosphere at 14.7 psia.

$$L_1 = 2000 \text{ Lo.}$$

$$L_2 = 500 \text{ Lo.}$$

Calculate the Lohm ratio:

$$L_1/L_2 = 2000/500 = 4.0$$

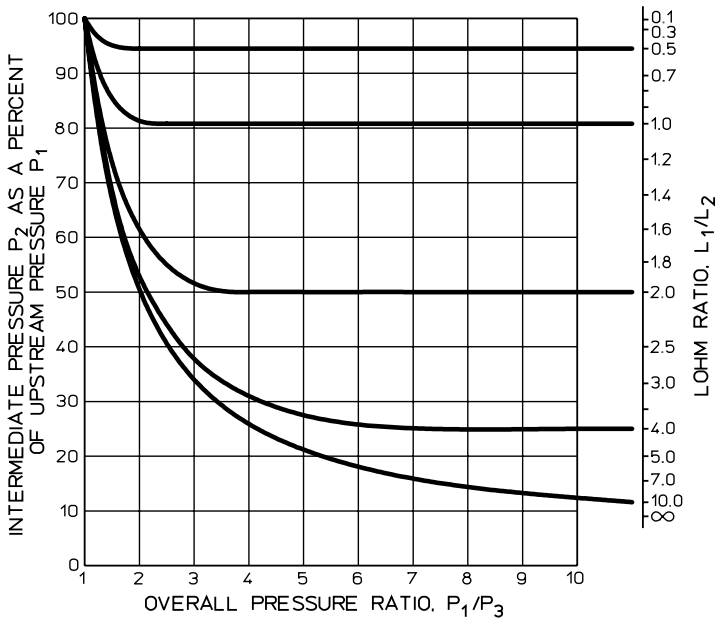
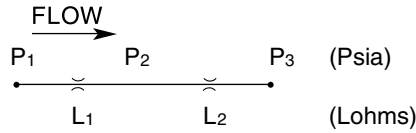
Calculate the overall pressure ratio: $P_1/P_3 = 72.0/14.7 = 4.9$

Read 28% from left hand scale of graph.

The upstream pressure is known, thus:

$P_2 = 0.28 \times 72.0 = 20 \text{ psia}$
--

GAS FLOW SERIES



TWO RESTRICTORS - GENERAL

The following will allow solutions to be obtained for 2 restrictor problems even when Lohm or pressure ratios are off – scale:

1. When Lohm ratio is less than 0.1, then $P_2 = P_1$.
2. When Lohm ratio is less than 8.0, then solution for pressure ratio greater than 10, is the same as at 10.
3. When Lohm ratio is greater than 1.5, then solution at high values of pressure ratio is such that ratio P_2/P_1 is equal to the reciprocal of the Lohm ratio.

GAS FLOW SERIES (Cont.)

The following formulas provide solutions to series gas flow problems which must be solved with more precision than can be obtained by use of the graph on [page C40](#). In each case, the graph may be used to determine whether or not each restrictor has a high enough pressure ratio (i.e. $P_1 / P_2 \geq 1.9$) to be in the sonic region.

- 1.) L_1 and L_2 are both sonic ($L_1 > L_2$):

$$P_2 = P_1 \times \frac{L_2}{L_1}$$

- 2.) L_1 is subsonic, and L_2 is sonic ($L_1 \neq L_2$):

$$P_2 = \frac{4 P_1 L_2^2}{L_1^2 + 4 L_2^2}$$

- 3.) L_1 is subsonic, and L_2 is sonic ($L_1 = L_2$):

$$P_2 = 0.8 \times P_1$$

- 4.) L_1 is sonic, and L_2 is subsonic ($L_1 > L_2$):

$$P_2 = P_3 + \frac{P_1^2 L_2^2}{4 P_3 L_1^2}$$

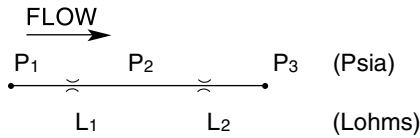
- 5.) L_1 is subsonic, and L_2 is subsonic ($L_1 \neq L_2$):

$$P_2 = \frac{1}{2} \left[P_1 - A + \sqrt{(P_1 - A)^2 + 4 P_3 A} \right], \quad A = P_3 \left(\frac{L_1}{L_2} \right)^2$$

- 6.) L_1 is subsonic, and L_2 is subsonic ($L_1 = L_2$):

$$P_2 = \frac{\Delta P_{1-3} + \sqrt{\Delta P_{1-3}^2 + 4 P_3^2}}{2}$$

GAS FLOW SERIES (Cont.)



EXAMPLE: Find the intermediate pressure in the example problem on page C39 with more precision.

$$L_1 = 2000 \text{ Lo.}, \quad L_2 = 500 \text{ Lo.}$$

$$P_1 = 72 \text{ psia}, \quad P_2 = 20 \text{ psia}, \quad P_3 = 14.7 \text{ psia}$$

$$P_1 / P_2 = 72 / 20 = 3.60 \quad (\text{Sonic})$$

$$P_2 / P_3 = 20 / 14.7 = 1.36 \quad (\text{Subsonic})$$

$$P_2 = P_3 + \frac{P_1^2 L_2^2}{4 P_3 L_1^2} = 14.7 + \frac{72^2 \times 500^2}{4 \times 14.7 \times 2000^2} = 20.2 \text{ psia}$$

EXAMPLE: Find the intermediate pressure between two restrictors with an upstream pressure of 30 psia, exhausting to atmosphere at 14.7 psia.

$$L_1 = 1500 \text{ Lo.}, \quad L_2 = 1500 \text{ Lo.}$$

Use solution procedure from page C39 to determine approximate value of intermediate pressure, P_2 :

$$L_1 / L_2 = 1500 / 1500 = 1.0, \quad P_1 / P_3 = 30.0 / 14.7 = 2.04$$

$$P_2 = 0.81 \times 30.0 = 24 \text{ psia. (approx.)}$$

$$P_1 / P_2 = 30.0 / 24.0 = 1.25, \quad P_2 / P_3 = 24.0 / 14.7 = 1.63$$

(L_1 and L_2 are both subsonic)

$$P_2 = \frac{\Delta P_{1-3} + \sqrt{\Delta P_{1-3}^2 + 4 P_3^2}}{2} = \frac{15.3 + \sqrt{15.3^2 + 4 \times 14.7^2}}{2}$$

$$P_2 = 24.2 \text{ psia}$$

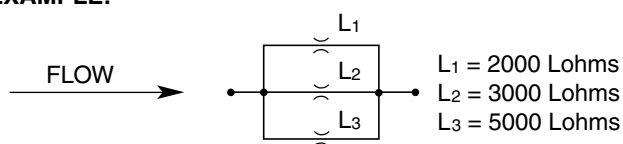
GAS FLOW PARALLEL

For parallel flow, the total Lohm rating is:

$$\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \dots + \frac{1}{L_N}$$

Note that this relationship is identical to that for hydraulic flow, and to the electrical equation.

EXAMPLE:



$$\frac{1}{L_T} = \frac{1}{2000} + \frac{1}{3000} + \frac{1}{5000} = 0.00103$$

Therefore, $L_T = 970$ Lohms

MOMENTUM FORCES - GAS FLOW

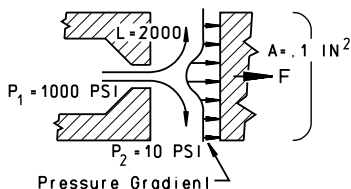
When a flowing stream of gas is subject to a change in velocity (either speed or direction), forces arise which are the reaction to the change in momentum of the stream. This is particularly important in valve design where the position of a moving element may be affected.

The direction in which the momentum force acts is always opposite to the acceleration which is imparted to the flow stream. The magnitude of the force may be calculated by using the momentum Lohm Laws which apply to air at near room temperature.

$$F = \frac{0.4 \times P_1}{L} \quad F = \frac{\text{SLPM}}{700} \quad (\text{sonic flow})$$

EXAMPLE: Where a gas changes direction.

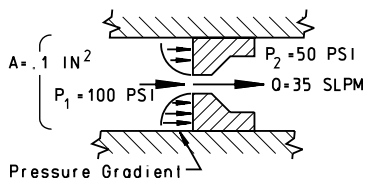
$$F = \frac{0.4 \times P_1}{L} = \frac{0.4 \times 1000}{2000} = 0.2 \text{ lbf.}$$



The momentum force of 0.2 lbs. in this example must be added to the force produced by static pressure on the plate ($0.1 \text{ in.}^2 \times 10 \text{ psi} = 1 \text{ lb.}$) to give the total force on the plate.

EXAMPLE: Where a gas changes speed.

$$F = \frac{\text{SLPM}}{700} = \frac{35}{700} = 0.05 \text{ lbf.}$$



The momentum force of 0.05 lb. in this example must be subtracted from the force produced by static pressure on the plate ($0.1 \text{ in.}^2 \times [100 - 50] = 5 \text{ lb.}$) to give the total force on the piston.

TRANSIENT GAS FLOW

This type of flow normally concerns the charging of a volume through a fixed resistance such as an orifice. Use of the Lohm system simplifies the calculation of the time required to blow down or charge up a vessel.

The first step is to calculate system time constant, τ , which takes into consideration the type of gas, pressure–vessel volume, absolute temperature, and flow resistance. The time constant is given by:

$$\tau = \frac{4 \text{ ft } V L}{K}$$

Note: Select K from the appropriate “psia” column of the Volumetric Flow Table on page C31. Keep the units of pressure vessel volume (V) consistent with the volumetric flow units.

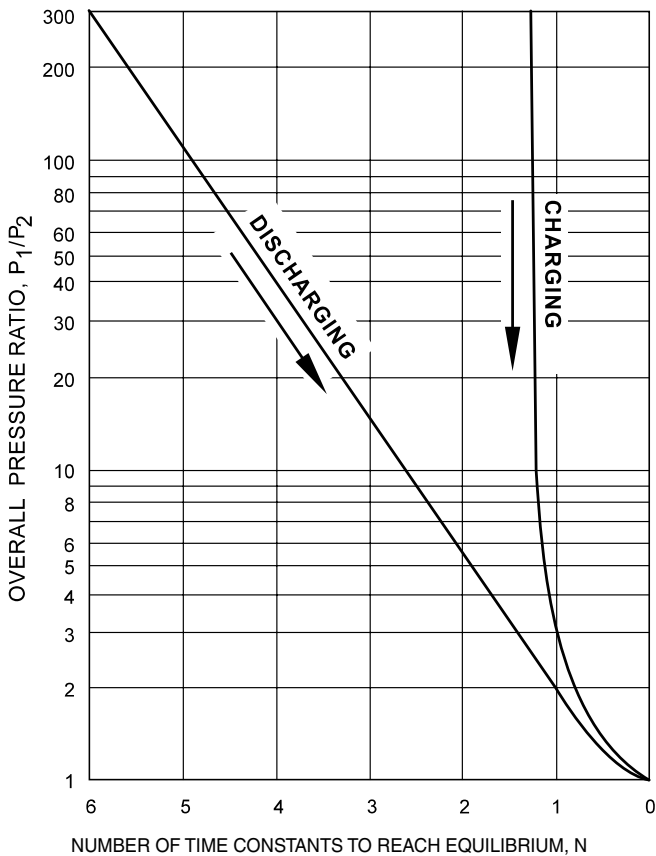
The larger the value of τ , the more sluggish the system.

Once τ has been calculated, the ratio of upstream pressure to downstream pressure for both the initial and final conditions must be computed. Then, from the pressure–ratio graph, initial and final values for N can be found. N is the number of system time constants required for the system to reach equilibrium.

If the final condition is equilibrium, where upstream and downstream pressures are equal, the final pressure ratio is 1 and the final value of N is 0. With these values, the time for the system to blow down or charge up can be calculated from:

$$t = \tau (N_i - N_f) \qquad t = \text{Time (sec.)}$$

TRANSIENT GAS FLOW



NOMENCLATURE

- K = Units correction factor
- L = Flow resistance, (Lohms)
- N_i = Initial number of system time constants
- N_f = Final number of system time constants
- P_1 = Upstream gas pressure
- P_2 = Downstream gas pressure
- f_r = Temperature factor
- t = Time to charge up or blow down a pressure vessel (sec.)
- V = Pressure vessel volume
- τ = System time constant (sec.)

TEMPERATURE CHANGE IN GAS FLOW

When a gas flows through an orifice it is subject to a throttling process. This results in the gas temperature changing to an extent determined by the pressure drop. Many of the common gasses will be chilled by throttling, although some gasses will increase in temperature.

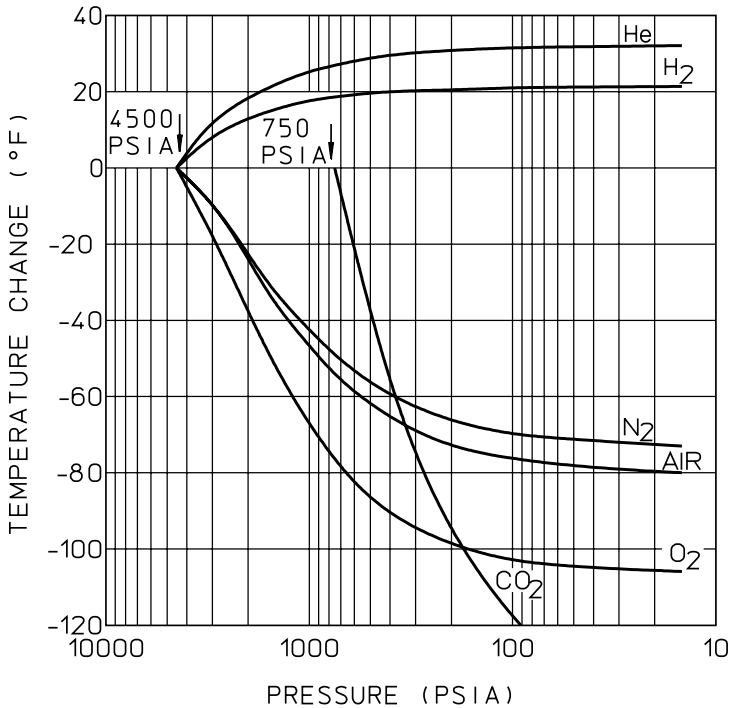
A positive Joule–Thomson coefficient, which is a function of both temperature and pressure, will produce cooling of the gas. This is only the case at below the “inversion” temperature. At the inversion temperature, the Joule – Thomson coefficient is zero, so no heating or cooling occurs.

The following graph allows downstream temperature to be found when starting from an upstream pressure of 4500 psia; 750 psia for CO₂. Solutions may be obtained for other upstream pressures by shifting the graph lines vertically to pass through the zero “temp. change” line at the appropriate pressure. The graph works for a wide range of initial temperatures, but is most accurate when the initial temperature is close to 70°F.

The graph is entered on the zero “temp. change” line at the point corresponding to the actual upstream pressure. Then the graph line, or a parallel line, for the applicable gas, is followed to the right. When the value of the downstream pressure (read on the X-axis) is reached, the temperature change can be read on the Y-axis.

Note that actual downstream temperature will not normally be as extreme as calculated due to heat transfer to or from the piping.

TEMPERATURE CHANGE IN GAS FLOW



EXAMPLE:

A Lee IMH orifice is used in a 4500 psia helium gas system to obtain a pressure drop down to 300 psia starting with an upstream temperature of 80°F. What downstream gas temperature will result?

Enter the graph at the 4500 psia point and follow the helium line to a pressure of 300 psia. Then read the temperature change on the left hand scale. This value is +30°F; thus, the calculated downstream temperature is 110°F.

PNEUMATIC POWER

A gas flowing through an orifice is throttled (causing turbulence and heating), and expanded (causing cooling). Thus, it is subject to energy conversions which reduce the amount of energy available to do work. The rate at which available energy is lost can be termed the pneumatic power, which is a function of the pressures, Lohm rate of the orifice, and the flow. For nitrogen, the relationship is shown on the accompanying graph.

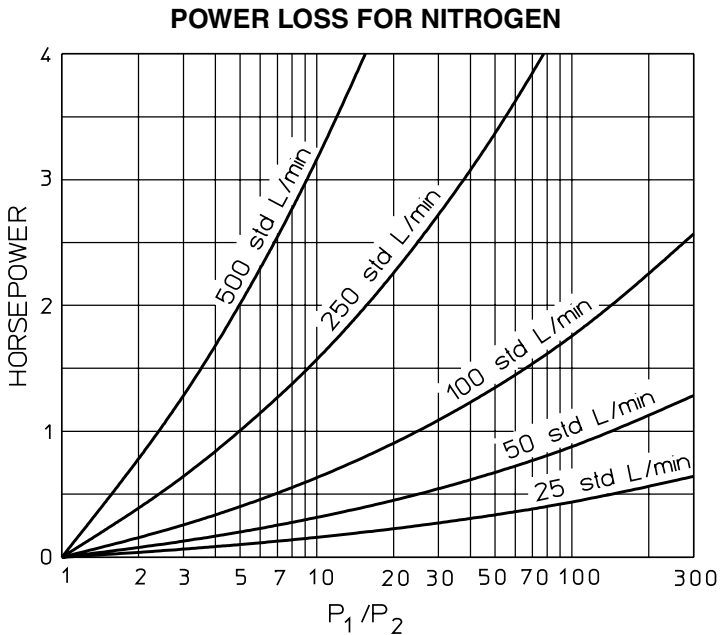
When the flow rate and pressure ratio is known, the resulting power consumption can be determined from the graph. If flow is not known, it can be readily calculated from the Lohm rate using the gas Lohm Law. Simply enter the graph at the appropriate pressure ratio (X-axis), and read vertically to the line corresponding to the applicable flow rate. The resulting power may then be read horizontally across on the Y-axis. Note that pressure ratio is the ratio of the absolute pressures.

For more precise calculations, or to extend the range of the pneumatic power graph, the following formula may be used for nitrogen or air.

$$HP = \frac{2.2 P_1}{L} \left[(P_1/P_2)^{1/4} - 1 \right]$$

Note that due to compressor inefficiencies, more power will be needed to compress the gas than will be expended when it flows through an orifice.

PNEUMATIC POWER



EXAMPLE:

For a 500 Lohm orifice flowing nitrogen at 750 psia exhausting to 75 psia, the flow can be easily calculated from the gas Lohm Law.

$$Q = \frac{270 P_1}{L} = \frac{270 (750)}{500} = 405 \text{ std L/min.}$$

Next, determine the pressure ratio, P_1/P_2 , which in this example is $750/75 = 10$. Then, from the graph:

Pneumatic power = 2.5 HP

GAS PROPERTIES

Gas	k	R ft lb/lb°R	Density		cp* Btu/lb°R	cv* Btu/lb°R
			lb _m /ft ³	lb _m /std L		
H ₂	1.40	766.6	0.00532	0.000188	3.420	2.435
He	1.66	386.1	0.01056	0.000373	1.250	0.754
Neon	1.66	76.6	0.0533	0.00188	0.248	0.150
Nat. Gas	1.22	79.2	0.0516	0.00182	0.560	0.458
N ₂	1.40	55.2	0.0739	0.00261	0.247	0.176
CO	1.41	55.2	0.0739	0.00261	0.243	0.172
Air	1.40	53.3	0.0764	0.00270	0.241	0.173
Ethane	1.21	51.4	0.0793	0.00280	0.386	0.320
O ₂	1.40	48.3	0.0845	0.00298	0.217	0.155
Argon	1.67	38.7	0.1053	0.00372	0.124	0.074
CO ₂	1.28	35.1	0.1162	0.00410	0.205	0.160
N ₂ O	1.26	35.1	0.1162	0.00410	0.221	0.176
SO ₂	1.25	24.1	0.1691	0.00597	0.154	0.123
Freon-12	1.13	12.8	0.319	0.01127	0.145	0.129

*values at 68°F and 14.7 psia

cp = Specific heat at constant pressure

cv = Specific heat at constant volume

k = Ratio of specific heats, $\frac{c_p}{c_v}$

R = Gas Constant, $\frac{R_o}{\text{Molecular. Wt.}}$

ROB NUMBER

The ROB Number, a system of rating the relative resistance to blockage of safety screens, has been developed to minimize the guesswork and expensive testing formerly involved in selecting a screen.

The ROB Number was conceived to aid system designers in choosing the optimum screen for their conditions relative to other screen options available. The ROB Number is not used to predict absolute screen life.

The ROB Number system is based on a few assumptions.

- The same contamination level applies for all screen options.
- Fluid contamination level is not affected by having a safety screen in the system.
- When particles block holes, the manner in which they block different size holes is essentially the same.
- Particle distribution follows a log - log² distribution.

ROB NUMBER DEFINITION

A fluid contamination level per MIL-STD-1246 Class 200 was chosen as the basis of comparison with the ROB Number defined as;

$$ROB = \frac{N}{63.25n}$$

where $n = 10^{(4.9029 - 0.926 \log^2 d)}$
d = hole size (μ)
N = # of holes in a screen

A master screen of ROB = 1 is therefore defined as having 1000 holes all 100 μ in size.

The following tables give the ROB Number for single holes of a given diameter. To determine the ROB Number for a screen, multiply the single hole value by the number of holes in the screen.

Screen ROB # = Single orifice ROB # x # of holes.

The screen safety factor is defined as the ratio of the screen ROB Number to the ROB Number of the orifice it is protecting. You should choose a screen to provide the highest practical safety factor.

ROB NUMBER EXAMPLE

EXAMPLE: Which safety screen would be the better choice to protect a 0.030 diameter orifice: A 0.008 hole size screen with 850 holes, or a 0.015 hole size screen with 450 holes?

SOLUTION: From the table on page C54, we find that a single orifice of 0.030 diameter has a ROB Number of 9.71.

Again using the table for 0.008 and 0.015 holes and multiplying by the respective number of holes gives the following results:

	HOLE SIZE		# OF HOLES	ROB NUMBER	SAFETY FACTOR
	(in)	(μ)			
Orifice	0.030	762	1	9.7	1
Screen 1	0.008	203	850	14.4	1.5
Screen 2	0.015	381	450	131	13.5

The results show screen 2 to be the better choice.

SINGLE ORIFICE RO_B NUMBERS

HOLE SIZE		SINGLE ORIFICE RO _B #
Inch	Micron	
0.0010	25	0.0000133
0.0015	38	0.0000408
0.0020	51	0.0000979
0.0025	64	0.000202
0.0030	76	0.000376
0.0035	89	0.000650
0.0040	102	0.00106
0.0045	114	0.00165
0.0050	127	0.00248
0.0055	140	0.00361
0.0060	152	0.00511
0.0065	165	0.00709
0.0070	178	0.00963
0.0075	191	0.0129
0.0080	203	0.0169
0.0085	216	0.0220
0.0090	229	0.0281
0.0095	241	0.0357
0.010	254	0.0448
0.011	279	0.0687
0.012	305	0.1023
0.013	330	0.1482
0.014	356	0.210
0.015	381	0.291
0.016	406	0.397
0.017	432	0.533
0.018	457	0.706
0.019	483	0.922
0.020	508	1.19
0.021	533	1.52

HOLE SIZE		SINGLE ORIFICE RO _B #
Inch	Micron	
0.022	559	1.93
0.023	584	2.42
0.024	610	3.01
0.025	635	3.72
0.026	660	4.56
0.027	686	5.56
0.028	711	6.73
0.029	737	8.10
0.030	762	9.71
0.031	787	11.6
0.032	813	13.7
0.033	838	16.2
0.034	864	19.1
0.035	889	22.3
0.036	914	26.0
0.037	940	30.3
0.038	965	35.1
0.039	991	40.5
0.040	1016	46.6
0.041	1041	53.5
0.042	1067	61.2
0.043	1092	69.9
0.044	1118	79.5
0.045	1143	90.3
0.046	1168	102
0.047	1194	116
0.048	1219	130
0.049	1245	147
0.050	1270	165
0.051	1295	185

SINGLE ORIFICE R_{OB} NUMBERS

HOLE SIZE		SINGLE ORIFICE R_{OB} #
Inch	Micron	
0.052	1321	207
0.053	1346	231
0.054	1372	257
0.055	1397	286
0.056	1422	318
0.057	1448	352
0.058	1473	390
0.059	1499	431
0.060	1524	476
0.061	1549	525
0.062	1575	578
0.063	1600	635
0.064	1626	698
0.065	1651	765
0.066	1676	838
0.067	1702	917
0.068	1727	1002
0.069	1753	1094
0.070	1780	1.2E + 03
0.071	1800	1.3E + 03
0.072	1830	1.4E + 03
0.073	1850	1.5E + 03
0.074	1880	1.7E + 03
0.075	1910	1.8E + 03
0.076	1930	2.0E + 03
0.077	1960	2.1E + 03
0.078	1980	2.3E + 03
0.079	2010	2.5E + 03
0.080	2030	2.7E + 03
0.081	2060	2.9E + 03

HOLE SIZE		SINGLE ORIFICE R_{OB} #
Inch	Micron	
0.082	2080	3.1E + 03
0.083	2110	3.4E + 03
0.084	2130	3.6E + 03
0.085	2160	3.9E + 03
0.086	2180	4.2E + 03
0.087	2210	4.5E + 03
0.088	2240	4.8E + 03
0.089	2260	5.2E + 03
0.090	2290	5.6E + 03
0.091	2310	5.9E + 03
0.092	2340	6.4E + 03
0.093	2360	6.8E + 03
0.094	2390	7.3E + 03
0.095	2410	7.8E + 03
0.096	2440	8.3E + 03
0.097	2460	8.9E + 03
0.098	2490	9.5E + 03
0.099	2510	1.0E + 04
0.10	2540	1.1E + 04
0.11	2790	2.0E + 04
0.12	3050	3.4E + 04
0.13	3300	5.8E + 04
0.14	3560	9.4E + 04
0.15	3810	1.5E + 05
0.16	4060	2.3E + 05
0.17	4320	3.4E + 05
0.18	4570	5.0E + 05
0.19	4830	7.3E + 05
0.20	5080	1.0E + 06

CONTAMINATION LEVEL CORRELATION

Fluid contamination can be described by a number of techniques:

- The Gravimetric Method: The contaminant level is expressed as the mass of contaminant per unit volume of fluid.
- Parts Per Million: The degree of contamination is based on mass or volume per million units (e.g. gms/10⁶ gms).

The above techniques describe bulk or total contamination but give little information regarding size of contaminant. For example, unless the size and density of the contaminating particles is known, no conclusions may be drawn relative to numbers of particles.

Other techniques look at numbers of particles, describing contamination in terms of its size and concentration. These may be an interval concentration, for example the number of contaminant particles (per unit volume) between 5 and 15 μ in size. Additionally, contamination may be expressed as a cumulative concentration. In this case contamination levels are described by the total number of particles per unit volume above a given size. For example, the number of particles above 25 μ in size per 100 mL.

Most commonly used cleanliness specifications are based on numbers of particles rather than gravimetric techniques. However, particle distributions which were determined to be representative of service distributions (e.g. NAS 1638 distributions) correlate reasonably with those obtained gravimetrically with AC test dust. The table on page C57 (from An Encyclopedia of Fluid Contamination Control by E.C. Fitch) provides a correlation of some different cleanliness specifications.

NAS* 1638	Number of Particles per 100 mL Micron Range					ISO 4406
Class	5-15 μ	15-25 μ	25-50 μ	50-100 μ	>100 μ	Class
00	125	22	4	1	—	8/5
0	250	44	8	2	—	9/6
1	500	89	16	3	1	10/7
2	1K	178	32	6	1	11/8
3	2K	356	63	11	2	12/9
4	4K	712	126	22	4	13/10
5	8K	1425	253	45	8	14/11
6	16K	2.8K	506	90	16	15/12
7	32K	5.7K	1012	180	32	16/13
8	64K	11.4K	2.0K	360	64	17/14
9	128K	22.8K	4.1K	720	128	18/15
10	256K	45.6K	8.1K	1440	256	19/16
11	512K	91.2K	16.2K	2.8K	512	20/17
12	1M	182K	32.4K	5.8K	1024	21/18

- SAE standard AS 4059 also applies. This lists fluid particulate contamination cumulatively for 5 ranges for contamination classes from 000 to 12.
 - >2 μ • >5 μ • >15 μ • >25 μ • >50 μ

CONTAMINATION LEVEL CORRELATION

ISO 4406 Code	Particles Per mL >10 μ	ACFTD Gravimetric, Level mg/L	MIL-STD 1246 Level	NAS 1638 Class
26/23	140 000	1000		
25/23	85 000	1000		
23/20	14 000	100	700	
21/18	4 500			12
20/18	2 400		500	
20/17	2 300			11
20/16	1 400	10		
19/16	1 200			10
18/15	580			9
17/14	280		300	8
16/13	140	1		7
15/12	70			6
14/12	40		200	
14/11	35			5
13/10	14	.1		4
12/9	9			3
18/8	5			2
10/8	3		100	
10/7	2.3			1
10/6	1.4	.01		
9/6	1.2			0
8/5	0.6			00
7/5	0.3		50	
6/3	0.14	.001		
5/2	0.04		25	
2/.8	0.01		10	

PARTICLE SIZE COMPARISON

SIZES OF FAMILIAR OBJECTS		
SUBSTANCE	MICRONS	INCHES
Grain of Table Salt	100	0.0039
Human Hair	70	0.0016
Lower Limit of Visibility	40	0.0016
White Blood Cells	25	0.0010
Talcum Powder	10	0.0004
Red Blood Cells	8	0.0003
Bacteria (Average)	2	0.00008

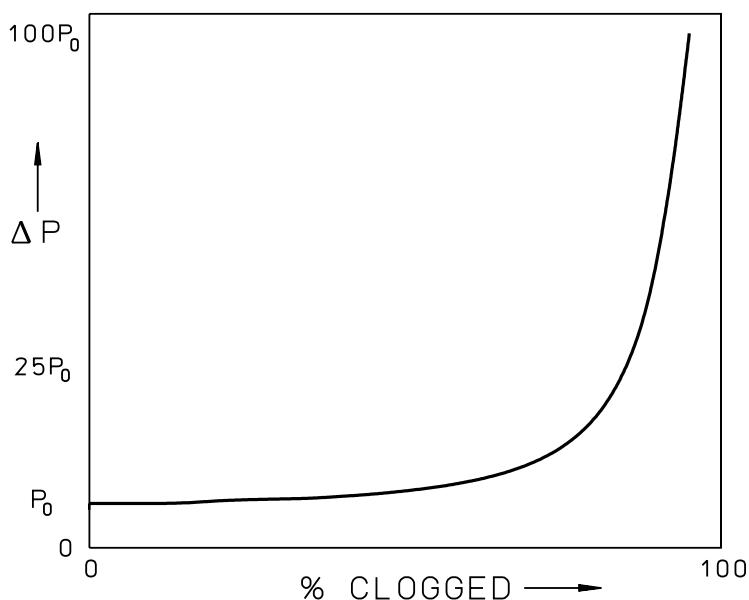
SCREEN SIZES		
U.S. SIEVE NO.	OPENING IN INCHES	OPENING IN MICRONS
50	0.0117	297
60	0.0090	228
70	0.0083	210
100	0.0059	149
140	0.0041	105
200	0.0029	74
270	0.0021	53
325	0.0017	44
Paper	0.00039	10
Paper	0.00019	5

CLOGGING

As a safety screen accumulates particles, the pressure drop will slowly increase until the screen is almost fully clogged. Then the pressure drop increases dramatically. For example, consider a clean safety screen in a 3000 psi hydraulic system. At its normal flow rate the screen pressure drop is 6 psi. That same screen will see a pressure drop of only 150 psi when 80% clogged. However, at 95% clogged, the differential pressure jumps to 2500 psi. This phenomenon is represented by the following formula:

$$\Delta P = \frac{\Delta P_0}{(1 - \% \text{ clogged})^2}$$

Where ΔP_0 is the pressure drop across the screen when it is clean



PRIMARY STANDARDS*

- Meter* Length equal to 1,650,763.73 wavelengths in vacuum of the radiation corresponding to the transition between the levels 2 p₁₀ and 5 d₅ of the krypton-86 atom.
- Kilogram* Mass equal to the mass of the international prototype of the kilogram. This is a particular cylinder of platinum-iridium alloy which is preserved in a vault at Sevres, France by the International Bureau of Weights and Measures.
- Second* Time duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium-133 atom.

DERIVED STANDARD

- Newton* Force which gives to a mass of 1 kilogram an acceleration of 1 meter per sec. per sec.

EXACT CONVERSIONS*

1 pascal	= 1 newton/meter ²
1 atmosphere	= 101 325 pascals
1 bar	= 100 000 pascals
1 centipoise	= 0.001 newton-second/meter ²
1 centistoke	= 1 x 10 ⁻⁶ meter ² /second
1 fluid ounce (U.S.)	= 2.95735295625 x 10 ⁻⁵ meter ³
1 foot	= 0.3048 meter
1 gallon (U.S.)	= 3.785411784 x 10 ⁻³ meter ³
1 gram	= 0.001 kilogram
1 inch	= 0.0254 meter
1 kilogram force	= 9.80665 newtons
1 liter	= 0.001 meter ³
1 micron	= 1 x 10 ⁻⁶ meter
1 milliliter	= 1 x 10 ⁻⁶ meter ³
1 ounce mass (avdp)	= 0.028349523125 kilogram
1 pound force (avdp)	= 4.4482216152605 newtons
1 pound mass (avdp)	= 0.45359237 kilogram

*Exact by National Bureau of Standards definition

DERIVED CONVERSIONS:

1 foot of H ₂ O at 4°C	= 2988.98 pascals
1 gram/centimeter ³	= 1 000 kilograms/meter ³
1 inch of H ₂ O at 4°C	= 249.082 pascals
1 inch of Hg at 0°C	= 3386.389 pascals
1 pound _F /inch ²	= 6894.7572 pascals
1 pound _M /inch ³	= 27,679.905 Kilograms/meter ³
1 quart (U.S.)	= 9.4635295 x 10 ⁻⁴ meter ³
1 drop	= 50 microliters
1 bar	= 14.503774 pound _F /inch ²

CONVERSION FACTORS

VOLUME

Into To Convert	FT. ³	IN. ³	GAL. (U.S.)	QUART (U.S.)	FL.OZ. (U.S.)	liter	mL	m ³
FT. ³	—	1728	7.481	29.92	957.5	28.32	2.832 x 10 ⁴	2.832 x 10 ⁻²
IN. ³	5.787 x 10 ⁻⁴	—	4.329 x 10 ⁻³	1.732 x 10 ⁻²	0.5541	1.639 x 10 ⁻²	16.39	1.639 x 10 ⁻⁵
GAL. (U.S.)	0.1337	231.0	—	4.000	128.0	3.785	3785	3.785 x 10 ⁻³
QUART (U.S.)	3.342 x 10 ⁻²	57.75	0.2500	—	32.00	0.9464	946.4	9.464 x 10 ⁻⁴
FL.OZ. (U.S.)	1.044 x 10 ⁻³	1.805	7.813 x 10 ⁻³	3.125 x 10 ⁻²	—	2.957 x 10 ⁻²	29.57	2.957 x 10 ⁻⁵
liter	3.531 x 10 ⁻²	61.02	0.2642	1.057	33.81	—	1000	1.000 x 10 ⁻³
mL	3.531 x 10 ⁻⁵	6.102 x 10 ⁻²	2.642 x 10 ⁻⁴	1.057 x 10 ⁻³	3.381 x 10 ⁻²	1.000 x 10 ⁻³	—	1.000 x 10 ⁻⁶
m ³	35.31	6.102 x 10 ⁴	264.2	1057	3.381 x 10 ⁴	1000	1.000 x 10 ⁶	—

Multiply by 

MASS

Into To Convert	LB _M (avdp)	OZ _M (avdp)	SLUG	gram	kg _m
LB _M (avdp)	—	16.00	3.108 x 10 ⁻²	453.6	0.4536
OZ _M (avdp)	6.250 x 10 ⁻²	—	1.943 x 10 ⁻³	28.35	2.835 x 10 ⁻²
SLUG	32.17	514.8	—	1.459 x 10 ⁴	14.59
gram	2.205 x 10 ⁻³	3.527 x 10 ⁻²	6.852 x 10 ⁻⁵	—	1.000 x 10 ⁻³
kg _m	2.205	35.27	6.852 x 10 ⁻²	1000	—

Multiply by 

CONVERSION FACTORS

PRESSURE

↓ To Convert → Into	LB. IN. ²	IN. HG at 0°C	IN.H ₂ O at 4°C	FT.H ₂ O at 4°C	ATM	kg _F cm ²	kg _F m ²	kPa
LB. IN. ²	—	2.036	27.68	2.307	6.805 x 10 ⁻²	7.031 x 10 ⁻²	703.1	6.895
IN. HG at 0°C	0.4912	—	13.60	1.133	3.342 x 10 ⁻²	3.453 x 10 ⁻²	345.3	3.386
IN. H ₂ O at 4°C	3.613 x 10 ⁻²	7.355 x 10 ⁻²	—	8.333 x 10 ⁻²	2.458 x 10 ⁻³	2.540 x 10 ⁻³	25.40	0.2491
FT. H ₂ O at 4°C	0.4335	0.8826	12.00	—	2.950 x 10 ⁻²	3.048 x 10 ⁻²	304.8	2.989
ATM	14.70	29.92	406.8	33.90	—	1.033	1.033 x 10 ⁴	101.3
kg _F cm ²	14.22	28.96	393.7	32.81	0.9678	—	1.000 x 10 ⁴	98.07
kg _F m ²	1.422 x 10 ⁻³	2.896 x 10 ⁻³	3.937 x 10 ⁻²	3.281 x 10 ⁻³	9.678 x 10 ⁻⁵	1.000 x 10 ⁻⁴	—	9.807 x 10 ⁻³
kPa	0.1450	0.2953	4.015	0.3346	9.869 x 10 ⁻³	1.020 x 10 ⁻²	102.0	—

Multiply by ——— ↑

CONVERSION FACTORS - VOLUME TO MASS WATER AT 39.2°F (4°C)

MASS

V O L U M E	↓ To Convert	→ Into	LB _M (avdp)	OZ _M (avdp)	SLUG	gram	kg _m
	FT. ³		62.43	998.8	1.940	2.832×10^4	28.32
	IN. ³		3.613×10^{-2}	0.5780	1.123×10^{-3}	16.39	1.639×10^{-2}
	GAL. (U.S.)		8.345	133.5	0.2594	3785	3.785
	QT. (U.S.)		2.086	33.38	6.484×10^{-2}	946.3	0.9463
	FL. OZ. (U.S.)		6.520×10^{-2}	1.043	2.026×10^{-3}	29.57	2.957×10^{-2}
	liter		2.205	35.27	6.852×10^{-2}	1000	1.000
	mL		2.205×10^{-3}	3.527×10^{-2}	6.852×10^{-5}	1.000	1.000×10^{-3}
	m ³		2205	3.527×10^4	68.52	1.000×10^6	1000

Multiply by $\frac{1}{\text{value}}$

NOTE: For application of these factors to fluids with specific gravity other than 1.0, these factors must be multiplied by the actual specific gravity.

EXAMPLE:

Problem: Determine flow rate in lb./hr. which is equivalent to 430 mL/min. Fluid is MIL-H-5606, S.G. is 0.84.

Solution:

$$\frac{\text{lb}}{\text{hr}} = 430 \frac{\text{mL}}{\text{min}} \times 0.84 \times 2.20 \times 10^{-3} \frac{\text{lb}}{\text{mL}} \times \frac{60 \text{ min}}{1 \text{ hr}} = 47.8$$

CONVERSION FACTORS - MASS TO VOLUME WATER AT 39.2°F (4°C)

		MASS				
		LB _M (avdp)	OZ _M (avdp)	SLUG	gram	kg _m
V O L U M E	FT. ³	1.602×10^{-2}	1.001×10^{-3}	0.5154	3.532×10^{-5}	3.532×10^{-2}
	IN. ³	27.68	1.730	890.6	6.103×10^{-2}	61.03
	GAL.(U.S.)	0.1198	7.489×10^{-3}	3.855	2.642×10^{-4}	0.2642
	QT. (U.S.)	0.4793	2.996×10^{-2}	15.42	9.464×10^{-4}	0.9464
	FL. OZ. (U.S.)	15.34	0.9586	493.5	3.381×10^{-2}	33.81
	liter	0.4536	2.835×10^{-2}	14.59	1.000×10^{-3}	1.000
	mL	453.6	28.35	1.459×10^4	1.000	1000
	m ³	4.536×10^{-4}	2.835×10^{-5}	1.459×10^{-2}	1.000×10^{-6}	1.000×10^{-3}

Multiply by $\nearrow$

NOTE: For application of these factors to fluids with specific gravity other than 1.0, these factors must be divided by the actual specific gravity.

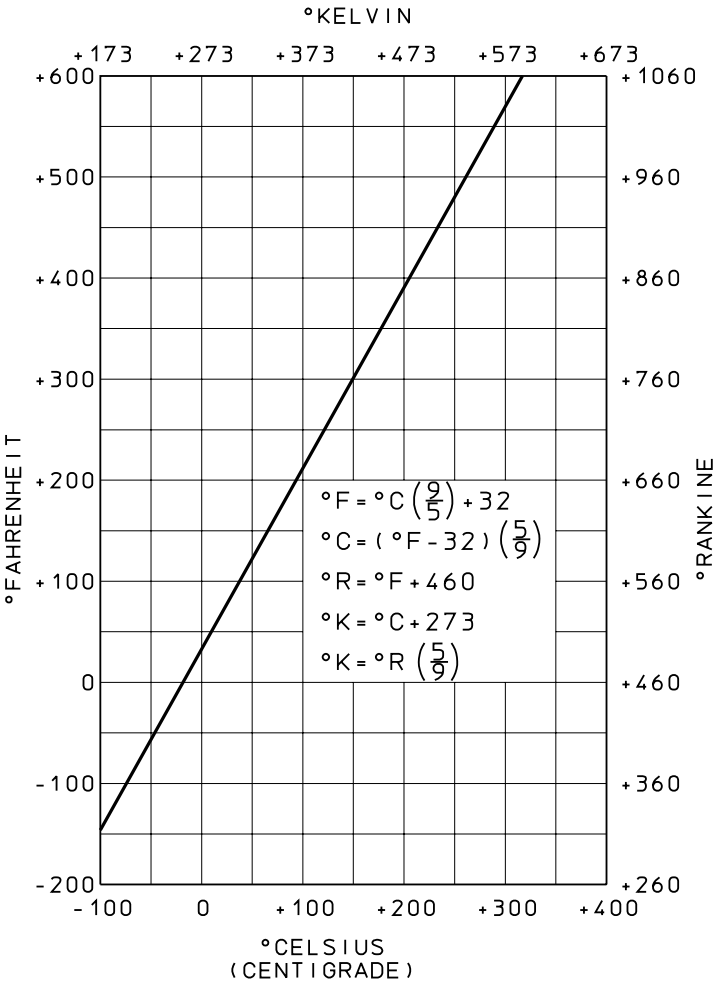
EXAMPLE:

Problem: Determine volume in gallons which would be occupied by 3.0kg of sea water, S.G. is 1.02 .

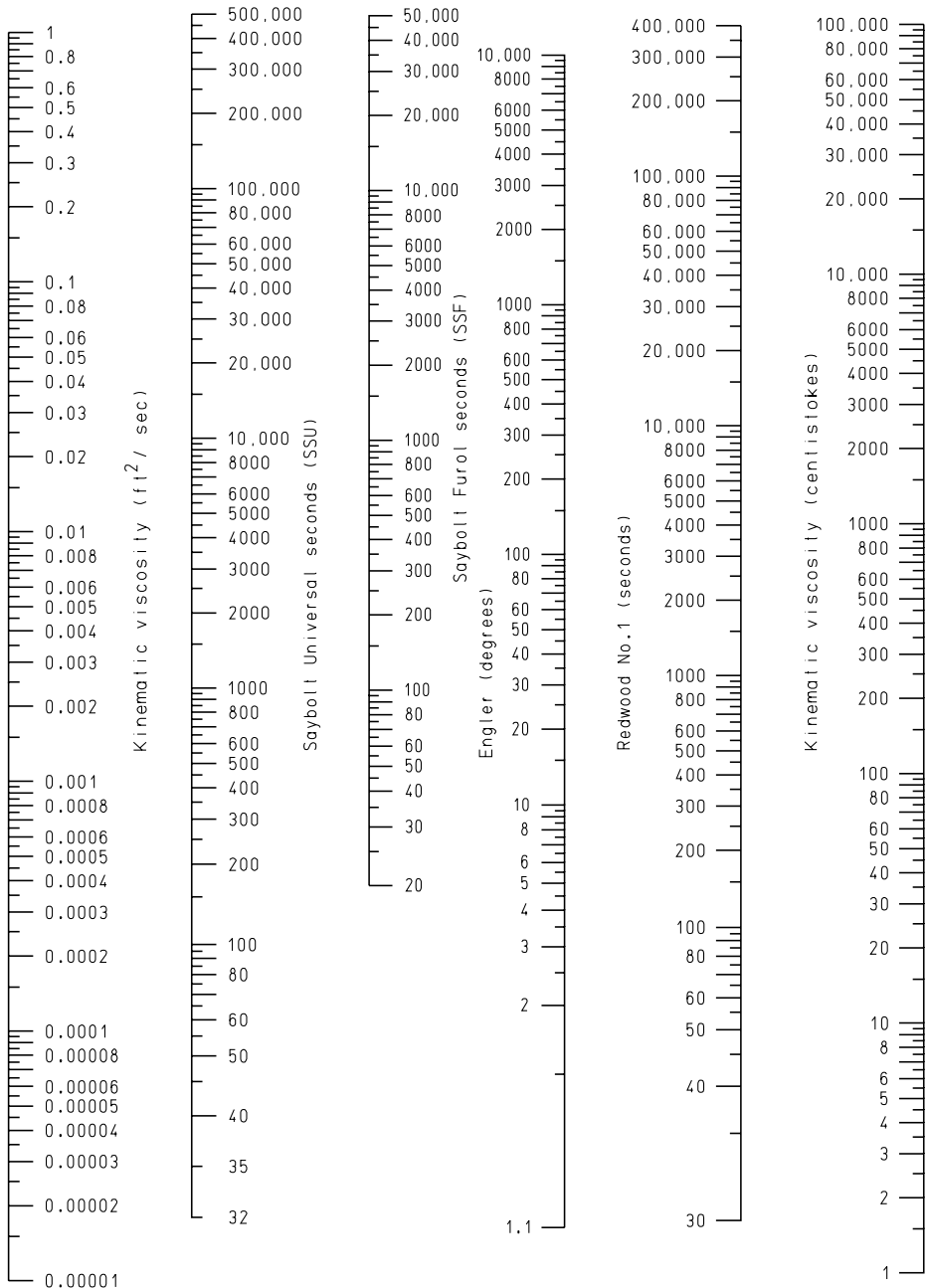
Solution:

$$\text{GAL.} = 3.0 \text{ kg} \times \frac{0.2642}{1.02} \frac{\text{GAL}}{\text{kg}} = 0.777 \text{ GAL.}$$

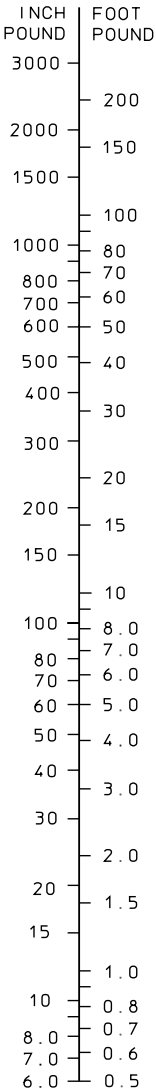
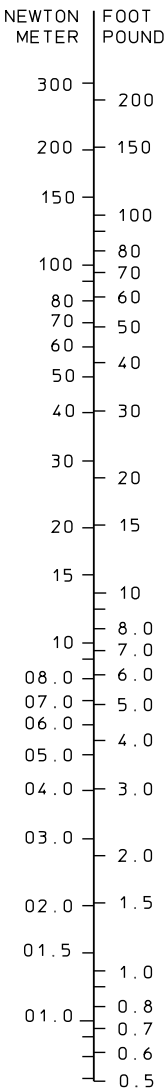
TEMPERATURE CONVERSION



VISCOSITY CONVERSION

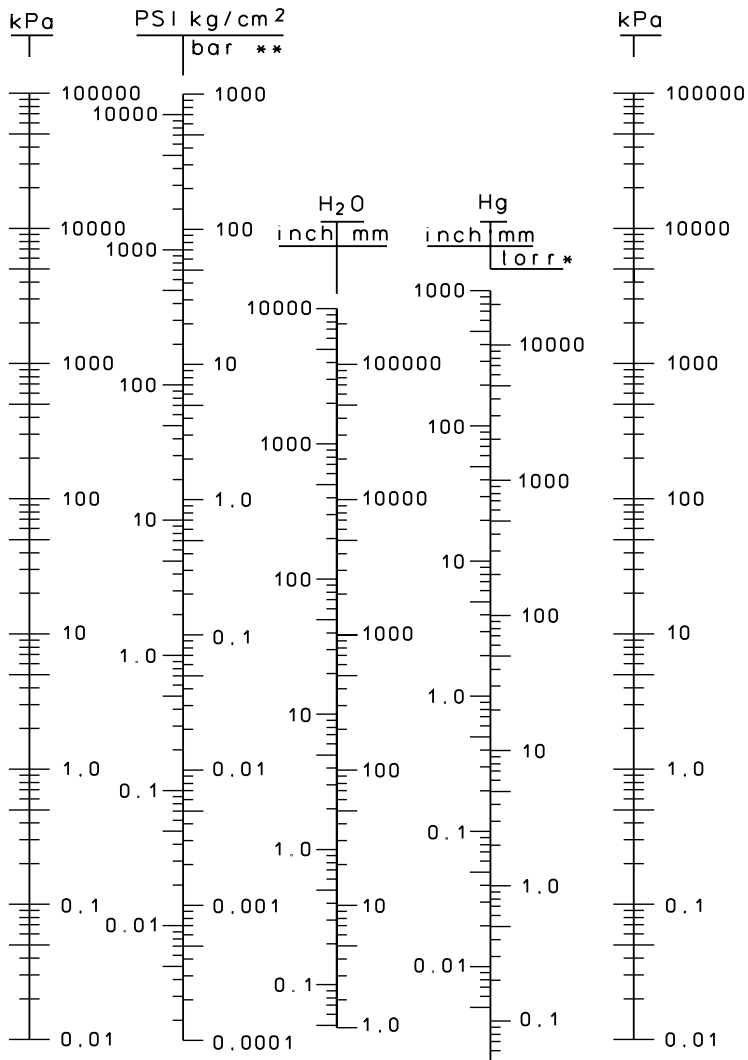


TORQUE CONVERSION CHART



CONNECT HORIZONTALLY

PRESSURE CONVERSION CHART



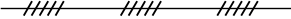
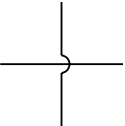
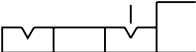
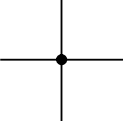
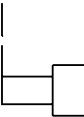
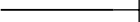
CONNECT HORIZONTALLY

NOTE: * 1 torr = 1 mm Hg = 0.535 inch H₂O

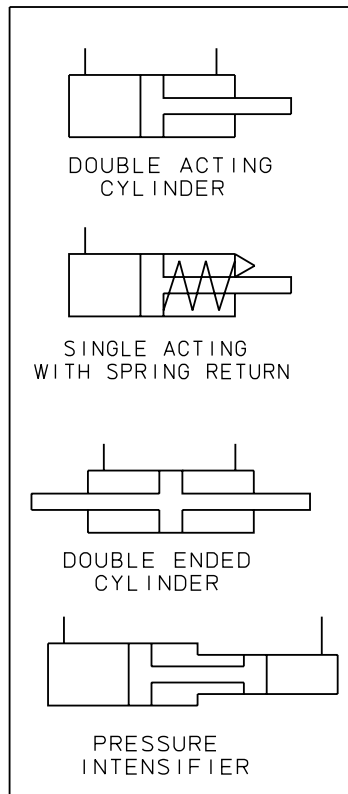
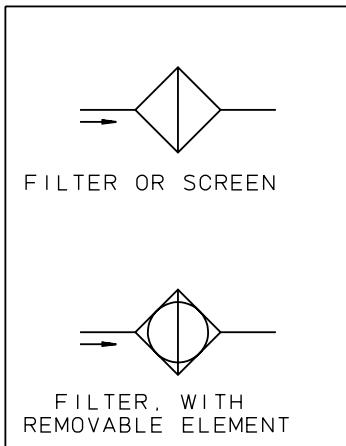
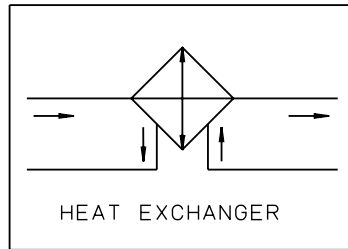
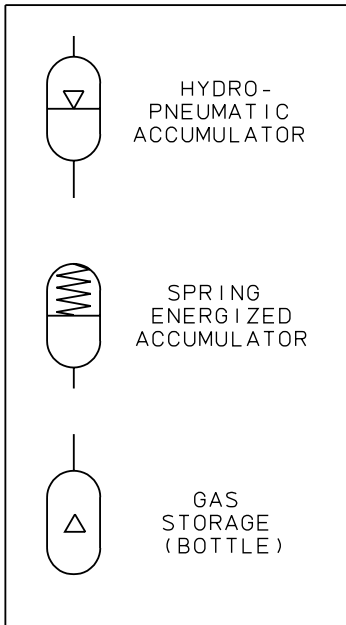
** 1 bar = 1.02 kg/cm² = 14.5 PSI

1 PSI = 6.895 kPa = 0.07031 kg/cm²

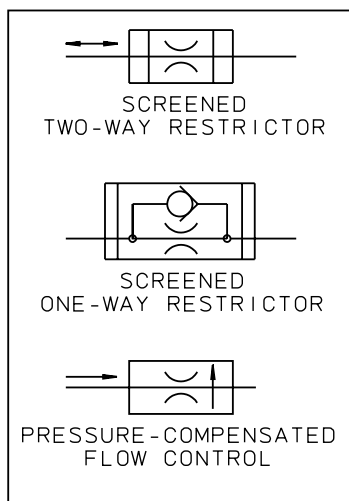
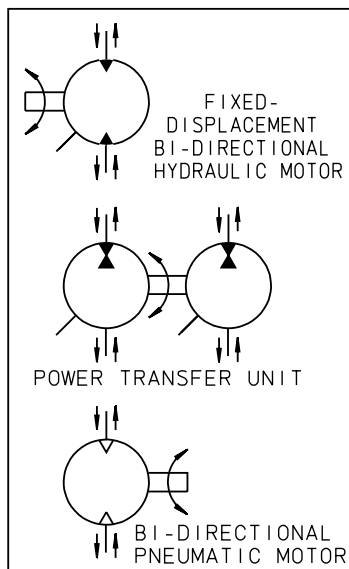
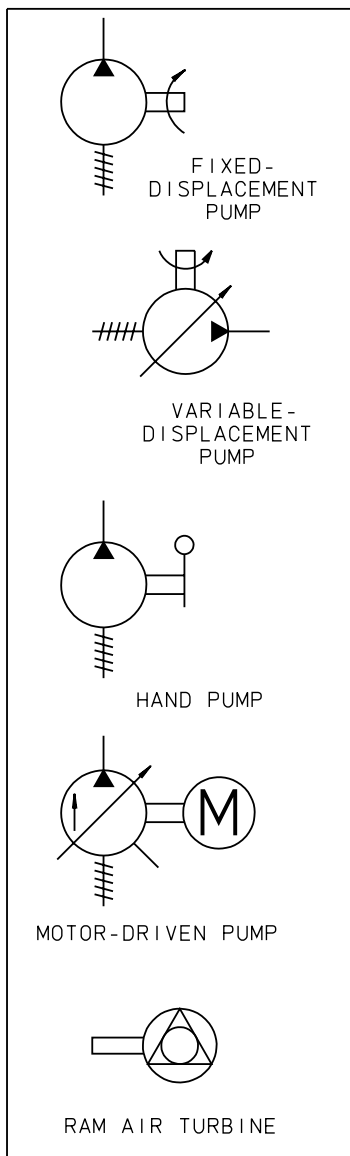
GRAPHIC SYMBOLS
FOR HYDRAULICS AND PNEUMATICS

 HIGH PRESSURE FLUID FLOW LINE	 SPRING FOR VALVE CONTROL
 HIGH PRESSURE PILOT LINE	 PUSH BUTTON
 RETURN LINE	 LEVER
 SUCTION LINE	 PEDAL
 LINES CROSSING	 DETENT
 LINES JOINING	 SOLENOID OPERATED
 FLEXIBLE HOSE	 PILOT OPERATED
 CAPPED LINE	

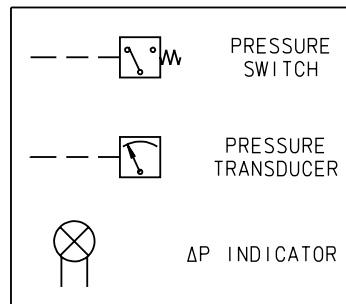
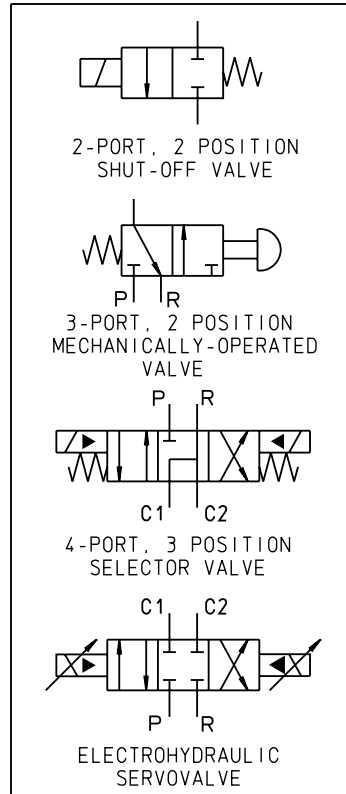
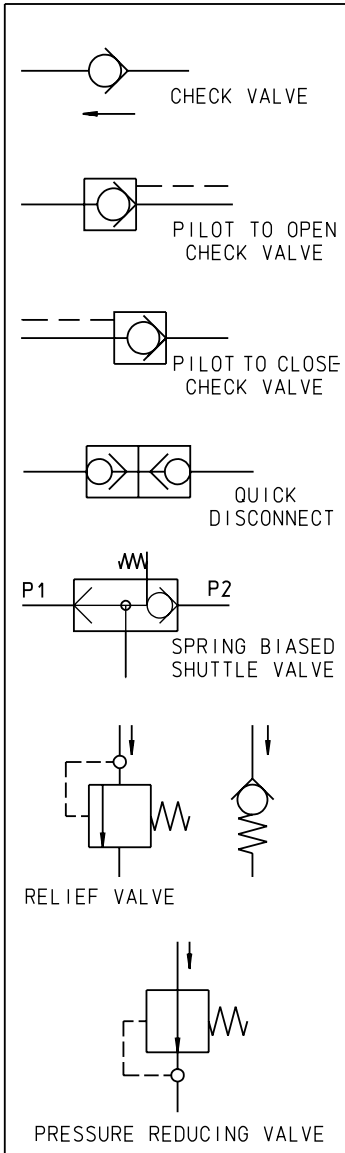
GRAPHIC SYMBOLS FOR HYDRAULICS AND PNEUMATICS



GRAPHIC SYMBOLS FOR HYDRAULICS AND PNEUMATICS



GRAPHIC SYMBOLS FOR HYDRAULICS AND PNEUMATICS



DEFINITIONS OF VISCOSITY

- *Absolute Viscosity* is the ratio of the shear stress in a fluid to the rate of shearing strain.
- *Unit of absolute viscosity* in the metric system: poise and centipoise;
 - 1 poise = 1 gm/(cm)(sec.)
 - 1 centipoise = 1/100 poise
- *Unit of absolute viscosity* in the English system:
 - slug/(ft.) (sec.); 1 slug/(ft.)(sec.) = 478.8 poise
- *Kinematic Viscosity* is the absolute viscosity ÷ density.
- *Unit of kinematic viscosity* in the metric system (and commonly used in the countries using the English system): stoke and centistoke;
 - 1 stoke = 1 poise/density (gm/ml)
 - 1 centistoke = 1/100 stoke
- *Other units of kinematic viscosity*; In the English system, the most practical unit for making calculations is ft.²/sec.;
 - 1 ft.²/sec. = 92903 centistokes
 - 1 centistoke = 1/92903 ft.²/sec.
- *Saybolt Universal Seconds*, SSU, is the kinematic viscosity as determined by the time in seconds required for 60 cc of fluid to flow through a standard orifice.
- *Saybolt-Furol*, SSF, utilizes a larger orifice and is used for very viscous fluids. Time of efflux is approx. 1/10 that of Universal.
- *Engler degrees* are obtained by dividing the outflow time of a specified amount of fluid through a specified orifice by the outflow time of water at 68°F. The method is used predominantly in European countries.
- *Viscosity Index* is an empirical number indicating the effect of temperature change on viscosity. Fluids with the same viscosity at a given temperature do not necessarily have the same viscosity index.
- *SAE Viscosity Numbers* are a means of classifying crankcase lubricating oils in terms of viscosity. Other factors are not considered.

NOTE: See [page C66](#) for conversions.

The dimensions and configurations in this handbook are for reference purposes only, and may be updated at any time. Contact The Lee Company for current inspection drawings.

POLICY FOR SPECIALLY FABRICATED PARTS

The Lee Company offers a wide range of standard products to help designers find the right solutions to their problems. Should your requirements fall beyond what is listed in this handbook, we will be pleased to work with you and develop a custom design that meets your exact application specifications as we have the capability to design and manufacture variations to the products listed in this handbook on a prototype basis or for future production.

In this case, we assign a special part number to the design and the subsequent purchase of this part number would be in accordance with the originators requirements. In some cases, a non-recurring charge may be necessary to partially offset the costs of design, manufacturing, testing or tooling. Our policy for specially designed products is that the design will be the sole property of the Lee Company, without exception.

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Buyer and seller (The Lee Company) shall comply with the laws and regulations of the United States of America (USA) relating to exports and foreign transactions, including but not limited to: the International Traffic in Arms Regulations (22 CFR, parts 120-130) and the Export Administration Regulations (15 CFR, parts 730-774). Buyer agrees to hold seller harmless due to Buyer's breach of such obligation.

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2. It is the clear intent of The Lee Company to encourage all members of the engineering profession to use the Lohm System, whether they are customers or competitors or others who could benefit from its use.

WARRANTY

The Lee Company is proud to warrant that all products described in this handbook are free from defect in design, workmanship and materials and that they conform to any applicable specifications, drawings or approved samples.

Our products will only operate as well as the systems in which they are installed. We therefore expect the buyers of our products to be responsible for the proper design and fabrication of the systems in which our products are used. In order to assist our customers, we maintain a staff of sales engineers that can recommend the proper products to satisfy a particular system requirement. However, the buyer assumes sole responsibility of verifying the compatibility of our products with the fluid media.

Should any Lee Company product not satisfy this warranty, we will promptly repair or replace it within a four (4) year period or the product's published cycle life, whichever is less, without responsibility for indirect, incidental, consequential, or punitive damages, provided the product was used for its intended purpose and in its intended environment. This constitutes the exclusive remedy available to the buyer. The Lee Company disclaims any express or implied warranty for merchantability or fitness for a particular purpose.

This warranty shall apply only on the conditions that; Buyer purchased the items directly from the Lee Company or a Lee Company Authorized Representative (as per the Lee Company website), potential defects are reported to us in a timely manner, potentially defective items have been returned to us for analysis, Lee Company engineering has determined the products to be defective, and the products have not been subject to any modification or replication program (i.e. reverse engineering), either formal or informal, sponsored or supported by Buyer.

Should any Lee product fail to perform to its specifications as stated in this handbook, a Returned Material Authorization, "RMA", number is required prior to returning the product. Please contact The Lee Company for the RMA number. Products returned without an RMA number may not be accepted.

U.S. Sales Offices

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Tel: 860 399-6281

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Tel: 972 791-1010

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Tel: 206 495-2825

Huntington Beach, California

Tel: 972 951-1057

International Sales Offices

Lee Products Limited – London

Subsidiary / United Kingdom & Ireland

Tel: + 44 1753 886664

sales@leeproducts.co.uk

LEE COMPANY S.A. – Paris

Subsidiary / France, Spain & French speaking Switzerland

Tel: + 33 1 30 64 99 44

info@leecompany.fr

Toulouse Office Tel: + 33 5 67 31 0092

t.jullien@leecompany.fr

Madrid Office Tel: + 34 913 010 572

pablo.sanchez@leecompany.es

Lee Hydraulische

Miniatürkompontenten GmbH – Frankfurt

Subsidiary / Germany, Austria, Eastern Europe & German speaking Switzerland

Tel: + 49 6169 773690

info@lee.de

Lee SRL. – Milan

Subsidiary / Italy & Italian speaking Switzerland

Tel: + 39 02 43981750

sales@leesrl.it

The Lee Company

Scandinavia AB – Stockholm

Subsidiary / Denmark, Sweden, Norway, & Finland

Tel: + 46 8 579 70170

Helsinki, Finland Office Tel: + 358 44 0111 246

sales@theleeco.se

Distributor for Belgium, Netherlands and Luxemburg

Denis de Ploeg BV

Tel: + 31 43 820 0250

info@ddp.nl

Distributor for Australia and New Zealand

CGB Precision Products Pty Ltd

Tel: + 61 3 9775 1125

sales@cgb.com.au

Distributor for People's Republic of China and Hong Kong

EBS Flow Control, Ltd.

Tel: + 86 10 84721177

info@ebshk.com.cn

Distributor for Japan

Jupitor Corporation

Tel: + 81 33 403 1315

lee-sales@jupitor.co.jp

Distributor for Korea

Min Sung GC Corporation

Tel: + 82 2 961 7833

minsung@minsunggc.com

Distributor for Taiwan

Windarc Technology Co., Ltd.

Tel: + 886 9 6307 0609

windarc.chen@gmail.com

Agent for South America

Trusty Comércio e Representações Ltda.

Tel: + 55 12 3132 3418

+ 55 12 98127 5339

rui@tcr-brazil.com.br

Agent for Israel

ENL Engineering and Logistics Ltd.

Tel: + 972 3 549 3644

enleng@netvision.net.il

Agent for India

Hind Industrial and Mercantile Corp. Pvt. Ltd.

Tel: +91 99204 05099

sales@hindco.in

Agent for Singapore, Indonesia, Thailand and Malaysia

Winova Pte. Ltd.

Tel: + 65 6425 2116

sales@winova.com.sg



**The Lee Company
Industrial Microhydraulics Group**

82 Pequot Park Road
Westbrook, Connecticut 06498-0424 USA

Tel: 860 399-6281

Fax: 860 399-7058 (Order Entry)
860 399-4842 (Technical Information)

www.theleeco.com

**Technical Services and Sales Information also
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Chicago, IL.....773 693-0880

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