The Public Utilities Commission of Ohio

Public Utilities Commission of Ohio
Service Monitoring and Enforcement Department
180 East Broad Street, 7th Floor
Columbus, OH 43215

Pipeline Failure Investigation Report – Short Form

Operator: **Columbia Gas of Ohio** Date of Occurrence: **October 1, 2020**

Location: **Kitts Hill Road Regulator Station (N38.56087 / W082.56420) - Premise #406042**

Incident Criteria			
Deaths -	Names and Ages -		
Injuries -	Names and Ages -		
Estimated Property Damage -	Type **Natural Gas - Maximum Allowable Operating Pressure (MAOP) Excursion**		
Estimated Gas Lost (MMCF) -	Report to NRC at 800-424-8802? ☒ Yes ☐ No	NRC Report # **1288732 (48 hr.) - Reported by Rob Smith**	

Justification for use of Short Form

☐ Event involved a release of gas from piping not regulated under the Pipeline Safety Regulations (non-jurisdictional)

☐ Event does not meet the definition of Incident in 49 CFR 191.3 (non-reportable)

☐ Event meets the definition of Incident but did not result in a death, injury requiring in-patient hospitalization, or property damage in excess of $50,000 not including damage to the operator's gas infrastructure (non-significant)

☐ Event involved a release from a Gas Gathering pipeline regulated under the Ohio Administrative Code 4905.911

☒ Other: **MAOP Excursion (Overpressure)**

Describe Event

Background

Columbia Gas of Ohio, Inc. (Columbia Gas) provides natural gas service to more than 1.38 million customers through 20,147 miles of pipeline. Columbia Gas is a natural gas company subject to the jurisdiction of the Public Utilities Commission of Ohio (PUCO) under Title 49 of the Ohio Revised Code and rules adopted by the PUCO in the Ohio Administrative Code.

Summary

On Thursday, October 1, 2020 around 1:46am Eastern Standard Time (EST), a set of 2" Fisher E-Body regulators (monitor and control) with 657 Actuators and Ametek Pressure Controllers located at Kitts Hill, Ohio, lost inlet supply pressure, causing both regulators to fail in the open position and over-pressure a high pressure distribution system. The town border station was owned and operated by Columbia Gas of Ohio (COH) and the regulator station was called Kitts Hill / Gore Hill station (Premise #406042). The high pressure distribution system had a 175 pounds per square inch gage (psig) maximum allow operating pressure (MAOP). The MAOP excursion caused the high pressure distribution system to reach a pressure of 420 psig. This high pressure distribution system had 105 customers and also fed a medium pressure district regulator station. This MAOP excusion did not cause any explosions, fires or injuries, but the high pressure distribution system did exceed the design pressure of the pipeline components.

The previous day, Wednesday, September 30, 2020, construction work was performed at the Kitts Hill regulator station by Columbia Gas Transmission and COH. A temporary pipeline was installed to feed the Kitts Hill regulator station, so Columbia Gas Transmission could remove an older pipeline called R-673. The temporary pipeline started feeding the Kitts Hill regulator station and the short section of the R-673 pipeline was removed and the valve was turned to the closed position. COH had two Measurement and Regulator (M&R) technicans working the by-pass during the construction and checking the station. When the temporary piping started feeding the regulator station and a short section of R673 was removed, the two M&R technicans took the station off of by-pass and let the station start feeding again into the high pressure distribution system.

The two M&R technicans reviewed the piping and the downstream pressure for approximately 90 minutes and left the station around 12:00 – 12:30 pm EST.

The two COH M&R technicans did not notice the inlet supply to the Fisher E-body regulators was located on the deactivated section of pipe. This deactivated section still had some residual gas pressure, which allowed the regulators to still feed the pressure control located on each of the regulators. This regulator configuration uses pressure from the inlet piping and outlet piping to operate the regulator. The gas started seeping out of the deactivated pipeline, approximately 13 hours later, the pressure had dropped enough to prevent the regulators from operating properly which caused the regulators to fail in the open position. The cause of this MAOP excursion was human-error by the COH M&R Technician. A timeline of events is below:

On Thursday, September 30, 2020 Columbia Gas Transmission was removing a tap to Kitts Hill regulator station from R673 pipeline and supplying a temporary feed from R672 pipeline. The R673 pipeline receives a feed from R501 pipeline and the R672 pipeline receives a feed from R601 pipeline. The R501 pipeline is in a common corridor with R601 pipeline and both of these pipelines can supply a feed to the Kitts Hill regulator station (refer to Appendix A – Diagram drawing of station piping). The R501 and R601 pipelines are both 20" in diameter with a common 900 psig MAOP. The R501 pipeline will be removed from service at the end of calendar year 2020 and is being replaced with a new pipeline called R801. In future, the Kitts Hill regulator station will only have one feed from R672 pipeline. Columbia Gas Transmission contracted APEX to install a temporary pipeline feed to the Kitts Hill regulator station and isolate the valve on R673 pipeline and remove a section of piping from R673 pipeline.

COH had two M&R employees running the regulator station on by-pass and watching the downstream pressure during Columbia Gas Transmission's construction. One of the M&R employees had 32 years of experience in operating natural gas regulators and the other employee recently transferred to the M&R position and had 11 months of experience in regulators (gas pressure regulator is used to reduce a supply (or inlet) pressure to a lower outlet pressure and work to maintain this outlet pressure despite fluctuations in the inlet pressure. The reduction of the inlet pressure to a lower outlet pressure is the key characteristic of pressure regulators. Some of the components to consider in a regulator are the springs, casing pressure rating, body outlet rating, orifice rating and size, and the diaphragm). The control and monitor (overpressure protection) regulators installed at the Kitts Hill regulator station were 2-inch Fisher E-body with 657 Direct Actuators and Ametek model 40 pressure controllers. The Ametek controller is a pneumatic indicating pressure controller with four different lines. One line is for the inlet supply to the pressure controller; one line is the variable control line (downstream sensing line); one line is the output supply line (supplies feed to the top of the 657 Actuators) and the other line is a vent line, which terminates outside (Ametek controllers purge a small amount of gas to atmosphere). Once the COH M&R employees were able to stabilize the downstream pressure, the inlet and outlet valves to the regulator station were operated to the closed position. The M&R technician purged the natural gas out of the regulator station between the two closed valves and removed the bolts from the ell located downstream of the inlet valve and upstream of the monitor regulator. This would allow for the temporary supply feed to be connected to the regulator station. A blind-flange was installed on the inlet valve to the regulator station and the temporary supply line installed with a flange to the monitor regulator (refer to Appendix B – photo with description regulator station). Once the temporary feed was connected, the M&R technician purged the air from the regulator station with natural gas by slowly opening the downstream valve. This downstream pressure allowed the station piping and the temporary feed line to be leak checked. The temporary supply feed was energized to the regulator station, which allowed the regulators to supply gas to the downstream high-pressure distribution system. The by-pass valve was turned to the closed position. Columbia Gas Transmission shut the valve for R673 and separated some of the below ground piping and a small portion of the above ground piping (refer to Appendix C – Photo of temporary piping and removed piping). The COH M&R technicians watched the station feed for the next 90 minutes and checked to make sure the pressure was correct. The M&R technicians documented on station piping paperwork, what sections of piping were removed, the operations of the regulator station and the time (refer to Appendix D – Station documentation log). The M&R technicians cleared the regulator station around 12:30pm EST.

On Thursday, October 1, 2020 around 1:46am EST, COH Gas Control SCADA received a high alarm from an electronic pressure recorder at the Kitts Hill regulator station. The pressure was around 143 psig on the high-pressure distribution system piping. The high / high alarm activated at 1:58am EST with a pressure of 176 psig. A COH employee arrived on scene around 2:33am EST and verified the downstream pressure reached 420 psig (refer to Appendix R – COH Timeline). The Kitts Hill regulator station piping was isolated from the downstream high-pressure distribution system. COH started purging the high-pressure

distribution system piping at 2:50am EST. The natural gas pressure was fully purged from the high-pressure distribution system at 7:07am EST.

The National Response Center was contacted at 7:33am EST and Public Utilities Commission of Ohio was notified, and Staff was dispatched at 7:55am EST. Staff arrived on the scene at 10:05am EST (GPS Coordinates: N38.56087 / W082.56420). The investigation revealed the inlet supply taps to the Ametek pneumatic pressure controller were located on the deactivated section of pipe. The residual gas still in the pipe from the day prior, seeped from the pipeline, which caused the pressure control to lose inlet supply pressure and caused the control and monitor regulators to fail open. The failed open regulators allowed the inlet pressure to flow downstream into the high-pressure distribution system. The inlet supply lines to the Ametek controller were located about 6-inches upstream of the by-pass valve on the same horizontal run (refer to Appendix B – photo with description regulator station). Staff performed a face to face interview with the two COH M&R technicians and one of the M&R technicians was Operator Qualified to work on pressure controlled regulators and the other M&R technician was still in training and was not qualified to work on pressure controlled regulators. The qualified M&R technician stated he did not recognize the location of the inlet supply lines feeding the Ametek pressure controller. Staff asked the qualified M&R technician if they used a work plan or a checklist, prior to putting the regulator station back in service and M&R technician said, they did not have a work plan or checklist for this job.

Conclusion and Recommendations:

Conclusion: The Columbia Gas of Ohio Measurement and Regulator (M&R) Technician did not recognize the location of the inlet supply lines, which feed the pressure controllers (part of monitor and control regulators). The inlet supply lines were located on a deactivated pipeline. The residual natural gas pressure in the deactivated pipeline seeped out, causing the monitor and control regulators to fail in the open position. This caused the inlet transmission line pressure to feed into the high pressure distribution system. This maximum allowable operating pressure excursion was caused by human-error.

Recommendations:

1. Columbia Gas of Ohio must have a work plan and job checklist when activating natural gas pipelines and M&R stations.

2. Columbia Gas of Ohio must have two operator qualified individuals performing work at each regulator station.

3. Columbia Gas of Ohio must conduct a pre-job meeting to discuss an overview of the job prior to the work taking place at each job site.

Appendices(s) / Attachments

A. Diagram drawing station piping

B. Photo of regulator station inside piping

C. Photo of outside piping

D. Copy of regulator station log

E. NRC Report (48 hr.)

F. Manual for Ametek Model 40 (Pneumatic Controller)

G. Manual for Fisher 657 Direct Actuator

H. Manual for Fisher E-Body

I. Columbia Gas Transmission Written Statements

J. Columbia Gas of Ohio Written Statements

K. Map of System - Kitts Hill

L. Pipe Design and Pressure Test

M. COH's Procedure - Startup / Shutdown of Regulator Stations

N. 3 Years of Inspections for Kitts Hill Station

O. Components in System Exceeding Pressure Design

P. COH Communication with Columbia Gas Transmission

Q. Schematic of Kitts Hill Station

R. COH Timeline

S. Desription 1st Cut Service Regulators Each House

T. Procedures for Establishing Work Plan

U. Mr. Haaser (M&R Tech.) OQ

V. COH's D/A Plan

W. Analog Recorder with Pressures at Time of Failure

X. Hourly Weather Chart - Day MAOP Excursion

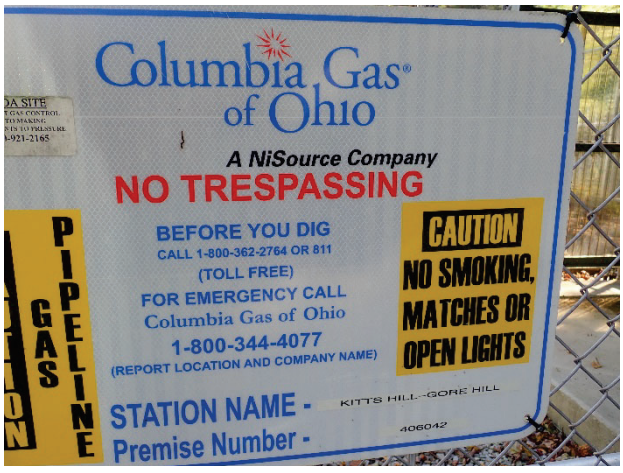
Y. Mr. Harper (M&R Tech) OQ

Z. Regulator Inspection Procedure

Attachments/Pictures (if any)

- **Additional Photos (Attachment – Photos 10-1-2020)**

View of Photos



Kitts Hill / Gore Hill Town Border

Public Utilities Commission of Ohio
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Inside Station Piping

Inside Station View

View of Monitor Regulator

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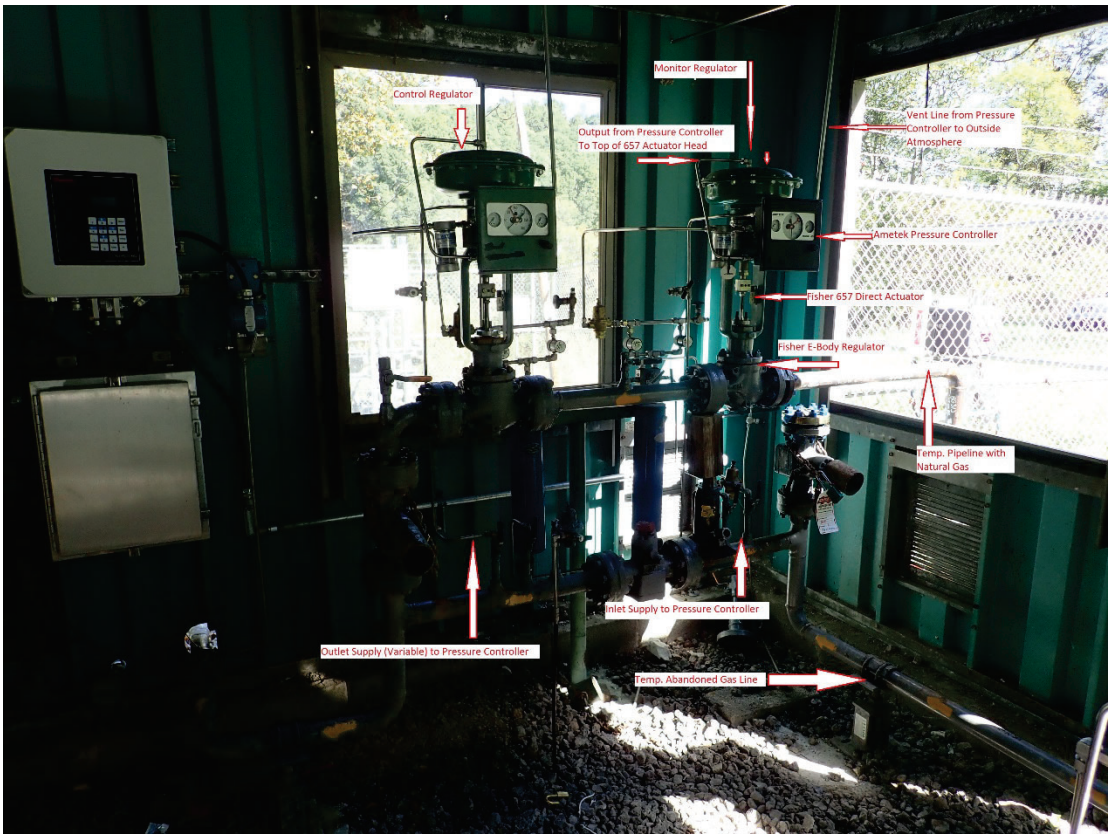
View of Heater (location inside building)



Detail Description Station

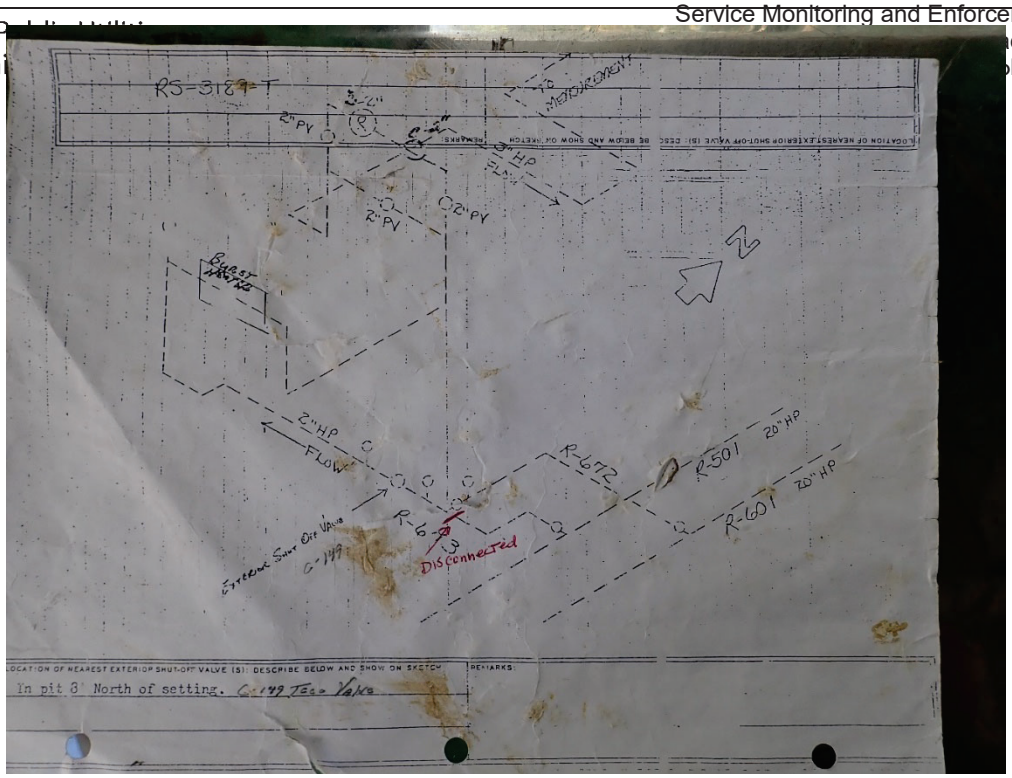
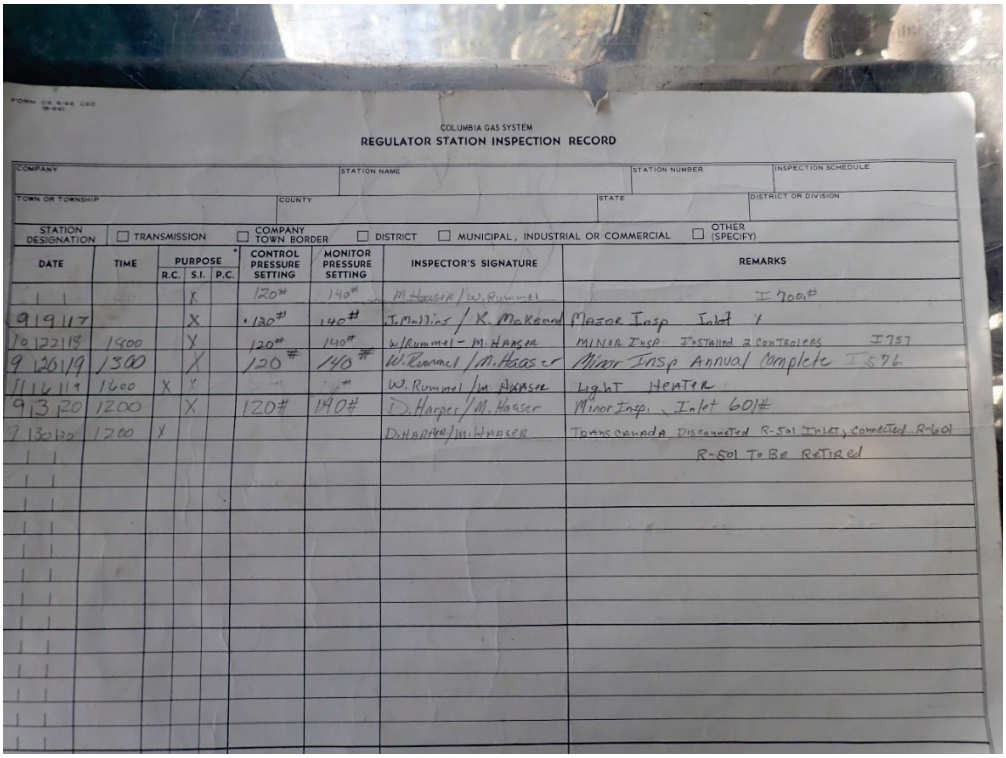


Diagram of Station



COLUMBIA GAS SYSTEM
REGULATOR STATION INSPECTION RECORD

COMPANY | STATION NAME | STATION NUMBER | INSPECTION SCHEDULE
TOWN OR TOWNSHIP | COUNTY | STATE | DISTRICT OR DIVISION
STATION DESIGNATION ☐ TRANSMISSION ☐ COMPANY TOWN BORDER ☐ DISTRICT ☐ MUNICIPAL, INDUSTRIAL OR COMMERCIAL ☐ OTHER (SPECIFY)

DATE	TIME	PURPOSE R.C.	PURPOSE S.I.	PURPOSE P.C.	CONTROL PRESSURE SETTING	MONITOR PRESSURE SETTING	INSPECTOR'S SIGNATURE	REMARKS
			X		120#	140#	M Hauser / W. Rummel	I 700#
9 19 17			X		120#	140#	J. Mullins / K. McKeand	Major Insp Inlet 1
10 12 18	1400		X		120#	140#	W/Rummel - M. Hauser	MINOR Insp Installed 2 Controlers I 757
9 26 19	1300		X		120#	140#	W. Rummel / M. Hauser	Minor Insp Annual Complete I 576
11 6 19	1600	X	X				W. Rummel / M. Hauser	Light Heater
9 13 20	1200		X		120#	140#	D. Harper / M. Hauser	Minor Insp. Inlet 601#
7 13 20	1200	X					D. Harper / M. Hauser	Transducer Disconnected R-501 Inlet, Connected R-601 R-501 To Be Retired

Regulator Inspection Log

The Public Utilities
Commission of Ohio

Public Utilities Commission of Ohio
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180 East Broad Street, 7th Floor
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Outside View of Station

Work Performed Outside of Station with Temporary Feed

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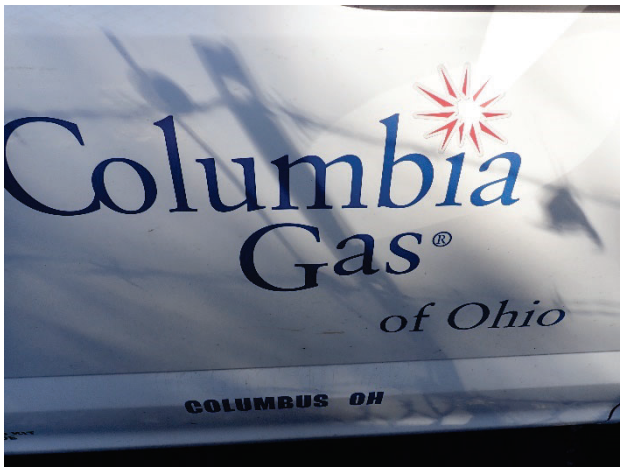
APEX – Contractor for Columbia Gas Transmission (Installation Temporary By-Pass / Removal R673)

Columbia Gas Transmission – Construction

View of Temporary Feed from R601

Distance View of Outside Area



View of Columbia Gas of Ohio Logo – M&R Truck

Areas Affected – MAOP Excursion – 1st Cut Regulator to 4906 St. Rt. 141

View of Piping Affected MAOP Excursion- Medium Pressure Regulator Station

Another View Piping Affected MAOP Excursion (School Downstream of Medium Pressure Regulator Station Piping)

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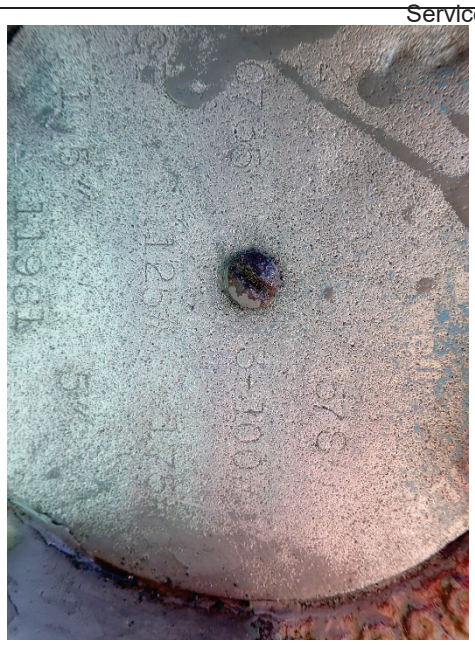
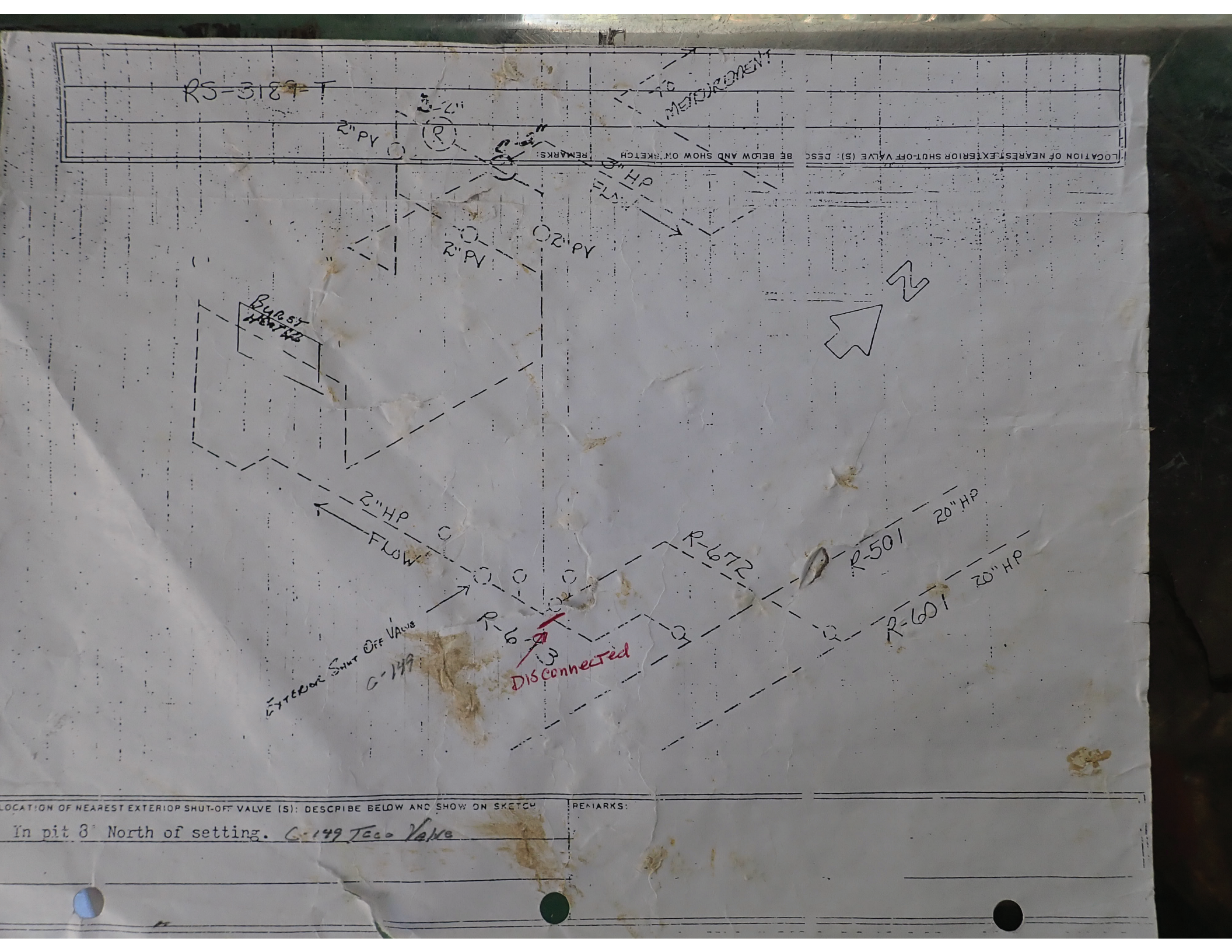


Pressure Rating Plate – Medium Pressure Regulator Station

View of Flange Design – Medium Pressure Regulator Station (ANSI 150) – Affected MAOP Excursion

Investigator: **Michael F. Purcell II** Date: **November 2, 2020**



LOCATION OF NEAREST EXTERIOR SHUT-OFF VALVE (S): DESCRIBE BELOW AND SHOW ON SKETCH

In pit 8' North of setting. C-149 Teco Valve

REMARKS:


Monitor Regulator
Control Regulator
Vent Line from Pressure Controller to Outside Atmosphere
Output from Pressure Controller To Top of 657 Actuator Head
Ametek Pressure Controller
Fisher 657 Direct Actuator
Fisher E-Body Regulator
Temp. Pipeline with Natural Gas
Inlet Supply to Pressure Controller
Outlet Supply (Variable) to Pressure Controller
Temp. Abandoned Gas Line


Temporary Piping
Existing Piping
Existing piping from R672
Removed Piping from R673
CAUTION
CAUTION
CAUTION

FORM CS 6-66 CSD (6-66)

COLUMBIA GAS SYSTEM

REGULATOR STATION INSPECTION RECORD

COMPANY	STATION NAME	STATION NUMBER	INSPECTION SCHEDULE

TOWN OR TOWNSHIP	COUNTY	STATE	DISTRICT OR DIVISION

STATION DESIGNATION ☐ TRANSMISSION ☐ COMPANY TOWN BORDER ☐ DISTRICT ☐ MUNICIPAL, INDUSTRIAL OR COMMERCIAL ☐ OTHER (SPECIFY)

DATE	TIME	PURPOSE * R.C.	S.I.	P.C.	CONTROL PRESSURE SETTING	MONITOR PRESSURE SETTING	INSPECTOR'S SIGNATURE	REMARKS
/ /			X		120#	140#	M. Haaser / W. Rummel	I 700.#
9/9/17			X		120#	140#	J. Mullins / K. McKeand	Major Insp Inlet 1
10/22/18	1600		X		120#	140#	W/Rummel - M. Haaser	MINOR INSP. INSTALLED 2 CONTROLERS I757
9/26/19	1300		X		120#	140#	W. Rummel / M. Haaser	Minor Insp Annual Complete I 576.
11/6/19	1600	X	X			#	W. Rummel / M. Haaser	Light Heater
9/3/20	1200		X		120#	140#	D. Harper / M. Haaser	Minor Insp. Inlet 601#
7/30/20	1200	X					D. HARPER / M. HAASER	TRANSCANADA DISCONNECTED R-501 INLET, CONNECTED R-601 R-501 TO BE RETIRED
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FORM CS 6-66 CSD
(8-66)

COLUMBIA GAS SYSTEM

REGULATOR STATION INSPECTION RECORD

COMPANY	STATION NAME	STATION NUMBER	INSPECTION SCHEDULE
COH	Kitts Hill Gore Hill	R53189-T	Annual

TOWN OR TOWNSHIP	COUNTY	STATE	DISTRICT OR DIVISION
Kitts Hill	Lawrence	Ohio	

STATION DESIGNATION ☐ TRANSMISSION ☒ COMPANY TOWN BORDER ☐ DISTRICT ☐ MUNICIPAL, INDUSTRIAL OR COMMERCIAL ☐ OTHER (SPECIFY)

DATE	TIME	PURPOSE * R.C.	S.I.	P.C.	CONTROL PRESSURE SETTING	MONITOR PRESSURE SETTING	INSPECTOR'S SIGNATURE	REMARKS
10 24 06	9 45 Am			X	110#	125#	James Bond	Raised Pressure
10 24 06	1 30 Pm						Lyndy Bond	Lit Heaters
2 15 07	6:45 Am			Y			J. Bond & Johnson	Ok 670 & 110
5 14 07	10 30 Am			X	100#	125#	James Bond	Lowered Pressure and Turned Heaters After Lyndy Lyndy
7 27 07	1 45 Pm		X		100#	125#	James Bond	Annual Insp.
11 13 07	10 00 Am			Y	120#	150#	James Bond	Raised Pressure
4 13 08	8 45 Am			X	90#	125#	James Bond	Lowered Pressure
7 22 08	9 30 Am		X		100.0	125#	James Bond	Annual Insp.
10 16 08	12 30 Pm			Y	120.0	140#	James Bond	Raised Pressure
7 13 09	12 00 Pm		X		100.0	125.0#	James Bond	Annual Insp.
10 13 09	12 15 Pm			X	120.0	135.0	James Bond	Raised Pressure
7 27 10	10 00 AM		X		100.0	120.0	James Bond	Annual Insp. Minor
11 24 10	9 15 Am			X	125#	150#	James Bond	Raised Pressure
9 16 11	1:00 Pm		X		120#	140#	J. Bond J. Mullins	Annual Insp Minor
5 17 12	3:00 Pm			X	105.0	140#	James Bond	Lowered Pressure
10 4 12	5:00 Pm		X		110#	125#	J. Bond J. Mullins	Annual Insp. Major
8 20 13	11:30 Am		X		100.00	125#	J. Bond J. Mullins	Annual Insp. Minor
11 12 13	9:00 Am			X	120.#	140.#	James Bond	Raised Pressure
8 27 14	10:30 Am		X		120#	140#	J. Bond J. Mullins	Annual Insp. Minor
8 11 15	9:30 Am		X		120#	140#	J. Bond J. Mullins	Annual Reg Insp. Minor
8 12 16	10:00 AM				120#	140#	J. Bond J. Mullins	Annual Reg Insp. Minor
7 5 17	10 AM			V	—	—	W. Rummell	Station out of Service H.P. Back Feed
7 5 17							Via SR 141 HP to MP Cut @ 39.8#	
7 7 17	11:30 AM	V			120#	—	C. Pinson	Returned to Service Lock up Good on Both.

* R.C. – ROUTINE CHECK S.I. – SCHEDULE INSPECTION P.C. – PRESSURE CHANGE

U.S. Department of Transportation
Pipeline and Hazardous Materials Safety Administration

National Response Center Incident Report # 1288927
INC

GOVERNMENT USE ONLY
Information released to a third party shall comply with any applicable federal and/or state Freedom of Information and Privacy Laws.This is the summary NRC report. Further information about this report can be obtained at http://www.nrc.uscg.mil/

Incident Description

Report taken by:	NCT7613
At:	10:36
On:	10/03/2020
Incident Type:	PIPELINE
Incident Cause:	OVER PRESSURING
Affected Area:	
Incident:	DISCOVERED on 10/01/2020 local incident time.
Affected Medium:	NON-RELEASE (N/A) , POSSIBLE AIR RELEASE
Offshore:	N

Reporting Party

Name:	ROB SMITH
Organization:	COLUMBIA GAS OF OHIO
Address:	3550 JOHNNY APPLESEED CT COLUMBUS OH 43231 , , , COLUMBUS ,OH 43231
Primary Phone:	6144191096
Second Phone:	
Type of Organization:	PUBLIC UTILITY

Suspected Responsible Party

Name:	ROB SMITH
Organization:	COLUMBIA GAS OF OHIO
Address:	3550 JOHNNY APPLESEED CT , , , COLUMBUS ,OH43231
Primary Phone:	6144191096
Second Phone:	
Type of Organization:	PUBLIC UTILITY

Incident Location

Incident Location:	
Address:	8358 STATE ROUTE
Streets:	
County:	LAWRENCE
Nearest City:	KITTS HILL
State:	OH
Zip:	
Subdivision:	
Distance from city:	
Latitude:	
Longitude:	
Section:	
Township:	
Range:	

Released Material

Chris Code:	ONG
Official Material Name:	NATURAL GAS
Quantity Released:	0 UNKNOWN AMOUNT
Quantity in Water:	

Description of Incident

//////THIS IS A 48 HOUR UPDATE FOR NRC REPORT 1288732./////// UPDATED INFO: - CALLER DOES NOT HAVE AN UPDATE TO MAKE OTHER THAN THERE HAS STILL NOT BEEN A RELEASE. NO CHANGES FROM THE ORIGINAL REPORT. THERE ARE STILL 105 CUSTOMERS WITHOUT GAS SERVICE. ORIGINAL REPORT: CALLER IS REPORTING THE POTENTIAL RELEASE OF AN UNKNOWN AMOUNT OF NATURAL GAS FROM A 3 INCH DISTRIBUTION PIPELINE. THE CALLER STATED THAT THERE IS A NATURAL GAS

OUTAGE OF 105 CUSTOMERS THAT HAVE BEEN AFFECTED. CALLER STATED THAT CODE 191.3 (DEFINITION OF INCIDENT) IS THE REASON FOR REPORTING THE POTENTIAL RELEASE AND THE OVER PRESSURING.

Sensitive Information

Incident Details - PIPELINE

Pipeline Type:	DISTRIBUTION
DOT Regulated:	Y
Pipeline Above/Below Ground:	BELOW
Exposed or Under Water:	N
Pipeline Covered:	U

Sheen Size:	
Sheen Length:	
Sheen Width:	
Sheen Color:	
Direction of Sheen Travel:	
Sheen Odor Description:	
Body of Water:	
Tributary of:	
Nearest River Mile Marker:	
Water Supply Contaminated:	U

Impacts

INVESTIGATION IS STILL UNDERWAY.

Fire Involved:	N	Fire Extinguished:	U
Injuries:	N	Number of Injuries:	
Number Hospitalized:			
Fatalities:	N	Number of Fatalities:	
Evacuations:	N	Number Evacuated:	
Who evacuated:		Radius/Area:	
Damages:	N	Damage Amount:	
Waterway Closure:	N		
Air Closure:	N		
Road Closure:	N		
Major Artery:	N		
Direction of Road Closure:			
Rail Track Closure:	N		
Direction of Track Closure:			
Track Milepost:			
Media Interest:	NONE		
Environmental Impact:	U		
Community Impact due to Material:			

Remedial Actions

INVESTIGATION IS STILL UNDERWAY.

Released Secured:	U
Release Rate:	
Estimated Release Duration:	

Weather

Weather Condition:	
Air temperature:	
Wind Speed:	
Wind Direction:	
Wave Condition:	
Current Speed:	
Current Direction:	
Water Temperature:	

Additional Agencies Notified

Federal Agency Notified:
State Agency Notified:
State/local on Scene: PUCO
State Agency Number:

Additional Information

//////THIS IS A 48 HOUR UPDATE FOR NRC REPORT 1288732./////// CALLER STATES THE SITUATION IS DEEMED SAFE AND THERE IS NO GAS BLOWING.

Notification by NRC

Organization	Sub Organization	Date Time Sent	E-mail	Phone
CENTERS FOR DISEASE CONTROL	GRASP	10/03/2020 10:43	eocgis@cdc.gov	(770) 4887100

END INCIDENT REPORT 1288927

PNEUMATIC CONTROLLERS AND TRANSMITTERS

Model 40 Pneumatic Indicating Controllers

DESCRIPTION

Model 40 Pneumatic Controllers automatically position a valve or other final control element to maintain process pressure at the desired set point. As receiving controllers, they can control any process variable transmitted as a pneumatic signal.

Standard models have proportional band adjustments for controlling processes where load changes are infrequent and can be corrected by the manual reset feature, standard in every controller. By a simple screwdriver adjustment, the standard proportional controller can be changed to two-position control action with adjustable differential gap.

Model 40 controllers are available with control modes of 100% proportional, 200% proportionaly, 200% proportional plus reset and 300% proportional plus reset plus rate (PID) for processes with frequent load changes and 75% proportional (positioner only). They not only satisfy ordinary control requirements, but are equally proficient in controlling processes with unfavorable characteristics.

The basic instrument is also available as an indicating pneumatic transmitter. Mounted close to the point of measurement, it transmits an air pressure signal proportional to the measured variable to another indicator, recorder or controller.

Model 40
Pneumatic Controllers

FEATURES

- Quality, flexibility, accuracy and dependability
- Indication of measured variable
- A non-bleed, high-capacity relay with excellent stability and fast response
- Easy field calibration
- Broad selection of control modes; proportional plus reset, proportional plus reset plus rate, differential gap and two position bypass
- Wide selection of process measuring elements for pressure, differential pressure, flow and level
- Large, easy-to-read black on white dial for maximum resolution
- Case and door with epoxy powdered finish for environmental protection
- Meets EPA NSPS OOOO (Quad-O) for bleed rate less than 6.0 scfh GO GREEN

SPECIFICATIONS

INDICATION ACCURACY: 1% middle half of scale, 1-1/2% remainder; most ranges may be calibrated to 1/2% accuracy at nominal extra charge

SENSITIVITY: Less than 0.1% of full scale at 100% proportional band

FREQUENCY RESPONSE: Flat to 400 CPM with 200 feet of 1/4" tubing and 1.2 cubic inch capacity. Flat to 120 CPM with 18' 3/8" tubing and 200 cubic inch capacity

CONSTRUCTION: Moving parts are designed as light as possible to keep friction and inertia forces low, also resulting in higher resistance to vibration and shock

MOUNTING: Surface, flush panel, pipe-supported or valve-mounted; dimensions on page 8

AIR SUPPLY: 20 psi for 3-15 psi range; 35 psi for 3-27 and 6-30 psi range; 65 psi for 12-60 psi range.

A filter and dripwell are recommended ahead of each controller to ensure clean, dry air supply; may be operated on natural gas or bottled CO_2

CONNECTIONS: Standard back connections are 1/4" female NPT

MEASURING ELEMENTS: A wide range of precalibration measuring elements for pressure available – consult factory

MODULAR CONSTRUCTION: Each of the following components may be removed without disturbing the other components: control chassis complete, precalibrated elements, feedback assemblies, complete relay units, or supply gauge only, nozzle feed orifice and cleaner assembly only, relay diaphragm housing and valve stem only, output gauge and tubing only

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PNEUMATIC CONTROLLERS AND TRANSMITTERS

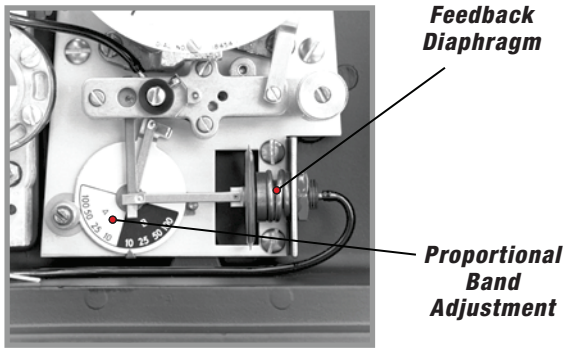
Model 40 Pneumatic Indicating Controllers

Guide to Controller Selection

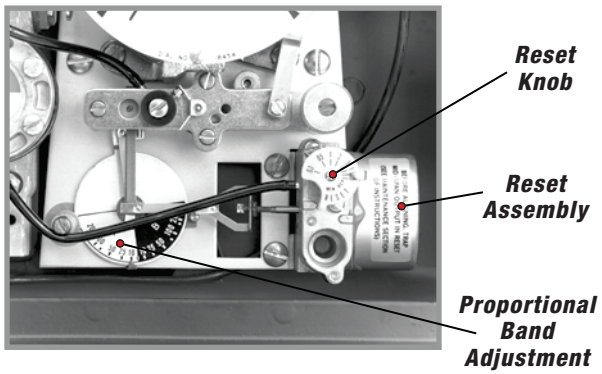
Type Of Process Dynamics	Description	Examples	Control Required
Capacity Lag Large Tank	Found when there is an appreciable inventory or storage of the controlled medium	Level control in process retention tanks; batch heating	On-Off differential gap
Transfer Lag	Found when it is necessary to force corrective action through a resistive element before it affects the process	—	Proportional plus rate plus reset
Instantaneous Response	Found when the manipulated variable is the same as the controlled variable or if they are dynamically equal	Flow control, pressure control or liquids in pipelines or other vessels completely filled with the liquid	Proportional plus reset
Velocity/Distance Lag	Found when the measuring device is downstream of the point of corrective action; equals the separating distance ÷ the stream velocity	Any process control requiring reaction time before measurement or any analytical variable control loop where the sampling system produces dead time	Proportional plus slow reset (do not use rate); eliminate dead time if possible

CONTROL ACTIONS

Proportional Control: This action provides an output signal proportional to the measured variable. Standard output pressure for controllers is 3-15 psi with proportional band adjustment of 1 to 100%. Band widths to 200% are also available. Outputs of 6-30 psi and 3-27 psi are optional. An index on the chassis plate of the controller permits precise setting of band widths. Proportional control alone is ideal for process pressure regulation service (upstream) or relief service (downstream). Standard proportional controllers are recommended for most batch processes and a great many continuous processes where load changes are small or infrequent.



Proportional Plus Reset Action: When load changes are large or frequent and the process will not tolerate quick or drastic changes in control action, automatic reset is desirable to avoid excessive offset from the desired value under wideband proportional control. The feedback diaphragm on the standard proportional controllers is replaced with a reset assembly. A standard reset needle valve offers a wide range of settings from 0.03 to 5.0 minutes per repeat (optional 0.03 to 0.5 minutes repeat available).



Differential Gap Action: This is a two-position control mode standard in all Model 40 Proportional Controllers. The output pressure of the controller remains at maximum (20 psi standard) or minimum (0 psi) until the controlled measurement crosses a band or gap, causing the output pressure to reverse. The measured variable must then span the gap in the opposite direction before the output signal is restored to the original condition. Differential gap action is useful in controlling pumps and compressors to prevent excessive on-off cycling. Several controllers set in sequence with overlapping bands may be used for cutting in several stages of a process successively and cutting them out in reverse order. Gap may be adjusted over the full range of the proportional band.

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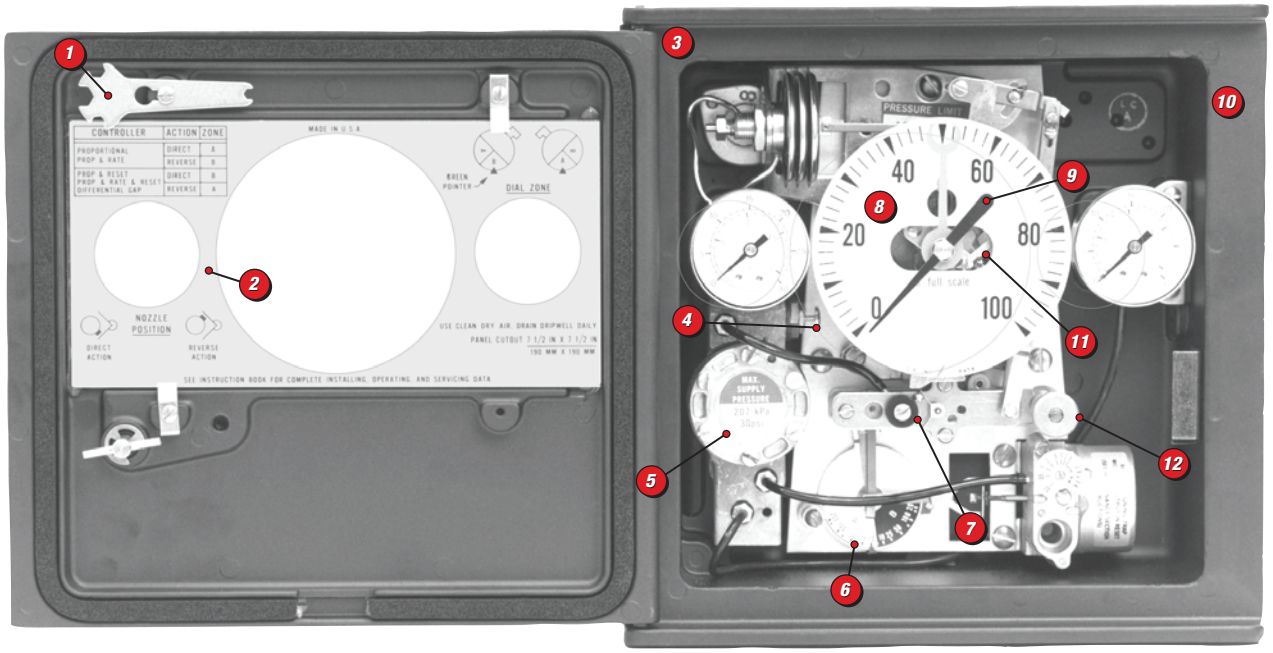
PNEUMATIC CONTROLLERS AND TRANSMITTERS

Model 40 Pneumatic Indicating Controllers

FEATURES

1. **ADJUSTING WRENCH** – 1/4" x 1/8" stored on door can be used for all necessary adjustments on movement, pointers and nozzle.
2. **SHROUD** – Anodized aluminum shroud brightens dial area for greater visibility under adverse lighting conditions.
3. **FINISH** – Die-cast aluminum with semi-flat black powdered epoxy finish.
4. **ORIFICE** – Sapphire 0.008" bore with integral push-button cleaner.
5. **RELAYS** – Non-bleed, high capacity relay is standard on all controllers. Bleed rate of less than 0.1 SCFM at 9 psi output and the capacity to deliver over 3.0 SCFM result in an exceptionally stable, fast responding controller. May be easily dismantled for cleaning without disturbing factory-set adjustments. Anodizing is available for maximizing corrosion resistance.
6. **PROPORTIONAL BAND ADJUSTMENT** – Adjustable by screwdriver within 90 degree quadrant indicated on dial. For available band widths and control options, consult factory.
7. **NOZZLE** – Specifically designed for increased stability of pneumatic circuit; nickel silver nozzle can be turned on turret to reverse control action; 0.018" bore.
8. **DIAL** – Large, easy-to-read black on white dial face with full 7" scale for maximum resolution.
9. **PROCESS INDICATIONS** – Black adjustable pointer on 3-1/2" precision gauge dial (7" scale length). Readily adjusted to compensate for hydrostatic heads in piping.
10. **CASE** – Cast aluminum with dust ledge and deep weatherproof gaskets, captive stainless hinge pins and latch shaft, and rectangular glass. Optional gas-tight construction with case tapped for 1/2" pipe vent. For high-pressure applications, shatter-proof glass and blowout grommets are available. Anodizing is available for maximizing corrosion resistance.
11. **MOVEMENT** – Micrometer range adjustment plus adjustable sector and link for scale-shape calibration of both indicating and set point mechanisms provides easy field calibration.
12. **SET-POINT ADJUST** – Internal or external available.



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PNEUMATIC CONTROLLERS AND TRANSMITTERS

Model 40 Pneumatic Transmitters

DESCRIPTION

The Model 40 Pneumatic Transmitter is designed to sense pressure and transmit an air signal which is precisely proportional to the measured variable. This output signal from the transmitter may be fed to any remotely located monitoring, recording or control instrument.

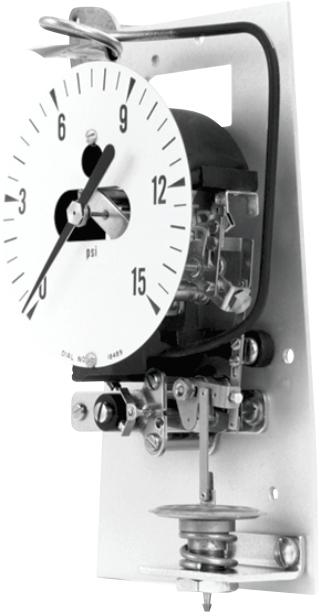
Model 40 pneumatic transmitters insure increased safety by eliminating the need for piping high-pressure, toxic, corrosive, inflammable or other dangerous fluids or gases through the plant.

Model 40 transmitters provide an added convenience, in that operation of a single transmitter with its high capacity relay can be used to actuate a number of receivers for indication, recording or control at a number of points throughout a plant. Also, transmitters measuring many different variables provide standard 3-15 psi output signals, thereby reducing all variables to common readout devices and simplifying centralized panelboards and control stations.

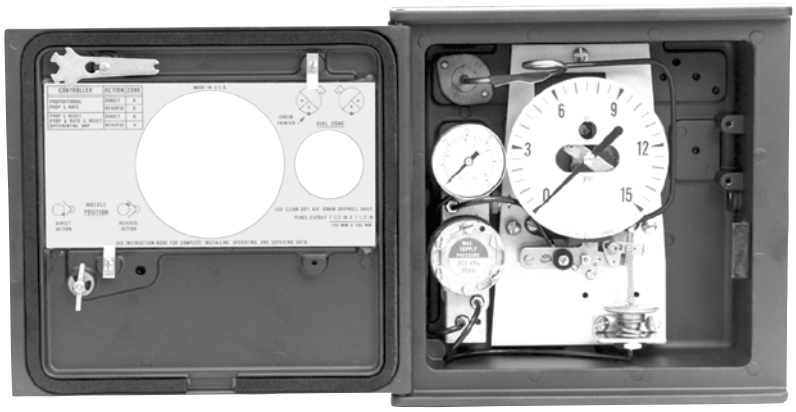
Model 40 transmitters are designed, in physical appearance, to match the Indicating Pneumatic Controllers.

FEATURES

- Reliability – highly essential, since a transmitter must operate for extended periods in inaccessible places without attention
- Sensitivity and freedom from deadband – an absolute requirement, since the transmitter constitutes the first instrument in the control loop
- High accuracy and repeatability – mandatory for consistency and control stability
- Measuring elements – ranges and materials are same as those for indicating controllers, however, the element assemblies are not interchangeable between controllers and transmitters
- Stabilized pneumatic circuit – output signal is stabilized with all combinations of output capacity or load and transmission line resistance. Changes in air supply pressure to the transmitter have a negligible effect on the output
- Accuracy – measurement to output, within 1% of full scale on indicating transmitters; 0.5% on most ranges of indicating transmitters available at extra charge
- Feedback assembly – a diaphragm capsule of Ni-Span C provides precise follow-up to maintain exact transmitter calibration
- Air supply and output pressure – 20 psi supply pressure and an output pressure range of 3-15 psi are standard. A filter and drip-well are recommended ahead of each transmitter, to ensure a clean, dry air supply



Model 40 Pneumatic Transmitter



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PNEUMATIC CONTROLLERS AND TRANSMITTERS

Precalibrated Measuring Elements

PRESSURE

"C" Type Bourdon Tubes: Model 40 Pneumatic Controllers and Transmitters are furnished with precalibrated "C" type Bourdon tube measuring elements. The wide, powerful Bourdon tube is carefully drawn, coiled and heat-treated to ensure a precise measuring element, permanent in calibration, and having exceptional overrange capacity. Phosphor bronze tubes are soft-soldered into cast brass sockets. Stainless steel elements are inert gas welded to provide maximum corrosion resistance. Standard ranges are listed in Table 1.

Model 40 Pneumatic Controller

Table 1. Bourdon Tube Ranges/Materials

Element Range	Phosphor Bronze	316 SS
0-30" Hg VAC	✓	✓
0-13 to 0-17 psi	✓	✓
0-25 to 0-35	✓	✓
0-50 to 0-70	✓	✓
0-85 to 0-110	✓	✓
0-150 to 0-180	—	✓
0-190 to 0-230	✓	✓
0-250 to 0-350	✓	✓
0-350 to 0-450	—	✓
0-450 to 0-550	—	✓
0-550 to 0-700	—	✓
0-900 to 0-1200	—	✓
0-1200 to 0-1700	—	✓
0-1700 to 0-2300	—	✓
0-2300 to 0-3000	—	✓

✓ = *Available elements*
Compound ranges available. Consult your representative, or customer service at usg.sales@ametek.com

Differential Pressure Cell: The differential pressure element used in the Model 40 controller is available in ranges from 10" W.C. to 400 psid with static working pressure to 3000 psi. The basic unit incorporates a high and low pressure bellows connected to a center plate. When two different pressures are applied to the high and low side, the high pressure bellows contract, forcing the fill fluid through the center plate into the low pressure bellows which expand. The motion of the low pressure bellows is transmitted via a temperature compensated linkage to the instrument output shaft.

Consult factory for available ranges, bellows, housing materials, and static working pressure.

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PNEUMATIC CONTROLLERS AND TRANSMITTERS

Precalibrated Measuring Elements

PRESSURE

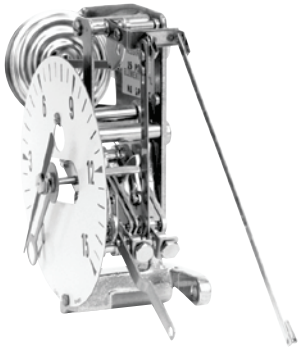
Diaphragm: Low pressure controllers and transmitters are offered with a standard diaphragm measuring element comprised of stacked capsules of Ni-Span C or stainless steel. Diaphragm capsules are made of contoured plates with nested corrugations and silver-brazed, or welded edges. They have a long working stroke, yet occupy minimum space. A sturdy element with large effective area, this design provides friction-free operation and precise indication. The constant thermal elastic characteristic of Ni-Span C practically eliminates thermal shift with wide variation in ambient temperatures. Welded type 316 stainless steel diaphragms are also offered for the ranges indicated in Table 3. Diaphragm elements are interchangeable with bourdon elements.

Table 3. Diaphragm Ranges/Materials

Element Range	NI-Span C	316 SS
0-50 to 0-60"	✓	✓
0-66 to 0-105"	✓	—
0-90 to 0-110"	—	✓
0-120 to 0-160"	—	✓
0-6 to 0-8 psi	—	✓
0-8 to 0-11 psi	—	✓
0-9 to 0-12 psi	✓	—
0-11 to 0-13.5 psi	—	✓
3-15 psi	✓	✓

✓ = *Available elements*

Low Pressure Controller



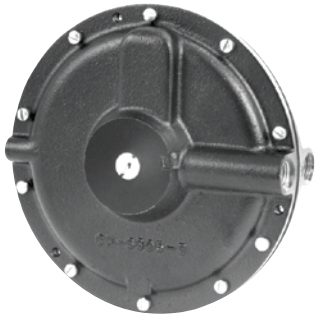
Slack Diaphragms: Extremely low gauge pressures are measured and controlled by molded BUNA-N slack diaphragm elements (Table 4) for measuring clean, dry air only.

Low differential pressures such as encountered in air flow and draft applications are measured by molded BUNA-N slack diaphragm elements. Elements are also used in extremely low compound pressure ranges and vacuum range transmitters and controllers. Differential measurements at static pressures as high as 15 psi can be made.

Table 4. Low Pressure Diaphragm Ranges

Range Inches H_2O	Pressure	Pressure Differential
0-4.5 to 0-8.4	✓	✓
0-8.5 to 14.5	✓	✓
0-14.6 to 0-24.9	✓	✓
0-25 to 0-43.9	✓	✓
0-44 to 0-80	✓	✓

✓ = *Available elements*
Center zero DP ranges are also available from 4.5/0/4.5 W.C. through 44/0/44 W.C.



Slack Diaphragm

for measuring clean, dry air only – for other media, see DP cell options

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PNEUMATIC CONTROLLERS AND TRANSMITTERS

Model 40 Controller-Pilot Positioner

DESCRIPTION

The Model 40 Controller-Pilot Positioner combines in one compact unit the functions of (a) – an indicating pneumatic controller for pressure, temperature or any pneumatically transmitted variable, and (b) – a valve positioner which amplifies air power to position a pneumatically operated control valve accurately and rapidly.

This instrument accurately positions the valve in response to changes in measured variables as small as 0.1% full scale. It ensures rapid valve response even through full travel and results in economies through use of smaller topworks. Instead of pneumatic feedback from valve stem position, the instrument employs mechanical feedback to the controller through a lever system. Thus the valve is forced to assume a precise position proportional to the controlled variable.

The unit includes a high-capacity, non-bleed relay providing more rapid and accurate positioning. By means of a unique valve stem take-off, the Controller-Pilot Positioner will actuate any diaphragm motor valve with stem travels from 3/8" to 4" in any combination of stem direction and air-to-open or air-to-close topworks. A rear mounting pad provides for the vertical location of the instrument on virtually all makes and sizes of diaphragm motor operators.

The standard Controller-Pilot Positioner operates on any air supply pressure from 20 psi to as high as 65 psi and is available with 1-75% proportional control or 1-75% differential gap action – with easy field reversibility.

It may be actuated by any of the measuring elements described on pages 5 and 6 (except slack diaphragms or DP cells), or it may be used as a pneumatic received in conjunction with a distantly located Indicating Pneumatic Transmitter.

FEATURES

There are several advantages to the Controller-Pilot Positioner over two separate units:

- It is located close to the process and directly on the valve for fast, accurate response
- It needs only one air supply and thus reduces installation and maintenance costs
- It mounts readily on all standard diaphragm valves and other pneumatic actuators
- It saves space required for a second instrument
- It is low in initial cost as well as maintenance and operating costs

Model 40 Controller-Pilot Positioner

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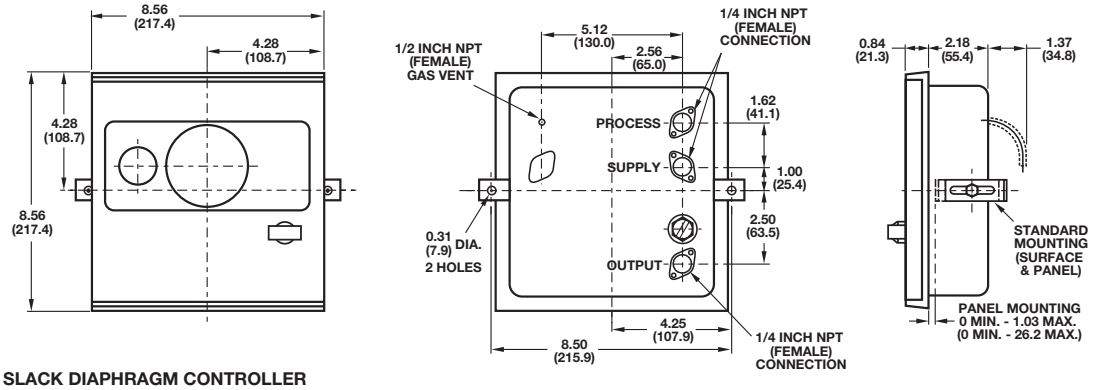
PNEUMATIC CONTROLLERS AND TRANSMITTERS

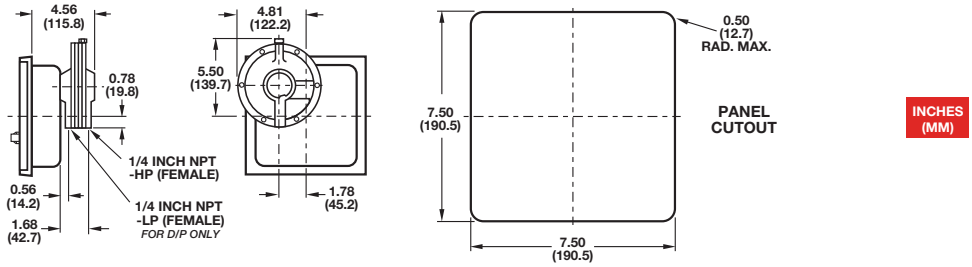
Model 40 Standard Dimensions

INDICATING CONTROLLER



SLACK DIAPHRAGM CONTROLLER

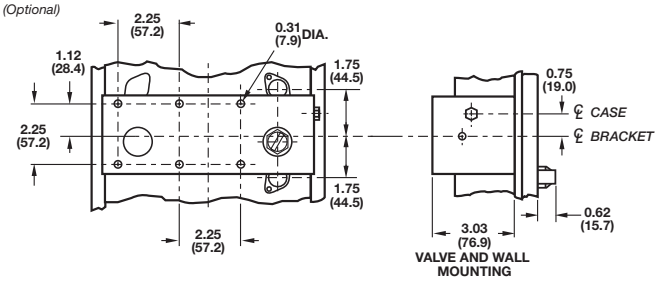
(Not available valve mounted)



INCHES (MM)

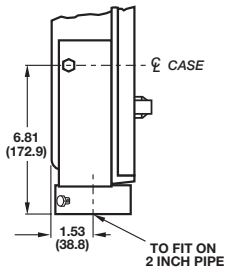
VALVE MOUNTING

(Optional)

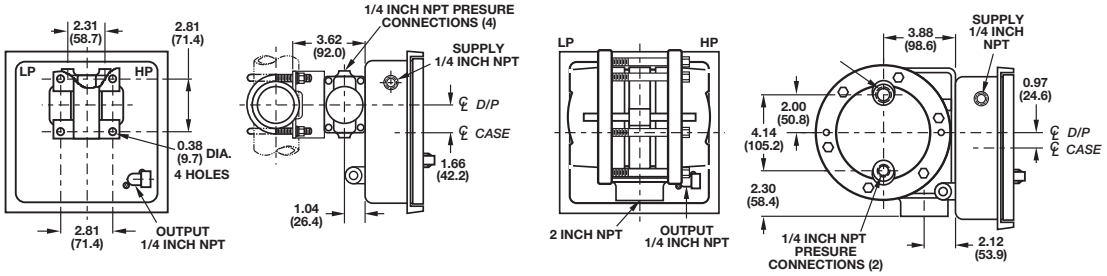


PIPE MOUNTING

(Optional)



DIFFERENTIAL PRESSURE CONTROLLER



BARTON 224
FOR BRASS UNITS ONLY

BARTON 199

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PNEUMATIC CONTROLLERS AND TRANSMITTERS

Pneumatic Indicating Controllers

Model Numbering:

Model 40 Pressure Instruments

Model 40

Control Mode

1	200% Prop. & Reset	5	75% Prop. (Positioner only)
2	100% Prop.	7	300% PID (3/15 psi only)
3	200% Prop.		

Output

1	3/15 psi	3	6/30 psi
2	3/27 psi	5	12/60 psi (Prop. only)

Instrument Type

B	Controller w/2 Pos. By-pass (not with PID)
K	Controller
P	Pilot Positioner (75% Prop. 12/60 out only)
T	Transmitter (100% Prop. Only) 3/15 psi only

Element Type

B	Bourdon Tube	F	Slack Diaphragm (D/P or Center 0)
C	Barton #199 (Consult Factory)	I	Barton #224 (Consult Factory)
D	Metal Diaphragm (Pressure)	J	Metal Diaphagm (Suppressed Zero)
E	Metal Diaphragm (0-30" Hg Vacuum Ni Span C only)	R	Indicating Level
		S	Slack Diaphragm (Pressure)

Element Material

0	No Element	7	BUNA
1	Bronze (except 160 PSI must be Stainless Steel)	S	Special
3	Stainless Steel (316)	8	BUNA-N (Center 0) (ncluded in Element Type "F")
5	Ni Span C	X	Type C, or I (see pneumatic diffential pressure units)

Element Range

Enter first 2 digits of desired span so that it gives the desired span when multiplied by the multiplier and the unit of measure below
Examples: 0 to 100 psi span is 101 (10 x 10 psi); 3 to 15 psi span is 120 (12 x 1 psi)

Multiplier and Units

0	x 1 psi	3	x 1000 psi
1	x 10 psi	5	x 1 in. Water
2	x 100 psi	6	x 10 in. Water

Engineering Units or Dial Number

Options

AB	External Set Point Knob
AC	Overrange Stop (Element Type B, D, J only)
AD	Air Filter, Regulator and Drip Well
AG	Shatterproof Glass
AH	Blowout Grommet
AI	External Reset Connection
AM	Metal Tags
AP	Vented Case (1/2" NPT)
AR	Special Calibration
AW	Fast Reset Valve
BH	Pipe Mounting Bracket
BI	Valve and Wall Mounting Bracket
BK	Wall Mounting Bracket
BL	Supply Gauge
BR	Blank Shroud
OX	Cleaned for Oxygen Service
—	Custom Scale
DQ	Anodized Case, Door, Relay

Model 40	1	1	B	B	3	30	1	?	BL

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Fisher® 657 and 667 Diaphragm Actuators

Fisher 657 and 667 spring-opposed diaphragm actuators position the valve plug in the valve in response to varying controller or valve positioner pneumatic output signals applied to the actuator diaphragm. Zero setting of the actuator is determined by the compression of the actuator spring. Span is set by both the actuator spring rate and the number of springs available. The 657 actuator is direct-acting; the 667 is reverse-acting. These actuators are designed to provide dependable on-off or throttling operation of automatic control valves.

657 ACTUATOR **667 ACTUATOR**

Fisher 657 and 667 Actuators Mounted on easy-e™ Valves

Features

- **Application Versatility—**Five actuator types in eleven sizes are available for an extensive variety of applications. Spring rates, travel stops, and manual operators are available for nearly any control valve application.
- **Excellent Linearity Between Loading Pressure and Travel—**A molded diaphragm travels in a deep diaphragm casing, minimizing area change throughout the travel.
- **High Degree of Dynamic Stability and Frequency Response—**A shallow casing on the pressure side means reduced volume on that side, thereby minimizing response time.
- **High Thrust Capability—**The molded diaphragm allows maximum thrust for given diaphragm size.
- **Long Service Life—**Rugged thick-walled cast iron and steel construction provides increased stability, corrosion protection, and protection from deformation should over-pressurization occur.
- **Cold Service Applications—**Enhanced product specifications for all sizes of 657 and 667 diaphragm actuators allow performance to -50°C (-58°F). Use of a positioner is recommended to ensure responsiveness in applications operating below -40°C (-40°F).
- **Positive Connections—**A split block stem connection provides a solid transfer of motion while allowing easy mounting. The absence of linkages helps to avoid lost motion and inaccurate valve positioning.

Specifications

Standard Operating Pressure Range(1)

657 and 667: ■ 0.2 to 1.0 bar (3 to 15 psig) or ■ 0.4 to 2.0 bar (6 to 30 psig)
657-4 and 667-4: 0.2 to 1.9 bar (3 to 27 psig)
667 Size 76: ■ 0.4 to 2.0 bar (6 to 30 psig) or ■ 0 to 3.1 bar (0 to 45 psig)

Maximum Travel

See table 1

Output Indication

Stainless steel disk or pointer and graduated scale

Stroking Speed

Dependent on actuator size, travel, spring rate, initial spring compression, and supply pressure. If stroking speed is critical, consult your Emerson Process Management sales office

Maximum Allowable Thrust(2)

See table 1

Operating Temperature Range(1)

Standard Construction (Nitrile Elastomers): -40 to 82°C (-40 to 180°F)
Optional Construction (Silicone Diaphragm): -40 to 149°C (-40 to 300°F)
Maximum Valve Packing Box Temperature: 427°C (800°F) with cast iron yoke

Volumetric Displacement

See table 2

Signal Connections

Sizes 30 - 60 and 667 Size 76: 1/4 NPT internal
Sizes 70 and 87: 1/2 NPT internal
Size 80
657: 3/4 NPT internal with 1/4 NPT internal bushing
667: 1/2 NPT internal with 1/4 NPT internal bushing
Size 100: 1 NPT internal with 1/4 NPT internal bushing

Effective Diaphragm Area

See table 1

Construction Materials (refer to figure 1)

Diaphragm Casing
Sizes 30 -87: Steel
Size 80: ■ Cast iron or ■ steel
Size 100: ■ Cast aluminum
Diaphragm
Sizes 30 -87: ■ Nitrile on nylon, ■ Silicone on polyester
Size 100: Nitrile on polyester
Diaphragm Plate
657 Sizes 30-60, 100: ■ Cast aluminum
657 Sizes 70 -87: ■ Cast iron or ■ steel
667 Sizes 30 -60, 100: ■ Cast aluminum or ■ steel
667 Sizes 70 -87: ■ Cast iron or ■ steel
Actuator Spring: Steel
Spring Adjustor: Steel
Spring Seat: ■ Steel or ■ cast iron
Actuator Stem: Steel
Travel Indicator: Stainless steel
O-Rings: Nitrile
Seal Bushing: Brass
Stem Connector: Zinc-plated steel
Yoke
Sizes 30 -80: ■ Cast iron or ■ steel
Size 100: Steel

Construction Materials for Cold Service [to -50°C (-58°F)] 657 and 667--all sizes

Yoke: Steel (Grade LCC)
Diaphragm: Silicone
O-Rings:(3) Ethylene Propylene
Bolting: Stainless Steel B8M Cl 2
Stem Connector: Stainless Steel
Lubricant: Silicone

Stem and Yoke Boss Diameters

See table 1

Approximate Weight

See table 3

Options

■ Oversize signal connections, ■ Plastic yoke covers, ■ Watertight yoke (sealed construction for certain applications where valve stem and packing must be protected)

1. The pressure and temperature limits in this bulletin and in any applicable standard or code limitation should not be exceeded.
2. Do not exceed the thrust limits in this bulletin.
3. Includes diaphragm casing seals, casing-mounted handwheel on 657, seal bushing on 667.

Available Configurations

Direct Action

All 657 actuators are direct acting. Applying air pressure to the upper diaphragm casing forces the actuator stem downward. When this pressure is reduced, the opposing spring force moves the actuator stem upward. Should the loading pressure fail, the spring forces the stem to the extreme upward position. This provides fail-open action for push-down-to-close valves and fail-closed action for push-down-to-open valves.

657—A direct-acting actuator used on sliding-stem valves. Available in sizes 30 through 100. See figures 1, 2, 5, and 6.

657-4—A 657 actuator in sizes 70 and 87, designed with 102 mm (4-inch) travel.

Reverse Action

All 667 actuators are reverse acting. Applying air pressure to the lower diaphragm casing forces the actuator stem upward against the opposing spring force. When this loading pressure is reduced, the spring moves the actuator stem downward. Should the loading pressure fail, the spring forces the stem to the extreme downward position. These actuators provide fail-closed action for push-down-to-close valves and fail-open action for push-down-to-open valves.

667—A reverse-acting actuator used on sliding-stem valves. Available in sizes 30 through 100 and 76. See figures 1, 2, and 7.

667-4—A 667 actuator in sizes 70 and 87, designed with 102 mm (4-inch) travel.

Accessories

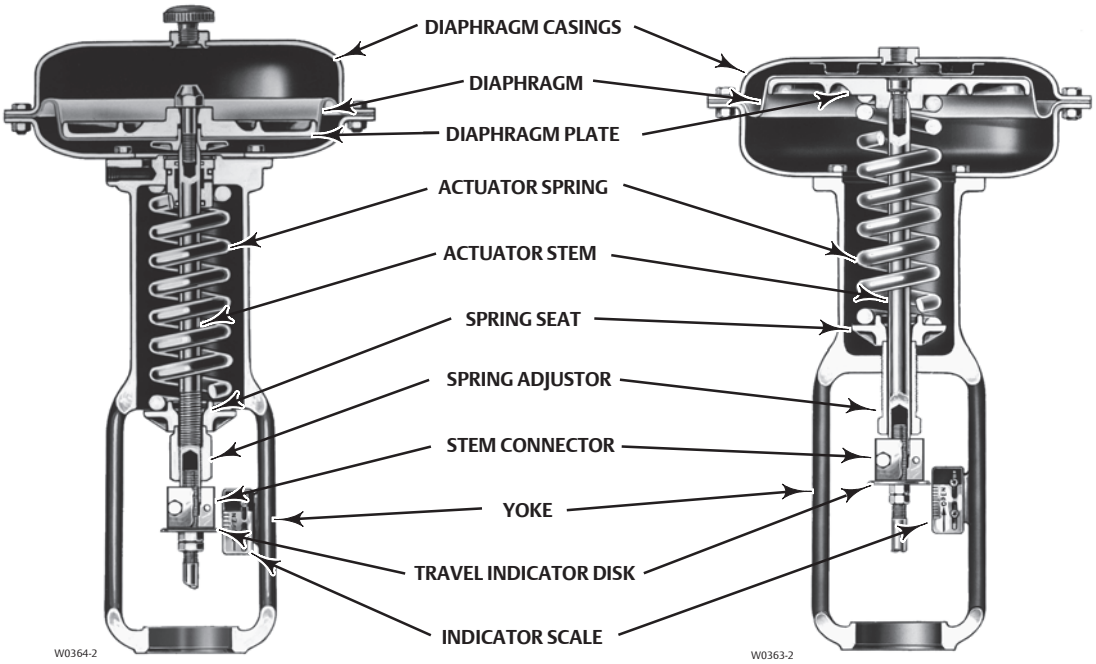
Handwheels

Handwheels for diaphragm actuators are often used as adjustable travel stops. They also provide a ready means of positioning the control valve in an emergency. The specifications in tables 5 and 6 apply to handwheels on both 657 and 667 Series actuators. For repeated or daily manual operation, the unit should be equipped with a side-mounted handwheel actuator.

Top-Mounted Handwheels—Typical 657 and 667 actuators with handwheels mounted on the diaphragm case are shown in figure 2 (not available on a 667 actuator, size 80). On the 657 actuator, the handwheel can be set to limit the travel in the upward direction; on the 667 actuator, travel in the downward direction can be restricted. A P-2 travel stop (figure 4) is available for a 667 actuator, sizes 45-60 to limit travel in either the upward or downward directions. An actuator with a P-2 travel stop is limited to a maximum travel of 19 mm (0.75 inch). The handwheel on the size 100 is similar in function to those on the smaller sizes, but it uses a gear drive similar to the drive employed on the integral side-mounted handwheels (see figure 2).

Contents

Figure 1. Typical Actuators



667 SIZES 30-87

657 SIZES 30-87

657 SIZE 100

Table 1. Additional Specifications for Fisher 657 and 667 Series Actuators

ACTUATOR SIZE	EFFECTIVE DIAPHRAGM AREA	YOKE BOSS DIAMETER	STEM DIA	MAXIMUM TRAVEL	MAXIMUM ALLOWABLE THRUST(1)
	cm^2	mm			N
30	297	54	9.5	19	10,231
34	445	54	9.5	29	10,231
40	445	71	12.7	38	12,010
45	677	71	12.7	51	25,132
46	1006	71	12.7	51	33,584
50	677	90	19.1	51	25,131
60	1006	90	19.1	51	30,246
70(2)	1419	90	19.1	76	39,142
				102(3)	
76(667)	1006	90	19.1	51	30,246
80	1761	127	25.4	76	63,392
			31.8		88,075(4)
87(2)	1419	127	25.4	76	39,142
				102(3)	
100	2902	127H(5)	31.8	102	200,160
		178	50.8		
	$Inch^2$	Inch			Lb
30	46	2-1/8	3/8	0.75	2300
34	69	2-1/8	3/8	1.125	2300
40	69	2-13/16	1/2	1.5	2700
45	105	2-13/16	1/2	2	5650
46	156	2-13/16	1/2	2	7550
50	105	3-9/16	3/4	2	5650
60	156	3-9/16	3/4	2	6800
70(2)	220	3-9/16	3/4	3	8800
				4(3)	
76(667)	156	3-9/16	3/4	2	6800
80	273	5	1	3	14,150
			1-1/4		19,800(4)
87(2)	220	5	1	3	8800
				4(3)	
100	450	5H(5)	1-1/4	4	45,000
		7	2		

1. These values are based on material limitations such as yoke, stem connection, diaphragm plate, and travel stop strengths.
2. Values also apply to 657-4 and 667-4 actuators.
3. For 657-4 and 667-4 actuator constructions.
4. Steel construction.
5. H=Heavy actuator-to-valve bolting.

Table 2. Volumetric Casing Displacement for Fisher 657 and 667 Series Actuators

ACTUATOR SIZE		CLEARANCE VOLUME(1)	TRAVEL, mm							
			11	16	19	29	38	51	76	102
		cm^3	Casing Volume(2), cm^3							
30		540	918	1080	1180	---	---	---	---	---
34 and 40		934	1470	1700	1850	2330	2790	---	---	---
45 and 50		1560	---	2790	3000	3720	4420	5410	---	---
46, 60, and 76		2180	---	3880	4210	5280	6340	7740	---	---
70 and 87		3490	5240	5950	6420	7830	9240	11,110	14,880	18,570
80		4820	---	---	---	10,490	12,450	14,860	19,340	---
100	657	10,880	---	---	16,400	19,170	21,940	25,630	33,000	40,380
	667	12,780	---	---	18,320	21,070	23,840	27,530	34,900	42,280
		Inch^3	TRAVEL, INCH							
			0.4375	0.625	0.75	1.125	1.5	2	3	4
			Casing Volume(2), Inch^3							
30		33	56	66	72	---	---	---	---	---
34 and 40		57	90	104	113	142	170	---	---	---
45 and 50		95	---	170	183	227	270	330	---	---
46, 60, and 76		133	---	237	257	322	387	472	---	---
70 and 87		213	320	363	392	478	564	678	980	1133
80		294	---	---	---	640	760	907	1180	---
100	657	664	---	---	1002	1170	1339	1564	2014	2464
	667	780	---	---	1118	1286	1455	1680	2130	2580

1. Clearance volume indicates casing volume at zero travel.
2. Includes clearance volume.

Table 3. Approximate Actuator Weights (without handwheel)

ACTUATOR SIZE	ACTUATOR			
	657	667	657	667
	Kg		Lb	
30	16	15	36	34
34	22	22	48	48
40	23	23	51	50
45	37	41	82	90
46	49	55	107	121
50	42	43	92	94
60	53	55	116	122
70	107	115	235	254
76	---	86	---	190
80	234	284	515	626
87	116	118	255	260
100	346	544	762	1200

Table 4. Thrust Capabilities(1) by Input Signal Range

TRAVEL	ACTUATOR SIZE	PRESSURE RANGE TO ACTUATOR DIAPHRAGM(2)	THRUST CAPABILITIES	
			657	667
mm		Bar	N	
19	30	0.2-1	2250	1840
		0.4-2	3890	3270
	34	0.2-1	3380	3380
		0.4-2	5830	5530
29	40	0.2-1	3380	2760
		0.4-2	5530	3680
	45	0.2-1	4670	4670
		0.4-2	8410	8870
	46	0.2-1	6940	6250
		0.4-2	13,190	11,800
38	50	0.2-1	5140	3740
		0.4-2	8410	7010
	60	0.2-1	6940	4860
		0.4-2	13,190	8330
51	70	0.2-1	7830	7830
		0.4-2	18,590	13,700
	80	0.2-1	10,110	11,250
		0.4-2	18,950	19,680
	87	0.2-1	6850	7830
		0.4-2	18,590	13,700
76	100	0.2-1	16,010	8010
		0.4-2	32,030	36,030
102		0.2-1	12,010	---
		0.4-2	22,019	28,024
Inch		Psig	Lb	
0.75	30	3-15	506	414
		6-30	874	736
	34	3-15	759	759
		6-30	1311	1242
1.125	40	3-15	759	621
		6-30	1242	828
	45	3-15	1050	1050
		6-30	1890	1995
	46	3-15	1560	1404
		6-30	2964	2652
1.5	50	3-15	1155	840
		6-30	1890	1575
	60	3-15	1560	1092
		6-30	2964	1872
2	70	3-15	1760	1760
		6-30	4180	3080
	80	3-15	2272	2528
		6-30	4260	4424
	87	3-15	1540	1760
		6-30	4180	3080
3	100	3-15	3600	1800
		6-30	7200	8100
4		3-15	2700	---
		6-30	4950	6300

1. For Size 76 667 actuators, contact your Emerson Process Management sales office.
2. Consult Fisher 657 and 667 instruction manuals (D100306X012, D100307X012, D100310X012, and D100311X012) for additional information on maximum pressure limitations.

Clockwise rotation of the handwheel on the 657 actuator moves the actuator stem downward, compressing the spring. Spring action returns the stem as the handwheel is turned counterclockwise. With the 667 actuator, counterclockwise rotation moves the stem upward, and spring action returns the stem on clockwise rotation.

Side-Mounted Handwheels—Figure 3 shows the side-mounted handwheels (designated by the letters MO) applicable to sizes 34 through 87, 657 and 667 actuators. Size 30 actuators do not have a side-mounted handwheel available.

All side-mounted handwheels can be used to stroke the valve in either direction at any point in the actuator stem travel. Unlike the top-mounted handwheel, the side-mounted handwheel can be positioned to limit travel in either direction, but not both at the same time. With the handwheel in the neutral position, automatic operation is possible throughout full valve travel. In any other position, valve travel will be restricted. The handwheel is furnished with a spring-loaded ball detent which prevents vibration from changing the setting.

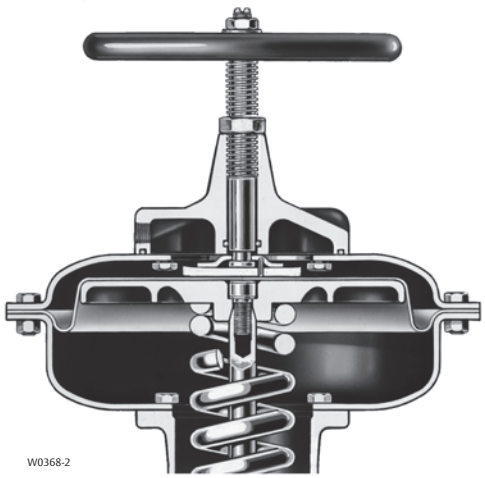
Adjustable Travel Stops

Top-mounted adjustable travel stops are available for 657 and 667 Series actuators. They are used to limit travel in the up, down, or up and down directions. Figure 4 illustrates the different constructions. Table 7 locates the different style constructions with actuator type and use.

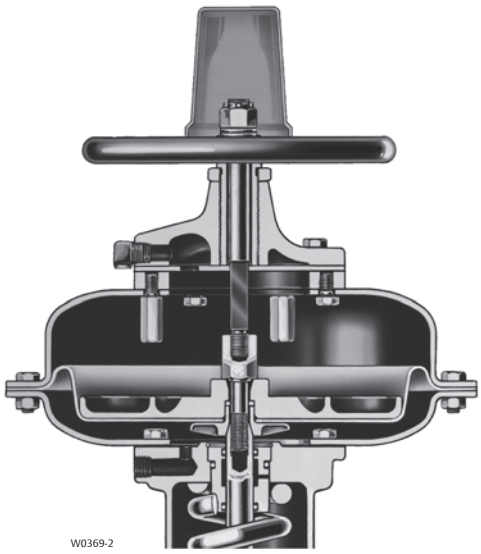
Other

Accessories such as transducers, positioners, position transmitters, air relays, volume boosters, switching valves, lockup valves, limit switches, and solenoid valves are also available for actuator mounting. They are described in separate publications. Contact your Emerson Process Management sales office for details.

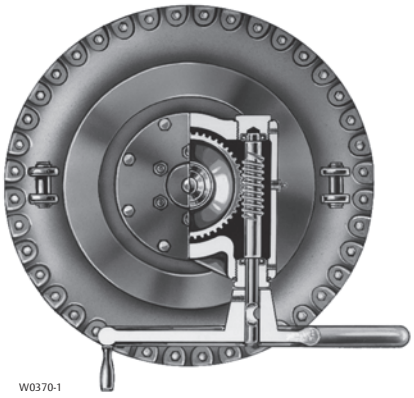
Figure 2. Typical Top-Mounted Handwheels



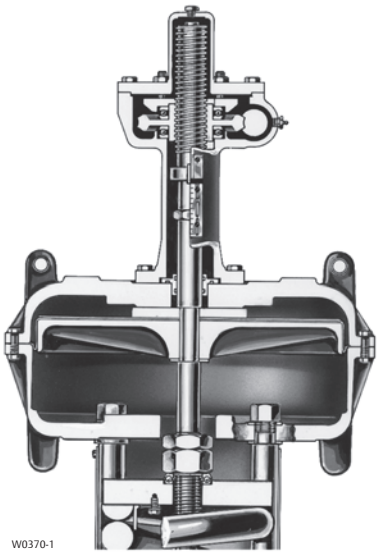
657 ACTUATOR
(EXCEPT SIZE 100)



667 ACTUATOR
(EXCEPT SIZES 80 AND 100)



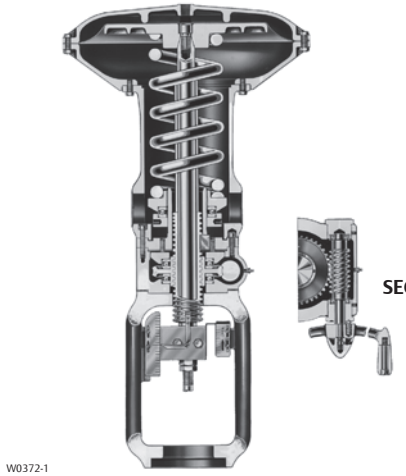
TOP VIEW



657 ACTUATOR SIZE 100
(GEAR DRIVEN)

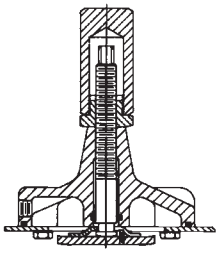
Figure 3. Typical Side-Mounted Handwheels for Fisher 657 and 667 Series Actuators

SIZES 34 THROUGH 60

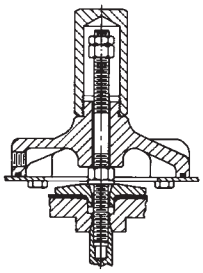


SIZES 70, 76, 80, AND 87

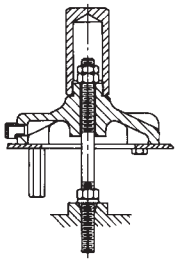
Figure 4. Adjustable Travel Stops



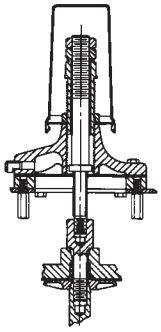
STYLE 1
657 AND 657-4
UP STOP



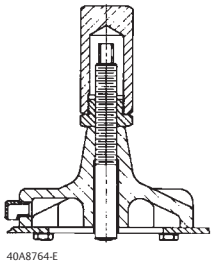
STYLE 2
657 AND 657-4
DOWN STOP



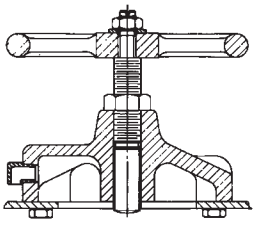
STYLE 10
667 DOWN STOP



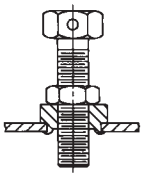
STYLE 11
667 UP
AND DOWN STOP



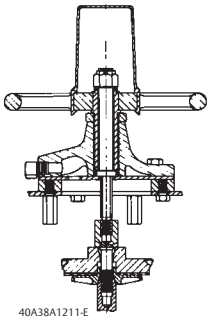
STYLE 12
667 UP STOP



STYLE 13
667 UP STOP



STYLE 14
667 UP STOP



STYLE P2
667 UP AND
DOWN STOP

Table 5. Fisher 657 Handwheel Specifications

657 ACTUATOR SIZE	TOP-MOUNTED HANDWHEEL				SIDE-MOUNTED HANDWHEEL			
	Handwheel Diameter	Turns Per mm Travel	Rim Force(1)	Maximum Handwheel Output Force(3)	Handwheel Diameter	Turns Per mm Travel	Rim Force(1)	Maximum Handwheel Output Force(3)
	mm		N	N	mm		N	N
30	171	0.3	190	6670	---	---	---	---
34 and 40	222	0.3	210	10,010	304	0.2	230	10,010
45 and 50	222	0.3	420	15,080	355	0.3	360	15,080
46 and 60	222	0.3	490	22,690	355	0.3	540	22,690
70 and 87	355	0.3	590	29,360	432	0.8	160	29,360
80	355	0.3	770	37,770	432	0.4	240	37,770
100(2)	406	6	270	160,000	---	---	---	---
	Inch	Turns Per Inch Travel	Lb	Lb	Inch	Turns Per Inch Travel	Lb	Lb
30	6.75	8	42	1500	---	---	---	---
34 and 40	8.75	8	48	2250	12	5.14	52	2250
45 and 50	8.75	8	95	3390	14	6.65	81	3390
46 and 60	8.75	8	110	5100	14	6.65	122	5100
70 and 87	14	8	132	6600	17	20	36	6600
80	14	8	173	8490	17	10	53	8490
100(2)	16	144	60	36,000	---	---	---	---

1. Tangential handwheel force required to produce the handwheel output force shown. (Proportional to handwheel output force).
2. Top-mounted with gear drive.
3. Maximum force available to compress the actuator spring and close the valve.

Table 6. Fisher 667 Handwheel Specifications

667 ACTUATOR SIZE	TOP-MOUNTED HANDWHEEL				SIDE-MOUNTED HANDWHEEL				
	Handwheel Diameter	Turns Per mm Travel	Rim Force(1)	Maximum Handwheel Output Force(3)	667 ACTUATOR SIZE	Handwheel Diameter	Turns Per mm Travel	Rim Force(1)	Maximum Handwheel Output Force(3)
	mm		N	N		mm		N	N
30	171	0.3	200	6670	30	---	---	---	---
34 and 40	222	0.3	230	10,010	34 and 40	304	0.2	230	10,010
45 and 50	222	0.2	460	17,790	45 and 50	355	0.3	360	15,080
	355	0.2	430	26,690					
46, 60, and 76	222	0.2	460	17,790	46 and 60	355	0.3	540	22,690
	355	0.2	430	26,690					
70 and 87	355	0.2	520	26,690	70, 76, and 87	432	0.8	160	29,360
	762 mm Bar	0.2	410	44,480					
100(2)	406	6	270	160,000	80	432	0.4	240	37,770
667 ACTUATOR SIZE	**Inch**	**Turns Per Inch Travel**	**Lb**	**Lb**	**667 ACTUATOR SIZE**	**Inch**	**Turns Per Inch Travel**	**Lb**	**Lb**
30	6.75	8	45	1500	30	---	---	---	---
34 and 40	8.75	8	51	2250	34 and 40	12	5.14	52	2250
45 and 50	8.75	6	103	4000	45 and 50	14	6.65	81	3390
	14	6	97	6000					
46, 60, and 76	8.75	6	103	4000	46 and 60	14	6.65	122	5100
	14	6	97	6000					
70 and 87	14	6	118	6000	70, 76, and 87	17	20	36	6600
	30 Inch Bar	6	92	10000					
100(2)	16	144	60	36,000	80	17	10	53	8490

1. Tangential handwheel force required to produce the handwheel output force shown. (Proportional to handwheel output force).
2. Top-mounted with gear drive.
3. Maximum force available to compress actuator spring.

Table 7. Adjustable Travel Stop Styles (1)

Actuator Size	30	34	40	45	46	50	60 and 667 Size 76	70	87	80	100
657 Up Stop	1	1	1	1	1	1	1	1	1	NOTE 2	NOTE 2
657 Down Stop	2	2	2	2	2	2	2	2	2	---	---
667 Up Stop	12, 13(3), 14	12, 13(3), 14	12, 13(3), 14	12, 13(3), 14	12, 13(3), 14	12, 13(3), 14	12, 13(3), 14	12	12	13(3)	---
667 Down Stop	10	10	10	10	10	10	10	10	10	---	NOTE 2
667 Up and Down Stop	---	11	11	11(4), P2(5)	11(4), P2(5)	11(4), P2(5)	11(4), P2(5)	---	---	---	---

1. See figure 4.
2. Top-mounted handwheel, see figure 2.
3. Adjustable handwheel up stop.
4. 38 mm (1.5 inch) maximum travel.
5. Adjustable handwheel up and down stop, 19 mm (0.75 inch) maximum travel.

Figure 5. Fisher 646 Electro-Pneumatic Transducer on 657 Actuator

W4917-1

Figure 6. Fisher 3582i Valve Positioner on 657 Actuator

W4930

Figure 7. Fisher 4200 Position Transmitter on 667 Actuator

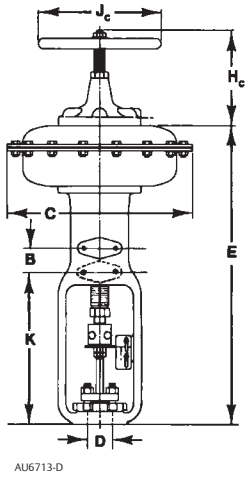
W4273-1

Table 8. Dimensions

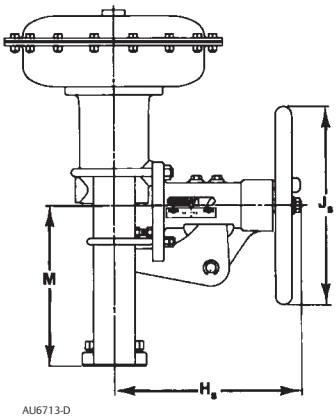
DIMENSION REFERENCE		ACTUATOR SIZE												
		30	34	40	45	46	47	50	60	70	76	80	87	100
		mm												
B	657, -4	0	25	25	38	38	38	38	38	38	---	---	38	---
	667, -4	38	38	38	38	38	38	38	38	38	38	---	38	---
C		289	333	333	406	473	536	406	473	536	473	635	536	729
D		54	54	71	71	71	71	90	90	90	90	127	127	127[2]
E	657	440	498	548	659	656	---	722	722	840	---	1075	938	NOTE 3
	657-4	---	---	---	---	---	---	---	---	994	---	---	1089	---
	657MO[1]	440	498	548	659	656	---	722	722	976	---	1183	1057	NOTE 4
	657-4 MO	---	---	---	---	---	---	---	---	1124	---	---	1204	---
	667	478	573	594	768	748	---	784	784	933	881	1257	1003	1857
	667-4	---	---	---	---	---	---	---	---	1070	---	---	1143	---
	667MO	478	573	594	768	748	---	784	784	1164	1112	1392	1245	2346
	657-4 MO	---	---	---	---	---	---	---	---	1314	---	---	1394	---
H_c	657	121	164	164	202	202	---	202	202	313	---	227	313	---
	667	119	121	137	159	159	---	159	159	286	159	---	286	---
H_s		---	284	286	375	375	---	378	378	292	222	303	292	401
J_c		171	222	222	222	222	356	222	222	356	356	356	356	---
J_s		---	305	305	356	356	---	356	356	432	432	432	432	406
K	657, -4	213	222	272	291	291	395	354	354	406	---	435	780	451
	667, -4	194	224	244	310	310	---	325	325	375	375	432	419	451
M	657, -4	---	226	248	306	306	---	370	370	446	---	503	527	NOTE 5
	667, -4	---	214	248	362	362	---	378	378	446	446	503	527	2105
N	657	---	---	---	---	---	---	---	---	---	---	254	---	---
	657MO	---	---	---	---	---	---	---	---	219	---	384	219	---
	657-4MO	---	---	---	---	---	---	---	---	219	---	---	219	---
	667	---	---	---	---	---	---	---	---	---	---	254	---	---
	667MO	---	---	---	---	---	---	---	---	219	219	384	219	---
	667-4MO	---	---	---	---	---	---	---	---	219	---	---	219	---
		Inches												
B	657, -4	0.00	1.00	1.00	1.50	1.50	1.50	1.50	1.50	1.50	---	---	1.50	---
	667, -4	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	---	1.50	---
C		11.38	13.12	13.12	16.00	18.62	21.12	16.00	18.62	21.12	18.62	25.00	21.12	28.69
D		2.125	2.125	2.8125	2.8125	2.8125	2.8125	3.5625	3.5625	3.5625	3.5625	5	5	5[2]
E	657	17.31	19.62	21.56	25.94	25.81	---	28.44	28.44	33.06	---	42.31	36.94	NOTE 3
	657-4	---	---	---	---	---	---	---	---	39.12	---	---	42.88	---
	657MO	17.31	19.62	21.56	25.94	25.81	---	28.44	28.44	38.44	---	46.56	41.62	NOTE 4
	657-4 MO	---	---	---	---	---	---	---	---	44.25	---	---	47.38	---
	667	18.81	22.56	23.38	30.25	29.44	---	30.88	30.88	36.75	34.70	49.50	39.50	73.12
	667-4	---	---	---	---	---	---	---	---	42.12	---	---	45.00	---
	667MO	18.81	22.56	23.38	30.25	29.44	---	30.88	30.88	45.81	43.76	54.81	49.00	92.38
	657-4 MO	---	---	---	---	---	---	---	---	51.75	---	---	54.88	---
H_c	657	4.75	6.44	6.44	7.94	7.94	---	7.94	7.94	12.31	---	8.94	12.31	---
	667	4.69	4.75	5.38	6.25	6.25	---	6.25	6.25	11.25	6.25	---	11.25	---
H_s		---	11.19	11.25	14.75	14.75	---	14.88	14.88	11.50	11.50	11.94	11.50	15.78
J_c		6.75	8.75	8.75	8.75	8.75	14.00	8.75	8.75	14.00	8.75	14.00	14.00	---
J_s		---	12.00	12.00	14.00	14.00	---	14.00	14.00	17.00	17.00	17.00	17.00	16.00
K	657, -4	8.38	8.75	10.69	11.44	11.44	15.56	13.94	13.94	16.00	---	17.12	18.88	17.75
	667, -4	7.62	8.83	9.62	12.19	12.19	---	12.81	12.81	14.75	14.75	17.00	16.50	17.75
M	657, -4	---	8.88	9.75	12.06	12.06	---	14.56	14.56	17.56	---	19.81	20.75	NOTE 5
	667, -4	---	8.44	9.75	14.25	14.25	---	14.88	14.88	17.56	17.56	19.81	20.75	82.88
N	657	---	---	---	---	---	---	---	---	---	---	10.00	---	---
	657MO	---	---	---	---	---	---	---	---	8.62	---	15.12	8.62	---
	657-4MO	---	---	---	---	---	---	---	---	8.62	---	---	8.62	---
	667	---	---	---	---	---	---	---	---	---	---	10.00	---	---
	667MO	---	---	---	---	---	---	---	---	8.62	8.62	15.12	8.62	---
	667-4MO	---	---	---	---	---	---	---	---	8.62	---	---	8.62	---

1. MO = Manual operator.
2. Also available with 7 inch boss.
3. With group 1 springs, E=1959 mm (77.12 inch). With group 2 springs, E=1497 mm (58.94 inch).
4. With group 1 springs, E=2345 mm (92.31 inch). With group 2 springs, E=1883 mm (74.12 inch).
5. With group 1 springs, M=2103 mm (82.81 inch). With group 2 springs, M=1654 mm (65.12 inch).

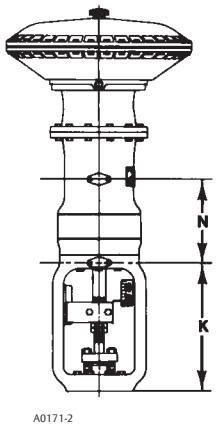
Figure 8. Dimensions (also see table 8)



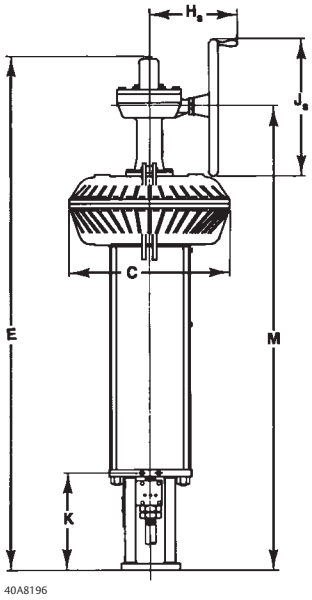
**657, 667,
657-4, AND 667-4
SIZES 30 THROUGH 87**



**657, 667,
657-4, AND 667-4
SIZES 30 THROUGH 87**



**ALL TYPES
SIZES 70, 80, 87, AND
667 SIZE 76**



**657 AND 667
SIZE 100**

Ordering Information

When ordering, specify:

Application

1. On-off or throttling service

2. Input signal range

3. Maximum supply pressure

4. Valve body type and size with which the actuator will be used

5. Valve plug travel

6. Actuator thrust required with actuator stem both fully retracted and fully extended

7. Stroking time requirements, if critical

8. Seismic requirements, if critical

9. Ambient temperature range

Actuator and Positioner

Be sure to specify: actuator type number; whether a positioner is required; whether a top-mounted handwheel is required; and whether an adjustable up or down travel stop is required. Refer to the Specifications section. Review the information under each specification and in the referenced tables and figures. Specify the desired choice wherever there is a selection to be made.

Valve Body and Accessories

Refer to the separate valve body bulletin and bulletins covering accessories for ordering information.

Emerson Process Management
Marshalltown, Iowa 50158 USA
Sorocaba, 18087 Brazil
Chatham, Kent ME4 4QZ UK
Dubai, United Arab Emirates
Singapore 128461 Singapore

www.Fisher.com

Fisher™ EZ Sliding-Stem Control Valve

Fisher EZ valves (figure 1) are used for throttling or on-off control of a wide variety of liquids and gases. The single-port, globe-style body design offers quick-change trim and a post-guided, unbalanced valve plug. The EZ valve is used in chemical or hydrocarbon processing applications or wherever control of non-lubricating, viscous, or other hard-to-handle fluids is required.

Metal-to-metal seating is standard for all general applications over a wide range of pressure drops and temperatures. Metal-to-PTFE seating is optional for stringent shutoff requirements.

W2174-2

Fisher EZ Valve with 657 Actuator

The easy-e™ Valve Family

EZ valve bodies are part of the versatile easy-e family of industrial control valves. easy-e valve bodies share the following characteristics:

- Multiple trim material choices
- Trim temperature capability with standard metal seats to 427°C (800°F)
    - FGM gaskets
- Interchangeable, restricted-capacity trims and full-sized trims to match variable process flow demands
- Different valve plug styles that provide particular flow characteristics for highly-specialized applications. Standard plugs are available with the following flow characteristics:
    - quick-opening
    - linear
    - equal percentage
- Optional constructions allow material compatibility with NACE MR0175 / ISO 15156 and MR0103. Contact your Emerson sales office or Local Business Partner for details.
- 316 stainless steel packing box parts are standard (including packing flange, studs, and nuts)

Features

- **Trim Designed for Stability--** Post guiding provides valve plug stability with less chance of a sticking valve plug due to non-lubricating or sticky process fluids or build-up of entrained solids. Post guiding stabilizes the valve plug at all points in its travel range to reduce vibration, mechanical noise, and trim wear.

- **Compliance with the Clean Air Act--** ENVIRO-SEAL packing systems (figure 3) that provide an improved stem seal to help prevent the loss of process fluid are available. These packing systems feature PTFE, Graphite ULF, or duplex packing with live-loading for reduced packing maintenance.

- **Sour Service Capability--** Unless otherwise noted, references are to NACE MR0175-2002. Optional materials are available to meet NACE MR0103 and NACE MR0175 / ISO 15156. Material requirements under these standards vary by edition and year of issue; the specific standard must be specified.

- **Compliance with European Standards--** Valves are available with dimensions specified by EN/DIN standards. See figure 6.

- **Reliability--** The process fluid flows through the trim, flushing away solid deposits above and below the guide bushing, thus reducing the possibility of a sticking valve plug.

- **Easy Maintenance--** Quick-change trim, with a clamped-in seat ring, reduces the disassembly time. The valve body can stay in the pipeline during removal of trim parts for inspection or maintenance.

- **Application Flexibility--** Low-flow requirements can be satisfied with standard restricted-capacity trim or with Micro-Form, Micro-Flute, or Micro-Flow valve plugs. If flow requirements change, the valve can be converted to full-sized trim.

- **Economy--** Streamlined flow passages provide greater capacities than most globe valves of the same line size.

Table of Contents

Specifications

Valve Sizes

NPS ■ 1/2, ■ 3/4, ■ 1, ■ 1-1/2, ■ 2, ■ 3, and ■ 4

End Connection Styles(1, 2)

Cast Iron Valves
Flanged: NPS 1 through 4, ■ CL125 flat-face or ■ CL250 raised-face flanges per ASME B16.1
Steel and Stainless Steel Valves
Flanged: ■ CL150, CL300, or CL600 raised-face (RF) or ring-type joint (RTJ) flanges per ASME B16.5, ■ Raised-face (RF) flanges per EN1092-1/B
Screwed or Socket Welding: NPS 1/2 through 2, consistent with ASME B16.11
Buttwelding (schedule 40 or 80): NPS 1 through 4, consistent with ASME B16.25

Maximum Inlet Pressure and Temperatures(1, 2)

As listed below, unless limited by maximum pressure drop or material temperature capabilities
Cast Iron Valves
Flanged: Consistent with CL125B or CL250B pressure-temperature ratings per ASME B16.1
Steel and Stainless Steel Valves
Flanged: Consistent with CL150, CL300, and CL600(3) per ASME B16.34
Screwed or Welding: Consistent with CL600(3) per ASME B16.34

Maximum Pressure Drops(2)

Same as maximum inlet pressure for specific construction defined above, except where further limited as shown in tables 8, 9, and 11. For soft seats on NACE service, see figure 4

Shutoff Classification Per ANSI/FCI 70-2 and IEC 60534-4

Metal Seating: Class IV is standard. Class V and VI is optional
PTFE Composition Seating: Class VI

Construction Materials

Body and Bonnet: ■ Cast iron, ■ WCC steel, ■ CF8M (316 stainless steel), ■ WC9 chrome moly steel, or ■ other materials upon request
Trim Materials: See tables 3, 4, 5, and 15
All Other Parts: See tables 6 and 10

Material Temperature Capabilities(2)

Body-Trim Combinations: See table 7
Bolting for NACE MR0175 / ISO 15156 and MR0103: See table 17
All Other Parts: See tables 6 and 10

Flow Characteristics

■ Equal percentage, ■ quick opening, and ■ linear. With soft seat, equal percentage is standard

Flow Direction

Up through the seat ring

Flow Coefficients and Noise Level Predictions

See table 14 and Fisher Catalog 12

Port Diameters and Valve Plug Travels

See table 15

Yoke Boss and Stem Diameters

See table 15

Typical Bonnet Styles

■ Plain or ■ extension. See figure 6 for standard dimensions
■ ENVIRO-SEAL bellows seal bonnet. See figure 2. Also, see Bulletin 59.1:070, ENVIRO-SEAL Bellows Seal Bonnets (D101641X012) for more information.

- continued -

Specifications (continued)

Packing Arrangements

Standard Material: Single PTFE V-ring
Optional Materials: See table 6.
ENVIRO-SEAL Packing Systems: See figure 3.
ENVIRO-SEAL Packing Systems in vacuum service: Standard ENVIRO-SEAL packing systems can be used in vacuum service with packing rings in standard orientation. Do not reverse the ENVIRO-SEAL PTFE packing rings. Also, see Bulletin 59.1:061, ENVIRO-SEAL Packing Systems for Sliding-Stem Valves (D101633X012) for more information.

Approximate Weights

NPS 1/2, 3/4 valves: 9 kg (20 lb)
NPS 1 valve: 11 kg (25 lb)
NPS 1-1/2 valve: 18 kg (40 lb)
NPS 2 valve: 36 kg (80 lb)
NPS 3 valve: 54 kg (120 lb)
NPS 4 valve: 75 kg (165 lb)

Valve Dimensions

See figure 6
■ ENVIRO-SEAL bellows seal bonnet dimensions, see figure 5

Optional Safety Instrumented System Classification

SIL3 capable — certified by exida Consulting LLC

Additional Options

■ Lubricator or ■ lubricator/isolating valve for packing lubrication and ■ valve body drain plug

1. EN (or other) ratings and end connections can usually be supplied; consult your Emerson Automation Solutions sales office.
2. Do not exceed the pressure/temperature limits in this bulletin. Any applicable standard or code limitations should not be exceeded.
3. Certain bonnet bolting material selections may require a CL600 easy-e valve assembly to be derated. Contact your Emerson sales office or Local Business Partner for more information.

ENVIRO-SEAL Packing System Specifications

Applicable Stem Diameters

■ 9.5 mm (3/8 inches), ■ 12.7 (1/2), ■ 19.1 (3/4) diameter valve stems

Maximum Pressure/Temperature Limits(1)

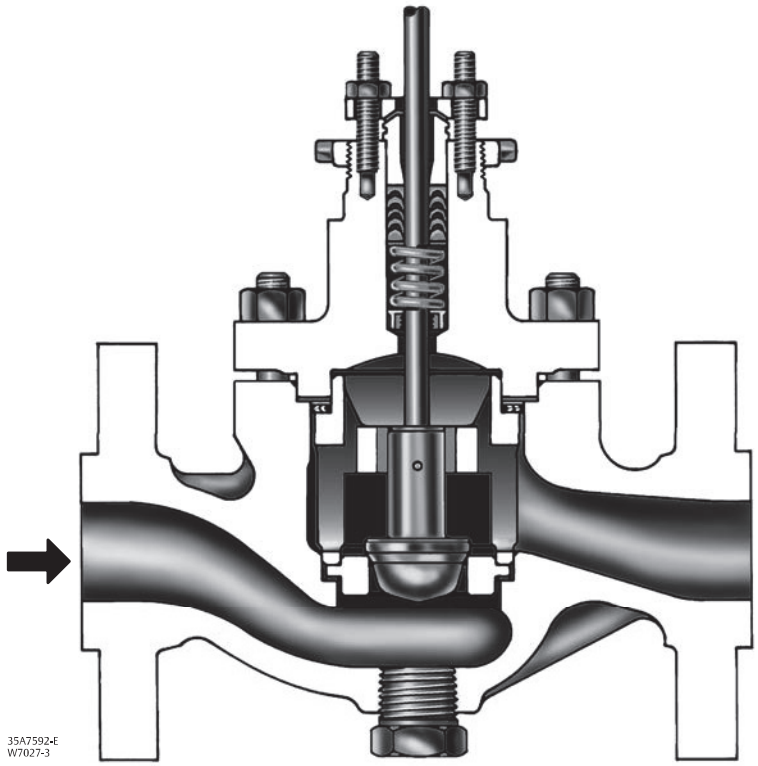
To Meet the EPA Fugitive Emission Standard of 100 PPM(2)
For ENVIRO-SEAL PTFE and ENVIRO-SEAL Duplex packing systems: full CL300 up to 232°C (450°F)
For ENVIRO-SEAL Graphite ULF packing: 104 bar (1500 psig) at 316°C (600°F)

Construction Materials

PTFE Packing Systems
Packing Ring and Lower Wiper: PTFE V-ring(3)
Male and Female Adaptor Rings: Carbon-filled PTFE V-ring
Graphite ULF Packing Systems: Graphite rings
Anti-Extrusion Washer: Filled PTFE (not required for Graphite ULF packing)
Lantern Ring: S31600 (316 stainless steel) (not required for Graphite ULF packing)
Packing Box Flange: S31600
Spring: ■ 17-7PH stainless steel or ■ N07718
Packing Follower: S31600 lined with carbon-filled PTFE
Packing Box Studs: Strain-hardened 316 stainless steel
Packing Box Nuts: 316 stainless steel SA194 Grade 8M

1. Refer to the valve specifications in this bulletin for pressure/temperature limits of valve parts. Do not exceed the pressure/temperature rating of the valve. Do not exceed any applicable code or standard limitation.
2. The Environmental Protection Agency (EPA) has set a limit of 100 parts per million (ppm) for fugitive emissions from a valve in selected VOC (Volatile Organic Compound) services.
3. In vacuum service, it is not necessary to reverse the ENVIRO-SEAL PTFE packing rings.

Figure 1. Fisher EZ Sectional with Optional Drain Plug



ENVIRO-SEAL, HIGH-SEAL Packing Systems

ENVIRO-SEAL and HIGH-SEAL packing systems offer exceptional sealing capabilities. These systems easily install in your existing valves or can be purchased with new valves. These systems offer an improved method of sealing your process to conserve valuable process fluid. The long-life and reliability of these systems also help to reduce your maintenance costs and downtime.

For applications requiring compliance with environmental protection regulations, the unique ENVIRO-SEAL packing system (figure 3) and, for hazardous service, the ENVIRO-SEAL bellows seal system (figure 2) are offered. The emission control packing system helps to keep emission concentrations below the EPA 100 ppm requirement.

For an excellent stem seal in applications that are not environmentally-sensitive, the HIGH-SEAL Graphite ULF packing system (figure 3) is offered. The HIGH-SEAL packing system provides excellent sealing at pressure/temperature ratings beyond ENVIRO-SEAL limits. ENVIRO-SEAL systems may also be applied for excellent stem sealing in higher pressure/temperature applications not requiring EPA compliance.

ENVIRO-SEAL packing systems, available with PTFE, Graphite ULF, or duplex packing, and the HIGH-SEAL Graphite ULF packing system feature live-loading and unique packing-ring arrangements for long-term, consistent sealing performance.

ENVIRO-SEAL, HIGH-SEAL Features

- Excellent Sealing Capabilities-- The packing system provides excellent sealing, guiding, and transmission of loading force. The excellent sealing of the ENVIRO-SEAL system can control emissions to below the EPA (Environmental Protection Agency) minimum of 100 ppm (parts per million).
- Improved Service Life-- ENVIRO-SEAL and HIGH-SEAL system design, very smooth stem surface, and live-loading combine to give you long service with very low maintenance. The external live-loading provides a constant load over the life of the packing material, which greatly reduces your need for packing box adjustment and maintenance.
- Easy Installation in Existing Valves-- All parts needed to install the systems in existing valves are available in a convenient kit.
- Adaptable to Many Applications-- ENVIRO-SEAL systems are available with PTFE or Graphite ULF packing for 9.5 through 31.8 mm (3/8 through 1-1/4 inch) diameter valve stems. HIGH-SEAL systems with Graphite ULF packing are available for 9.5 through 50.8 mm (3/8 through 2-inch) diameter valve stems. Standard ENVIRO-SEAL packing systems can be used in vacuum service with packing rings in standard orientation. It is not necessary to reverse the ENVIRO-SEAL PTFE packing rings.

Figure 2. Fisher EZ Valve with ENVIRO-SEAL Bellows Seal Bonnet

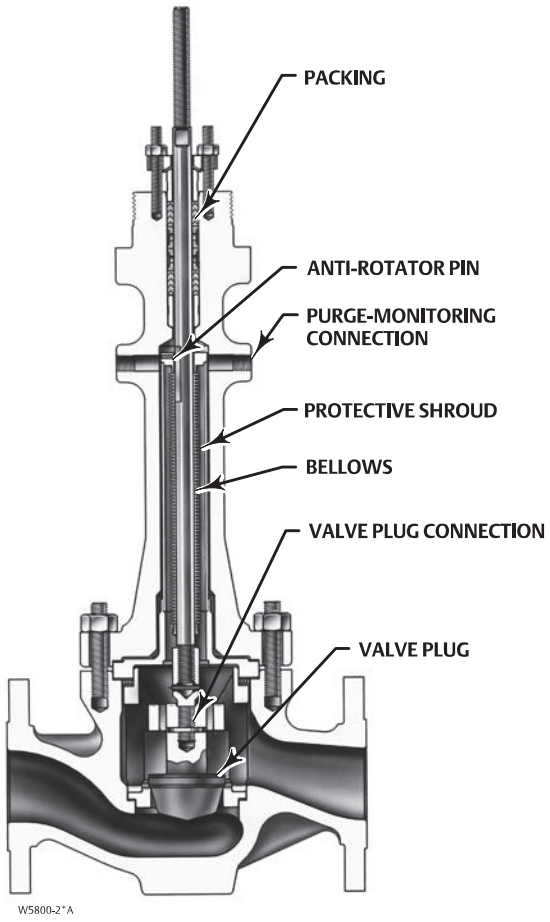
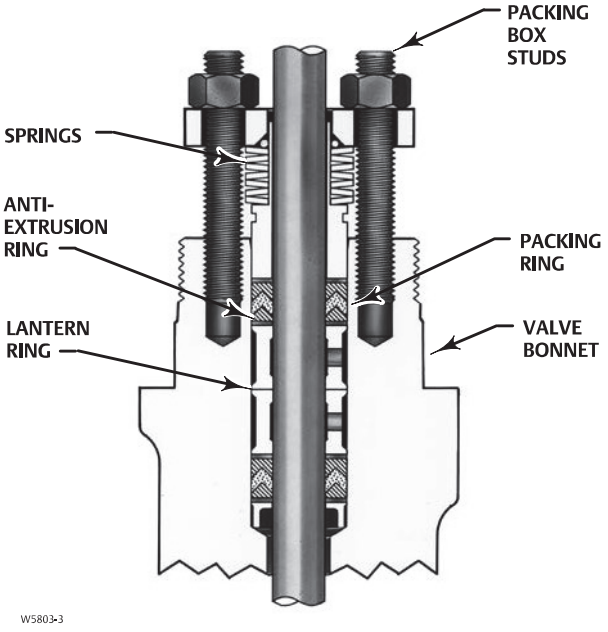
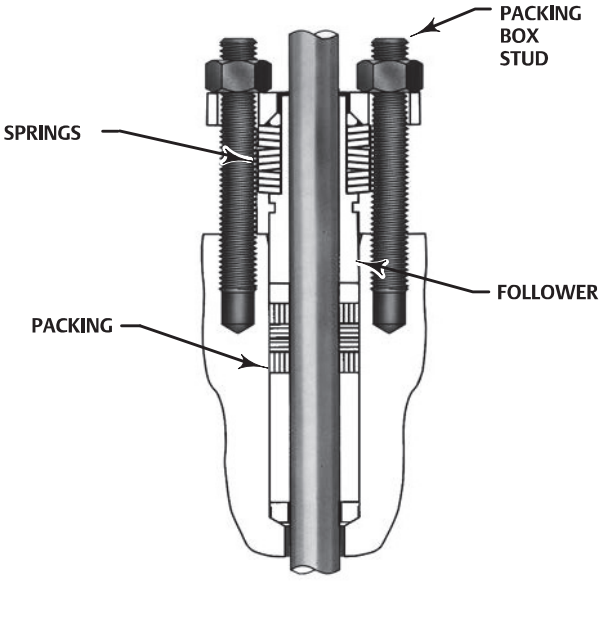


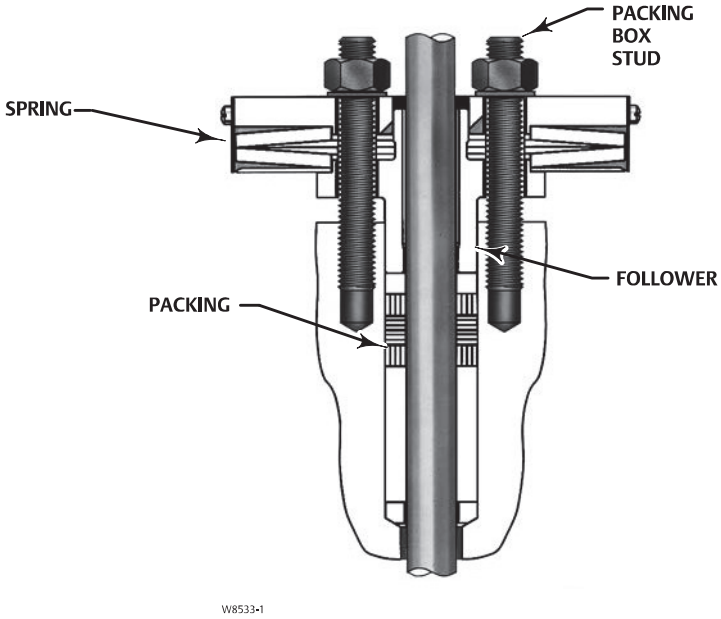
Figure 3. ENVIRO-SEAL and HIGH-SEAL Packing Systems



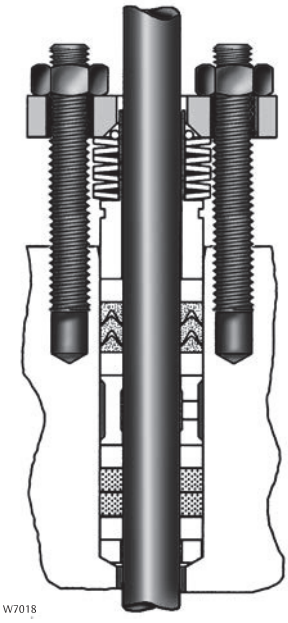
TYPICAL ENVIRO-SEAL PACKING SYSTEM WITH PTFE PACKING



TYPICAL ENVIRO-SEAL PACKING SYSTEM WITH GRAPHITE ULF PACKING



TYPICAL HIGH-SEAL PACKING SYSTEM WITH GRAPHITE ULF PACKING



TYPICAL ENVIRO-SEAL PACKING SYSTEM WITH DUPLEX PACKING

Class VI Shutoff Capabilities

EZ valves with metal seat and PTFE soft seat constructions can provide ANSI/FCI Class VI shutoff capabilities. See tables 1 and 2. For metal seated constructions consult your Emerson sales office or Local Business Partner.

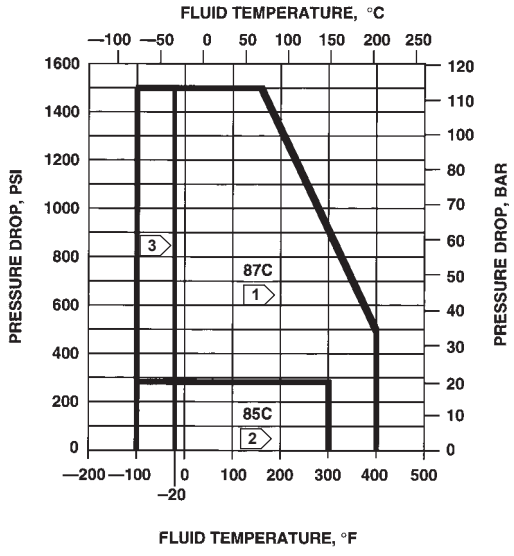
Table 1. Class VI Shutoff Availability

Valve	Port Size, Inches	Seat	Minimum Seat Load
EZ	≤ 4	PTFE	See Catalog 14

Table 2. Class VI Trim Materials

VALVE	CAGE/SEAT RING RETAINER	VALVE PLUG	SEAT RING	TRIM TEMPERATURE LIMIT	
				°C	°F
EZ	CF8M	S31600 w/ PTFE disk seat	S31600 w/ standard beveled seat	-73 to 149	-100 to 300
	CB7CU-1	S41600 w/ PTFE disk seat	S41600 w/ standard beveled seat	-29 to 204	-20 to 400

Figure 4. Pressure Drop / Temperature Capabilities for PTFE Seat Trim



Notes:
1 Also applies to trims 101C, 127C, 137C, 151C, 153C, 154C, and 158C.
2 Also applies to trims 104C, 128C, 129C, 139C, 152C, 155C, 156C, and 157C.
3 Trim selections requiring Class VI shutoff are limited to -29°C (-20°F) minimum temperature. Some PTFE seat constructions can be used to -73°C (-100°F) minimum temperature if Class VI shutoff is not required. See table 7 for additional valve body/trim temperature limitations.

Micro-Flute Valve Plugs for Minimum Leakage

The EZ valve can be furnished with PTFE composition-seat Micro-Flute valve plugs for Class VI shutoff per ANSI/FCI 70-2 and IEC 60534-4.

These valve plugs are available on NPS 1/2 to 2 valves with a 9.5 mm (3/8 inch) stem diameter, 9.5 mm (3/8 inch) actuator-stem connection, and 6.4 mm (0.25 inch) seat ring port diameter. These plugs have the same flow coefficients as standard Micro-Flute plugs. Standard seat rings are used.

The valve plugs have a screwed retainer that holds the seat disk and valve plug tip to the valve stem.

Table 3. Material Cross Reference

Standard Designation	Other Designation	Standard Designation	Other Designation
CB7Cu-1	17-4 PH Stainless Steel, Cast	WC9	Chrome-Moly Steel, Cast
S17400	17-4 PH Stainless Steel	N04400	Alloy 400
CF8M	316 Stainless Steel, Cast	N05500	Alloy K500
S31600	316 Stainless Steel	M35-1	Alloy 400 Cast
CoCr-A	Alloy 6 Hardfacing	S31603	316L Stainless Steel
R30006	Alloy 6, Cast	S41600	416 Stainless Steel
Alloy 6B	Alloy 6, Wrought	WCC	WCC Steel, Cast

Table 4. Typical Combinations of Metal Trim Parts for Equal Percentage (Including Micro-Form), Linear, and Quick Opening Valve Plugs

Trim Designation	Valve Plug	Valve Stem	Seat Ring	Seat Ring Retainer	Disk Seat and Retainer for Optional PTFE-Seat Construction	Guide Bushing
101(1)	S41600 (416 stainless steel) hardened	S31600 (316 stainless steel)	S41600 hardened	CB7Cu-1 (17-4 PH stainless steel)	S41600	S17400 (17-4 PH stainless steel)
104	S31600 (316 stainless steel)	S31600	S31600	CB7Cu-1	S31600	S17400
120	N05500	N05500	N05500	M35-1	N05500	N05500
127 and 127H(3)	S31600 w/CoCr-A seat & guide	S31600	S31600 w/CoCr-A seat	CF8M (316 stainless steel)	---	Alloy 6B
128	S31600 w/CoCr-A seat	S31600	S31600 w/CoCr-A seat	CF8M	---	Alloy 6B
129(2)	S31600	S31600	S31600	CF8M	S31600	Alloy 6B
137	S31600 w/CoCr-A seat & guide	S31600	S31600 w/CoCr-A seat	CB7Cu-1	---	S17400
139	S31600 w/CoCr-A seat	S31600	S31600 w/CoCr-A seat	CB7Cu-1	---	S17400

1. Standard trim for cast iron, WCC, and WC9 valve bodies, except Micro-Flow and Micro-Flute.
2. Standard trim for CF8M valve body.
3. Utilizes special welded seat ring retainer-guide bushing assembly required for high temperature service.

Table 5. Typical Combinations of Metal Trim Parts for Micro-Flute and Micro-Flow Valve Plugs (These Constructions Do Not Use Guide Bushing)

Trim Designation	Valve Plug	Valve Stem	Seat Ring	Seat Ring Retainer	Disk Seat and Retainer for Optional PTFE-Seat Construction
151	S41600 (416 SST) hardened	S31600 (316 stainless steel)	S41600 hardened	CB7Cu-1 (17-4 PH stainless steel)	---
152(2)	S31600 (316 SST) w/CoCr-A seat, R30006 tip	S31600	S31600	CB7Cu-1	S31600
153	N05500	N05500	N05500	M35-1	N05500
154	S31600 w/CoCr-A seat, R30006 tip	S31600	S31600 w/CoCr-A seat & bore	CF8M (316 stainless steel)	---
155	S31600 w/CoCr-A seat, R30006 tip	S31600	S31600 w/CoCr-A seat(3)	CF8M	---
156(1)	S31600 w/CoCr-A seat, R30006 tip	S31600	S31600	CF8M	S31600
157	S31600 w/CoCr-A seat, R30006 tip	S31600	S31600 w/CoCr-A seat(3)	CB7Cu-1	---
158	S31600 w/CoCr-A seat, R30006 tip	S31600	S31600 w/CoCr-A seat & bore	CB7Cu-1	---

1. Trim 156 can be used with a composition seal if requested.
2. Standard trim for Micro-Flow and Micro-Flute constructions in cast iron, WCC, CF8M, and WC9 valve bodies.
3. Micro-Flute and Micro-Flow valve plugs have a CoCr-A seat and R30006 tip, but are not recommended for erosive service without the additional use of CoCr-A on the seat and bore of the seat ring.

Table 6. Construction Materials and Temperature Limits

PART			MATERIAL	TEMPERATURE CAPABILITIES °C		°F	
Body-to-bonnet bolting. See table 17 for NACE bolting materials and temperatures	Cast iron valve body	Cap screws	Steel SAE Grade 5	-29	232(1)	-20	450(1)
	WCC steel body	Studs	Steel SA-193-B7	-29	427	-20	800
		Nuts	Steel SA-194-2H (lubricated)				
	CF8M (316 stainless steel) body	Studs	Steel SA-193-B7 (standard)	-48	427	-55	800
		Nuts	Steel SA-194-2H (standard)				
		Studs	304 stainless steel SA-320-B8	-198	38	-325	100
		Nuts	304 stainless steel SA-194-8				
		Studs	316 stainless steel SA-193-B8M (strain hardened)	-198	427	-325	800
		Nuts	316 stainless steel SA-194-8M (lubricated)				
Seat disk (optional)			PTFE	-73	204	-100	400
Bonnet and seat ring gasket			S31600 (316 stainless steel)/graphite(2)	-198	593(4)	-325	1100(4)
			PTFE-coated N04400 (optional for trim 120)	-73	149	-100	300
Spiral wound gaskets			N04400/PTFE (optional for trims 120 & 153)	-73	149	-100	300
			N06600/graphite (FGM) standard	-198	593(4)	-325	1100(4)
Shim			S31600	These materials not limiting factors			
			N04400 (standard for trims 120 & 153)	These materials not limiting factors			
Packing flange studs and nuts when used with std bonnet			S31600	-198	593	-325	1100
Packing (temperatures shown are material temperature capabilities). See table 8 for proper bonnet selection			PTFE V-ring	-40	232	-40	450
			PTFE/composition	-73	232	-100	450
			Graphite ribbon/filament	-198	538(5)	-325	1000(5)
			Graphite ribbon for high-temperature oxidizing service	-198	649	-325	1200
Packing follower			S31600(2)	-198	593	-325	1100
			N04400 (optional for trims 120 & 153)	-198	482	-325	900
Packing spring			S31600	-198	593	-325	1100
Lantern ring (for double packing)			S31600(3)	-198	593	-325	1100
			N04400 (standard for trims 120 & 153)	-198	482	-325	900
Packing box ring			S31600(3)	-198	593	-325	1100
			N04400	-198	482	-325	900

1. Temperature limit for bodies with screwed end connections is 208°C (406°F).
2. Standard for all trim.
3. Standard for all trim except for trim 120 and 153.
4. Except 427°C (800°F) for oxidizing service.
5. Except 371°C (700°F) for oxidizing service.

Table 7. Valve Body/Trim Temperature Capabilities for Metal Trim Parts

VALVE BODY MATERIAL	VALVE BODY SIZE, NPS	TEMPERATURE CAPABILITIES									
		Trim for Equal Percentage (Including Micro-Form), Linear, and Quick Opening Valve Plugs					Trim for Micro-Flute and Micro-Flow Valve Plugs				
		Trim Designation	°C		°F		Trim Designation	°C		°F	
			Min	Max	Min	Max		Min	Max	Min	Max
Cast iron	1/2, 3/4, 1, 1-1/2, or 2	101	-29	232	-20	450	151	-29	232	-20	450
		120	-73	232	-100	450	153	-73	232	-100	450
		87, 127, 137	-73	232	-100	450	154, 158	-73	232	-100	450
		85, 86, 128, 129	-73	232(1)	-100	450(1)	---	---	---	---	---
		139, 104	-73	232(1)	-100	450(1)	152, 155, 156, 157	-73	149	-100	300
	3 or 4	101	-29	232	-20	450	---	---	---	---	---
		104, 139	-73	232(1)	-100	450(1)	---	---	---	---	---
		120	-73	232	-100	450	---	---	---	---	---
		87, 127	-73	232	-100	450	---	---	---	---	---
		85, 86, 128, 129	-73	232(1)	-100	450(1)	---	---	---	---	---
		137	-73	232	-100	450	---	---	---	---	---
WCC steel	1/2, 3/4, 1, 1-1/2, or 2	101	-29	427	-20	800	151	-29	316	-20	600
		104, 139	-29	427(1)	-20	800(1)	152, 157	-29	149	-20	300
		120	-29	316	-20	600	153	-29	316	-20	600
		87, 127	-29	260	-20	500	154	-29	427	-20	800
		86, 128	-29	260(1)	-20	500(1)	---	---	---	---	---
		85, 129	-29	260(1)	-20	500(1)	156	-29	149	-20	300
		137, 127H	-29	427	-20	800	158	-29	427	-20	800
	3	101, 127H	-29	427	-20	800	---	---	---	---	---
		104, 139	-29	371(1)	-20	700(1)	---	---	---	---	---
		120	-29	316	-20	600	---	---	---	---	---
		87, 127	-29	371	-20	700	---	---	---	---	---
		85, 86, 128, 129	-29	371(1)	-20	700(1)	---	---	---	---	---
		137	-29	371	-20	700	---	---	---	---	---
	4	101	-29	427	-20	800	---	---	---	---	---
		104, 139	-29	371(1)	-20	700(1)	---	---	---	---	---
		120	-29	316	-20	600	---	---	---	---	---
		87, 127, 127H	-29	338	-20	640	---	---	---	---	---
		85, 86, 128, 129	-29	338(1)	-20	640(1)	---	---	---	---	---
		137	-29	371	-20	700	---	---	---	---	---
CF8M (316 stainless steel)	1/2, 3/4, 1, or 1-1/2	101	-29	354	-20	670	151	-29	316	-20	600
		104	-101	371(1)	-150	700(1)	152	-101	149	-150	300
		120	-198	316	-325	600	153	-198	316	-325	600
		87, 127	-198	260	-325	500	154	-198	593	-325	1100
		127H(3)	-198	593	-325	1100	---	---	---	---	---
		86, 128	-198	260(1)	-325	500(1)	---	---	---	---	---
		85, 129	-198	260(1)	-325	500(1)	156	-198	149	-325	300
		137	-101	371	-150	700	158	-101	371	-150	700
		139	-101	371(1)	-150	700(1)	157	-101	149	-150	300
	2	101	-29	288	-20	550	151	-29	288	-20	550
		104	-101	299(1)	-150	570(1)	152	-101	149	-150	300
		120	-198	316	-325	600	153	-198	316	-325	600

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Summary: Staff Report of Investigation Exhibit 1 Part 1 electronically filed by Mr. Thomas E Stikeleather on behalf of PUCO Staff.