SS-260
Gas Stop/Ratio Valve

Installation and Operation Manual
Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual 26311, Revision Status & Distribution Restrictions of Woodward Technical Publications, on the publications page of the Woodward website: www.woodward.com/publications

The latest version of most publications is available on the publications page. If your publication is not there, please contact your customer service representative to get the latest copy.

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

If the cover of this publication states "Translation of the Original Instructions" please note:

The original source of this publication may have been updated since this translation was made. Be sure to check manual 26311, Revision Status & Distribution Restrictions of Woodward Technical Publications, to verify whether this translation is up to date. Out-of-date translations are marked with . Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

Revisions—Changes in this publication since the last revision are indicated by a black line alongside the text.
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Important Definitions

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

- **DANGER**—Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- **WARNING**—Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- **CAUTION**—Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- **NOTICE**—Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT**—Designates an operating tip or maintenance suggestion.

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**WARNING**

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

---

**WARNING**

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:
- Eye Protection
- Hearing Protection
- Hard Hat
- Gloves
- Safety Boots
- Respirator

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

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**WARNING**

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

---

**WARNING**

Automotive Applications

On- and off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.
Battery Charging Device

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Electrostatic Discharge Awareness

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

- Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).
- Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.
- Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules.

Follow these precautions when working with or near the control.
1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.
Regulatory Compliance

European Compliance for CE Marking
(These listings are limited only to those units bearing the CE Marking.)

EMC Directive: Declared to 2004/108/EC COUNCIL DIRECTIVE of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and all applicable amendments. 2004/108/EC is met by evaluation of the physical nature to the EMC protection requirement. Electromagnetically passive or “benign” devices are excluded from the scope of the Directive 2004/108/EC, however they also meet the protection requirement and intent of the directive.


Other European Compliance
Compliance with the following European Directives or standards does not qualify this product for application of the CE Marking:


ATEX: Exempt from the non-electrical portion of the ATEX Directive 94/9/EC due to no potential ignition sources per EN 13463-1.

Other International Compliance
GOST R: Certified for use in explosive atmospheres within the Russian Federation per GOST R certificate POCC US. ГБ06.Б01025 as ExnAlIT3 X.
North American Compliance
Suitability for use in North American Hazardous Locations is the result of compliance of the individual components:

**Servo Valve:** FM Certified for Class I, Division 2, Groups A, B, C, D, FM 4B9A6AX, for use in the United States.

Some units are CSA Certified for Canadian Class I, Division 2, Groups A, B, C, D as a component for use in other equipment subject to acceptance by CSA or Inspection Authority having jurisdiction, per CSA 1072373.

**Junction Box:** UL Listed for Class I, Zone 1, AEx e II, Ex e II, T6, UL E203312 for use in United States and Canada.

**LVDT:** ETL Certified for Class I, Divisions 1 and 2, Groups A, B, C, D, T3, ETL J98036083-003 for use in United States and Canada.

**Special Conditions for Safe Use**
Wiring must be in accordance with North American Class I, Division 2 or European Zone 2, Category 3 wiring methods as applicable, and in accordance with the authority having jurisdiction.

Field Wiring must be suitable for at least 100 °C.

T3 reflects conditions without process fluid. The surface temperature of this valve approaches the maximum temperature of the applied process media. It is the responsibility of the user to ensure that the external environment contains no hazardous gases capable of ignition in the range of the process media temperatures.

Compliance with the Machinery Directive 2006/42/EC noise measurement and mitigation requirements is the responsibility of the manufacturer of the machinery into which this product is incorporated.

The risk of electrostatic discharge is reduced by permanent installation of the valve, proper connection to the protective earth (PE) terminals, and care when cleaning. The valve should not be cleaned unless the area is known to be non-hazardous.

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**WARNING**

EXPLOSION HAZARD—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

Substitution of components may impair suitability for Class I, Division 2 or Zone 2 applications.

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**AVERTISSEMENT**

RISQUE D'EXPLOSION—Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.

La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, Division 2 ou Zone 2.
Chapter 1.
General Information

The Woodward Gas Stop/Ratio Valve (Figure 1-1) performs a dual function for industrial or utility gas turbines. One function rapidly shuts off fuel to the turbine fuel control system. Another function provides accurate control of gas fuel pressure at the outlet of the stop/ratio valve. This pressure is applied to the inlets of the gas fuel control valve.

The Gas Stop/Ratio Valve features a modular design, and meets critical control characteristics while allowing the same valve design to accommodate a variety of stroke, force output, and mechanical interface arrangements. The electrical and mechanical interfaces have been designed for quick and easy assembly or removal of the valve, at the factory or in the field. The components include an on-board hydraulic filter, electrohydraulic servo valve, trip valve, single-acting hydraulic cylinder, and redundant LVDTs.

Optimum control of the gas turbine requires that the actuator and valve accurately and quickly track the demand signals transmitted by the control. The stop/ratio valve has been designed to provide output forces that exceed the opening and closing requirements with some margin. The additional margin helps ensure that the system moves rapidly even under service conditions where the valve has been contaminated or worn. The hydraulic trip relay valve has been selected to provide high operating force margins, high flow capacity, and to ensure the desired closure rate of the valve under trip conditions.

By using a long actuation rod between the hydraulic cylinder and the valve lever arm, the side-loading forces on the actuator shaft and seals are greatly reduced, decreasing the wear between sliding parts, and increasing the useful service life of the system. The ample distance between the wetted heavy-duty linear slide rings within the stop/ratio valve accommodates any remaining side load. These provisions provide extended service life even in severe service conditions.

This manual applies to SS-260 Stop/Ratio Valves for GE Frame turbines. The primary differences between these two stop/ratio valves, shown in this manual, are as follows:

<table>
<thead>
<tr>
<th>Feature</th>
<th>SS-260 Fisher Valve</th>
<th>LVDT Redundancy</th>
<th>Trip Circuit Operating Pressure*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flanged</td>
<td>Dual</td>
<td>LP or HP</td>
<td></td>
</tr>
<tr>
<td>Flangeless</td>
<td>Triple</td>
<td>LP or HP</td>
<td></td>
</tr>
</tbody>
</table>

* Units may have either low pressure (LP) or high pressure (HP) trip valves as per the applicable GE ordering drawing. The trip circuit operating pressure is 100 psig (6.9 bar) for LP circuits and 1600 psig (110 bar) for HP circuits.
### Gas Stop/Ratio Valve Functional Characteristics

<table>
<thead>
<tr>
<th>Functional Requirement</th>
<th>Gas Stop/Ratio Valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve Type</td>
<td>Fisher Type 8” SS-260 Vee-Ball®</td>
</tr>
<tr>
<td>Process Fluid</td>
<td>Natural gas and syngas</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>Natural gas 50 to 550 °F (10 to 288 °C) (heated fuel)</td>
</tr>
<tr>
<td>Position Accuracy</td>
<td>±1% full scale (over ±25 °F/±14 °C deviation from calibration)</td>
</tr>
<tr>
<td>Position Repeatability</td>
<td>±0.5% of point over the range of 10 to 100%</td>
</tr>
<tr>
<td>Hydraulic Fluid Type</td>
<td>Petroleum Based hydraulic fluids as well as fire resistant hydraulic fluids such as Fyrquel EHC</td>
</tr>
<tr>
<td>Operating Hydraulic Supply Pressure</td>
<td>1200 to 2400 psig (8274 to 16 552 kPa) (rated at 1600 psig/11 032 kPa)</td>
</tr>
<tr>
<td>Proof Test Fluid Pressure Level</td>
<td>2400 psig (16 548 kPa) minimum per SAE J214 (Prod Test)</td>
</tr>
<tr>
<td>Minimum Burst Fluid Pressure</td>
<td>6000 psig (41 370 kPa) minimum per SAE J214</td>
</tr>
<tr>
<td>Fluid Filtration Required</td>
<td>10–15 µm at 75 Beta</td>
</tr>
<tr>
<td>Hydraulic Fluid Contamination Level</td>
<td>Per ISO 4406 code 18/16/13 max, code 16/14/11 preferred</td>
</tr>
<tr>
<td>Hydraulic Fluid Temperature</td>
<td>+50 to +150 °F (+10 to +66 °C)</td>
</tr>
<tr>
<td>Actuator Ambient Temperature</td>
<td>–20 to +180 °F (–29 to +82 °C)</td>
</tr>
<tr>
<td>Vibration Test Level</td>
<td>Random 0.01500 g^2/Hz from 10 to 40 Hz ramping down to 0.00015 g^2/Hz at 500 Hz (1.04 Grms)</td>
</tr>
<tr>
<td>Shock</td>
<td>Limited to 30 g by servo valve</td>
</tr>
<tr>
<td>Trip Time</td>
<td>Less than 0.250 seconds (100–5% stroke)</td>
</tr>
<tr>
<td>Open Slew Time</td>
<td>5 to 95% in 0.630 ±0.27 seconds</td>
</tr>
<tr>
<td>Close Slew Time</td>
<td>95 to 5% in 0.630 ± 0.27 seconds</td>
</tr>
<tr>
<td>Trip Pressure (relative to hydraulic return pressure)</td>
<td>Low Pressure Trip Option: Pick up = 24 ±6 psid (165 ±41 kPa) Drop out = 22 ±6 psid (152 ±41 kPa) High Pressure Trip Option: Pick up = 750 ±100 psig (5171 ±690 kPa) Drop out = 750 ±100 psig (5171 ±690 kPa)</td>
</tr>
<tr>
<td>Hydraulic Fluid Connections</td>
<td>Trip Relay Pressure–1.062-12 UNF straight thread port (~12) Supply Pressure–1.312-12 UN straight thread port (~16) Return Port–1.625-12 UN straight thread port (~20)</td>
</tr>
<tr>
<td>Servo Input Current Rating</td>
<td>–7.2 to +8.8 mA (null bias 0.8 ±0.32 mA)</td>
</tr>
<tr>
<td>Servo Valve Flow Rating</td>
<td>15.0 US gal/min (56.8 L/min) at 1000 psid (6895 kPa) valve drop, 4-way</td>
</tr>
<tr>
<td>Servo Valve Rated Leakage</td>
<td>0.43 US gal/min (1.63 L/min) at 1500 psid (10 342 kPa)</td>
</tr>
<tr>
<td>Cylinder Bore</td>
<td>3.125 inch (79.38 mm) diameter</td>
</tr>
<tr>
<td>Stroke</td>
<td>6.00 inch (152.4 mm)</td>
</tr>
<tr>
<td>Static Seals</td>
<td>Elastomer per US MIL-R-83248 (Viton)</td>
</tr>
<tr>
<td>Paint</td>
<td>Two part Epoxy</td>
</tr>
<tr>
<td>Actuation Forces (opening at 1600 psig/11 034 kPa) (closing via spring)</td>
<td>Opening Force Fully Extended 4335 lb/19267 N Fully Retracted 7538 lb/33502 N Closing Force Fully Extended 7554 lb/33573 N Fully Retracted 4350 lb/19333 N</td>
</tr>
<tr>
<td>Design Availability Objective</td>
<td>Better than 99.5% over an 8760 hour period</td>
</tr>
<tr>
<td>Sound Level</td>
<td>Per Fisher-Rosemount Catalog 12</td>
</tr>
<tr>
<td>Weight</td>
<td>Flanged—975 lb (442 kg) Flangeless—880 lb (399 kg)</td>
</tr>
</tbody>
</table>

**NOTE**—Vee-Ball® is a trademark of Fisher-Rosemount.
Figure 1-1. 8" SS-260 Gas Stop/Ratio Valve (Partial Cutaway)
## Material List for Figure 1-1

<table>
<thead>
<tr>
<th>Item #</th>
<th>Part Name</th>
<th>Quan.</th>
<th>Base Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fisher SS-260 Vee-Ball</td>
<td>1</td>
<td>Various</td>
</tr>
<tr>
<td>2</td>
<td>Hydraulic Manifold</td>
<td>1</td>
<td>6061 Aluminum</td>
</tr>
<tr>
<td>3</td>
<td>Manifold Bolts</td>
<td>4</td>
<td>Steel</td>
</tr>
<tr>
<td>4</td>
<td>Trip Relay Valve</td>
<td>1</td>
<td>Steel</td>
</tr>
<tr>
<td>6</td>
<td>Hydraulic Filter</td>
<td>1</td>
<td>Various</td>
</tr>
<tr>
<td>7</td>
<td>O-rings</td>
<td></td>
<td>Viton Fluorocarbon per MIL-R-83248</td>
</tr>
<tr>
<td>8</td>
<td>Servo Valve</td>
<td>1</td>
<td>Various</td>
</tr>
<tr>
<td>9</td>
<td>Hydraulic Cylinder</td>
<td>1</td>
<td>1117 Mild Steel</td>
</tr>
<tr>
<td>10</td>
<td>Backup Rings</td>
<td>3</td>
<td>PTFE</td>
</tr>
<tr>
<td>11</td>
<td>Glydring</td>
<td>1</td>
<td>Turcon T46 (medium bronze-filled PTFE)</td>
</tr>
<tr>
<td>12</td>
<td>Syladring</td>
<td>2</td>
<td>Turcite T47 (medium bronze-filled PTFE)</td>
</tr>
<tr>
<td>13</td>
<td>LVDT</td>
<td>1</td>
<td>Various</td>
</tr>
<tr>
<td>14</td>
<td>Spring Access Cover</td>
<td>1</td>
<td>Aluminum</td>
</tr>
<tr>
<td>15</td>
<td>Spring Access Cvr Screws</td>
<td>4</td>
<td>Steel</td>
</tr>
<tr>
<td>16</td>
<td>Springs</td>
<td>2</td>
<td>AISI 5160H Steel</td>
</tr>
<tr>
<td>17</td>
<td>End Plate</td>
<td>1</td>
<td>Mild Steel</td>
</tr>
<tr>
<td>18</td>
<td>Guide Rods</td>
<td>4</td>
<td>“Stressproof” Steel</td>
</tr>
<tr>
<td>19</td>
<td>Guide Rod Nuts</td>
<td>4</td>
<td>Steel</td>
</tr>
<tr>
<td>20</td>
<td>Conduit</td>
<td>2</td>
<td>Various</td>
</tr>
<tr>
<td>21</td>
<td>Wiring Box Assembly</td>
<td>1</td>
<td>Various</td>
</tr>
<tr>
<td>22</td>
<td>Terminal Strip</td>
<td>1</td>
<td>NOT SHOWN</td>
</tr>
<tr>
<td>23</td>
<td>Eye Bolt</td>
<td>2</td>
<td>Steel</td>
</tr>
<tr>
<td>24</td>
<td>Eye Bolt Nut</td>
<td>2</td>
<td>Steel</td>
</tr>
<tr>
<td>25</td>
<td>Push Rod</td>
<td>1</td>
<td>“Stressproof” Steel</td>
</tr>
<tr>
<td>26</td>
<td>Spring Plate</td>
<td>1</td>
<td>1117 Steel</td>
</tr>
<tr>
<td>27</td>
<td>Guide Bushing</td>
<td>1</td>
<td>SAE 660 Bearing Bronze</td>
</tr>
<tr>
<td>28</td>
<td>Upper End Plate</td>
<td>1</td>
<td>6061-T6 Aluminum</td>
</tr>
<tr>
<td>29</td>
<td>Piston</td>
<td>1</td>
<td>AISI 1018 Steel</td>
</tr>
<tr>
<td>30</td>
<td>Cushion Spring</td>
<td>1</td>
<td>17-7 PH Stainless Steel</td>
</tr>
<tr>
<td>31</td>
<td>Cushion Piston</td>
<td>1</td>
<td>1117 Steel</td>
</tr>
<tr>
<td>32</td>
<td>Retaining Ring</td>
<td>1</td>
<td>Steel</td>
</tr>
<tr>
<td>33</td>
<td>Stop Plate</td>
<td>1</td>
<td>1117 Steel</td>
</tr>
<tr>
<td>34</td>
<td>Return Tube (drain tube)</td>
<td>1</td>
<td>1117 Steel</td>
</tr>
<tr>
<td>35</td>
<td>Screw</td>
<td>1</td>
<td>Steel</td>
</tr>
<tr>
<td>36</td>
<td>Tubular Housing</td>
<td>1</td>
<td>5052 Aluminum</td>
</tr>
<tr>
<td>37</td>
<td>Rod Ends</td>
<td>2</td>
<td>Steel</td>
</tr>
<tr>
<td>38</td>
<td>Turnbuckle</td>
<td>2</td>
<td>Steel</td>
</tr>
<tr>
<td>39</td>
<td>Nuts</td>
<td>2</td>
<td>Steel</td>
</tr>
<tr>
<td>40</td>
<td>LVDT Bracket</td>
<td>1</td>
<td>Steel</td>
</tr>
<tr>
<td>41</td>
<td>Lever</td>
<td>1</td>
<td>Steel</td>
</tr>
<tr>
<td>42</td>
<td>Screw</td>
<td>1</td>
<td>Steel</td>
</tr>
<tr>
<td>43</td>
<td>Locking Nut</td>
<td>1</td>
<td>Steel</td>
</tr>
</tbody>
</table>
Figure 1-2a. 8" SS-260 Gas Stop/Ratio Valve Outline Drawing
(shown with high pressure trip valve)
Figure 1-2b. 8" SS-260 Gas Stop/Ratio Valve Outline Drawing (shown with high pressure trip valve)
Figure 1-2c. 8" SS-260 Gas Stop/Ratio Valve Outline Drawing
(shown with low pressure trip valve)
Figure 1-2d. 8" SS-260 Gas Stop/Ratio Valve Outline Drawing
(shown with low pressure trip valve)
Notes for Figure 1-2

1. Installation Orientation:
   Actuator must be oriented vertically, above pipe. Actuator and its support struts
   must be supported only by the fuel pipe flanges.
   See elsewhere in this manual for other installation recommendations

2. Replacement Parts
   Servo Valve—Woodward part number 1350-1006
   O-rings for servo valve—Woodward part number 1355-115 (4x) and 1355-107 (1x)
   Filter element—Woodward part number 1326-8002
   LVDT—Woodward part number 1886-7009
   Trip relay valve—Woodward part number 1309-045
   Seal kit for trip relay valve—Woodward part number 8928-368

Figure 1-3. 8" SS-260 Gas Stop/Ratio Valve Hydraulic Schematic
Figure 1-4a. 8" SS-260 Gas Stop/Ratio Valve Electrical Schematic and Wiring Diagram
Figure 1-4b. 8" SS-260 Gas Stop/Ratio Valve Electrical Schematic and Wiring Diagram
Chapter 2.
Stop/Ratio Valve Operation

The Gas Stop/Ratio Valve actuator is controlled by an electronic servo-control system (not included), which compares the commanded and actual valve positions. The control system modulates the input current signal to the electrohydraulic servo valve to minimize the positioning system error. See Figure 1-3 for a functional schematic of the single acting actuator.

Hydraulic oil enters the actuator via a removable element filter with integral high $\Delta P$ indicator and is directed to a four way, electrohydraulic servo valve used in a three-way configuration. The PC1 control pressure output from the servo valve is directed to the top of the hydraulic piston. When the force exerted by the hydraulic pressure exceeds the force of the opposing loading springs, the output piston extends, rotating the valve in the opening direction.

The trip relay circuit utilizes a trip relay valve and two logic valves to override the servo pressure that is normally directed to the top of the hydraulic piston. When trip pressure is lost, these valves act in concert to block the servo valve output and to dump the pressure above the hydraulic piston to drain. The actuator spring force then rapidly retracts the actuator, rotating the gas valve to the closed position.

Redundant LVDT position feedback transducers are also mounted within each actuator. The LVDT sensor cores and support rods are connected to the main actuator output rod by a guided coupling arrangement that maintains LVDT core/coil alignment.
Chapter 3. 
Standard Component Details

Triple Coil Electrohydraulic Servo Valve Assembly

The stop/ratio valve actuator utilizes a two stage hydraulic servo valve to modulate the position of the output shaft and thereby control the stop ratio valve. The first stage torque motor utilizes a triple wound coil, which controls the position of the first and second stage valves in proportion to the total electrical current applied to the three coils.

If the control system requires a rapid movement of the valve to increase fuel pressure to the control valves, the total current is increased well above the null current. In such a condition, supply oil is admitted to the cavity above the actuator piston. The flow rate delivered to the upper piston cavity is proportional to the total current applied to the three coils. Thus, the actuator stroke velocity and the valve opening are also proportional to the current (above null) supplied to the torque motor above the null point.

If the control system requires a rapid movement to reduce fuel pressure downstream of the stop/ratio valve, the total current is reduced well below the null current. In such a condition, the actuator piston cavity is connected to the hydraulic drain circuit. The flow rate returning from the upper piston cavity of the valve is proportional to the magnitude of the total current below the null value. The flow rate and closing velocity of the valve are in this case proportional to the total current below the null point.

Near the null current, the servo valve essentially isolates the upper piston cavity from the hydraulic supply and drain, and the upper piston pressure and spring load are balanced to maintain a constant position. The control system, which regulates the amount of current delivered to the coils, modulates the current supplied to the coil to obtain proper closed loop operation of the system.

Trip Relay Valve Assembly

The stop/ratio trip relay circuit utilizes a three-way, two position, hydraulically operated valve to override the commanded actuator position in response to a drop in trip pressure. The output of this trip relay valve controls two logic valves. A pilot-to-open (PTO) logic valve is interposed between the servo valve and the top of the hydraulic cylinder. A pilot-to-close (PTC) logic valve is interposed between the top of the hydraulic piston and drain. These logic valves, operated by the trip relay valve, provide the large flow area required for rapid actuator motion.

Both a low pressure trip valve and a high pressure trip valve are offered, as designated on the GE Order Drawing. These trip valves accommodate low pressure or high pressure trip circuits and operate as follows.
SS-260 Gas Stop/Ratio Valve Manual 26276

Low Pressure Trip Valve

When the externally supplied trip pressure is greater than 24 ±6 psid (165 ±41 kPa), relative to drain pressure, the PTO logic valves allow servo valve pressure to reach the top of the hydraulic piston and the PTC valve prevents loss of this pressure to drain. When trip pressure falls below 22 ±6 psid (152 ±41 kPa), relative to drain pressure, the trip relay valve shifts, causing the PTC and PTO valves to also shift. The PTO valve closes, blocking the servo valve outlet, and the PTC valve opens, dumping the hydraulic piston pressure to drain. The force supplied by the actuator return springs then pushes the actuator pushrod up, rotating the gas valve to the closed position, stopping fuel flow to the fuel metering system.

High Pressure Trip Valve

When the externally supplied trip pressure is greater than 750 ±100 psid (5171 ±690 kPa), relative to drain pressure, the PTO logic valves allow servo valve pressure to reach the top of the hydraulic piston and the PTC valve prevents loss of this pressure to drain. When trip pressure falls below 750 ±100 psid (5171 ±690 kPa), relative to drain pressure, the trip relay valve shifts, causing the PTC and PTO valves also to shift. The PTO valve closes, blocking the servo valve outlet, and the PTC valve opens, dumping the hydraulic piston pressure to drain. The force supplied by the actuator return springs then pushes the actuator pushrod up, rotating the gas valve to the closed position, stopping fuel flow to the fuel metering system.

NOTICE

Entrapped air may defeat the hydraulic cushion action of the actuator, resulting in excessive impact forces during a “trip” command. So, during the initial start-up and prior to operation following service of the actuator, oil filter, or hydraulic supply line, the following procedure must be completed before the unit is commanded to “trip”.

- Bleed entrapped air from the hydraulic line supplying the actuator.
- Command the actuator to rapidly stroke (but do not command it to “trip”) between its fully retracted and fully extended positions at lease 20 cycles to purge entrapped air from the actuator.

This precautionary procedure is especially important when the actuator is oriented horizontally or upside-down (actuator below the process valve). There is risk of actuator damage if it is commanded to “trip” before entrapped air has been removed from the actuator and from the hydraulic supply line.

Hydraulic Filter Assembly

The stop/ratio actuator is supplied with an integrated, high capacity filter. This broad range filter protects the internal hydraulic control components from large oil-borne contaminants that might cause the hydraulic components to stick or operate erratically. The filter is supplied with a visual indicator which indicates when the pressure differential exceeds the recommended value, indicating that replacement of the element is necessary.
LVDT Position Feedback Sensors

The stop/ratio actuator uses redundant LVDTs for position feedback. The flanged version uses dual LVDTs whereas the flangeless version uses triple LVDTs. The LVDTs are factory set to give 0.7 ±0.1 Vrms feedback at the valve-closed position and 3.5 ±0.5 Vrms feedback at the valve-open position. The actual voltage values for each LVDT are recorded on a label placed inside the actuator electrical box, for reference during field calibration.
Chapter 4.
Installation

General

See Chapter 1 and Figure 1-2 (outline drawing) for:
- Overall dimensions
- Process piping flange locations
- Hydraulic fitting sizes
- Electrical connections
- Lift points and center of gravity
- Weight of the valve

The design of the Vee-Ball® valve requires that the rotary drive shaft be mounted horizontally. Additionally, a vertical actuator position is generally preferred to conserve floor space as well as ease of making electrical, fuel, and hydraulic connections and changing the hydraulic filter element.

The stop/ratio valve is designed for support by the piping flanges alone. Additional supports are neither needed nor recommended.

The standard stop/ratio valve is supplied with a left-hand orientation as shown in the outline drawing. The valve can be configured with a right-hand orientation; however, this request must be on the purchase order at the time the order is placed for this change to take place.

**WARNING**

Due to typical noise levels in turbine environments, hearing protection should be worn when working on or around the valve.

**WARNING**

The surface of this product can become hot enough or cold enough to be a hazard. Use protective gear for product handling in these circumstances. Temperature ratings are included in the specification section of this manual.

**NOTICE**

Entrapped air may defeat the hydraulic cushion action of the actuator, resulting in excessive impact forces during a “trip” command. So, during the initial start-up and prior to operation following service of the actuator, oil filter, or hydraulic supply line, the following procedure must be completed before the unit is commanded to “trip”.
- Bleed entrapped air from the hydraulic line supplying the actuator.
- Command the actuator to rapidly stroke (but do not command it to “trip”) between its fully retracted and fully extended positions at lease 20 cycles to purge entrapped air from the actuator.

This precautionary procedure is especially important when the actuator is oriented horizontally or upside-down (actuator below the process valve). There is risk of actuator damage if it is commanded to “trip” before entrapped air has been removed from the actuator and from the hydraulic supply line.
EXPLOSION HAZARD—The surface temperature of this valve approaches the maximum temperature of the applied process media. It is the responsibility of the user to ensure that the external environment contains no hazardous gases capable of ignition in the range of the process media temperature.

External fire protection is not provided in the scope of this product. It is the responsibility of the user to satisfy any applicable requirements for their system.

Do not lift or handle the valve by any conduit. Lift or handle the valve only by using the eyebolts.

Unpacking

The valve is shipped in an airtight bag with desiccant to ensure a non-corrosive environment. We recommend that the valve be kept in its shipping container until installation. If the valve is to be stored for extended periods of time, encase the valve in an airtight container with desiccant.

Piping Installation

Refer to ASME B16.5 for details of flange, gasket, and bolt types and dimensions.

Verify that the process piping flange-to-flange-face dimensions meet the requirements of the outline drawing (Figure 1-2) within standard piping tolerances. The valve should mount between the piping interfaces such that the flange bolts can be installed with only manual pressure applied to align the flanges. Mechanical devices such as hydraulic or mechanical jacks, pulleys, chain-falls, or similar should never be used to force the piping system to align with the valve flanges.

The stop/ratio valve, with its integral strut supports, must be supported only by the pipe flanges. Additional supports are neither needed nor recommended.

The SS-260 stop/ratio valve is equipped with an integral strut support system to minimize possible overstressing of the Fisher SS-260 valve neck during shipping and handling, as well as during operation. Inertial forces generated by the trip action of the actuator, or by externally induced motion of the piping to which the stop ratio valve is attached, must be contained by the integral support system. If the integral support system is not properly installed during trip operation, overstressing of the Fisher SS-260 valve neck may occur.

The stop/ratio valve is shipped with disposable shipping plates and four temporary studs to secure its strut support system during transport. This strut system must remain intact until the stop/ratio valve is readied for installation into the process piping. The strut support system reduces stresses incurred by the Fisher SS-260 valve neck and shaft during transit and operation.
Preparing the stop/ratio valve for installation requires the following procedure:

1. Suspend the stop/ratio valve assembly from the lifting hooks at its top.
2. Loosen the four ¾-16 strut attaching bolts.

**NOTICE**

Do not rest the weight of the stop/ratio valve assembly on the Fisher valve once the strut supports system bolts are loosened.

3. Remove and discard the four temporary flange studs and shipping plates.
4. Position the suspended stop/ratio valve assembly between the process piping flanges.
5. Position the lower strut brackets outboard of the process pipe flanges as shown in Figure 4-1.

**IMPORTANT**

The mating faces of the struts and strut brackets must remain free of lubrication, paint, or other contaminants to assure adequate friction and proper strut function.

Grade 5 (metric class 8.8) bolts or studs should be used to install the valve into the process piping.

For the flanged version, four 7 inch (177.8 mm) long threaded studs or bolts are required to secure the strut brackets. Standard length flange bolts are required in the remaining 8 flange bolt positions.

![Figure 4-1a. Close-up of Strut Brackets on Pipe Flanges (flanged version)](image-url)
For the flangeless version, the threaded stud length and diameter for Class 600 flanges must conform to the following table according to the valve flange size.

<table>
<thead>
<tr>
<th>Nominal Pipe Size</th>
<th>Number of Bolts</th>
<th>Diameter of Bolts</th>
<th>Stud Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 inch/203.2 mm</td>
<td>8</td>
<td>1.125 inch/28.6 mm</td>
<td>17 inch (min) / 432 mm (min)</td>
</tr>
<tr>
<td>8 inch/203.2 mm</td>
<td>4</td>
<td>1.125 inch/28.6 mm</td>
<td>21 inch (min) / 533 mm (min)</td>
</tr>
</tbody>
</table>

Flange gasket materials should conform to ANSI B16.20. The user should select a gasket material which will withstand the expected bolt loading without injurious crushing, and which is suitable for the service conditions.

When installing the valve into the process piping, it is important to properly torque the stud/bolts in the appropriate sequence in order to keep the flanges of the mating hardware parallel to each other. A two-step torque method is recommended. Once the studs/bolts are hand tightened, torque the studs/bolts in a crossing pattern to half the torque value listed in the following table. Once all studs/bolts have been tightened to approximately that value, repeat the pattern until the rated torque value below is obtained.

<table>
<thead>
<tr>
<th>Bolt Size</th>
<th>Rated Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.125 inch (28.6 mm)</td>
<td>300-350 lb-ft (407–475 N•m)</td>
</tr>
<tr>
<td>0.875 inch (22.2 mm)</td>
<td>150–175 lb-ft (203–237 N•m)</td>
</tr>
</tbody>
</table>

6. Install the pipe flange gaskets, flange studs, and flange stud nuts, snugging all flange nuts, but not tightening them at this time.
7. Partially tighten the four 0.750–16 strut attachment bolts enough to assure alignment of the strut and the strut bracket faces. Do not fully tighten at this time.
8. Tighten the piping flange studs per torque values above.
9. Tighten the four 0.750–16 strut attachment bolts to 280–300 lb-ft (380–407 N•m).
Hydraulic Connections

There are three hydraulic connections that must be made to each valve: supply, return, and trip oil. The connections to the valve are straight-thread O-ring style ports per SAE J514. The tubing up to the valve must be constructed to eliminate any transfer of vibration or other forces into the valve.

Make provisions for proper filtration of the hydraulic fluid that will supply the actuator. The system filtration should be designed to assure a supply of hydraulic oil with a maximum ISO 4406 contamination level of 18/16/13 and a preferred level of 16/14/11. The filter element included with the actuator is not intended to provide adequate filtration over the entire life of the actuator.

The hydraulic supply to the actuator is to be 1.000 inch (25.40 mm) tubing.

The hydraulic drain should be 1.25 inch (31.8 mm) tubing and must not restrict the flow of fluid from the valve. The drain pressure must not exceed 30 psig (207 kPa) under any condition.

The trip relay valve supply should be 0.750 inch (19.05 mm) tubing. The Trip Relay Pressure, under normal operating conditions, should be at least 40 psi (276 kPa) above drain pressure.

Electrical Connections

EXPLOSION HAZARD—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

Due to the hazardous location listings associated with this valve, proper wire type and wiring practices are critical to operation.

Protective earth (PE) ground must be connected on the junction box per the installation drawing to reduce the risk of electrostatic discharge in an explosive atmosphere.

Do not connect any cable grounds to “instrument ground”, “control ground”, or any non-earth ground system. Make all required electrical connections based on the wiring diagram (Figure 1-4).

The use of cable with individually-shielded twisted pairs is recommended. All signal lines should be shielded to prevent picking up stray signals from nearby equipment. Installations with severe electromagnetic interference (EMI) may require shielded cable run in conduit, double-shielded wire, or other precautions. Connect the shields at the control system side or as indicated by the control system wiring practices, but never at both ends of the shield such that a ground loop is created. Wires exposed beyond the shield must be less than 2 inches (51 mm). The wiring should provide signal attenuation to greater than 60 dB.
Servo Valve Electrical Connection

Servo valve cable must consist of three individually shielded twisted pairs. Each pair should be connected to one coil of the servo valve as indicated in Figure 1-4 (Wiring Diagram).

For flanged versions, the LVDT cable must consist of four individually shielded twisted pairs. For flangeless versions, the LVDT cable must consist of six individually shielded twisted pairs. Separate pairs should be used for each of the excitation voltages to the LVDT, and separate pairs should be used for each of the feedback voltages from the LVDT.

Fuel Vent Port

The fuel vent port, located on the SS-260 valve shaft packing assembly, must be vented to a safe location. In normal operation, this vent should have zero leakage. However, if excessive leakage is detected from this vent port, contact a Woodward representative for assistance.

Electronic Settings

Dynamic Tuning Parameters

It is imperative that the correct dynamic characteristics of this valve be input into the control system to ensure that the operation of the valve/control system is within acceptable limits.

![Block Diagram](image)

Figure 4-2. Stop/Ratio Valve Block Diagram

Ksv nominal = 8.1 in³/sec/mA at 1600 psi supply (valve opening); 14.8 in³/sec/mA at 1600 psi supply (valve closing); Ksv is proportional to square root of supply, and constant with position.

ZetaSV = 0.8

WnSV = 126 rad/s (20 Hz); WnSV is proportional to square root of supply

Ac = 9.62 in²

KL = 0.467 Vrms/inch

Servo Travel = 6.0 inches

TauL = 0.005 seconds (typical, depends on excitation/demodulation)
Null Current Adjustment

Every valve shipped contains documentation that gives the actual Null Current as measured by Woodward. It is imperative that the control system null current match the as-measured current for each valve in the system. Incorrect null current setting, with proportional control only, will result in position error.

Rigging Procedure

Inside the electrical enclosure of the valve, there is an adhesive label that contains the appropriate valve position (as a percent of full stroke), the physical stroke (inches), and the corresponding LVDT feedback signals for each LVDT (assuming 7.0 Vrms excitation at 3000 Hz).

Once the control system is connected to the valve and control of the valve is established, set the valve command position to 0% of full stroke. Measure the feedback voltage from each LVDT. Adjust the Offset in the feedback loop until the feedback voltage matches the documented values (see the label inside the electrical enclosure) for that position. Adjust the command position to 100% of full stroke. Adjust the Gain of the feedback loop until the LVDT feedback voltage matches the documented values. Set the command position to close the valve. Verify that the valve is closed visually and that the feedback voltage from the LVDT is 0.7 ± 0.1 Vrms. This process may have to be repeated to ensure the feedback voltages at both the 0% and 100% command positions match the documented values.
Chapter 5. Maintenance and Hardware Replacement

Maintenance

**WARNING** Any cleaning by hand or with water spray must be performed while the area is known to be non-hazardous to prevent an electrostatic discharge in an explosive atmosphere.

The Gas Stop/Ratio Valve requires no maintenance or adjustment in preparation for or during normal operation.

Woodward recommends routine checks of the DP gauge on the filter assembly to verify that the filter is not partially clogged. If the DP indicator shows red, the filter element needs to be replaced.

In the event that any of the standard components of the valve become inoperative, field replacement of certain components is possible. Contact a Woodward representative for assistance.

Hardware Replacement

**WARNING** To prevent possible serious personal injury, or damage to equipment, be sure all electric power, hydraulic pressure, and gas pressure have been removed from the valve and actuator before beginning any maintenance or repairs.

**WARNING** EXPLOSION HAZARD—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

Substitution of components may impair suitability for Class I, Division 2 or Zone 2 applications.

**WARNING** External fire protection is not provided in the scope of this product. It is the responsibility of the user to satisfy any applicable requirements for their system.

**WARNING** Due to typical noise levels in turbine environments, hearing protection should be worn when working on or around the Gas Stop/Ratio valve.

**WARNING** The surface of this product can become hot enough or cold enough to be a hazard. Use protective gear for product handling in these circumstances. Temperature ratings are included in the specification section of this manual.

**WARNING** Do not lift or handle the valve by any conduit. Lift or handle the valve only by using the eyebolts.

See the outline drawing (Figure 1-2) for the location of items.
Safety Block
(example, Woodward part number 3621-1091)

This part is used to mechanically block the actuator so that it cannot move during service.

**WARNING**

Use care and follow all instructions after removal of the spring access cover. Internal components can potentially crush fingers, and some components are held under significant force.

**Inserting Safety Block:**
1. Remove the access cover from the side of the stop/ratio actuator housing by removing the four #10-32 UNF screws and washers.
2. Apply hydraulic pressure to the stop/ratio actuator and manually manipulate the actuator electronic control to cause the actuator to stroke 75% to 100%.
3. Carefully insert the safety block through the access opening as shown in Figure 5-1, straddling the middle LVDT if applicable and the piston rod as shown. The safety block is provided with the stop/ratio valve. It is an aluminum weldment having dimensions of approximately 6 inches tall by 3 inches wide by 8 inches long (152 mm x 76 mm x 203 mm). The safety block should be oriented with the opening towards the piston rod and the 6 inch dimension parallel to the piston rod shaft, with the piston rod and middle LVDT (if applicable) centered between the 6-inch tall sides, fully inserted as shown. Its purpose is to prevent accidental movement of the actuator while the actuator is being serviced.
4. Manipulate the actuator control to command a fully closed stop/ratio valve position. This will result in the stop/ratio actuator piston resting on the safety block in about the 95% stroke position. In this position, the lower linkage bolt that connects the actuator and the Fisher gas valve becomes readily accessible.
5. Hydraulic pressure and electrical connections can now be removed, and the actuator will not move.

**Removing Safety Block:**
1. Hook up electrical connections and hydraulic pressure to actuator.
2. Apply hydraulic pressure to the stop/ratio actuator, and manually manipulate the actuator electronic control to cause the actuator to stroke 75% to 100%.
3. Carefully remove the safety block from the access opening as shown in Figure 5-1.
4. Reinstall the access cover on the side of the stop/ratio actuator housing. Torque screws to 34 ± 4 lb-in (3.8 ± 0.5 N•m).

![Figure 5-1. Safety Block](image)
Hydraulic Filter Assembly/Cartridge

The hydraulic filter is located on the hydraulic manifold, hanging directly under the servo valve.

Replacement of Filter Assembly
1. Remove four 0.312-18 UNC socket head cap screws.
2. Remove the filter assembly from manifold block.

**IMPORTANT**

The filter contains a large amount of hydraulic fluid that may be spilled during filter removal.

3. Remove the two O-rings present in the interface between the filter and the manifold.
4. Obtain a new filter assembly.
5. Place two new O-rings in the new filter assembly.
6. Install filter onto manifold assembly. Be sure to place the filter in the correct orientation. See the outline drawings (Figure 1-2).
7. Install four 0.312-18 cap screws through filter and torque into manifold to 160–200 lb-in (18.1–22.6 N•m).

**NOTICE**

Entrapped air may defeat the hydraulic cushion action of the actuator, resulting in excessive impact forces during a “trip” command. So, during the initial start-up and prior to operation following service of the actuator, oil filter, or hydraulic supply line, the following procedure must be completed before the unit is commanded to “trip”.

- **Bleed entrapped air from the hydraulic line supplying the actuator.**
- **Command the actuator to rapidly stroke (but do not command it to “trip”) between its fully retracted and fully extended positions at lease 20 cycles to purge entrapped air from the actuator.**

This precautionary procedure is especially important when the actuator is oriented horizontally or upside-down (actuator below the process valve). There is risk of actuator damage if it is commanded to “trip” before entrapped air has been removed from the actuator and from the hydraulic supply line.

Replacement of Filter Cartridge

**IMPORTANT**

The filter contains a large amount of hydraulic fluid that may be spilled during filter removal.

1. Using a 1-5/16 inch (~33+ mm) wrench, loosen the bowl from the filter assembly.
2. Remove the filter element by pulling it downward.
3. Obtain a new filter element.
4. Lubricate the O-ring on the ID of the cartridge with hydraulic fluid.
5. Install the cartridge into the assembly by sliding the open end of the cartridge upward onto the nipple.
6. Install the filter bowl. Tighten only by hand.
**NOTICE**

Entrapped air may defeat the hydraulic cushion action of the actuator, resulting in excessive impact forces during a “trip” command. So, during the initial start-up and prior to operation following service of the actuator, oil filter, or hydraulic supply line, the following procedure must be completed before the unit is commanded to “trip”.

- Bleed entrapped air from the hydraulic line supplying the actuator.
- Command the actuator to rapidly stroke (but do not command it to “trip”) between its fully retracted and fully extended positions at lease 20 cycles to purge entrapped air from the actuator.

This precautionary procedure is especially important when the actuator is oriented horizontally or upside-down (actuator below the process valve). There is risk of actuator damage if it is commanded to “trip” before entrapped air has been removed from the actuator and from the hydraulic supply line.

**Trip Relay Valve Cartridge**

The trip relay valve cartridge is located in an adaptor block mounted on top of the hydraulic manifold block.

**IMPORTANT**

Hydraulic fluid may spill during cartridge removal.

1. Using a 1.5 inch (~38+ mm) wrench, loosen the trip relay valve from the hydraulic manifold.
2. Slowly remove the cartridge from the manifold.
3. Obtain new trip relay valve cartridge and verify part number and revision with existing unit.
4. Verify that all O-rings and backup rings are present on new cartridge.
5. Lubricate O-rings with hydraulic fluid or petroleum jelly.
6. Install cartridge into manifold housing.
7. Torque to 80–90 lb-ft (108–122 N•m).

**Servo Valve**

The servo valve is located on the top of the hydraulic manifold directly above the filter assembly. Refer to the outline drawings (Figure 1-2).

**IMPORTANT**

There could be a substantial amount of hydraulic fluid upon removal.

1. Remove the cover to the electrical junction box.
2. Disconnect the servo valve wires from the connector blocks labeled 1–6.
3. Loosen the conduit fittings from the electrical box and the servo valve.
4. Carefully remove the conduit from the servo valve and pull the wiring out of the conduit.
5. Remove the four 0.312-18 UNC socket head cap screws holding the servo valve to the manifold.
6. Discard the eight O-rings between the servo valve, the adapter plate, and the manifold.
7. Obtain replacement servo valve and verify part number and revision with existing unit.
8. Place four new O-rings on the adapter plate.
9. Reposition adapter plate onto hydraulic manifold ensuring hydraulic passages and bolt holes are aligned correctly. Be sure that all four O-rings remain in their proper location during assembly on the lower side of the adapter plate facing the manifold.
10. Remove protective plate from replacement servo valve and verify that O-rings are on all four counter bores of the servo valve.
11. Place the servo valve onto the adapter plate that has been positioned on the hydraulic manifold. Be sure to orient the servo valve to match the original orientation. Be sure that all four O-rings remain in their proper location during assembly.
12. Install four 0.312-18 UNC socket head cap screws and torque to 108–132 lb-in (12.2–14.9 N•m).
13. Install the servo valve wiring through conduit and into electrical box.
14. Connect conduit to servo valve and torque to 100–125 lb-in (11–14 N•m).
15. Torque conduit to electrical box to 100–125 lb-in (11–14 N•m).
16. Install wires into servo valve connector blocks labeled 1–6 as shown in the wiring diagram (Figure 1-4). If it is necessary to cut wires for installation, be sure to retain at least one service loop of wiring.
17. Replace cover onto junction box and tighten screws.

LVDT Replacement

To prevent possible personal injury, do NOT remove the spring cover (which is spring-loaded to over 4000 lb/17760 N). The four 0.750-16 UNF spring cover attaching nuts have metal tab locks and should not be disturbed.

The LVDTs are located on the upper mounting plate located on the top of the large spring cylinder and below the hydraulic manifold. Refer to the outline drawings (Figure 1-2).

1. Remove the cover to the electrical junction box.
2. Disconnect the wires of the defective LVDT from the connector blocks.
3. Loosen the conduit fittings from the electrical box and from the defective LVDT.
4. Carefully remove the conduit from the defective LVDT and pull the LVDT wiring out of the conduit.
5. Remove the 0.500-20 UNF mounting nuts from all three LVDTs.
6. Remove the two 0.500-13 UNC socket head cap screws holding the LVDT bracket to the upper mounting plate.
7. Remove the LVDT mounting plate by lifting vertically upwards.
8. Remove the four #10-32 UNF screws holding the access cover on the side of the spring cylinder to gain access to the LVDT core rods.
9. Loosen the 0.375-24 UNF screws holding the access cover on the side of the spring cylinder to gain access to the LVDT core rods.
10. Remove the defective LVDT rod using the 0.250 inch flats at the top of the threads. The rod will be difficult to unscrew due to the thread-locking feature incorporated into the spring plate.
11. Obtain replacement LVDT and verify part number and revision with existing unit.
12. Install the 0.375-24 UNF jam nut onto the replacement LVDT core rod.
13. Install replacement LVDT rod into spring plate, positioning the rod height to approximately match the other LVDT rod heights. Do not tighten the jam nut at this time.
14. Carefully slide replacement LVDT through upper mounting plate and over the LVDT rod. Be careful to not force the LVDT at any time since this could damage the LVDT rod.
15. Replace the LVDT mounting plate over the three LVDTs.
16. Install the two 0.500-13 UNC socket head cap screws holding the LVDT bracket to the upper mounting plate and torque to 60–70 lb-ft (81.3–95 N•m).
17. Install the 0.500-20 UNF mounting nuts on all three LVDTs and torque the mounting nuts to 400–500 lb-in (45–56 N•m).
18. Install replaced LVDT wiring through conduit and into electrical box.
19. Connect conduit to LVDT and torque to 450–550 lb-in (51–62 N•m).
20. Torque conduit to electrical box to 450–550 lb-in (51–62 N•m).
21. Install wires into LVDT connector blocks as shown in the wiring diagram (Figure 1-4). If it is necessary to cut wires for installation, be sure to retain at least one service loop of wiring.
22. Once the LVDT is installed, it must then be calibrated as described below.

**LVDT Calibration**

1. Whenever an LVDT is replaced, or whenever its core rod adjustment is disturbed, the LVDT output voltage must be calibrated in the following way.

   **WARNING** Use care and follow all instructions after removal of the spring access cover. Internal components can potentially crush fingers, and some components are held under significant force.

   2. Shut off the hydraulic supply to the stop/ratio actuator.
   3. Remove the access cover from the side of the stop/ratio actuator housing by removing the four #10-32 UNF screws and washers, exposing the LVDT core rod adjustment.
   4. Loosen the LVDT core rod jam nut and adjust the LVDT rod so that the output of the replaced LVDT is 0.7 ± 0.1 Vrms with the stop/ratio actuator fully retracted (gas valve fully closed).
   5. Tighten the 0.375-24 UNF LVDT rod jam nut to 270–320 lb-in (31–36 N•m).
   6. Confirm that the LVDT output remains 0.7 ±0.1 Vrms. Readjust if required.
   7. Install the stroke measurement attachment bar (Woodward part number 3780-1034 provided with the stop/ratio actuator) to the moving plate of the actuator as shown in Figure 5-2.
   8. Attach an accurate stroke measurement device (dial indicator or equivalent), capable of measuring 6 inches (152 mm) of stroke, to the stop/ratio actuator body. Position the indicator plunger tip on the measurement bar, as shown in Figure 5-2.
   9. Apply hydraulic pressure to the stop/ratio actuator and manually command the actuator to stroke 6.000 ±0.010 inches (152.4 ±0.25 mm) by manipulating the electronic controller.
10. Note and record the LVDT output voltages at this 6.000 inches stroke position.
11. Remove the actuator control command, returning the actuator to its rest (gas valve closed) position.
12. Shut off the stop/ratio actuator hydraulic supply.
13. Update the stop/ratio control logic with the new LVDT output voltage value.
14. Remove the cover on the stop/ratio actuator electrical junction box.
15. Replace the original LVDT max output voltage value on the label in the stop/ratio actuator electrical junction box with the newly measured value.
16. Replace the cover on the junction box and tighten the screws.
17. Remove the dial indicator and measurement bar.
18. Reinstall the access cover with four #10-32 UNF screws, adjusting the closed indicator mark to align with the position indicator screw slot. Tighten the four cover attaching screws to 30–40 lb-in (3.4–4.5 N•m).

Figure 5-2. Stroke Measurement Attachment Bar

Separating the Stop/Ratio Actuator & Transfer Case Assembly from the Fisher Gas Valve

![Warning]

To prevent possible personal injury, do NOT remove the spring cover (which is spring-loaded to over 4000 lb/17 760 N). The four 0.750-16 UNF spring cover attaching nuts have metal tab locks and should not be disturbed.

1. Shut off the stop/ratio actuator hydraulic pressure.
2. Remove the linkage access cover and end plate assembly from the actuator transfer case. It is not necessary to remove the shaft position indicator or hub from the end plate.
3. Remove the actuator pushrod linkage cross bolt.
4. Loosen the clamp bolt on the actuator lever. Remove the lever.
5. Provide means to support the Fisher gas valve and to support and lift the stop/ratio actuator and transfer case assembly.
6. Remove the four 0.625-11 UNC bolts that attach the Fisher gas valve to the stop/ratio actuator transfer case.
7. Separate the transfer case and Fisher gas valve.
Joining the Actuator/Transfer Case Assembly to the Gas Valve

1. Remove the linkage access cover and end plate from the actuator transfer case.
2. Remove the lower rod end and its jam nut from the actuator pushrod.
3. Remove the turnbuckle from the actuator pushrod. Leave its jam nut on the pushrod.
4. Supporting both the actuator and the Fisher gas valve, join the actuator and valve, carefully guiding the valve shaft through the transfer case bearing.
5. Install the four 0.625-11 UNC bolts that secure the gas valve to the actuator. Tighten the bolts to 130–150 lb-ft (476–203 N•m)
6. Temporarily place the lever onto the valve shaft, oriented approximately as shown in Figure 5-3.
7. Pre-rig the valve by rotating the lever as required. A pry bar inserted through the transfer case inspection window can be used to move the lever.
8. Pre-adjust the Fisher gas valve per the Fisher SS_260 Vee-ball Instruction Manual (Form 5290; SS-260 errata sheet, Oct 2004 or later):
   - Make sure the valve is closed.
   - Insert a screwdriver or pry bar between the outboard ear of the ball and the valve body.
   - Pry the ball tightly against the thrust washer and the bearing on the actuator side of the valve.
   - Pre-position the Fisher gas valve in the fully closed position, as directed, setting the minimum gap between the valve seal and the seal protector ring is 0.010–0.020 inch (0.25–0.51 mm).

Refer to the Fisher Vee-Ball® Valve manual for instruction in preventing damage to the valve seal by closing the ball too far.

9. Remove the lever, if necessary, and reinstall it, engaging the lever and shaft spline teeth so as to achieve the closest possible alignment of the index marks on the lever face and the transfer case (see Figure 5-3). The lever index mark should be no more than 1.00 inch (25.4 mm) above (CCW from) the transfer case index mark and should be more than 0.50 inch (12.7 mm) below (CW from) the case index mark.

Figure 5-3. Alignment of Index Marks
10. Push the lever onto the shaft so that it contacts, or nearly contacts, the bronze shaft bearing in the back of the actuator transfer case.

11. Install the lever clamp bolt, and lock nut. Push the lever inward so that it contacts the rear bearing and tighten the lever clamp bolt. Tighten the lever clamp bolt to 50–70 lb-ft (68–95 N•m).

12. Rotate the lever CW (opening valve direction) to clear the pushrod linkage.

**WARNING** Do not allow the Vee-Ball Valve to rotate much beyond its fully closed position in the closing direction.

13. Preset the jam nut on the pushrod so that 1.00 ±0.03 inch (25.4 ±0.8 mm) of thread is exposed between the jam nut and the end of the pushrod.

14. Install the turnbuckle on the pushrod so that the turnbuckle contacts the jam nut. Do not yet tighten the nut.

15. Pre-set the jam nut on the lower rod end so that 1.00 ±0.03 inch (25.4 ±0.8 mm) of thread is exposed between the jam nut and the end of the rod end.

16. While keeping the turnbuckle from turning, install the lower rod end into the turnbuckle until its preset jam nut contacts the turnbuckle. Do not yet tighten the jam nut.

17. With minimal rotation of the lower rod end, align the lower rod end with its mating slot in the lever, as the lever is rotated CCW to bring its index mark into approximate alignment with the index mark on the transfer case face.

18. While keeping the lower rod end from turning, adjust the turnbuckle to align the lower rod end eye with the lever cross hole.

19. Install the lever cross bolt, washer, and lock nut. Tighten the locknut to 130–145 lb-ft (176–197 N•m).

20. Adjust the turnbuckle as required to achieve a final rigging of the valve per the Fisher SS_260 Vee-ball instruction manual (Form 5290; SS-260 errata sheet, Oct 2004 or later). The final position of the valve must be approached in the valve closing direction, whereby the turnbuckle is being shortened (pushrod in tension), replicating actuator motion.

**IMPORTANT** When rigging the SS-260 valve per the Fisher specified procedure, the specified valve seat retainer gap (0.010–0.020 inch/0.25–0.51 mm) is to be that point at which the smallest gap can be found around the entire periphery of the gap between the seal and seal protector ring. The ball is to be approximately centered with respect to the seal retainer ring bore.

21. Without turning the turnbuckle, move the upper and lower turnbuckle jam nuts about 2–4 threads away from the turnbuckle.

22. Apply Loctite 246 compound to the exposed threads between the turnbuckle and the jam nuts.

23. Holding the turnbuckle to prevent its rotation, tighten the jam nuts to 100–120 lb-ft (136–163 N•m). Wipe away excess Loctite.

24. Immediately (before the Loctite sets up) rotate the pushrod by hand to confirm that it is free to rock and that the lower rod end is not jammed against the side of the slot in the lever. If it is jammed, hold the turnbuckle to prevent its rotation while loosening the lower jam nut. Slightly rotate the turnbuckle as required, then re-tighten the lower jam nut while holding the turnbuckle to prevent its rotation. Repeat steps 23 and 24 to achieve a free pushrod.

25. Install the linkage access cover. Tighten screws to 75–100 lb-in (8.5–11.3 N•m).
26. Install the actuator transfer case end plate, orienting the end plate so the shaft position indicator has the word “CLOSED” at the top and orienting the shaft hub so the pointer aligns with the “CLOSED” index line. Tighten the bolts to 55–70 lb-ft (75–95 N·m).

27. If necessary, adjust the shaft position indicator “pointer” to align with the “CLOSED” position index line on the surrounding indicator scale. Re-tighten the pointer screws to 30–35 lb-in (3.4–4.0 N·m).

---

**NOTICE**

Entrapped air may defeat the hydraulic cushion action of the actuator, resulting in excessive impact forces during a “trip” command. So, during the initial start-up and prior to operation following service of the actuator, oil filter, or hydraulic supply line, the following procedure must be completed before the unit is commanded to “trip”.

- **Bleed entrapped air from the hydraulic line supplying the actuator.**
- **Command the actuator to rapidly stroke (but do not command it to “trip”) between its fully retracted and fully extended positions at least 20 cycles to purge entrapped air from the actuator.**

This precautionary procedure is especially important when the actuator is oriented horizontally or upside-down (actuator below the process valve). There is risk of actuator damage if it is commanded to “trip” before entrapped air has been removed from the actuator and from the hydraulic supply line.

---

**Separating the Stop/Ratio Actuator from the Transfer Case and Fisher Gas Valve Assembly**

1. Shut off the stop/ratio actuator hydraulic pressure.
2. Remove the linkage access cover and transfer case end plate assembly. It is not necessary to remove the shaft position indicator or hub from the end plate.
3. Remove the linkage cross bolt.
4. Provide means to support the Fisher gas valve/transfer case assembly and to support and lift the stop/ratio actuator.
5. Remove the four hex head 0.750-10 UNC bolts that attach the actuator to the transfer case.
6. Lift the actuator way from the transfer case/valve assembly.

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**WARNING**

To prevent possible personal injury, do NOT remove the spring cover (which is spring-loaded to over 4000 lb/17 760 N). The four 0.750-16 UNF spring cover attaching nuts have metal tab locks and should not be disturbed.

---

**Joining the Actuator to the Transfer Case and Gas Valve Assembly**

1. Remove the linkage access cover and end plate from the actuator transfer case.
2. Remove the lower rod end and its jam nut from the actuator pushrod.
3. Remove the turnbuckle from the actuator pushrod. Leave its jam nut on the pushrod.
4. Supporting both the actuator and the Fisher gas valve, join the actuator to the valve and transfer case assembly, carefully guiding the actuator pushrod through the transfer case throat.
5. Install the four 0.750-10 UNC bolts that attach the stop/ratio actuator to the transfer case. Tighten these bolts to 160–180 lb-ft (217–244 N•m).
6. Temporarily place the lever onto the valve shaft, oriented approximately as shown in Figure 5-3.
7. Pre-rig the valve by rotating the lever as required. A pry bar inserted through the transfer case inspection window can be used to move the lever.

**NOTICE**

Refer to the Fisher Vee-Ball® Valve manual for instruction in preventing damage to the valve seal by closing the ball too far.

8. Pre-adjust the Fisher gas valve per the Fisher SS_260 Vee-ball Instruction Manual (Form 5290; SS-260 errata sheet, Oct 2004 or later):
   - Make sure the valve is closed.
   - Insert a screwdriver or pry bar between the outboard ear of the ball and the valve body.
   - Pry the ball tightly against the thrust washer and the bearing on the actuator side of the valve.
   - Pre-position the Fisher gas valve in the fully closed position, as directed, setting the minimum gap between the valve seal and the seal protector ring is 0.010–0.020 inch (0.25–0.51 mm).
9. Remove the lever, if necessary, and reinstall it, engaging the lever and shaft spline teeth so as to achieve the closest possible alignment of the index marks on the lever face and the transfer case (see Figure 5-3). The lever index mark should be no more than 1.00 inch (25.4 mm) above (CCW from) the transfer case index mark and should be more than 0.50 inch (12.7 mm) below (CW from) the case index mark.
10. Push the lever onto the shaft so that it contacts, or nearly contacts, the bronze shaft bearing in the back of the actuator transfer case.
11. Install the lever clamp bolt, and lock nut. Push the lever inward so that it contacts the rear bearing and tighten the lever clamp bolt. Tighten the lever clamp bolt to 50–70 lb-ft (68–95 N•m).
12. Rotate the lever CW (opening valve direction) to clear the pushrod linkage.

**WARNING**

Do not allow the Vee-Ball Valve to rotate much beyond its fully closed position in the closing direction.

13. Preset the jam nut on the pushrod so that 1.00 ±0.03 inch (25.4 ±0.8 mm) of thread is exposed between the jam nut and the end of the pushrod.
14. Install the turnbuckle on the pushrod so that the turnbuckle contacts the jam nut. Do not yet tighten the nut.
15. Pre-set the jam nut on the lower rod end so that 1.00 ±0.03 inch (25.4 ±0.8 mm) of thread is exposed between the jam nut and the end of the rod end.
16. While keeping the turnbuckle from turning, install the lower rod end into the turnbuckle until its preset jam nut contacts the turnbuckle. Do not tighten the jam nut yet.
17. With minimal rotation of the lower rod end, align the lower rod end with its mating slot in the lever, as the lever is rotated CCW to bring its index mark into approximate alignment with the index mark on the transfer case face.
18. While keeping the lower rod end from turning, adjust the turnbuckle to align the lower rod end eye with the lever cross hole.
19. Install the lever cross bolt, washer, and lock nut. Tighten the locknut to 130–145 lb-ft (176–197 N•m).
20. Adjust the turnbuckle as required to achieve a final rigging of the valve per the Fisher SS_260 Vee-ball Instruction Manual (Form 5290; SS-260 errata sheet, Oct 2004 or later). The final position of the valve must be approached in the valve closing direction, whereby the turnbuckle is being shortened (pushrod in tension), replicating actuator motion.

When rigging the SS-260 valve per the Fisher specified procedure, the specified valve seat retainer gap (0.010–0.020 inch/0.25–0.51 mm) is to be that point at which the smallest gap can be found around the entire periphery of the gap between the seal and seal protector ring. The ball is to be approximately centered with respect to the seal retainer ring bore.

21. Without turning the turnbuckle, move the upper and lower turnbuckle jam nuts about 2–4 threads away from the turnbuckle.
22. Apply Loctite 246 compound to the exposed threads between the turnbuckle and the jam nuts.
23. Holding the turnbuckle to prevent its rotation, tighten the jam nuts to 100–120 lb-ft (136-163 N•m). Wipe away excess Loctite.
24. Immediately (before the Loctite sets up) rotate the pushrod by hand to confirm that it is free to rock and that the lower rod end is not jammed against the side of the slot in the lever. If it is jammed, hold the turnbuckle to prevent its rotation while loosening the lower jam nut. Slightly rotate the turnbuckle as required, then re-tighten the lower jam nut while holding the turnbuckle to prevent its rotation. Repeat steps 23 and 24 to achieve a free pushrod.
25. Install the linkage access cover. Tighten screws to 75–100 lb-in (8.5–11.3 N•m).
26. Install the actuator transfer case end plate, orienting the end plate so the shaft position indicator has the word “CLOSED” at the top and orienting the shaft hub so the pointer aligns with the “CLOSED” index line. Tighten the bolts to 55–70 lb-ft (75–95 N•m).
27. If necessary, adjust the shaft position indicator “pointer” to align with the “CLOSED” position index line on the surrounding indicator scale. Re-tighten the pointer screws to 30–35 lb-in (3.4–4.0 N•m).

Entrapped air may defeat the hydraulic cushion action of the actuator, resulting in excessive impact forces during a “trip” command. So, during the initial start-up and prior to operation following service of the actuator, oil filter, or hydraulic supply line, the following procedure must be completed before the unit is commanded to “trip”.

- Bleed entrapped air from the hydraulic line supplying the actuator.
- Command the actuator to rapidly stroke (but do not command it to “trip”) between its fully retracted and fully extended positions at least 20 cycles to purge entrapped air from the actuator.

This precautionary procedure is especially important when the actuator is oriented horizontally or upside-down (actuator below the process valve). There is risk of actuator damage if it is commanded to “trip” before entrapped air has been removed from the actuator and from the hydraulic supply line.
Changing Right-hand Actuator to Left-hand

Refer to the Fisher Vee-Ball Valve manual for instruction in preventing damage to the valve seal by closing the ball too far.

Execution of this procedure requires that the Fisher Vee-Ball be removed from the pipeline.

1. The SS-260 valve orientation (RH) shown on the outline drawing (Figure 1-2) is Woodward’s standard orientation (Fisher Style B, position 1). The following procedure is given to facilitate installation where the standard orientation cannot be accommodated.
2. Separate the actuator / transfer case assembly from the Fisher gas valve, following the instructions above.
3. Referring to the appropriate Fisher manual (Form 5290, Type Vee-Ball), change the mounting yoke and lever from Style B to Style C. Maintain action PDTO (Push Down To Open) and position 1 (vertical actuator above the horizontal pipeline).
4. Join the actuator/transfer case assembly to the Fisher gas valve, following the instructions above.

Do not allow the Vee-Ball Valve to rotate much beyond its fully closed position in the closing direction.

Entrapped air may defeat the hydraulic cushion action of the actuator, resulting in excessive impact forces during a “trip” command. So, during the initial start-up and prior to operation following service of the actuator, oil filter, or hydraulic supply line, the following procedure must be completed before the unit is commanded to “trip”.
   - Bleed entrapped air from the hydraulic line supplying the actuator.
   - Command the actuator to rapidly stroke (but do not command it to “trip”) between its fully retracted and fully extended positions at least 20 cycles to purge entrapped air from the actuator.

This precautionary procedure is especially important when the actuator is oriented horizontally or upside-down (actuator below the process valve). There is risk of actuator damage if it is commanded to “trip” before entrapped air has been removed from the actuator and from the hydraulic supply line.
### Troubleshooting Charts

Faults in the fuel control or governing system are often associated with speed variations of the prime mover, but such speed variations do not always indicate fuel control or governing system faults. Therefore, when improper speed variations occur, check all components including the engine or turbine for proper operation. Refer to applicable electronic control manuals for assistance in isolating the trouble. The following steps describe troubleshooting for the gas fuel stop/ratio valve.

Disassembly of the gas fuel stop/ratio valve in the field is not recommended due to the dangerous forces contained in the springs. Under unusual circumstances where disassembly becomes necessary, all work and adjustments should be made by personnel thoroughly trained in the proper procedures.

When requesting information or service help from Woodward, it is important to include the part number and serial number of the valve assembly in your communication.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Causes</th>
<th>Remedies</th>
</tr>
</thead>
<tbody>
<tr>
<td>External hydraulic leakage</td>
<td>Static O-ring seal(s) missing or deteriorated</td>
<td>Replace O-rings fitted to user-serviceable components (filter, servo valve, trip relay valve) as needed. Otherwise, return actuator to Woodward for service.</td>
</tr>
<tr>
<td></td>
<td>Dynamic O-ring seal missing or deteriorated</td>
<td>Return actuator to Woodward for service.</td>
</tr>
<tr>
<td>Internal hydraulic leakage</td>
<td>Servo valve internal O-ring seal(s) missing or deteriorated</td>
<td>Replace servo valve.</td>
</tr>
<tr>
<td></td>
<td>Servo valve metering edges worn</td>
<td>Replace servo valve.</td>
</tr>
<tr>
<td></td>
<td>Piston seal missing or deteriorated</td>
<td>Return actuator to Woodward for service.</td>
</tr>
<tr>
<td>External gas fuel leakage</td>
<td>Piping flange gaskets missing or deteriorated</td>
<td>Replace gaskets.</td>
</tr>
<tr>
<td></td>
<td>Piping flanges improperly aligned</td>
<td>Rework piping as needed to achieve alignment requirements detailed in Chapter 4.</td>
</tr>
<tr>
<td></td>
<td>Piping flange bolts improperly torqued</td>
<td>Rework bolts as needed to achieve torque requirements detailed in Chapter 4.</td>
</tr>
<tr>
<td></td>
<td>Packing follower needs adjustment</td>
<td>Adjust follower per Fisher manual Form 5290, Type Vee-Ball.</td>
</tr>
<tr>
<td></td>
<td>Packing missing or deteriorated</td>
<td>Service packing per Fisher manual Form 5290, Type Vee-Ball.</td>
</tr>
<tr>
<td>Internal gas fuel leakage</td>
<td>Vee-Ball seal missing or deteriorated</td>
<td>Service seal per Fisher manual Form 5290, Type Vee-Ball, and Fisher Errata Sheet Type Vee-Ball SS-260.</td>
</tr>
<tr>
<td>Valve will not open</td>
<td>Servo valve command current incorrect. (The sum of the current through the three coils of the servo valve must be greater than the null bias of the servo valve for the gas valve to open.)</td>
<td>Trace and verify that all wiring is in accordance with the electrical schematic (Figure 1-4) and the GE system wiring schematic(s). Pay special attention to the polarity of the wiring to the servo valve and LVDT.</td>
</tr>
<tr>
<td></td>
<td>Servo valve failure</td>
<td>Replace servo valve.</td>
</tr>
<tr>
<td></td>
<td>Hydraulic supply pressure inadequate</td>
<td>Supply pressure must be greater than 1200 psig/8274 kPa (1600 psig/11 032 kPa preferred).</td>
</tr>
<tr>
<td></td>
<td>Trip relay pressure inadequate</td>
<td>Trip pressure must be greater than 40 psid (276 kPa) above drain pressure.</td>
</tr>
<tr>
<td></td>
<td>Vee-Ball jammed</td>
<td>Service Vee-Ball per Fisher manual Form 5290, Type Vee-Ball.</td>
</tr>
<tr>
<td>Symptom</td>
<td>Possible Causes</td>
<td>Remedies</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Valve will not close</td>
<td>Servo valve command current incorrect. (The sum of the current through the three coils of the servo valve must be less than the null bias of the servo valve for the gas valve to close.)</td>
<td>Trace and verify that all wiring is in accordance with the electrical schematic (Figure 1-4) and the GE system wiring schematic(s). Pay special attention to the polarity of the wiring to the servo valve and LVDT.</td>
</tr>
<tr>
<td></td>
<td>Servo valve failure</td>
<td>Replace servo valve.</td>
</tr>
<tr>
<td></td>
<td>LVDT failure</td>
<td>Replace LVDT.</td>
</tr>
<tr>
<td></td>
<td>Springs broken</td>
<td>Return actuator to Woodward for service.</td>
</tr>
<tr>
<td></td>
<td>Linkage broken</td>
<td>Return actuator to Woodward for service.</td>
</tr>
<tr>
<td></td>
<td>Vee-Ball jammed</td>
<td>Service Vee-Ball per Fisher manual Form 5290, Type Vee-Ball and errata sheet Vee-Ball SS-260.</td>
</tr>
<tr>
<td>Valve will not respond smoothly</td>
<td>Hydraulic filter clogged</td>
<td>Check the differential pressure indicator on the filter housing.</td>
</tr>
<tr>
<td></td>
<td>Servo valve spool sticking</td>
<td>Verify hydraulic contamination levels are within recommendations of Chapter 1. The use of dither may improve performance in contaminated systems.</td>
</tr>
<tr>
<td></td>
<td>Servo valve internal pilot filter clogged</td>
<td>Replace servo valve.</td>
</tr>
<tr>
<td></td>
<td>Excessive friction in Vee-Ball assembly</td>
<td>Service Vee-Ball per Fisher manual Form 5290, Type Vee-Ball, and Fisher Errata Sheet Type Vee-Ball SS-260.</td>
</tr>
<tr>
<td></td>
<td>Rod-end(s) worn out</td>
<td>Return actuator to Woodward for service.</td>
</tr>
<tr>
<td></td>
<td>Piston seal worn out</td>
<td>Return actuator to Woodward for service.</td>
</tr>
<tr>
<td>Actuator seals wear out prematurely</td>
<td>Hydraulic contamination level is excessive</td>
<td>Verify hydraulic contamination levels are within recommendations of Chapter 1. The use of excessive dither may reduce life in contaminated systems.</td>
</tr>
<tr>
<td></td>
<td>System is oscillating (seal life is proportional to distance traveled). Even small oscillations (on the order of ±1%) at slow frequencies (on the order of 0.1 Hz) cause wear to accumulate rapidly.</td>
<td>Determine and eliminate the root cause of oscillation.</td>
</tr>
<tr>
<td>Valve falsely trips to closed position</td>
<td>Trip pressure is too low</td>
<td>Assure that trip pressure is per specifications.</td>
</tr>
<tr>
<td></td>
<td>Drain pressure is too high or is surging to too high a value</td>
<td>Reduce drain pressure.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduce restrictions in drain line.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduce drain line flow surges causing drain line pressure surges.</td>
</tr>
</tbody>
</table>
Chapter 6.
Service Options

Product Service Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact the manufacturer or packager of your system.
- Contact the Woodward Full Service Distributor serving your area.
- Contact Woodward technical assistance (see “How to Contact Woodward” later in this chapter) and discuss your problem. In many cases, your problem can be resolved over the phone. If not, you can select which course of action to pursue based on the available services listed in this chapter.

OEM and Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A Full Service Distributor has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.

- An Authorized Independent Service Facility (AISF) provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.

- A Recognized Engine Retrofitter (RER) is an independent company that does retrofits and upgrades on reciprocating gas engines and dual-fuel conversions, and can provide the full line of Woodward systems and components for the retrofits and overhauls, emission compliance upgrades, long term service contracts, emergency repairs, etc.

- A Recognized Turbine Retrofitter (RTR) is an independent company that does both steam and gas turbine control retrofits and upgrades globally, and can provide the full line of Woodward systems and components for the retrofits and overhauls, long term service contracts, emergency repairs, etc.

You can locate your nearest Woodward distributor, AISF, RER, or RTR on our website at:

www.woodward.com/directory
Woodward Factory Servicing Options

The following factory options for servicing Woodward products are available through your local Full-Service Distributor or the OEM or Packager of the equipment system, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is originally shipped from Woodward or a service is performed:

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime. This is a flat-rate program and includes the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205).

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned within 60 days, a credit for the core charge will be issued.

Flat Rate Repair: Flat Rate Repair is available for the majority of standard products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be. All repair work carries the standard Woodward service warranty (Woodward Product and Service Warranty 5-01-1205) on replaced parts and labor.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option with the exception that the unit will be returned to you in "like-new" condition and carry with it the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205). This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:

- return authorization number;
- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.
Packing a Control

Use the following materials when returning a complete control:
• protective caps on any connectors;
• antistatic protective bags on all electronic modules;
• packing materials that will not damage the surface of the unit;
• at least 100 mm (4 inches) of tightly packed, industry-approved packing material;
• a packing carton with double walls;
• a strong tape around the outside of the carton for increased strength.

NOTICE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules.

Replacement Parts

When ordering replacement parts for controls, include the following information:
• the part number(s) (XXXX-XXXX) that is on the enclosure nameplate;
• the unit serial number, which is also on the nameplate.

Engineering Services

Woodward offers various Engineering Services for our products. For these services, you can contact us by telephone, by email, or through the Woodward website.
• Technical Support
• Product Training
• Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward’s worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact. Emergency assistance is also available during non-business hours by phoning Woodward and stating the urgency of your problem.

Product Training is available as standard classes at many of our worldwide locations. We also offer customized classes, which can be tailored to your needs and can be held at one of our locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from many of our worldwide locations or from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact us via telephone, email us, or use our website: www.woodward.com.
How to Contact Woodward

For assistance, call one of the following Woodward facilities to obtain the address and phone number of the facility nearest your location where you will be able to get information and service.

### Electrical Power Systems

<table>
<thead>
<tr>
<th>Facility</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>+55 (19) 3708 4800</td>
</tr>
<tr>
<td>China</td>
<td>+86 (512) 6762 6727</td>
</tr>
<tr>
<td>Germany</td>
<td>+49 (0) 21 52 14 51</td>
</tr>
<tr>
<td>India</td>
<td>+91 (129) 4097100</td>
</tr>
<tr>
<td>Japan</td>
<td>+81 (43) 213-2191</td>
</tr>
<tr>
<td>Korea</td>
<td>+82 (51) 636-7080</td>
</tr>
<tr>
<td>Poland</td>
<td>+48 12 295 13 00</td>
</tr>
<tr>
<td>United States</td>
<td>+1 (970) 482-5811</td>
</tr>
</tbody>
</table>

### Engine Systems

<table>
<thead>
<tr>
<th>Facility</th>
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<tbody>
<tr>
<td>Brazil</td>
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<tr>
<td>China</td>
<td>+86 (512) 6762 6727</td>
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<tr>
<td>Germany</td>
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<tr>
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<tr>
<td>Japan</td>
<td>+81 (43) 213-2191</td>
</tr>
<tr>
<td>Korea</td>
<td>+82 (51) 636-7080</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>+31 (23) 5661111</td>
</tr>
<tr>
<td>United States</td>
<td>+1 (970) 482-5811</td>
</tr>
</tbody>
</table>

### Turbine Systems

<table>
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<th>Facility</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
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<tr>
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</tr>
<tr>
<td>Germany</td>
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</tr>
<tr>
<td>United States</td>
<td>+1 (970) 482-5811</td>
</tr>
</tbody>
</table>

You can also locate your nearest Woodward distributor or service facility on our website at: [www.woodward.com/directory](http://www.woodward.com/directory)

### Technical Assistance

If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

- **Your Name**
- **Site Location**
- **Phone Number**
- **Fax Number**
- **Engine/Turbine Model Number**
- **Manufacturer**
- **Number of Cylinders (if applicable)**
- **Type of Fuel (gas, gaseous, steam, etc)**
- **Rating**
- **Application**

#### Control/Governor #1

- **Woodward Part Number & Rev. Letter**
- **Control Description or Governor Type**
- **Serial Number**

#### Control/Governor #2

- **Woodward Part Number & Rev. Letter**
- **Control Description or Governor Type**
- **Serial Number**

#### Control/Governor #3

- **Woodward Part Number & Rev. Letter**
- **Control Description or Governor Type**
- **Serial Number**

*If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.*
Revision History

Changes in Revision R—
• Updated ATEX information (page v)
• Updated Declaration

Changes in Revision P—
• Added warnings required by ATEX changes (pages vi, 20, 23)
• Updated Declaration

Changes in Revision N—
• Updated Pressure Equipment Directive and GOST R information
• Updated Declaration of Conformity

Changes in Revision M—
• Added Safety Block instructions (page 24)
DECLARATION OF CONFORMITY

Manufacturer’s Name: WOODWARD INC (WWD)
Manufacturer’s Address: 1000 E. Drake Rd. Fort Collins, CO, USA, 80525
Model Name(s): Gas Stop/Ratio Valve, consisting of an electrohydraulic actuator and gas valve
2004/108/EC COUNCIL DIRECTIVE of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and all applicable amendments. 2004/108/EC is met by evaluation of the physical nature to the EMC protection requirement. Electromagnetically passive or “benign” devices are excluded from the scope of the Directive 2004/108/EC, however they also meet the protection requirement and intent of the directive.
Marking(s): ☑ Category 3 Group II G, Ex nA IIIC T3X Gc. IP54

Applicable Standards:
EN 60079-0:2012: Electrical apparatus for explosive gas atmospheres – Part 0: General Requirements
EN 60079 15, 2010: Electrical apparatus for explosive gas atmospheres – Part 15: Type of protection ‘n’
EN61000-6-4, 2007: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments. (By technical evaluation, not testing.)
EN61000-6-2, 2005: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments. (By technical evaluation, not testing.)

We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

MANUFACTURER:

Signature

Christopher Perkins

Full Name

Engineering Manager

Position

Woodward, Inc, Fort Collins, CO, USA

Place

Date

00146-04-CE-02-03 Rev L

5-09-1183 Rev 16, 22 Jan 2009
DECLARATION OF INCORPORATION
Of Partly Completed Machinery
2006/42/EC

Manufacturer’s Name: WOODWARD GOVERNOR COMPANY (WGC)
Manufacturer’s Address: 1000 E. Drake Rd. 3800 N. Wilson Ave.
Fort Collins, CO, USA, 80525 Loveland, CO, USA 80538

Model Name(s)/Number(s): Gas Stop Ratio Valves, consisting of an electrohydraulic actuator and
gas valve.

This product complies, where applicable, with the following
Essential Requirements of Annex I: 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7

The relevant technical documentation is compiled in accordance with part B of Annex VII.
Woodward shall transmit relevant information if required by a reasoned request by the national
authorities. The method of transmittal shall be agreed upon by the applicable parties.

This product must not be put into service until the final machinery into which it is to be
incorporated has been declared in conformity with the provisions of this Directive, where
appropriate.

The undersigned hereby declares, on behalf of Woodward Governor Company of Loveland and
Fort Collins, Colorado that the above referenced product is in conformity with Directive
2006/42/EC as partly completed machinery:

MANUFACTURER

Signature
Arlen McMurray

Full Name
Quality Manager

Position
WGC, Fort Collins, CO, USA

Place
31 Dec. 09

Date

5-09-11B2 (REV. 9) 00146-04-CE-02-01
Declaration of Conformity
Pressure Equipment Directive 97/23/EC

<table>
<thead>
<tr>
<th>Name and address of manufacturer</th>
<th>European Representative</th>
</tr>
</thead>
</table>
| Fisher Controls International, LLC (Valve Division)  
P.O. Box 1658  
4725 Highway 75 South  
Sherman, TX 75091-1658  
USA | Emerson Process Management  
Rue Paul Baudry  
BP 10, 68701  
Cernay, France |

Name and address of the Notified Body monitoring the manufacturer’s QA system
Hartford Steam Boiler International GmbH  
Landersumer Weg 40, D-48431 Rheine, Germany

Description of Pressure Equipment: Valve
Type: SS-260
Serial Number(s): 19176153

Category: III
Conformity Assessment Module: H
Notified Body I.D. Number: 0871

EC Type Examination Certificate: Not applicable
EC Design Examination Certificate (B1): Not applicable
EC Certificate of Conformity: Not applicable
PED Quality Assurance Certificate: HSB-07-08-025-03

Technical Standards and Specifications Used
- Diffusers: ASME B & PV Code, Section VIII, Division 1
- Valves: ASME B16.34 (EU 1362 for DIN flanges)
- Whisper Disk: ASME B & PV Code, Section VIII, Division 1

We hereby declare that the pressure equipment detailed above and information given is in compliance with the Pressure Equipment Directive 97/23/EC.

Authorized Person for the Manufacturer: Eric Williamson
Title: DOCUMENTATION TECH

Woodward Note:
This is a SAMPLE declaration of conformity only. The original serialized DoC for each individual valve is shipped with the valve.

Signature

Date: 9 Nov, 2009