WOODWARD

Product Manual 26376
(Revision D, 10/2019)
Original Instructions

Gas Stop/Ratio Valve
10-inch

Installation and Operation Manual

General Precautions	**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.**

Revisions	**This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, on the *publications page* of the Woodward website:** **http://www.woodward.com/** **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.**

Proper Use	**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.**

Translated Publications	**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 *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, 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 Out-of-date translations are marked with ⚠.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— A bold, black line alongside the text identifies changes in this publication since the last revision.

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Important Definitions

This is the safety alert symbol 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.

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.

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.

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

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

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 for use in the United States per FM 4B9A6.AX.

CSA Certified for Class I Division 2, Groups A, B, C, D for use in Canada per CSA 1072373.

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

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

Solenoid: CSA Certified for Class I, Division 2, Groups A, B, C, D for use in the United States and Canada per CSA 1260548.

SIL Compliance:
SIL certification is available for specific Woodward item numbers. Please contact a Woodward representative for assistance.

Gas Stop/Ratio Valve – Certified SIL 3 Capable for safe position fuel shutoff function in safety instrumented systems. Evaluated to IEC 61508 Parts 1-7. Refer to the instructions of this Installation and Operation Manual, Chapter 6 – Safety Management – Safe Position Fuel Shutoff Function.
SIL Certificate WOO 1905012 C001

Special Conditions for Safe Use:

Wiring must be in accordance with North American Class I, Division 2 wiring methods as applicable, and in accordance with the authority having jurisdiction.

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

The wiring junction box provides earth ground terminals if needed for a separate earth ground to meet wiring requirements.

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.

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.

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 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.

IMPORTANT

Units may have either low pressure (LP), high pressure (HP), or electric 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.

Table 1-1. Gas Stop/Ratio Valve Functional Characteristics

Functional Requirement	Gas Stop/Ratio Valve
Valve Type	Fisher Type 10" V300 Vee-Ball®
Process Fluid	Natural gas and syngas
Temperature Range	Natural gas 50 to 450 °F (10 to 232 °C) (heated fuel)
Position Accuracy	±1% full scale (over ±25 °F/±14 °C deviation from calibration)
Position Repeatability	±0.5% of point over the range of 10 to 100%
Hydraulic Fluid Type	Petroleum Based hydraulic fluids as well as fire resistant hydraulic fluids such as Fyrquel EHC
Operating Hydraulic Supply Pressure	1200 to 1700 psig (8274 to 11 722 kPa) (rated at 1600 psig/11 032 kPa)
Proof Test Fluid Pressure Level	2400 psig (16 548 kPa) minimum per SAE J214 (Prod Test)
Minimum Burst Fluid Pressure	6000 psig (41 370 kPa) minimum per SAE J214
Fluid Filtration Required	10–15 µm at 75 Beta
Hydraulic Fluid Contamination Level	Per ISO 4406 code 18/16/13 max, code 16/14/11 preferred
Hydraulic Fluid Temperature	+50 to +150 °F (+10 to +66 °C)
Actuator Ambient Temperature	–20 to +180 °F (–29 to +82 °C)
Vibration Test Level	Random 0.01500 gr^2/Hz from 10 to 40 Hz ramping down to 0.00015 gr^2/Hz at 500 Hz (1.04 Grms)
Shock	Limited to 30 g by servo valve
Trip Time	Less than 0.250 seconds (100–5% stroke)
Open Slew Time	5 to 95% in 0.630 ±0.27 seconds
Close Slew Time	95 to 5% in 0.630 ± 0.27 seconds
Trip Pressure (relative to hydraulic return pressure)	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)
Trip Solenoid Valve	125 Vdc, 10 W
Hydraulic Fluid Connections	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)
Servo Input Current Rating	–7.2 to +8.8 mA (null bias 0.8 ±0.32 mA)
Servo Valve Flow Rating	15.0 US gal/min (56.8 L/min) at 1000 psid (6895 kPa) valve drop, 4-way
Servo Valve Rated Leakage	0.43 US gal/min (1.63 L/min) at 1500 psid (10 342 kPa)
Cylinder Bore	3.125 inch (79.38 mm) diameter
Stroke	6.00 inch (152.4 mm)
Static Seals	Elastomer per US MIL-R-83248 (Viton)
Paint	Two part Epoxy
Actuation Forces (opening at 1600 psig/11 034 kPa) (closing via spring)	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
Design Availability Objective	Better than 99.5% over an 8760 hour period
Sound Level	Per Fisher-Rosemount Catalog 12
Weight	1248 lb (566 kg)

NOTE—Vee-Ball® is a trademark of Fisher-Rosemount.

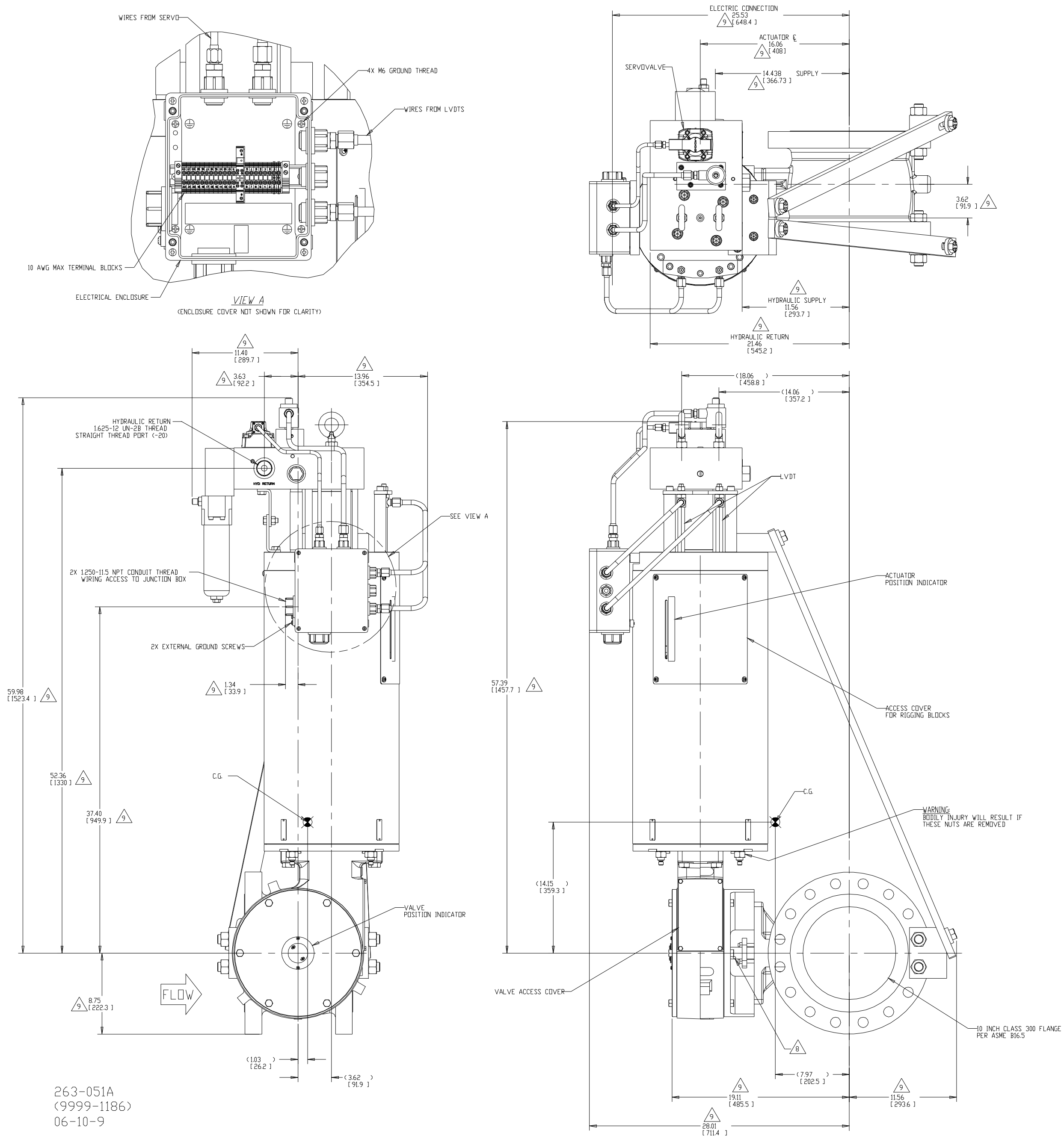

Figure 1-1a. 10” Gas Stop/Ratio Valve Outline Drawing

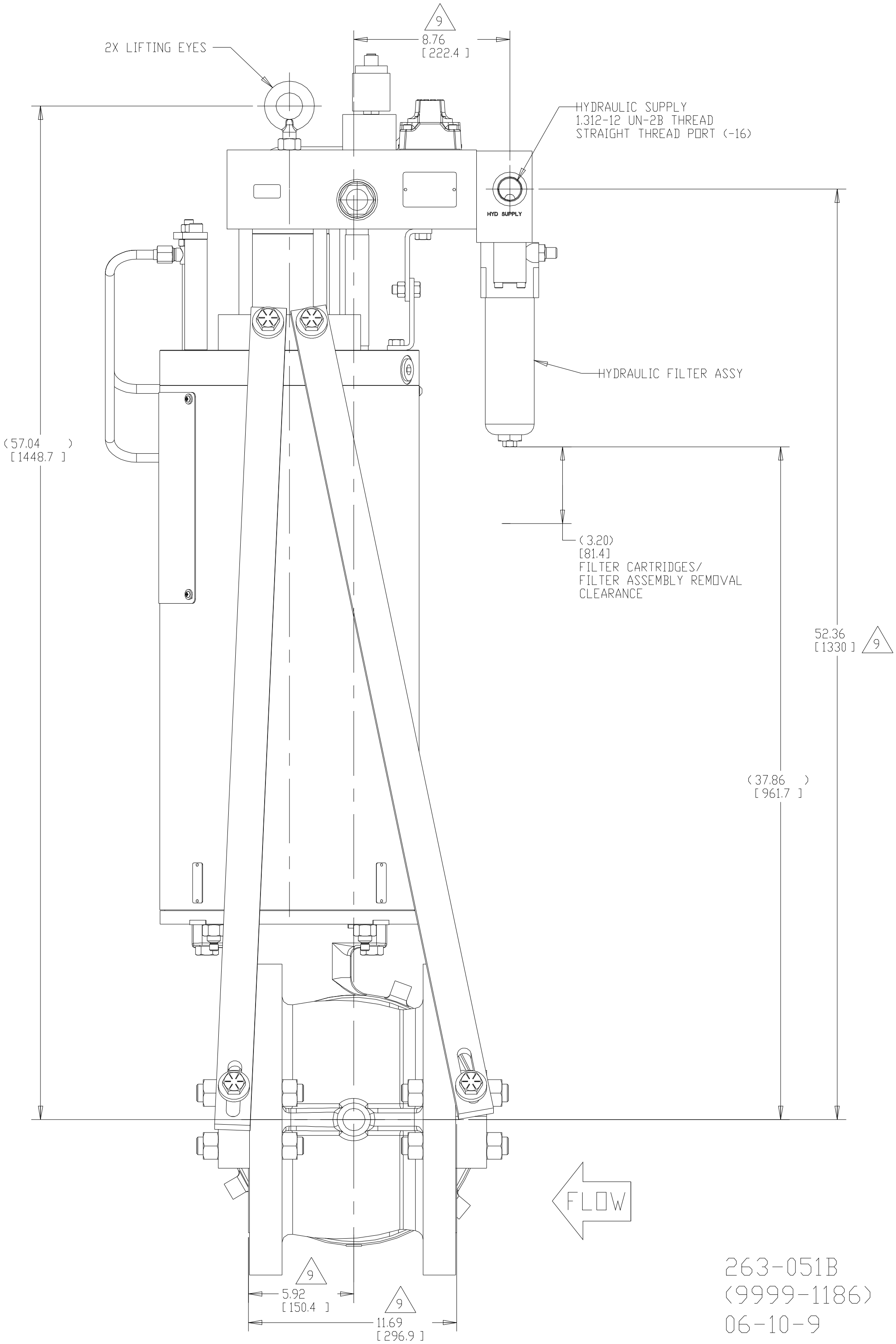

Figure 1-1b. 10” Gas Stop/Ratio Valve Outline Drawing

Notes for Figure 1-1

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

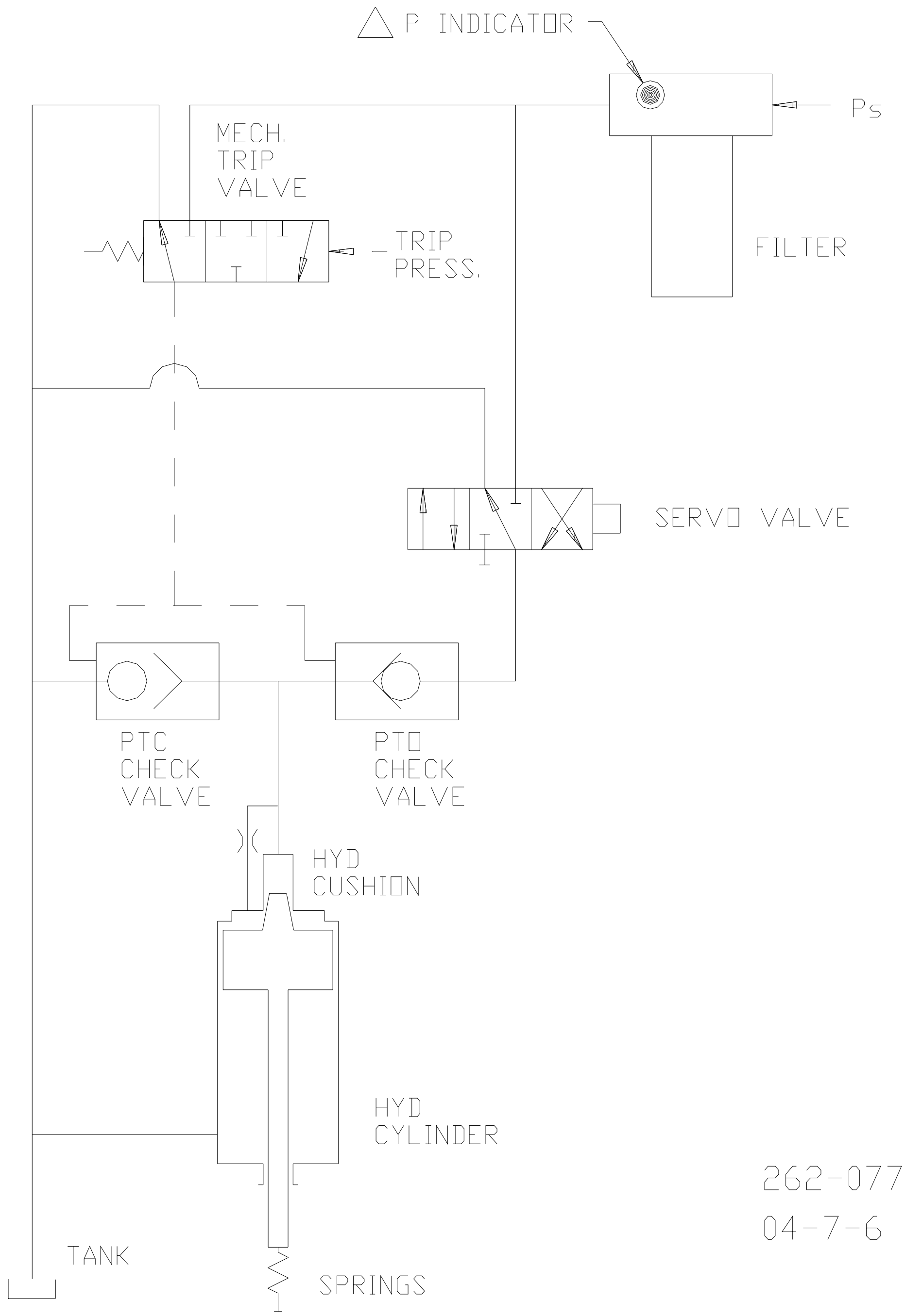

Figure 1-2a. 10” Gas Stop/Ratio Valve Hydraulic Schematic (hydraulic trip)

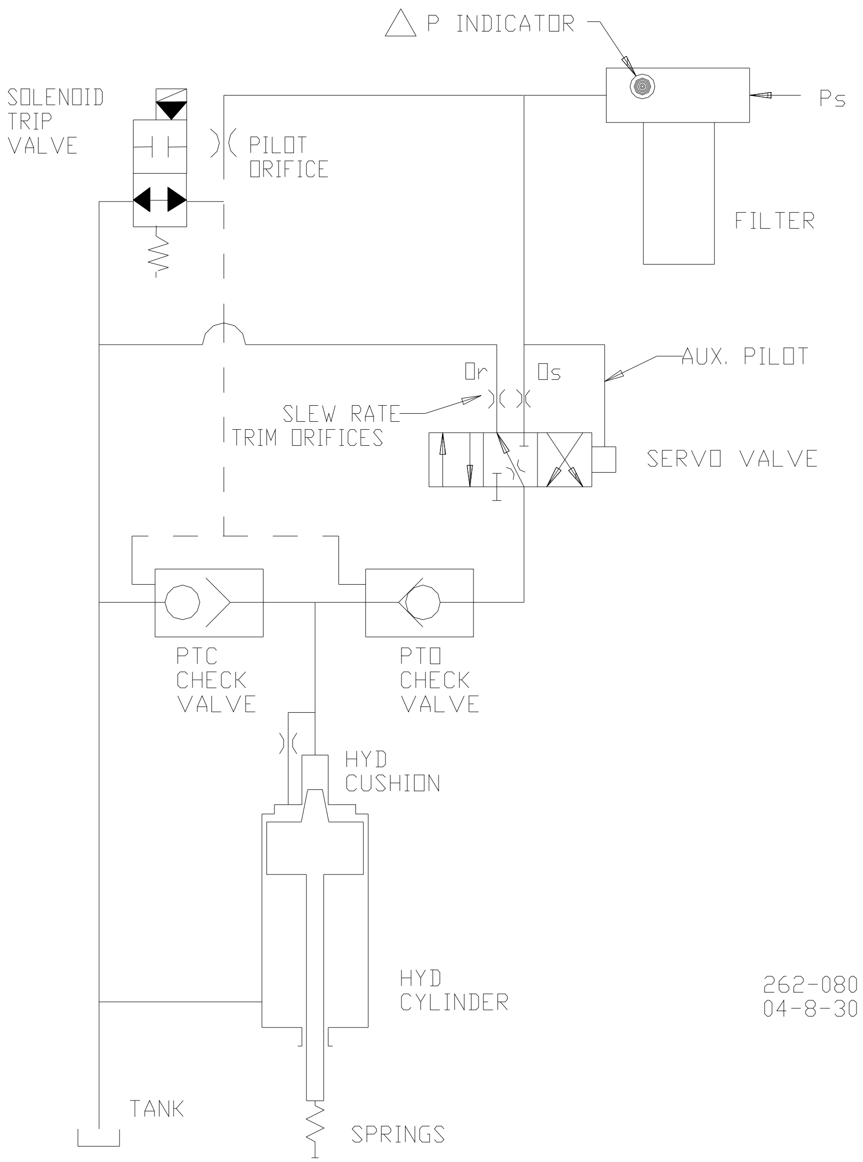

Figure 1-2b. 10" Gas Stop/Ratio Valve Hydraulic Schematic (electric trip)

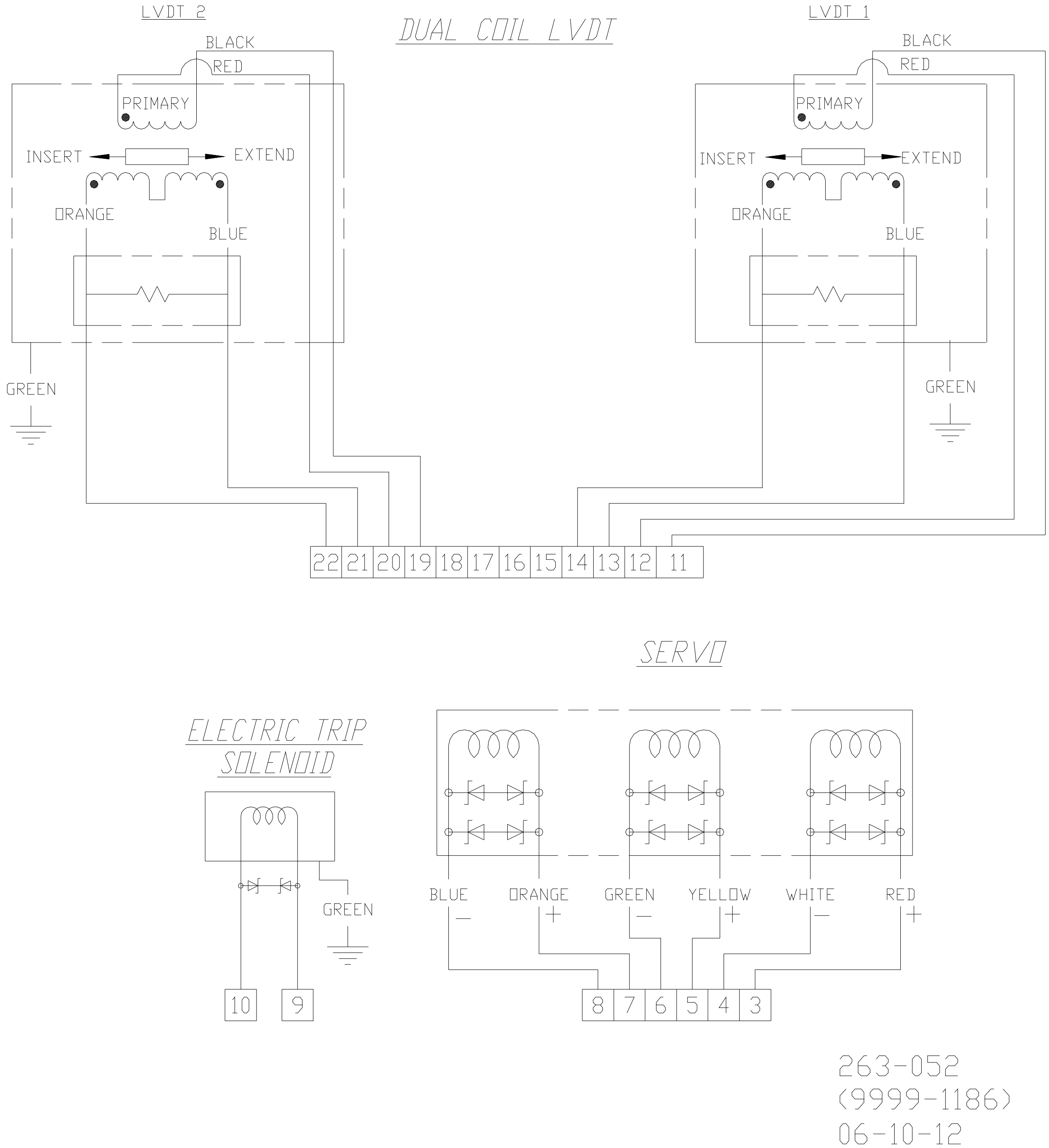

Figure 1-3. 10” Gas Stop/Ratio Valve Electrical Schematic and Wiring Diagram

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 ΔP 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.

Hydraulic Trip

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.

Electric Trip

The trip relay circuit utilizes a solenoid-operated valve and two logic valves to override the servo pressure that is normally directed to the top of the hydraulic piston. When trip solenoid is de-energized, 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.

Position Feedback

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.

A low pressure trip, high pressure trip, and electric trip valve are offered, as designated on the GE Order Drawing. These trip valves accommodate low pressure, high pressure, or electric trip circuits and operate as follows.

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.

Electric Trip Valve

When the trip valve solenoid is energized, 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 the trip valve solenoid is de-energized, the trip 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 pulls the actuator pushrod up, opening the gas valve.

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 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.

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.**
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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.

⚠WARNING

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.

⚠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 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	**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.

NOTICE	**The Vee-Ball stop/ratio valve is equipped with an integral strut support system to minimize possible overstressing of the Fisher Vee-Ball 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 Vee-Ball 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 Vee-Ball 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.

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 28 flange bolt positions.

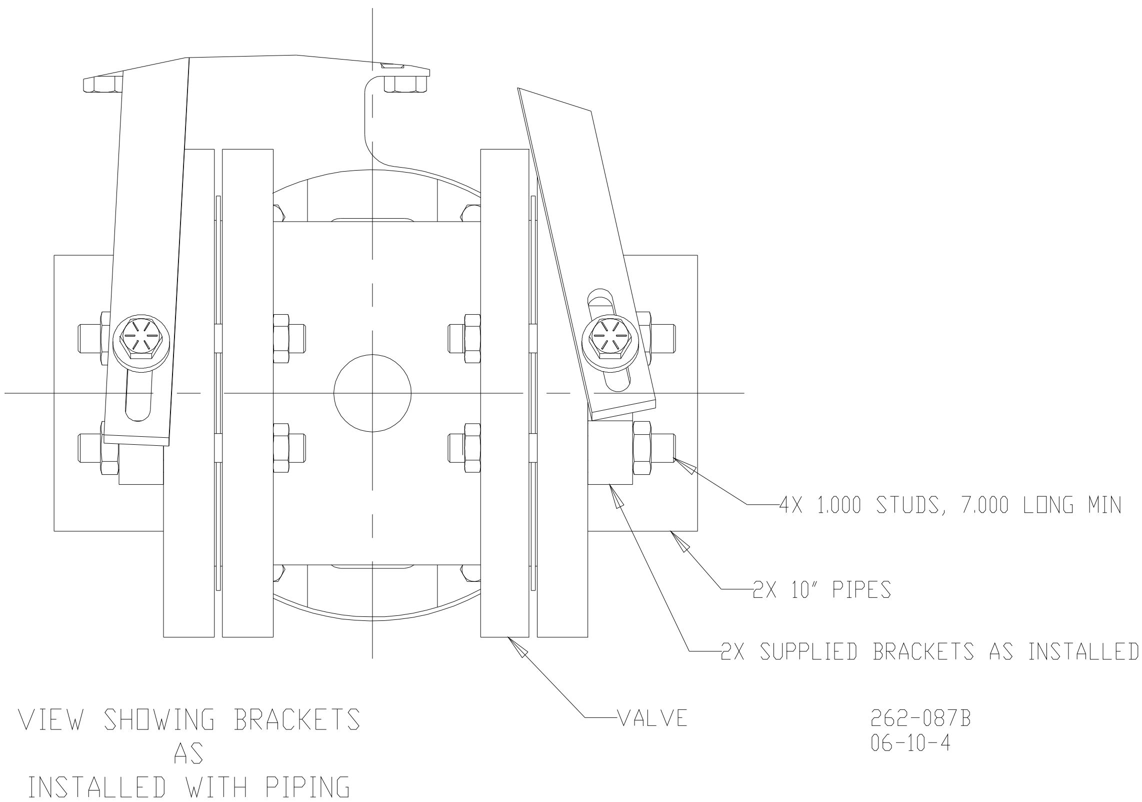

Figure 4-1. Close-up of Strut Brackets on Pipe Flanges

Hydraulic Connections

High/Low Pressure Trip

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.

Electric Trip

There are two hydraulic connections that must be made to each valve: supply and return. 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.

All Trips

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

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

NOTICE	**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).

The LVDT cable must consist of four 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 Vee-Ball stop/ratio 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.

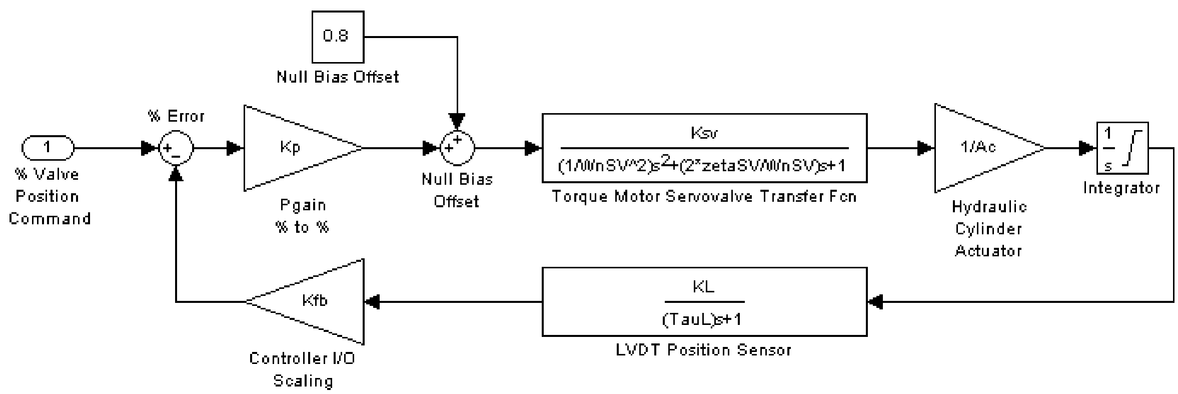

Figure 4-2. Stop/Ratio Valve Block Diagram

Ksv nominal =	8.1 in^3/sec/mA at 1600 psi supply (valve opening); 14.8 in^3/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 in^2
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

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	**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	**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	**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.**

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

IMPORTANT	**Disassembly of this valve without a Woodward Technician present will void the Woodward warranty.**

See the outline drawing (Figure 1-2) for the location of items.

Hydraulic Filter Assembly/Cartridge

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

Replacement of Filter Assembly Procedure

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 1-1).
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 Procedure

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 (Low & High Pressure Trip) Replacement Procedure

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).

Trip Solenoid Valve (Electric Trip) Replacement Procedure

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

IMPORTANT	**Hydraulic fluid may spill during cartridge removal.**

1. Loosen the trip solenoid valve and slowly remove it from the adaptor block.
2. Obtain new trip solenoid valve and verify part number and revision with existing unit.
3. Verify that all O-rings and backup rings are present on new valve.
4. Lubricate O-rings with hydraulic fluid or petroleum jelly.
5. Install valve into the adaptor block.
6. Torque to 80–90 lb-ft (108–122 N·m).

Servo Valve Replacement Procedure

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).

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 adaptor 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 Procedure

WARNING	**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 jam nut on the defective LVDT core rod.
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 Procedure

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 5-1.
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 5-1.
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 5-1. Stroke Measurement Attachment Bar

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.

Symptom	Possible Causes	Remedies
External hydraulic leakage	Static O-ring seal(s) missing or deteriorated	Replace O-rings fitted to user-serviceable components (filter, servo valve, trip relay valve) as needed. Otherwise, return actuator to Woodward for service.
	Dynamic O-ring seal missing or deteriorated	Return actuator to Woodward for service.
Internal hydraulic leakage	Servo valve internal O-ring seal(s) missing or deteriorated	Replace servo valve.
	Servo valve metering edges worn	Replace servo valve.
	Piston seal missing or deteriorated	Return actuator to Woodward for service.
External gas fuel leakage	Piping flange gaskets missing or deteriorated	Replace gaskets.
	Piping flanges improperly aligned	Rework piping as needed to achieve alignment requirements detailed in Chapter 4.
	Piping flange bolts improperly torqued	Rework bolts as needed to achieve torque requirements detailed in Chapter 4.
	Packing follower needs adjustment	Adjust follower per Fisher manual Form 5290, Type Vee-Ball.
	Packing missing or deteriorated	Service packing per Fisher manual Form 5290, Type Vee-Ball.
Internal gas fuel leakage	Vee-Ball seal missing or deteriorated	Service seal per Fisher manual Form 5290, Type Vee-Ball.
Valve will not open	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.)	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.
	Servo valve failure	Replace servo valve.
	Hydraulic supply pressure inadequate	Supply pressure must be greater than 1200 psig/8274 kPa (1600 psig/11 032 kPa preferred).
	Trip relay pressure inadequate	Trip pressure must be greater than 40 psid (276 kPa) above drain pressure.
	Vee-Ball jammed	Service Vee-Ball per Fisher manual Form 5290, Type Vee-Ball.
Valve will not close	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.)	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.
	Servo valve failure	Replace servo valve.
	LVDT failure	Replace LVDT.
	Springs broken	Return actuator to Woodward for service.
	Linkage broken	Return actuator to Woodward for service.
	Vee-Ball jammed	Service Vee-Ball per Fisher manual Form 5290, Type Vee-Ball.

Symptom	Possible Causes	Remedies
Valve will not respond smoothly	Hydraulic filter clogged	Check the differential pressure indicator on the filter housing.
	Servo valve spool sticking	Verify hydraulic contamination levels are within recommendations of Chapter 1. The use of dither may improve performance in contaminated systems.
	Servo valve internal pilot filter clogged	Replace servo valve.
	Excessive friction in Vee-Ball assembly	Service Vee-Ball per Fisher manual Form 5290, Type Vee-Ball.
	Rod-end(s) worn out	Return actuator to Woodward for service.
	Piston seal worn out	Return actuator to Woodward for service.
Actuator seals wear out prematurely	Hydraulic contamination level is excessive	Verify hydraulic contamination levels are within recommendations of Chapter 1. The use of excessive dither may reduce life in contaminated systems.
	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.	Determine and eliminate the root cause of oscillation.
Valve falsely trips to closed position	Trip pressure is too low	Assure that trip pressure is per specifications.
	Drain pressure is too high or is surging to too high a value	Reduce drain pressure. Reduce restrictions in drain line. Reduce drain line flow surges causing drain line pressure surges.

Chapter 6. Safety Management – Safe Position Fuel Shutoff Function

Safety Function

The Gas Stop/Ratio Valve will move to the closed position within the full stroke trip time listed in this manual.

Product Variations Certified

The SIL (Safety Integrity Level) rated Gas Stop/Ratio Valves for fuel shutoff are designed and certified to the functional safety standards according to IEC 61508, Parts 1 through 7. Reference the exida FMEDA report: WOO 19/05-012 R002, and Certification: WOO 1905012 C001. The exida FMEDA report is available on a per request basis from Woodward.

The functional safety requirements in this chapter apply to all Gas Stop/Ratio Valve configurations listed in Table 6-1.

The The Gas Stop/Ratio Valve configurations listed in Table 5-1 are certified for use in applications up to SIL 3 according to IEC 61508. The SIL of an entire SIF (Safety Instrumented Function)must be verified via calculation of Average PFD (Probability of Failure on Demand) considering redundant architectures, proof test interval, proof test effectiveness, any automatic diagnostics, average repair and the specific failure rates of all products included in the SIF. Each element must be checked to assure compliance with the minimum HFT (Hardware Fault Tolerance) requirements.

The SonicFlo™ Gas Fuel Control Valves are classified as a device that is part Type A element according to IEC 61508, having a HFT of 0.

The Gas Stop/Ratio Valves are designed and verified to withstand the worst-case (or greater) expected environmental conditions as listed in other sections of this manual.

SFF (Safe Failure Fraction) for Gas Stop/Ratio Valve – Over Speed SIF

The Gas Stop/Ratio Valve is only one part of a shutoff system that supports an over-speed shutdown SIF. This system consists of a speed sensor, a processing unit and a fuel shutoff actuation subsystem of which Gas Stop/Ratio Valve is a component.

The SFF (Safe Failure Fraction) for each subsystem should be calculated. The SFF summarizes the fraction of failures which lead to a safe state plus the fraction of failures which will be detected by diagnostic measures and lead to a defined safety action. This is reflected in the following formulas for SFF:

$SFF = \lambda SD + \lambda SU + \lambda DD / \lambda TOTAL$
Where $\lambda TOTAL = \lambda SD + \lambda SU + \lambda DD + \lambda DU$

The failure rates listed below, for only the Gas Stop/Ratio Valve, do not include failures due to wear-out of any components and are only valid for the useful lifetime of the Gas Stop/Ratio Valve. They reflect random failures and include failures due to external events such as unexpected use. Reference the exida FMEDA report: WOO 19/05-012 R002 for detailed information concerning the SFF and PFD.

Failure Rates for Static Applications[1] with Good Maintenance Assumptions in FIT @ SSI=2

Table 6-1. Failure Rates according to IEC 61508 in FIT

Application/Device/Configuration	λSD	λSU [2]	λDD	λDU	#	E
Full Stroke, Clean Service, Hydraulic Trip	0	197	0	803	2088	575
Full Stroke, Clean Service, Electric Trip	0	575	0	923	2301	585
Full Stroke, Clean Service, Hydraulic Trip, with PVST	69	128	429	374	2088	575
Full Stroke, Clean Service, Electric Trip, with PVST	443	132	526	397	2301	585

According to IEC 61508 the architectural constraints of an element must be determined. This can be done by following the 1H approach according to 7.4.4.2 of IEC 61508 or the 2H approach according to 7.4.4.3 of IEC 61508. Reference the exida FMEDA report: WOO 19/05-012 R002for additional information, including the assumptions used for the calculated FIT (Failure in Time) values in Table 5-1.

To claim diagnostic coverage for Partial Valve Stroke Testing (PVST), the PVST must be automatically performed at a rate at least ten times faster than the demand frequency with inclusions of position detection from the actuator's LVDT(s). Additionally, the PVST of the safety instrumented function must provide a full cycle test of the solenoid and/or hydraulic pilot valve depending on the device configuration. In cases where this is not true, another method must be used to perform a full solenoid/pilot valve cycle during automated diagnostics in order to use the PVST numbers.

Response Time Data

The Gas Stop/Ratio Valve full stroke trip time is as listed in this manual.

Limitations

When proper installation, maintenance, proof testing, and environmental limitations are observed, the design life of the Gas Stop/Ratio Valve is 250,000 hours of operation. Under "normal" operating conditions Gas Stop/Ratio Valves should be serviced with a factory or authorized service center overhaul every 50,000 hours not to exceed 6 years in service. Refer to service bulletin 01614 for additional service guidelines.

Management of Functional Safety

The Gas Stop/Ratio Valve is intended for use according to the requirements of a safety lifecycle management process such as IEC 61508 or IEC 61511. The safety performance numbers in this chapter can be used for the evaluation of the overall safety lifecycle.

[1] Static Application failure rates are applicable if the device is static for a period of more than 200 hours.
[2] It is important to realize that the No Effect failures are no longer included in the Safe Undetected failure category according to IEC 61508, ed2, 2010.

Restrictions

The user must complete a full functional check of the Gas Stop/Ratio Valve after initial installation, and after any modification of the overall safety system. No modification shall be made to the Gas Stop/Ratio Valve unless directed by Woodward. This functional check should include as much of the safety system as possible, such as sensors, transmitters, actuators, and trip blocks. The results of any functional check shall be recorded for future review.

Competence of Personnel

All personnel involved in the installation and maintenance of the Gas Stop/Ratio Valve must have appropriate training. Training and guidance materials are included in this manual.
These personnel shall report back to Woodward any failures detected during operation that may impact functional safety.

Operation and Maintenance Practice

A periodic proof (functional) test of the Gas Stop/Ratio Valve is required to verify that any dangerous faults not detected by safety controller internal run-time diagnostics are detected. More information is in the “Proof Test” section below. The frequency of the proof test is determined by the overall safety system design, of which the Gas Stop/Ratio Valve is part of the safety system. The safety numbers are given in the following sections to help the system integrator determine the appropriate test interval.

No special tools are required for operation or maintenance of the SonicFlo™ Gas Fuel Control Valve.

Installation and Site Acceptance Testing

Installation and use of the Gas Stop/Ratio Valve must conform to the guidelines and restrictions included in this manual.

Functional Testing after Initial Installation

A functional test of Gas Stop/Ratio Valve is required prior to use in a safety system. This should be done as part of the overall safety system installation check and should include all I/O interfaces to and from the Gas Stop/Ratio Valve. For guidance on the functional test, see the Proof Test procedure below.

Functional Testing after Changes

A functional test of the Gas Stop/Ratio Valve is required after making any changes that affect the safety system. Although there are functions in the Gas Stop/Ratio Valve that are not directly safety related, it is recommended that a functional test be performed after any change.

Proof Test (Functional Test)

The SonicFlo™ Gas Fuel Control Valve must be periodically proof tested to ensure there are no dangerous faults present that are not detected by on-line diagnostics. This proof test should be performed at least once per year.

Suggested Proof Test

The suggested proof test consists of a full stroke of the valve, shown in the table below.

Table 6-2. Suggested Proof Test

Step	Action
1	Bypass the safety function and take appropriate action to avoid a false trip.
2	Issue a trip command to the Gas Stop/Ratio Valve to force the actuator/valve assembly to the Fail-Safe state and confirm that the Safe State was achieved and within the correct time.
Note:	This tests for all failures that could prevent the functioning of the control valve as well as the rest of the final control element.
3	Inspect the actuator and valve for any leaks, visible damage or contamination.
4	Re-store the original supply/input to the actuator and confirm that the normal operating state was achieved.
5	Remove the bypass and otherwise restore normal operation.

For the test to be effective the movement of the valve must be confirmed. To confirm the effectiveness of the test both the travel of the valve and slew rate must be monitored and compared to expected results to validate the testing.

Proof Test Coverage

The Proof Test Coverage for the Gas Stop/Ratio Valve is given in the table below.

Table 6-3. Proof Test Coverage

Device	λDUPT5F (FIT)	Proof Test Coverage	
		No PVST	with PVST
Full Stroke, Clean Service, Hydraulic Trip	247	69%	34%
Full Stroke, Clean Service, Electric Trip	252	73%	37%

The suggested proof test and proof test coverage is referenced in exida FMEDA report;
WOO 19/05-012 R002.

Terms and Definitions

Safety Freedom	Freedom from unacceptable risk of harm
Basic Safety	The equipment must be designed and manufactured such that it protects against risk of damage to persons by electrical shock and other hazards and against resulting fire and explosion. The protection must be effective under all conditions of the nominal operation and under single fault condition
Functional Safety	The ability of a system to carry out the actions necessary to achieve or to maintain a defined safe state for the equipment / machinery / plant / apparatus under control of the system
Safety Assessment	The investigation to arrive at a judgment - based on evidence - of the safety achieved by safety-related systems
Element	Part of a subsystem comprising a single component or any group of components that performs one or more element safety functions
Fail-Safe State	State of the process when safety is achieved; A loss or significant decrease of inlet supply pressure establish high volume reverse flow exhaust
Fail Safe	Failure that causes the hydraulic interface valve to go to the defined fail-safe state without a demand from the process
Fail Dangerous	Failure that does not permit the SIF to respond to a demand from the process (i.e. being unable to go to the defined fail-safe state)
Fail Dangerous Undetected	Failure that is dangerous and that is not being diagnosed by automatic testing
Fail Dangerous Detected	Failure that is dangerous but is detected by automatic testing
Fail Annunciation Undetected	Failure that does not cause a false trip or prevent the safety function but does cause loss of an automatic diagnostic and is not detected by another diagnostic
Fail Annunciation Detected	Failure that does not cause a false trip or prevent the safety function but does cause loss of an automatic diagnostic or false diagnostic indication
Fail No Effect	Failure of a component that is part of the safety function but that has no effect on the safety function
Low Demand Mode	Mode where the safety function is only performed on demand, to transfer the EUC into a specified safe state, and where the frequency of demands is no greater than one per year and no greater than twice the proof test frequency
High Demand Mode	Mode where the safety function is only performed on demand, to transfer the EUC into a specified safe state, and where the frequency of demands is greater than one per year or greater than twice the proof test frequency
Continuous Mode	Mode where the safety function maintains the EUC in a safe state as part of normal operation

Acronyms

EUC	Equipment Under Control
FMEDA	Failure Modes, Effects and Diagnostic Analysis
HFT	Hardware Fault Tolerance
MOC	Management of Change. These are specific procedures to follow for any work activities in compliance with government regulatory authorities or requirements of a standard
PFDavg	Average Probability of Failure on Demand
PFH	Probability of Failure per Hour
SFF	Safe Failure Fraction, the fraction of the overall failure rate of an element that results in either a safe fault or a diagnosed dangerous fault
SIF	Safety Instrumented Function, a set of equipment intended to reduce the risk due to a specific hazard (a safety loop)
SIL	Safety Integrity Level, discrete level (one out of a possible four) for specifying the safety integrity requirements of the safety functions to be allocated to the E/E/PE safety-related systems where Safety Integrity Level 4 is the highest level and Safety Integrity Level 1 is the lowest
SIS	Safety Instrumented System – Implementation of one or more Safety Instrumented Functions. A SIS is composed of any combination of sensor(s), logic solver(s), and final element(s)

Chapter 7.
Product Support and Service Options

Product Support 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 or 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 current list of Woodward Business Partners is available at **www.woodward.com/directory**.

Product Service 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**.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory at **www.woodward.com/directory**, which also contains the most current product support and contact information.

You can also contact the Woodward Customer Service Department at one of the following Woodward facilities to obtain the address and phone number of the nearest facility at which you can obtain information and service.

Products Used in Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany:	
Kempen	+49 (0) 21 52 14 51
Stuttgart	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Products Used in Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Products Used in Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name ______________________

Site Location ______________________

Phone Number ______________________

Fax Number ______________________

Prime Mover Information

Manufacturer ______________________

Turbine Model Number ______________________

Type of Fuel (gas, steam, etc.) ______________________

Power Output Rating ______________________

Application (power generation, marine, etc.) ______________________

Control/Governor Information

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 ______________________

Symptoms

Description ______________________

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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 D—

- Reworked and edited most of the Regulatory Compliance Section
- Added SIL certification information to Regulatory Compliance section.
- Added Chapter 6 Safety Management – Safe Position Fuel Shutoff Function
- Removed all Declarations

Changes in Revision C—

- Updated Pressure Equipment and Machinery Directives
- Updated Declarations

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 26376.

B26376 : D

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Woodward has company-owned plants, subsidiaries, and branches, as well as authorized distributors and other authorized service and sales facilities throughout the world.

Complete address / phone / fax / email information for all locations is available on our website.