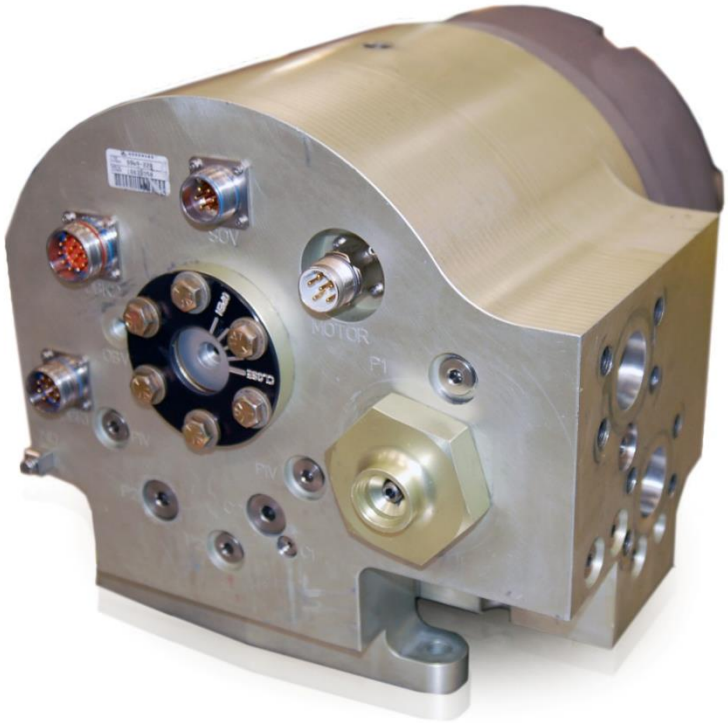
WOODWARD

Product Manual 26739
(Revision C, 12/2023)

Original Instructions



LQ50 Valve Actuator Assembly

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. The latest version of most publications is available on the Woodward website.

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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. The latest version of most publications is available on the Woodward website.

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Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

If your publication is not on the Woodward website, please contact your customer service representative to get the latest copy.

Revisions— A bold, black line alongside the text identifies changes in this publication since the last revision.

Manual 26739

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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

European Compliance for CE Marking:

EMC Directive: Declared to Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility.

Pressure Equipment Directive: Directive 2014/68/EU on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment.
PED Category II
PED Module H - Full Quality Assurance

ATEX – Potentially Explosive Atmospheres Directive: Directive 2014/34/EU on the harmonization of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres.
Zone 2, Category 3, Group II G, Ex nA IIC T3 Gc

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

Machinery Directive Compliant as partly completed machinery with Directive 2006/42/EC of the European Parliament and the Council of 17 May 2006 on machinery.

ATEX Directive: Exempt from the non-electrical portion of the ATEX Directive 2014/34/EU due to no potential ignition sources per EN ISO 80079-36:2016 for Zone 2 installation.

RoHS Directive: Restriction of Hazardous Substances 2011/65/EU:
Woodward Turbomachinery Systems products are intended exclusively for sale and use only as a part of Large Scale Fixed Installations per the meaning of Art.2.4(e) of directive 2011/65/EU. This fulfills the requirements stated in Art.2.4(c) and as such the product is excluded from the scope of RoHS2.

North American Compliance:
These listings are limited only to those units bearing the CSA identification.

CSA: CSA Certified for Class I, Division 2, Groups A, B, C, & D, T3 at 93 °C Ambient. For use in Canada and the United States. Certificate 2613273.

⚠WARNING

EXPLOSION HAZARD—Do not connect or disconnect while circuit is live unless the area is free of ignitable concentrations.

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

⚠ AVERTISSEMENT

RISQUE D'EXPLOSION - Ne pas brancher ou debrancher lorsque le circuit est sous tension, a moins que le milieu soit libre de substances inflammables concentrees.

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

Special Conditions for Safe Use

Wiring must be in accordance with North American Class I, Division 1 or 2 or European Zone 1, Category 2 or Zone 2, Category 3 wiring methods as applicable, and in accordance with the authority having jurisdiction.

Use of the position switch is limited to a maximum input of 125 V, 0.5 A. Product has been tested for ATEX compliance with a resistive load only.

Use supply wire suitable for at least 103 °C and 10 °C above the maximum fluid and ambient temperature.

Make sure the electrical cover set screw is installed and properly tightened to ensure that the electrical cover is grounded.

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.

Chapter 1.
General Information

Introduction

The LQ50 Valve/Actuator Assembly integrated liquid fuel metering system features valve position control, all-electric actuation, fuel bypass, fuel flow regulation, and fault indication. This system may allow multiple independent metered flow paths with a single pump, but is primarily intended for single metered path systems.

The LQ50 Valve assembly is a brushless dc limited-angle torquer which positions a metering port for liquid fuel control. The LQ50 actuator is directly coupled to both the metering port and two position-feedback resolvers. There are no intervening gears, linkages, or flex couplings. The high torque actuator and shearing action of the shoe on the rotor valve provide a high degree of contamination resistance.

⚠WARNING

The controlling device, not the DVP(s) or valve(s), sets turbine stability and response. Follow the instructions for the controlling device while setting up the turbine control system. Failure to follow instructions can cause personal injury and/or property damage.

Turbine manufacturer's requirements for fuel flow to the turbine can vary considerably depending on fuel pressures, fuel types, fuel and ambient temperatures, turbine size, etc. Information on predicting fuel flow through the LQ50 valve as a function of command input signal can be obtained from the flow calibration data supplied with each valve and, for nominal flow data, from information given in the following section. This fuel flow information may be critical to the proper operation of your gas turbine and may be required information for the electronic control system to accelerate and/or decelerate the turbine properly.

IMPORTANT

For complete information on drivers, see manual 26329 for the DVP driver.

Valve Identity Module (ID Module)

The LQ50 valve has the Identity Module physically positioned within the valve assembly. The purpose of the ID Module is to store and provide to the DVP driver parameter information that is specific to the valve, including but not limited to valve type, resolver position calibration, and flow characterization information. This information is transferred to the DVP upon initial start-up or when explicitly invoking an auto detection procedure.

DVP Driver

The fuel valve is electrically actuated by the Digital Valve Positioner (DVP) off-board driver. The valve/DVP system is designed to accept a demand signal, and then accurately position the fuel metering element. Position feedback is achieved using two resolvers. The resolvers are directly coupled to the fuel-metering element, thus eliminating the need for couplings or gear trains and their associated inaccuracies. The use of a second resolver provides redundancy in terms of position feedback.

Positioner Control Architecture

The DVP / valve system will take a position demand signal and provide the corresponding position of the valve. This Positioner controller supports an external flow control algorithm that provides an input to the DVP as either an analog or a digital demand signal. Refer to DVP manual 26329 for more detailed information.

DVP/Valve Operating Modes

The valve can be in four operational modes.

- Running
- Shutdown
- Shutdown position
- Shutdown system

See DVP manual 26329 for configuration options.

Running:
In this mode the valve is operating normally and is in position control; a setpoint is defined based on demand from external sources.

Shutdown:
In this mode the valve is still in position control, but there has been a situation that forced the valve into shutdown. The position will be set to zero %. There are different situations that will force the valve into shutdown. See troubleshooting for more details.

Shutdown Position:
If the valve is into the shutdown position mode, the valve will not control position any more. The driver will try to close the valve in current control mode.

Shutdown System:
If the valve is into shutdown system mode, the driver will try to close the valve with a PWM signal. This is the last attempt to close the valve. See troubleshooting for more details on the different situations that will put the valve into the different modes.

Valve Specific Parameters for Available with the DVP

The following is a description of the valve-specific parameters accessible with the Service Tool Interface. See DVP manual 26329 for specific information and complete guide.

Table 1-1. Valve Specific Parameters

User Configurable Parameter Area	Service Tool Page Location	Service Too Section	Parameter name
Relubrication Function	Setpoint Source Selection	Relubrication Function Settings	Mode
			Position Step
			Impulse Half Duration
			Delay Time
Shaft Resolver Redundancy Manager	LAT Control Operating Summary	Position Feedback Redundancy Manager	User Resolver
			Max Resolver Difference Alarm
			Max Resolver Diff Shutdown
Input Filter Settings	LAT Actuator/Valve Configuration	Input Filter Settings	Filter mode
			Bandwidth (corner frequency)
			Damping Factor
			Noise Suppression Threshold
			Noise Supp. Gain (Below Threshold)

The valve is connected to the DVP, which is connected to the engine control system. Reference DVP Manual 26329 for Installation details.

LQ50 Valve Flow Accuracy

The metering flow accuracy of the LQ50 valve is ±5% of nominal flow point or ±0.1% of maximum rated flow, whichever is greater. The maximum rated flow is based on metering port size: the 387 mm² (0.6 in²) port is 20 865 kg/h
(46 000 lb/h). This flow rate is based on a fuel specific gravity of 0.84.

During calibration, each LQ50 valve is set up at a nominal “rig flow point” which corresponds to a specific position demand signal. Each valve is then flow tested to ensure compliance with the above mentioned flow tolerance bands. This procedure ensures excellent valve to valve flow repeatability.

See Figure 1-1 to predict the metered fuel flow through the LQ50 as a function of Demand Input and metering port size. Note: These curves represent the "nominal" flow based on statistical data. Flow variation from valve to valve will occur within the stated accuracy limits of the product and should be considered in the control application. To determine the exact flow curve of a particular valve, reference the flow test data sheet that accompanies each valve. This data can also be requested through Woodward by providing the valve serial number and part number.

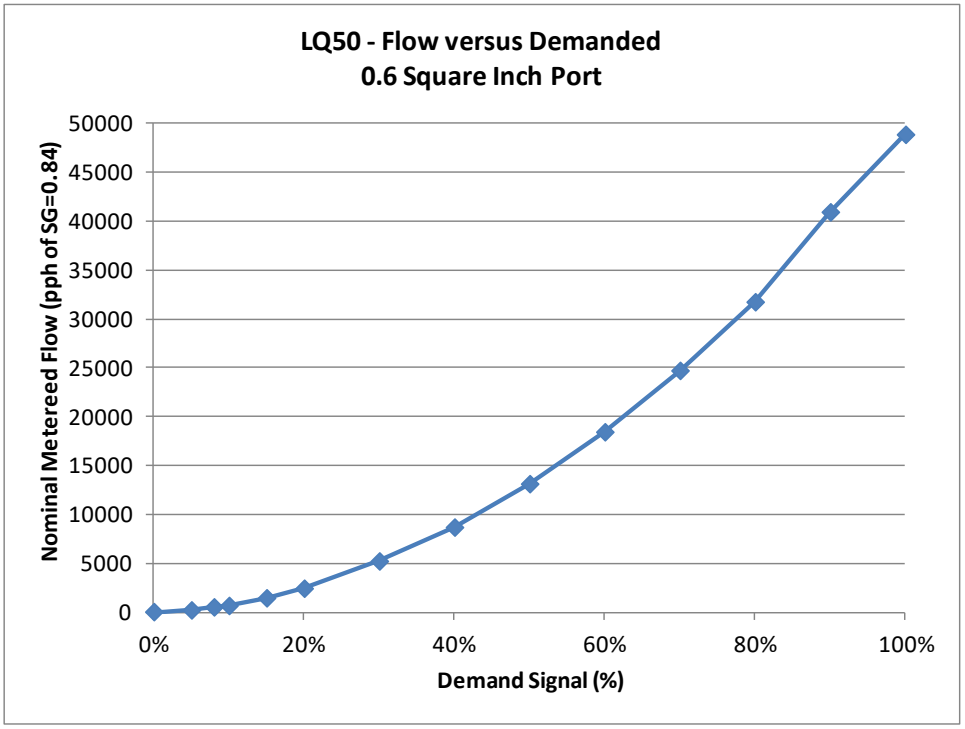

Figure 1-1. LQ50 Flow vs Demand (0.6 in² port)

Table 1-2. LQ50 Flow vs Demand (0.6 in² port)

Demand Signal (%)	Nominal Flow (lb/h of SG=0.84)
0	4
5	179
8	491
10	635
15	1417
20	2398
30	5187
40	8654
50	13094
60	18402
70	24682
80	31705
90	40902
100	48833

LQ50 Fuel Metering Valve

The LQ50 valve is suitable for use on gas turbines in the 6 MW to 60 MW output power range, depending on available fuel properties and conditions. There is one port size for the LQ50; the 387 mm² (0.6 in²) port is rated for 20 865 kg/h (46 000 lb/h). This flow assumes a specific gravity of 0.84. All materials of the LQ50 are corrosion resistant, or protected against corrosion.

The LQ50 Liquid Fuel Valve has all-electric actuation. The actuation, metering, and feedback are integrated on the motor rotor. Feedback is given by two three-speed resolvers. The LQ50 uses a patented single-stage droop-compensated differential pressure regulator. This maintains the differential pressure across the metering port at approximately constant, and the only factor affecting the output flow is the port area. The nominal set point for the LQ50 differential pressure is 345 kPa (3.45 bar / 50 psid).

The LQ50 is a bypassing-type fuel metering valve. This means that it is intended for use with positive displacement pumps. The pump flow provided by the pump is either metered to the gas turbine combustors or it is bypassed back to the tank. The valve is not intended for use with any pump types other than positive displacement pumps.

In addition to the base metering valve, the LQ50 has a pressurizing valve option and an integral, separately commandable shutoff valve option. The pressurizing valve increases the pressure downstream of the metering port (and therefore upstream of the metering port) to enable low flows to be accurately and predictably metered when downstream manifold pressure is very low. The pressure downstream of the metering port is increased to 3100 kPa (31 bar / 450 psi) above bypass pressure with the pressurizing valve.

The shutoff valve is designed to seal off fuel flow downstream to the engine. A separately commandable four-way, two-position solenoid valve is used in conjunction with the pressurizing valve described above to form the shutoff valve. The solenoid must be energized to run the gas turbine. If power is lost to the solenoid valve, fuel flow will be terminated. A position switch, which indicates when the shutoff valve is at closed position, is provided with the shutoff valve option.

Operation of the LQ50 Valve

The LQ50 Liquid Fuel Metering Valve meters fuel as a function of the angular position of its ported metering sleeve/shaft. The metering sleeve/shaft is positioned by the integrated, brushless, dc, limited angle torquer motor (LAT). A resolver mounted directly on the shaft of the valve provides valve position feedback.

To accurately meter fuel, the valve maintains a constant pressure drop across the fuel metering port in the metering sleeve/shaft. The valve regulates the intermediate pressure to maintain this constant pressure differential by a droop-compensated single-stage bypassing differential pressure regulator.

Given the constant pressure differential within the fuel valve, the fuel flow through the metering port is always proportional to the area of the port opening. Fuel flow through the metering port of the valve is described by the following equation:

$$MassFuelFlow = k \times Area \times \sqrt{\Delta P \times SG}$$

Under operating conditions, fuel at the system pressure (P1) flows to the metering sleeve/shaft and to one side of the regulator piston. Metered fuel at the metered pressure (P2) is directed to downstream and to the other side of the regulator piston.

The bypass regulator piston takes a position at which the force from pressure P1 acting on the piston's effective area is equal to the sum of the forces from the pressure (P2) at the other side of the regulator and the force from the ΔP spring. All excess supply flow is directed back to the tank in return at PR, allowing the pressure between P1 and P2 to remain regulated.

When the LQ50 metering valve is at low flow (or closed), most of the flow from the fuel pump will need to be bypassed back to the tank through the ΔP regulator. In the case of a pump connected to an electric motor, it may be that most of the pump flow capacity will need to be bypassed. For the LQ50, this may be up to 22 680 kg/h (50 000 lb/h). In order to bypass this much flow, there must be a minimum difference between the inlet and bypass pressures, because of the finite size of the ports in the bypass valve. This difference is about 2413 kPa (24.13 bar / 350 psid), for 22 680 kg/h (50 000 lb/h). Therefore, the supply pressure will climb to 2413 kPa (24.13 bar / 350 psid) above bypass pressure. But at low metered flows, the valve downstream pressure can be virtually zero because there simply isn't enough flow for the nozzles or other downstream hardware to create enough restriction to increase that pressure. The pressurizing valve option increases the pressure between the metering port and valve outlet. In this way, the supply pressure is high enough to bypass the full 22 680 kg/h (50 000 lb/h) pump flow and keep pressure regulator in control at 345 kPa (3.45 bar / 50 psid). The pressurizing valve (PIV) option is set to crack at 3103 kPa (31.03 bar / 450 psid). The PIV is an option for the base valve that must be specified by the customer.

The LQ50 metering section does not have a failsafe return spring to return the valve to minimum position if the signal from the driver should be lost. Therefore, it is possible that with certain system faults the valve will NOT return to the minimum flow condition even though the engine may be in an operational condition whereby the fuel needs to be cut off. In fact, even if the valve returns to minimum, there will still be leakage through the metering port to the engine (normally this leakage will be less than 36 kg/h or 80 lb/h). This is the reason that an option of the LQ50 is for a separately commandable shutoff valve.

The shutoff includes a four-way, two-position solenoid valve, which will drive the PIV to close upon loss of excitation voltage to the solenoid coil. Therefore, in order to run the engine, the solenoid valve must be energized with the proper voltage—24 V (dc) per Chapter 3: Detailed Specifications. When the solenoid is de-energized, pressure between the metering port and the fuel nozzles is ported to the spring cavity of the PIV. In this way the pressure on both sides of the PIV piston is roughly the same, and the spring will drive the piston closed. At the same time, the solenoid valve connects the spring cavity of the differential pressure regulator to bypass pressure, and therefore the differential pressure regulator will shift to "full bypass" condition in order to "unload" the pump. Due to the timing of these two devices there can be a transient increase in supply pressure during a shutdown. Validation testing has shown this transient pressure spike to be less than 2070 kPa (20.7 bar / 300 psi).

The shutoff option includes a closed-position switch, which indicates that the PIV piston has contacted its seal seat and therefore has closed off fuel flow to the engine. This switch is actuated by a "push rod" that is connected to the PIV spring seat and moves with the piston to indicate the closed position. This switch has both normally open and normally closed contacts.

If a separate shutoff valve is used it should be a 3-way bypass style shutoff so that the pump is not dead headed resulting in running on the pump pressure relief valve.

WARNING

An LQ50 without the shutoff option MUST have a separate liquid fuel shutoff valve in line with the LQ50 metering valve. The LQ50 base metering valve is not a failsafe valve—failure to provide a separate shutoff valve may result in a possibly dangerous overspeed situation.

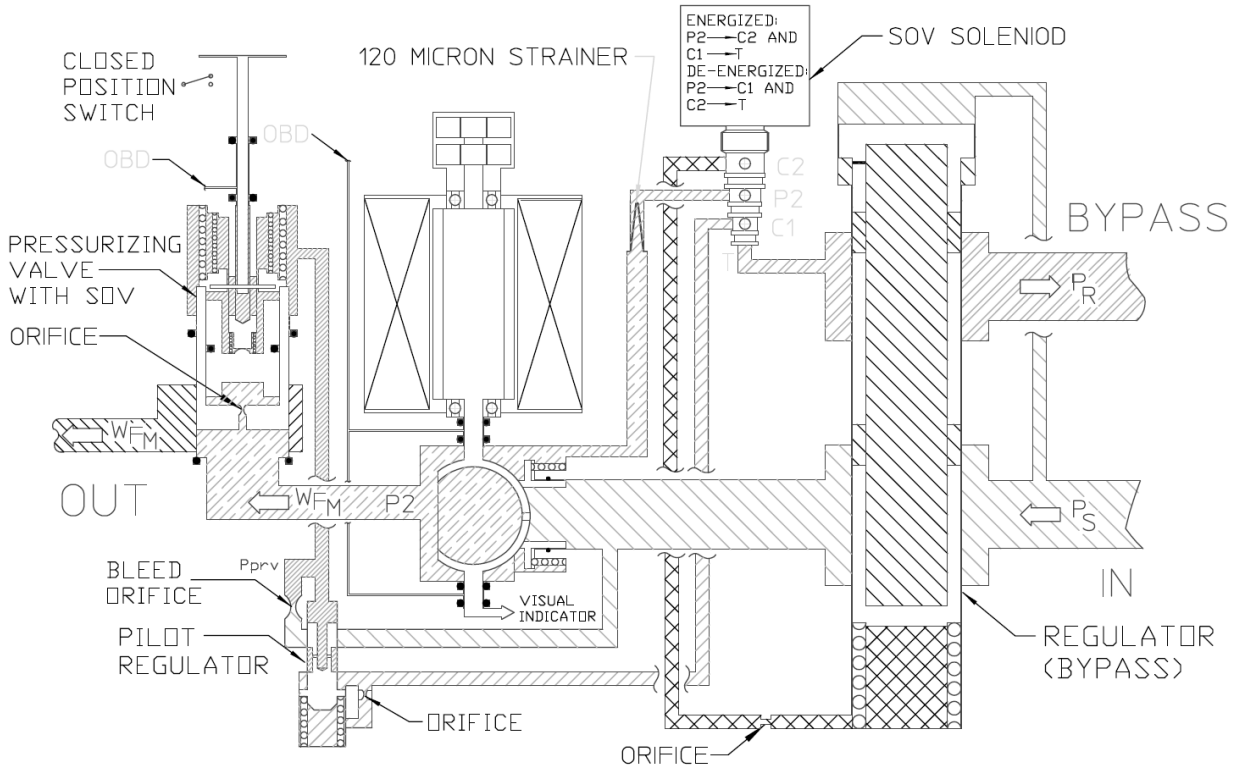

Figure 1-2. LQ50 Schematic with PIV and Optional SOV

Operating Envelope of the LQ50 Valve

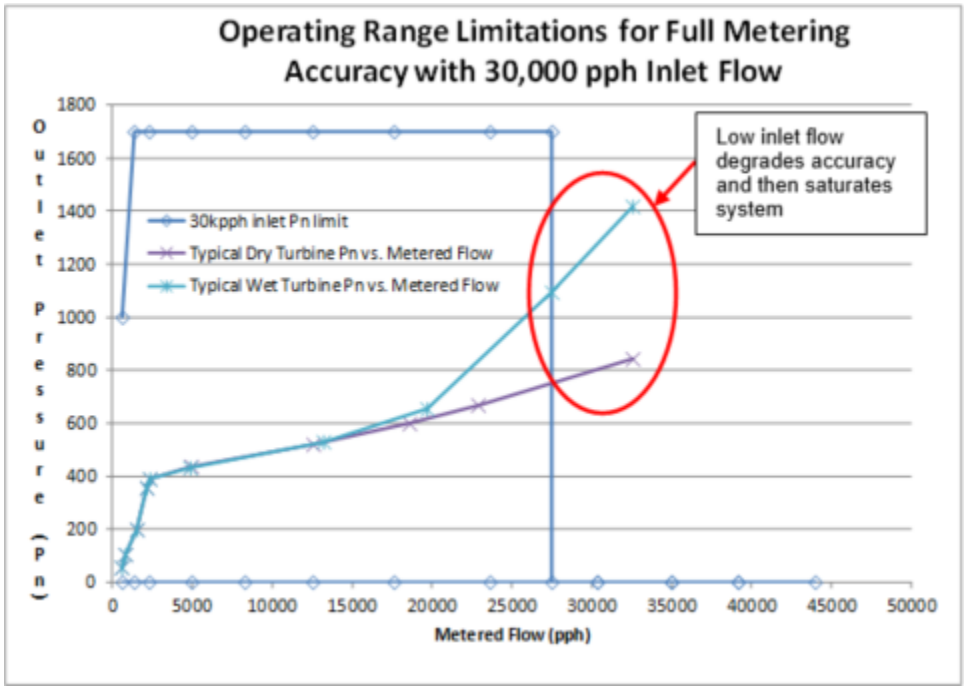

Figure 1-3. Operating Limitations with 30 000 pph Inlet Flow

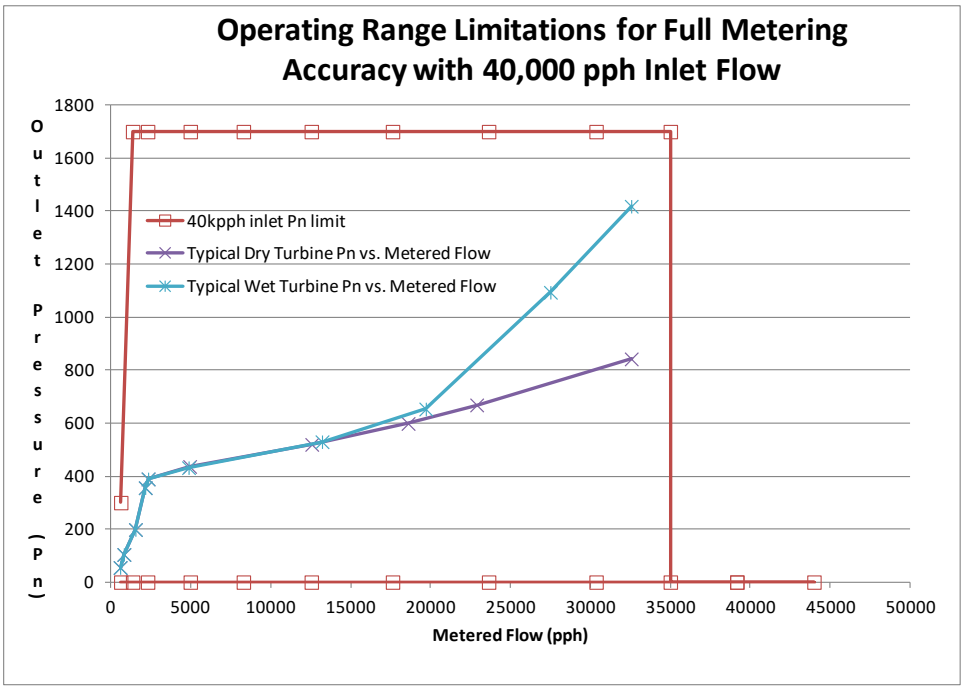

Figure 1-4. Operating Limitations with 40 000 pph Inlet Flow

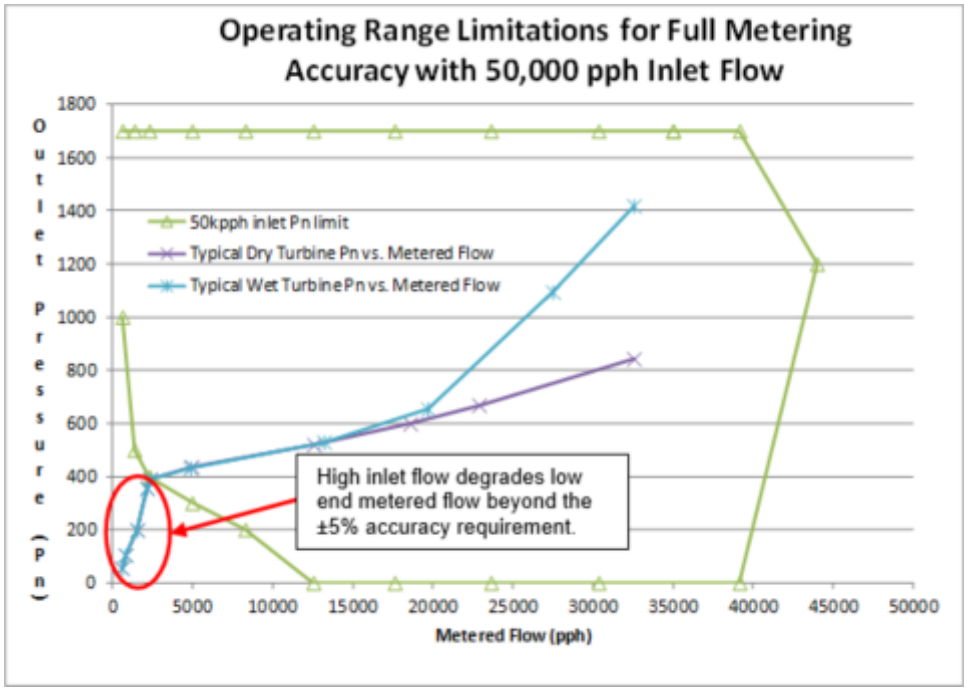

Figure 1-5. Operating Limitations with 50 000 pph Inlet Flow

The LQ50 with integral pressurizing valve meets the ±5% accuracy specification when the inlet flow and outlet pressure (Pn) are within the limits shown in the figures above. If a pressurizing valve is not included in the LQ50, then there is an additional restriction that the outlet pressure must always be 3103 kPa (31.0 bar / 450 psi) above the bypass pressure. The LQ50 supply flow must be maintained at least 1134 kg/h (2500 lb/h) above the maximum application metered flow requirement to avoid regulator saturation.

Chapter 2.
Installation

⚠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

Do not lift or handle the valve by any conduit or connector. Lift or handle only by using the threaded eyebolt hole provided or by using a sling in accordance with these instructions to avoid personal injury.

⚠CAUTION

Due to typical noise levels in turbine environments, hearing protection should be worn when working on or around the LQ50 valve.

⚠CAUTION

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.

LQ50 Valve Unpacking

Use care when unpacking the LQ50 Valve. Abuse can damage seals, installation surfaces, and factory adjustments. Notify the shipper and Woodward if damage is found.

LQ50 Lifting

The LQ50 must be lifted with a sling or by using the ½-13 threaded lifting hole provided. The sling must straddle the LQ50 center of gravity in order to remain secure (see Figure 2-1). It is recommended that one strap be placed under the round electrical cover and a second between the mounting feet.

LQ50 Valve Mounting

The valve should be mounted as close to the turbine as practical in order to minimize the volume of fuel between the valve and the turbine. The inlet volume to the LQ50 must also be below 2000 cu in for acceptable dynamic performance. Ensure that the valve is not mounted in an area that would exceed the temperature limits specified in Chapter 3: Detailed Specifications. The LQ50 valve should be mounted to a thermally conductive surface to conduct heat away from the actuator and maintain proper coil temperature.

See Figures 2-1 and 2-2 for dimensions of the LQ50 mounting hole pattern. The valve should be securely attached to a rigid surface that will not exceed the vibration limits specified in Chapter 3: Detailed Specifications. The recommended mounting hardware is four 0.375-16 UNC (or M10 x 1.5) bolts torqued at (11 to 14) N.m / (8 to 10) lb-ft of minimum length 32 mm (1.25 inches).

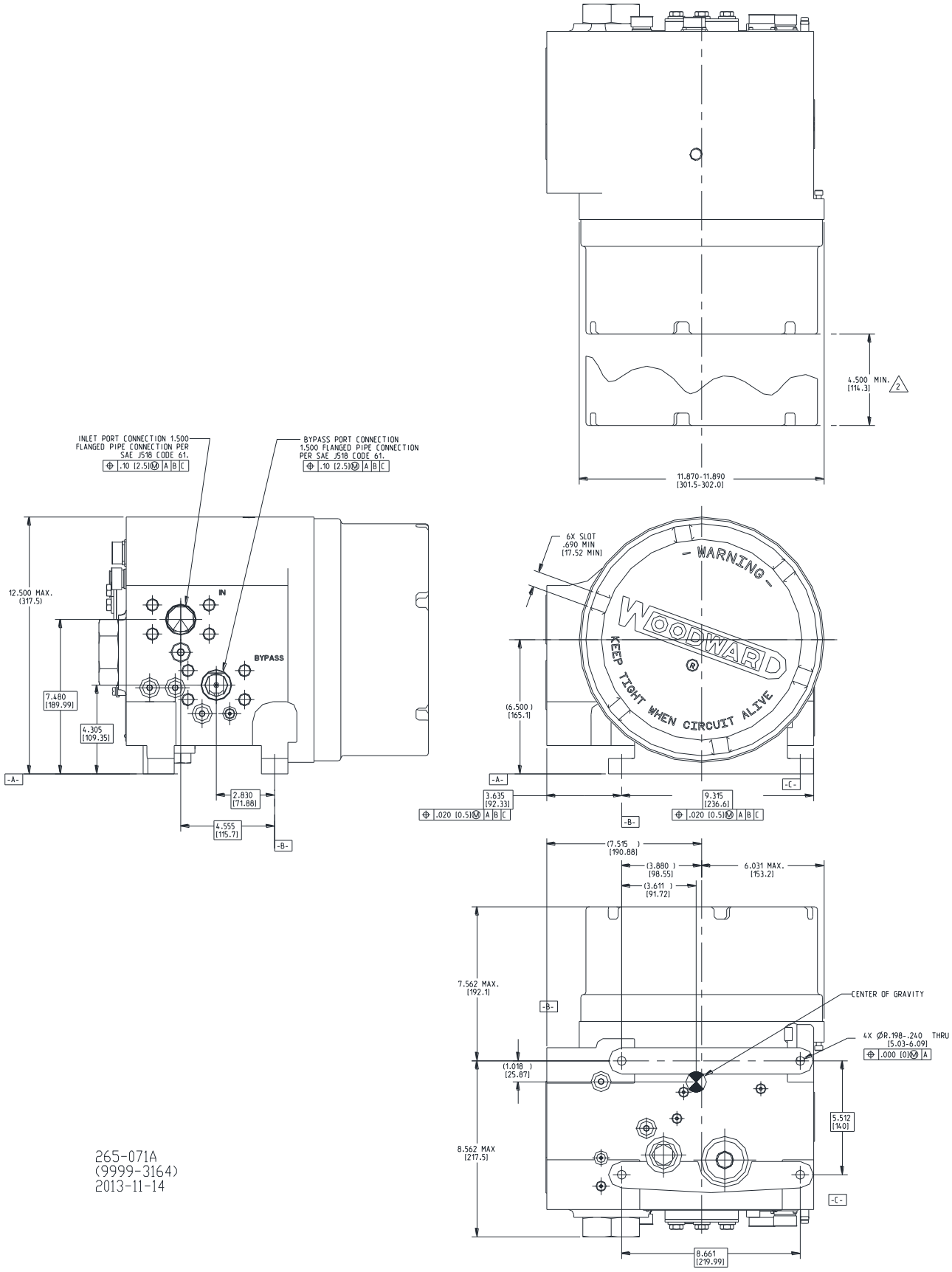

Figure 2-1a. LQ50 Outline Drawing with Connectors

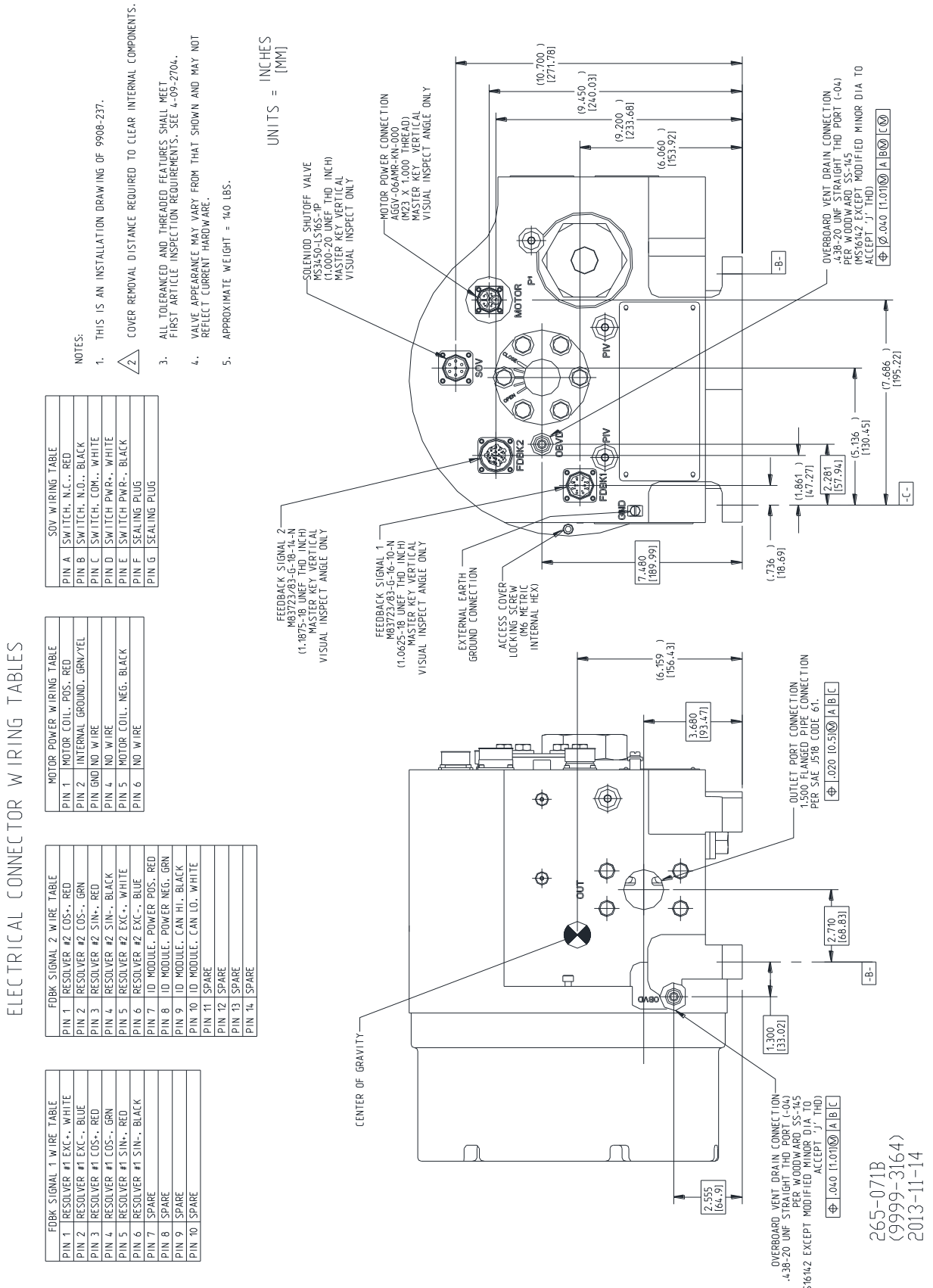

Figure 2-1b. LQ50 Outline Drawing with Connectors

WARNING

Due to the hazardous location listings associated with this product, 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 diagrams (Figure 2-2).

Connect inlet, outlet, and overboard lines to the valve. The inlet port receives pressurized fuel from the pump. The outlet line should be attached to the fuel line(s) going to the turbine combustors. The bypass line must be connected back to the fuel storage tank. The overboard (OBVD) drain port depicted in Figure 3-5 is a vent between dual redundant shaft seals. It must be connected by means of steel piping to a fuel collection, purge, vent, or flare off system so as not to be exposed to danger of obstruction, physical damage, or back pressure in excess of 69 kPa (0.69 bar / 10 psig).

WARNING

Do not plug the overboard drain as this may cause fuel to enter the LQ50 actuator, resulting in a hazardous condition with the potential to case personal injury and/or damage to the actuator.

The overboard drain piping must be sufficiently sloped to eliminate the possibility of stagnant water which could freeze and plug the drain, resulting in a hazardous condition with the potential to cause personal injury and/or damage to the valve.

IMPORTANT

Leakage exceeding 20 cm^3/min from the overboard drain line indicates a worn or damaged shaft seal in the LQ50 valve and should be investigated immediately. Special tooling is required to replace the shaft seal. Contact Woodward for service.

Table 2-1. Fuel Connections

Inlet:	1.5 Inch Flanged Pipe Connection per SAE J518 Code 61
Outlet:	1.5 Inch Flanged Pipe Connection per SAE J518 Code 61
Bypass:	1.5 Inch Flanged Pipe Connection per SAE J518 Code 61
OVBD:	two 0.438-20 SAE Straight Thread Ports (-04) (Overboard Drain Ports)

The SAE J518 Code 61 fluid connections require four 1/2-13 x 1-1/2 inch long bolts per flange. As recommended by the SAE J518 standard Grade 5 bolts should be used with an installation torque of (186 to 203) N•m / (1650 to 1800) in-lb. The maximum piping loads on these fluid connections are:

- Moment 800 lb-in (torsion and bending)
- Tensile 200 lb
- Shear 400 lb

Table 2-2. Cable Connections

Motor Power Connector:	M23x1.0 Metric Thread
Feedback Connection 1:	M83723/83G1610N
Feedback Connection 2 & ID Module Connection:	M83723/83G1814N
Optional SOV Connection:	MS3450-LS16S-1P
External Grounding Stud:	Suitable for wire size 10 mm^2 to 4 mm^2 (8 AWG to 12 AWG)

LQ50 Wiring

WARNING

For use in an ATEX Zone 2 environment, connect only resistive loads to the position switch (through the SOV connector) that meet the limits of Chapter 3: Detailed Specifications. The making/breaking of highly inductive or capacitive loads has not been evaluated and may impair the suitability of the device.

Connectors

The driver must be mounted close enough to the valve and the driver power supply to meet wire length requirements specified in the driver manual.

Make electrical connections between the valve and driver with cables built to the requirements of Figures 2-2a/b/c. The optional SOV and feedback switch are wired directly to the turbine control system and have no connection to the DVP.

Connect external ground terminal of actuator to earth ground. This must be the same grounding system as the driver's earth ground.

WARNING

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

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.

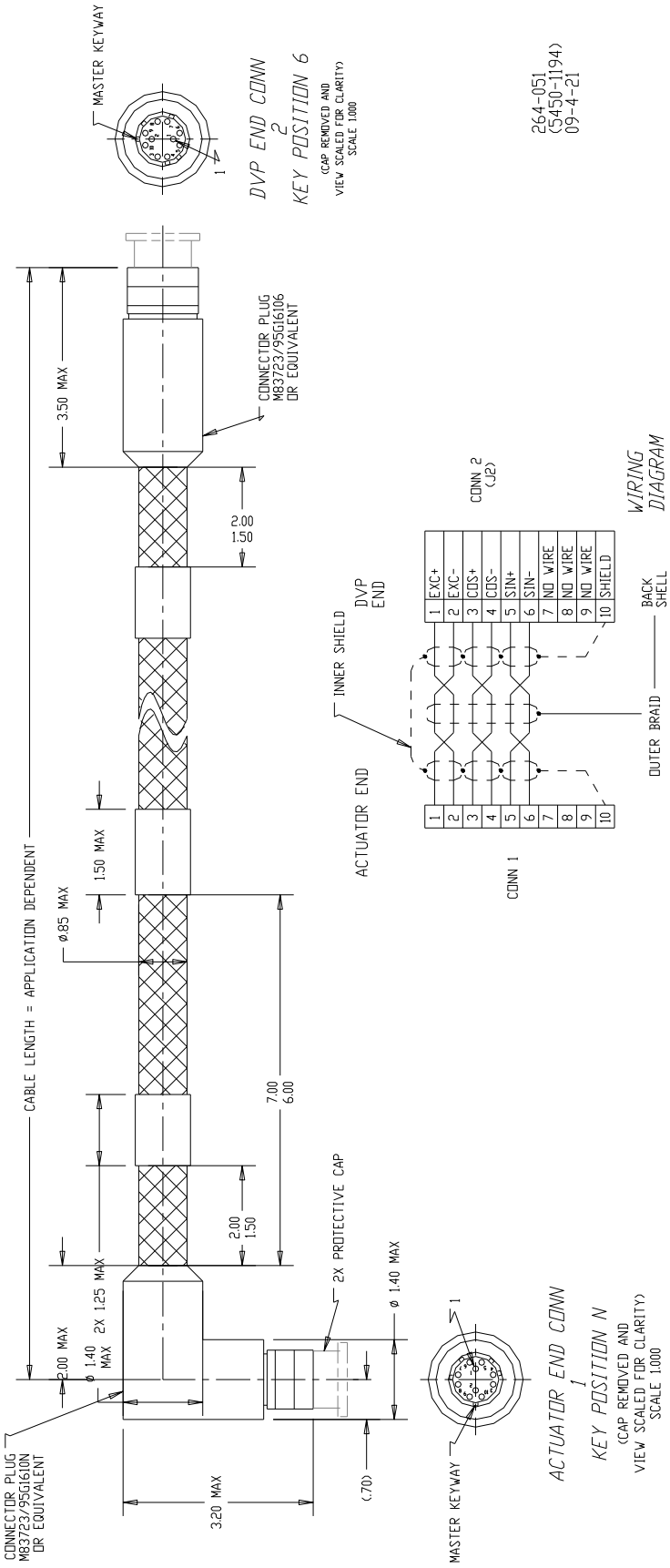

Figure 2-2a. Cable, Feedback 1 Resolver Signal

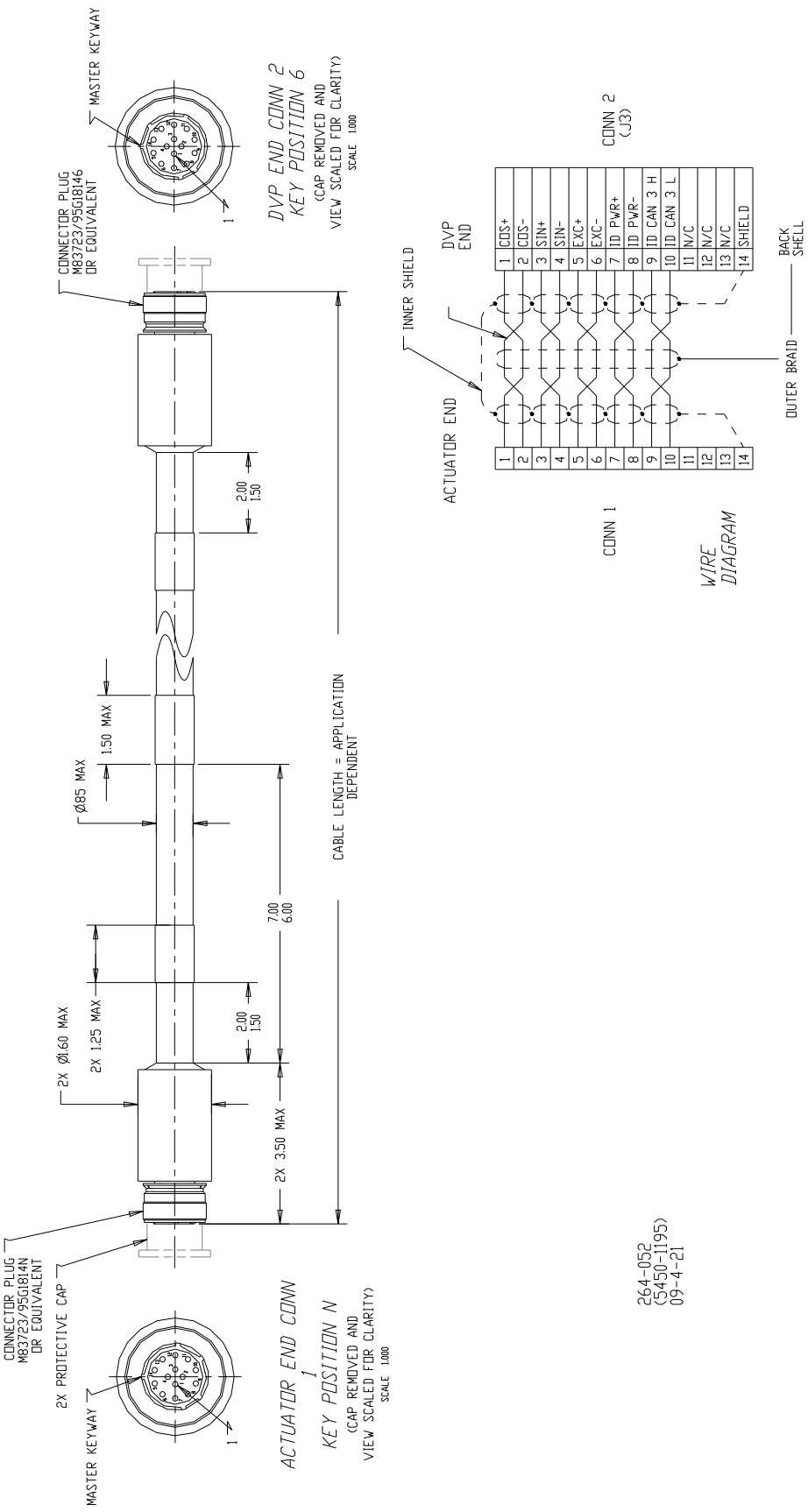

Figure 2-2b. Cable, Feedback 2 Resolver Signal and ID Module

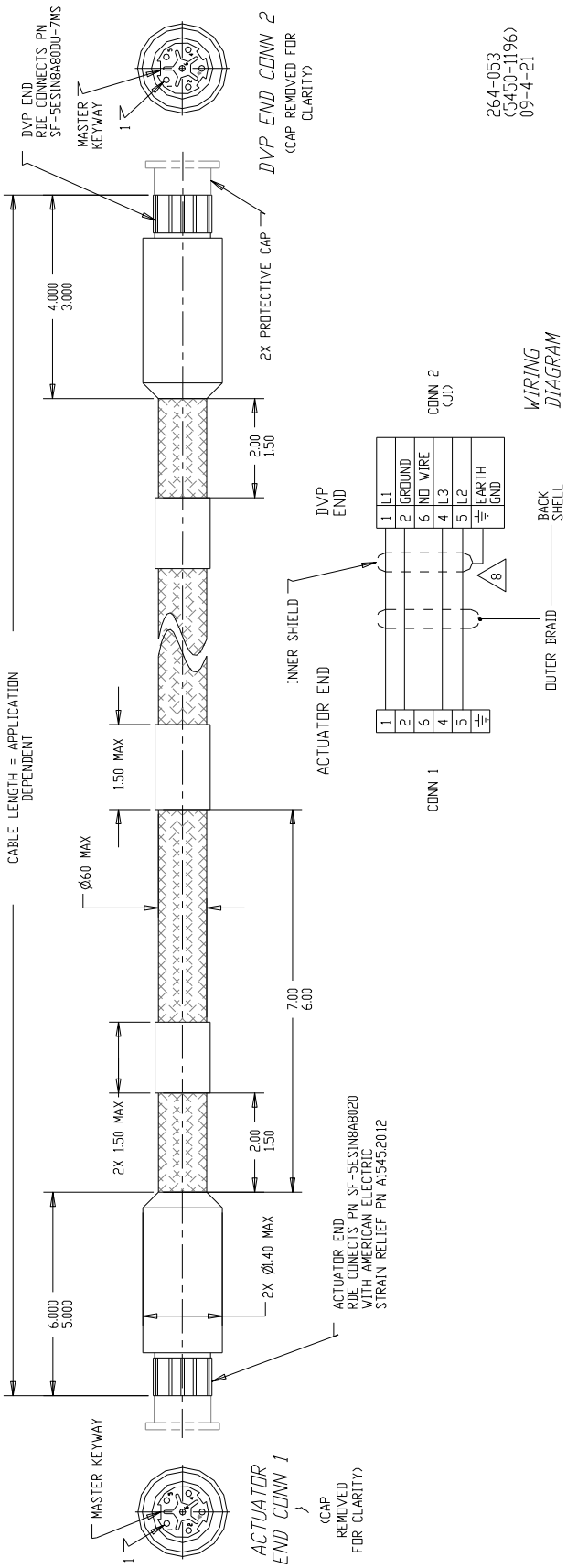

Figure 2-2c. Cable, Motor Power

With SOV Option

Cable must connect to MS3450-LS16S-1P at Valve end with the following pin outs. The solenoid and switch must be controlled and monitored by the turbine control system directly. There is no connection between the SOV and the DVP. When the SOV is seated and therefore has closed off fuel flow to the engine, the NO contact will be closed and the NC contact will be open. When the SOV is open (or not fully seated), the NO contact will be open, and the NC contact will be closed.

Table 2-3. Optional SOV Connector MS3450-LS16S-1P Pin Outs

SOV Wiring Table	
PIN A	POS SWITCH, NC, RED
PIN B	POS SWITCH, NO BLACK
PIN C	POS SWITCH, COM, WHITE
PIN D	SOLENOID, PWR +, WHITE
PIN E	SOLENOID, PWR -, BLACK
PIN F	NO WIRE
PIN G	NO WIRE

Refer to manual 26329 for DVP end connection.

Installation and Application Pre-Start Checks

Every LQ50 installation should include, as a minimum, the recommended checks outlined in Table 2-2 below. All prime mover OEM recommendations and all required plant safety checks must always be followed and supersede any recommended actions. It is the responsibility of the end user to ensure all procedures are carried out in a safe manner.

Table 2-4. Recommended System Checks

	Wiring	Physical/Mechanical Installation	Turbine Control Integration
Installation	Connectors	3-way shutoff valve recommended	Verify independant overspeed system
(before fuel or power is applied to system)	Shielding	Valve and DVP mounting - torque, vibration isolation	
	Point to point verification	Pipe sizes	
	Wire rating / gage/ Type	Pump flow rate / pressure	
	Wire routing / length	Pressure relief valve setting	
	Power source - voltage / current	OBVD vents connected properly	
	Power redundancy	Piping connections / loads	
	Hazardous Location compliance	Flange bolt torques and seals	
	CAN termination applied correctly	Verify product rating (Pressure, Environment , Listings)	
		No piping obstructions	
		Fuel system flushing	
Pre-operational checks		Verify fuel compatability/quality	Configure DVP for control system
(before applying fuel to system)		Pressure relief valve operation	Verify communication
			Verify fault and diagnostic behavior (trip string)
			Demand and feedback loop check 0-100%
			Visual check of correct valve movement
			Verify internal shutdown operation and annunciation
			Verify independent shutdown function and annunciation
			Recommend demand is 0% at shutdown
			Verify low demand signal noise
			Verify voltage at DVP within limits during full valve step
			Verify shutdown from safety system including overspeed
			Document and archive DVP configuration settings
Pre-start		Verify no leaks	Wet motor test recommended
(before turbine lightoff)		Verify dP performance	Verify purge sequence operation
		Bypass back pressure (100 to 200 psig prefered)	Flow rate verification (manifold pressure)
		Verify no signs of Cavitation (audible)	Verify internal shutdown operation and annunciation
			Verify independent shutdown function and annunciation
			Verify shutdown from safety system including overspeed
Operational		Verify dP performance	Verify fuel flow stability (manifold pressure)
		Bypass back pressure (100 to 200 psig prefered)	Flow rate verification (manifold pressure)
		Verify no signs of Cavitation (audible)	Verify transient performance
		Verify operating temperatures, Valve and DVP	Verify low demand signal noise
			Verify fuel schedule and emissions compliance

Chapter 3.
Detailed Specifications

LQ50 Valve Specifications

Environmental Specifications	
Operating Temperature	(–29 to +93) °C / (–20 to +200) °F
Storage Temperature	(–40 to +121) °C / (–40 to +250) °F
Vibration	US MIL-STD-810C, Procedure 1, Table 514.2-ii, Figure 514.2-2, Curve J 20–2000 Hz (5g) Tested to a random vibration profile per MS202F, Method 214A Test Condition D
Shock	US MIL-STD-810C, Method 516.2, Procedure 1, 20 g, 11 ms, sawtooth wave form
Valve Weight	68 kg (150 lb) with pressurizing and shutoff valves
Nominal Piping Size	38 mm (1.5 inches)
Air Born Noise	Ear protection must be worn while Valve is operating
Electromagnetic Interference	EN61000-6-4, 2007: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments, and EN61000-6-2, 2005: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments
Ingress Protection Rating	IP56

Electrical Characteristics	
DVP Input Voltage	125 V (dc) (Ref. DVP manual 26329)
Max Motor Input Current	10 A continuous, 20 A transient
DVP Input Voltage	(90 to 140) V (dc)
DVP Input Current	2 A steady state, 6 A max. transient for 50 ms
SOV Solenoid—Voltage	24 V (dc)
Resistance	(53.2 to 58.8) Ω at 24 °C (76 °F)
OR Voltage	125 V (dc)
Resistance	(742 to 820) Ω at 24 °C (76 °F)
Position Switch	125 V (dc), 0.5 A, resistive load only
Feedback Device—Type	Frameless resolver (three speed)
Excitation	7 V (ac) at 4000 Hz, resistance (36 to 49) Ω at 20 °C
Return	3.5 V (ac) at 4000 Hz, for sine and cosine, each (75 to 101) Ω at 20 °C

Steady State Performance Characteristics	
Range of Maximum Metered Flows	0.6 in²: (9979 to 20 865) kg/h / (22 000 to 46 000) lb/h
Minimum Metered Flow	227 kg/h (500 lb/h)
Fuel Supply Pressure Range—Normal Operation	(3450 to 12 400) kPa / (34.5 to 124) bar / (500 to 1800) psig
Proof Pressure	19.3 MPa (193 bar / 2800 psig)
Burst Pressure	62 MPa (620 bar / 9000 psig)
Max Bypass Pressure	2070 kPa (20.7 bar / 300 psig)
OBVD Pressure	69 kPa (0.7 bar / 10 psig) max

Fuel Pressure Differentials	
Total Valve Pressure Drop	Less than 690 kPa (6.9 bar / 100 psid) when outlet pressure is greater than 4.1 MPa (41 bar / 600 psid) above bypass pressure
Nominal Regulated Metering Valve ΔP	345 kPa (3.45 bar/50 psid)
Chip Shearing Force Capability	267 N (60 lb force) minimum at the metering port edge
Flow Metering Accuracy	Greater of ±5% of nominal point or ±0.1% of maximum rated flow (see Figures 1-3, 1-4, 1-5)
Metered Flow Dynamic Response	Bandwidth = 40 rad/s, damping factor = 1 dP Bandwidth = (30 to 50) rad/s, damping factor = 0.4 to 0.8
Max Slew Time	0.200 s
Hysteresis	Less than 0.5% of full stroke
Position Loop Bandwidth	35 rad/s with a damping factor of 1

Inlet Requirements	
Maximum Inlet Volume	2000 in^3 (for system stability)
Inlet Flow Rate	Minimum –1134 kg/h (2500 lb/h) above metered flow in application. Maximum – 22 680 kg/h (50 000 lb/h)

Liquid Fuel Types and Test Fluids	
Operating Fuel Types	The valve is compatible with most types of diesels, kerosenes, gasolines, heavy and light distillates including naphtha, gas turbine fuels and fuel oils, and other liquid fuels such as biodiesel that are compatible with fluorocarbon (FKM) type elastomers and conform to international standards for utility, marine, and aviation gas turbine service. Ultra low sulfur diesels are also acceptable with proper lubricity additives to bring the wear scar below 860 µm (0.86 mm) as measured by the HFRR test specified in ISO 12156-1. Other fuels such as ethanol or methanol may be acceptable with internal seal compound substitutions. Contact Woodward for these and other special fuel applications.
Fluid Inlet Temperature Range	(–29 to +93) °C / (–20 to +200) °F
Fuel Specific Gravity Range	0.650 to 1.0
Fuel Viscosity Range	0.50 to 12.0 Centistokes
Inlet Fuel Filtration Levels	Liquid fuel must be filtered to limit particulate size to 20 µm or smaller. Water content must be limited to 0.1% by volume. Solids, sediment, and particulates must be limited to 1.0 mg per liter of fuel.
Mean Time Between Overhauls	>50 000 operating hours

Chapter 4.
Maintenance

The valve assembly is designed to avoid the accumulation of air and fuel vapor in service, and does not require any action by the user to purge air or vapor from the assembly following installation or use on the engine system.

The valve is also designed such that during normal operation or storage, fuel or condensed water vapor does not accumulate within any part of the assembly in such a way as to cause damage or deterioration.

When removed from the engine system, it is generally not possible to drain all fuel, condensed water vapor, or other contaminants from the assembly without further disassembly. Handle the valve accordingly by placing in a sealed bag before shipping.

There are no field-replaceable parts on the LQ50. No field maintenance is required. Maintenance is to be performed only by Woodward qualified personnel.

To eliminate the risk of forced outages the LQ50 should be returned to Woodward for factory overhaul every 6 years or 50 000 hours of operation.

Chapter 5. Troubleshooting

WARNING

The valve(s) may not fail shut in every situation. If the DVP is unable to shut the valve in a fault situation, the valve will stay open. For safe turbine operation in fault situations, the valve must be used in conjunction with an additional high-speed shutoff valve. Also, the DVP fault relay should be tied into the engine protection system.

WARNING

Before attempting any troubleshooting action, verify that the prime mover is shut down and that fuel pressure is not present to valves that may open due to actuator motion.

System Stability Problems

If system pressure or flow instability occurs verify the inlet volume and inlet flow rate are within specification limits. As a general rule the system stability is improved with smaller inlet volumes. The maximum recommended inlet volume is in the specification sheet. Note that air trapped in the inlet pipe will behave like a very large volume and must be purged. The valve flow accuracy and stability is also adversely affected by excessive inlet flow. Inlet flow must exceed the metered flow as outlined in the specification sheet but should be kept to a minimum for optimum performance.

Valve Problems

This troubleshooting section does not give the certain cause of any problem. Nor does it cover all possible problems or all possible causes of any problem. This section will not enable a technician to locate a faulty component in the valve.

If trouble occurs, use Figure 5-1, the Troubleshooting Flowchart, as a guide to locate and repair the problem. Follow the flow chart down from the title block to the next block. Rectangular boxes contain suggestions on where to look for a problem. Diamond-shaped boxes ask you questions based on the information you have gathered. The answer to that question will guide you to the next step in the troubleshooting procedure. By following the flowchart, you should be able to identify and correct most problems that may occur with the valve. If after following these troubleshooting procedures you are unable to find the cause of a problem and repair it, contact Woodward for assistance.

If the results of these procedures indicate that the valve may be faulty, replace the suspected unit with a valve known to be good to verify that the cause of the problem is in the valve.

To verify electrical connections within the valve, disconnect the electrical cables at the DVP and measure resistances between DVP connector terminals. Note that the following resistances are approximate and do not include tolerances. This test is to check for open or short circuits, and to test the wiring from the DVP to the valve.

Table 5-1. Resistance (at room temperature; see Table 2-1 for pins)

Motor coil	(0.39 to 0.45) Ω
Resolver excitation	(36.6 to 49.4) Ω
Resolver sin or cos	(74.8 to 101.2) Ω
SOV	800 Ω for 125 V (dc) version 29 Ω for 24 V (dc) version

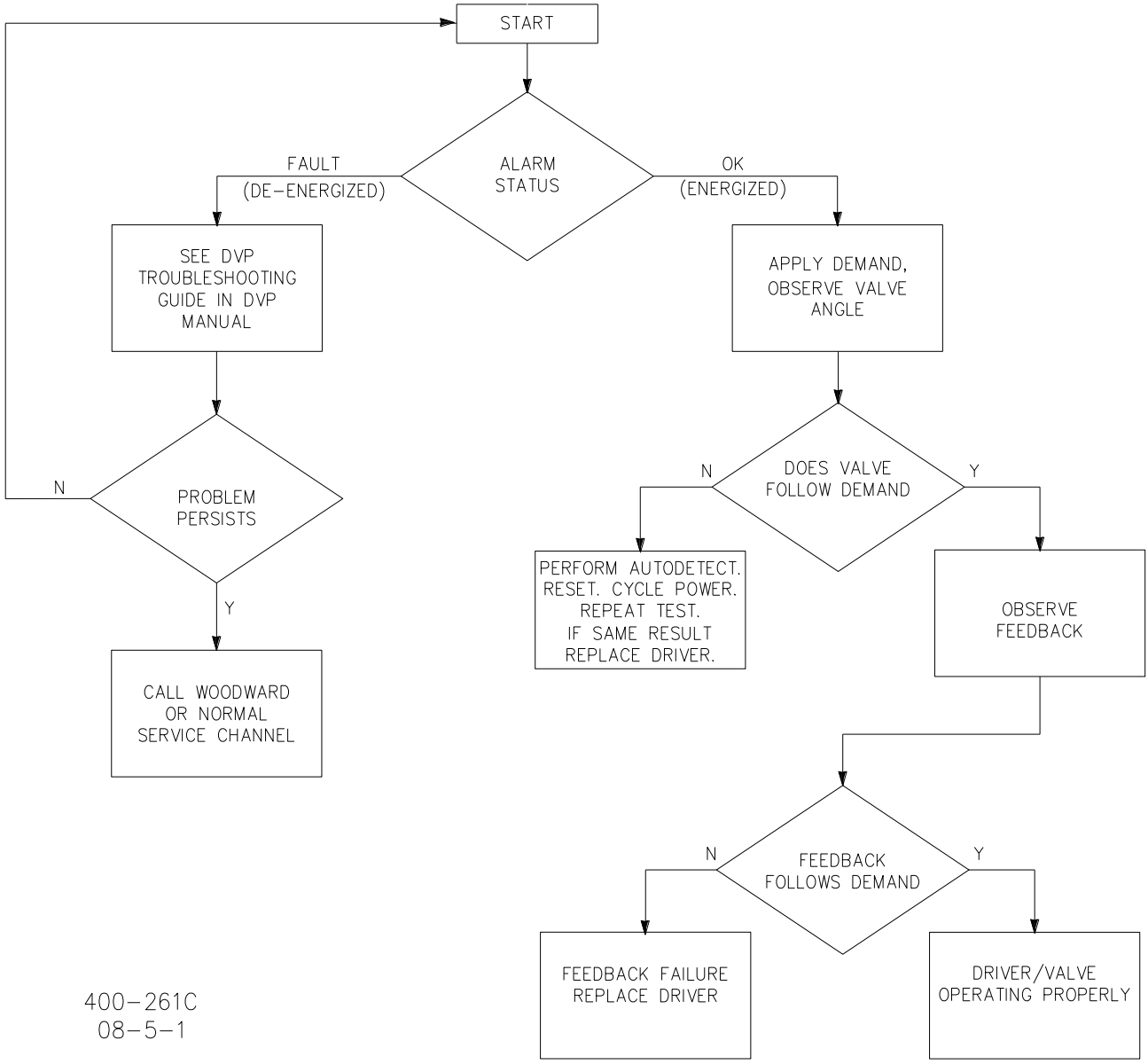

Figure 5-1. Troubleshooting Flowchart

Chapter 6.
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:
https://www.woodward.com/en/support/industrial/service-and-spare-parts/find-a-local-partner

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 (5-09-0690) 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 5-09-0690).

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 5-09-0690) 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 5-09-0690). 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 one of the Full-Service Distributors listed at **www.woodward.com/local-partner.**

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory at **https://www.woodward.com/support**, 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) 8818 5515
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (32) 422-5551
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) 8818 5515
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+ 82 (32) 422-5551
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) 8818 5515
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+ 82 (32) 422-5551
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 _____

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 C—

- Removed CE line under Pressure Equipment Directive
- Replaced new Declarations

Changes in Revision B—

- The following Directives/Certifications updated in the Regulatory Compliance section
  - Pressure Equipment Directive
  - ATEX Potentially Explosive Atmospheres Directive
  - ATEX Directive
- Added RoHS Directive
- Replaced Declarations

Changes in Revision A—

- Updated Certifications
- Replaced Declarations

Declarations

EU DECLARATION OF CONFORMITY

EU DoC No.:	00410-04-EU-02-02
Manufacturer's Name:	WOODWARD INC.
Manufacturer's Contact Address:	1041 Woodward Way Fort Collins, CO 80524 USA
Model Name(s)/Number(s):	LQ50
The object of the declaration described above is in conformity with the following relevant Union harmonization legislation:	Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres Directive 2014/68/EU of the European Parliament and of the Council of 15 May 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment PED Category II Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC)
Markings in addition to CE marking:	Ex II 3 G, Ex nA nC IIC T3 Gc,
Applicable Standards:	ASME Boiler and Pressure Vessel Code VIII, Div. 2, 2007/A08 EN IEC 60079-0:2018 – Explosive atmospheres – Part 0: Equipment – General requirements EN 60079-15:2010 – Explosive atmospheres – Part 15: Equipment protection by type of protection 'n' EN 61000-6-4, 2007/A1:2011: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments EN 61000-6-2, 2005: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments
Conformity Assessment:	PED Module H – Full Quality Assurance, CE-0062-PED-H-WDI 001-22-USA Bureau Veritas SAS (0062) Tour ALTO, 4 Place des Saisons, 92400 COURBEVOIE, FRANCE

This declaration of conformity is issued under the sole responsibility of the manufacturer
We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

MANUFACTURER

Annette Lynch
Signature

Annette Lynch
Full Name

Engineering Manager
Position

Woodward, Fort Collins, CO, USA
Place

19 December 2023
Date

5-09-1183 Rev 34

DECLARATION OF INCORPORATION
Of Partly Completed Machinery
2006/42/EC

File name: 00410-04-EU-02-01
Manufacturer's Name: WOODWARD INC.

Contact Address: 1041 Woodward Way
Fort Collins, CO 80524 USA

Model Names: LQ50

This product complies, where applicable, with the following Essential Requirements of Annex I: 1.1, 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.

The person authorized to compile the technical documentation:

Name: Dominik Kania, Managing Director
Address: Woodward Poland Sp. z o.o., ul. Skarbowa 32, 32-005 Niepolomice, Poland

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 Inc. of Loveland and Fort Collins, Colorado that the above referenced product is in conformity with Directive 2006/42/EC as partly completed machinery:

MANUFACTURER

Annette Lynch
Signature

Annette Lynch
Full Name

Engineering Manager
Position

Woodward Inc., Fort Collins, CO, USA
Place

19 December 2023
Date

Document: 5-09-1182 (rev. 18)

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Released

We appreciate your comments about the content of our publications.

Send comments to: industrial.support@woodward.com

Please reference publication 26739.

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1041 Woodward Way, Fort Collins CO 80524, USA
Phone +1 (970) 482-5811

Email and Website—www.woodward.com

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.