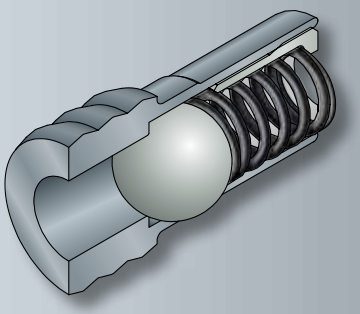
IMH Handbook of Hydraulics and Pneumatics



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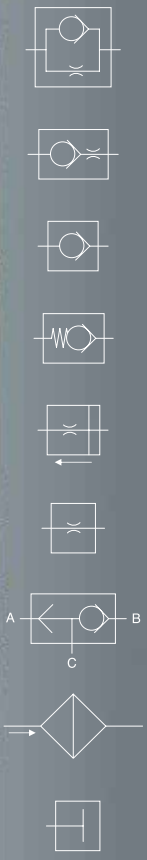
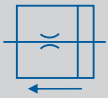


Innovation in Miniature

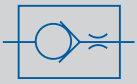
LEE®

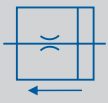
THE LEE COMPANY

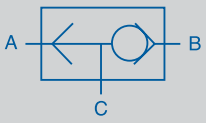
Industrial Microhydraulics Group

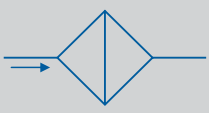



The Lee Company






IMH Handbook of Hydraulics and Pneumatics

8th Edition

THE LEE COMPANY
INDUSTRIAL
MICROHYDRAULICS GROUP

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Phone: 860 399-6281

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860 399-4842 (technical information)

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 at its Technical Centers in Westbrook and Essex, Connecticut where all manufacturing is performed. 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 and San Bruno, Chicago, Tampa, Dallas, Detroit, and at the Technical Center 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 contact us here at the Technical Center, or contact the field sales office (see page C76) nearest you.

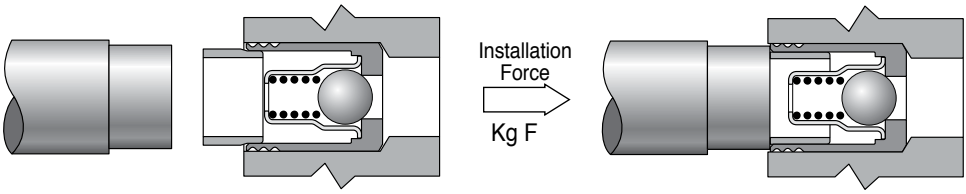
IMH HANDBOOK

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.

INSERTS INTRODUCTION

INSERTS

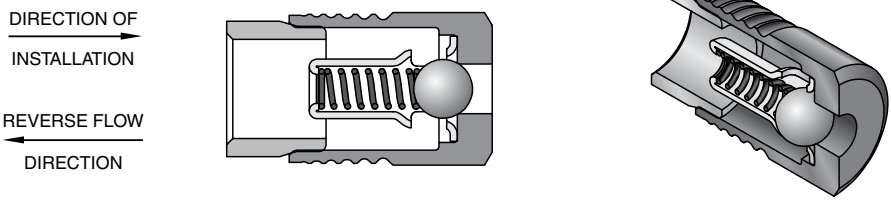
The first section of the Handbook contains products intended for installation into metals (Section Two products are to be installed into plastic). The inserts are designed using the insert principle, which uses a pin to expand a grooved section of the insert's body into the housing wall to effect a seal 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.



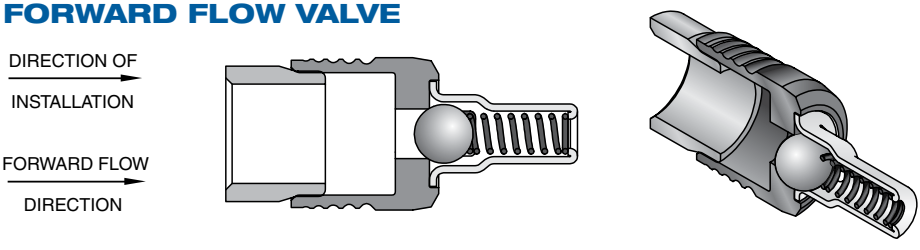
The insert principle eliminates the need for threads and o-rings. Simply insert the component into a drilled hole and drive the expander pin flush to within 0.25mm (0.010") above flush of the insert. The installation tool can bottom on the insert body. Lee Installation Tools are available for each product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



FORWARD FLOW VALVE



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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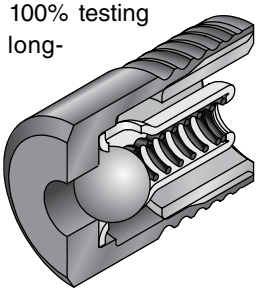
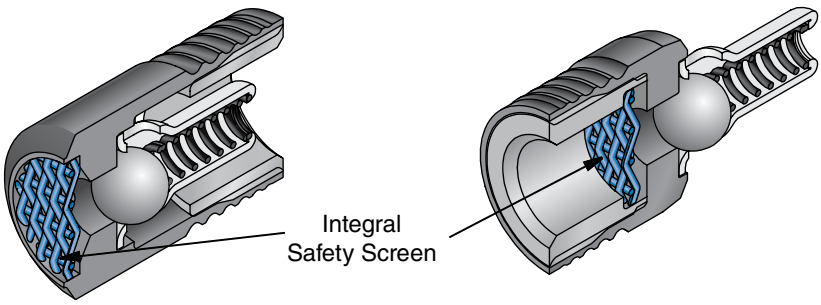
INSERT CHECK VALVES

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.



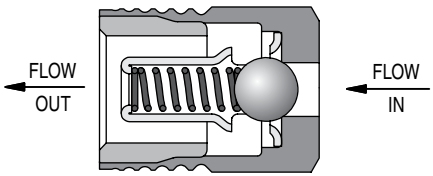
A high quality metal to metal seat limits leakage in the checked direction to no more than 20 sccm of air at 172 kPa (25 psi) differential. The valves are compatible with hydraulic fluids, brake fluids, fuels and oils. Integral safety screen protection is available, (see drawings below).



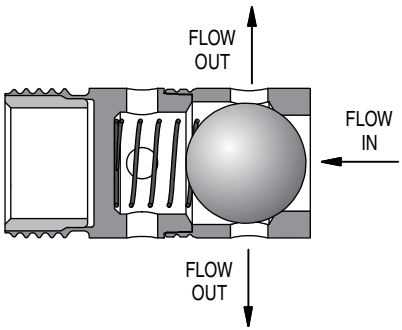
Screened Reverse **Screened Forward**

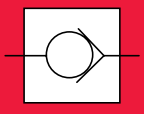
IMH Cheks come in two styles, “axial” and “side exit,” (see drawings below). 558, 855 and 400 Bar models are axial flowing and the 832 models are side exit flowing. Some models are available with a ceramic ball as standard.

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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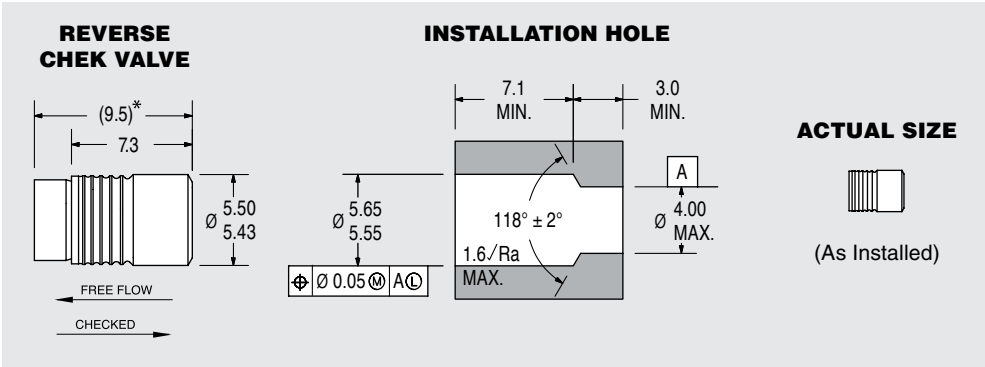
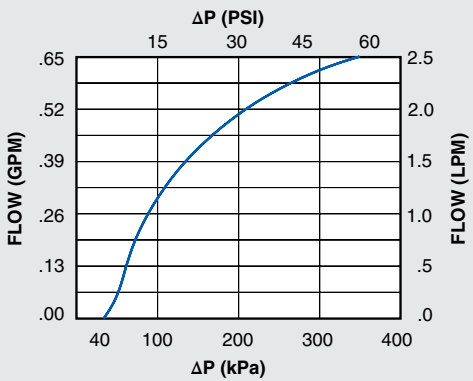
INSERT CHECK VALVES

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

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)

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)

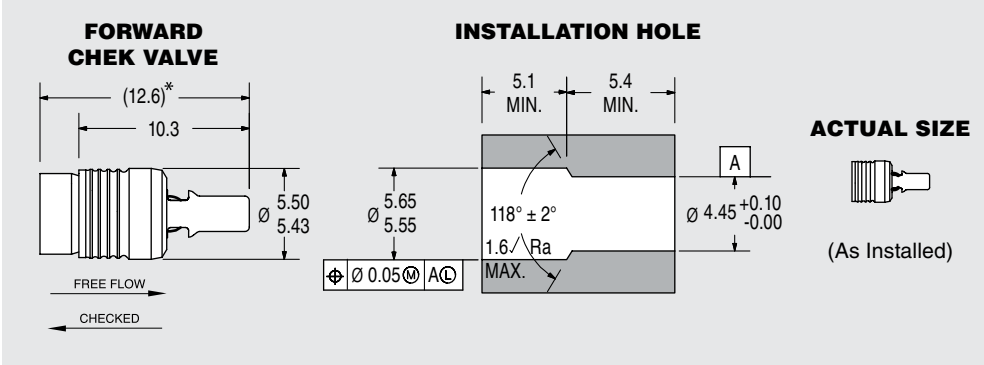
MATERIALS

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

INSTALLATION

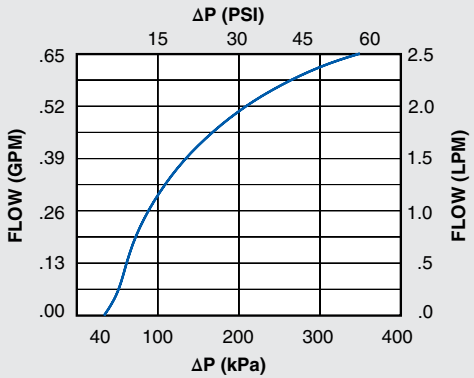
Tool Part Number CCRT0900120S
Force ..... 625 Kg F (max.)
For installation procedure see page A1.

558 SERIES CHEK VALVE – FORWARD FLOW



* *LOA before installation.*
All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

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)

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

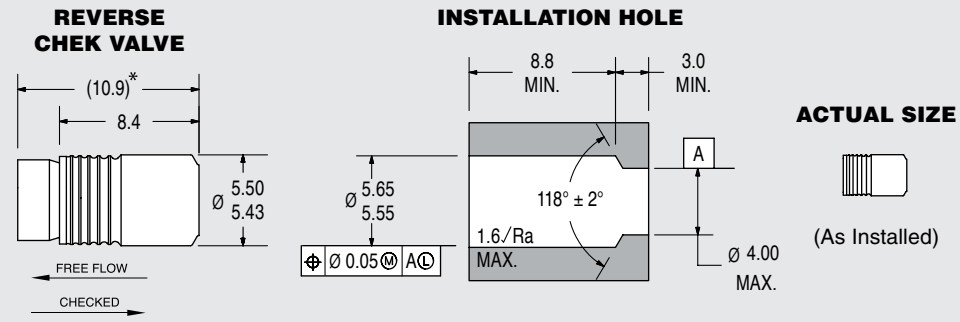
Body ..... 303 Stainless Steel
Cage ..... 305 Stainless Steel
Pin ..... 416 Stainless Steel
Spring ..... 302 Stainless Steel
Ball..... 440C Stainless Steel

INSTALLATION

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

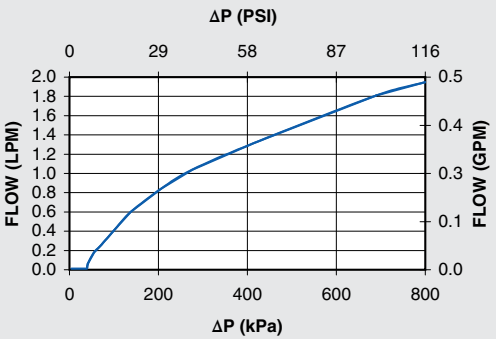
INSERT CHECK VALVES

558 SERIES CHEK VALVE – SCREENED REVERSE FLOW



* *LOA before installation.*
All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

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)

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)

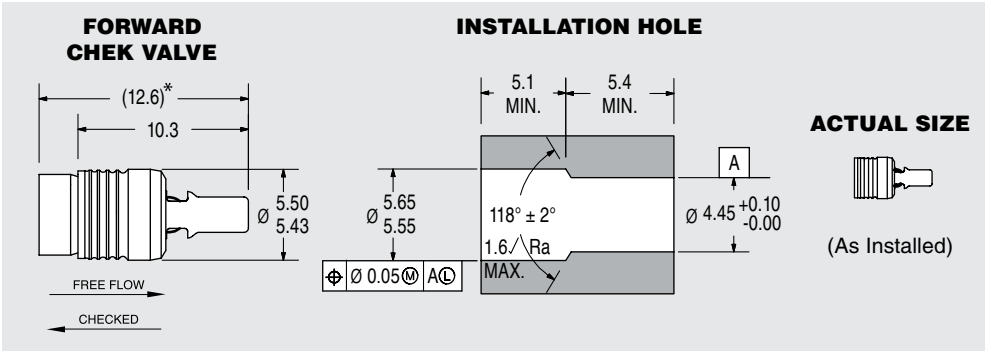
MATERIALS

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

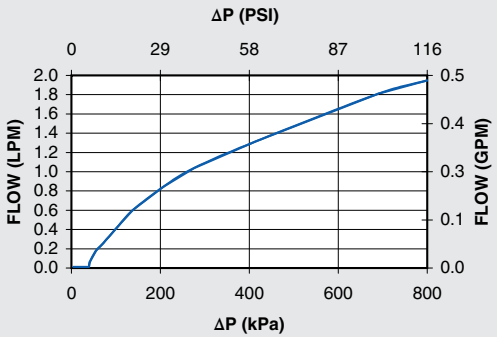
Tool Part Number CCRT0900120S
Force ..... 625 Kg F (max.)
For installation procedure see page A1.

558 SERIES CHEK VALVE – SCREENED FORWARD FLOW



* *LOA before installation.*
All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

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)

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

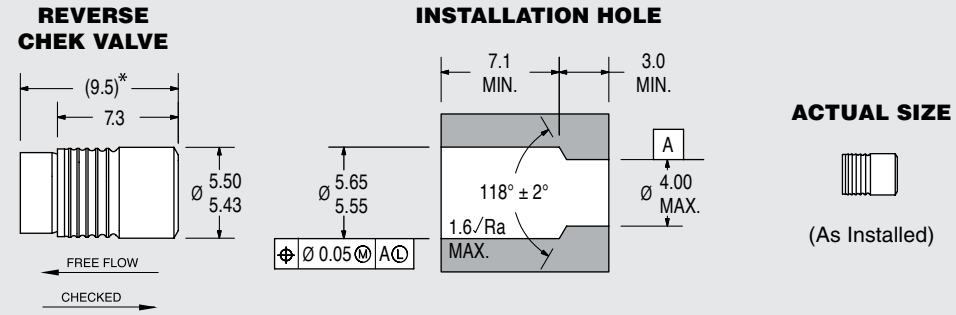
Body ..... 303 Stainless Steel
Cage ..... 305 Stainless Steel
Pin ..... 303 Stainless Steel
Spring ..... 302 Stainless Steel
Ball..... 440C Stainless Steel
Screen ..... 316 Stainless Steel

INSTALLATION

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

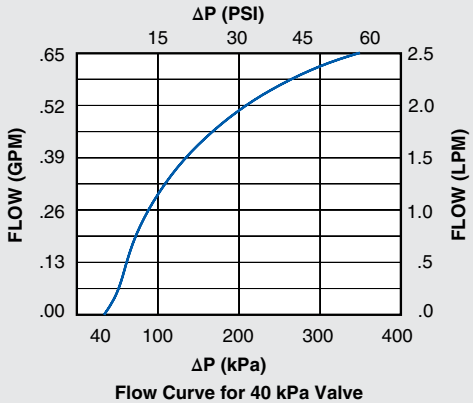
INSERT CHECK VALVES

558 SERIES CHEK VALVE – CERAMIC BALL REVERSE FLOW



* *LOA before installation.*
All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

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)

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)

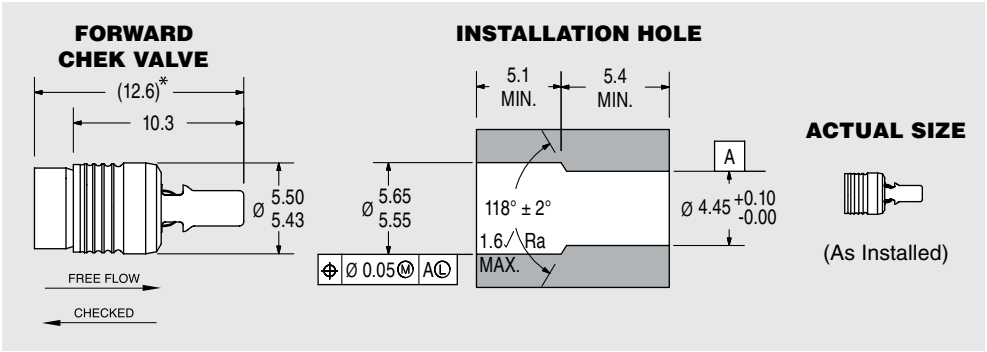
MATERIALS

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

INSTALLATION

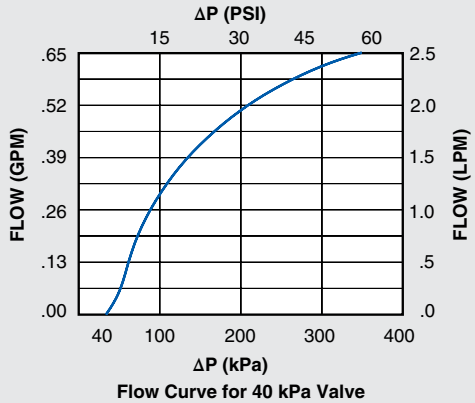
Tool Part Number CCRT0900120S
Force ..... 625 Kg F (max.)
For installation procedure see page A1.

558 SERIES CHEK VALVE – CERAMIC BALL FORWARD FLOW



* *LOA before installation.*
All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

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)

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

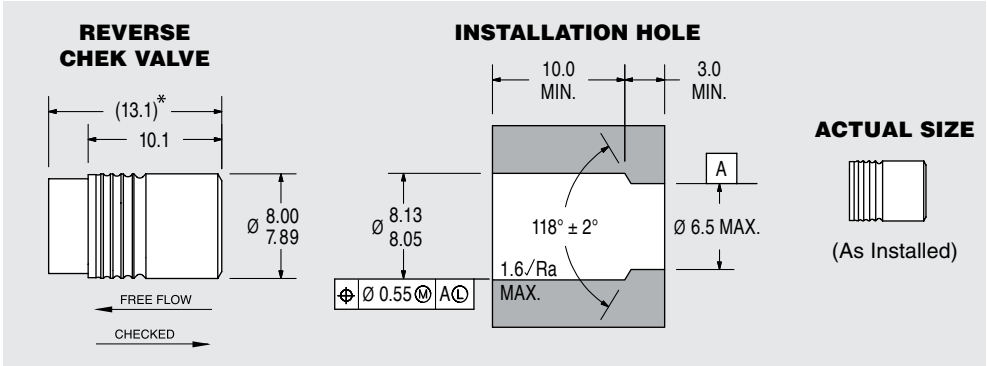
Body ..... 303 Stainless Steel
Cage ..... 305 Stainless Steel
Pin ..... 416 Stainless Steel
Spring ..... 302 Stainless Steel
Ball..... Ceramic

INSTALLATION

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

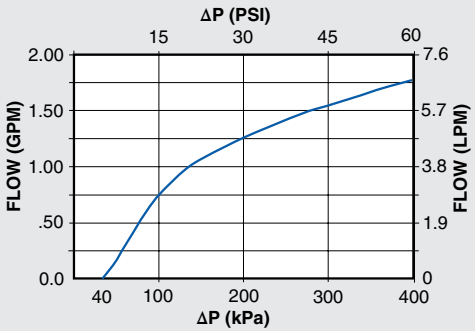
INSERT CHECK VALVES

855 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

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)

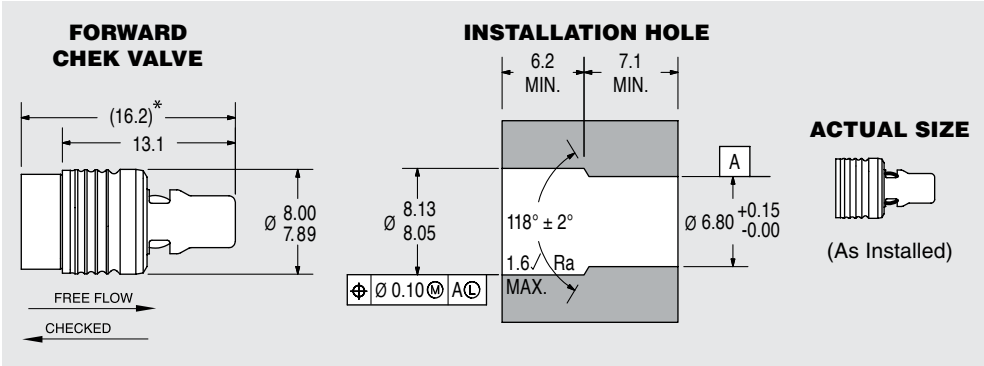
MATERIALS

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

INSTALLATION

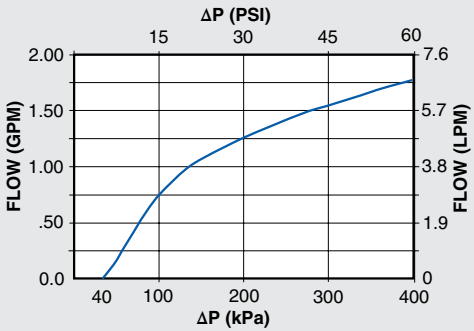
Tool Part Number CCRT0900150S
Force ..... 680 Kg F (max.)
For installation procedure see page A1.

855 SERIES CHEK VALVE – FORWARD FLOW



* *LOA before installation.*
All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

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

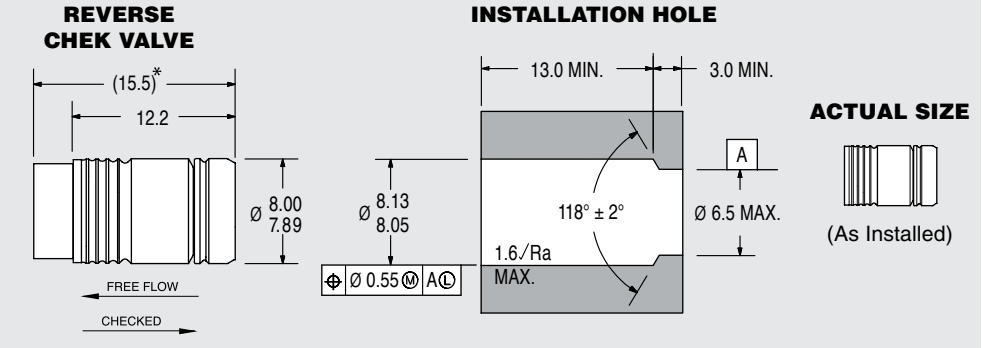
LEE PART NO.	CRACKING PRESSURE
CCFM2800200S	0 kPa (No Spring)
CCFM2800204S	4 ± 3 kPa (0.6 ± 0.4 psid)
CCFM2800207S	7 ± 5 kPa (1 ± 0.7 psid)
CCFM2800214S	14 ± 5 kPa (2 ± 0.7 psid)
CCFM2800240S	40 ± 30 kPa (6 ± 4.4 psid)
CCFM2800269S	69 ± 30 kPa (10 ± 4.4 psid)

INSTALLATION

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

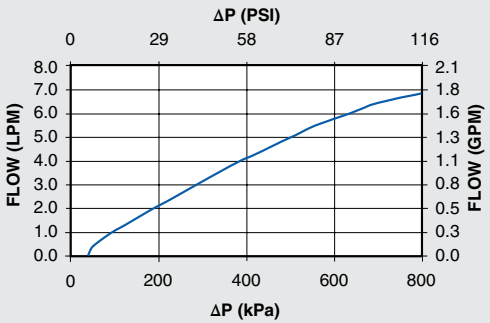
INSERT CHECK VALVES

855 SERIES CHEK VALVE – SCREENED REVERSE FLOW



* *LOA before installation.*
All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

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)

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

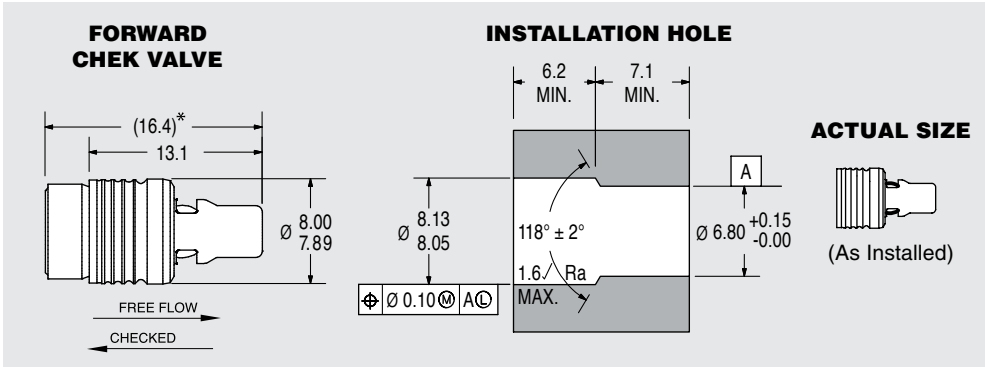
INSTALLATION

Tool Part Number CCRT0900150S

Force ..... 680 Kg F (max.)

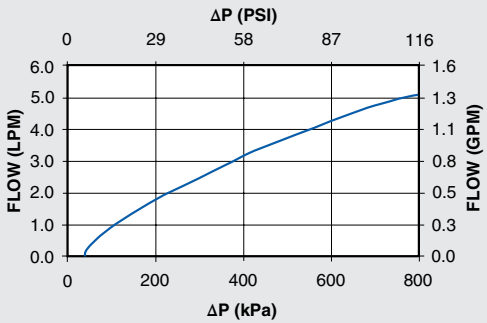
For installation procedure see page A1.

855 SERIES CHEK VALVE – SCREENED FORWARD FLOW



* *LOA before installation.*
All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

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)

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

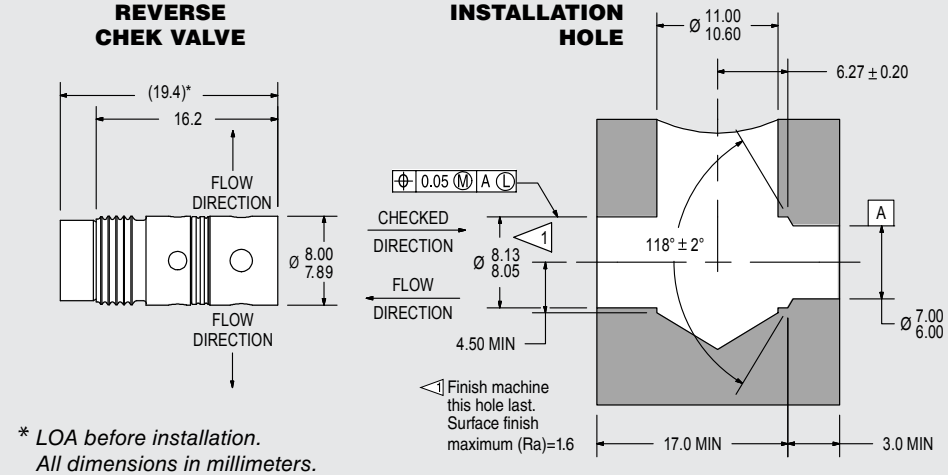
Body ..... 303 Stainless Steel
Cage ..... 305 Stainless Steel
Pin ..... 303 Stainless Steel
Spring ..... 302 Stainless Steel
Ball..... 440C Stainless Steel
Screen ..... 316 Stainless Steel

INSTALLATION

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

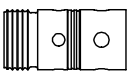
INSERT CHECK VALVES

832 SERIES SIDE EXIT CHEK VALVE
REVERSE FLOW



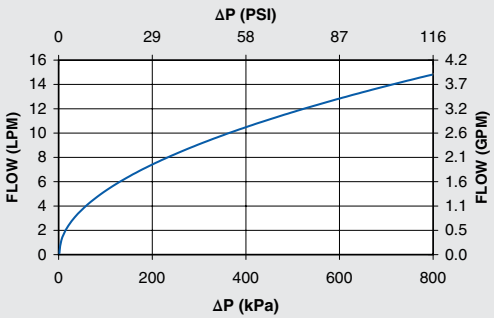
* *LOA before installation.*
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

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

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)

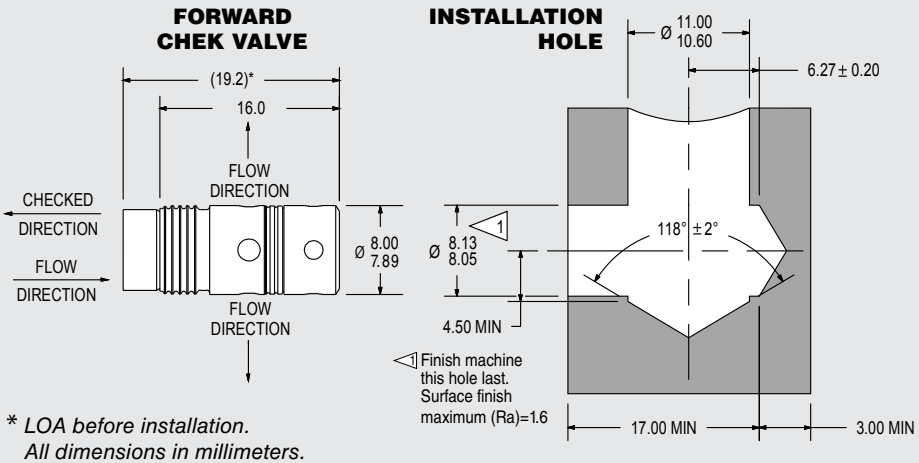
MATERIALS

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

INSTALLATION

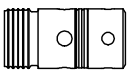
Tool Part Number CCRT0900150S
Force ..... 545 Kg F (min.)
635 Kg F (max.)
For installation procedure see page A1.

832 SERIES SIDE EXIT CHEK VALVE
FORWARD FLOW



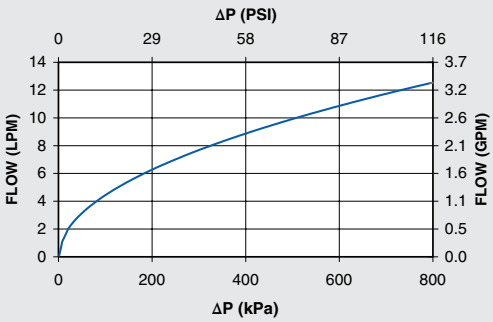
* *LOA before installation.*
All dimensions in millimeters.

ACTUAL SIZE



(As Installed)

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 0 kPa Valve

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

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

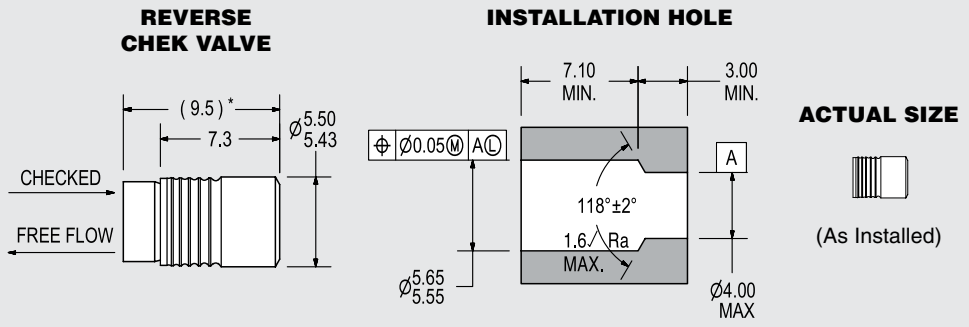
Upper Body.....303 Stainless Steel
Lower Body.....303 Stainless Steel
Pin .....416 Stainless Steel
Spring .....302 Stainless Steel
Ball.....440C Stainless Steel

INSTALLATION

Tool Part Number CCRT0900150S
Force ..... 545 Kg F (min.)
635 Kg F (max.)
For installation procedure see page A1.

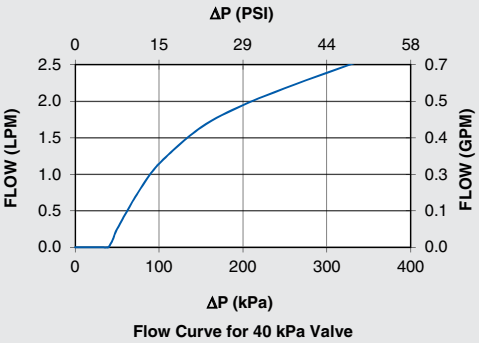
INSERT CHECK VALVES

400 BAR 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

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)

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)

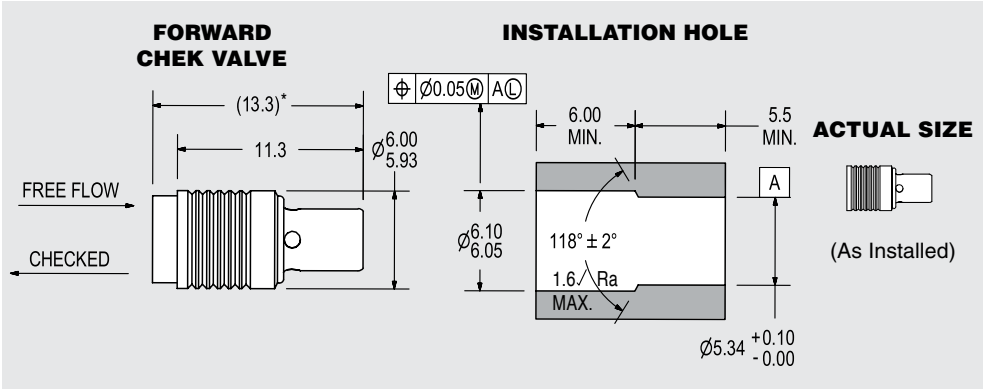
MATERIALS

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

INSTALLATION

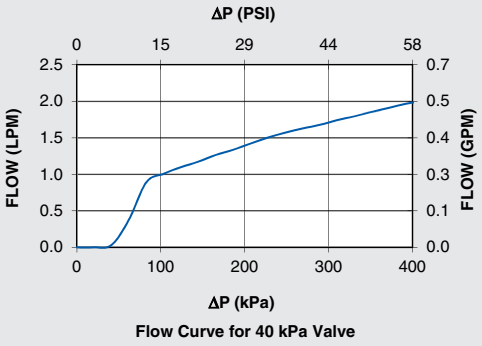
Tool Part Number CCRT0900120S
Force ..... 625 Kg F (max.)
For installation procedure see page A1.

400 BAR CHEK VALVE
FORWARD FLOW



* *LOA before installation.*
All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

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)

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.

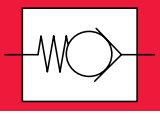
INSERT RELIEF VALVES

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.



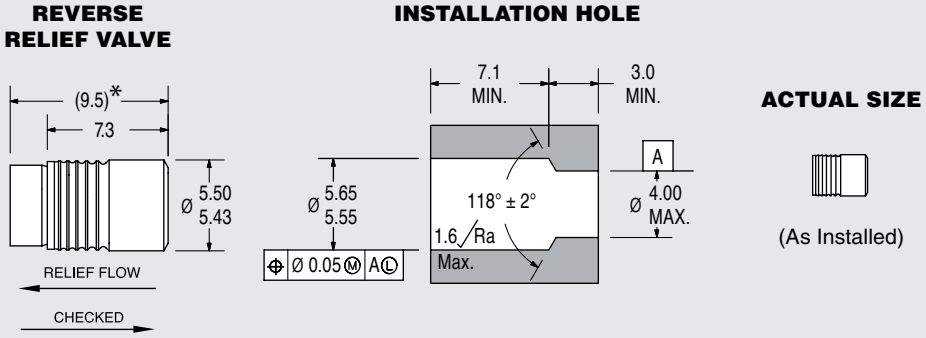
Features and Benefits

- 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.

TABLE OF CONTENTS

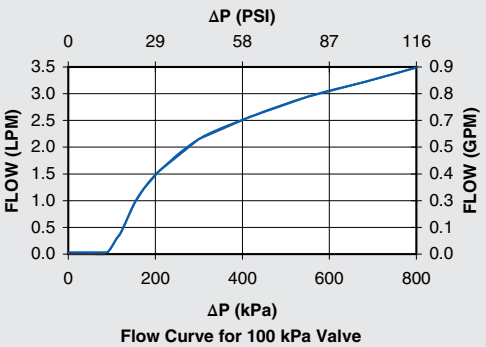
INSERT RELIEF VALVES

558 SERIES RELIEF VALVE – REVERSE FLOW



All dimensions are in millimeters.
* *LOA before installation*

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 100 kPa Valve

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)

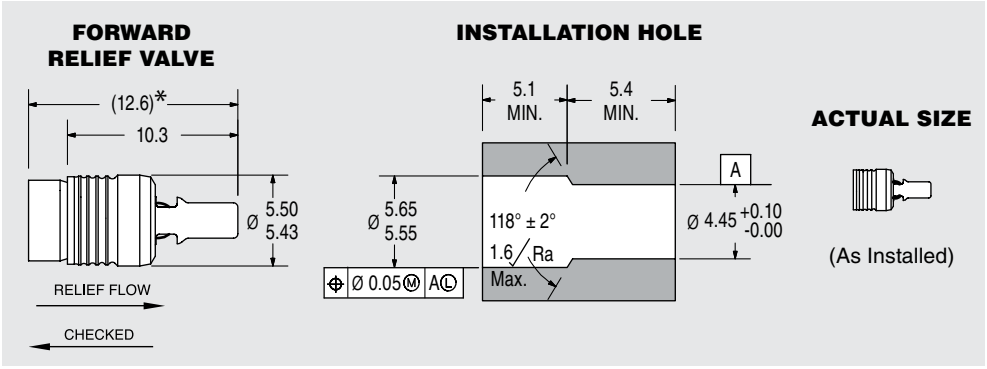
MATERIALS

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

INSTALLATION

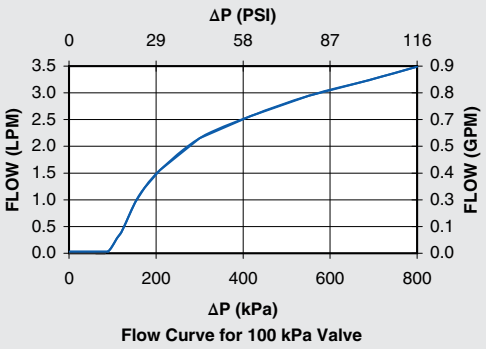
Tool Part Number CCRT0900120S
Force ..... 625 Kg F (max.)
For installation procedure see page A1.

558 SERIES RELIEF VALVE – FORWARD FLOW



All dimensions are in millimeters.
** LOA before installation*

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 100 kPa Valve

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

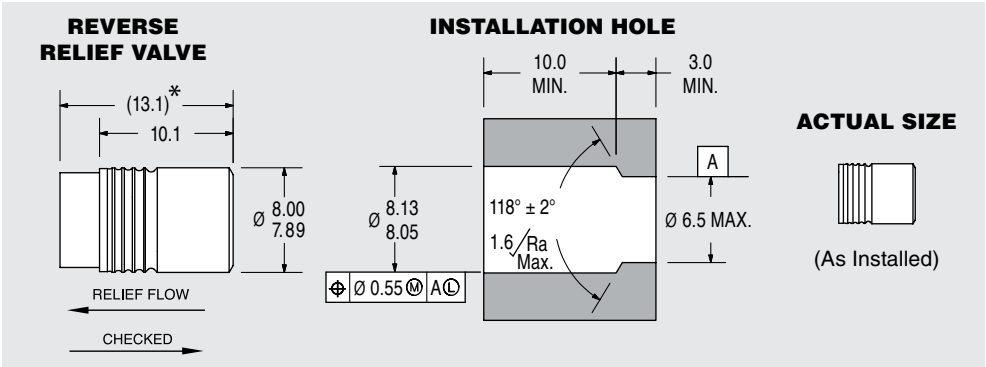
Body ..... 303 Stainless Steel
Cage ..... 305 Stainless Steel
Pin ..... 416 Stainless Steel
Spring ..... 302 Stainless Steel
Ball..... 440C Stainless Steel

INSTALLATION

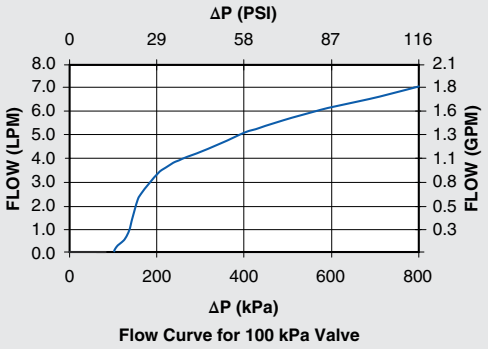
Tool Part Number CCRT0900120S
Force ..... 625 Kg F (max.)
For installation procedure see page A1.

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)

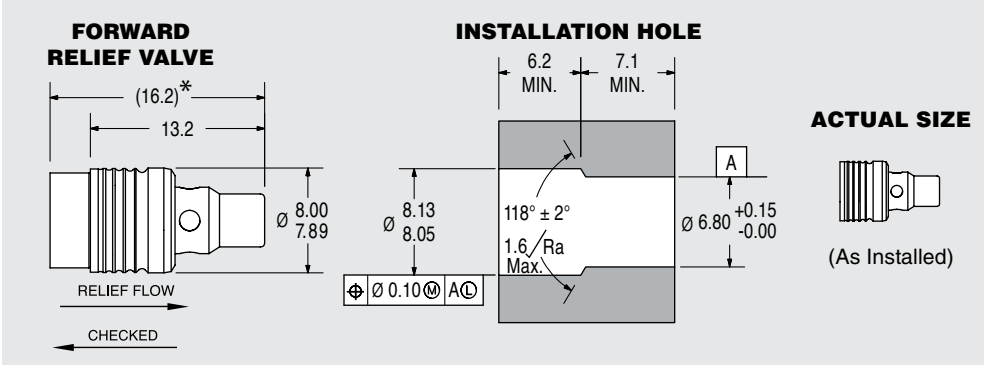
MATERIALS

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

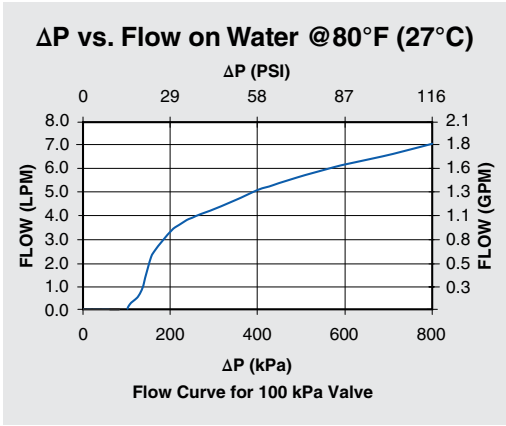
INSTALLATION

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*



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
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)

MATERIALS

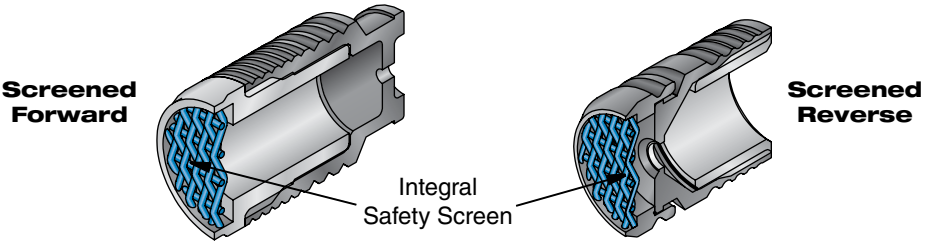
Body ..... 303 Stainless Steel
Cage ..... 416 Stainless Steel
Pin ..... 416 Stainless Steel
Spring ..... 302/17-7* Stainless Steel
Ball..... 440C Stainless Steel

INSTALLATION

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

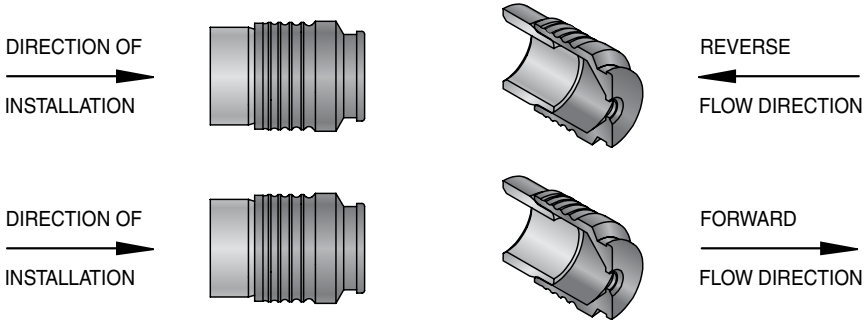
INSERT ORIFICES

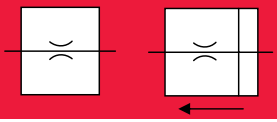
IMH Orifices are economical, reliable, highly accurate miniature restrictors. These orifices are 100% flow tested to ensure that every part is within ± 5% of its nominal flow rate. Tighter flow tolerances are available as specials. Tight flow tolerances are only possible if entrance and exit conditions 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

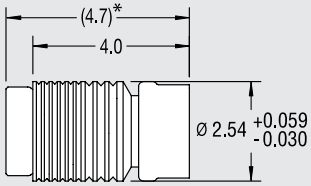
- Accurate flow
  - Eliminate expensive alternative components.
  - More consistent system performance.
- Self retained
  - Easy installation.
  - Maintains flow accuracy.
- Integral safety screens
  - Saves space and weight.
  - Simplifies assembly.
  - Ensures reliability.
- 100% flow tested
  - All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

TABLE OF CONTENTS

INSERT ORIFICES

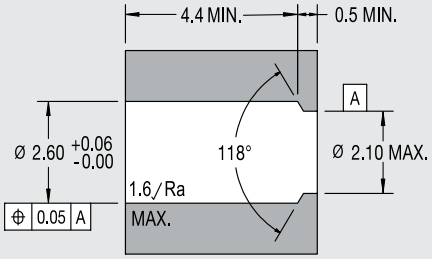
2.5mm INSERT ORIFICE FOR LIQUIDS SCREENED – REVERSE FLOW

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

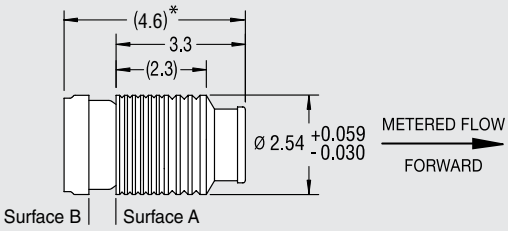
Body ..... 303 Stainless Steel
Pin ..... 416 Stainless Steel
Screen ..... 316 Stainless Steel

INSTALLATION

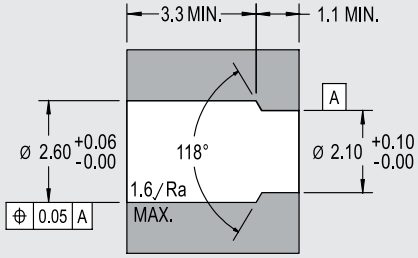
Tool Part Number..... CCRT0029354S
Force..... 178 Kg F (max.)
For installation procedure see page A1.

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

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.

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 ..... 303 Stainless Steel
Screen ..... 316 Stainless Steel

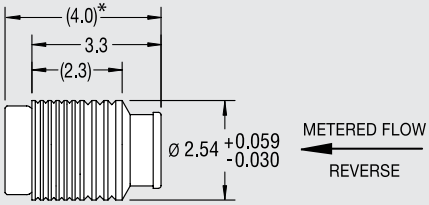
INSTALLATION

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

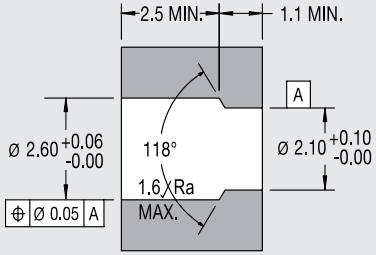
INSERT ORIFICES

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

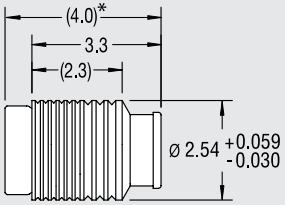
Tool Part Number..... CCRT0029354S

Force..... 178 Kg F (max.)

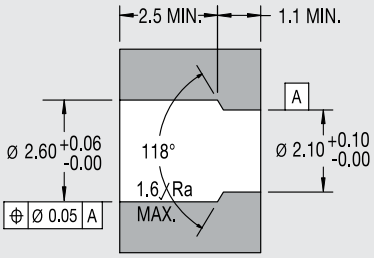
For installation procedure see page A1.

2.5mm INSERT ORIFICE FOR LIQUIDS UNSCREENED – FORWARD FLOW

IMH ORIFICE UNSCREENED



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: ± 5%

Test Fluid: Distilled Water

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

MATERIALS

Body ..... 303 Stainless Steel

Pin ..... 416 Stainless Steel

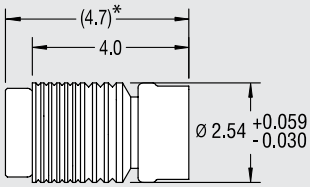
INSTALLATION

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

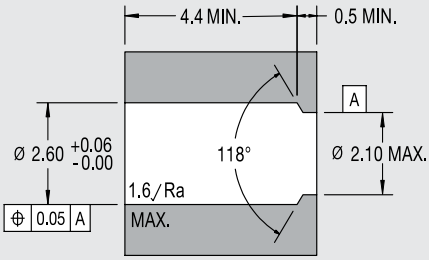
INSERT ORIFICES

2.5mm INSERT ORIFICE FOR GASES SCREENED – REVERSE FLOW

IMH ORIFICE SCREENED



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

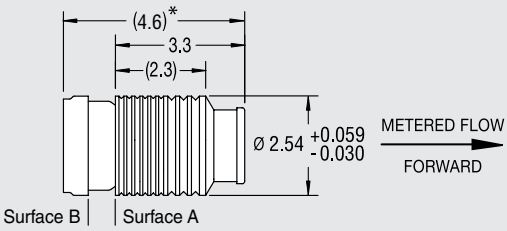
Body ..... 303 Stainless Steel
Pin ..... 416 Stainless Steel
Screen ..... 316 Stainless Steel

INSTALLATION

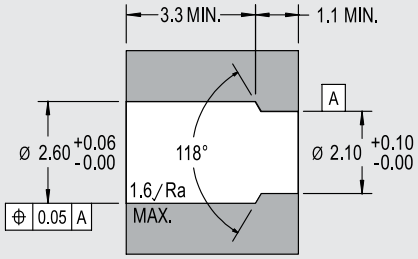
Tool Part Number..... CCRT0029354S
Force..... 178 Kg F (max.)
For installation procedure see page A1.

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

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.

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 ..... 303 Stainless Steel
Screen ..... 316 Stainless Steel

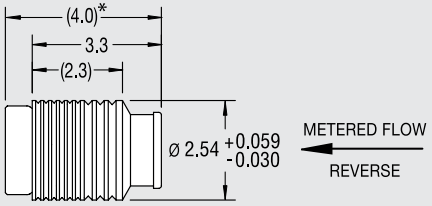
INSTALLATION

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

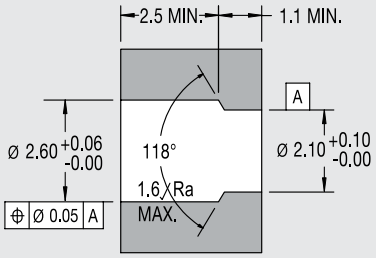
INSERT ORIFICES

2.5mm INSERT ORIFICE FOR GASES UNSCREENED – REVERSE FLOW

IMH ORIFICE UNSCREENED



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

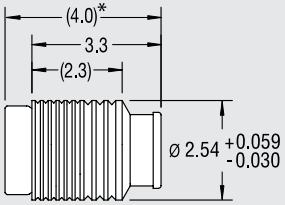
Tool Part Number..... CCRT0029354S

Force..... 178 Kg F (max.)

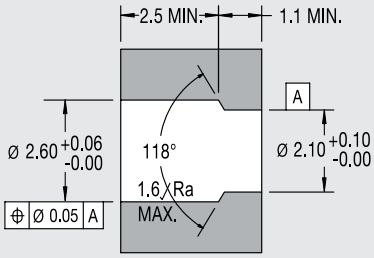
For installation procedure see page A1.

2.5mm INSERT ORIFICE FOR GASES UNSCREENED – FORWARD FLOW

IMH ORIFICE UNSCREENED



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: ± 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

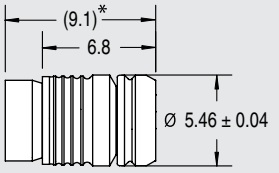
INSTALLATION

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

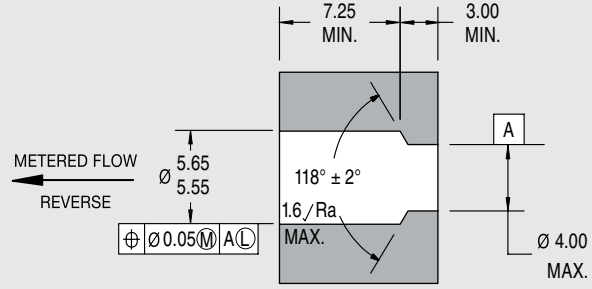
INSERT ORIFICES

5.5mm INSERT ORIFICE FOR LIQUIDS SCREENED – REVERSE FLOW

IMH ORIFICE SCREENED



INSTALLATION HOLE SCREENED REVERSE



* *LOA before installation.*
All dimensions in millimeters.

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

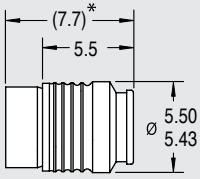
Body ..... 303 Stainless Steel
Pin ..... 416 Stainless Steel
Screen ..... 316 Stainless Steel

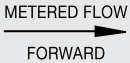
INSTALLATION

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

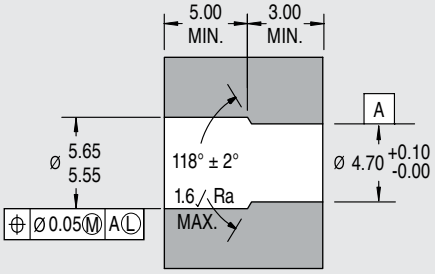
5.5mm INSERT ORIFICE FOR LIQUIDS SCREENED – FORWARD FLOW

IMH ORIFICE SCREENED





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: ± 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

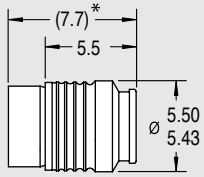
INSTALLATION

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

INSERT ORIFICES

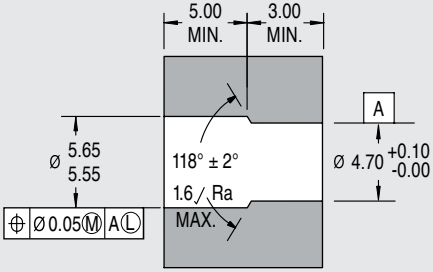
5.5mm INSERT ORIFICE FOR LIQUIDS UNSCREENED – REVERSE FLOW

IMH ORIFICE UNSCREENED



METERED FLOW
REVERSE

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

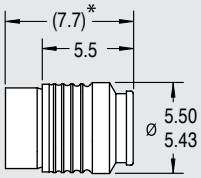
Pin ..... 416 Stainless Steel

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

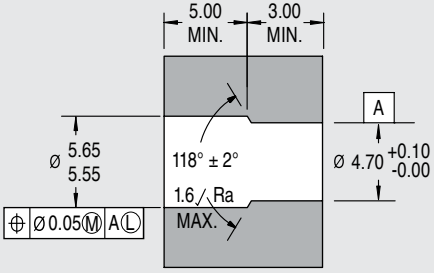
IMH ORIFICE UNSCREENED



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: ± 5%

Test Fluid: Distilled Water

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

MATERIALS

Body ..... 303 Stainless Steel

Pin ..... 416 Stainless Steel

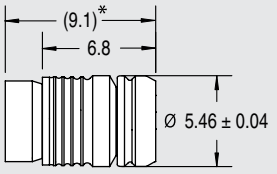
INSTALLATION

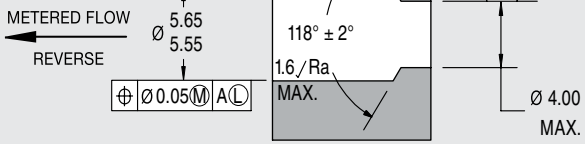
Tool Part Number..... CCRT0900120S
Force..... 625 Kg F (max.)
For installation procedure see page A1.

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

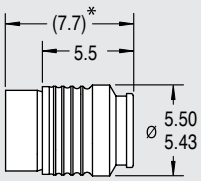
Body ..... 303 Stainless Steel
Pin ..... 416 Stainless Steel
Screen ..... 316 Stainless Steel

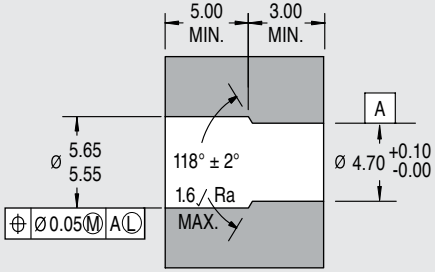
INSTALLATION

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





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: ± 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

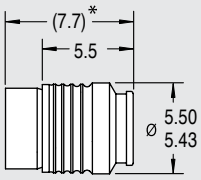
INSTALLATION

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

INSERT ORIFICES

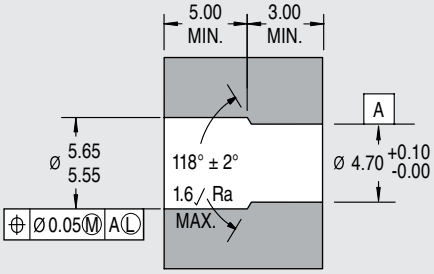
5.5mm INSERT ORIFICE FOR GASES UNSCREENED – REVERSE FLOW

IMH ORIFICE UNSCREENED



METERED FLOW
REVERSE

INSTALLATION HOLE UNSCREENED



* *LOA before installation.*
All dimensions in millimeters.

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

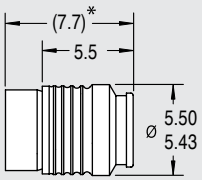
Pin ..... 416 Stainless Steel

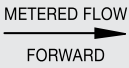
INSTALLATION

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

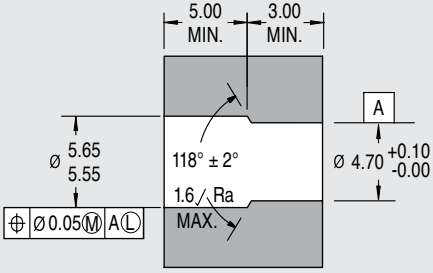
5.5mm INSERT ORIFICE FOR GASES UNSCREENED – FORWARD FLOW

IMH ORIFICE UNSCREENED





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: ± 5%

Test Fluid: Clean & Dry Nitrogen

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

MATERIALS

Body ..... 303 Stainless Steel

Pin ..... 416 Stainless Steel

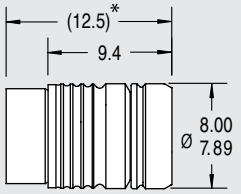
INSTALLATION

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

INSERT ORIFICES

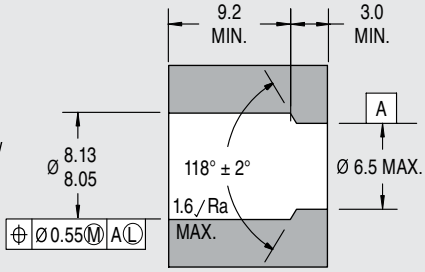
8.0mm INSERT ORIFICE FOR LIQUIDS SCREENED – REVERSE FLOW

IMH ORIFICE SCREENED



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
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

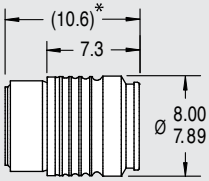
Body ..... 303 Stainless Steel
Pin ..... 416 Stainless Steel
Screen ..... 316 Stainless Steel

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

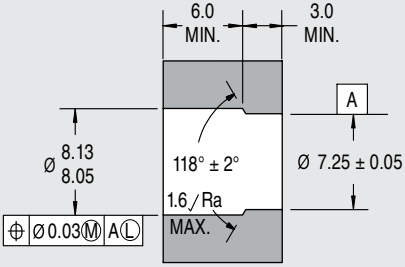
IMH ORIFICE SCREENED



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
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: ± 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

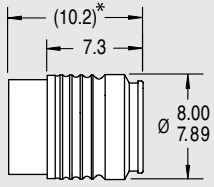
INSTALLATION

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

INSERT ORIFICES

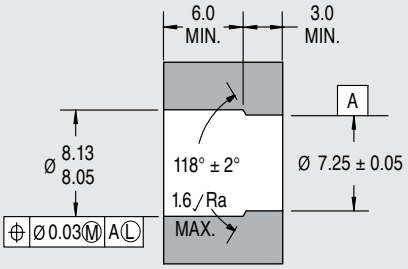
8.0mm INSERT ORIFICE FOR LIQUIDS UNSCREENED – REVERSE FLOW

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

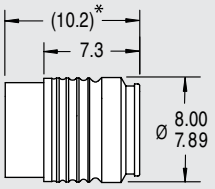
Pin ..... 416 Stainless Steel

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

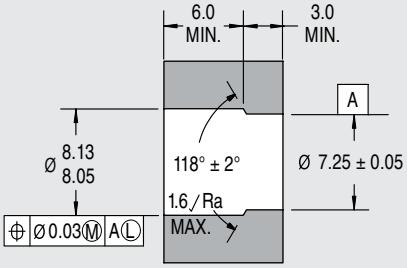
IMH ORIFICE UNSCREENED



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: ± 5%

Test Fluid: Distilled Water

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

MATERIALS

Body ..... 303 Stainless Steel

Pin ..... 416 Stainless Steel

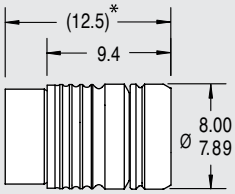
INSTALLATION

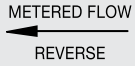
Tool Part Number..... CCRT0900150S
Force..... 680 Kg F (max.)
For installation procedure see page A1.

INSERT ORIFICES

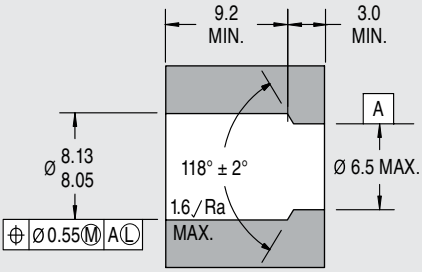
8.0mm INSERT ORIFICE FOR GASES SCREENED – REVERSE FLOW

IMH ORIFICE SCREENED





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

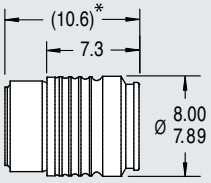
Body ..... 303 Stainless Steel
Pin ..... 416 Stainless Steel
Screen ..... 316 Stainless Steel

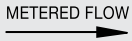
INSTALLATION

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

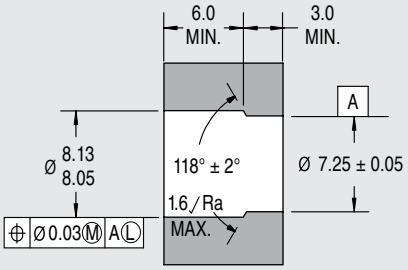
8.0mm INSERT ORIFICE FOR GASES SCREENED – FORWARD FLOW

IMH ORIFICE SCREENED





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: ± 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

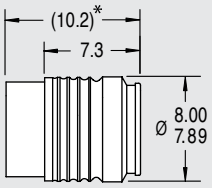
INSTALLATION

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

INSERT ORIFICES

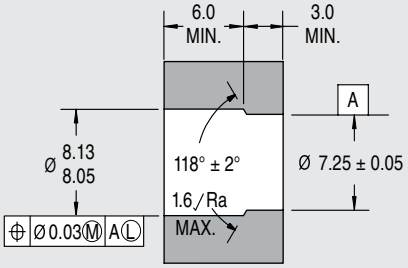
8.0mm INSERT ORIFICE FOR GASES UNSCREENED – REVERSE FLOW

IMH ORIFICE UNSCREENED



METERED FLOW
REVERSE

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

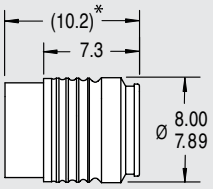
Pin ..... 416 Stainless Steel

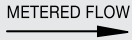
INSTALLATION

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

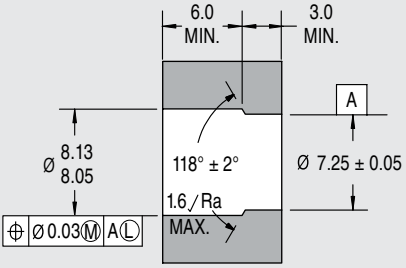
8.0mm INSERT ORIFICE FOR GASES UNSCREENED – FORWARD FLOW

IMH ORIFICE UNSCREENED





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: ± 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.

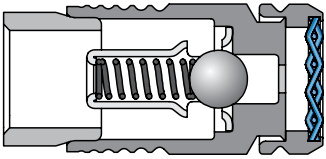
INSERT RESTRICTOR CHECKS

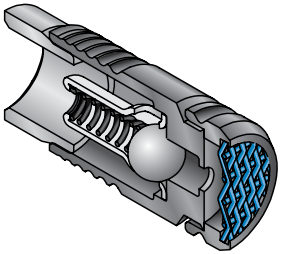
Restrictor checks are functionally an orifice in series with a check valve, all in one package. IMH Restrictor Checks are the same size as their equivalent check valves. These valves come in forward and reverse flow directions and incorporate a screen of an appropriate filtration size for orifice diameters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

Reverse Flow Direction

DIRECTION OF
INSTALLATION

REVERSE FLOW
DIRECTION

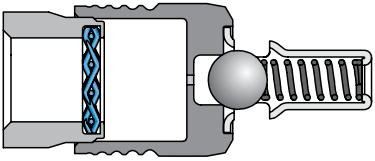


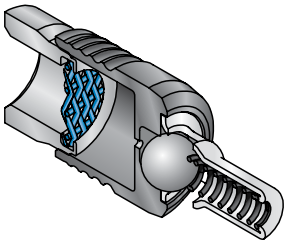


Forward Flow Direction

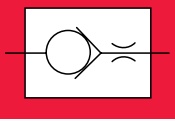
DIRECTION OF
INSTALLATION

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.

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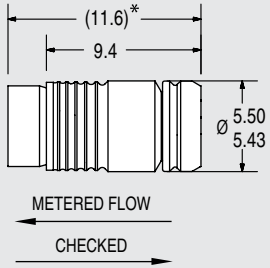
5.5mm RESTRICTOR CHECKS

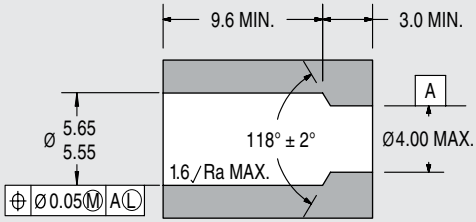
INSERT RESTRICTOR CHECKS

RESTRICTOR CHEK – SCREENED REVERSE FLOW

REVERSE RESTRICTOR CHEK



INSTALLATION HOLE



* *LOA before installation.*
All dimensions in millimeters.

ACTUAL SIZE

(As Installed)

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

PERFORMANCE

Metered Flow Lohm Rate Tolerance: ± 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

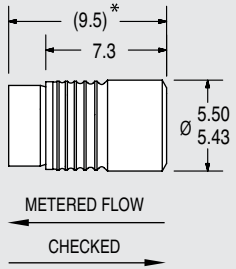
Body ..... 303 Stainless Steel
Pin ..... 416 Stainless Steel
Cage ..... 305 Stainless Steel
Spring ..... 302 Stainless Steel
Ball ..... 440C Stainless Steel
Screen ..... 316 Stainless Steel

INSTALLATION

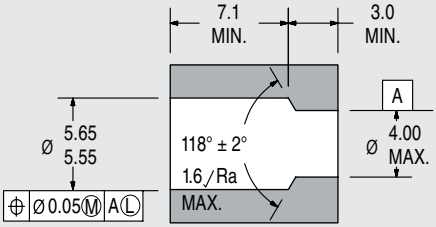
Tool Part Number CCRT0900120S
Force ..... 625 Kg F (max.)
For installation procedure see page A1.

RESTRICTOR CHEK – REVERSE FLOW

REVERSE RESTRICTOR CHEK



INSTALLATION HOLE



* *LOA before installation.*
All dimensions in millimeters.

ACTUAL SIZE

(As Installed)

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

PERFORMANCE

Metered Flow Lohm Rate Tolerance: ± 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

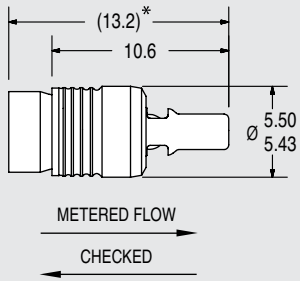
INSTALLATION

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

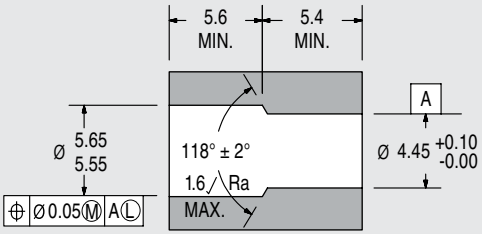
INSERT RESTRICTOR CHECKS

RESTRICTOR CHEK – SCREENED FORWARD FLOW

FORWARD RESTRICTOR CHEK



INSTALLATION HOLE



* *LOA before installation.*
All dimensions in millimeters.

ACTUAL SIZE

(As Installed)

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

PERFORMANCE

Metered Flow Lohm Rate Tolerance: ± 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

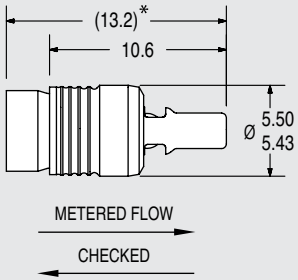
Body ..... 303 Stainless Steel
Pin ..... 303 Stainless Steel
Cage ..... 305 Stainless Steel
Spring ..... 302 Stainless Steel
Ball ..... 440C Stainless Steel
Screen ..... 316 Stainless Steel

INSTALLATION

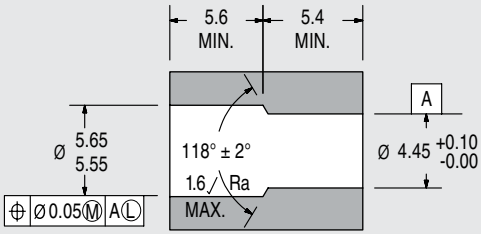
Tool Part Number CCRT0900120S
Force ..... 625 Kg F (max.)
For installation procedure see page A1.

RESTRICTOR CHEK – FORWARD FLOW

FORWARD RESTRICTOR CHEK



INSTALLATION HOLE



* *LOA before installation.*
All dimensions in millimeters.

ACTUAL SIZE

(As Installed)

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

PERFORMANCE

Metered Flow Lohm Rate Tolerance: ± 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

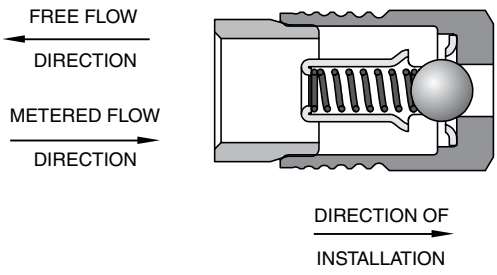
INSTALLATION

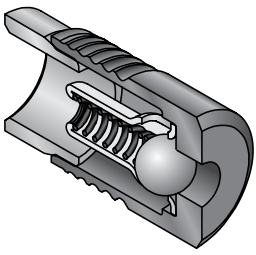
Tool Part Number CCRT0900120S
Force ..... 625 Kg F (max.)
For installation procedure see page A1.

INSERT FLOW CONTROLS

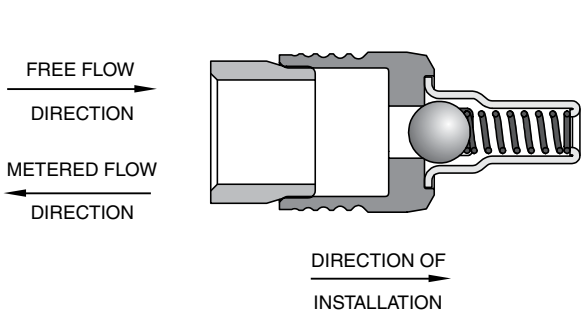
Flow Controls are functionally an orifice in parallel with a check valve — all in one package. IMH Flow Controls are the same size as the equivalent IMH check valve. Flow Controls are available in two diameters; 5.5mm and 8.0mm. The 5.5mm version covers lohm rates from 2,000 lohms [0.5mm (0.020")] to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

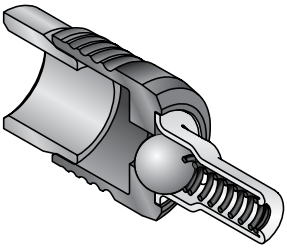
Reverse Flow Valve

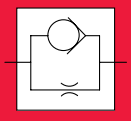




Forward Flow Valve







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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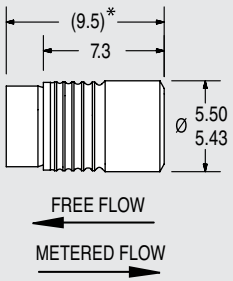
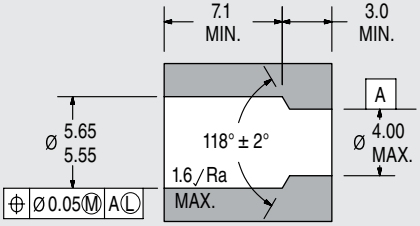
INSERT FLOW CONTROLS

5.5mm FLOW CONTROL – REVERSE FLOW

REVERSE FLOW CONTROL



INSTALLATION HOLE

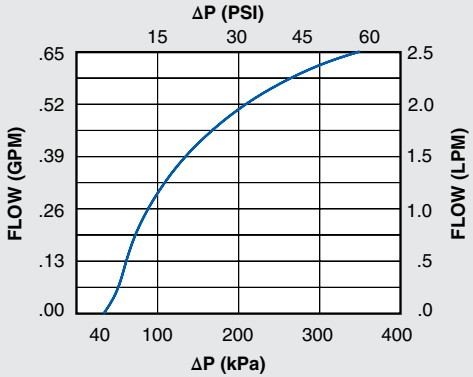


ACTUAL SIZE

(As Installed)

* *LOA before installation.*
All dimensions in millimeters.

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



Flow Curve for 40 kPa Valve

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

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

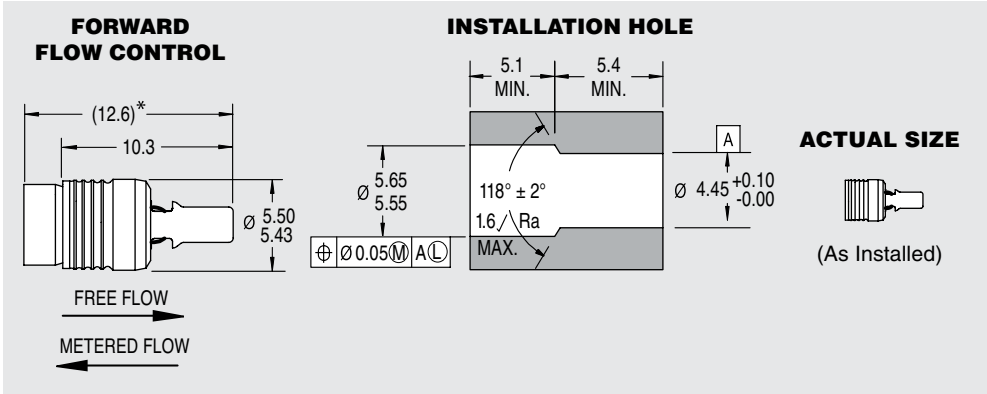
MATERIALS

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

INSTALLATION

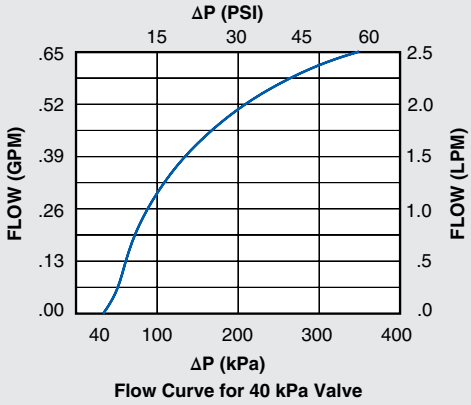
Tool Part Number CCRT0900120S
Force ..... 625 Kg F (max.)
For installation procedure see page A1.

5.5mm FLOW CONTROL – FORWARD FLOW



* *LOA before installation.*
All dimensions in millimeters.

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



Flow Curve for 40 kPa Valve

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

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

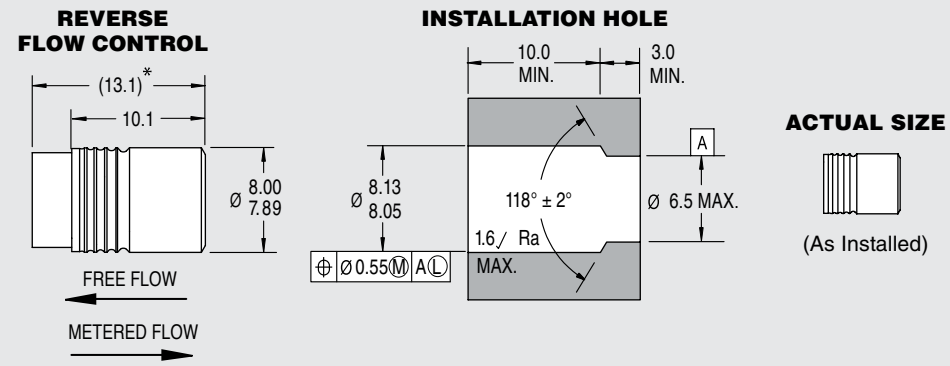
Body.....303 Stainless Steel
Pin.....416 Stainless Steel
Cage.....305 Stainless Steel
Spring.....302 Stainless Steel
Ball.....440C Stainless Steel

INSTALLATION

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

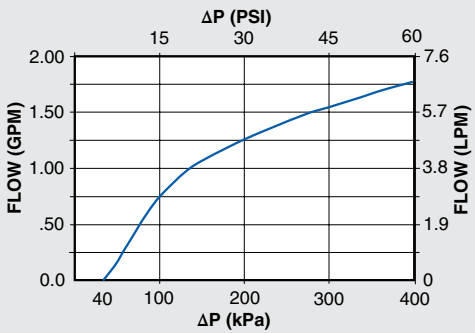
INSERT FLOW CONTROLS

8.0mm FLOW CONTROL – REVERSE



* *LOA before installation.*
All dimensions in millimeters.

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



Flow Curve for 40 kPa Valve

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

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

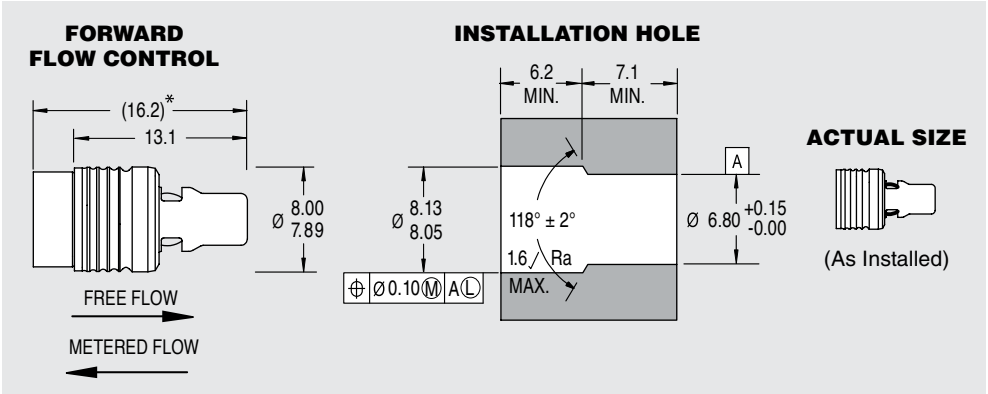
MATERIALS

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

INSTALLATION

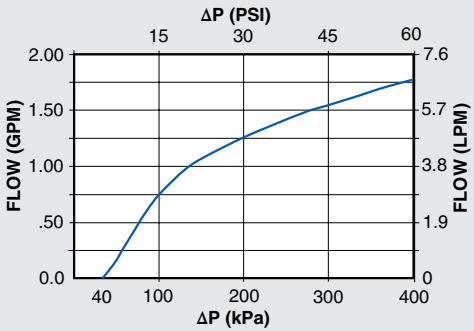
Tool Part Number CCRT0900150S
Force ..... 680 Kg F (max.)
For installation procedure see page A1.

8.0mm FLOW CONTROL – FORWARD



* *LOA before installation.*
All dimensions in millimeters.

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



Flow Curve for 40 kPa Valve

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

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

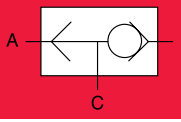
4 MPa (580 psid)
Free Flow Direction

MATERIALS

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

INSTALLATION

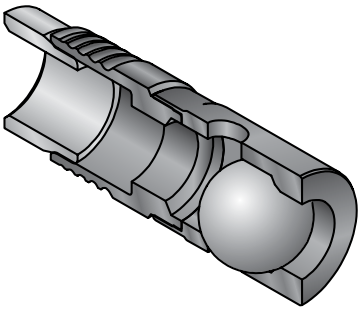
Tool Part Number CCRT0900150S
Force ..... 680 Kg F (max.)
For installation procedure see page A1.



INSERT SHUTTLE VALVES

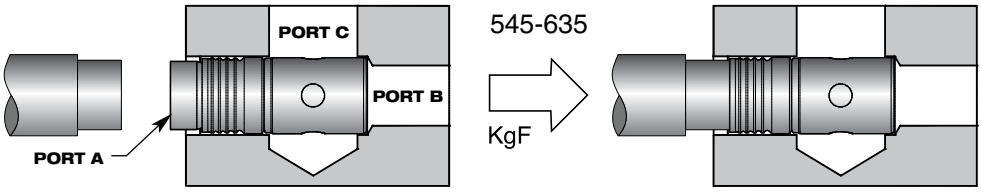
The IMH Shuttle valve is a miniature, economical and reliable solution to the problem of hydraulic isolation in manifolds. This valve features a compact, non-detented, selective design that is ideal as a signal for auxiliary functions, such as hydraulically released, spring applied brakes as well as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



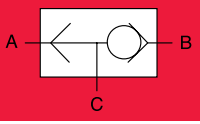
The all metal construction provides high reliability, yet leakage is drip tight. Each valve is 100% factory tested for flow and leakage to ensure consistent, long term performance.

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 ±0.25mm (±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.



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

* at 50 psid



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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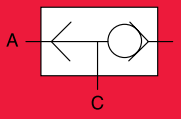
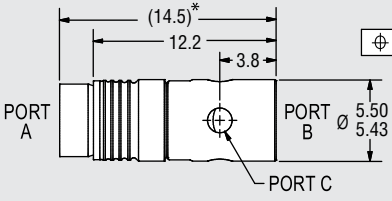


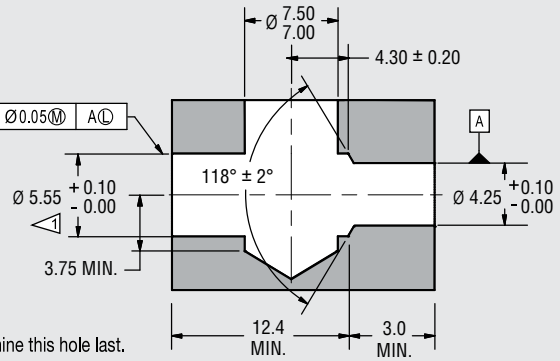
INSERT SHUTTLE VALVES

5.5mm SHUTTLE VALVE

SHUTTLE VALVE



INSTALLATION HOLE



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

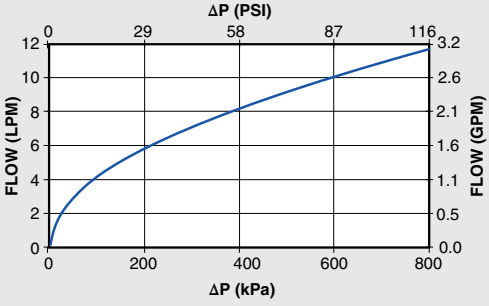
1 Finish machine this hole last.
Surface finish maximum (Ra) = 1.6

* *LOA before installation.*
All dimensions in millimeters.

ACTUAL SIZE

(As Installed)

ΔP vs. Flow on Water @80°F (27°C)



LEE PART NUMBER

CCSV5510000S

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

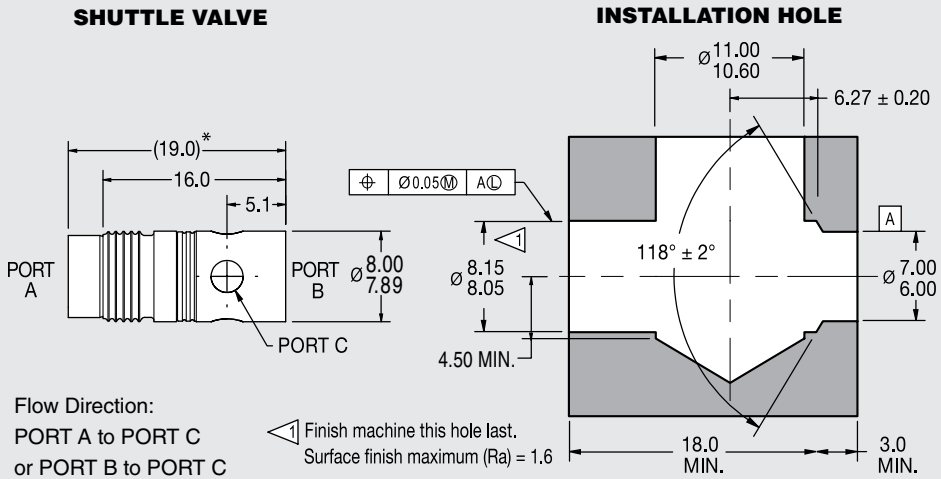
Upper Body.....303 Stainless Steel
Lower Body.....303 Stainless Steel
Pin .....416 Stainless Steel
Ball.....440C Stainless Steel

INSTALLATION

Tool Part Number CCRT0900120S
Force ..... 545 Kg F (min.)
635 Kg F (max.)

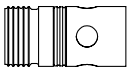
For installation procedure see page A63.

8.0mm SHUTTLE VALVE



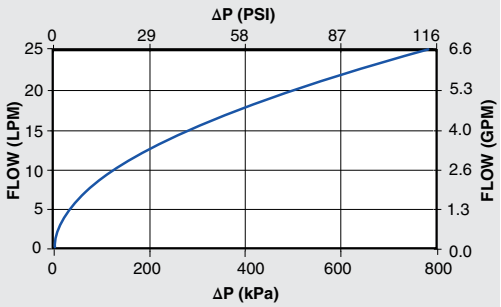
* *LOA before installation.*
All dimensions in millimeters.

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
Pin .....416 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

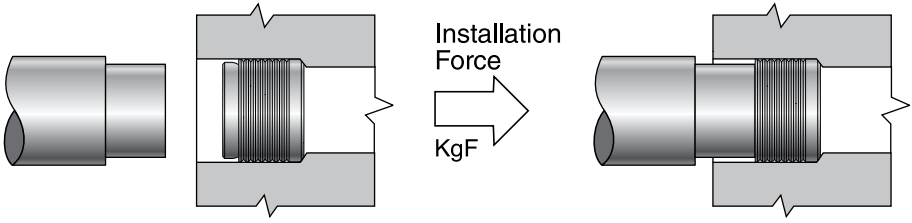
INSERT SAFETY SCREENS

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.

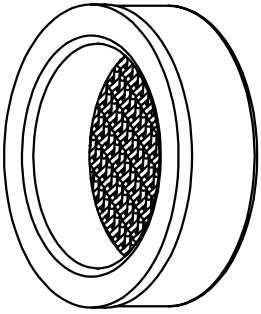
IMH Screens are available in Insert or Cartridge styles. Insert Screens feature an integral locking end, while Cartridge Screens are designed to be retained by the customer, or for 5.5 and 8mm sizes, retained by a separate locking end.

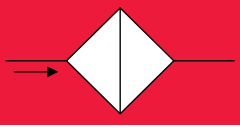
IMH Insert Style Screens use the proven *Lee Insert Principle* of controlled expansion during installation to lock the screen in place.

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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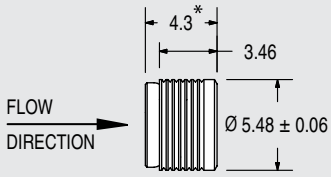
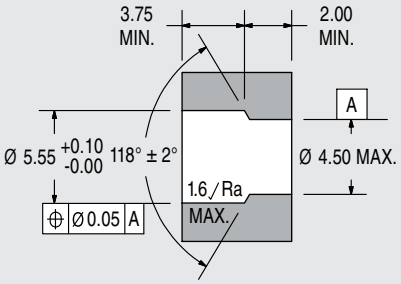
INSERT SAFETY SCREENS

5.5mm 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
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

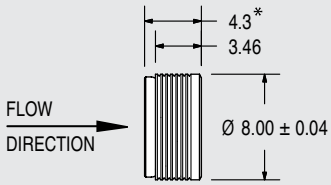
MATERIALS	
Body	303 Stainless Steel
Pin	416 Stainless Steel
Screen	316 Stainless Steel

INSTALLATION	
Tool Part Number	CCRT0901034S
Force	510 Kg F (max.)

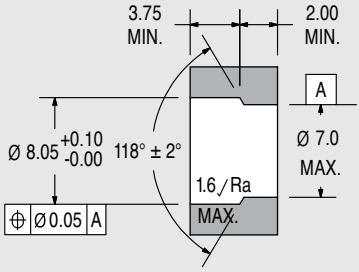
For installation procedure see page A67.

8.0mm INSERT SAFETY SCREEN

INSERT SCREEN



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
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

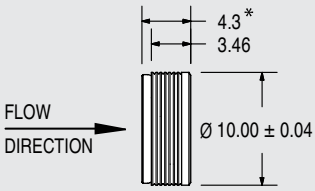
INSTALLATION

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

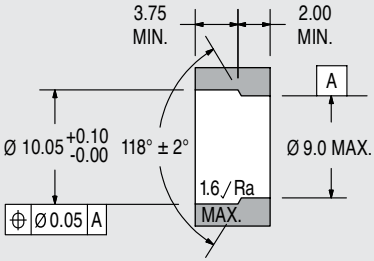
INSERT SAFETY SCREENS

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

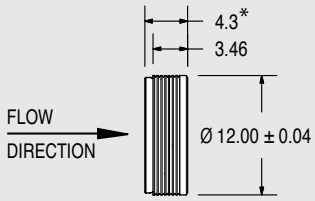
MATERIALS	
Body	303 Stainless Steel
Pin	416 Stainless Steel
Screen	316 Stainless Steel

INSTALLATION	
Tool Part Number	CCRT0901035S
Force	1135 Kg F (max.)

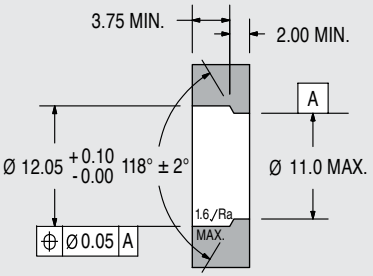
For installation procedure see page A67.

12.0mm INSERT SAFETY SCREEN

INSERT SCREEN

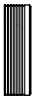


INSTALLATION HOLE



* *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

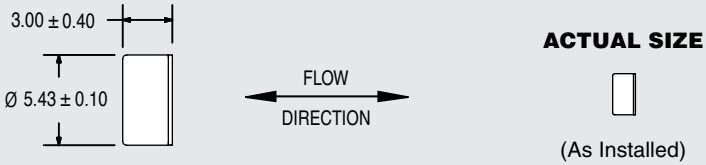
Body ..... 303 Stainless Steel
Pin ..... 416 Stainless Steel
Screen ..... 316 Stainless Steel

INSTALLATION

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

CARTRIDGE SCREENS

5.5mm CARTRIDGE SCREEN



All dimensions in millimeters.

LEE PART NUMBER	MICRON RATING	LOHM RATE	OPEN AREA (mm^2)	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.

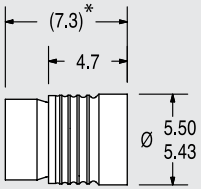
MATERIALS

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

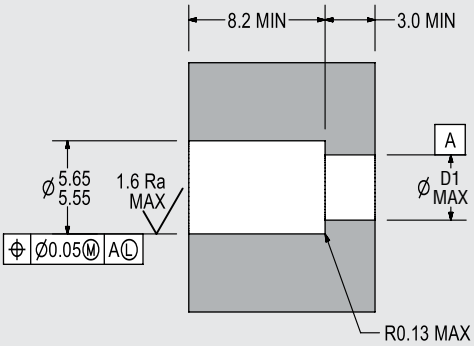
5.5mm INSERT – SCREEN RETAINER

For use in retaining the 5.5mm Cartridge Screen

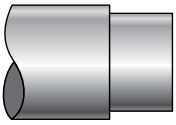
SCREEN RETAINER



INSTALLATION HOLE

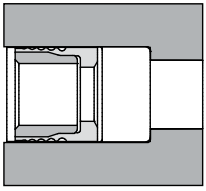


* *LOA before installation.*
All dimensions in millimeters.



Installation Force
662 Kg F
Max.

(As Installed)



ACTUAL SIZE

(As Installed)

LEE PART NUMBER
SCRR5510001S Screen and Retainer sold separately.

MATERIALS	
Body	303 Stainless Steel
Pin	416 Stainless Steel

INSTALLATION

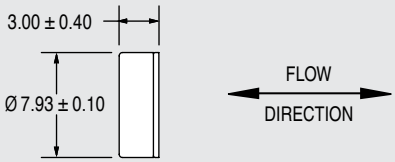
Tool Part Number CCRT0900120S
Force .....662 Kg F (max.)

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 (mm^2)	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

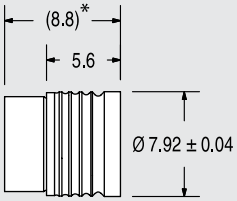
Pintal ..... 17-7 Stainless Steel

Screen ..... 316 Stainless Steel

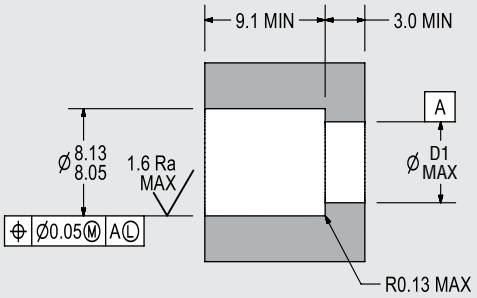
8.0mm INSERT – SCREEN RETAINER

For use in retaining the 8.0mm Cartridge Screen

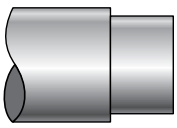
SCREEN RETAINER



INSTALLATION HOLE



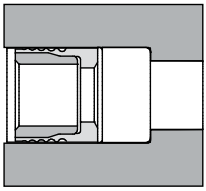
* *LOA before installation.*
All dimensions in millimeters.



Installation Force

680 Kg F Max.

(As Installed)



ACTUAL SIZE

(As Installed)

LEE PART NUMBER
SCRR8010001S Screen and Retainer sold separately.

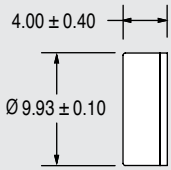
MATERIALS
Body ..... 303 Stainless Steel Pin ..... 416 Stainless Steel

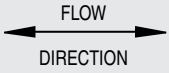
INSTALLATION
Tool Part Number ..... CCRT0900150S Force ..... 680 Kg F (max.) To install, insert the 8.0mm Cartridge Screen into the installation hole as shown. Then insert the Screen Retainer into the installation hole and drive the expander pin flush to within 0.25mm (0.010") above flush of the retainer. 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

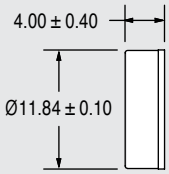


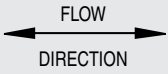


ACTUAL SIZE

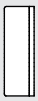
(As Installed)

12mm CARTRIDGE SCREEN



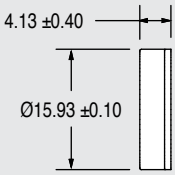


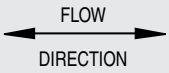
ACTUAL SIZE



(As Installed)

16mm CARTRIDGE SCREEN





ACTUAL SIZE

(As Installed)

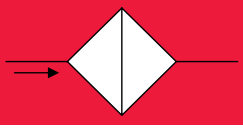
All dimensions in millimeters.

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

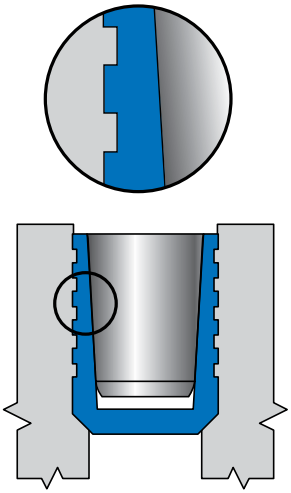
LEE PART NUMBER	MICRON RATING	LOHM RATE	OPEN AREA (mm^2)	ROB NUMBER	MIN. BURST PRESSURE (MPa)
SCRM7161040S	40	30	34	0.64	24 (3,500 psi)
SCRM7161075S	75	20	29	1.16	24 (3,500 psi)
SCRM7161125S	125	30	23	2.05	24 (3,500 psi)
SCRM7161170S	170	20	28	5.06	24 (3,500 psi)
SCRM7161300S	300	15	35	23.5	24 (3,500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

LEE BETAPLUGS®

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



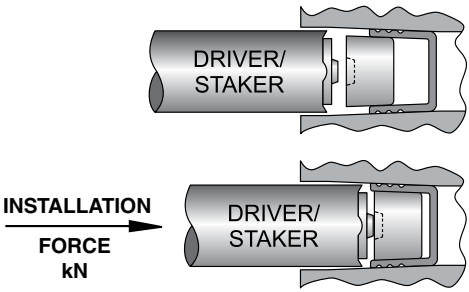
KNOWN BOSS STRESS

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

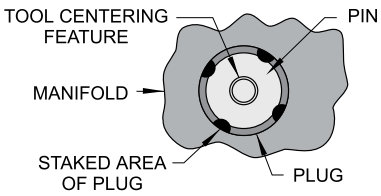
The matching tapers of the Betaplug and its installation hole create a perfect fit, eliminating the need for additional expansion. Since the Betaplug's expansion is precisely controlled by the size of the tapered pin, the amount of expansion and any resulting boss stress is completely predictable.

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

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.

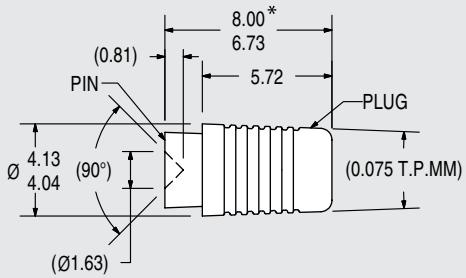
MATERIALS
Pin & Plug .....6061 Aluminum

LEE BETAPLUGS®

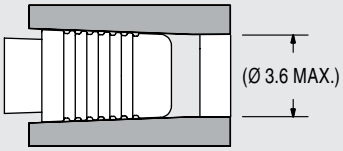
6000 SERIES BETAPLUG

4mm

BETAPLUG



MAXIMUM PASSAGE DIAMETER



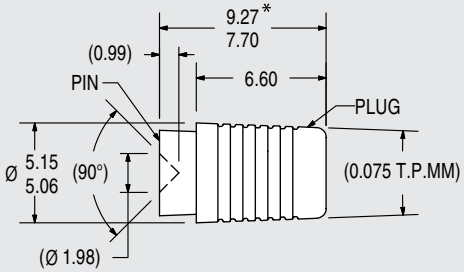
ACTUAL SIZE

(As Installed)

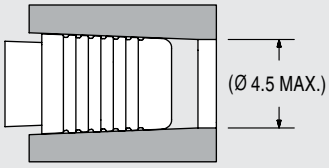
LEE PART NUMBER	BURST PRESSURE †
PLBA0402604S	483 Bar (7,000 psi)

5mm

BETAPLUG



MAXIMUM PASSAGE DIAMETER



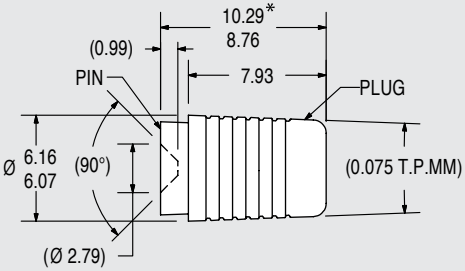
ACTUAL SIZE

(As Installed)

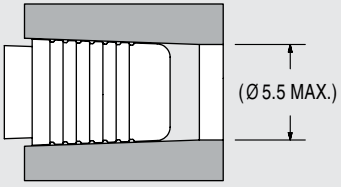
LEE PART NUMBER	BURST PRESSURE †
PLBA0502604S	483 Bar (7,000 psi)

6mm

BETAPLUG



MAXIMUM PASSAGE DIAMETER



ACTUAL SIZE

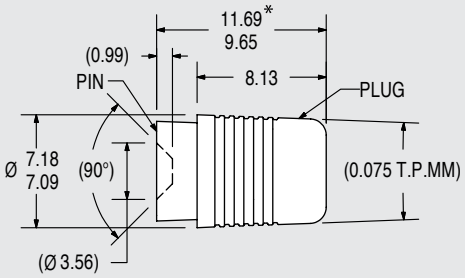
(As Installed)

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

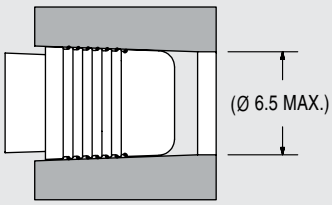
** LOA before installation. All dimensions in millimeters.*
† Typical burst pressure for A380 die-cast aluminum

6000 SERIES BETAPLUG (cont.)

7mm **BETAPLUG**



MAXIMUM PASSAGE DIAMETER

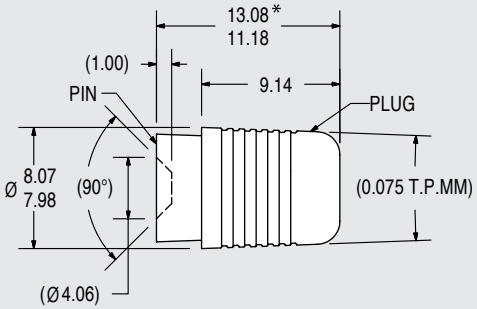


ACTUAL SIZE

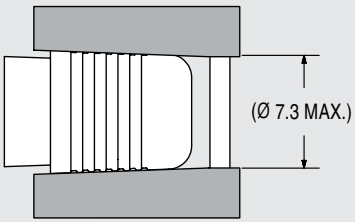
(As Installed)

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

8mm **BETAPLUG**



MAXIMUM PASSAGE DIAMETER



ACTUAL SIZE

(As Installed)

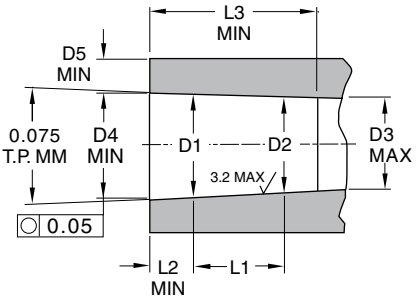
LEE PART NUMBER	BURST PRESSURE †
PLBA0803604S	276 Bar (4,000 psi)

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

LEE BETAPLUGS®

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 ±0.3° 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.

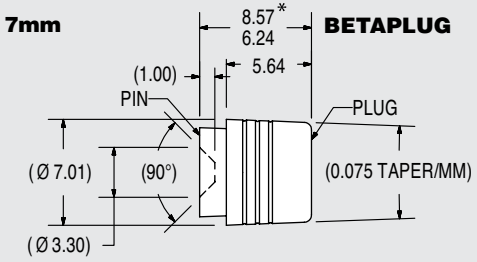
TOOLING

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)

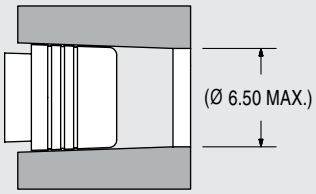
LEE BETAPLUGS®

SHORT BETAPLUG

7mm BETAPLUG



MAXIMUM PASSAGE DIAMETER

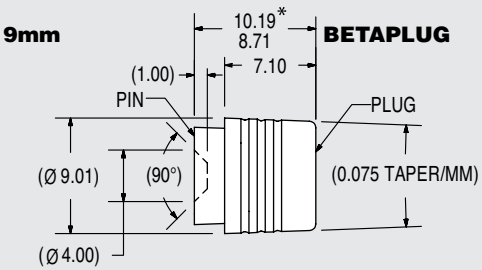


ACTUAL SIZE

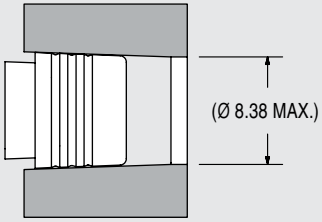
(As Installed)

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

9mm BETAPLUG



MAXIMUM PASSAGE DIAMETER

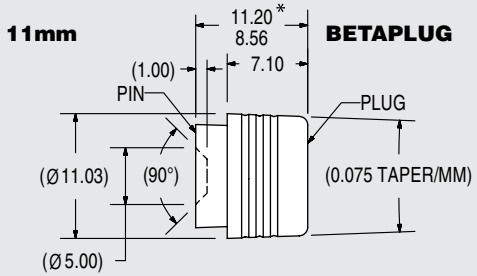


ACTUAL SIZE

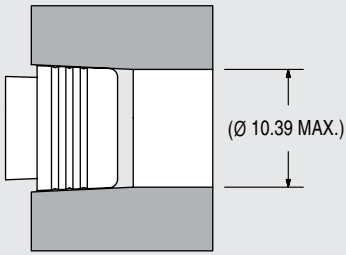
(As Installed)

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

11mm BETAPLUG



MAXIMUM PASSAGE DIAMETER



ACTUAL SIZE

(As Installed)

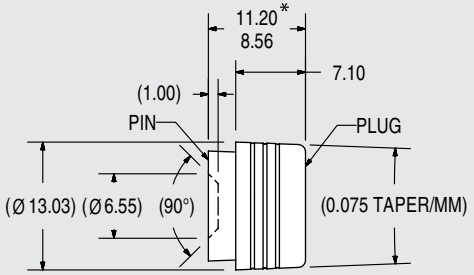
LEE PART NUMBER	RATED PRESSURE †
PLBA1103610S	35 Bar (500 psi)

** LOA before installation. All dimensions in millimeters.*

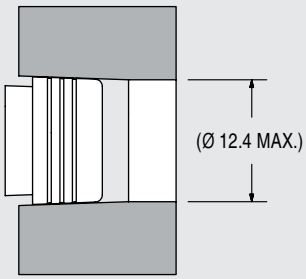
† Rated pressures may be higher depending upon specific application requirements. Contact your Lee Sales Engineer for higher pressure requirements.

SHORT BETAPLUG (cont.)

13mm **BETAPLUG**



MAXIMUM PASSAGE DIAMETER

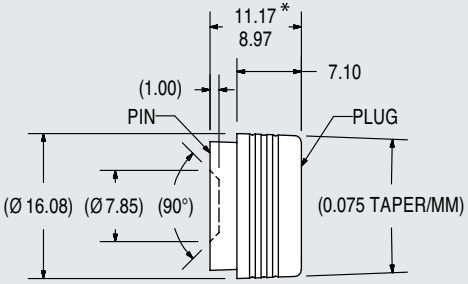


ACTUAL SIZE

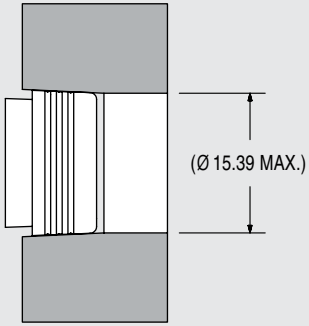
(As Installed)

LEE PART NUMBER	RATED PRESSURE †
PLBA1304610S	35 Bar (500 psi)

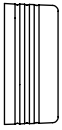
16mm **BETAPLUG**



MAXIMUM PASSAGE DIAMETER



ACTUAL SIZE



(As Installed)

LEE PART NUMBER	RATED PRESSURE †
PLBA1604610S	35 Bar (500 psi)

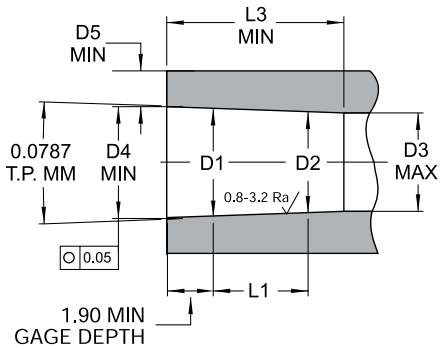
* *LOA before installation. All dimensions in millimeters.*
† *Rated pressures may be higher depending upon specific application requirements. Contact your Lee Sales Engineer for higher pressure requirements.*

LEE BETAPLUGS®

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

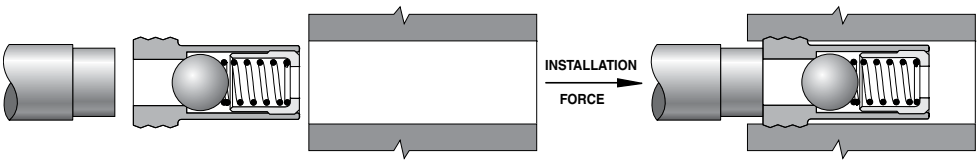
* Depth of tapered hole (L3) from depth of minimum diameter (D4).
All dimensions are in millimeters.

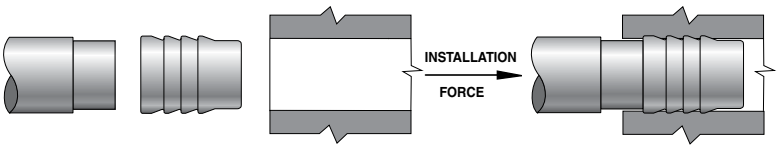
TOOLING

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.

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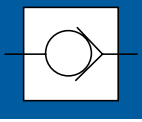
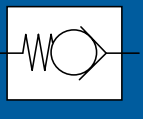


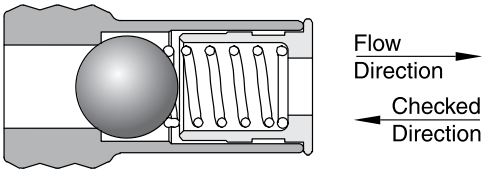


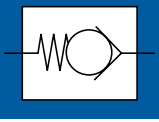
CHECK & RELIEF VALVES FOR PLASTIC

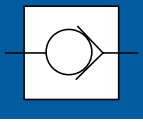
IMH Checks and Relief Valves for plastic installation have the same internal design as the inserts in Section I. A high quality metal to metal seat provides low leakage and highly repeatable cracking pressure. Their all stainless steel design provides compatibility with a wide range of fluids and gases. 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







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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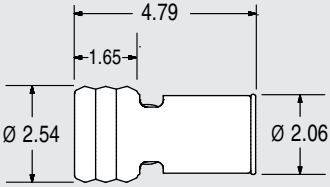
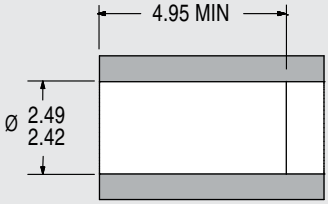
CHECK & RELIEF VALVES FOR PLASTIC

2.5mm CHECK VALVE for PLASTIC INSTALLATION

CHEK VALVE



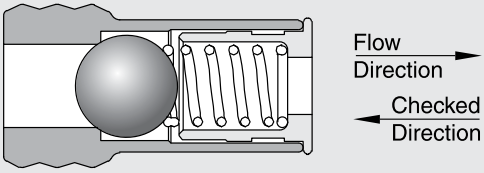
INSTALLATION HOLE



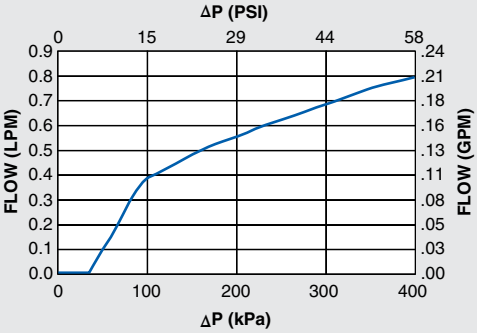
ACTUAL SIZE

(As Installed)

All dimensions in millimeters.



ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

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)

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

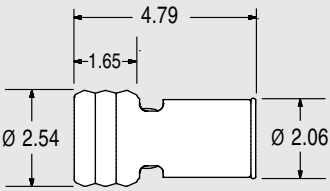
INSTALLATION

Tool Part Number CCRT0024277S

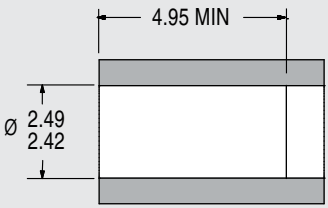
To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities.

2.5mm CHECK VALVE – CERAMIC BALL for PLASTIC INSTALLATION

CHEK VALVE



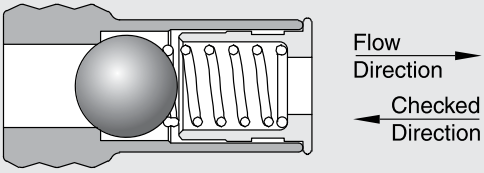
INSTALLATION HOLE



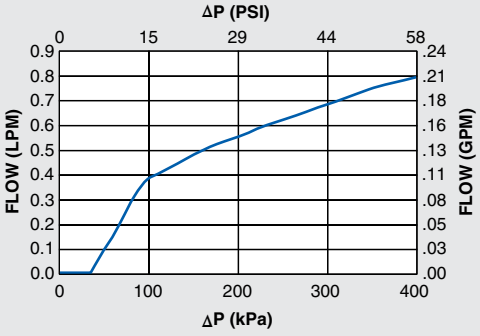
ACTUAL SIZE

(As Installed)

All dimensions in millimeters.



ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

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

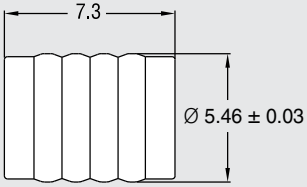
Tool Part Number CCRT0024277S

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.

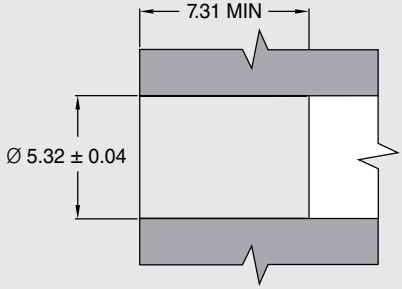
CHECK & RELIEF VALVES FOR PLASTIC

5.5mm CHECK VALVE for PLASTIC INSTALLATION

CHEK VALVE

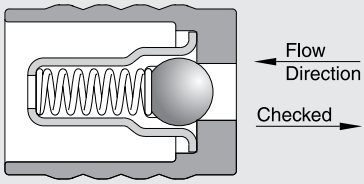


INSTALLATION HOLE



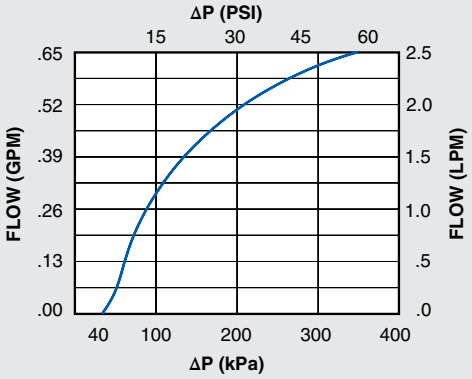
ACTUAL SIZE

(As Installed)



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 water

MATERIALS

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

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)

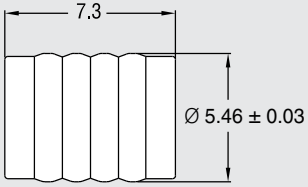
INSTALLATION

Tool Part Number CCRT0900170S

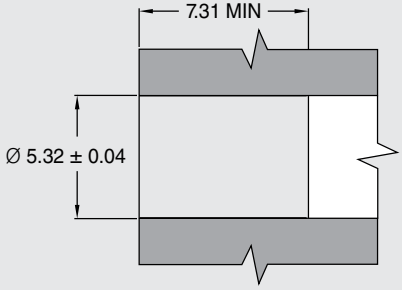
To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities. See page B27.

5.5mm CHECK VALVE – CERAMIC BALL for PLASTIC INSTALLATION

CHEK VALVE

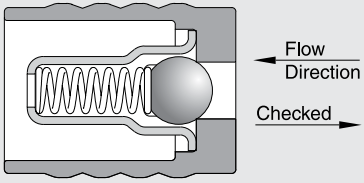


INSTALLATION HOLE



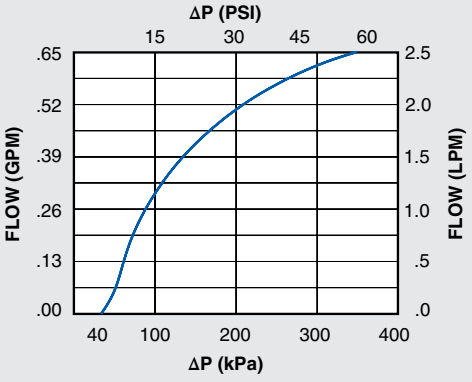
ACTUAL SIZE

(As Installed)



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 water

MATERIALS

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

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)

INSTALLATION

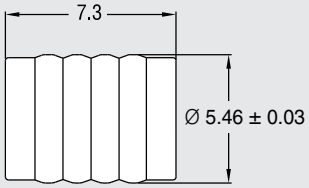
Tool Part Number CCRT0900170S

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.

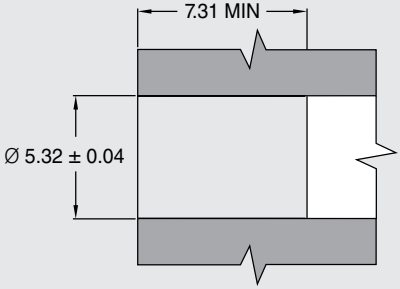
CHECK & RELIEF VALVES FOR PLASTIC

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

CHEK VALVE

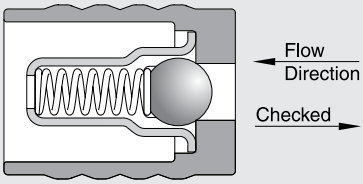


INSTALLATION HOLE



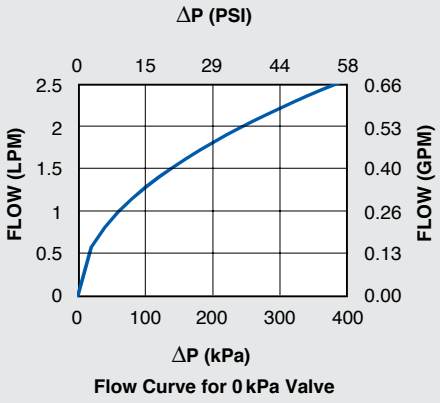
ACTUAL SIZE

(As Installed)



All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 0 kPa Valve

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

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)

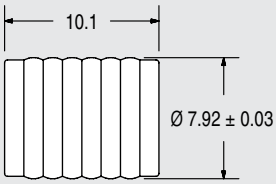
INSTALLATION

Tool Part Number CCRT0900170S

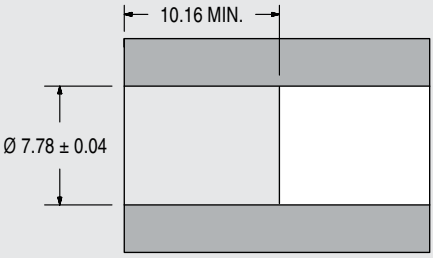
To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities. See page B27.

8.0mm CHECK VALVE for PLASTIC INSTALLATION

CHEK VALVE

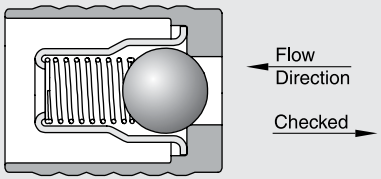


INSTALLATION HOLE



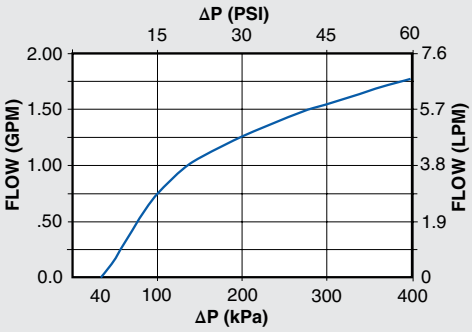
ACTUAL SIZE

(As Installed)



All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

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

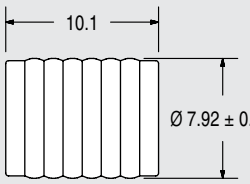
Tool Part Number CCRT0900180S

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.

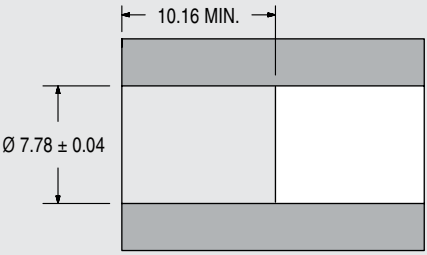
CHECK & RELIEF VALVES FOR PLASTIC

8.0mm CHECK VALVE – CERAMIC BALL for PLASTIC INSTALLATION

CHEK VALVE

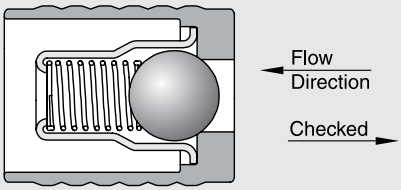


INSTALLATION HOLE



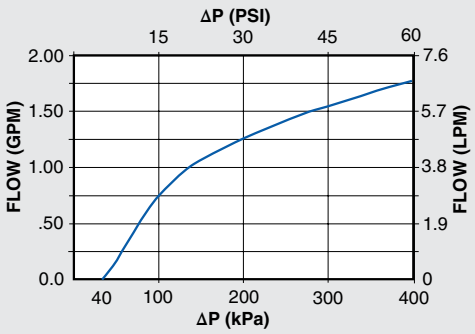
ACTUAL SIZE

(As Installed)



All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

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

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)

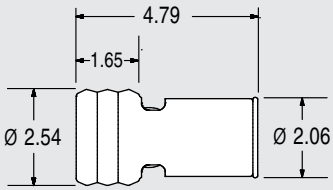
INSTALLATION

Tool Part Number CCRT0900180S

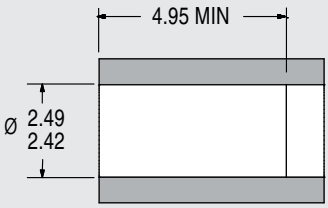
To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities. See page B27.

2.5mm RELIEF VALVE for PLASTIC INSTALLATION

RELIEF VALVE

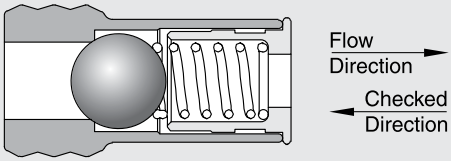


INSTALLATION HOLE



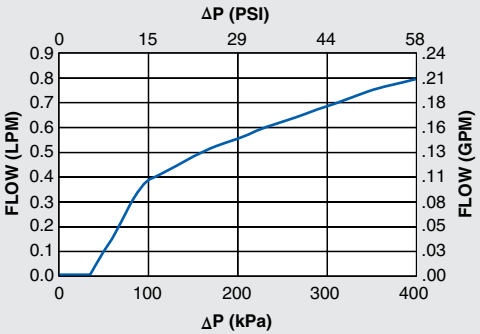
ACTUAL SIZE

(As Installed)



All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

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)

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

INSTALLATION

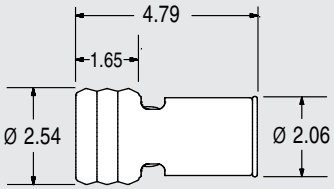
Tool Part Number CCRT0024277S

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.

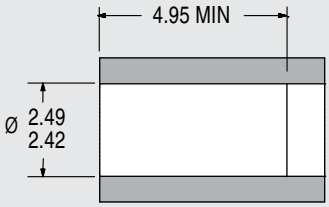
CHECK & RELIEF VALVES FOR PLASTIC

2.5mm RELIEF VALVE – CERAMIC BALL for PLASTIC INSTALLATION

RELIEF VALVE

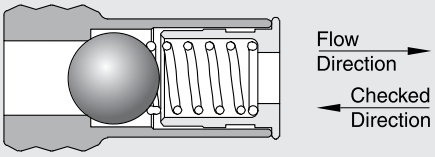


INSTALLATION HOLE



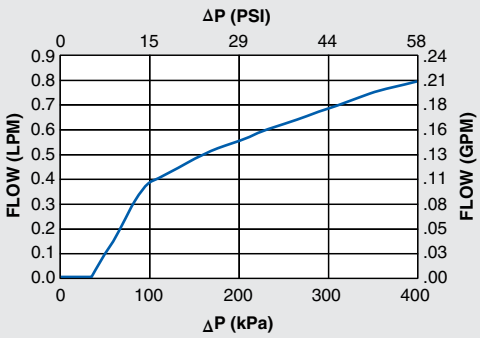
ACTUAL SIZE

(As Installed)



All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

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)

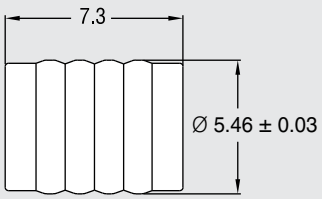
INSTALLATION

Tool Part Number CCRT0024277S

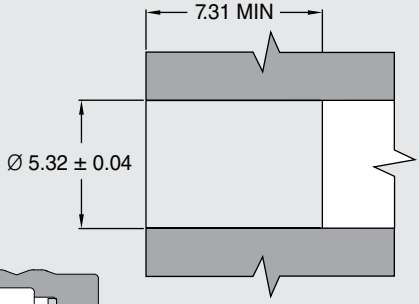
To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities.

5.5mm RELIEF VALVE for PLASTIC INSTALLATION

RELIEF VALVE

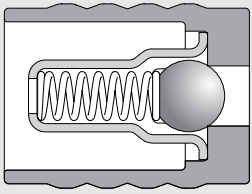


INSTALLATION HOLE



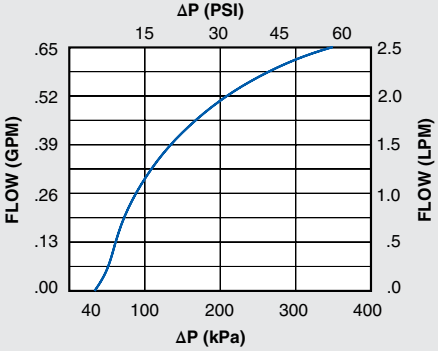
ACTUAL SIZE

(As Installed)



All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

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)

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

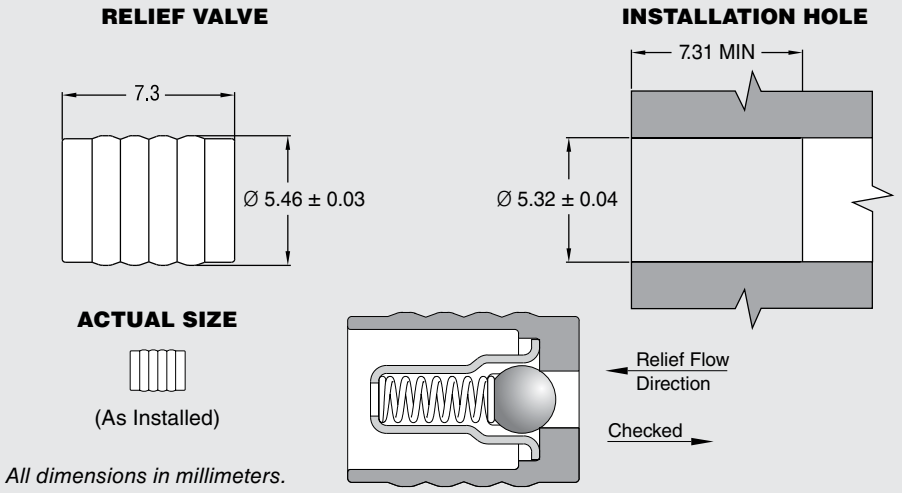
INSTALLATION

Tool Part Number CCRT0900170S

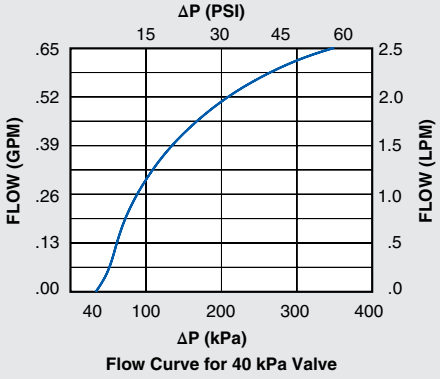
To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities. See page B27.

CHECK & RELIEF VALVES FOR PLASTIC

5.5mm RELIEF VALVE – CERAMIC BALL for PLASTIC INSTALLATION



ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

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)

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

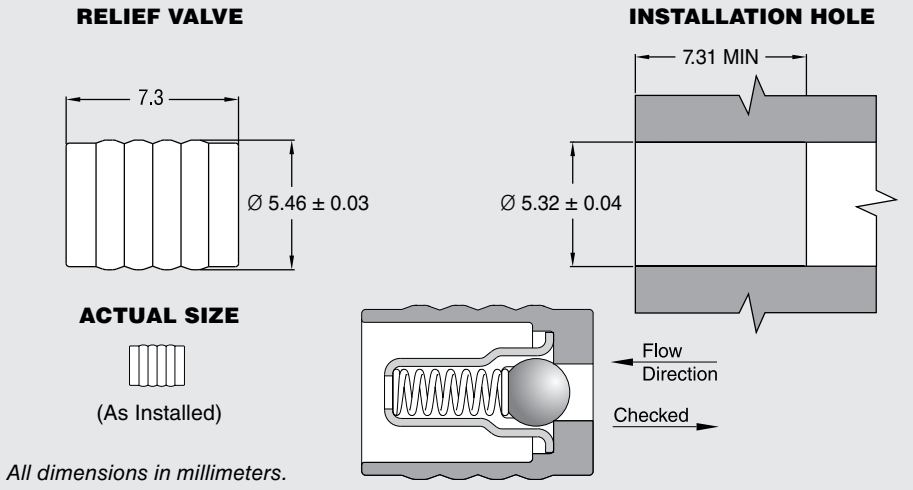
Body..... 303 Stainless Steel
Cage ..... 305 Stainless Steel
Spring ..... 302 Stainless Steel
Ball..... Ceramic

INSTALLATION

Tool Part Number CCRT0900170S

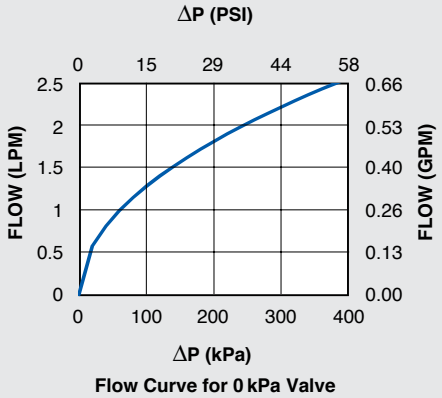
To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities. See page B27.

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



All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 0 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..... 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

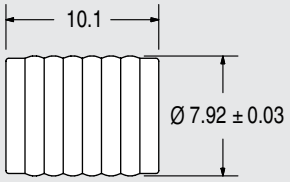
Tool Part Number CCRT0900170S

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.

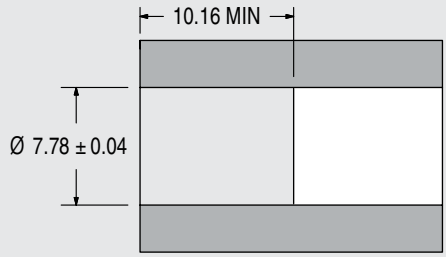
CHECK & RELIEF VALVES FOR PLASTIC

8.0mm RELIEF VALVE for PLASTIC INSTALLATION

RELIEF VALVE

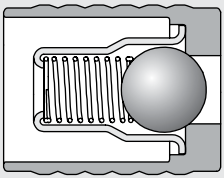


INSTALLATION HOLE



ACTUAL SIZE

(As Installed)

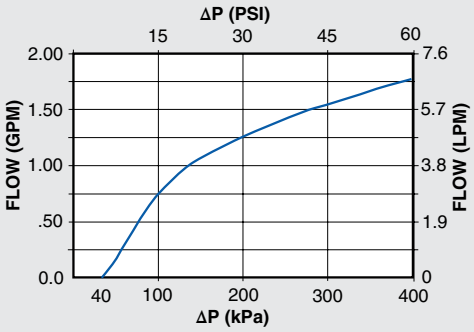


Relief Flow Direction

Checked

All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

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)

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

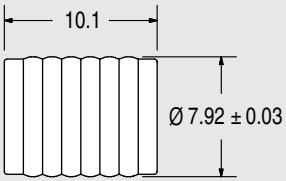
INSTALLATION

Tool Part Number CCRT0900180S

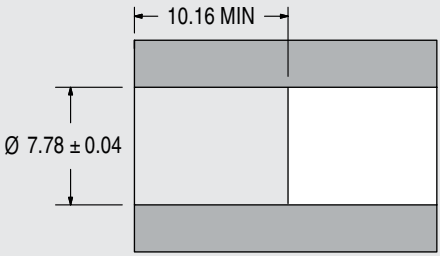
To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities. See page B27.

8.0mm RELIEF VALVE – CERAMIC BALL for PLASTIC INSTALLATION

RELIEF VALVE

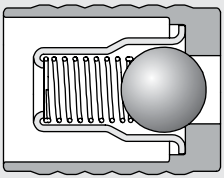


INSTALLATION HOLE



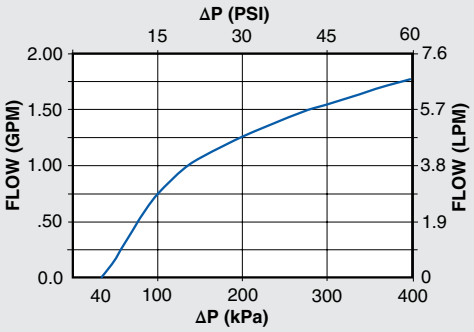
ACTUAL SIZE

(As Installed)



All dimensions in millimeters.

ΔP vs. Flow on Water @80°F (27°C)



Flow Curve for 40 kPa Valve

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)

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

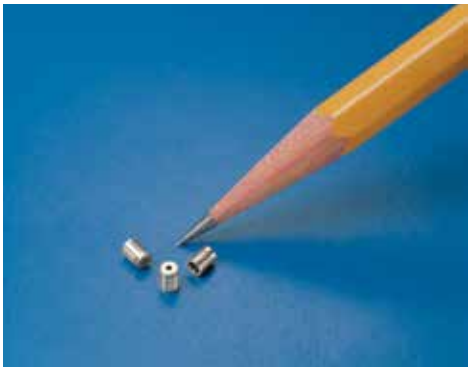
INSTALLATION

Tool Part Number CCRT0900180S

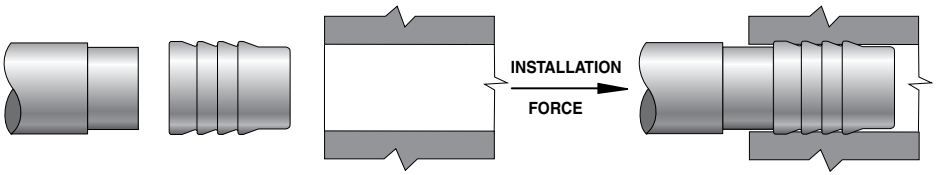
To install, simply press the valve into a plastic installation hole until the valve is flush minimum with the top of the installation hole. The valve can be installed in either direction, providing forward or reverse flow capabilities. See page B27.

ORIFICES FOR PLASTIC

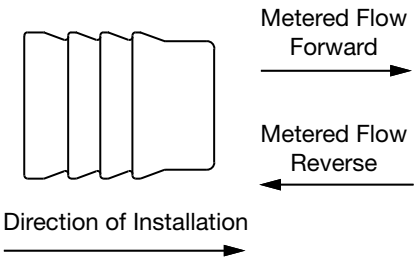
IMH Orifices for plastic are economical, reliable, highly accurate miniature restrictors. These orifices are 100% flow tested to ensure that every part is within ±5% of its nominal flow rate (tighter flow tolerances available as special orders). Tight flow tolerances are only possible if entrance and 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.



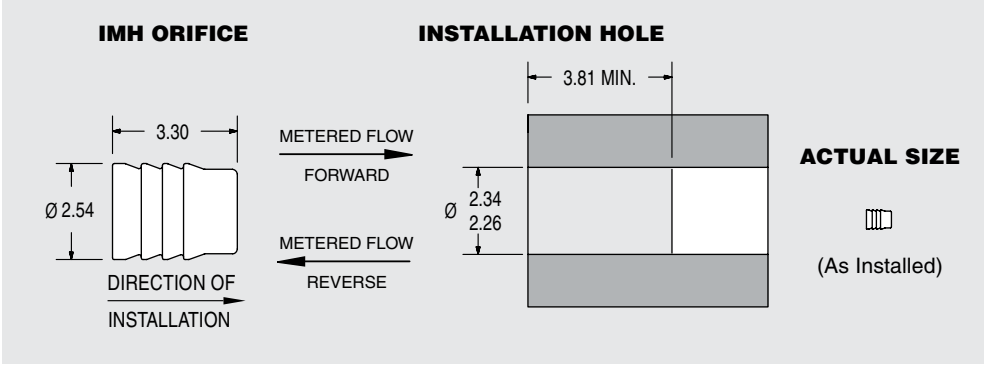
Features and Benefits

- 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.

TABLE OF CONTENTS

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

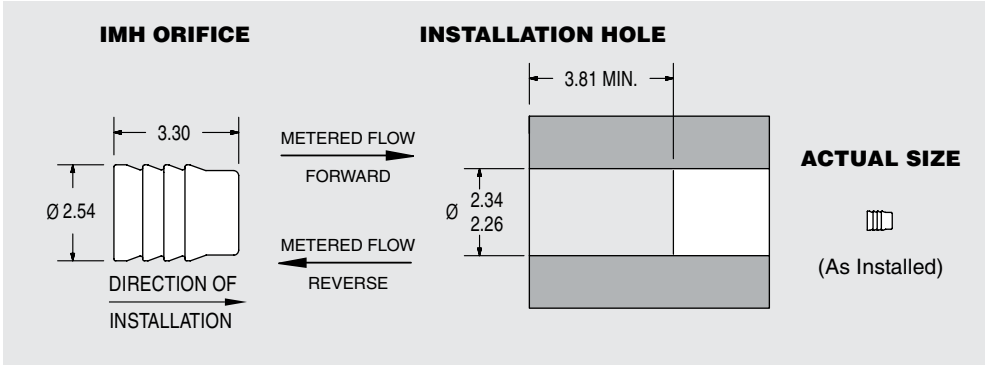
INSTALLATION

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: ± 5%

Test Fluid: Distilled Water

MATERIALS

Body.....316 Stainless Steel

INSTALLATION

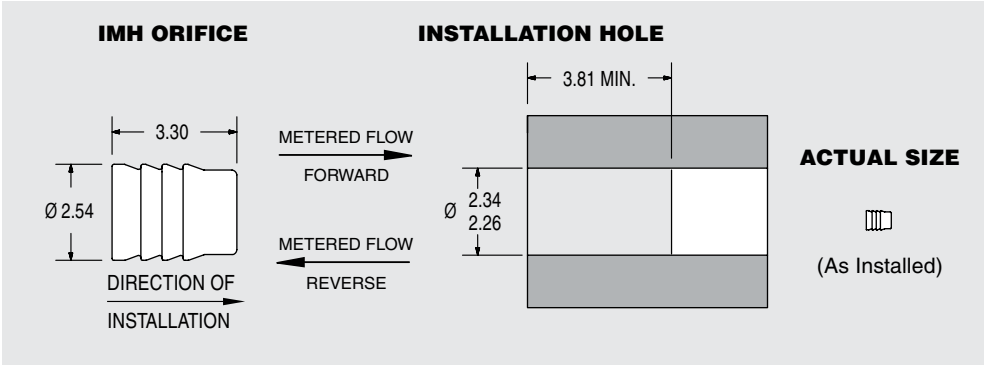
Tool Part Number CCRT0029354S

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

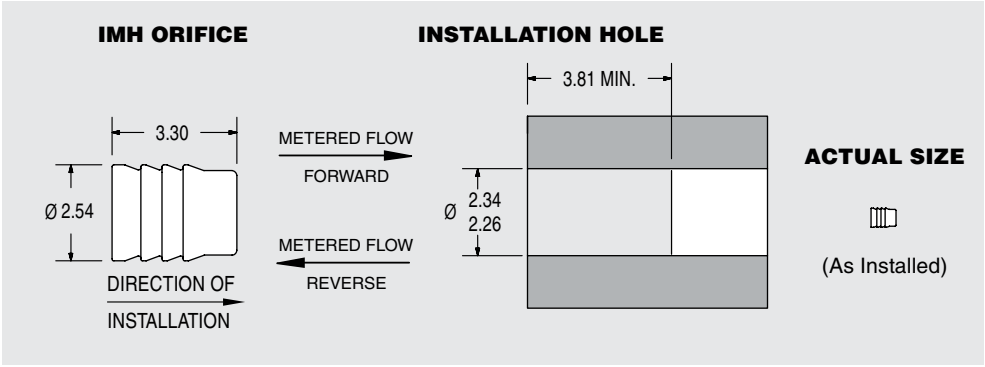
INSTALLATION

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: ± 5%

Test Fluid: Clean & Dry Nitrogen

MATERIALS

Body.....316 Stainless Steel

INSTALLATION

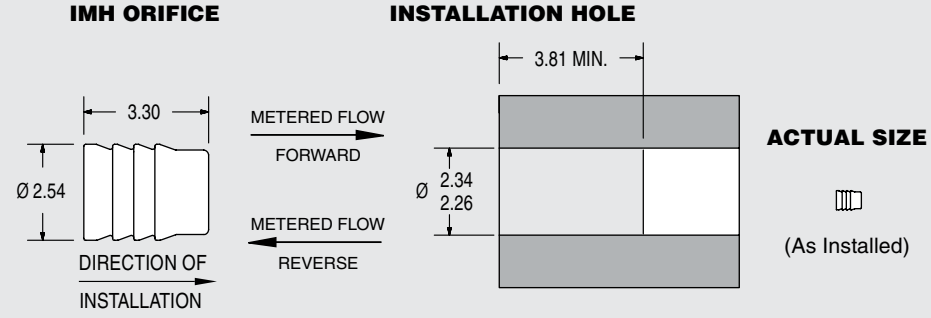
Tool Part Number CCRT0029354S

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

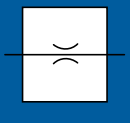
Body..... Brass C36000

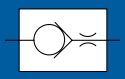
INSTALLATION

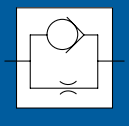
Tool Part Number CCRT0029354S

For installation procedure see page B19.

For companion 2.5mm Safety Screen see page B35.

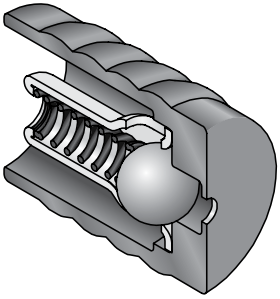






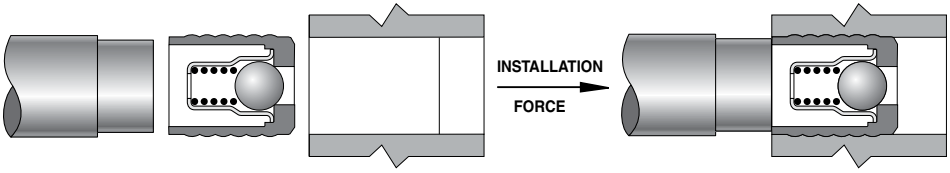
RESTRICTOR CHECKS & FLOW CONTROLS FOR PLASTIC

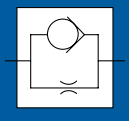
Restrictor Checks are functionally an orifice in series with a check valve, all in one compact package. Flow controls are functionally an orifice in parallel with a check valve, all in one package. Both come in a wide variety of metered lohm rates (orifices sizes).

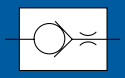


Where screening is necessary, companion screens for plastic are available in four different micron ratings (see pages B36-B37).

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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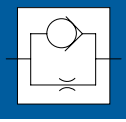
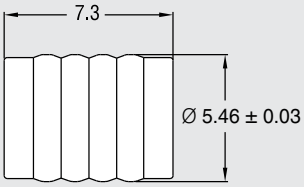


FLOW CONTROLS FOR PLASTIC

5.5mm FLOW CONTROL for PLASTIC INSTALLATION

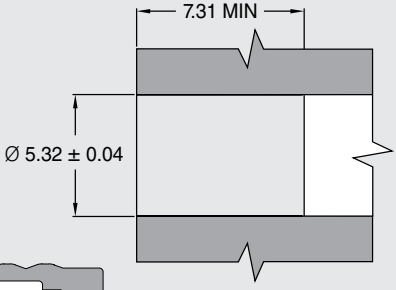
FLOW CONTROL

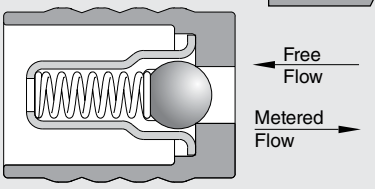


ACTUAL SIZE

(As Installed)

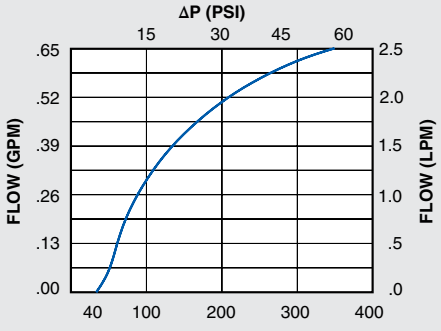
INSTALLATION HOLE





All dimensions in millimeters.

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



Flow Curve for 40 kPa Valve

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

PERFORMANCE

Metered Flow
Lohm Rate Tolerance: ± 15%

Free Flow Lohm Rate: 250 Lohms

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

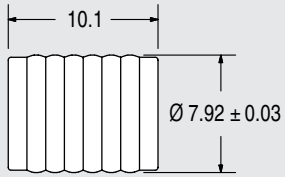
INSTALLATION

Tool Part Number CCRT0900170S

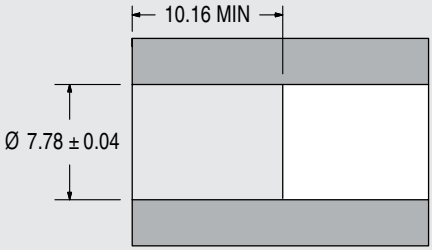
For installation procedure see page B27.

8.0mm FLOW CONTROL for PLASTIC INSTALLATION

FLOW CONTROL



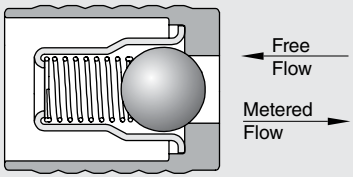
INSTALLATION HOLE



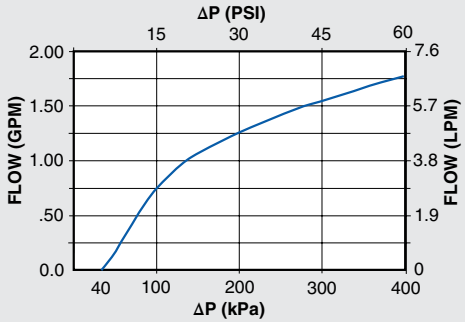
ACTUAL SIZE

(As Installed)

All dimensions in millimeters.



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



Flow Curve for 40 kPa Valve

LEE PART NUMBER	LOHM RATE
CFPM8001005S	500
CFPM8001006S	600
CFPM8001008S	800
CFPM8001010S	1000
CFPM8001012S	1200
CFPM8001015S	1500
CFPM8001020S	2000

PERFORMANCE

Metered Flow
Lohm Rate Tolerance: ± 15%

Free Flow Lohm Rate: 75 Lohms

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

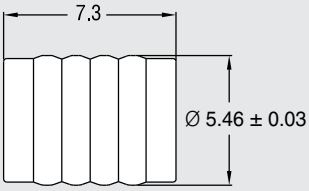
Tool Part Number CCRT0900180S

For installation procedure see page B27.

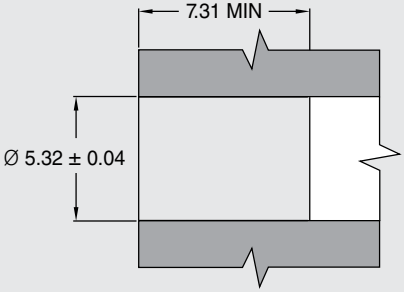
RESTRICTOR CHECKS FOR PLASTIC

5.5mm RESTRICTOR CHEK for PLASTIC INSTALLATION

RESTRICTOR CHECK

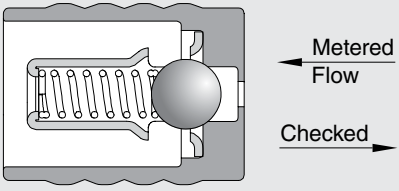


INSTALLATION HOLE



ACTUAL SIZE

(As Installed)



All dimensions in millimeters.

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: ± 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)

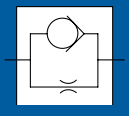
MATERIALS

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

INSTALLATION

Tool Part Number CCRT0900170S

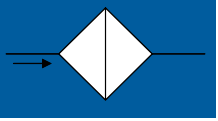
For installation procedure see page B27.



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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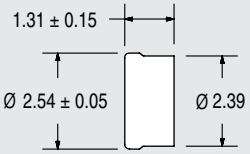
SAFETY SCREENS FOR PLASTIC

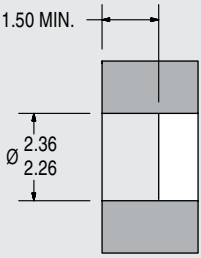
2.5mm SAFETY SCREEN for PLASTIC INSTALLATION

SCREEN



Flow Direction

INSTALLATION HOLE



All dimensions in millimeters.

ACTUAL SIZE

(As Installed)

MATERIALS

Body.....303 Stainless Steel
Screen.....316 Stainless Steel

INSTALLATION

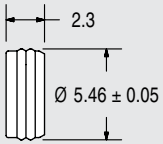
Tool Part Number CCRT0029354S

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 (mm^2)	ROB#
SCRM4253004S	4	1700	0.2	0.0033
SCRM4252040S	40	850	0.5	0.0097

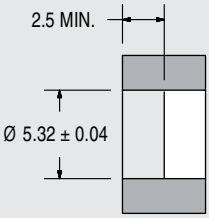
5.5mm SAFETY SCREEN for PLASTIC INSTALLATION

SCREEN



Flow Direction

INSTALLATION HOLE



All dimensions in millimeters.

ACTUAL SIZE

(As Installed)

MATERIALS

Body .....303 Stainless Steel

Screen.....316 Stainless Steel

INSTALLATION

Tool Part Number CCRT0900170S

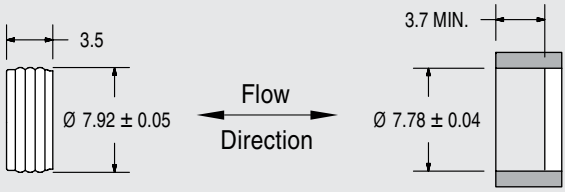
To install, simply press the screen into a plastic installation hole until the screen is flush minimum with the top of the installation hole. The screen can be installed in either direction.

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 **INSTALLATION HOLE**



All dimensions in millimeters.

ACTUAL SIZE

(As Installed)

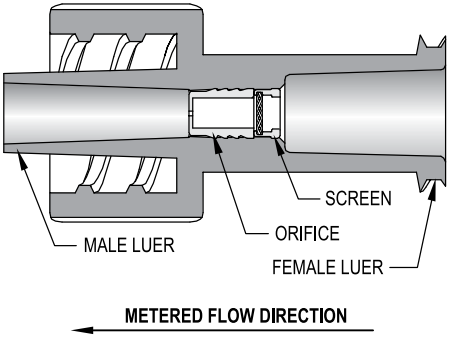
MATERIALS
Body.....303 Stainless Steel
Screen.....316 Stainless Steel

INSTALLATION
Tool Part Number CCRT0900180S
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.

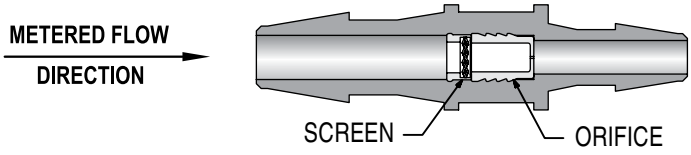
LEE PART NUMBER	MICRON RATING	LOHM RATE	OPEN AREA (mm^2)	ROB#
SCRM4801040S	40	80	7.1	0.13
SCRM4801075S	75	70	6.3	0.25
SCRM4801125S	125	90	5.3	0.47
SCRM4801170S	170	90	7.2	1.27

PRODUCTS IN PLASTIC FITTINGS

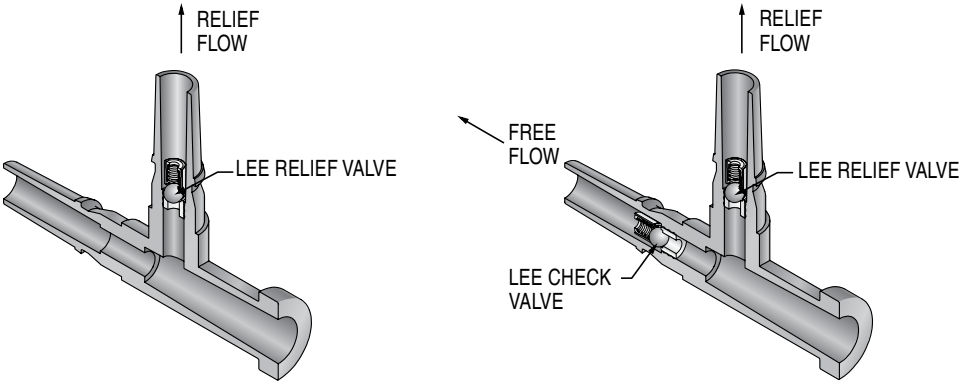
The Lee Company IMH Group offers our highly accurate Orifice installed into a male to female luer adaptor and features an integral safety screen to protect the orifice from contamination. Ideal for medical applications, the orifice and screen are 300 Series stainless steel and the fitting is made of 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 ±5% of its nominal flow rate. This provides far more accuracy than orifices specified by hole tolerance.



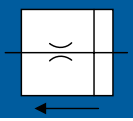
Orifices of very high lohm rates (very small hole diameters) are now available in a barb to barb union as standard. Lohm rates of as high as five million lohms, equivalent to as small as a 0.001mm (0.0004") diameter orifice, come flow tested to tolerances of ±5%. This incredible accuracy is simply not 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.

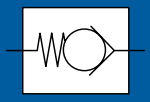


The IMH Group also offers a series of Luer Tee fittings with a relief valve in the branch of the Tee. These are particularly useful for a syringe driven system where a maximum force is required. One version uses a 2.5mm relief valve and another uses a 5.5mm model for higher flow. A third version has 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.



PRODUCTS IN PLASTIC FITTINGS





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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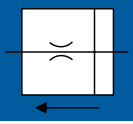
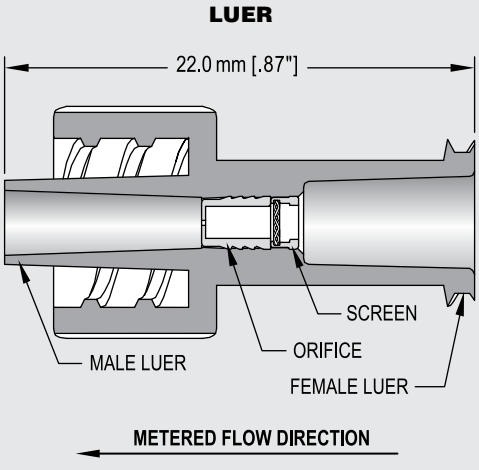
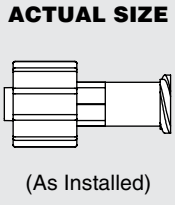


PRODUCTS IN PLASTIC FITTINGS

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





All dimensions in millimeters.

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: ± 5%

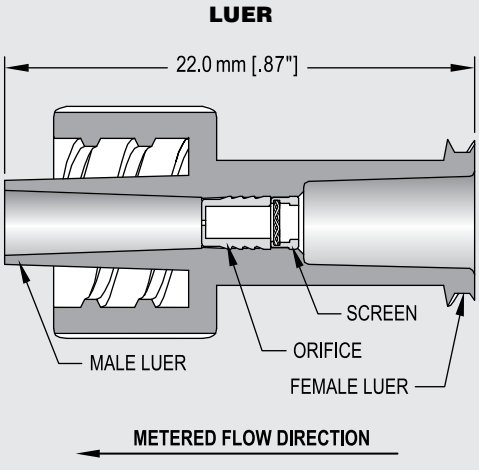
Screen Size: 40 Micron

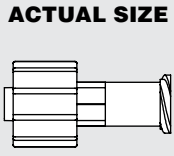
Test Fluid: Clean & Dry Nitrogen

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





All dimensions in millimeters.

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

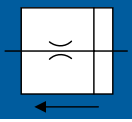
Metered Flow
Lohm Rate Tolerance: ± 5%

Screen Size: 40 Micron

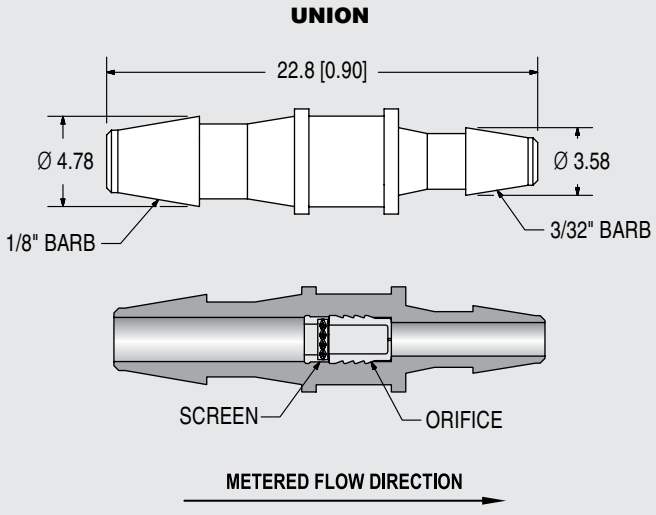
Test Fluid: Distilled Water

MATERIALS

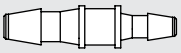
Fitting.....Polypropylene - Natural
Orifice.....303 Stainless Steel
Screen Body...303 Stainless Steel
Screen.....316 Stainless Steel



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



ACTUAL SIZE



(As Installed)

All dimensions in millimeters.

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%

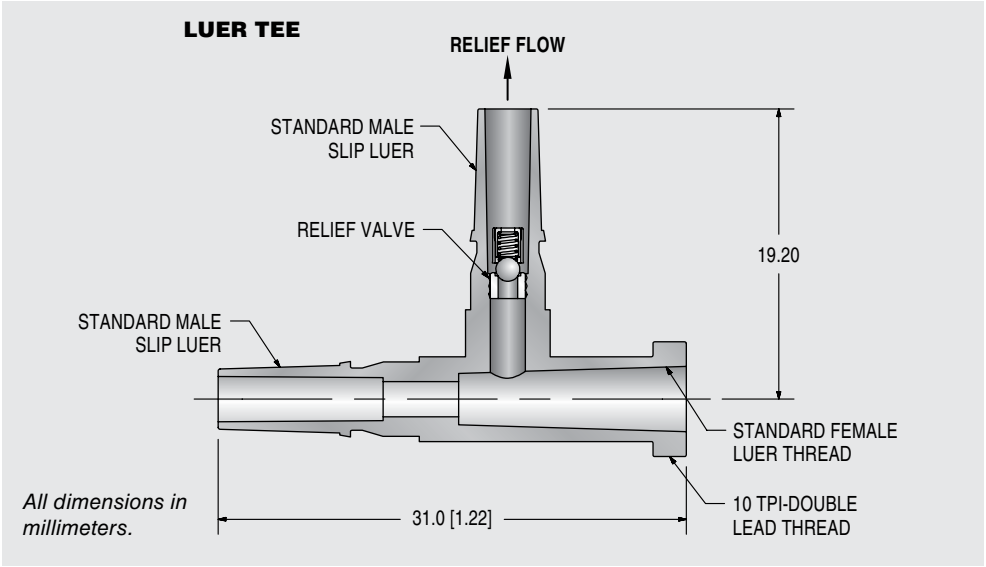
Screen Size: 4 Micron

Test Fluid: Clean & Dry Nitrogen

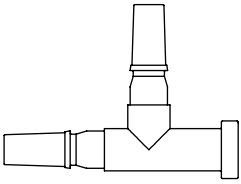
MATERIALS

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: ± 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

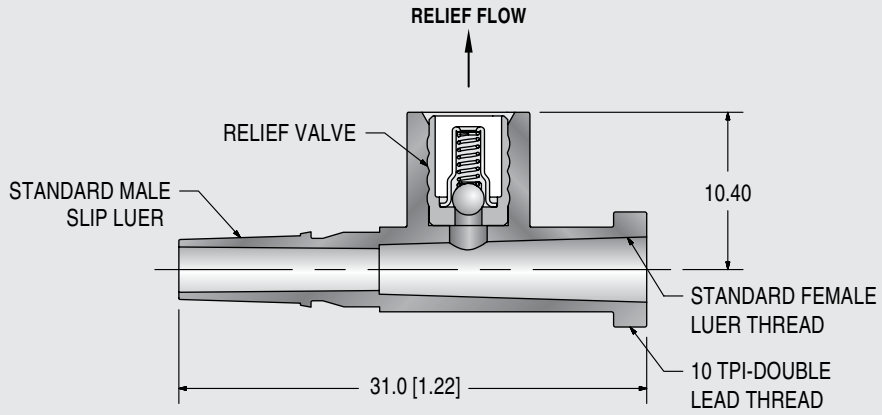
Spring.....302 Stainless Steel

Ball .....440C Stainless Steel

PRODUCTS IN PLASTIC FITTINGS

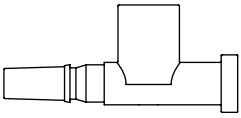
5.5mm RELIEF VALVE IN LUER TEE

LUER TEE



All dimensions in millimeters.

ACTUAL SIZE



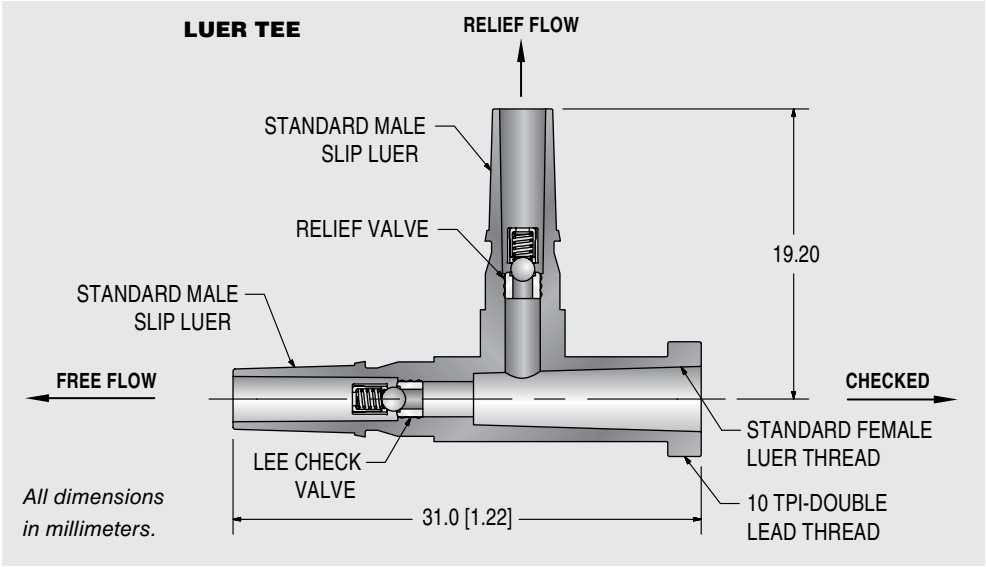
(As Installed)

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

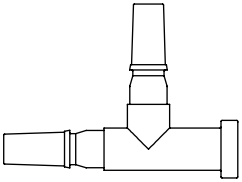
LEE PART NUMBER	CRACKING PRESSURE
CCPF0300100S	100 kPa (14.5 psid)
CCPF0300200S	200 kPa (29 psid)
CCPF0300300S	300 kPa (43.5 psid)
CCPF0300400S	400 kPa (58 psid)
CCPF0300500S	500 kPa (72.5 psid)

MATERIALS	
Fitting	Polypropylene - Blue
Relief Valve	
Body	303 Stainless Steel
Cage	305 Stainless Steel
Spring	302 Stainless Steel
Ball	440C Stainless Steel

2.5mm RELIEF AND CHECK VALVE IN LUER TEE



ACTUAL SIZE



(As Installed)

PERFORMANCE

Relief Valve Lohm Rate: 750 Lohms

Relief Valve Cracking Pressure Tolerance: ± 15%

Relief Valve Leakage: 1 Drop/min. (max.) on water

Check Valve Lohm Rate: 750 Lohms

Check Valve Cracking Pressure: 4 ± 3 kPa (0.6 ± 0.4 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.

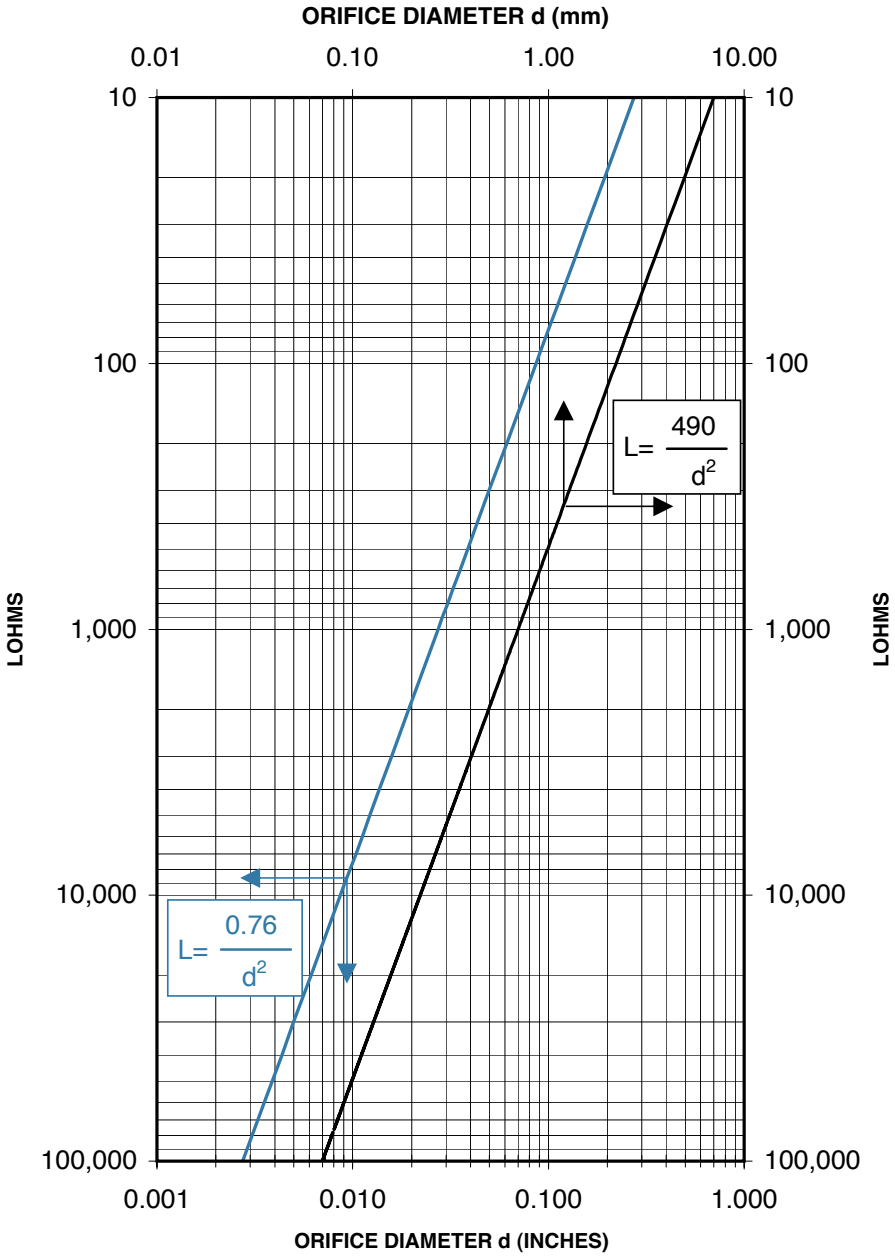
The graph on page C3 relates Lohms to hole diameter in inches and millimeters.

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.

TABLE OF CONTENTS

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.

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

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

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:

1. 1000 Lohms will permit a flow of 50 lb/hr water at 25 psi ΔP.
2. Flow Coefficient, $C_V = \frac{20}{L}$
3. $L = \frac{0.76}{d^2}$ $\qquad L = \frac{0.527}{C_d A}$

   d = Orifice diameter (inches)
   Cd = Coefficient of discharge
   A = Orifice area $(\text{inches})^2$
4. 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.

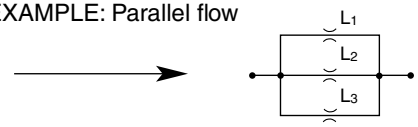
LIQUID FLOW - TWO FORMULAS FOR COMBINATIONS OF RESTRICTORS

PARALLEL FLOW, the total Lohm rating is:

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

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

EXAMPLE: Parallel flow



L_1 = 2000 Lohms
L_2 = 3000 Lohms
L_3 = 5000 Lohms

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

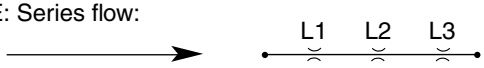
SERIES FLOW, the total Lohm rating is:

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

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 resistors 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

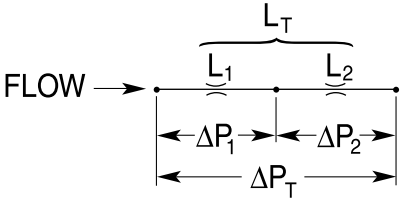
One of the reasons for using two restrictors in series is to allow fine tuning of a total resistance value. If L_1 is known and is more than 90% of L_T, then L_2 may vary by ±5% without altering the value of L_T by more than ±1%, even though the value of L_2 may be as high as 40% of L_T. This effect 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; υ = 21cs. 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, υ = 600cs.
2. Use knowledge of system to assume solution.
   H = 50 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 psid.

LIQUID FLOW – EXAMPLES

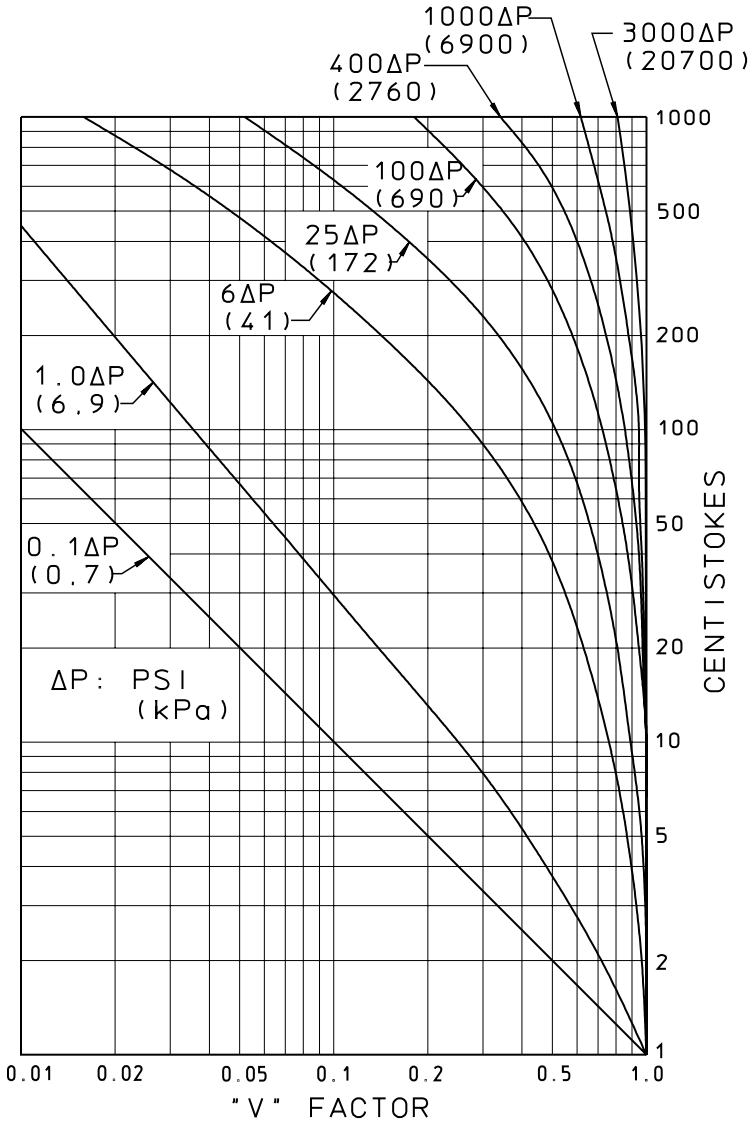
Problem 3. A Safety Screen is required to flow 775 lb/hr of diesel fuel @ 80°F with a maximum pressure drop of 5 psid. What is the maximum Lohm rate allowed for the Safety Screen?

Solution:

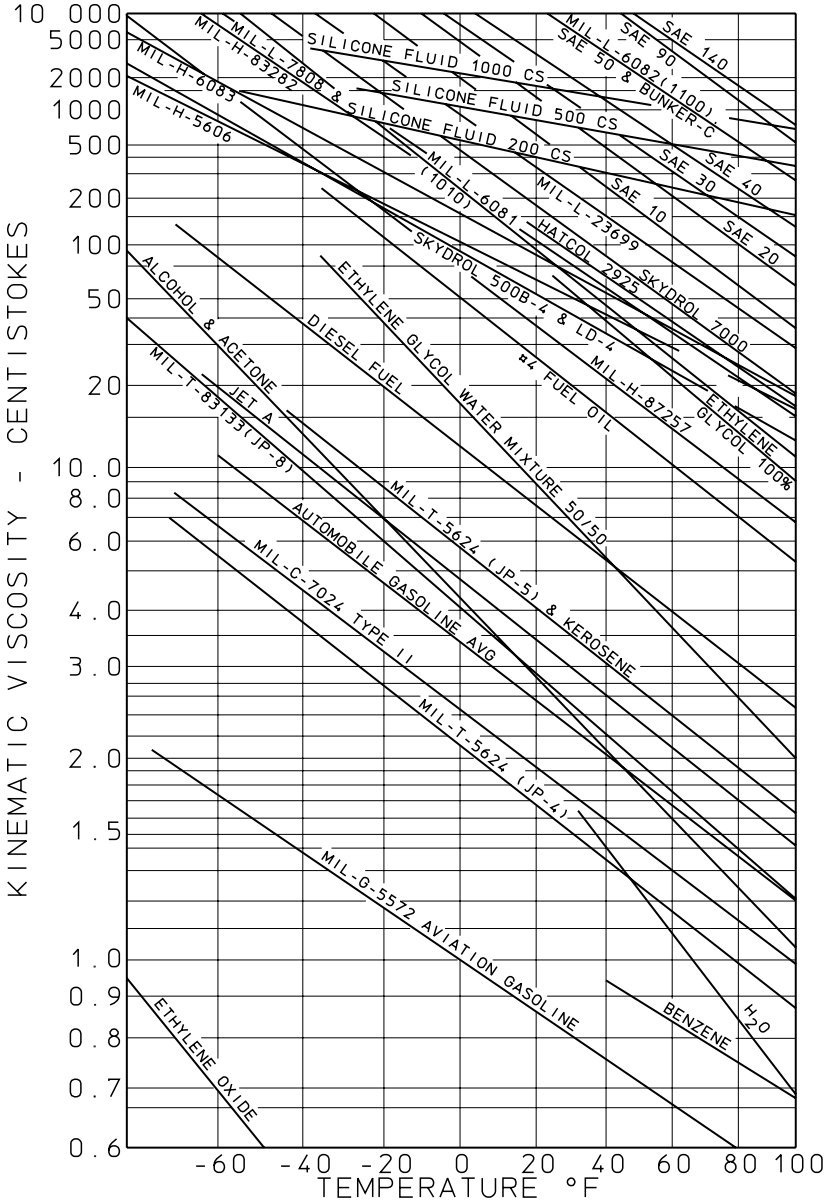
1. Find specific gravity; S = 0.87 from curve on page C15.
2. Find viscosity; $\boldsymbol{v}$ = 3.1cs from curve on page C13.
3. Use $\boldsymbol{v}$ and ΔP to determine viscosity compensation factor, V = 0.87 from curve on page C12.
4. Select units constant, K = 10,000 from table on page C9.

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

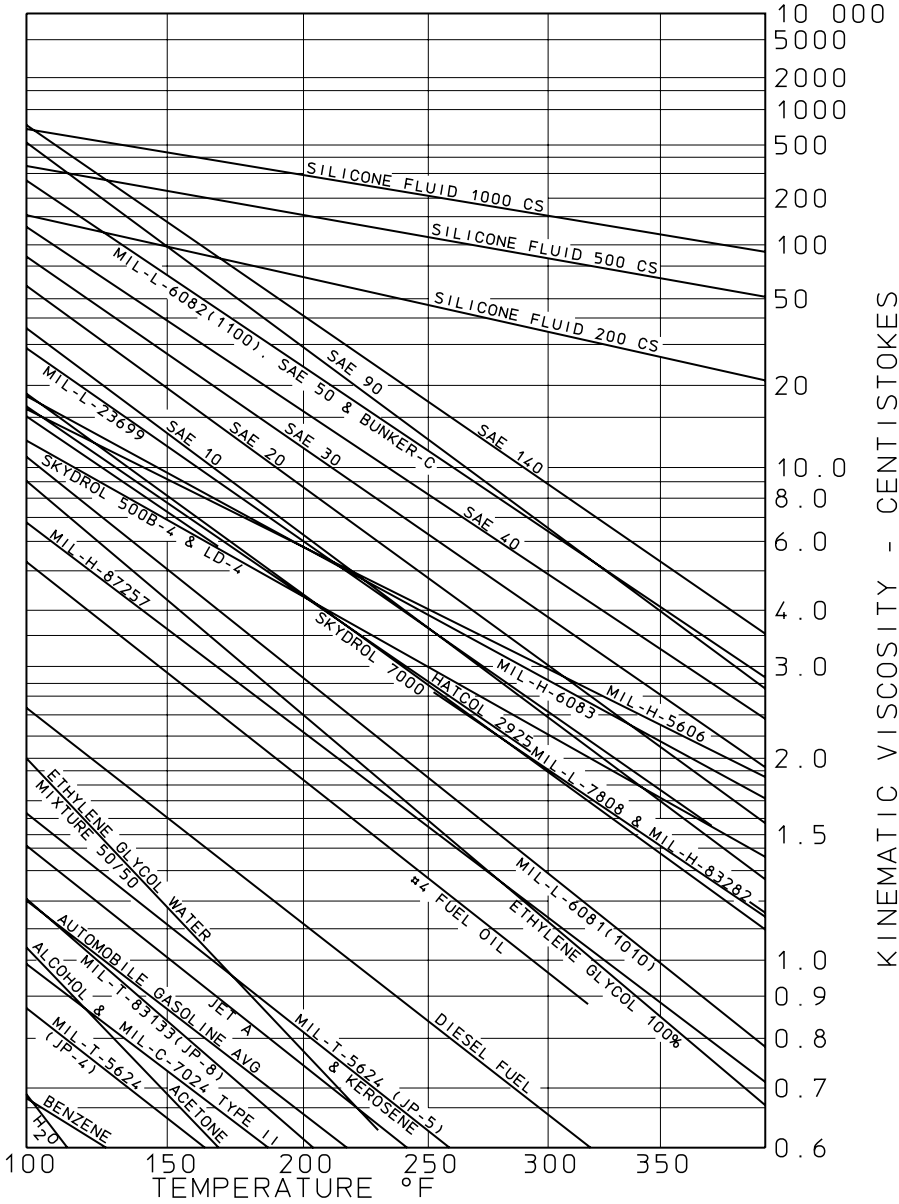
VISCOSITY COMPENSATION FACTOR FOR SINGLE ORIFICE



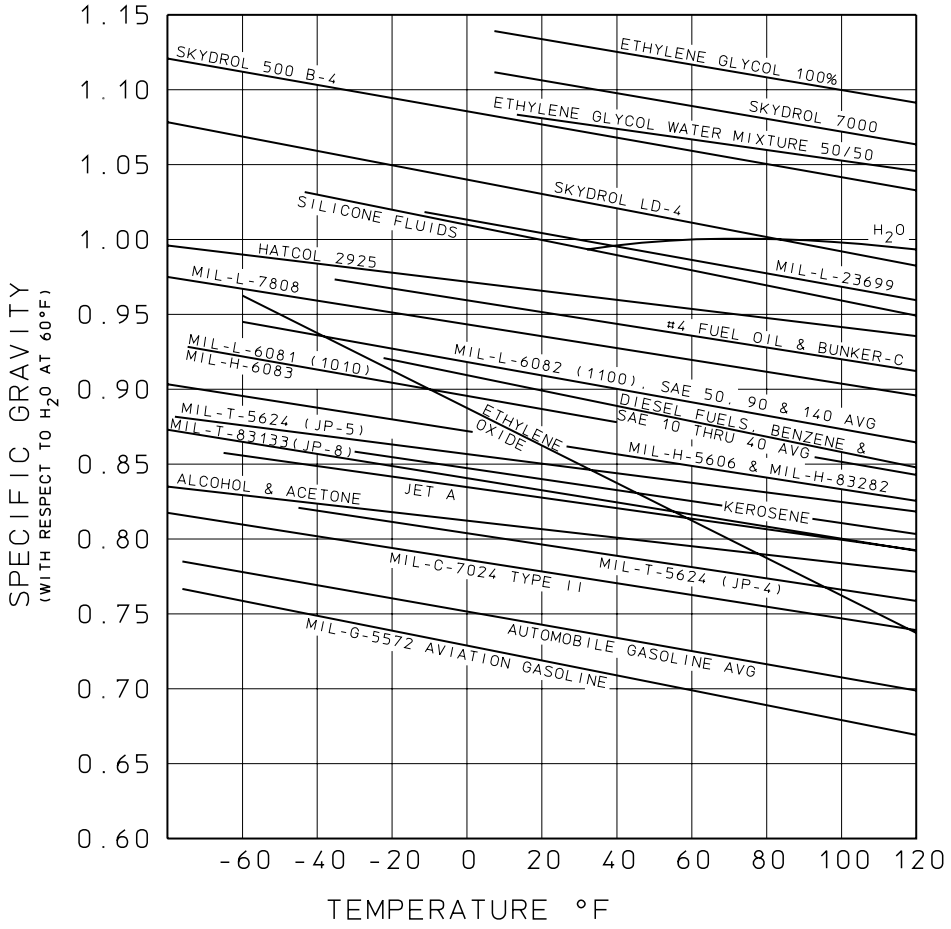
VISCOSITIES OF TYPICAL FLUIDS vs TEMPERATURE



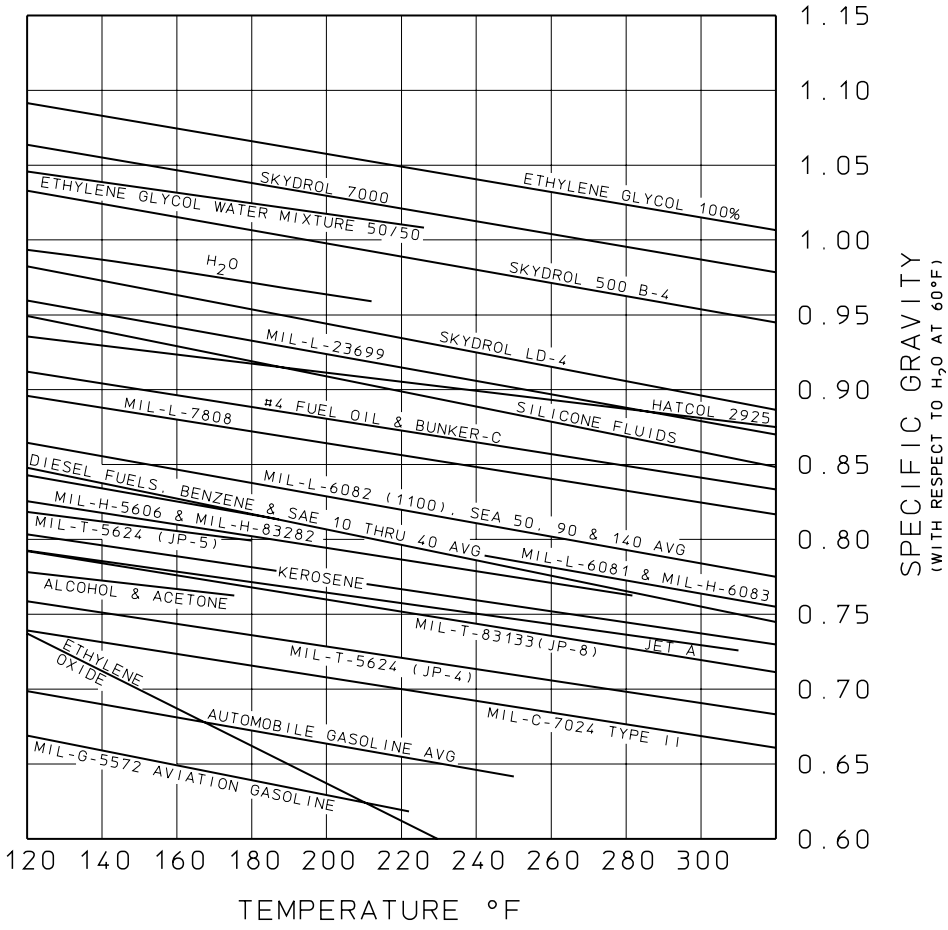
VISCOSITIES OF TYPICAL FLUIDS vs TEMPERATURE



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.

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

When H = psi ΔP
I = GPM flow rate

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

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

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.

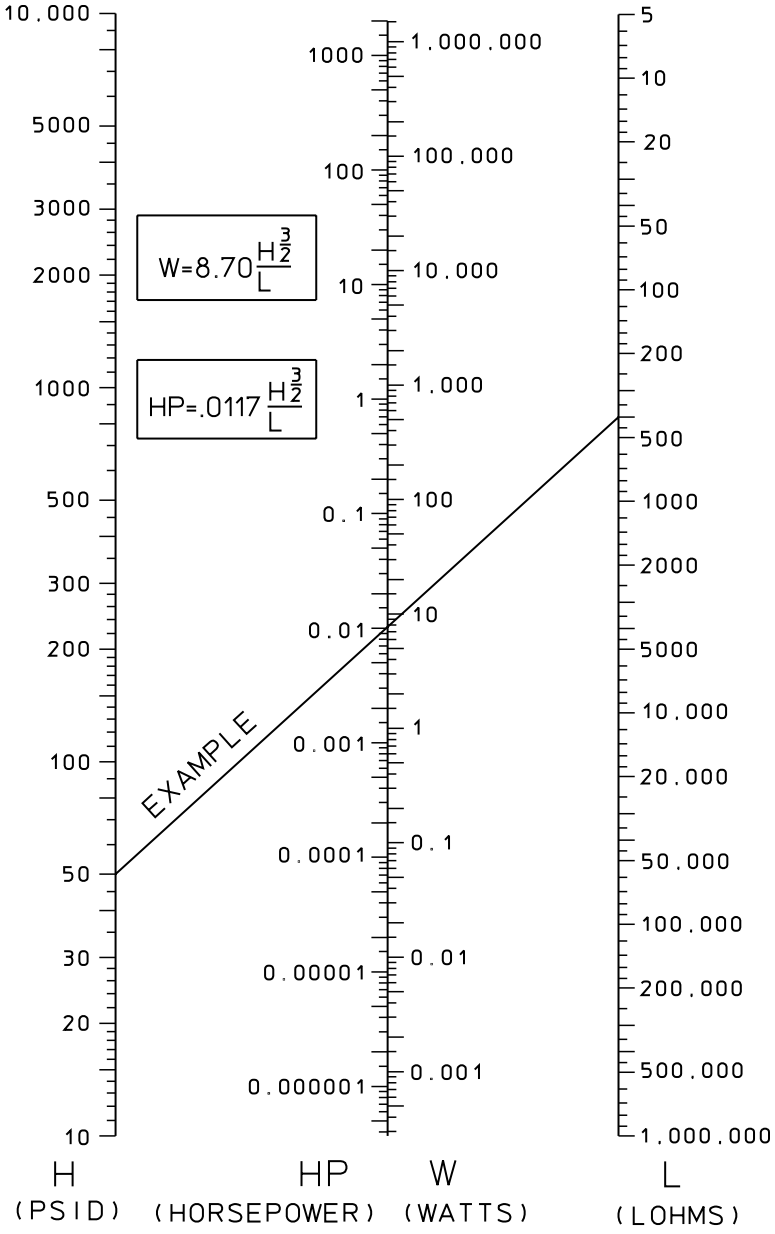
EXAMPLE:

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

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

$$H.P. = 0.010$$

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.

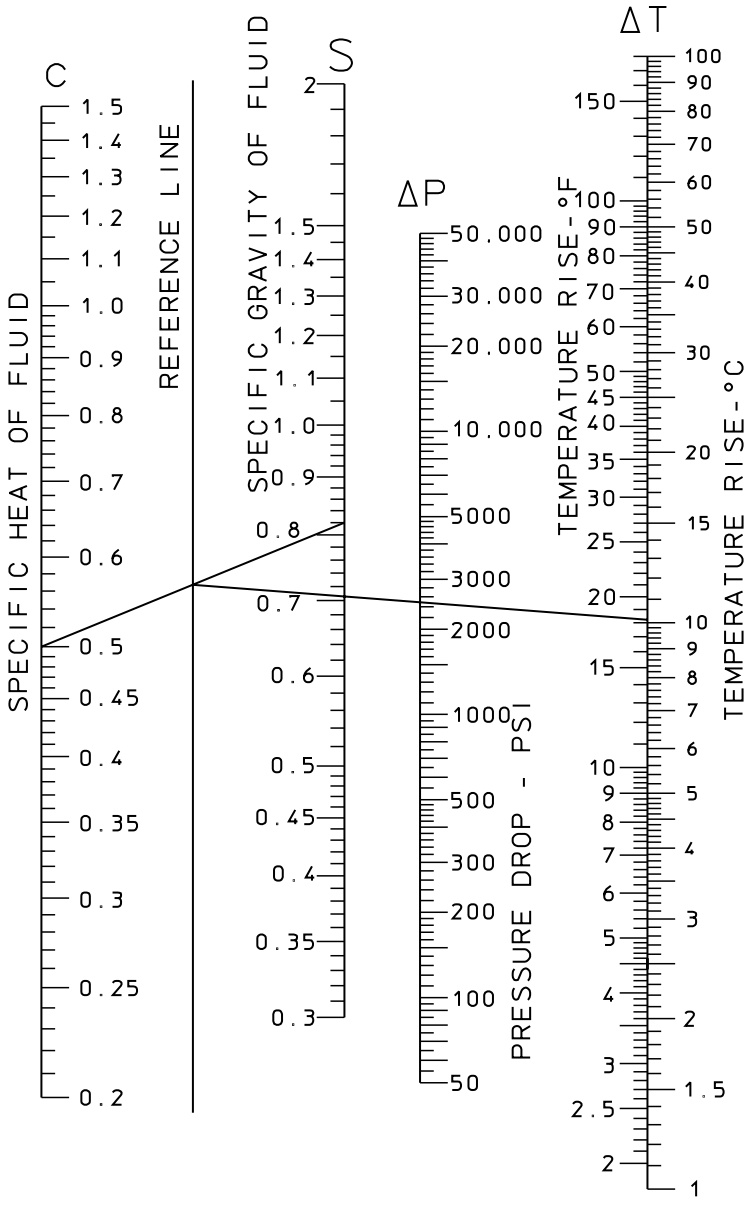
EXAMPLE:

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

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

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.

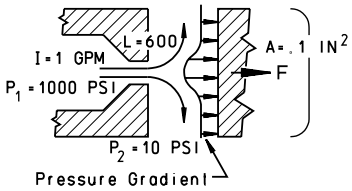
$$F = \frac{SI^2L}{400} \qquad F = \frac{H}{L} \qquad F = \frac{I\sqrt{HS}}{20}$$

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.

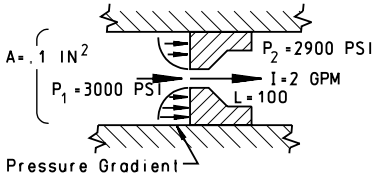
$$F_{momentum} = \frac{H}{L} = \frac{990}{600} = 1.7 \text{ lbf}$$



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.

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



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.

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

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.

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	ΔV/V/°F	°F, min.	°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/°F at 100°F
ΔP = Pressure rise, psi
ΔT = Temperature rise, °F
P_1, P_2 = 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 x 1.10 x 0.8 x 300,000 = 240,000 psi

EXAMPLE:

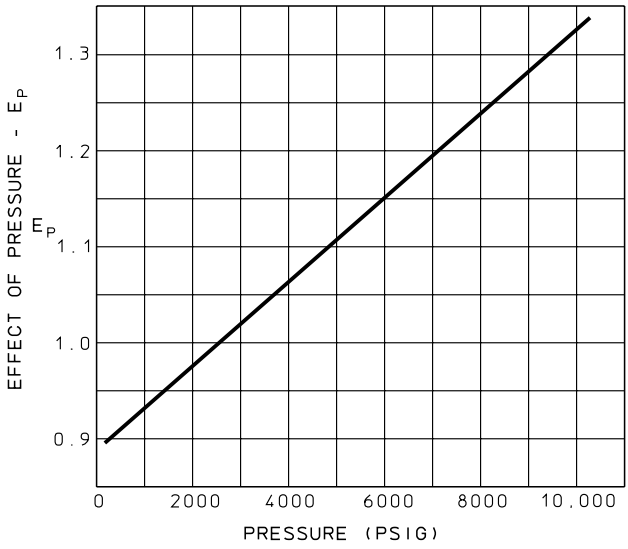
2000 psi, 160°F, 2% entrained air, MIL-H-83282.
Actual B = 0.98 x 0.86 x 0.98 x 300,000 = 248,000 psi

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

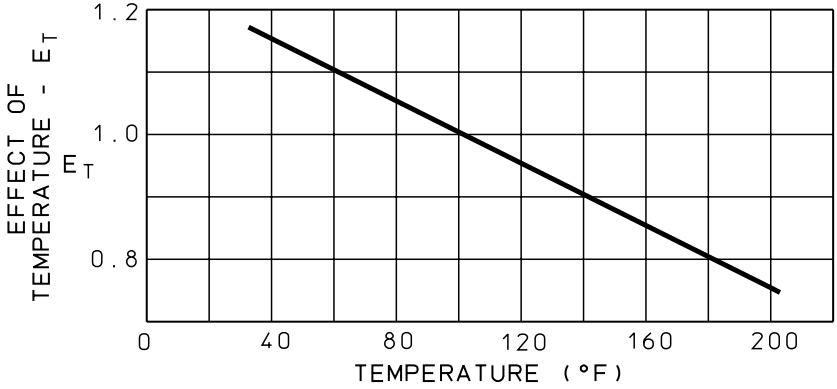
WORKING PRESSURE

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



TEMPERATURE

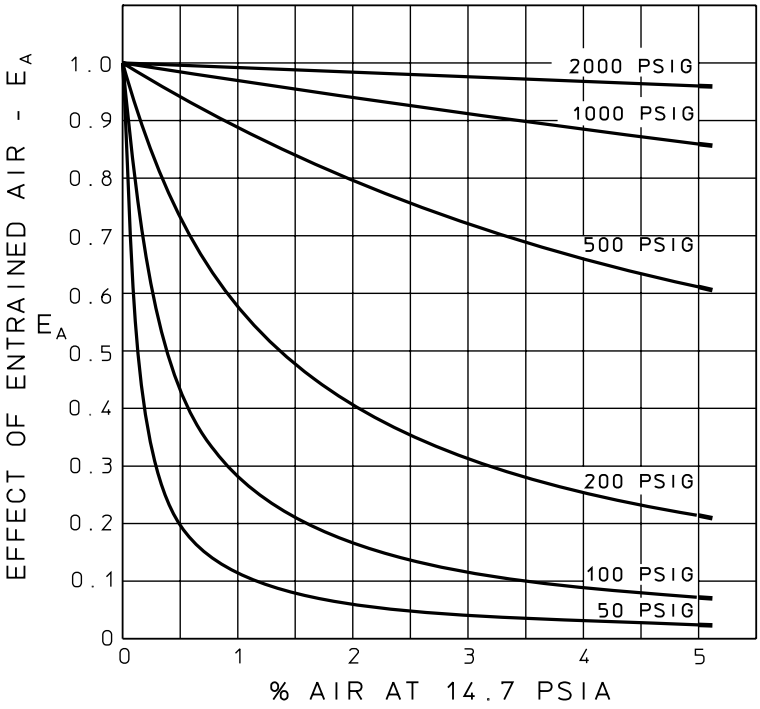
The effect of temperature on bulk modulus for hydrocarbon fluids.



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.

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

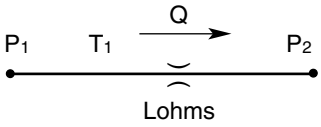
$$L = \frac{2\ K\ f_T \sqrt{\Delta P\ P_2}}{Q} \qquad \text{(Subsonic region)} \quad \text{i.e. } P_1/P_2 < 1.9$$

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

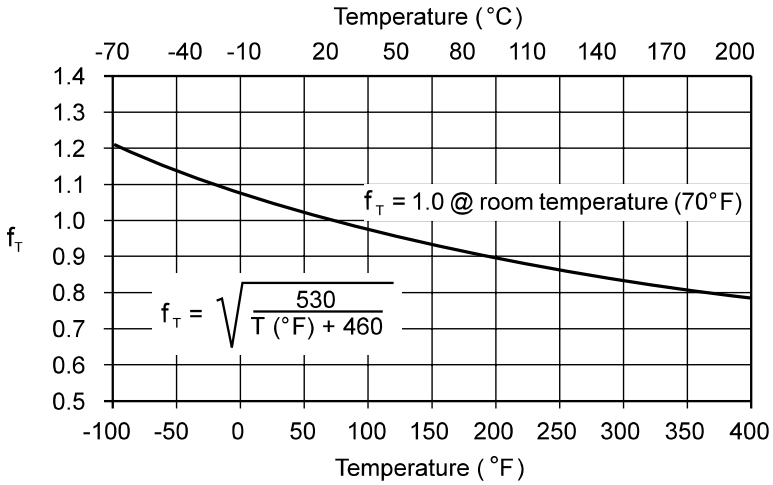


EXAMPLE: What restriction will permit a flow of 1.00 std L/min. of nitrogen at 90°F, with supply pressure at 5 psig, discharging to atmosphere?

$K = 276$ (see page C31)
$T_1 = 90°F,\ f_T = 0.98$ (see below)
$P_1 = 5.0 + 14.7 = 19.7$ psia, $P_2 = 14.7$ psia
$P_1 / P_2 = 19.7/14.7 = 1.34$ (subsonic)
$\Delta P = 5.0$ psid
$Q = 1.00$ 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:

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

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

VOLUMETRIC FLOW UNITS							
Abs. Pres	**psia**			**bar**		**kPa**	**mm. Hg**
Flow	**SLPM**	**SCFM**	**in³/min**	**SLPM**	**SCFM**	**SLPM**	**mL/min**
H_2	1030	36.3	62700	14900	526	149	19900
He	771	27.2	47100	11200	395	112	14900
Neon	343	12.1	20900	4980	176	49.8	6640
Nat. Gas	319	11.3	19400	4620	163	46.2	6160
N_2	276	9.73	16800	4000	141	40.0	5330
CO	274	9.69	16700	3980	141	39.8	5300
Air	271	9.56	16500	3930	139	39.3	5230
Ethane	251	8.86	15300	3640	129	36.4	4850
O_2	257	9.08	15700	3730	132	37.3	4970
Argon	245	8.65	14900	3550	125	35.5	4730
CO_2	213	7.52	13000	3090	109	30.9	4110
N_2O	214	7.56	13100	3100	110	31.0	4140
SO_2	176	6.21	10700	2550	90.1	25.5	3400
Freon-12	123	4.34	7510	1780	63.0	17.8	2380

GAS FLOW – UNITS CONSTANT "K"

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

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

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_2O	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. $\boxed{p\,V = m\,R\,T}$ (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?

$K = 276$ (see page C31)
$T_1 = 70°F$, $f_T = 1.00$ (see page C30)
$P_2 = 0.4912 \times 29.5 = 14.5$ psia
$P_1 = 10.0 + 14.5 = 24.5$ psia
$P_1 / P_2 = 24.5/14.5 = 1.69$ (subsonic)
$\Delta P = 24.5 - 14.5 = 10.0$ psid
$Q = 2.00$ std L/min.

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

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.

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

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:

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

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.

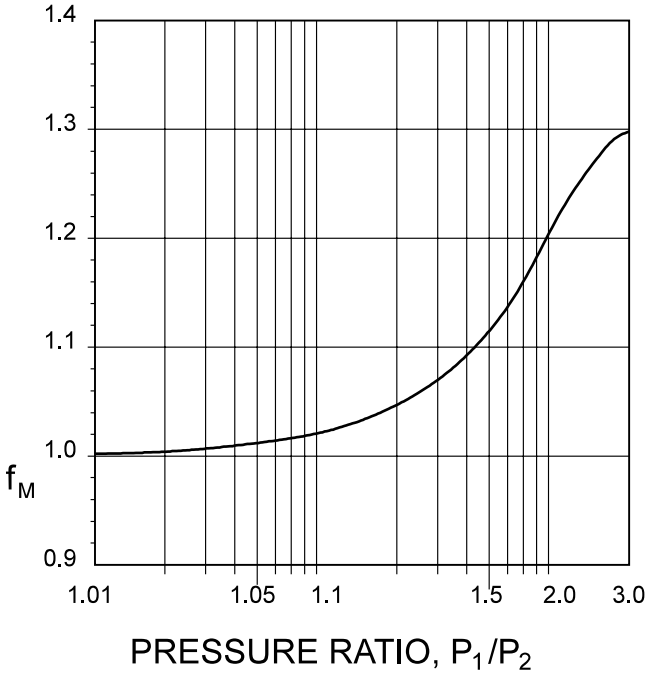
$$\text{Lohms} = \frac{K\ f_T\ f_M\ P_1}{Q} \qquad \text{(Sonic region)}$$

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?

$K = 1030$ (see page C31)
$T_1 = 70°F, \quad f_T = 1.0$ (see page C30)
$P_1 = 40.0 + 14.7 = 54.7$ psia
$P_2 = 14.7$ psia
$P_1 / P_2 = 54.7 / 14.7 = 3.72$
$f_M = 1.30$ (see page C38)
$Q = 0.50$ std L/min

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

GAS FLOW
FLOW FACTOR “fM” (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 Lo. L_2 = 500 Lo.

Calculate the Lohm ratio: $L_1/L_2 = 2000/500 = 4.0$

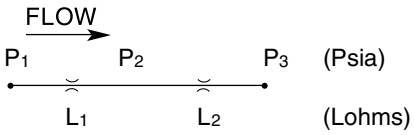
Calculate the overall pressure ratio: $P_1/P_3 = 72.0/14.7 = 4.9$

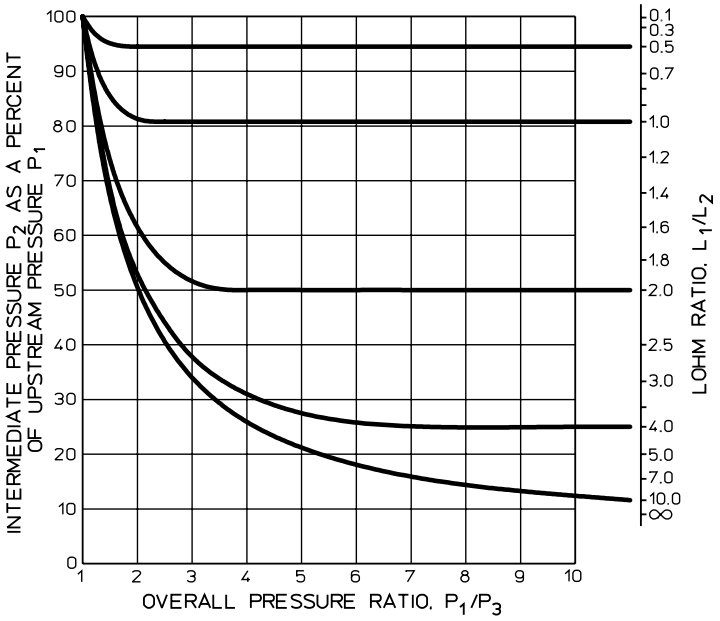
Read 28% from left hand scale of graph.

The upstream pressure is known, thus:

$P_2 = 0.28 \times 72.0 = 20$ 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 ($L_1 > L_2$):

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

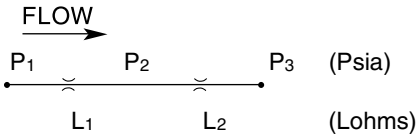
5.) L_1 is subsonic, and L_2 is subsonic ($L_1 \neq L_2$):

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

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

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

GAS FLOW SERIES (Cont.)



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

$L_1 = 2000$ Lo. , $L_2 = 500$ Lo.

$P_1 = 72$ psia, $P_2 = 20$ psia, $P_3 = 14.7$ psia

$P_1 / P_2 = 72 / 20 = 3.60$ (Sonic)

$P_2 / P_3 = 20 / 14.7 = 1.36$ (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.

$L_1 = 1500$ Lo. , $L_2 = 1500$ Lo.

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

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

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

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

(L_1 and L_2 are both subsonic)

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

$P_2 = 24.2$ psia

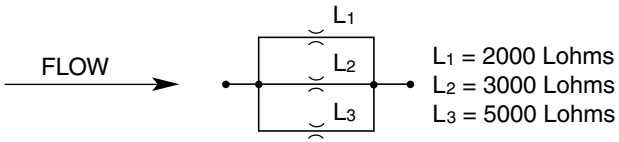
GAS FLOW PARALLEL

For parallel flow, the total Lohm rating is:

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

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

EXAMPLE:



L_1 = 2000 Lohms
L_2 = 3000 Lohms
L_3 = 5000 Lohms

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

Therefore, L_T = 970 Lohms

MOMENTUM FORCES – GAS FLOW

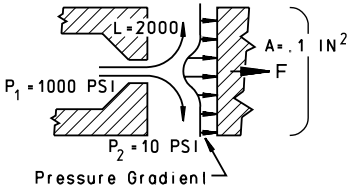
When a flowing stream of gas is subject to a change in velocity (either speed or direction), forces arise which are the reaction to the change in momentum of the stream. This is particularly important in valve design where the position of a moving element may be affected.

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.

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

EXAMPLE: Where a gas changes direction.

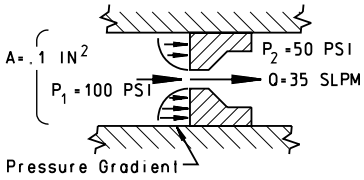
$$F = \frac{0.4 \times P_1}{L} = \frac{0.4 \times 1000}{2000} = 0.2 \text{ lbf.}$$



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 $in.^2$ x 10 psi = 1 lb.) to give the total force on the plate.

EXAMPLE: Where a gas changes speed.

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



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 $in.^2$ x [100-50] = 5 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:

$$\tau = \frac{4 f_T V L}{K}$$

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.

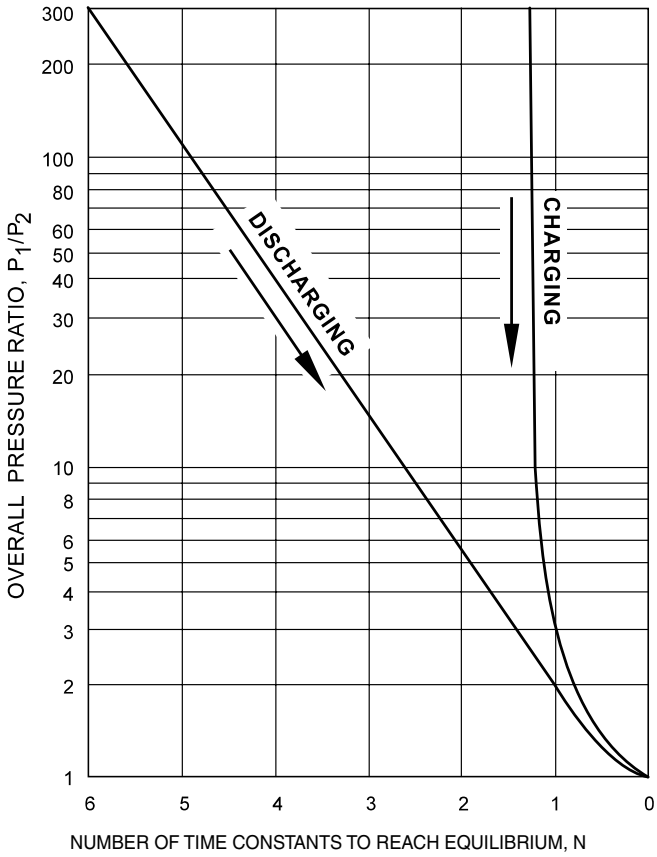
The larger the value of τ, the more sluggish the system.

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:

$t = \tau (N_i - N_f)$ $\quad$ t = 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_T = 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.

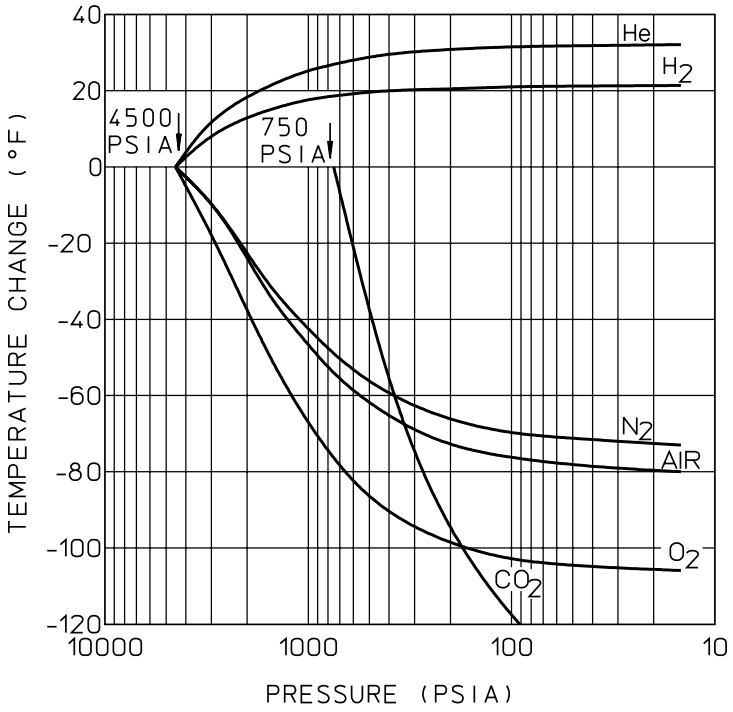
A positive Joule – Thomson coefficient, which is a function of both temperature and pressure, will produce cooling of the gas. This is only the case at below the "inversion" temperature. At the inversion temperature, the Joule – Thomson coefficient is zero, so no heating or cooling occurs.

The following graph allows downstream temperature to be found when starting from an upstream pressure of 4500 psia; 750 psia for CO_2 . 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.

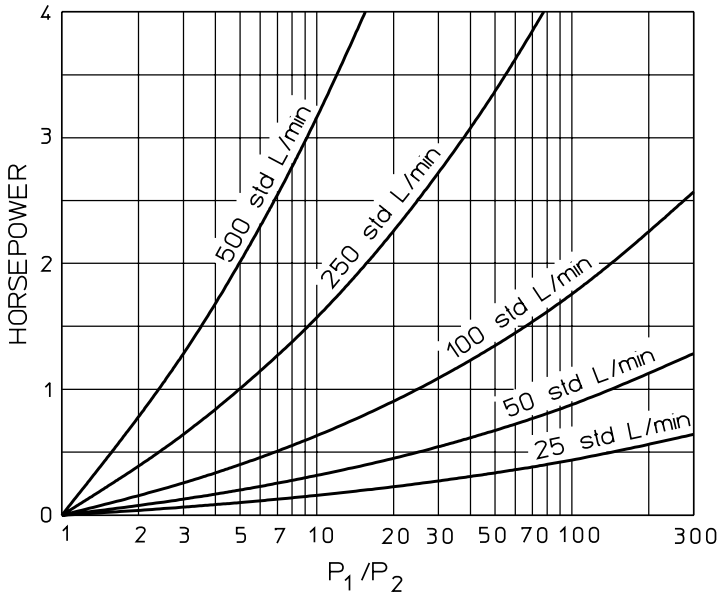
For more precise calculations, or to extend the range of the pneumatic power graph, the following formula may be used for nitrogen or air.

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

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

POWER LOSS FOR NITROGEN



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 lb_m/ft^3	Density lb_m/std L	c_P* Btu/lb°R	c_V* Btu/lb°R
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_2O	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

c_P = Specific heat at constant pressure

c_V = 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 - $\log^2$ 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 ROB NUMBERS

HOLE SIZE		SINGLE ORIFICE ROB #
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 ROB #
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 ROB NUMBERS

HOLE SIZE		SINGLE ORIFICE ROB #
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 ROB #
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/10^6 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

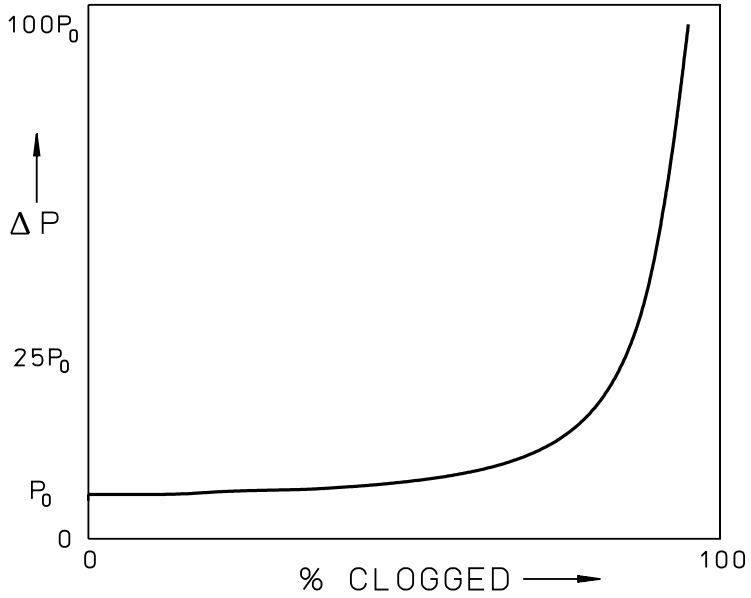
SCREEN SIZES		
U.S. SIEVE NO.	**OPENING IN INCHES**	**OPENING IN MICRONS**
50	0.0117	297
60	0.0090	228
70	0.0083	210
100	0.0059	149
140	0.0041	105
200	0.0029	74
270	0.0021	53
325	0.0017	44
Paper	0.00039	10
Paper	0.00019	5

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:

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

Where ΔP_O 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 p_{10} and 5 d_5 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_2O at 4°C	=	2988.98 pascals
1 gram/centimeter^3	=	1 000 kilograms/meter^3
1 inch of H_2O 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

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

Multiply by ↑

MASS

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

Multiply by ↑

CONVERSION FACTORS

PRESSURE

To Convert \ Into	$\frac{LB.}{IN.^2}$	IN. HG at 0°C	IN.H_2O at 4°C	FT.H_2O at 4°C	ATM	$\frac{kg_F}{cm^2}$	$\frac{kg_F}{m^2}$	kPa
LB. $IN.^2$	—	2.036	27.68	2.307	6.805×10^{-2}	7.031×10^{-2}	703.1	6.895
IN. HG at 0°C	0.4912	—	13.60	1.133	3.342×10^{-2}	3.453×10^{-2}	345.3	3.386
IN. H_2O at 4°C	3.613×10^{-2}	7.355×10^{-2}	—	8.333×10^{-2}	2.458×10^{-3}	2.540×10^{-3}	25.40	0.2491
FT. H_2O at 4°C	0.4335	0.8826	12.00	—	2.950×10^{-2}	3.048×10^{-2}	304.8	2.989
ATM	14.70	29.92	406.8	33.90	—	1.033	1.033×10^{4}	101.3
$\frac{kg_F}{cm^2}$	14.22	28.96	393.7	32.81	0.9678	—	1.000×10^{4}	98.07
$\frac{kg_F}{m^2}$	1.422×10^{-3}	2.896×10^{-3}	3.937×10^{-2}	3.281×10^{-3}	9.678×10^{-5}	1.000×10^{-4}	—	9.807×10^{-3}
kPa	0.1450	0.2953	4.015	0.3346	9.869×10^{-3}	1.020×10^{-2}	102.0	—

Multiply by

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

MASS

VOLUME: 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 ↑

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

VOLUME: To Convert → / Into ↓	LB_M (avdp)	OZ_M (avdp)	SLUG	gram	kg_m
$FT.^3$	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 ↑

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.

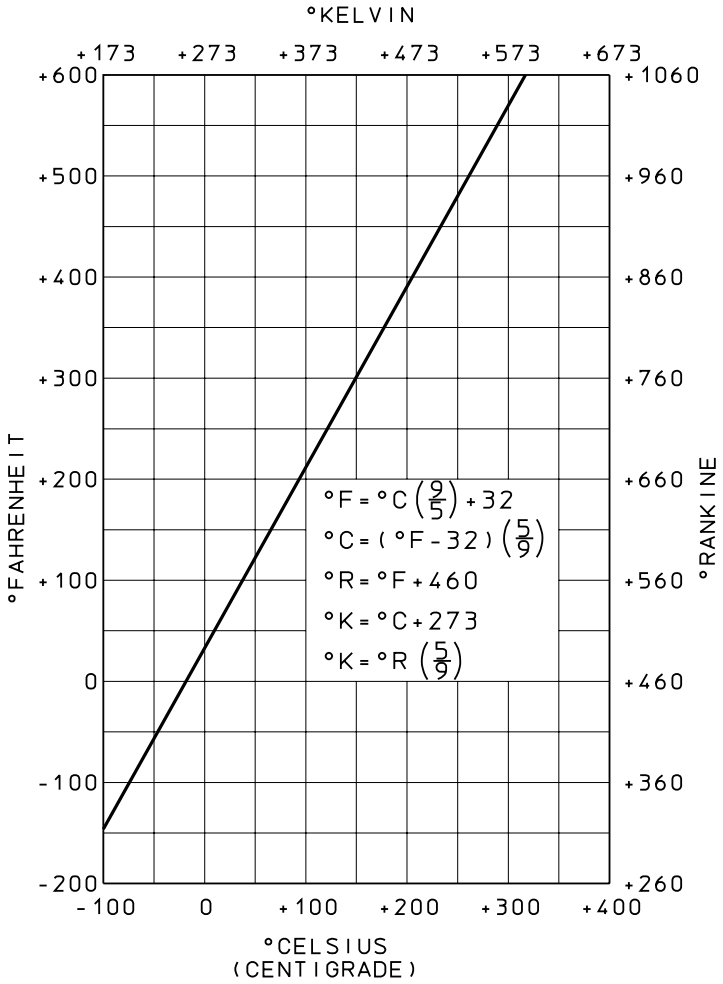
EXAMPLE:

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

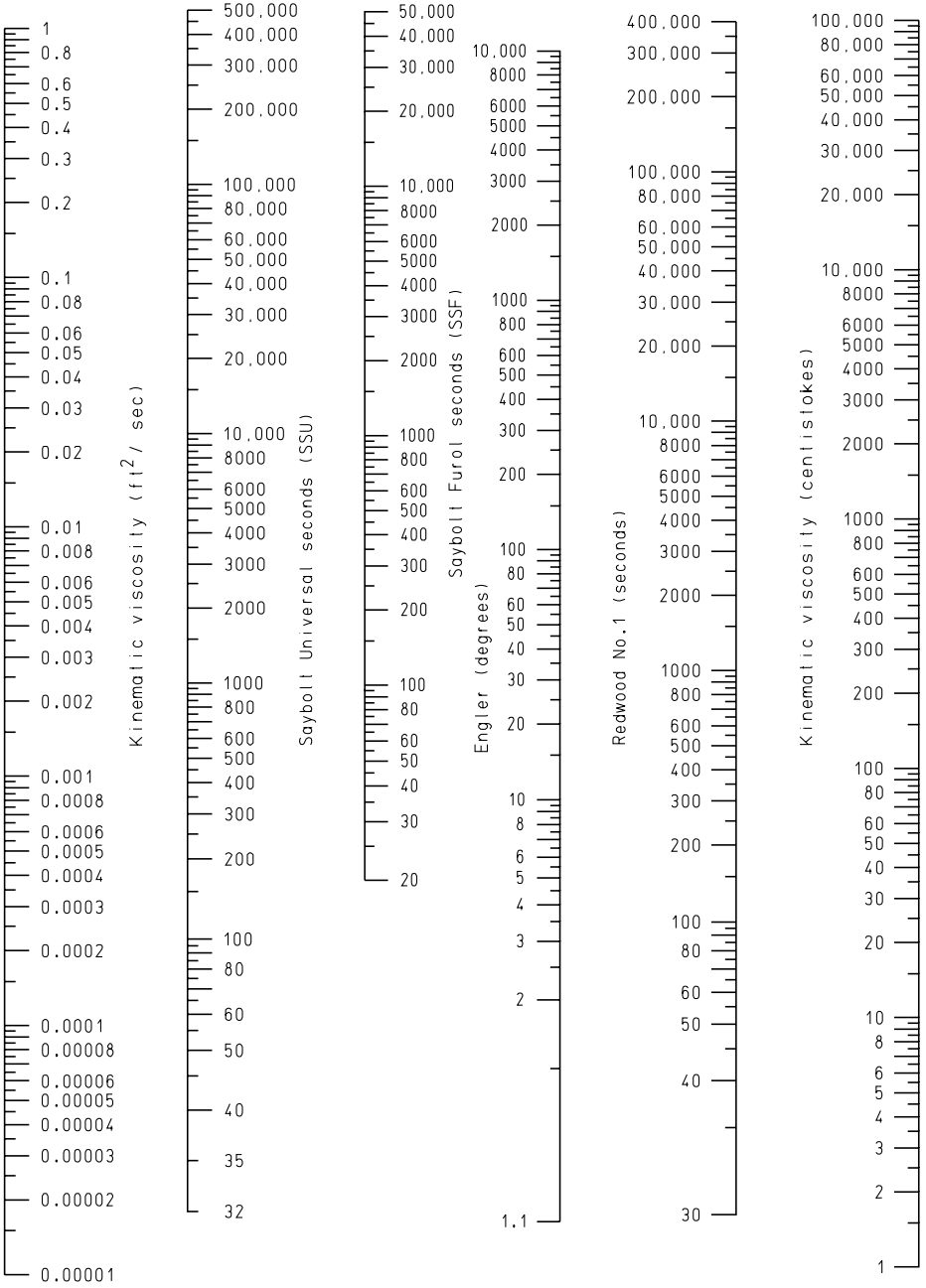
Solution:

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

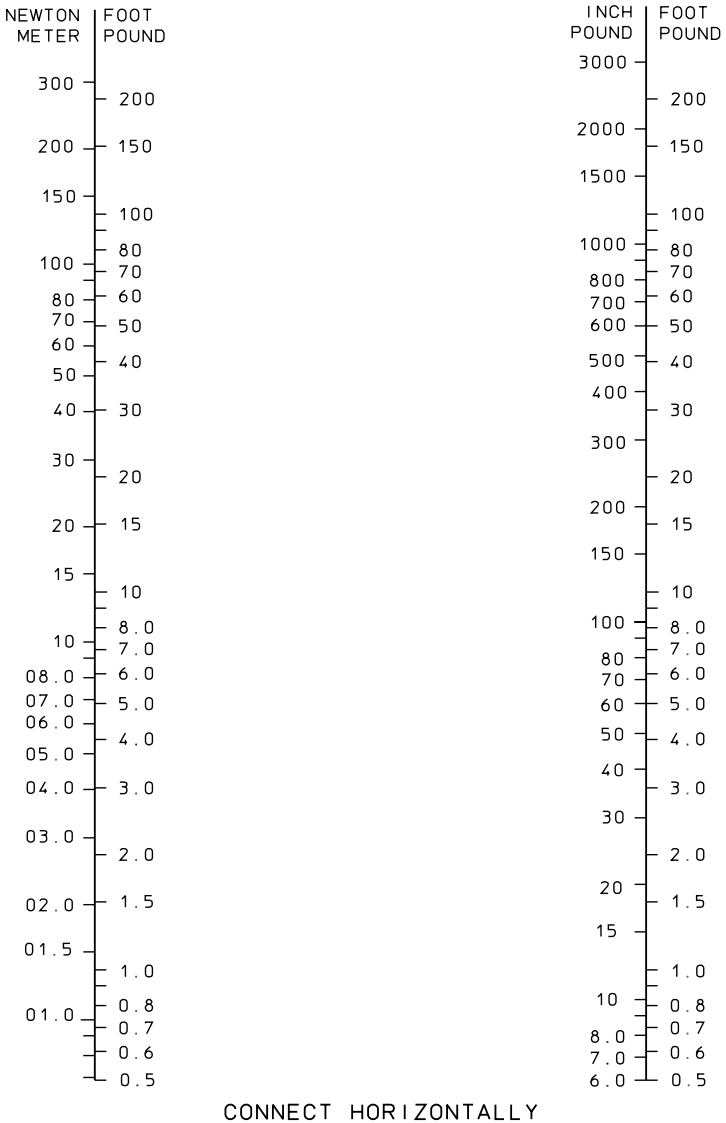
TEMPERATURE CONVERSION



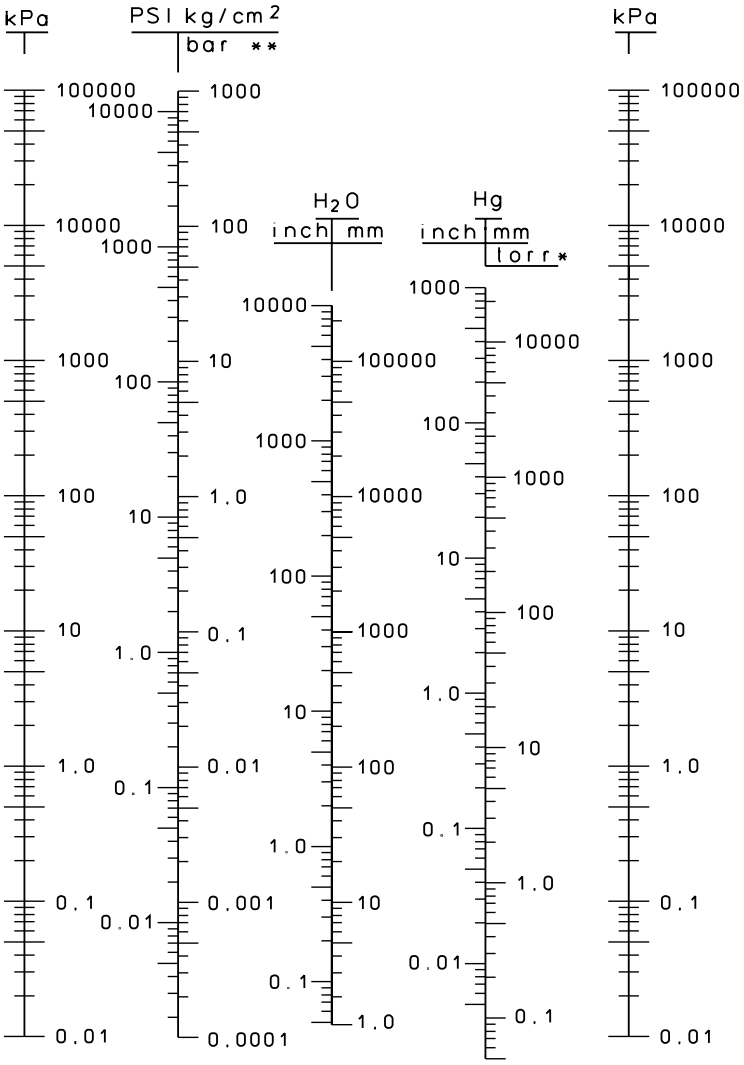
VISCOSITY CONVERSION



TORQUE CONVERSION CHART

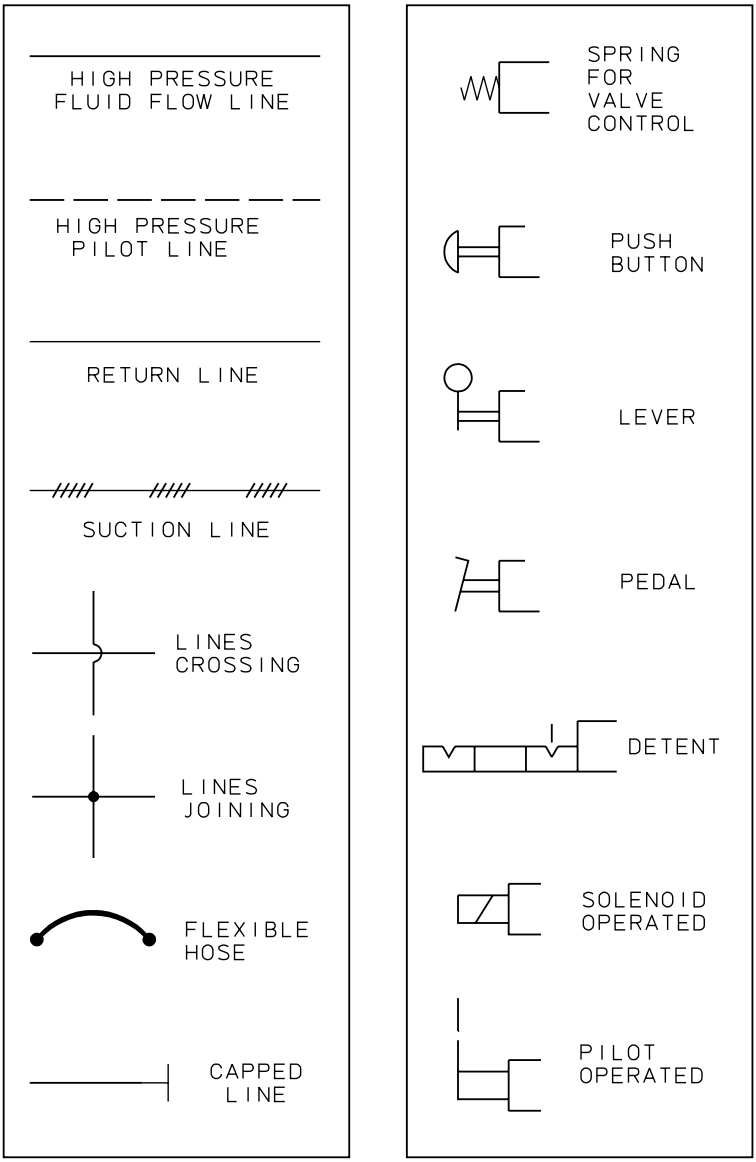


PRESSURE CONVERSION CHART

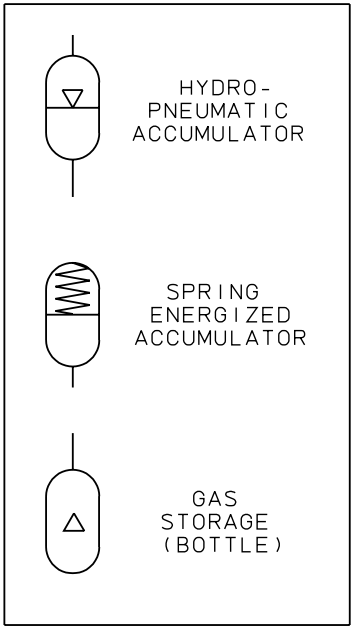


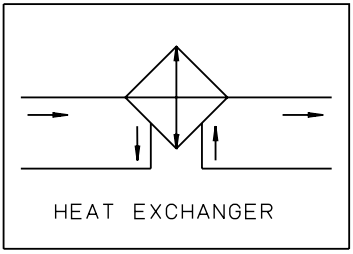
NOTE: *1 torr=1mm Hg=0.535 inch H_2O
**1 bar=1.02 kg/cm² =14.5 PSI
1 PSI=6.895 kPa=0.07031 kg/cm²

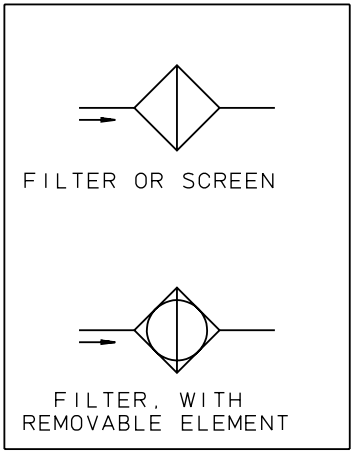
GRAPHIC SYMBOLS FOR HYDRAULICS AND PNEUMATICS

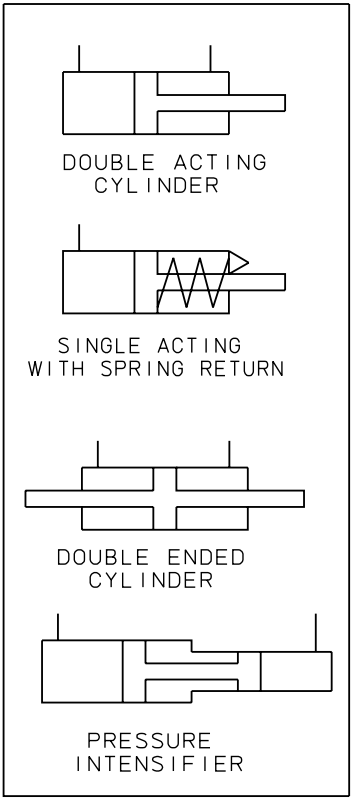


GRAPHIC SYMBOLS FOR HYDRAULICS AND PNEUMATICS









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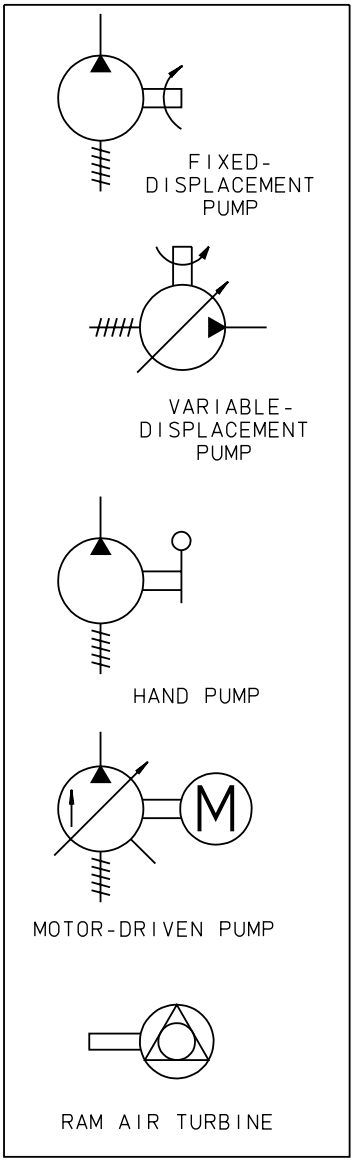
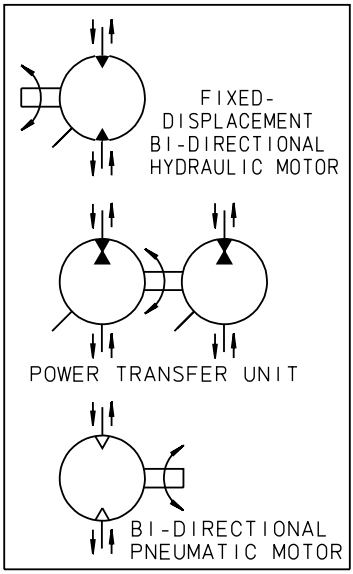
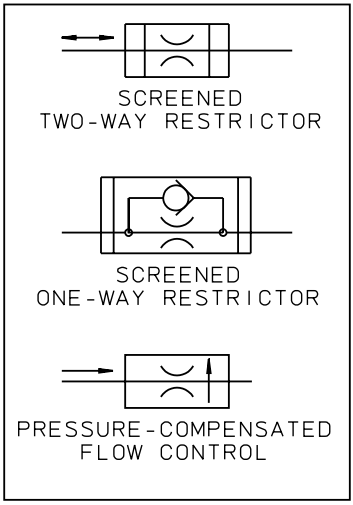
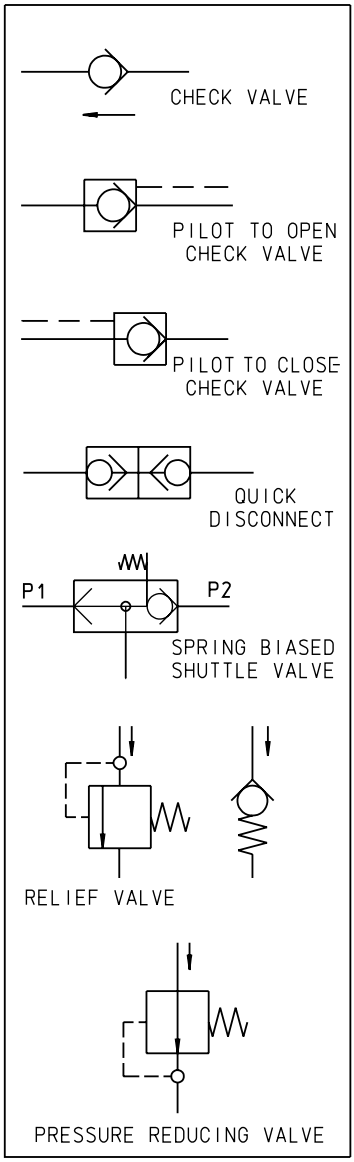
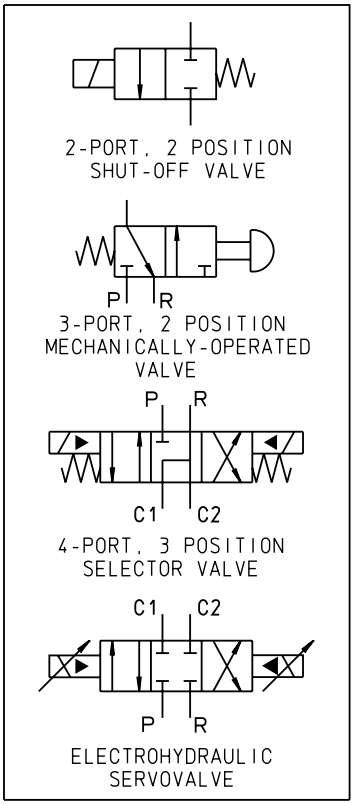


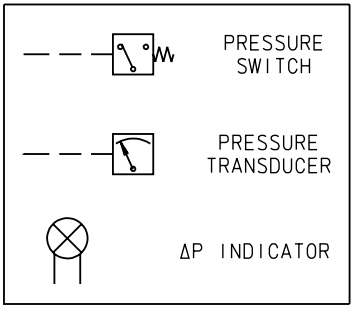




GRAPHIC SYMBOLS FOR HYDRAULICS AND PNEUMATICS







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 = $1/076 \times 10^{-5}$ $ft.^2/sec.$
- *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.

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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.

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