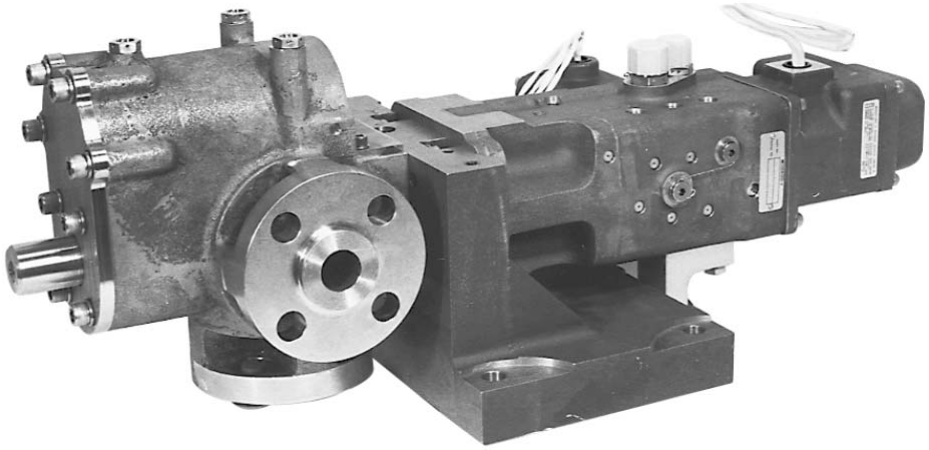
WOODWARD

Product Manual 40120
(Revision C)
Original Instructions



3151A Water Valve/TM-40LP Actuator Assembly for Gas Turbine Water Injection System

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 *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, on the *publications page* of the Woodward website:

www.woodward.com/publications

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

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 *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

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

Contents

Illustrations and Tables

Warnings and Notices

Important Definitions

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

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

⚠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.

⚠WARNING

Automotive Applications

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

NOTICE

Battery Charging Device

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

Electrostatic Discharge Awareness

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.

Chapter 1.
General Information

Introduction

The 3151A Water Valve/TM-40LP Actuator assembly meters water to gas-turbine combustors as part of a nitrous oxide (NOx) emission-reduction system.

Water Valve

The 3151A Water Valve is intended for use with high-pressure centrifugal-type pumps and provides metered bypass flow for pump-stability and heat-balance considerations.

The water valve is primarily constructed of stainless steel. A replaceable, hardened, stainless-steel sleeve is located in the drain flange area of the valve housing, and protects the housing from cavitation damage. The sleeve can be rotated in one-quarter turn increments, or it can be replaced, to extend valve life when used in severe conditions.

Ceramic is used on metering valve and regulator valve parts to prevent galling and to resist erosion in an area subjected to high-velocity water streams.

These design features make the 3151A water valve highly resistant to erosion, corrosion, and cavitation.

The water valve is designed to meter water up to 250 L/min (66 US gal/min) with input water pressures from 2413 to 10 342 kPa (350 to 1500 psi). The minimum flow is one gallon of water per minute, dependent upon inlet pressure.

The degree-of-flow accuracy is either 5.0% of point or 0.5% of maximum flow—whichever value is greater.

Standard seal material allows operation with water temperatures up to 66 °C (150 °F). The minimum operating temperature is 0 °C (32 °F).

Actuator

The TM-40LP Actuator is an electrohydraulic, proportional actuator of the "extend-with-increasing-current" design. The actuator may be used with many Woodward digital and analog electronic controls. It is contained in an aluminum case with internal parts of hardened, stainless steel.

The TM-40LP Actuator receives commands from an electronic control to position the water valve. The control may be calibrated so that the water valve closely follows the fuel-flow schedule to prevent unwanted water insertion during turbine load swings.

A dual-coil torque motor is available with the TM-40LP actuator permitting redundancy in this part of the actuator. The dual-coils can either be used independently or together to load share.

Hydraulic Fluid Specifications:

Fluid Type:	Mineral or synthetic based oil, diesel fuel, or light distillate fuel
Specific gravity:	0.6 to 1.0
Recommended viscosity:	0.6 to 400 centistokes
Supply pressure:	Any nominal level between 2758 and 8274 kPa (400 and 1200 psig)

Single Coil

Steady state flow:	2413 kPa/1.1 L/min (350 psig/0.3 US gal/min) 5171 kPa/1.9 L/min (750 psig/0.5 US gal/min)
Maximum transient flow:	2413 kPa/17.8 L/min (350 psig/4.7 US gal/min) 5171 kPa/18.5 L/min (750 psig/4.9 US gal/min)

Dual Coil

Steady state flow:	2103 kPa/1.9 L/min (305 psig/0.5 US gal/min) 5171 kPa/3.0 L/min (750 psig/0.8 US gal/min)
Maximum transient flow:	2413 kPa/18.5 L/min (350 psig/4.9 US gal/min) 5171 kPa/19.7L/min (750 psig/5.2 US gal/min)

LVDT Option

An optional LVDT may be used on the water valve/actuator assembly. The LVDT senses the position of the assembly's actuator and sends an appropriate signal to the electronic control. This allows the electronic control to closely monitor the valve's position in relation to the fuel-regulating device and to provide greater metering accuracy.

IMPORTANT **Contact Woodward for information regarding UL approval if using this actuator in hazardous locations.**

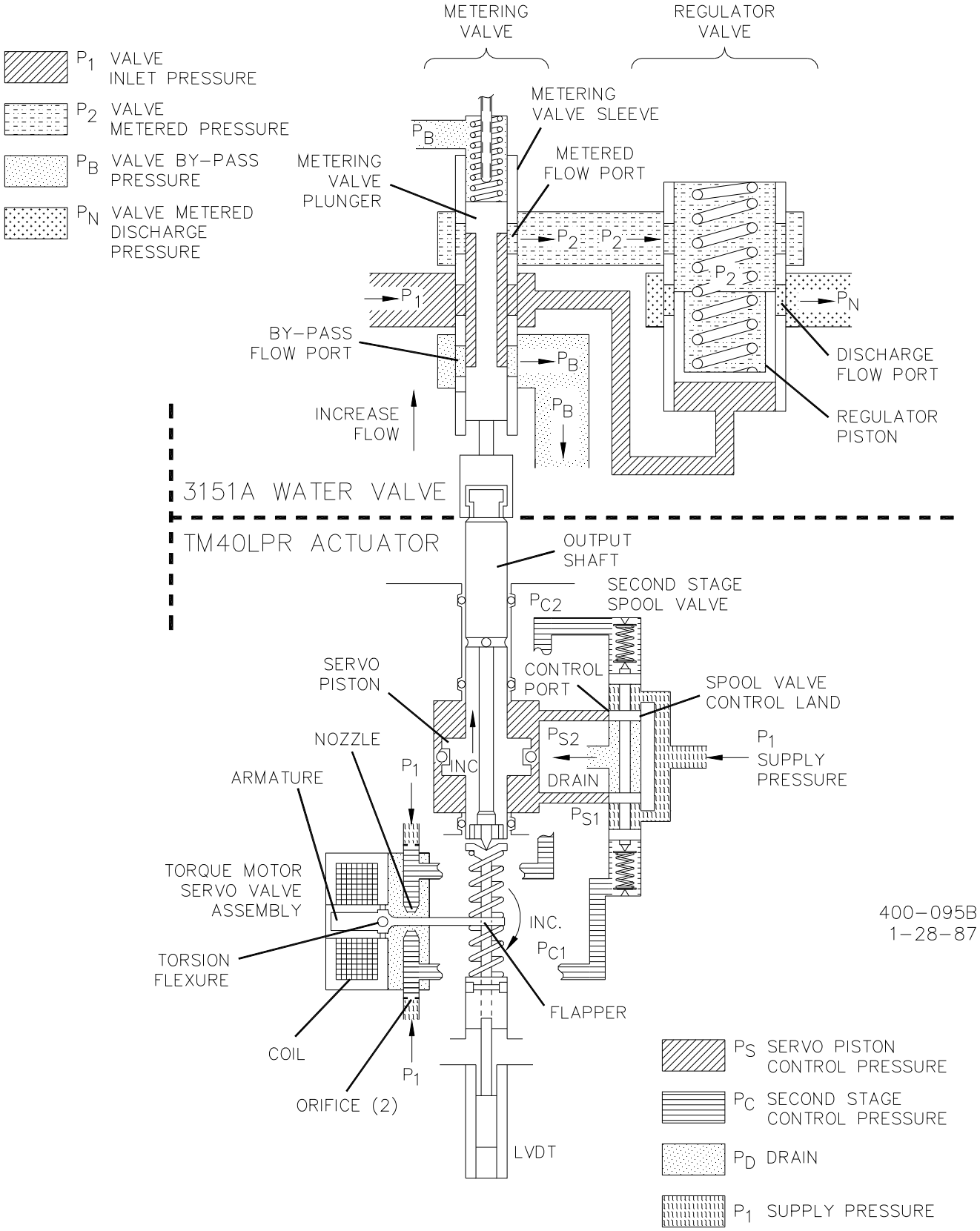


Figure 1-1. Water Valve/Actuator Schematic

Chapter 2.
Installation

Introduction

During installation, handle the valve/actuator with care. Improper handling can ruin seals, mating surfaces, and factory adjustments. Keep all plastic shipping caps and covers in place until ready to connect normal service/supply lines.

Packaging and Storage

The water valve/actuator assembly is calibrated and then drained of fluid at the factory. The assembly is bolted to a transportation skid and shipped in a protective box. Additional cleaning or calibration prior to installing and operating unit is not necessary.

The water valve/actuator assembly may be stored as received from the factory for a short period of time prior to installation.

IMPORTANT

Normally, Woodward considers short-term storage duration to be one month; however, environmental conditions may dictate either an increase or a decrease in a short-term storage period.

For long-term storage, or storing a previously used unit, refer to Woodward manual 25075, *Commercial Preservation Packaging for Storage of Mechanical-Hydraulic Controls*.

General Installation

The 3151A Water Valve MUST be installed with the pressure taps facing up and the axis vertical. This places the drain in a down position and ensures adequate water drainage.

IMPORTANT

Refer to the outline drawing, Figure 2-2, for:

- **Overall dimensions**
- **Location of installation holes**
- **Hydraulic fitting sizes**
- **Electrical connection locations**

Actuator Installation

Be sure that the hydraulic fluid used to supply the actuator is properly filtered. Woodward recommends:

- A 10 µm (nominal) filter to achieve ISO 4406 20/18/15 cleanliness
- Installing the filter within 1 meter of supply port
- Keeping the immediate area free of dirt and other contaminants during the installation process

Supply pressure for the actuator may be provided by either positive-displacement or centrifugal-type pumps. Woodward recommends installation of a pressure switch to be sure that correct supply pressure is present before start-up and to ensure pressure is continually maintained during actuator operation.

Be sure all hydraulic connections are correctly assembled and tight.

Water Valve Installation

The water valve must be installed with the drain port at the bottom to provide proper water drainage.

Since the valve contains a replaceable/rotatable sleeve at the drain flange, a minimum clearance of 89 mm (152 mm max.)/3.5 inches (6.0 inches max.) must be provided for the sleeve's removal or rotation. This consideration is especially important in operations with more than 6200 kPa (900 psi) water inlet pressure. The proper clearance can be obtained by constructing a piece of removable pipe in the drain line, or by constructing the drain so it can swing away from the valve housing.

Electrical Connections

TM-40LP actuators are supplied with receptacle or conduit type electrical connections. Figure 2-3 illustrates a typical wiring diagram for the assembly when it is used with Woodward equipment. If your system-wiring diagram shows a different wiring scheme, or if you need further wiring information, contact Woodward. In applications where the actuator is not used with a Woodward control, electrical input requirements will be supplied upon request.

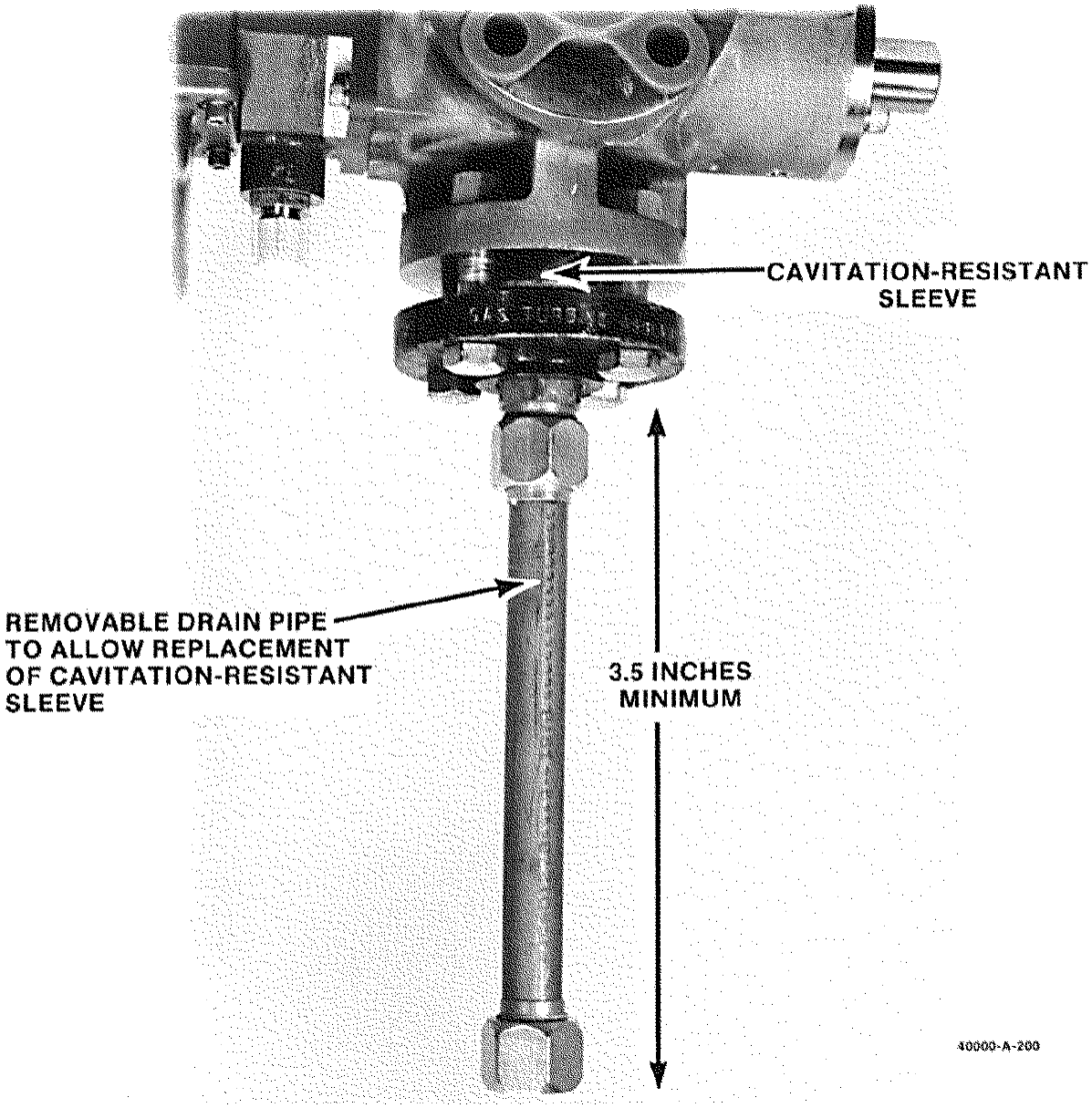


Figure 2-1. Valve Installed With Removable Drain Pipe

[see enlarged attachment at end]

Figure 2-2. Outline Drawing (see end of manual)

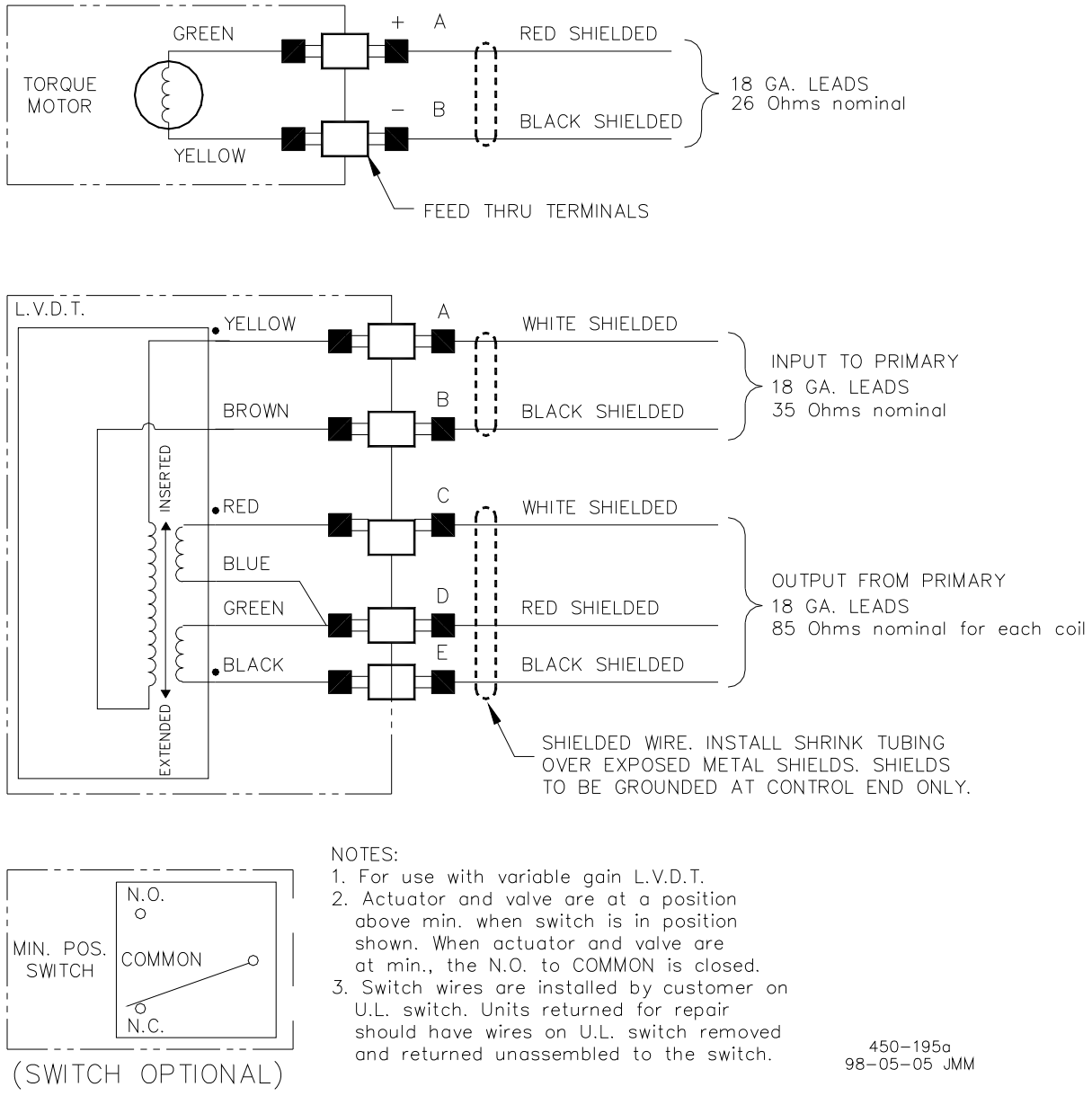


Figure 2-3. Wiring Diagram

Chapter 3.
Start-up and Adjustment

Initial Operation

Before initial use of the water valve/assembly, be sure that all installation steps found in this and/or accompanying manuals have been completed. All electrical connections, hydraulic fittings, and water fittings must be properly and securely installed.

NOTICE

Air trapped within the hydraulic system may cause erratic behavior of the actuator during the first few minutes of initial operation.

Proper actuator hydraulic supply pressure must be established before start-up.

Woodward recommends adequate dither be used on all hydraulic actuators to minimize mA threshold and hysteresis which can result from second stage static friction or hydraulic contamination.

Dither is a low amplitude, relatively high frequency periodic signal that is superimposed on the servovalve input current signal. A typical dither signal generated by a Woodward control is:

- 25 Hz, 0–10 mA (tunable) amplitude
- 25% duty cycle, bipolar, square wave

Adequate dither is defined as that amount which produces no more than 0.013 mm (0.0005 inch) total oscillation in output shaft position.

Adjustments

Normally, all operating adjustments on the 3151A Water Valve TM-40LP Actuator assembly are made to customer specifications at the factory. The unit should not require further adjustment.

IMPORTANT

Do not attempt adjustments to the actuator unless thoroughly familiar with procedures. The water valve/actuator assembly is not field adjustable. See "Troubleshooting" in Chapter 4 of this manual.

Null current shifts of up to ±4% of maximum rated current (200 mA) can occur due to variations in the following parameters:

- hydraulic supply and return pressures
- hydraulic fluid temperature
- servovalve and actuator wear

Due to the inherent null shifts and position drift of all hydraulic servovalves and proportional actuators, engine control applications must be designed with these errors in mind.

Inspection

Woodward recommends periodic inspection of the sleeve until you are able to determine an appropriate length of time between index operations. If the water pressure exceeds 6200 kPa (900 psi), the sleeve should be indexed at least after every 4320 hours of operation (6 months of continuous operation). However, you should be aware that service life of the sleeve is dependent on several factors--two important factors are water pressure and water purity. After four indexing operations, remove the sleeve and inspect for excessive cavitation damage of the interior surface.

NOTICE

Water must meet all purity and deionization requirements as established by the turbine manufacturer.

When indexing the sleeve, loosen the four drain-flange bolts, insert a 3/32 inch (~2.4 mm) allen wrench or a 1/8 inch (~3 mm) diameter punch in one of the four spanner holes, and turn the sleeve 1/4 turn. In order to help reposition the sleeve, the spanner holes are numbered and an index is marked on the drain flange (see Figure 3-1). The appropriate spanner hole should be aligned with the flange index. After four repositioning operations, the sleeve should be removed and examined.

To remove the sleeve, insert a punch or an allen wrench into a spanner hole. Place a screwdriver, or other lever, between the punch (allen wrench) and the flange face. Pry up until sleeve loosens and can be removed from the valve.

When free of the valve body, examine the interior surface of the sleeve for excessive pitting or distortion. Discoloration and minor wear of the internal surface is normal. If sleeve exhibits excessive pitting or distortion, replace it.

The sleeve contains an O-ring located in a groove on the surface of the outer diameter. Anytime the sleeve is removed, the O-ring should be replaced.

A replacement sleeve or O-ring may be ordered from Woodward.

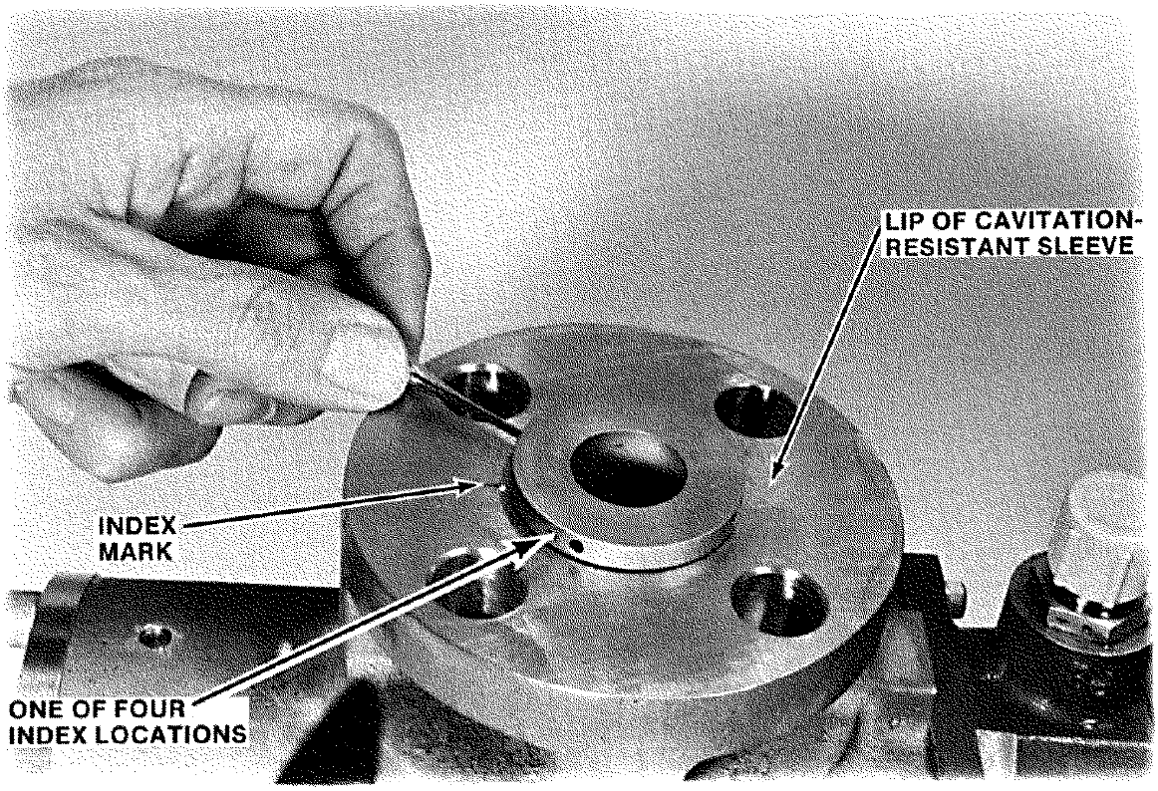


Figure 3-1. Indexing Cavitation-Resistant Sleeve

Chapter 4. Maintenance

Indexing Drain-Flange Sleeve

The cavitation-resistant sleeve located in the drain flange should be indexed on a routine basis. The frequency of sleeve rotation is determined by the amount of water found in each application. If uncertain of a rotation frequency, a period of not more than 4320 operational hours is suggested as a possible operating period between rotations.

Chapter 3 of this manual, "Operation and Adjustment," contains instructions on the adjustment and removal of the drain-flange sleeve.

Filter Cleaning

The TM-40LP actuator is equipped with a filter fitting located at the supply connection. If the filter becomes clogged, as evidenced by sluggish response, it may be removed, cleaned ultrasonically, and then back flushed with a light solvent. The O-ring (P/N 40120-003) may require replacement if the filter is removed.

NOTICE

Do not operate the valve/actuator assembly with the inlet filter fitting or the in-line filter removed or bypassed. Momentary exposure of the actuator to contaminants can cause internal damage.

Troubleshooting

If variations in water delivery occur, inspect all components, including the turbine, for proper operation. Refer to the correct Woodward control manual for assistance in isolating the problem.

Field disassembly or adjustment of the 3151A Water Valve/TM-40LP Actuator assembly is not recommended. All work and adjustments should be performed by personnel thoroughly in the proper procedures.

When requesting information or service from Woodward, be sure to specify the part number and serial number of your valve/actuator assembly.

Chapter 5.
Service Options

Product Service Options

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

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

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

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

- A **Full Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.
- A **Recognized Engine Retrofitter (RER)** is an independent company that does retrofits and upgrades on reciprocating gas engines and dual-fuel conversions, and can provide the full line of Woodward systems and components for the retrofits and overhauls, emission compliance upgrades, long term service contracts, emergency repairs, etc.
- A **Recognized Turbine Retrofitter (RTR)** is an independent company that does both steam and gas turbine control retrofits and upgrades globally, and can provide the full line of Woodward systems and components for the retrofits and overhauls, long term service contracts, emergency repairs, etc.

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

www.woodward.com/directory

Woodward Factory Servicing Options

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

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

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

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

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

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

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

Returning Equipment for Repair

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

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

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

Packing a Control

Use the following materials when returning a complete control:

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

NOTICE

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

Replacement Parts

When ordering replacement parts for controls, include the following information:

- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.

Engineering Services

Woodward offers various Engineering Services for our products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- Technical Support
- Product Training
- Field Service

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

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

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

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

How to Contact Woodward

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

Electrical Power Systems

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

Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-510
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Turbine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (129) 4097100
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

You can also locate your nearest Woodward distributor or service facility on our website at:

www.woodward.com/directory

Technical Assistance

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

Your Name	
Site Location	
Phone Number	
Fax Number	
Engine/Turbine Model Number	
Manufacturer	
Number of Cylinders (if applicable)	
Type of Fuel (gas, gaseous, steam, etc)	
Rating	
Application	
Control/Governor #1	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	
Control/Governor #2	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	
Control/Governor #3	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	

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

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 40120C.

B40120:C

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2013/1/Colorado

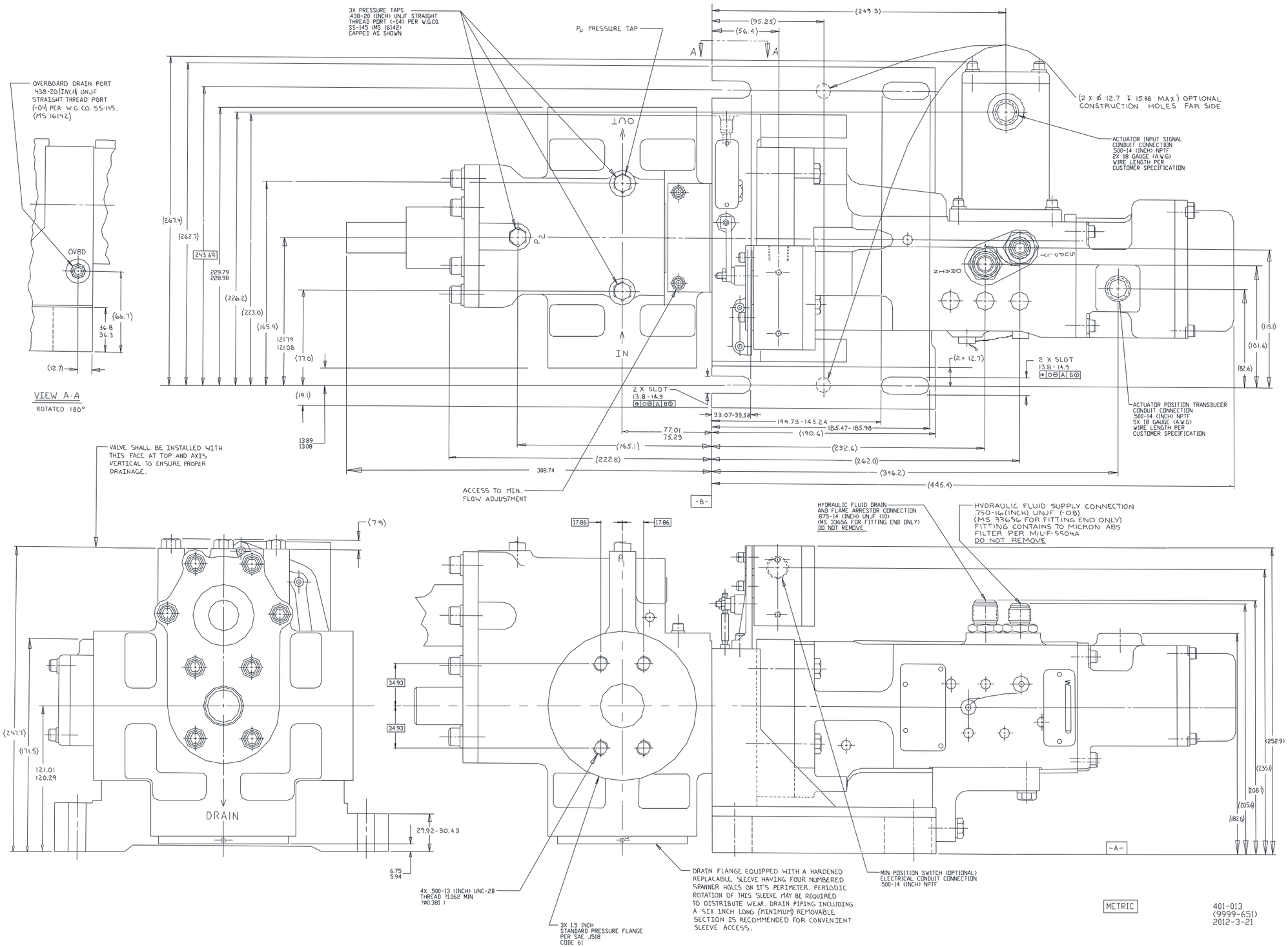

Figure 2-2. Outline Drawing (Woodward Manual 40120C)