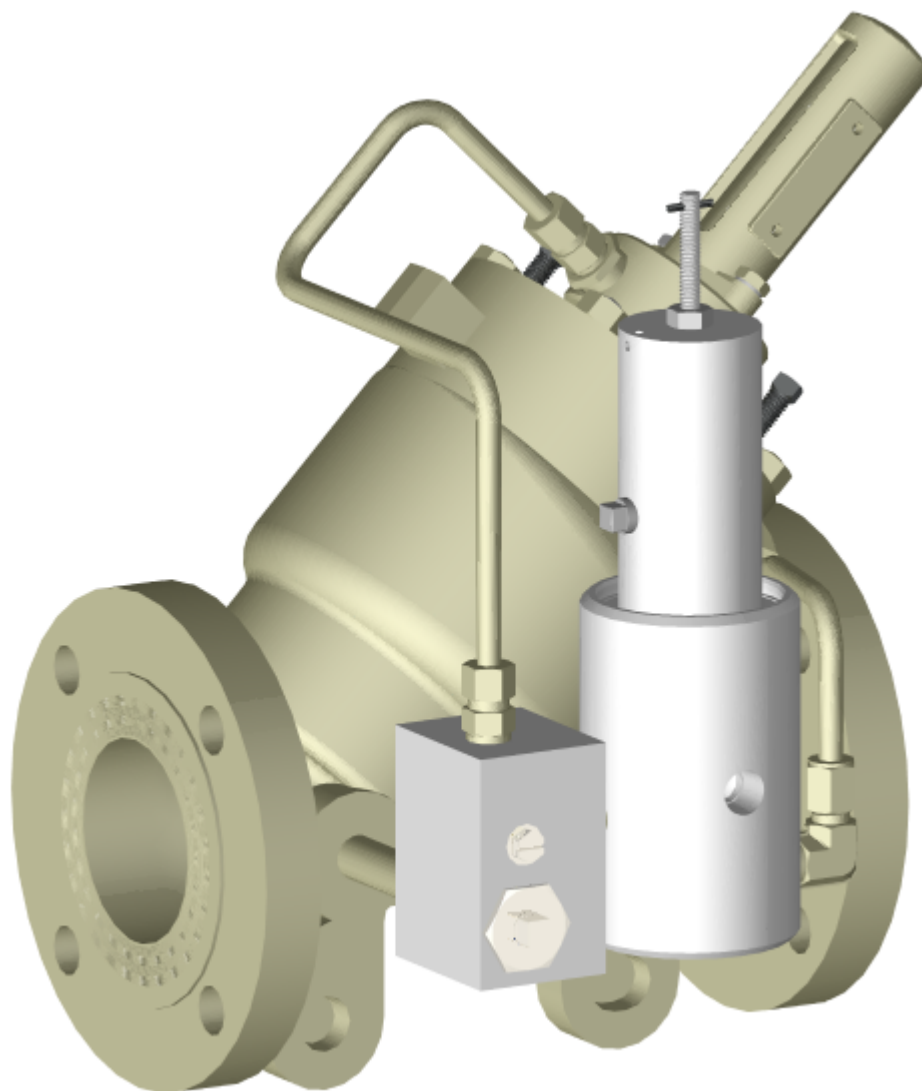


# Daniel™ Differential Control Valve

Model 770 - Models 1770 and 2770 Pilots



## Daniel customer service

Location	Telephone number	Fax number
North America/Latin America	+1.713.467.6000	+1.713.827.4805
Daniel Customer Service	+1.713.827.6314	+1.713.827.6312
USA (toll free)	+1.888.356.9001	+1.713.827.3380
Asia Pacific (Republic of Singapore)	+65.6777.8211	+65.6777.0947.0743
Europe (Stirling Scotland, UK)	+44 (0)1786.433400	+44 (0)1786.433401
Middle East Africa (Dubai, UAE)	+971 4 8118100	+971 4 8865465
Daniel Measurement and Control, Inc. (Headquarters) 11100 Brittmoore Park Drive Houston, TX 77041 USA <a href="http://www.daniel.com">http://www.daniel.com</a>		

### Email

- Customer Service: [tech.service@emersonprocess.com](mailto:tech.service@emersonprocess.com)
- Customer Support: [daniel.cst.support@emerson.com](mailto:daniel.cst.support@emerson.com)
- Asia-Pacific: [danielap.support@emerson.com](mailto:danielap.support@emerson.com)
- Europe: [DanielEMA.CST@EmersonProcess.com](mailto:DanielEMA.CST@EmersonProcess.com)

### Return Material Authorization (RMA)

A Return Material Authorization (RMA) number must be obtained prior to returning any equipment for any reason. Download the RMA form from the Support Services web page by selecting the link below.

<http://www2.emersonprocess.com/EN-US/BRANDS/DANIEL/SUPPORT-SERVICES/Pages/Support-Services.aspx>

## Signal words and symbols

Pay special attention to the following signal words, safety alert symbols and statements:



### Safety alert symbol

This is a safety alert symbol. It is used to alert you to potential physical injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

### **DANGER!**

Danger indicates a hazardous situation which, if not avoided, will result in death or serious injury.

### **WARNING!**

Warning indicates a hazardous situation which, if not avoided, could result in death or serious injury.

### **CAUTION!**

Caution indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

### **NOTICE**

Notice is used to address safety messages or practices not related to personal injury.

### **Important**

Important is a statement the user needs to know and consider.

### **Tip**

Tip provides information or suggestions for improved efficiency or best results.

### **Note**

Note is “general by-the-way” content not essential to the main flow of information.

## Important safety instructions

Daniel Measurement and Control, Inc. (Daniel) designs, manufactures and tests products to function within specific conditions. Because these products are sophisticated technical instruments, it is important that the owner and operation personnel must strictly adhere both to the information printed on the product and to all instructions provided in this manual prior to installation, operation, and maintenance.

Daniel also urges you to integrate this manual into your training and safety program.

BE SURE ALL PERSONNEL READ AND FOLLOW THE INSTRUCTIONS IN THIS MANUAL AND ALL NOTICES AND PRODUCT WARNINGS.

### **WARNING!**

**Failure to follow the installation, operation or maintenance instructions for a Daniel product could lead to serious injury or death from explosion or exposure to dangerous substances.**

**To reduce the risk:**

- **Comply with all information on the product, in this manual, and in any local and national codes that apply to this product.**
- **Do not allow untrained personnel to work with this product.**
- **Use Daniel parts and work procedures specified in this manual.**

## Product owners (Purchasers):

- Use the correct product for the environment and pressures present. See technical data or product specifications for limitations. If you are unsure, discuss your needs with your Daniel representative.
- Inform and train all personnel in the proper installation, operation, and maintenance of this product.
- To ensure safe and proper performance, only informed and trained personnel should install, operate, repair and maintain this product.
- Verify that this is the correct instruction manual for your Daniel product. If this is not the correct documentation, contact Daniel at 1-713-827-6314. You may also download the correct manual from: <http://www.Daniel.com>.
- Save this instruction manual for future reference.
- If you resell or transfer this product, it is your responsibility to forward this instruction manual along with the product to the new owner or transferee.
- ALWAYS READ AND FOLLOW THE INSTALLATION, OPERATIONS, MAINTENANCE AND TROUBLESHOOTING MANUAL(S) AND ALL PRODUCT WARNINGS AND INSTRUCTIONS.
- Do not use this equipment for any purpose other than its intended service. This may result in property damage and/or serious personal injury or death.

**Product operation (Personnel):**

- To prevent personal injury, personnel must follow all instructions of this manual prior to and during operation of the product.
- Follow all warnings, cautions, and notices marked on, and supplied with, this product.
- Verify that this is the correct instruction manual for your Daniel product. If this is not the correct documentation, contact Daniel at 1-713-827-6314. You may also download the correct manual from: <http://www.daniel.com>.
- Read and understand all instructions and operating procedures for this product.
- If you do not understand an instruction, or do not feel comfortable following the instructions, contact your Daniel representative for clarification or assistance.
- Install this product as specified in the INSTALLATION section of this manual per applicable local and national codes.
- Follow all instructions during the installation, operation, and maintenance of this product.
- Connect the product to the appropriate pressure and electrical sources when and where applicable.
- Ensure that all connections to pressure and electrical sources are secure prior to and during equipment operation.
- Use only replacement parts specified by Daniel. Unauthorized parts and procedures can affect this product's performance, safety, and invalidate the warranty. "Look-a-like" substitutions may result in deadly fire, explosion, release of toxic substances or improper operation.
- Save this instruction manual for future reference.

## Notice

THE CONTENTS OF THIS PUBLICATION ARE PRESENTED FOR INFORMATIONAL PURPOSES ONLY, AND WHILE EVERY EFFORT HAS BEEN MADE TO ENSURE THEIR ACCURACY, THEY ARE NOT TO BE CONSTRUED AS WARRANTIES OR GUARANTEES, EXPRESSED OR IMPLIED, REGARDING THE PRODUCTS OR SERVICES DESCRIBED HEREIN OR THEIR USE OR APPLICABILITY. ALL SALES ARE GOVERNED BY DANIEL'S TERMS AND CONDITIONS, WHICH ARE AVAILABLE UPON REQUEST. WE RESERVE THE RIGHT TO MODIFY OR IMPROVE THE DESIGNS OR SPECIFICATIONS OF SUCH PRODUCTS AT ANY TIME.

DANIEL DOES NOT ASSUME RESPONSIBILITY FOR THE SELECTION, USE OR MAINTENANCE OF ANY PRODUCT. RESPONSIBILITY FOR PROPER SELECTION, USE AND MAINTENANCE OF ANY DANIEL PRODUCT REMAINS SOLELY WITH THE PURCHASER AND END-USER.

TO THE BEST OF DANIEL'S KNOWLEDGE THE INFORMATION HEREIN IS COMPLETE AND ACCURATE. DANIEL MAKES NO WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THIS MANUAL AND, IN NO EVENT, SHALL DANIEL BE LIABLE FOR ANY INCIDENTAL, PUNITIVE, SPECIAL OR CONSEQUENTIAL DAMAGES INCLUDING, BUT NOT LIMITED TO, LOSS OF PRODUCTION, LOSS OF PROFITS, LOSS OF REVENUE OR USE AND COSTS INCURRED INCLUDING WITHOUT LIMITATION FOR CAPITAL, FUEL AND POWER, AND CLAIMS OF THIRD PARTIES.

PRODUCT NAMES USED HEREIN ARE FOR MANUFACTURER OR SUPPLIER IDENTIFICATION ONLY AND MAY BE TRADEMARKS/ REGISTERED TRADEMARKS OF THESE COMPANIES.

## Warranty and Limitations

1. LIMITED WARRANTY: Subject to the limitations contained in Section 2 herein, Daniel Measurement & Control, Inc. ("Daniel") warrants that the licensed firmware embodied in the Goods will execute the programming instructions provided by Daniel, and that the Goods manufactured by Daniel will be free from defects in materials or workmanship under normal use and care and Services will be performed by trained personnel using proper equipment and instrumentation for the particular Service provided. The foregoing warranties will apply until the expiration of the applicable warranty period. Goods are warranted for twelve (12) months from the date of initial installation or eighteen (18) months from the date of shipment by Daniel, whichever period expires first. Consumables and Services are warranted for a period of 90 days from the date of shipment or completion of the Services. Products purchased by Daniel from a third party for resale to Buyer ("Resale Products") shall carry only the warranty extended by the original manufacturer. Buyer agrees that Daniel has no liability for Resale Products beyond making a reasonable commercial effort to arrange for procurement and shipping of the Resale Products. If Buyer discovers any warranty defects and notifies Daniel thereof in writing during the applicable warranty period, Daniel shall, at its option, correct any errors that are found by Daniel in the firmware or Services or repair or replace F.O.B. point of manufacture that portion of the Goods or firmware found by Daniel to be defective, or refund the purchase price of the defective portion of the Goods/Services. All replacements or repairs necessitated by inadequate maintenance, normal wear and usage, unsuitable power sources or environmental conditions, accident, misuse, improper installation, modification, repair, use of unauthorized replacement parts, storage or handling, or any other cause not the fault of Daniel are not covered by this limited warranty, and shall be at Buyer's expense. Daniel shall not be obligated to pay any costs or charges incurred by Buyer or any other party except as may be agreed upon in writing in advance by Daniel. All costs of dismantling, reinstallation and freight and the time and expenses of Daniel's personnel and representatives for site travel and diagnosis under this warranty clause shall be borne by Buyer unless accepted in writing by Daniel. Goods repaired and parts replaced by Daniel during the warranty period shall be in warranty for the remainder of the original warranty period or ninety (90) days, whichever is longer. This limited warranty is the only warranty made by Daniel and can be amended only in a writing signed by Daniel. THE WARRANTIES AND REMEDIES SET FORTH ABOVE ARE EXCLUSIVE. THERE ARE NO REPRESENTATIONS OR WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, AS TO MERCHANTABILITY, FITNESS FOR PARTICULAR PURPOSE OR ANY OTHER MATTER WITH RESPECT TO ANY OF THE GOODS OR SERVICES. Buyer acknowledges and agrees that corrosion or erosion of materials is not covered by this warranty.

2. LIMITATION OF REMEDY AND LIABILITY: Daniel shall not be liable for damages caused by delay in performance. The remedies of Buyer set forth in this agreement are exclusive. In no event, regardless of the form of the claim or cause of action (whether based in contract, infringement, negligence, strict liability, other tort or otherwise), shall Daniel's liability to Buyer and/or its customers exceed the price to Buyer of the specific goods manufactured or services provided by Daniel giving rise to the claim or cause of action. Buyer agrees that in no event shall Daniel's liability to Buyer and/or its customers extend to include incidental, consequential or punitive damages. The term "consequential damages" shall include, but not be limited to, loss of anticipated profits, revenue or use and costs incurred including without limitation for capital, fuel and power, and claims of Buyer's customers.





# Contents

## Part I Plan

<b>Chapter 1</b>	<b>Introduction .....</b>	<b>3</b>
1.1	Purpose of this manual .....	3
1.2	Description of the Model 770 control valve .....	3
1.2.1	Control valve general features .....	3
1.2.2	Control valve applications .....	3
1.2.3	Operation overview of the control valve .....	3
1.2.4	Parts lists for the differential control valve pilots .....	10
1.3	Agency certifications for the Model 770 Control Valves .....	31
<b>Chapter 2</b>	<b>Operating conditions and specifications .....</b>	<b>33</b>
2.1	Operating conditions for the Model 770 .....	33
2.1.1	Design considerations .....	34
2.1.2	Environmental conditions .....	35
2.2	Specifications for the control valve .....	36
2.2.1	Interface requirements .....	36
2.2.2	Requirements and limitations for installation .....	37
2.3	Pilot spring selection .....	40
2.3.1	Pilot spring selection table .....	40
2.3.2	Table usage .....	43

## Part II Install

<b>Chapter 3</b>	<b>Installation prerequisites .....</b>	<b>47</b>
3.1	Model 770 pre-start checks .....	47
3.2	Model 770 installation procedure .....	48

## Part III Operate

<b>Chapter 4</b>	<b>Operation start up .....</b>	<b>53</b>
4.1	Model 770 adjustment and startup .....	53

## Part IV Maintain

<b>Chapter 5</b>	<b>Planned maintenance .....</b>	<b>57</b>
5.1	Maintenance considerations .....	58
5.2	Pilot disassembly (1770) .....	59
5.3	Pilot disassembly (2770) .....	59
5.4	Pilot assembly .....	60
<b>Chapter 6</b>	<b>Corrective maintenance .....</b>	<b>61</b>
6.1	Control valve troubleshooting .....	61
6.2	Verify the return to operational condition .....	61

**Chapter 7 Spare parts .....63**

7.1 Recommended spare parts ..... 63

7.2 Order spare parts ..... 63

**Appendices and reference**

**Appendix A Combination needle valve and strainer .....65**

A.1 Disassembly and assembly ..... 65

A.2 Needle valve and strainer combination ..... 66

A.3 Order spare parts ..... 68

# Part I

## Plan

### Chapters covered in this part:

- *Introduction*
- *Operating conditions and specifications*



# 1 Introduction

## Topics covered in this chapter:

- *Purpose of this manual*
- *Description of the Model 770 control valve*
- *Agency certifications for the Model 770 Control Valves*

## 1.1 Purpose of this manual

Daniel Measurement and Control Inc. designed this manual to guide owners and personnel in the installation, operation and maintenance of the *Daniel™ Differential Control Valve 770 and Models 1770 and 2770 Pilots Manual, 3-9008-608*. It is imperative that product owners and operation personnel read and follow the information contained in this manual to ensure that the control valve is installed correctly and is operating according to the design certifications and safety considerations.

## 1.2 Description of the Model 770 control valve

### 1.2.1 Control valve general features

The Model 770 (normally closed) differential control valve is designed to maintain a controlled pressure differential within  $\pm 2$  psi of the pilot set point, regardless of variations in upstream or downstream pressure. The pilots are balanced, single seated with large ports and operate on a differential as low as 5 psi (34.5 kPa).

### 1.2.2 Control valve applications

- Maintains system pressure at a predetermined level above product pressure
- Vapor pressure control on LPG, NH<sub>3</sub> and similar products
- Pump differential pressure control
- Provides constant pump discharge flow rate by controlling differential pressure across an orifice plate

### 1.2.3 Operation overview of the control valve

The Daniel Differential Control Valve operates on a balance-piston principle. When pressures on both sides of the valve piston are equalized, a spring (located on the top of the piston) acts as a differential force and closes the main valve piston. When the pressure against the bottom of the piston exceeds the pressure (plus the force of the spring) exerted against the top of the piston, spring tension is overcome and the valve opens. It is from this principle of operation that all variations of control, with the use of pilot valves

and accessories are made. The normally closed differential pilot, acting as a variable orifice, controls pressure applied to the spring side of the main valve piston. This in turn allows the main valve to regulate differential pressure.

### Opens on increasing differential pressure

The Model 770 valve is normally closed and throttles toward an open position on increasing differential pressure. It is a regulating or positioning type valve that does not require any outside power source to operate.

The pilot control is normally closed. It is an adjustable spring loaded variable orifice in the Z-port. The pilot is piston operated, spring biased (loaded) with differential pressure sensing chambers connected to the high and low pressure sources.

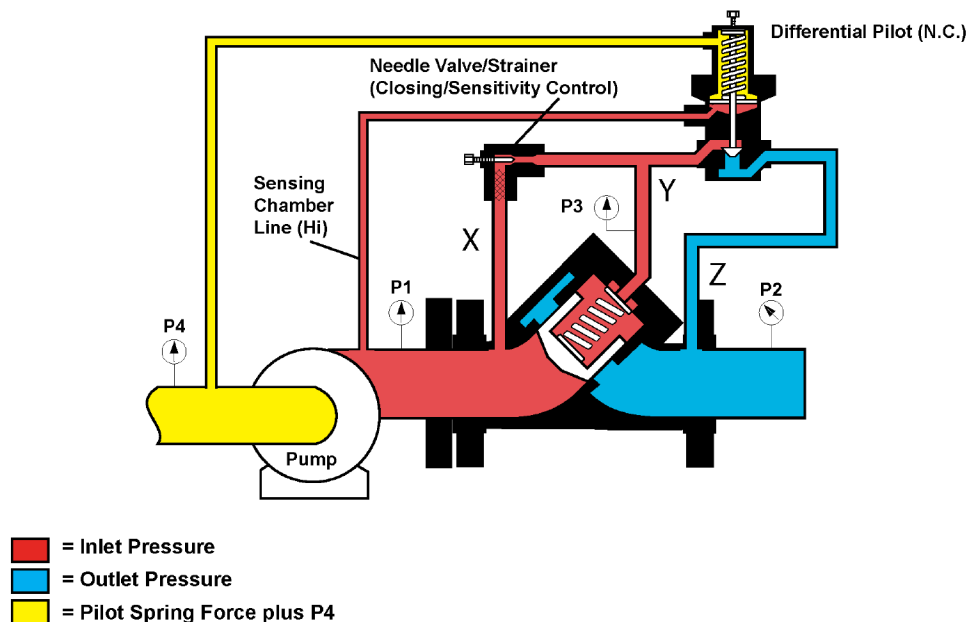
The Model 770 valve is used for:

- Pump differential pressure control
- Bypass differential pressure control for pumps, strainers, filters, etc.
- Vapor pressure control on LPG, NH3 and similar products.

### Closed position

In [Figure 1-1](#) the valve is closed. The differential pressure between (P1) and (P4) is less than the pilot spring setting, indicating the pump is not running or sufficient differential pressure ( $P1 - P4$ ) is not available to overcome the pilot spring setting. Pilot is closed. Y-port (P3) to Z-port (P2) is closed. X-port (P1) and Y-port (P3) pressures are balanced. The main valve spring, being the differential force, closes the piston and keeps it seated.

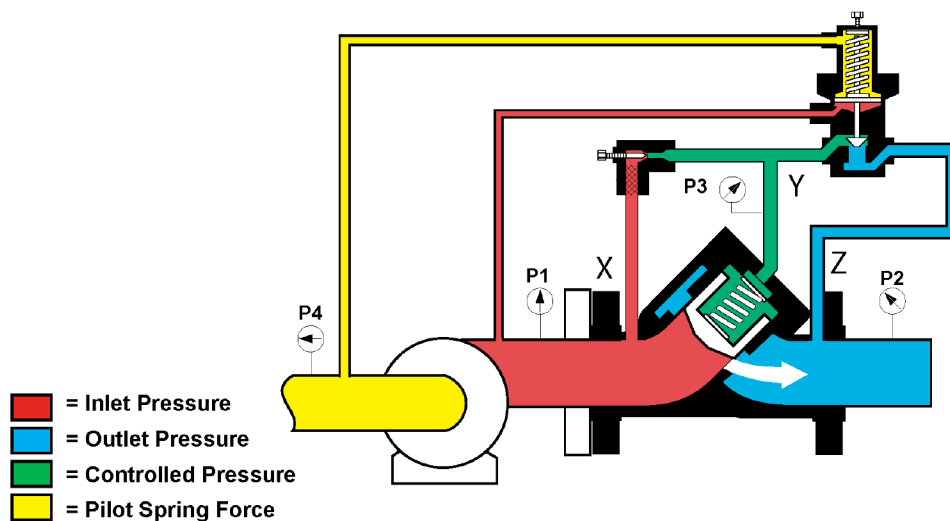
**Figure 1-1: Closed position**



### Open controlled position

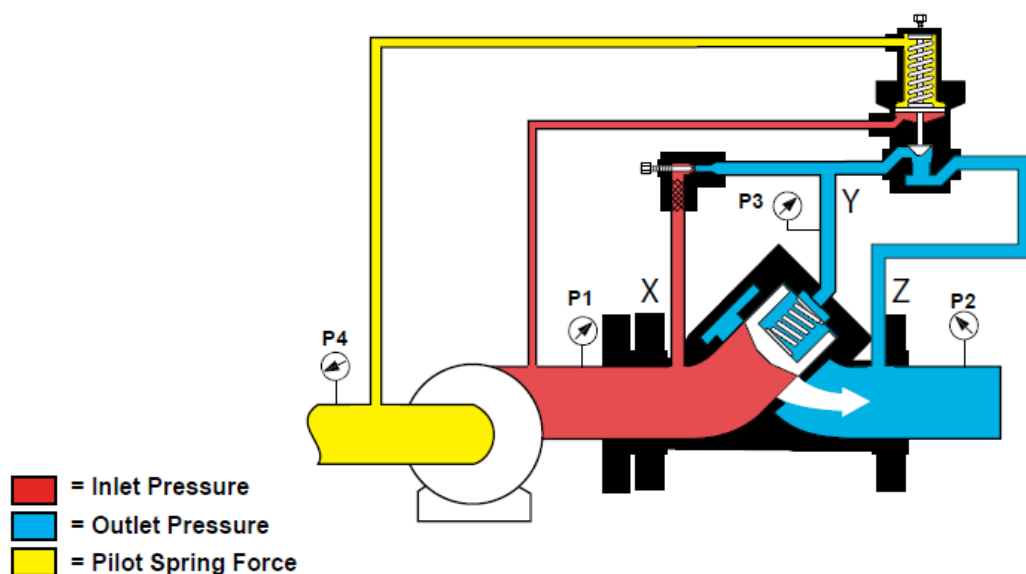
*Figure 1-2* illustrates the valve partially open. Differential pressure ( $P1$  minus  $P4$ ) has slightly exceeded the pilot spring setting. Z-port ( $P2$ ) is being opened by the throttling of the pilot, reducing the pressure on the Y-port ( $P3$ ). The decreasing pressure at Y-port ( $P3$ ) plus the main valve spring force positions the valve piston so that it balances the pump differential pressure ( $P1$  minus  $P4$ ) equal to the pilot setting (Plus or minus 2 psid).

**Figure 1-2: Open controlled position**



### Fully open - no control

In *Figure 1-3* the valve is fully open. Differential pressure ( $P1$  minus  $P4$ ) has exceeded the pilot spring setting. Y-port ( $P3$ ) is open to Z-port ( $P2$ ). The valve is floating the stream and is not required to control.

**Figure 1-3: Fully open - no control position****Opens on increasing differential pressure****Typical for LPG, NH3 or similar products**

The Model 770 as illustrated is identical to the previously described 770 valve except it is shown as a vapor pressure control valve for products having high flash points such as butane, propane, anhydrous ammonia or other products with similar characteristics.

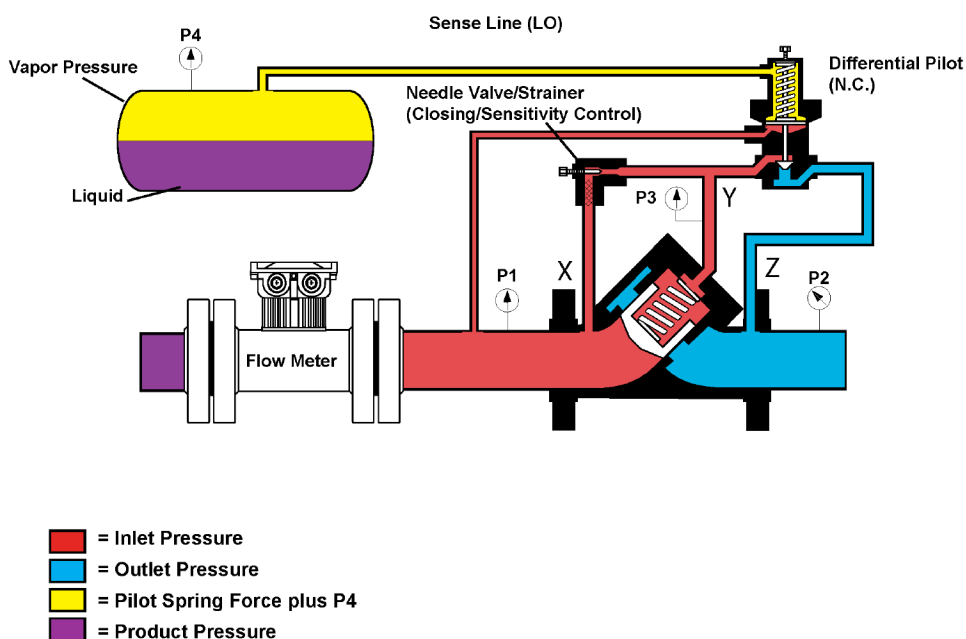
When metering these products, the pressure at the meter must be higher than the vapor pressure of the product, otherwise it turns into a gaseous state resulting in meter damage due to over-speed plus inaccurate measurement and possible pump damage. The differential pressure between the meter inlet pressure and the vapor pressure (P4) is generally 10 to 30 psid to assure that the product is in a liquid state when it passes through the meter.

**Closed position - vapor pressure**

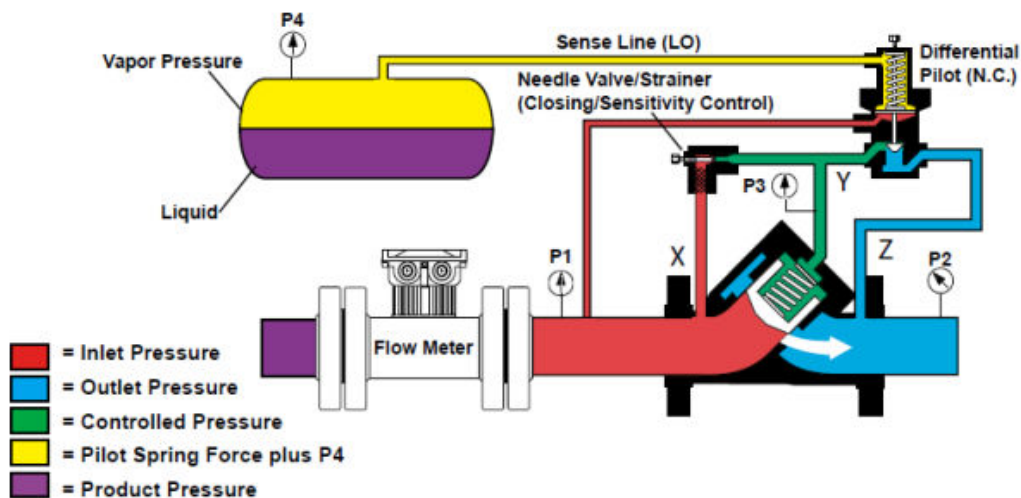
In [Figure 1-4](#) the valve is closed. Vapor pressure (P4) plus pilot spring setting is greater than the line pressure (P1), indicating the pump is not running or sufficient differential pressure (P1 minus P4) is not available to overcome the pilot spring setting. Pilot is closed. Y-port (P3) to Z-port (P2) is closed. X-port (P1) and Y-port (P3) pressures become balanced. The main valve spring being the differential force, closes the piston and keeps it sealed.

The Model 770 is recommended for applications requiring valve closure on decreasing pressure differential, such as, pump differential control, LPG or Anhydrous Ammonia vapor control.



**Figure 1-4: Closed position - vapor pressure****Open - controlled position**

*Figure 1-5* the pilot is partially open. Differential pressure ( $P1$  minus  $P4$ ) has slightly exceeded the pilot spring setting. Z-port ( $P2$ ) is being opened by the throttling of the pilot, reducing the pressure on Y-port ( $P3$ ). The decreasing pressure at Y-port ( $P3$ ) plus the main valve spring force establishes a position of the valve piston so that it balances inlet pressure ( $P1$ ) equal to the pilot setting plus vapor pressure ( $P4$ ) (Plus or minus 2 psid).

**Figure 1-5: Open - controlled position**

### Full open - no control

*Figure 1-6* the pilot is full open. Differential pressure ( $P1$  minus  $P4$ ) has exceeded the pilot spring setting. Y-port ( $P3$ ) is open to Z-port ( $P2$ ). The valve is floating the stream and is not required to control.

**Figure 1-6: Full open - no control**

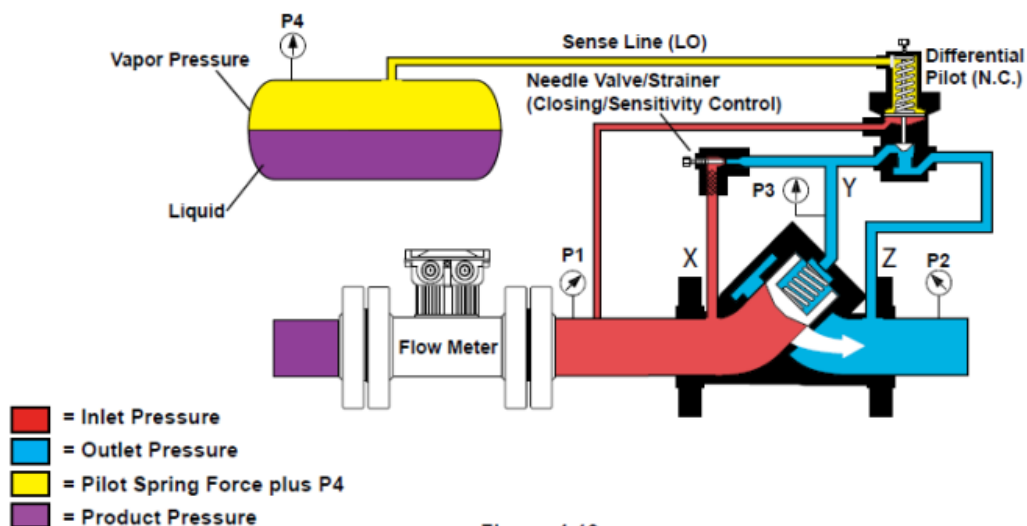


Figure 1.10

### Principle of Operation

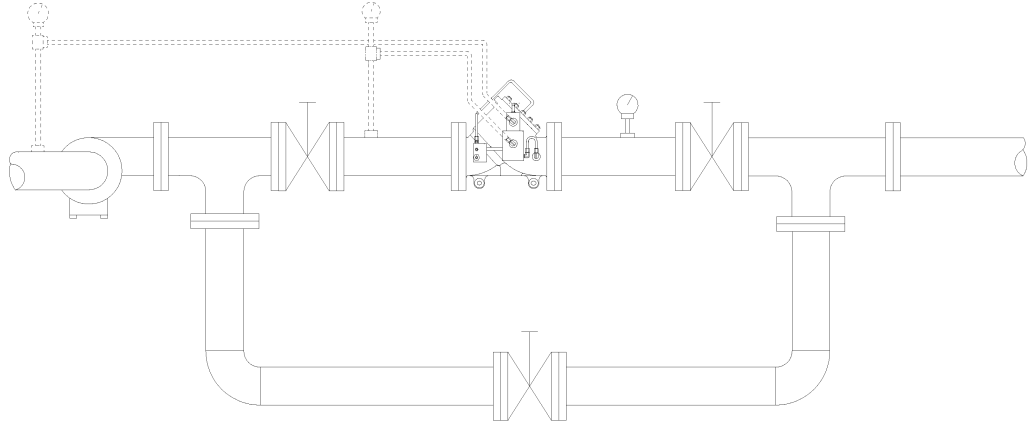
The Model 770 valve is controlled by a differential pressure pilot that, according to the application of the valve, either senses the differential pressure across a pump, the differential across a fixed or variable orifice, or the differential between pump discharge and storage vapor pressure (LPG or  $\text{NH}_3$ ). This enables the pilot to throttle the valve to maintain the desired minimum differential pressure, an operation which may be more easily understood by referring to the valve schematic drawings (*Figure 1-7*, *Figure 1-8* and *Figure 1-9*). These drawings illustrate typical installations of the valve for pump differential control, LPG or  $\text{NH}_3$ , and rate of flow control applications.

In the static condition, both the valve and pilot are fully closed, blocking all flow. Since the pilot controls the valve, it must sense a differential equal to its setting before it will allow the valve to open. Assuming that the valve is being used to control minimum pump differential (refer to *Figure 1-7*), the pilot will therefore apply initial pump discharge pressure to the top of the valve piston, keeping it tightly closed. As the discharge pressure rises, however, the pilot senses the differential across the pump and begins to gradually open and vent the discharge pressure on the top of the valve piston downstream. The result is that a differential is created between the top and the bottom of the piston, and the valve begins to open, placing the pump "on stream." When the differential pressure between the pump suction and discharge exceeds the setting of the pilot, it will open the valve completely to provide maximum flow rate.

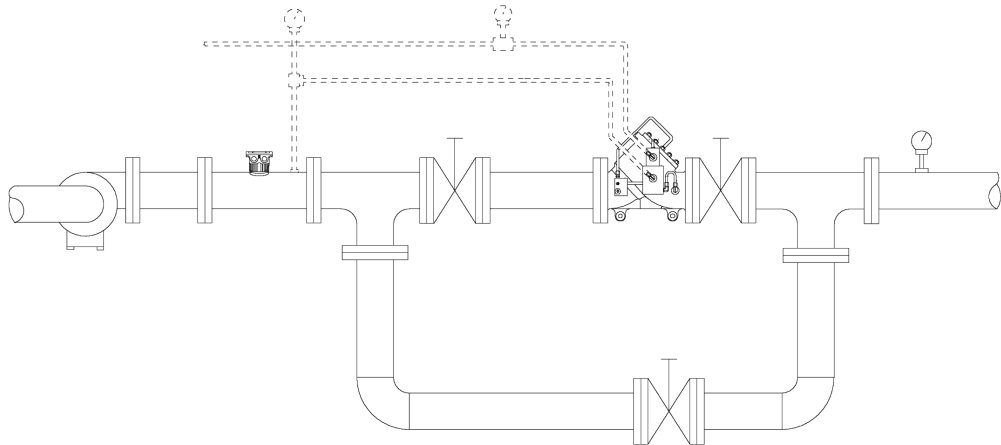
Once the pump is fully "on stream", the differential pressure pilot monitors the pump suction and discharge and subsequently varies the area of its orifice to throttle the valve and maintain the desired minimum differential. Throttling, of course, is dependent upon

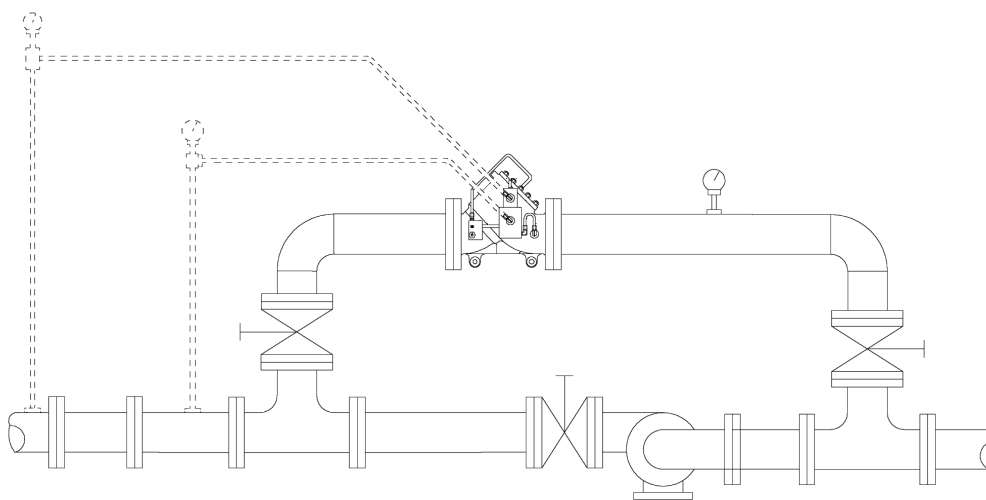
the amount of pump discharge pressure either applied to the top of the valve piston or bypassed through the pilot to the downstream side of the valve. The valve will throttle closed if pump differential pressure drops below the pilot setting.

**Figure 1-7: Maintain minimum pump differential**



**Figure 1-8: Differential pressure control (LNG, NH<sub>3</sub>)**



**Figure 1-9: Bypass rate of flow control**

## 1.2.4 Parts lists for the differential control valve pilots

This section included the necessary parts required to make up any standard unit covered in this manual.

For spring/piston combinations see [Section 2.3](#).

**Table 1-1: Pilot selection guide 1**

1770 Pilot Assembly	Spring range (Spring)
453500-X1E	0-20 psi (460223)
453500-X2E	0-40 psi (460022)
453500-X3E	30-80 psi (460023)
453500-X4E	70-180 psi (460024)
456500-X3E	150-350 psi (460023)
456500-X4E	350-650 psi (460024)

**Table 1-2: Pilot selection guide 2**

2770 Pilot Assembly	Spring range (Spring)
475500-X1E	5-100 psi (460223)
475500-X2E	50-250 psi (460022)
475500-X3E	200-400 psi (460023)
475500-X4E	350-650 psi (460024)
465500-X4E	600-950 psi (460023)

**Table 1-2: Pilot selection guide 2 (continued)**

<b>2770 Pilot Assembly</b>	<b>Spring range (Spring)</b>
465500-X5E	900-1500 psi (460024)

**Table 1-3: Pilot selection guide 3 (for sensing to vapor bomb)**

<b>1770 Pilot Assembly</b>	<b>Spring range (Spring)</b>
453505-X1E	0-20 psi (460223)
453505-X2E	0-40 psi (460022)
453505-X3E	30-80 psi (460023)
453505-X4E	70-180 psi (460024)

**Pilot body material**

X = (5) Steel

X = (6) Stainless steel

**Elastomers**

E = (0) NBR

E = (7) EPR

E = (5) FFKM

E = (4) NBR (Low swell)

E = (3) CR

E = FKM

E = (G) FKM GFLT

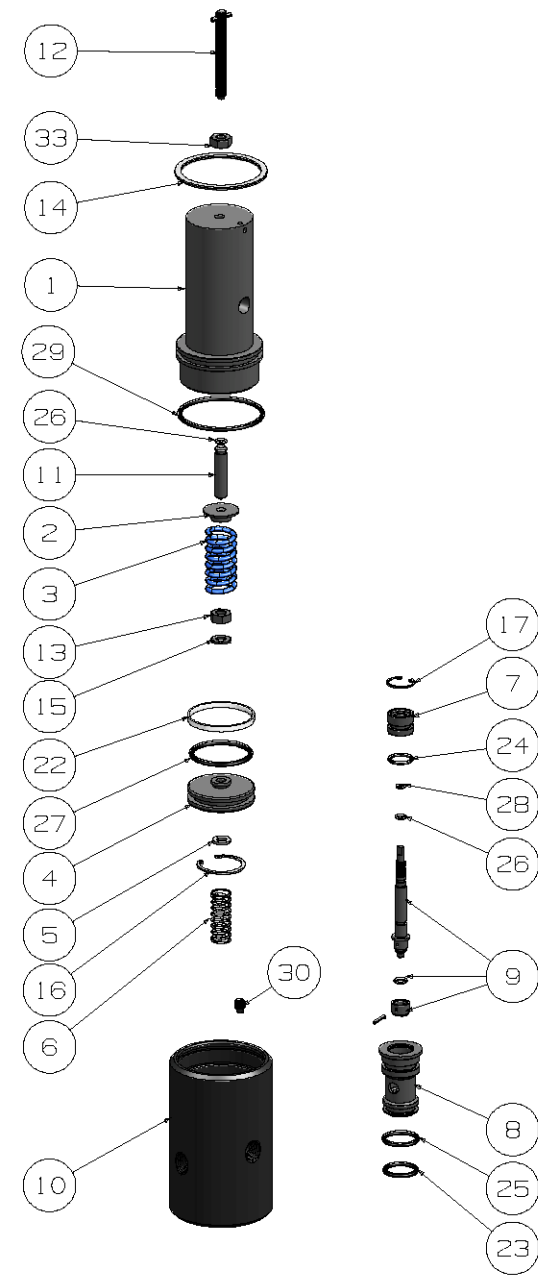
E = (M) FKM V 1289

E = (9) FKM for LPG Service

**Note**

"X" and "E" to be selected depending upon materials and elastomers required.

**Figure 1-10: Part identification for Model 1770 (453500) 0-180 psi range**



**Table 1-4: Part identification for Model 1770 (453500) 0-180 psi range**

Item number	Part number	Description	Quantity
1	460206-600	Pilot Valve Cover	1
2	460017	Spring Guide	1
3		Pressure Spring	1

**Table 1-4: Part identification for Model 1770 (453500) 0-180 psi range (continued)**

Item number	Part number	Description	Quantity
	460223	Spring, 0-20 lbs.	1
	460022	Spring, 0-40 lbs.	1
	460023	Spring, 30-80 lbs.	1
	460024	Spring, 70-180 lbs.	1
4	460516	Piston	1
5*	460013	Thrust Washer	1
6	460021	Damper Spring	1
7	460008	Guide Bushing	1
8	460007	Pilot Valve Cage	1
9*	460110-000	Poppet Shaft Assy, NBR	1
	460110-007	Poppet Shaft Assy, EPR	1
	460110-005	Poppet Shaft Assy, FFKM	1
	460110-00L	Poppet Shaft Assy, NBR (Low Swell)	1
	460110-003	Poppet Shaft Assy, CR	1
	460110	Poppet Shaft Assy, FKM	1
	460110-00G	Poppet Shaft Assy, FKM GFLT	1
	460110-00M	Poppet Shaft Assy, FKM V1289	1
10	453301-500M	Pilot Body CS	1
	453301-600M	Pilot Body ST S	1
11	460219	Spring Adj Stem	1
12	150687-124	Screw Set	1
13	151543-019	Nut Hex	1
14*	156465	Retaining Ring Internal	1
15	152267	Washer SS Lock	1
16	156466	Retaining Ring Internal	1
17*	156467	Retaining Ring Internal	1
22*	157158	Glyd Ring Outside	1
23*	157009	O-ring, NBR	1
	157009-005	O-ring, EPR	1
	157009-075	O-ring, FFKM	1
	157009-120	O-ring, NBR (low-swell)	1
	157009-116	O-ring, CR	1
	157009-022	O-ring, FKM	1
	157009-027	O-ring, FKM GFLT	1
	157009-029	O-ring, FKM V1289	1
24*	152090	O-ring, NBR	1

**Table 1-4: Part identification for Model 1770 (453500) 0-180 psi range (continued)**

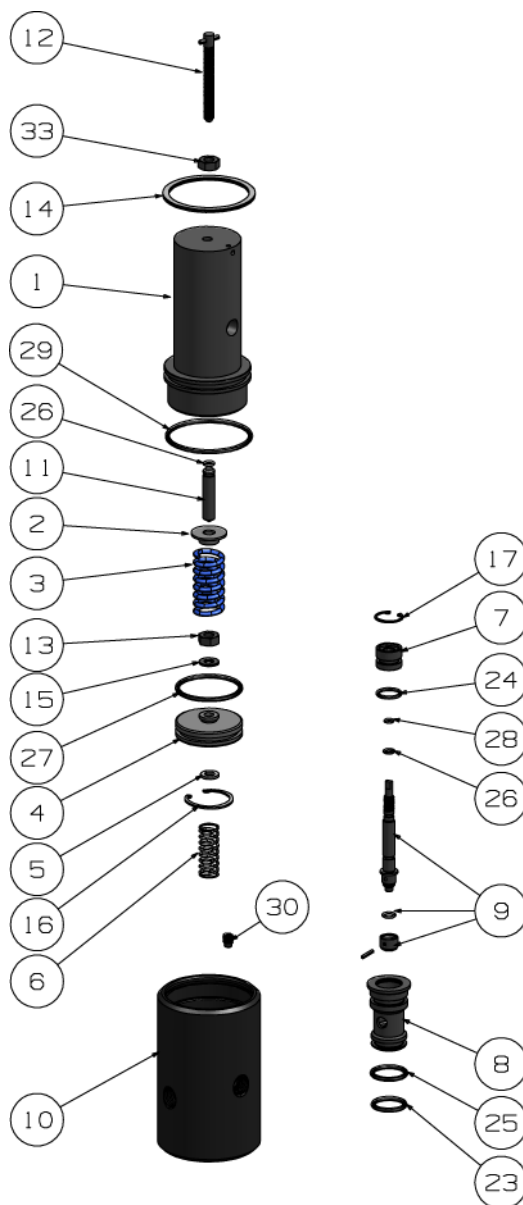
Item number	Part number	Description	Quantity
	152090-005	O-ring, EPR	1
	152090-075	O-ring, FFKM	1
	152090-120	O-ring, NBR (low-swell)	1
	152090-116	O-ring, CR	1
	152090-022	O-ring, FKM	1
	152090-027	O-ring, FKM GFLT	1
	152090-029	O-ring, FKM V1289	1
25 *	157010	O-ring, NBR	1
	157010-005	O-ring, EPR	1
	157010-075	O-ring, FFKM	1
	157010-120	O-ring, NBR (low-swell)	1
	157010-116	O-ring, CR	1
	157010-022	O-ring, FKM	1
	157010-027	O-ring, FKM GFLT	1
	157010-029	O-ring, FKM V1289	1
26 *	152066	O-ring, NBR	2
	152066-005	O-ring, EPR	2
	152066-075	O-ring, FFKM	2
	152066-120	O-ring, NBR (low-swell)	2
	152066-116	O-ring, CR	2
	152066-022	O-ring, FKM	2
	152066-027	O-ring, FKM GFLT	2
	152066-029	O-ring, FKM V1289	2
27 *	157029	O-ring, NBR	1
	157029-005	O-ring, EPR	1
	157029-075	O-ring, FFKM	1
	157029-120	O-ring, NBR (low-swell)	1
	157029-116	O-ring, CR	1
	157029-022	O-ring, FKM	1
	157029-027	O-ring, FKM GFLT	1
	157029-029	O-ring, FKM V1289	1
28 *	152064	O-ring, NBR	1
	152064-005	O-ring, EPR	1
	152064-075	O-ring, FFKM	1
	152064-120	O-ring, NBR (low-swell)	1
	152064-116	O-ring, CR	1



**Table 1-4: Part identification for Model 1770 (453500) 0-180 psi range (continued)**

Item number	Part number	Description	Quantity
	152064-022	O-ring, FKM	1
	152064-027	O-ring, FKM GFLT	1
	152064-029	O-ring, FKM V1289	1
29*	157011	O-ring, NBR	1
	157011-005	O-ring, EPR	1
	157011-075	O-ring, FFKM	1
	157011-120	O-ring, NBR (low-swell)	1
	157011-116	O-ring, CR	1
	157011-022	O-ring, FKM	1
	157011-027	O-ring, FKM GFLT	1
	157011-029	O-ring, FKM V1289	1
30	460108	Orifice Screw	1
33	151543-019	Nut, Hex	1

(\*) Recommended spare parts

**Figure 1-11: Part Identification for Model 1770 (453505) 0-180 psi range****Table 1-5: Part Identification for Model 1770 (453505) 0-180 psi range**

Item Number	Part Number	Description	Quantity
1	460206-600M	Pilot valve cover	1
2	460017	Spring guide (stainless steel)	1
3		Pressure Spring	
	460223	Spring, 0-20 lbs.	1
	460022	Spring, 0-40 lbs.	1

**Table 1-5: Part Identification for Model 1770 (453505) 0-180 psi range (continued)**

Item Number	Part Number	Description	Quantity
	460023	Spring, 30-80 lbs.	1
	460024	Spring, 70-180 lbs.	1
4	460116	Piston	1
5*	460013	Thrust washer (stainless steel)	1
6	460021	Damper spring	1
7	460008	Guide bushing	1
8	460007	Pilot valve cage	1
9*	460110-000	Poppet shaft assembly, NBR	1
	460110-007	Poppet shaft assembly, EPR	
	460110-005	Poppet shaft assembly, FFKM	
	460110-00L	Poppet shaft assembly, NBR (Low Swell)	
	460110-003	Poppet shaft assembly, CR	
	460110	Poppet shaft assembly, FKM	
	460110-00G	Poppet shaft assembly, FKM GFLT	
	460110-00M	Poppet shaft assembly, FKM V1289	
10	453301-500M	Pilot body CS	1
	453301-600M	Pilot body SS	
11	460219	Spring Adjustment Stem	1
12	150687-124	Screw set	1
13	151543-019	Nut Hex	1
14*	156465	Retaining ring, internal	1
15	152267	Washer SS lock, sprin	1
16	156466	Retaining ring, internal	1
17*	156467	Retaining ring, internal	1
23*	157009	O-ring, NBR	1
	157009-005	O-ring, EPR	1
	157009-075	O-ring, FFKM	1
	157009-120	O-ring, NBR (Low-swell)	1
	157009-116	O-ring, CR	1
	157009-022	O-ring, FKM	1
	157009-027	O-ring, FKM GFLT	1
	157009-029	O-ring, FKM V1289	1
24*	152090	O-ring, NBR	1
	152090-005	O-ring, EPR	1
	152090-075	O-ring, FFKM	1

**Table 1-5: Part Identification for Model 1770 (453505) 0-180 psi range (continued)**

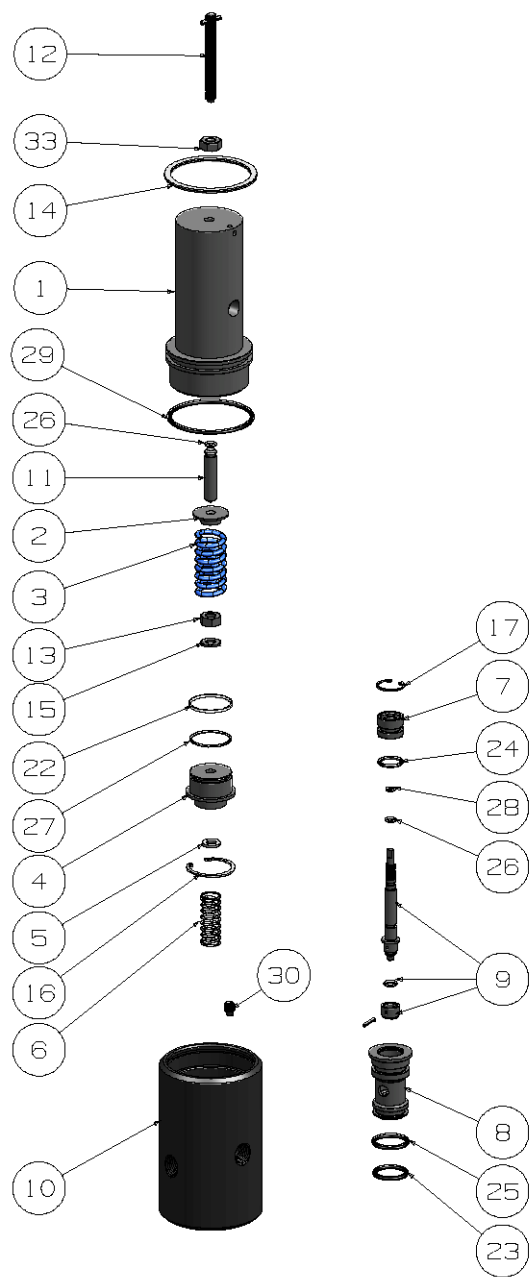
Item Number	Part Number	Description	Quantity
	152090-120	O-ring, NBR (Low-swell)	1
	152090-116	O-ring, CR	1
	152090-022	O-ring, FKM	1
	152090-027	O-ring, FKM GFLT	1
	152090-029	O-ring, FKM V1289	1
25 *	157010	O-ring, NBR	1
	157010-005	O-ring, EPD	1
	157010-075	O-ring, FFKM	1
	157010-120	O-ring, NBR (Low-swell)	1
	157010-116	O-ring, CR	1
	157010-022	O-ring, FKM	1
	157010-027	O-ring, FKM GFLT	1
	157010-029	O-ring, FKM V1289	1
26 *	152066	O-ring, NBR	2
	152066-005	O-ring, EPD	2
	152066-075	O-ring, FFKM	2
	152066-120	O-ring, NBR (Low-swell)	2
	152066-116	O-ring, CR	2
	152066-022	O-ring, FKM	2
	152066-027	O-ring, FKM GFLT	2
	152066-029	O-ring, FKM V1289	2
27 *	152073	O-ring, NBR	1
	152073-005	O-ring, EPD	1
	152073-075	O-ring, FFKM	1
	152073-120	O-ring, NBR (Low-swell)	1
	152073-116	O-ring, CR	1
	152073-022	O-ring, FKM	1
	152073-027	O-ring, FKM GFLT	1
	152073-029	O-ring, FKM V1289	1
28 *	152064	O-ring, NBR	1
	152064-005	O-ring, EPD	1
	152064-075	O-ring, FFKM	1
	152064-120	O-ring, NBR (Low-swell)	1
	152064-116	O-ring, CR	1
	152064-022	O-ring, FKM	1
	152064-027	O-ring, FKM GFLT	1

**Table 1-5: Part Identification for Model 1770 (453505) 0-180 psi range (continued)**

Item Number	Part Number	Description	Quantity
	152064-029	O-ring, FKM V1289	1
29*	157011	O-ring, NBR	1
	157011-005	O-ring, EPR	1
	157011-075	O-ring, FFKM	1
	157011-120	O-ring, NBR (Low-swell)	1
	157011-116	O-ring, CR	1
	157011-022	O-ring, FKM	1
	157011-027	O-ring, FKM GFLT	1
	157011-029	O-ring, FKM V1289	1
30	460108	Orifice Screw SS	1
33	151543-019	Nut Hex	1

(\*) Recommended spare parts

**Figure 1-12: Part Identification for Model 1770 (455500) 150-650 psi range**



**Table 1-6: Part identification for Model 1770 (455500) 150-650 psi range**

Item number	Part number	Description	Quantity
1	460206-600M	Pilot Valve Cover	1
2	460017	Spring Guide	1
3		Pressure Spring	1

**Table 1-6: Part identification for Model 1770 (455500) 150-650 psi range (continued)**

Item number	Part number	Description	Quantity
	460023	Spring, 150-350 lbs.	1
	460024	Spring, 350-650 lbs.	1
4	463116	Piston	1
5*	460013	Thrust Washer	1
6	460021	Damper Spring	1
7	460008	Guide Bushing	1
8	460007	Pilot Valve Cage	1
9*	460110-000	Poppet Shaft Assy, NBR	1
	460110-007	Poppet Shaft Assy, EPR	1
	460110-005	Poppet Shaft Assy, FFKM	1
	460110-00L	Poppet Shaft Assy, NBR (Low Swell)	1
	460110-003	Poppet Shaft Assy, CR	1
	460110	Poppet Shaft Assy, FKM	1
	460110-00G	Poppet Shaft Assy, FKM GFLT	1
	460110-00M	Poppet Shaft Assy, FKM V1289	1
10	453301-500M	Pilot Body W/MTR	1
11	460219	Spring Adj Stem	1
12	150687-124	Screw Set, Headless	1
13	151543-019	Nut Hex	2
14*	156465	Retaining Ring Internal	1
15	152267	Washer SS Lock	1
16	156466	Retaining Ring Internal	1
17*	156467	Retaining Ring Internal	1
22*	157163	Glyd Ring Outside	1
23*	157009	O-ring, NBR	1
	157009-005	O-ring, EPR	1
	157009-075	O-ring, FFKM	1
	157009-120	O-ring, NBR (low-swell)	1
	157009-116	O-ring, CR	1
	157009-022	O-ring, FKM	1
	157009-027	O-ring, FKM GFLT	1
	157009-029	O-ring, FKM V1289	1
24*	152090	O-ring, NBR	1
	152090-005	O-ring, EPR	1
	152090-075	O-ring, FFKM	1
	152090-120	O-ring, NBR (low-swell)	1

**Table 1-6: Part identification for Model 1770 (455500) 150-650 psi range (continued)**

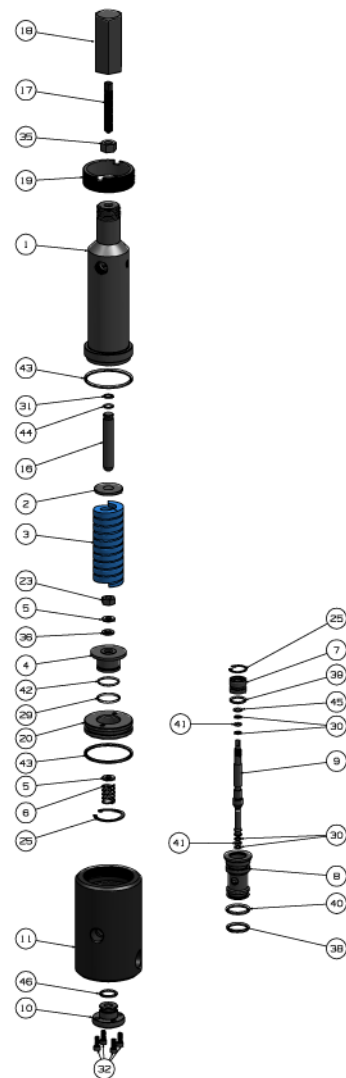
Item number	Part number	Description	Quantity
	152090-116	O-ring, CR	1
	152090-022	O-ring, FKM	1
	152090-027	O-ring, FKM GFLT	1
	152090-029	O-ring, FKM V1289	1
25*	157010	O-ring, NBR	1
	157010-005	O-ring, EPDM	1
	157010-075	O-ring, FFKM	1
	157010-120	O-ring, NBR (low-swell)	1
	157010-116	O-ring, CR	1
	157010-022	O-ring, FKM	1
	157010-027	O-ring, FKM GFLT	1
	152090-029	O-ring, FKM V1289	1
26*	152066	O-ring, NBR	2
	152066-005	O-ring, EPDM	2
	152066-075	O-ring, FFKM	2
	152066-120	O-ring, NBR (low-swell)	2
	152066-116	O-ring, CR	2
	152066-022	O-ring, FKM	2
	152066-027	O-ring, FKM GFLT	2
	157076-029	O-ring, FKM V1289	2
27*	157076	O-ring, NBR	1
	157076-005	O-ring, EPDM	1
	157076-075	O-ring, FFKM	1
	157076-120	O-ring, NBR (low-swell)	1
	157076-116	O-ring, CR	1
	157076-022	O-ring, FKM	1
	157076-027	O-ring, FKM GFLT	1
	157076-029	O-ring, FKM V1289	1
28*	152064	O-ring, NBR	1
	152064-005	O-ring, EPDM	1
	152064-075	O-ring, FFKM	1
	152064-120	O-ring, NBR (low-swell)	1
	152064-116	O-ring, CR	1
	152064-022	O-ring, FKM	1
	152064-027	O-ring, FKM GFLT	1
	152064-029	O-ring, FKM V1289	1



**Table 1-6: Part identification for Model 1770 (455500) 150-650 psi range (continued)**

Item number	Part number	Description	Quantity
29*	157011	O-ring, NBR	1
	157011-005	O-ring, EPR	1
	157011-075	O-ring, FFKM	1
	157011-120	O-ring, NBR (low-swell)	1
	157011-116	O-ring, CR	1
	157011-022	O-ring, FKM	1
	157011-027	O-ring, FKM GFLT	1
	157011-029	O-ring, FKM V1289	1
30	460108	Orifice Screw	1

(\*) Recommended spare parts

**Figure 1-13: Part identification for Model 2770 (465500) 600-1500 psi range****Table 1-7: Part identification for Model 2770 (465500) 600-1500 psi range**

Item number	Part number	Description	Quantity
1	466206	Piston Valve Cover	1
2	466017	Spring Guide	1
3		Spring Pressure	1
	466023	Spring, 600-950 lbs.	1
	466024	Spring, 900-1500 lbs.	1
4	466216	Piston	1
5	460013	Thrust Washer	2
6	460021	Damper Spring	1

**Table 1-7: Part identification for Model 2770 (465500) 600-1500 psi range (continued)**

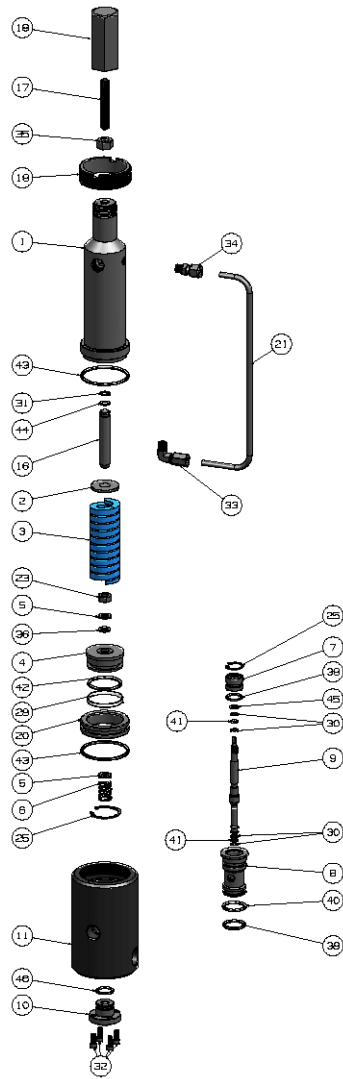
Item number	Part number	Description	Quantity
7	460008	Guide Bushing	1
8	466007	Pilot Valve Cage	1
9	466111	Poppet Shaft	1
10	466004	Bushing	1
11	465001	Valve Body	1
16	466212	Plunger	1
17	466208	Adjustment Screw	1
18	466003	Cap	1
19	466207	Cover Retainer	1
20	466002	Cylinder	1
23	151543-019M	Nut Hex	1
24	156466	Retaining Ring Internal	1
25	156467	Retaining Ring Internal	1
29	157164	Glyd Ring Outside	1
30	157212	Back- Up Ring Teflon	4
31	157207	Back- Up Ring Teflon	1
32	151001-019M	Screw Set	4
35	151627	Nut Jam	1
36	152267	Washer SS Lock	1
38	157009	O-ring, NBR	1
	157009-005	O-ring, EPR	1
	157009-075	O-ring, FFKM	1
	157009-120	O-ring, NBR (low-swell)	1
	157009-116	O-ring, CR	1
	157009-022	O-ring, FKM	1
	157009-027	O-ring, FKM GFLT	1
	157009-029	O-ring, FKM V1289	1
39	152090	O-ring, NBR	1
	152090-005	O-ring, EPR	1
	152090-075	O-ring, FFKM	1
	152090-120	O-ring, NBR (low-swell)	1
	152090-116	O-ring, CR	1
	152090-022	O-ring, FKM	1
	152090-027	O-ring, FKM GFLT	1
	152090-029	O-ring, FKM V1289	1
40	157010	O-ring, NBR	1

**Table 1-7: Part identification for Model 2770 (465500) 600-1500 psi range (continued)**

Item number	Part number	Description	Quantity
	157010-005	O-ring, EPR	1
	157010-075	O-ring, FFKM	1
	157010-120	O-ring, NBR (low-swell)	1
	157010-116	O-ring, CR	1
	157010-022	O-ring, FKM	1
	157010-027	O-ring, FKM GFLT	1
	157010-029	O-ring, FKM V1289	1
41	152066	O-ring, NBR	2
	152066-005	O-ring, EPR	2
	152066-075	O-ring, FFKM	2
	152066-120	O-ring, NBR (low-swell)	2
	152066-116	O-ring, CR	2
	152066-022	O-ring, FKM	2
	152066-027	O-ring, FKM GFLT	2
	152066-029	O-ring, FKM V1289	2
42	157034	O-ring, NBR	1
	157034-005	O-ring, EPR	1
	157034-075	O-ring, FFKM	1
	157034-120	O-ring, NBR (low-swell)	1
	157034-116	O-ring, CR	1
	157034-022	O-ring, FKM	1
	157034-027	O-ring, FKM GFLT	1
	157034-029	O-ring, FKM V1289	1
43	157061	O-ring, NBR	2
	157061-005	O-ring, EPR	2
	157061-075	O-ring, FFKM	2
	157061-120	O-ring, NBR (low-swell)	2
	157061-116	O-ring, CR	2
	157061-022	O-ring, FKM	2
	157061-027	O-ring, FKM GFLT	2
	157061-029	O-ring, FKM V1289	2
44	152086	O-ring, NBR	1
	152086-005	O-ring, EPR	1
	152086-075	O-ring, FFKM	1
	152086-120	O-ring, NBR (low-swell)	1
	152086-116	O-ring, CR	1

**Table 1-7: Part identification for Model 2770 (465500) 600-1500 psi range (continued)**

Item number	Part number	Description	Quantity
	152086-022	O-ring, FKM	1
	152086-027	O-ring, FKM GFLT	1
	152086-029	O-ring, FKM V1289	1
45	152067	O-ring, NBR	1
	152067-005	O-ring, EPDM	1
	152067-075	O-ring, FFKM	1
	152067-120	O-ring, NBR (low-swell)	1
	152067-116	O-ring, CR	1
	152067-022	O-ring, FKM	1
	152067-027	O-ring, FKM GFLT	1
	152067-029	O-ring, FKM V1289	1
46	157024	O-ring, NBR	1
	157024-005	O-ring, EPDM	1
	157024-075	O-ring, FFKM	1
	157024-120	O-ring, NBR (low-swell)	1
	157024-116	O-ring, CR	1
	157024-022	O-ring, FKM	1
	157024-027	O-ring, FKM GFLT	1
	157024-029	O-ring, FKM V1289	1

**Figure 1-14: Part identification for Model 2770 (475500) 5-650 psi range****Table 1-8: Part identification for Model 2770 (475500) 5-650 psi range**

Item number	Part number	Description	Quantity
1	466206	Pilot Valve Cover	1
2	466017	Spring Guide	1
3		Spring Pressure	1
	466223	Spring, 5-100	1
	466022	Spring, 50-250	1
	466023	Spring, 200-400	1
	466024	Spring, 350-650	1

**Table 1-8: Part identification for Model 2770 (475500) 5-650 psi range (continued)**

Item number	Part number	Description	Quantity
4	466316	Piston	1
5	460013	Thrust Washer	2
6	460021	Damper Spring	1
7	460008	Guide Bushing	1
8	466007	Pilot Valve Cage	1
9	466111	Poppet Shaft	1
10	466004	Bushing	1
11	465001	Valve Body	1
16	466212	Plunger	1
17	466208	Set Screw	1
18	466003	Cap	1
19	466207	Cover Retainer	1
20	466102	Cylinder	1
21	466209	Press Balancing Tube	1
23	151543-019	Nut Hex	1
24	156466	Retaining Ring Internal	1
25	156467	Retaining Ring Internal	1
29	157165	Glyd Ring	1
30	157212	Back- Up Ring Teflon	4
31	157207	Back- Up Ring Teflon	1
32	151001-019M	Screw Set	4
33	157144	Elbow	1
34	157143	Connector Straight	1
35	151627	Nut Jam	1
36	152267	Washer SS Lock	1
38	157009	O-ring, NBR	1
	157009-005	O-ring, EPR	1
	157009-075	O-ring, FFKM	1
	157009-120	O-ring, NBR (low-swell)	1
	157009-116	O-ring, CR	1
	157009-022	O-ring, FKM	1
	157009-027	O-ring, FKM GFLT	1
	157009-029	O-ring, FKM V1289	1
39	152090	O-ring, NBR	1
	152090-005	O-ring, EPR	1
	152090-075	O-ring, FFKM	1

**Table 1-8: Part identification for Model 2770 (475500) 5-650 psi range (continued)**

Item number	Part number	Description	Quantity
	152090-120	O-ring, NBR (low-swell)	1
	152090-116	O-ring, CR	1
	152090-022	O-ring, FKM	1
	152090-027	O-ring, FKM GFLT	1
	152090-029	O-ring, FKM V1289	1
40	157010	O-ring, NBR	1
	157010-005	O-ring, EPD	1
	157010-075	O-ring, FFKM	1
	157010-120	O-ring, NBR (low-swell)	1
	157010-116	O-ring, CR	1
	157010-022	O-ring, FKM	1
	157010-027	O-ring, FKM GFLT	1
	157010-029	O-ring, FKM V1289	1
41	152066	O-ring, NBR	2
	152066-005	O-ring, EPD	2
	152066-075	O-ring, FFKM	2
	152066-120	O-ring, NBR (low-swell)	2
	152066-116	O-ring, CR	2
	152066-022	O-ring, FKM	2
	152066-027	O-ring, FKM GFLT	2
	152066-029	O-ring, FKM V1289	2
42	157091	O-ring, NBR	1
	157091-005	O-ring, EPD	1
	157091-075	O-ring, FFKM	1
	157091-120	O-ring, NBR (low-swell)	1
	157091-116	O-ring, CR	1
	157091-022	O-ring, FKM	1
	157091-027	O-ring, FKM GFLT	1
	157091-029	O-ring, FKM V1289	1
43	157061	O-ring, NBR	2
	157061-005	O-ring, EPD	2
	157061-075	O-ring, FFKM	2
	157061-120	O-ring, NBR (low-swell)	2
	157061-116	O-ring, CR	2
	157061-022	O-ring, FKM	2
	157061-027	O-ring, FKM GFLT	2



**Table 1-8: Part identification for Model 2770 (475500) 5-650 psi range (continued)**

Item number	Part number	Description	Quantity
44	157061-029	O-ring, FKM V1289	2
	152086	O-ring, NBR	1
	152086-005	O-ring, EPDM	1
	152086-075	O-ring, FFKM	1
	152086-120	O-ring, NBR (low-swell)	1
	152086-116	O-ring, CR	1
	152086-022	O-ring, FKM	1
	152086-027	O-ring, FKM GFLT	1
45	152086-029	O-ring, FKM V1289	1
	152067	O-ring, NBR	1
	152067-005	O-ring, EPDM	1
	152067-075	O-ring, FFKM	1
	152067-120	O-ring, NBR (low-swell)	1
	152067-116	O-ring, CR	1
	152067-022	O-ring, FKM	1
	152067-027	O-ring, FKM GFLT	1
46	152067-029	O-ring, FKM V1289	1
	157024	O-ring, NBR	1
	157024-005	O-ring, EPDM	1
	157024-075	O-ring, FFKM	1
	157024-120	O-ring, NBR (low-swell)	1
	157024-116	O-ring, CR	1
	157024-022	O-ring, FKM	1
	157024-027	O-ring, FKM GFLT	1
47	157024-029	O-ring, FKM V1289	1

**Important**

Item numbers reference actual engineering drawings and are not meant to be consecutively numbered.

## 1.3 Agency certifications for the Model 770 Control Valves

The following product agency certifications are applicable to the Daniel Control Valves.

**Table 1-9: Agency certifications for control valves**

Certification type		Description
Pressure equipment		PED
Process temperature	Standard temperature	-29 °C to 66 °C (-20 °F to 150 °F)
	Optional temperature	-46 °C to 204 °C (-50 °F to 400 °F)

## 2 Operating conditions and specifications

### Topics covered in this chapter:

- [Operating conditions for the Model 770](#)
- [Specifications for the control valve](#)
- [Pilot spring selection](#)

### 2.1 Operating conditions for the Model 770

**Table 2-1: Operating conditions for the Model 770 control valve**

Condition type	Description
Fluid phase	Liquid
Process temperature	-29 °C to 66 °C (-20 °F to 150 °F)
Optional process temperature	-46 °C to 204 °C (-50 °F to 400 °F)
Fluid velocity	Operational recommended flow velocity up to 30 ft/sec. Beyond this point a high pressure drop and increased wear will result.
Fluid(s) controlled	<ul style="list-style-type: none"> <li>• Low/Medium viscosity crude oils and condensates</li> <li>• Refined products and intermediates (e.g.: <i>gasoline, diesel, kerosene, light fuel oils, jet fuel, LPG, butanes, naphtha, alkylate, reformate, straight run gasoline, cat-cracked gasoline</i>)</li> <li>• Petrochemicals (e.g.: <i>benzene, toluene, xylenes, cumene, olefins, pyrolysis gasoline</i>)</li> <li>• Natural gas liquids</li> </ul>
Differential pressure	The maximum allowable differential pressure of a control valve is 6894 kPa (1,000 psi). Consult factory for location of first shut-down valve.
Atmospheric pressure	Absolute
Sizes (NPS)	2, 3, 4, 6, 8, 10, 12, 16
Pressure class (ANSI)	150, 300, 600
Maximum safe working temperature range	<ul style="list-style-type: none"> <li>• -26 °C to 204 °C (-15 °F to 400 °F)</li> <li>• Using FKM O-rings</li> <li>• Temperature range is dependent on O-ring <math>T_{min}</math> and <math>T_{max}</math></li> <li>• Consult the factory for other safe working temperatures</li> </ul>

**Table 2-1: Operating conditions for the Model 770 control valve (continued)**

Condition type	Description			
Maximum safe working pressure	Flange connections/Ratings (DIN) for valve sizes DN50 and DN400: <ul style="list-style-type: none"> <li>DIN PN16 MWP at 120 °C: 16 bar</li> <li>DIN PN25 MWP at 120 °C: 25 bar</li> <li>DIN PN40 MWP at 120 °C: 40 bar</li> <li>DIN PN64 (class 300) MWP at 120 °C: 51 bar</li> <li>DIN PN64 (class 600) MWP at 120 °C: 64 bar</li> <li>DIN PN100 MWP at 120 °C: 100 bar</li> </ul> Flange connections/Ratings (ANSI) for valve sizes 2"-16": <ul style="list-style-type: none"> <li>Class 150 MWP at 100 °F: 285 psi</li> <li>Class 300 MWP at 100 °F: 740 psi</li> <li>Class 600 MWP at 100 °F: 1480 psi</li> </ul> * MWP: Maximum Working Pressure			
Materials of construction	O-Rings: <ul style="list-style-type: none"> <li>Standard: FKM</li> <li>Optional: Neoprene™, EPDM, FKM V1289, Nitrile, FFKM, FKM GLT</li> <li>For other material contact the factory</li> </ul> External hook up: <ul style="list-style-type: none"> <li>Class 150 and 300:               <ul style="list-style-type: none"> <li>NPS 2-6: Carbon steel/Stainless steel 10 mm (0.372")</li> <li>NPS 8-16 Carbon steel/Stainless steel 13 mm (0.5")</li> </ul> </li> <li>Class 600:               <ul style="list-style-type: none"> <li>NPS 2-6: Stainless steel 13 mm (0.5")</li> <li>Can be furnished in metric sizes</li> </ul> </li> </ul> Other internal parts: Stainless steel			
Pilot spring ranges	Class 150-300		Class 600	
	(kPa)	(PSI)	(kPa)	(PSI)
	0-138	0-20	345-690	5-100
	0-276	0-40	345-1724	50-250
	207-552	30-80	1379-2758	200-400
	485-1241	70-180	2413-4482	350-650
	1034-2413	150-350	4137-6550	600-950
	2413-4482	350-650	6205-10342	900-1500
	Spring selection based on control pressure set point. Refer to <a href="#">Section 2.3</a> Pilot spring selection for details.			

## 2.1.1 Design considerations

Some conditions to consider:

- Service operating pressure

- Service testing pressures
- Service process temperature and ambient site temperatures
- Chemical composition and toxicity of fluid in operating conditions
- Traffic, wind and earthquake at loading site
- Adverse force or stress caused by inadequate supports, attachments, piping, etc.
- Corrosion, erosion, fatigue, etc.
- Decomposition of unstable fluids in operating and test conditions
- Possible damage from external fire
- Mass fluid in process and test conditions

### **WARNING!**

#### FUNCTIONAL AND ENVIRONMENTAL HAZARD

Evaluate the functional and environmental conditions prior to installing a control valve. Install the control valve in a well-designed piping system.

Failure to comply may result in death or serious injury from pipe failure.

## 2.1.2 Environmental conditions

### **WARNING!**

#### EQUIPMENT HAZARD

Never use this equipment for any purpose other than its intended use.

Failure to comply may result in death, serious personal injury and/or property damage.

**Table 2-2: Environmental conditions**

Parameter type	Description
Severe service conditions	Ensure that piping or other attachments connected to the valve are not under stress. The design of the control valve has not been assessed for the effects of wind, earthquake loading and severe weather conditions.
Additional severe service conditions	<p>The valves are designed to be used on liquid applications for crude oil and refined products.</p> <p>The use of aggressive additives or oxygenates requires the use of the Aggressive Products (AP) option. The AP option valve cylinder incorporates cup-seals (PTFE Bal Seals) and an O-ring made from appropriate materials for severe conditions. Materials for pilots such as Low Swell NBR (main valve static O-rings) and FFKM or PTFE are available.</p>

**Table 2-2: Environmental conditions (continued)**

Parameter type	Description
Corrosive service	Select the material compatible with the specific processes and atmospheric environments. Implement a periodic inspection and maintenance program to ensure that pressure retaining components are free from corrosion and erosion.  The valve is not designed with corrosion allowance. Inspect the valve's metal parts periodically for corrosion and erosion, and inspect the seals and O-rings for wear and chemical deterioration.
Low and freezing temperatures	Specific gravities and viscosities at low or freezing temperature will reduce the flow range of the valve. Refer to <a href="#">Section 1.2.3</a> for more information.
Populated areas	For new installations, locate the control valve to an area that has fewer than 10 buildings intended for human occupancy within an area that extends 200 meters (220 yards) radially from the control valve. (Reference: Class 1 Location: U.S. DOT, CFR Title 49: Part 192.5)
Closed, poorly ventilated areas	Install the control valve in a well ventilated area, not less than one meter (approximately three feet) from source of ignition or source of heat which might damage the unit.
Elevation	No limit
Humidity	No limit
Proximity to open flame	Provide fire prevention measures and equipment per local regulations.
Proximity to vehicular traffic	The design of the control valve has not been assessed for the effects of traffic.

## 2.2 Specifications for the control valve

### 2.2.1 Interface requirements

#### **WARNING!**

##### **EXCEEDING REQUIREMENTS HAZARD**

Control valve requirements are defined to ensure safe equipment operation. Do not exceed published specifications.

Failure to comply may result in death, serious injury and/or damage to the equipment.

**Table 2-3: Interface requirements**

Requirements	Description
Hydraulic lines	<p>External hook up:</p> <ul style="list-style-type: none"> <li>ANSI class 150 and 300: <ul style="list-style-type: none"> <li>NPS 2-6: Carbon steel/Stainless steel 10 mm (0.375")</li> <li>NPS 8-16 Carbon steel/Stainless steel 13 mm (0.5")</li> <li>Can be furnished in metric sizes</li> </ul> </li> <li>ANSI class 600: <ul style="list-style-type: none"> <li>NPS 2-16: Stainless steel 13 mm (0.5")</li> <li>Can be furnished in metric sizes</li> </ul> </li> </ul>
Flange type	<p>The mechanical connections for Model 770 control valves are standard class 150, 300 and 600 ANSI R.F. flanges which are available only in stainless steel. Daniel also offers other types of flange connections which are available per customer request. For other ANSI ratings or flanges consult the factory engineers. For maximum working pressures at intermediate temperatures refer to ANSI B16.5.</p>
<p><b>⚠ WARNING!</b></p> <p><b>FLANGE SIZE HAZARD</b></p> <p>Customers must choose the appropriate size material of the flange for their piping requirements.</p> <p><b>Choosing an incorrect flange may cause a pressure leak, resulting in death or serious injury.</b></p>	

## 2.2.2 Requirements and limitations for installation

### NOTICE

Comply with local government regulations and company requirements.

See [Figure 2-1](#) for flow direction.

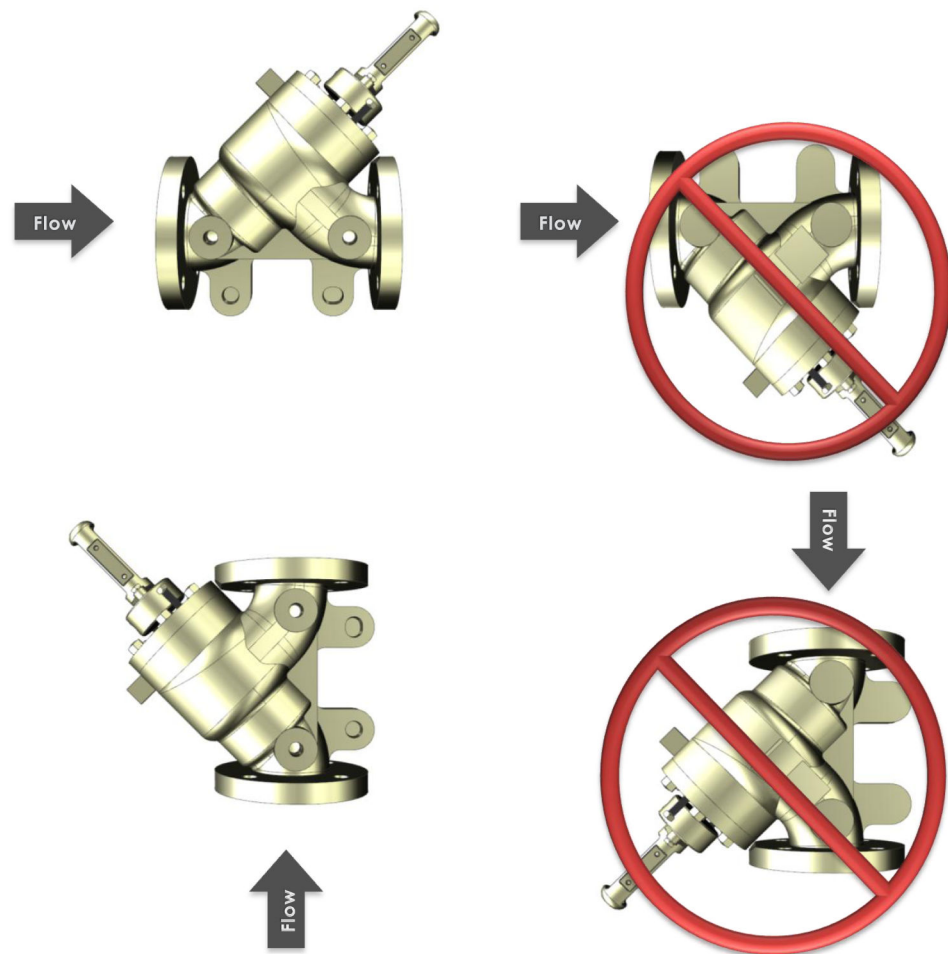
### NOTICE

Flush lines to remove welding bead, pipe scale, etc.

### NOTICE

Install the valve in a horizontal line with the cylinder head at the top.

**Figure 2-1: Valve orientation**



**⚠ WARNING!**

**EQUIPMENT HAZARD**

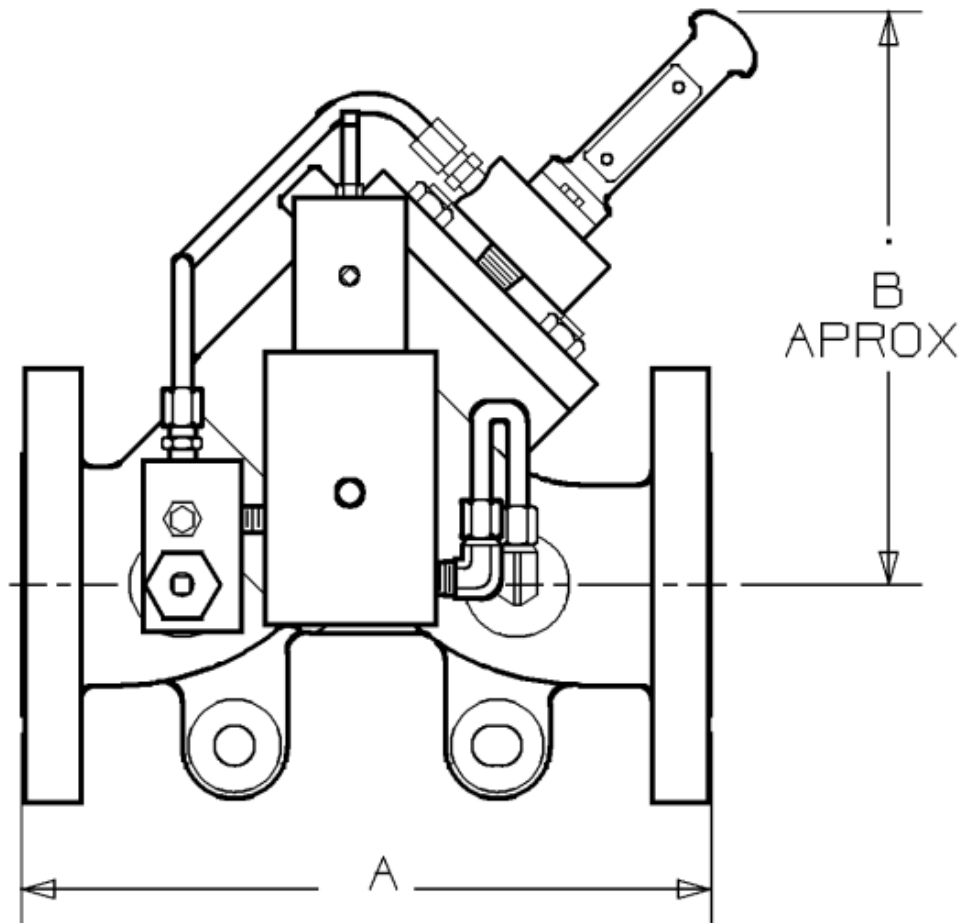
Never use this equipment for any purpose other than its intended use.

Failure to comply may result in death, serious personal injury and/or property damage.

**Minimum clearances for installation, operation and maintenance**

For certified prints, consult the factory.



**Figure 2-2: Flange connection/Ratings (DIN)****Table 2-4: Flange connections (DIN)**

	A						B			
	Class 150		Class 300		Class 600		Class 150-300		Class 600	
Valve size	inches	cm	inches	cm	inches	cm	inches	cm	inches	cm
2	10 1/4	26	10 1/2	27	11 1/2	29	10 7/8	28	10 7/8	28
3	11	28	13 1/8	33	14	36	10 7/8	28	11 1/4	29
4	13	33	14 1/2	37	17	43	10 7/8	28	11 1/2	29
6	17	43	17 7/8	45	22	56	13 5/8	35	13 5/8	35
8	22 1/4	57	23 1/4	59	26	66	17 1/4	44	17 3/4	45
10	26 1/2	67	27 7/8	71	31	79	17 5/8	45	20 5/8	52
12	30 1/2	77	33 5/8	85	36 1/2	93	22 7/8	58	22 7/8	57
16	41 3/8	105	43 1/3	110	46	117	30	76	30	76

**Table 2-5: Approximate shipping weights and cube**

	Approximate shipping weight						Approximate shipping cube			
Valve size	Model 770						Model 770			
	Class 150		Class 300		Class 600		Class 150-300		Class 600	
	lbs.	kilos	lbs.	kilos	lbs.	kilos	cubic feet	cubic meters	cubic feet	cubic meters
2	55	21	60	22	100	37	1.66	0.047	1.79	0.051
3	95	35	105	39	150	56	2.36	0.067	2.50	0.071
4	115	43	140	52	205	77	2.51	0.071	3.13	0.089
6	210	78	250	93	400	149	4.84	0.137	6.07	0.172
8	400	149	465	174	725	271	8.94	0.253	9.98	0.283
10	640	239	700	261	1170	437	12.08	0.342	15.13	0.428
12	1040	388	1215	454	1820	679	20.25	0.573	21.94	0.621
16	CF	CF	CF	CF	CF	CF	39.53	1.119	42.17	1.194

CF=consult factory

## 2.3 Pilot spring selection

### 2.3.1 Pilot spring selection table

The following Pilot spring selections table is a complete listing of regulating pilot valve figure numbers, part numbers, pilot springs, spring part numbers, and piston diameters.

The application of pilot springs is significant and often misunderstood. The pressure range of a specific pilot spring relates directly to the area of the pilot piston exposed to fluid sensing ( $\text{FORCE} = \text{PRESSURE} \times \text{AREA}$ ). In other words, the control range of a spring will vary with the outside diameter of the pilot's piston. In effect, a light spring combined with various piston diameters increases pilot sensitivity, whereas a heavier spring used without changing the piston size decreases sensitivity and accuracy of set point. The use of various sizes assures the most compact and flexible pilot available and is a key to the accurate set point control found in Daniel valves.

The table outlines the standard and optional springs, spring ranges and piston diameters for all integral and external piston operated pilots for Series 700 control valves.

---

**Figure 2-3: Conversion factors**

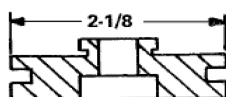
$$psi \times .07030695 = kg / cm^2$$

$$psi \times .6894757 = kPa$$

---

**Figure 2-4: Pilot spring selections**

Model No.	Description	Pilot Assy Part No.
1750	Pressure Reducing	435600
1754	Pressure Differential	453700
1760	Back Pressure	453200
1761	Pressure Relief	456200
1770	Pressure Differential	453500

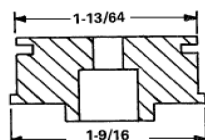


Available Spring Ranges (Psi)	Part number	Color Code
0-20	460223	Unpainted
0-40	460022	Blue
30-80	460023	Black or Red
70-180	460024	Bronze

Class	Max Range
150-300	180 psi

Large piston

Model No.	Description	Pilot Assy Part No.
1750	Pressure Reducing	456600
1754	Pressure Differential	456700
1760	Back Pressure	456100
1770	Pressure Differential	456500

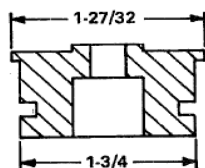


Available Spring Ranges (Psi)	Part number	Color Code
150-350	460023	Black or Red
350-650	460024	Bronze

Class	Max Range
150-300	650 psi

Small piston

Model No.	Description	Pilot Assy Part No.
2750	Pressure Reducing	475000
2754	Pressure Differential	475600
2760	Back Pressure	475100
2770	Pressure Differential	475500

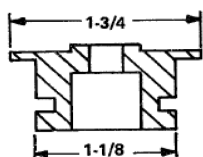


Available Spring Ranges (Psi)	Part number	Color Code
5-100	466223	Unpainted
50-250	466022	Blue
200-400	466023	Black or Red
350-650	466024	Bronze

Class	Max Range
600	650 psi

Large piston

Model No.	Description	Pilot Assy Part No.
2750	Pressure Reducing	465000
2754	Pressure Differential	465600
2760	Back Pressure	465100
2770	Pressure Differential	465500



Available Spring Ranges (Psi)	Part number	Color Code
600-950	466023	Black or Red
900-1,500	466024	Bronze

Class	Max Range
600	1,500 psi

Small piston

## 2.3.2 Table usage

Example: A customer has an ANSI 300 lb. Model 770 Differential Control Valve with a 207-552 kPa (30-80 psi) pilot spring set for 483 kPa (70 psi) control. Due to change in the system, he desires to control a 300 psi 2068 kPa (300 psi). For a spring range of 1034-2413 kPa (150-350 psi) the table lists a 460023 spring. But the existing spring range of 207-552 kPa (30-80 psi) also requires a 460023 spring.

Conclusion: Changing the spring will not solve this customer's problem. The pilot piston must be changed.

Proper use of the pilot spring selection table should eliminate any difficulty associated with changing a pilot spring. If any two facts are known about a pilot, other tabulated data can be determined. For example:

- Knowledge of piston diameter and spring color indicates the spring range of the pilot.
- Knowledge of the model number and piston diameter indicates the pilot part number.
- Knowledge of the pilot part number and spring color indicates the spring range.



# Part II

## Install





## 3 Installation prerequisites

Topics covered in this chapter:

- [Model 770 pre-start checks](#)
- [Model 770 installation procedure](#)

### 3.1 Model 770 pre-start checks

#### CAUTION!

##### EQUIPMENT HAZARD

Observe all precautionary signs posted on the equipment.

**Failure to do so may result in injury to personnel or cause damage to the equipment.**

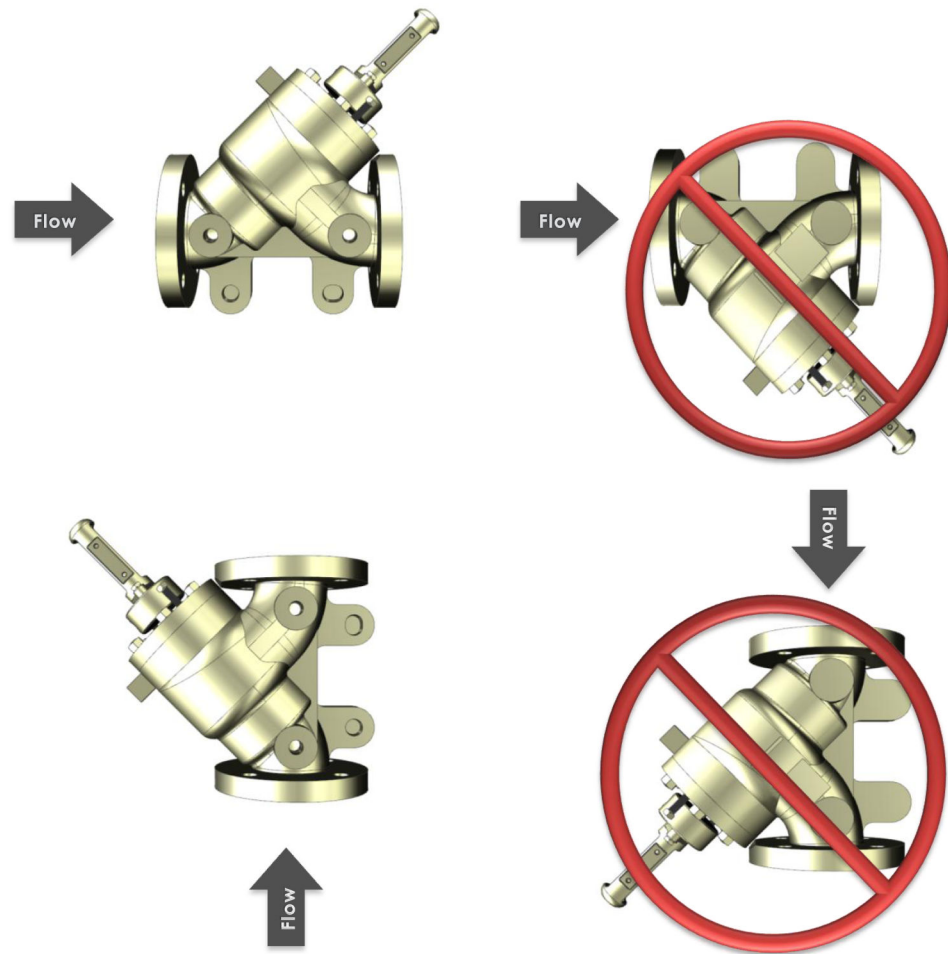
---

##### Important

The Daniel valve may be installed with a flow direction horizontal or vertical up but should never be installed with flow direction vertical down. When installed in a horizontal line, the valve should be installed so that the cylinder head is at the top of the valve and not the bottom.

---

**Figure 3-1: Valve orientation**



## 3.2 Model 770 installation procedure

### Prerequisites

Following the procedure below to install the Model 770.

#### **⚠ WARNING!**

##### **EQUIPMENT HAZARD**

**Never use this equipment for any purpose other than its intended use.**

**Failure to comply may result in death, serious personal injury and/or property damage.**

---

## Procedure

1. If possible, install the control valve within 7.6 m (25 feet) of the point at which downstream line pressure is to be controlled. This distance limitation is due to the sense line which must be run to the pilot (unless it is configured for internal sensing). Consult the factory if sense lines of greater length are required.

---

### Important

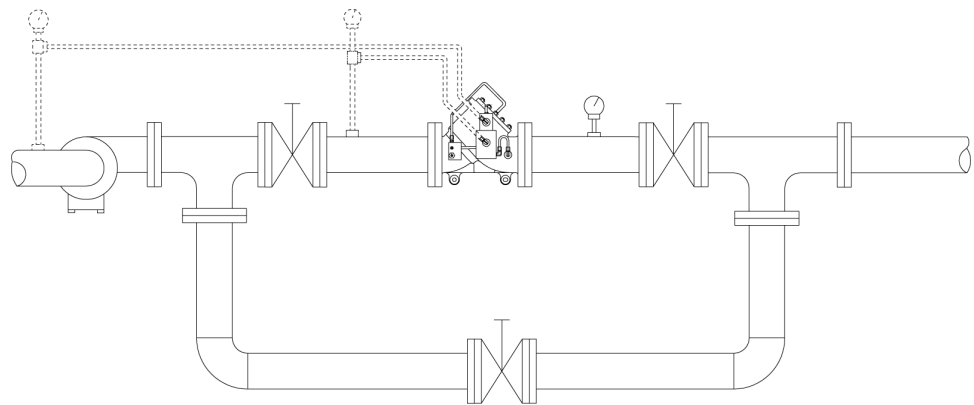
It is recommended that the control valve be installed between isolating valves ([Figure 4-2](#), A1-A3). This will permit the system to remain operational while maintenance is being performed on the valve.

---

2. Ensure that the line is completely free of all foreign material before the valve is bolted into the line.
  - a. If it is impractical to flush the line before installing the valve, bolt in the valve body. Remove the cylinder assembly by following the disassembly instructions on the basic valve and seal the opening with a temporary cover.
  - b. Disconnect or isolate the sense line if it is connected to the pilot. This will eliminate the possibility of foreign material flowing into the sensing chamber of the pilot. (Flushing the line will not be necessary if the product line and liquid are positively known to be clean.)
3. Two 3/8" sense lines are required between the pilot and the sensing points. This size line is a minimum requirement however, and is based on a maximum product viscosity of 500 SSU. Use a larger size sense line if the viscosity of the product is in excess of 500 SSU. The sense line is mated with the lower connection of the pilot.
4. Including pressure gauges in the valve circuit is recommended. These gauges indicate the differential pressure when installed at the location indicated on the valve schematic. It is very important that the gauges be installed since it must be monitored to properly adjust the valve. The gauges are not furnished by Daniel.

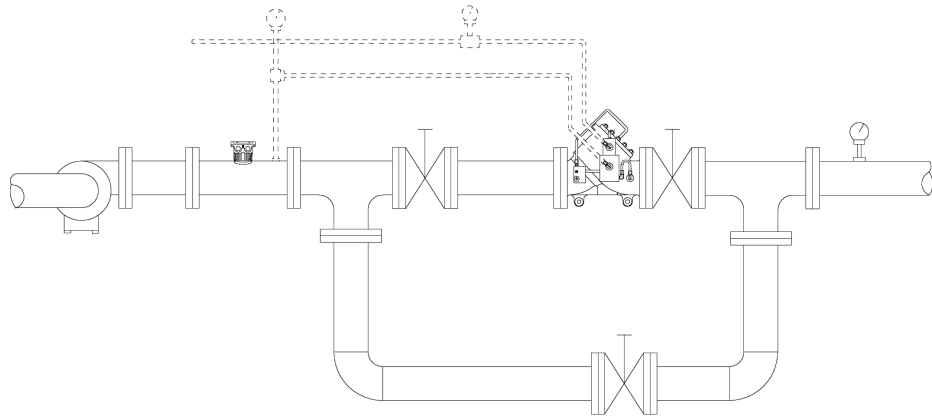
---

**Figure 3-2: Maintain minimum pump differential**



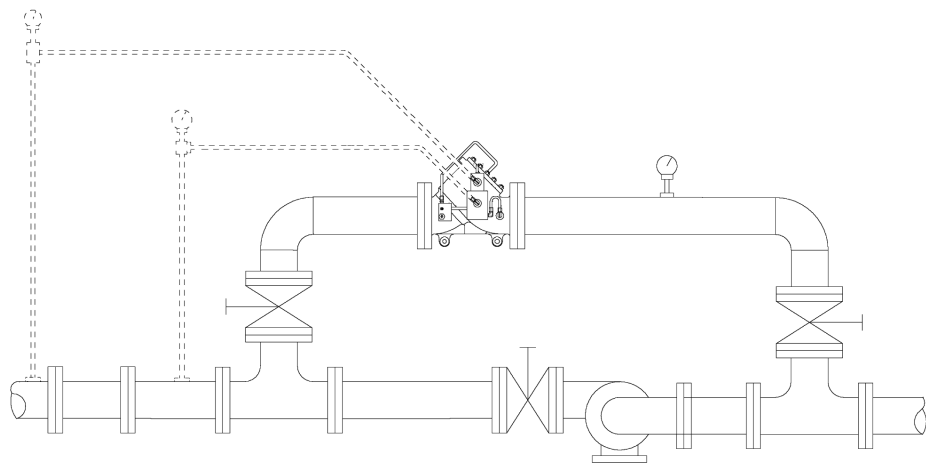
---

**Figure 3-3: Differential pressure control (LNG, NH3)**



---

**Figure 3-4: Bypass rate of flow control**



# **Part III**

## **Operate**



## 4 Operation start up

### 4.1 Model 770 adjustment and startup

#### Prerequisites

The valve is adjusted as outlined below. All isolation valves (A1, A2 and A3) must be closed before adjustment can begin. See [Figure 4-1](#)

#### Procedure

1. The first step in adjusting the valve is to bleed all air from the system. Start the pump (if a static head of 5-10 psi is not present) and open isolation valve A1. For external sensed pilots loosen the sense line connection at the pilot and the pilot supply line on the valve cylinder to allow air release. When all the air has been expelled from the system, retighten the sense line connection, close isolating valve A1, and deactivate the pump.
2. Open the sensitivity adjustment screw 3 turns from closed on a combination strainer/needle valve or one half turn from closed for needle valve only. Next turn the pilot adjustment screw counterclockwise until all spring tension is relieved. Then turn the screw clockwise until the adjustment screw travels approximately 12 mm (1/2"). This will ensure that some differential will be developed upon a start up.
3. Open isolation valve A3 (Valve A2, which is included only to bypass the control valve when it is being serviced, will always be closed during normal operation). Start the pump and immediately open valve A1. This valve should be opened slowly. Observe the pressure gauges at G2 and G3 while opening this valve and note the pressure at which the control valve begins to open. If the differential pressure at which the valve opens is higher than the pressure desired, turn the pilot adjustment screw counterclockwise, stop the pump, and restart it again. Repeat this procedure until the control valve begins to open at the desired differential pressure. If the differential pressure at which pressure at which the valve opens is lower than the pressure desired, turn the pilot adjustment screw clockwise and repeat the pump stopping and starting procedure until the correct opening differential is attained.
4. Fully open isolating valve A3 and observe the pressure gauge to determine at what pressure the valve is controlling. If the pressure is incorrect, turn the pilot adjustment screw clockwise to increase pressure. It may be necessary to partially close isolating valve A3 in order to build up sufficient pressure for setting the pilot.
5. If pulsation occurs in the control valve, it may be eliminated by turning the sensitivity, adjustment clockwise.

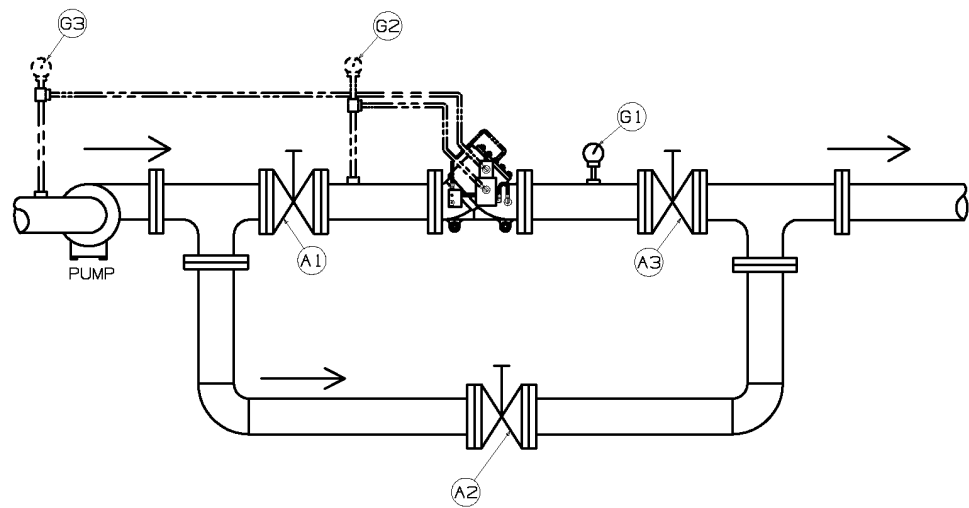
#### CAUTION!

#### EQUIPMENT DAMAGE POSSIBLE

**Never completely close the sensitivity adjustment. It should remain at least ¼ turn open.**

**If the sensitivity adjustment is fully closed, the valve will not operate properly.**

**Figure 4-1: Maintain minimum pump differential**





# Part IV

## Maintain

### Chapters covered in this part:

- *Planned maintenance*
- *Corrective maintenance*
- *Spare parts*



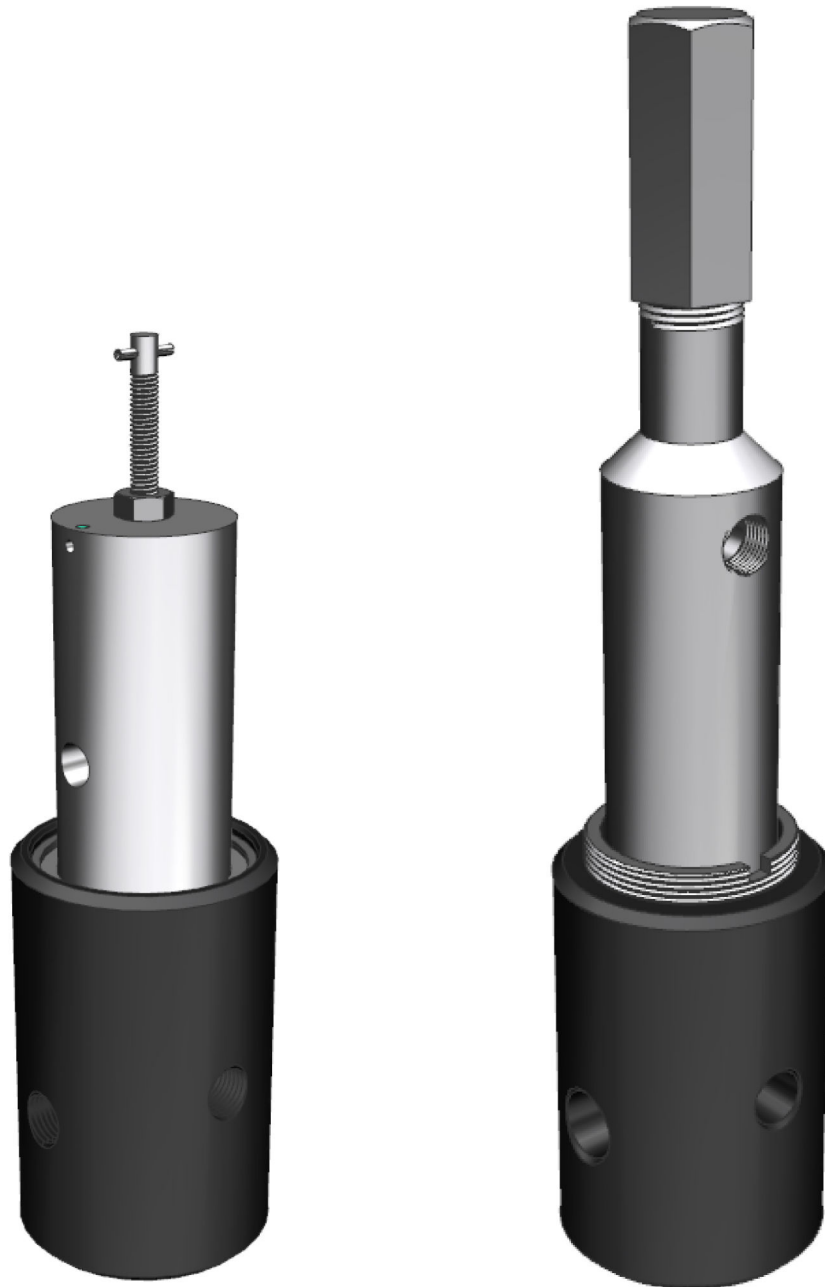
# 5      Planned maintenance

## **Topics covered in this chapter:**

- *Maintenance considerations*
- *Pilot disassembly (1770)*
- *Pilot disassembly (2770)*
- *Pilot assembly*

## 5.1 Maintenance considerations

**Figure 5-1: Model 1770 Differential Control Pilot and 2770 Differential Control Pilot**



## 5.2 Pilot disassembly (1770)

1. Remove the 1770 pilot from valve by disconnecting the external tubing.
2. Turn pressure adjustment screw counterclockwise until tension is relieved on the spring. Push in on pilot cover and remove by extracting the retaining ring.
3. Hold the shaft nut and remove the nut and lockwasher by disengaging the poppet shaft assembly from the sensing piston.
4. Remove sensing piston. Remove poppet shaft and cage as a unit after removing retainer ring.
5. Remove poppet shaft and guide bushing. Remove poppet shaft from guide bushing. Use 3/32" punch and drive roll pin from poppet shaft.
6. Use 3/32" punch and drive roll pin from poppet shaft. Remove retainer sleeve and O-ring from shaft.
7. Remove and inspect all O-rings.

### **⚠ CAUTION!**

#### **EQUIPMENT HAZARD**

**Observe all precautionary signs posted on the equipment.**

**Failure to do so may result in injury to personnel or cause damage to the equipment.**

### **⚠ CAUTION!**

#### **EQUIPMENT DAMAGE**

**Read the entire recommended procedure for all installation operations and maintenance procedures before attempting to install or disassemble the valve. Disassembly of this cylinder assembly is different from previous Daniel Control Valves and requires strict adherence to the procedures outlined in this manual.**

**Failure to read and comply with these procedures could result in damage to the equipment and compromise in the integrity of the operation.**

## 5.3 Pilot disassembly (2770)

1. Isolate and remove all pressure and drain before maintenance.
2. Remove the pilot from the valve by disconnecting the external tubing.
3. Turn pressure adjustment screw counter-clockwise until tension is relieved on the spring. Push in on the pilot cover and remove by extracting cover retainer. Unscrew counter-clockwise.
4. Disengage the poppet shaft assembly from the sensing piston by holding the shaft and removing the nut and lock washer.
5. Remove sensing piston.

6. Remove the poppet shaft and cage as a unit after removing the retainer ring. Remove the poppet shaft and remove the nut, the lock washer and the retainer sleeve. Remove the guide bushing by removing the retainer ring.
7. Remove and inspect all O-rings.

**⚠ CAUTION!**

**EQUIPMENT HAZARD**

**Observe all precautionary signs posted on the equipment.**

**Failure to do so may result in injury to personnel or cause damage to the equipment.**

## 5.4 Pilot assembly

1. Apply oil or grease to all O-rings to prevent cutting and to facilitate assembly.
2. Reassemble by reversing disassembly order. BE CAREFUL not to cut O-rings when assembling parts and assemblies. Be sure spring under sensing piston is in place.

---

**Important**

This pilot was designed without corrosion allowance. Periodically inspect the valve's metal parts for corrosion and erosion.

Inspect the seals and O-rings for wear and chemical deterioration.

---

---

**Important**

Ensure that piping or other attachments connected to the control valve are not under stress.

---

---

**Important**

Provide fire prevention measures and equipment per local regulations.

---

## 6 Corrective maintenance

### Topics covered in this chapter:

- [Control valve troubleshooting](#)
- [Verify the return to operational condition](#)

### 6.1 Control valve troubleshooting

Use the table below to troubleshoot the control valve. Contact the nearest Daniel Measurement and Control Sales or Service office for repairs. It is important that servicing be performed by trained and qualified service personnel.

### 6.2 Verify the return to operational condition

After correcting maintenance issues, verify that the control valve is working properly by following the steps below.

#### Procedure

1. Inspect all bolts used to secure the control valve in-line to ensure that proper mounting procedures have been followed and that flange connections are leak-free.
2. Evaluate the system setup to ensure that all components are in the correct sequence for accurate product measurement. Some components are isolation valves, strainers, flow straighteners, turbine meters, downstream sections, etc.





# 7 Spare parts

## Topics covered in this chapter:

- [Recommended spare parts](#)
- [Order spare parts](#)

## 7.1 Recommended spare parts

For spare parts for the 770 control valve, see the Part Lists. Each figure marks its spare parts with an asterisk.

## 7.2 Order spare parts

Provide the following information when ordering replacement parts:

- Valve serial number
- Part number
- Part description
- Quantity required
- Size
- Product, product viscosity, product specific gravity
- Minimum and maximum operating temperatures
- Minimum and maximum flow rates
- Minimum, normal and maximum operating pressure
- Control functions to be performed
- Flange connections
- O-ring material
- Control pilot materials
- Tubing material
- Main valve piston material



# Appendix A

## Combination needle valve and strainer

### Topics covered in this appendix:

- *Disassembly and assembly*
- *Needle valve and strainer combination*
- *Order spare parts*

## A.1 Disassembly and assembly

### Procedure

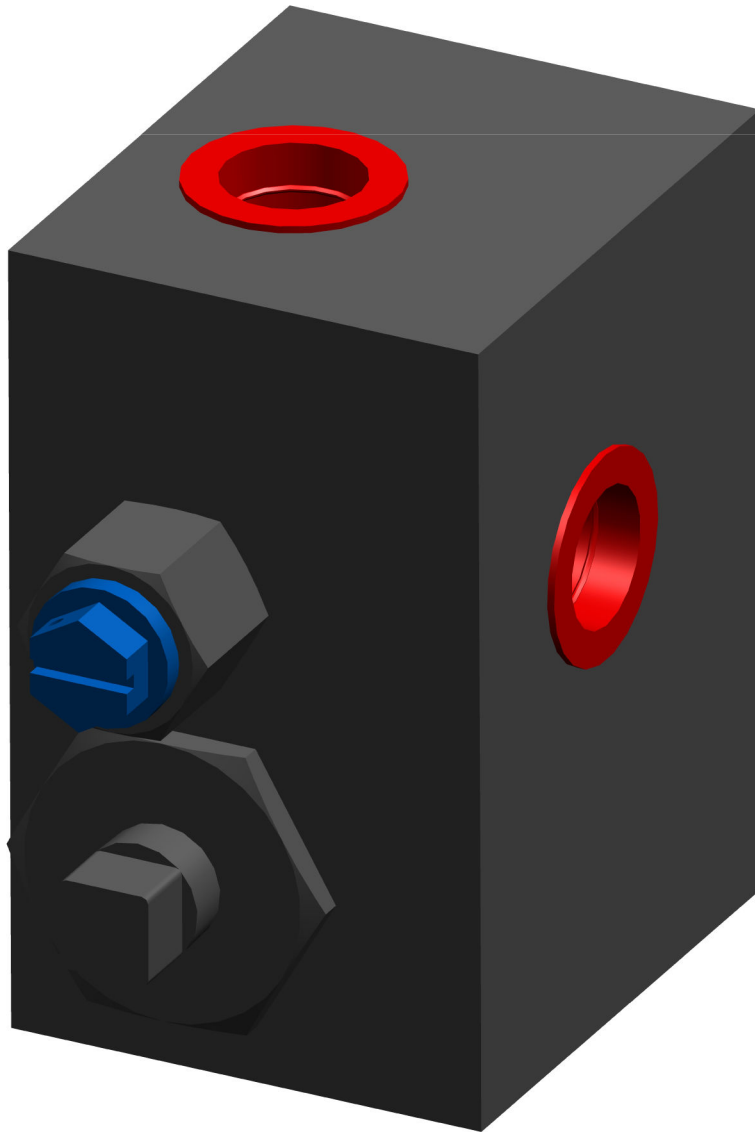
1. Isolate and remove all pressure and drain before maintenance.
2. Remove strainer (combination valve and strainer unit) by removing the strainer cap.
3. All parts associated with the adjustment stem are removable when the retainer is removed. Remove the adjustment stem by turning it counterclockwise.
4. For pilots used on crude oil, gasoline, diesel fuel or other general liquid hydrocarbon service, apply a light oil or general purpose grease to all O-rings to prevent cutting and to facilitate assembly. Use a light oil only for Butane and Propane service.

### Tools required:

- Retaining ring pliers
- Ratchet wrench
- Pin removal tool
- Needle nose pliers

---

**Figure A-1: Combination needle valve and strainer**



---

## **A.2 Needle valve and strainer combination**

- Part number 460710

Figure A-2: Needle valve and strainer combination

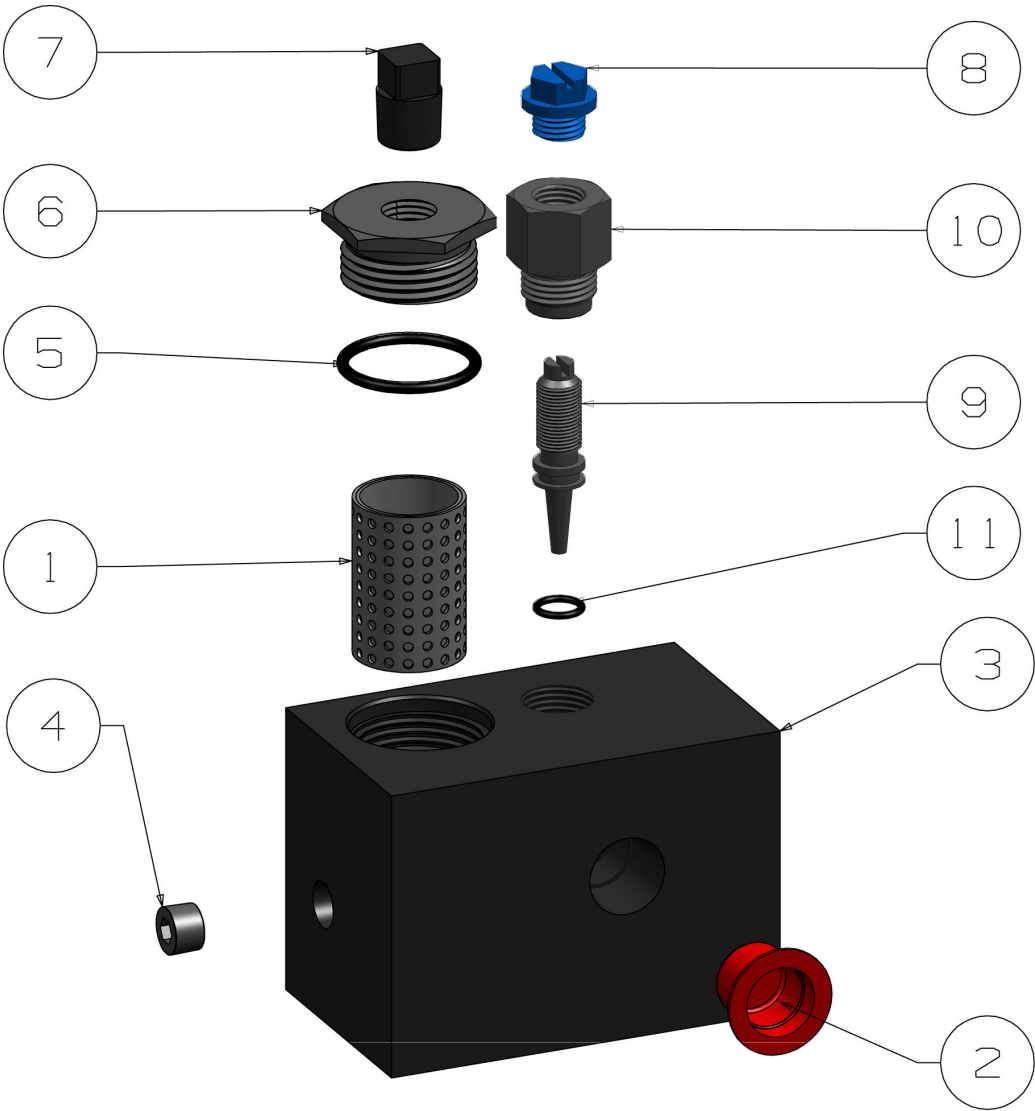


Table A-1: Part description for needle valve and strainer combination

Item	Description	Part number	Quantity required
1	Strainer assembly	460665	1
3	Needle body carbon steel	460688-500M	1
	Needle body stainless steel	460688-600M	1
4	Plug pipe	154772-019M	1

**Table A-1: Part description for needle valve and strainer combination (continued)**

Item	Description	Part number	Quantity required
5	O-ring, Buna-A	152042	1
	O-ring, EPR	152042-005	1
	O-ring, Kalrez	152042-075	1
	O-ring, low-swell Nitrile	152042-120	1
	O-ring, Neoprene	152042-116	1
	O-ring, FKM	152042-022	1
	O-ring, FKM V1289-75	152042-027	1
6	Strainer cap	460682M	1
7	Plug pipe square hd	154783M	1
8	Retainer cap	460686	1
9	Adjustment stem	460683-001M	1
10	Retainer	460684M	1
11	O-ring, Buna-A	152067	1
	O-ring, EPR	152067-005	1
	O-ring, Kalrez	152067-075	1
	O-ring, low-swell Nitrile	152067-120	1
	O-ring, Neoprene	152067-116	1
	O-ring, FKM	152067-022	1
	O-ring, FKM V1289-75	152067-027	1

## A.3 Order spare parts

Provide the following information when ordering parts:

- Valve serial number
- Part number
- Part description
- Quantity



**Daniel Measurement and Control, Inc.**

11100 Brittmoore Park Drive  
Houston, TX 77041 USA  
T +1 713-467-6000  
F +1 713-827-4805  
USA Toll Free 1 888-356-9001

**Daniel Measurement Services, Inc.**

T +1 713-827-6413  
**www.Daniel.com**

**Europe: Stirling, Scotland, UK**

T +44-1786-433400

**Middle East Africa: Dubai, UAE**

T +971-4-811-8100

**Asia Pacific: Singapore**

T +65-677-8211

©2015 Daniel Measurement and Control, Inc. All rights reserved.

The Emerson logo is a trademark and service mark of Emerson Electric Co. Daniel Measurement and Control, Inc., and Daniel Measurement Services, Inc., (Daniel) are Emerson Process Management business units. The Daniel name and logo are trademarks of Daniel Industries, Inc. The Senior, Junior, Simplex, MeterLink, SeniorSonic, JuniorSonic, and DanPac are trademarks of Daniel Industries, Inc. All other trademarks are property of their respective owners.

