



INSTALLATION, OPERATION & MAINTENANCE MANUAL IOM1021

RATE OF DROP TEST KIT

PORTABLE TEST KIT FOR SETTING AND TESTING

- *“LINEBREAK” CONTROLS*
- *“STATION BYPASS” CONTROLS*
- *“EMERGENCY SHUTDOWN” CONTROLS*
- *OTHER CONTROL SYSTEMS CONTAINING DIFFERENTIAL PILOT VALVES*





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1 Introduction

1.1 Company Background

Automation Technology was founded in 1995 as a manufacturer of pneumatic and hydraulic valve actuators. With products in a wide range of applications such as petrochemical, pipelines, refineries, pulp and paper, agriculture, pharmaceutical, municipalities, mining, power plants and marine transportation, ATI has succeeded in becoming a global leader in automation technology.

1.2 Scope & Purpose of Manual

This manual is intended to assist those who are involved with using an ATI Rate of Drop Test Kit for the installation, operation and maintenance of Linebreak, Emergency Shutdown, or Station Bypass controls, or other control systems with a Differential Pilot Valve (a.k.a. Differential Valve). This manual should be reviewed and thoroughly understood PRIOR to installing, operating or providing maintenance on the device. Refer to separate instruction manuals for details regarding optional accessories and other equipment used with these actuators.

Failure to read and comply with all applicable installation, operation and maintenance instructions may result in bodily injury or equipment damage and will void the Product warranty.

1.3 Company Contact

For any questions or clarifications, contact ATI or your nearest ATI Authorized Representative.

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2 Reference Documents

Refer to original order documentation for additional documents to supplement this publication. A full understanding of all options and accessories are required to complete installation, operation or maintenance of the as-built Product.

3 Definitions

Term/Abbreviation	Definition
DPV	Differential Pilot Valve, also known as a Diaphragm Pilot Valve or a Differential Pressure Pilot Switch. This valve has a diaphragm between a high-side pressure input and a low-side pressure input. The low-pressure side is also supported by an adjustable spring, which is used to calibrate the DPV to its setpoint.
ESD	Emergency Shut Down
MAWP	Maximum Allowable Working Pressure
RoD	Rate of Drop, Rate of Pressure Drop, $\Delta P/\Delta t$



4 Product Description

4.1 General Description & Typical Applications

Gas pipelines require safety controls to automatically operate valves in the case of unplanned pressure changes, such as pressure loss in the pipeline due to major leak or pipeline break, or reduced discharge pressure at a problem compressor. Linebreak and Station Bypass Controls monitor these pressure changes and send an instrument pressure signal to operate an automated pipeline isolation valve when a predetermined differential pressure or rate of pressure drop is exceeded.

The ATI Rate of Drop Test Kit is used to calibrate and simulate various pipeline operating scenarios in order to test automation control strategies. Supplied in a portable, self-contained enclosure, the RoD Test Kit is easily connected to the control system in the field. Quick-disconnect ports and precision gauges are included to measure the pipeline pressure and various pressures within the control module. Utilizing a precision differential gauge and a digital pressure gauge, the RoD Test Kit can simulate trip pressure conditions. When used as part of an appropriate field test procedure, various emergency scenarios can be simulated to test the control action of Linebreak, Station Bypass, and Emergency Shutdown control modules without inadvertently causing a shutdown.

Linebreak Operations & Differential Pressure Test

Many gas pipelines require safety devices that automatically close the main line valves in case of a major leak or break. By quickly and reliably closing the main line block valves, gas loss can be minimized to prevent injury to persons, damage to property and other economic loss.

A reliable way to identify a break in the pipeline is to detect an abnormal rate of pressure drop ($\Delta P/\Delta t$) that exceeds pressure changes expected for normal operation of the pipeline. A Linebreak device can be configured to operate with or without external power, to detect $\Delta P/\Delta t$ by monitoring the pressure difference across a calibrated orifice between a reference tank and the pipeline.

Pipeline working-pressure typically ranges between 150 and 1500 psig. During normal operation, pressure fluctuates as compressors cycle and as customers pull gas from the line. The rate of this pressure change may be about 7 psig/minute. A linebreak safety event would cause a pressure to drop at a faster rate. The speed of pressure drop change is determined by several factors, such as diameter and length of pipeline, dimensions of the break, temperature and pressure of the gas, and distance from the break to the actuator. Therefore, the Linebreak device must be set for local conditions, with adjustment to cope with the different operation conditions.

WORKING PRINCIPLE: A break in the pipeline causes an increase of velocity of gas in the line, which results in an increase in pressure drop. Although this pressure drop is measurable, it is generally not practical to detect it directly at a valve, because the pressure change at a full open valve will be very small. This small signal can be amplified with a reference tank that is connected to the pipeline through a calibrated orifice. In normal operation, the pressure in the pipeline and the reference tank are in balance. During a linebreak, pressure decreases in the pipeline, and the calibrated orifice will cause the pressure in the reference tank to drop more slowly than in the pipeline. This creates a differential pressure between the reference tank and the pipeline that is measured by a mechanical diaphragm or piston device, a Differential Pilot Valve (DPV), that will output a signal when differential pressure reaches its trip setting. This trip setting is a function of the design of the DPV and calibration of its internal spring, and the DPV sizing and selection must be made in conjunction with the size of the calibrated orifice and the size of the reference tank, all in consideration of pipeline operating conditions.

Other Operations using Differential Pressure Test

Other control systems on gas pipelines – such as Station Bypass, Emergency Shutdown, and High Differential Open Inhibit – require pilot devices that trip or reset and send signals based on pressure differential in the system.

The Rate of Drop Test Kit can be used to calibrate or inspect the settings of the pilot device(s) for these control systems.



4.2 Product Operation

Linebreak Operations & Differential Pressure Test

Linebreak Control is used to sense a rate of change in pressure in the pipeline. The pipeline operator must understand normal variation in pipeline pressure conditions and define the rate of pressure change that indicates an unexpected leak or break in the pipeline. When Linebreak Control senses that this pressure event has occurred, it will send an instrument pressure signal to close an automated pipeline valve. This control system can be implemented without an external power source and without risk of security breaches to software or communications systems.

Linebreak Control monitors pipeline pressure through one connection to the pipeline, typically downstream of the main pipeline isolation valve, and it compares real-time pipeline pressure to its reference tank. When pipeline pressure increases, gas flows into the Linebreak Control reference tank through a calibrated orifice, so that the pipeline and reference tank are at the same pressure during normal operation. When pipeline pressure drops, gas flow from the reference tank is restricted by the calibrated orifice, so the pressure of the reference tank will temporarily remain higher than pipeline pressure. Pressure in the reference tank will eventually drop to match the pipeline pressure, and the rate of pressure drop is a function of the orifice size, the pressure differential between the reference tank and pipeline, and the temperature of the gas.

Within the Linebreak Control, a Differential Pilot Valve (DPV) is connected between the high side (reference tank) and the low side (pipeline). When differential pressure exceeds the set point of the DPV, it sends an instrument pressure signal to close the pipeline valve.

Calibration of the DPV is done with the RoD Test Kit, which includes sensitive gauges to monitor small differences in the high-side and low-side connections across the orifice in the ATI Linebreak Control. The RoD test kit also includes valves required to simulate a linebreak, which allows for field testing of the ATI Linebreak.

Station Bypass Operation & Differential Pressure Test

An Automatic Station Bypass control monitors the differential pressure across suction and discharge lines at gas compressor stations and sends an instrument pressure signal when discharge pressure drops and differential pressure exceeds the set point of the control system.

Within the Station Bypass Control, a Differential Pilot Valve (DPV) is connected between the low side (suction) and the high side (discharge) of the compressor. In normal operation, discharge exceeds suction, and the DPV remains closed. If the differential between discharge and suction pressure drops below the reset point of the DPV, it sends an instrument pressure signal to open a compressor bypass valve.

Calibration of the DPV is done with the RoD Test Kit, which includes sensitive gauges to monitor small differences in pressure connections across the DPV in the Automatic Station Bypass Control.

Emergency Shutdown Operation & ESD Pilot Test

Emergency Shutdown Control monitors for high and/or low pressure conditions and sends an instrument pressure signal to actuate a valve to its safe position. This control system can be implemented without an external power source, and it may include Linebreak or Station Bypass controls.

Within the ESD Control, an adjustable pilot valve is set to trip when line pressure drops below a low-pressure limit or when line pressure rises above a high-pressure limit. ESD Control is also available with two adjustable pilot valves, to send an instrument pressure signal when line pressure rises or falls outside of its high or low limits.

The RoD Test Kit is intended for use with Controls that include a Differential Pilot Valve (DPV). To test Linebreak and Station Bypass functions, follow the relevant instructions for Differential Pressure Tests. Although not designed for this purpose, calibration testing of an adjustable ESD pilot may be accomplished with the RoD Test Kit, but this requires that the HI-side and LOW-side ports of the RoD Test Kit be connected, so they see equal pressure at all times and the differential gauge remains at its zero position; do not connect the LOW-side port to the ESD



pilot with the HI-side port vented to atmosphere, as this may damage the differential gauge. With the HIGH and LOW ports of the RoD Test Kit connected to the ESD pilot pressure, the digital gauge of the RoD Test Kit may be used to read the trip point of the ESD pilot.

4.3 Product Specifications

4.3.1	Operating Pressure	The working pressure range for the Product is as follows: MAXIMUM (MAWP): 1500 psig (103 bar) Consult ATI for supply pressure outside of this limit.
4.3.2	Temperature Limits	Temperature Rating for the Product is -20°F to +122°F (-29°C to +50°C). Materials of construction are suitable for a wider range of operation; consult ATI for special applications that require a rating outside of this range.
4.3.3	Fluid Type	The Product is designed for pneumatic service, with particulate-free air or gas.
4.3.4	Service Life	ATI products can generally be operated up to 5 years without maintenance. Gauges for this Product should be calibrated annually or per local maintenance intervals established for all pressure gauges.
4.3.5	Lubrication	For normal service, this Product does not require lubrication.
4.3.6	Lifting Point	The Product includes a case with a carrying handle.
4.3.7	Pressure Connections	The Product includes quantity of two 1/4" Thermoplastic Hose with Swagelok tube adapter end connections.
4.3.8	Protective Coating	The ATI standard protective coating includes surface preparation, prime coat and a finish coat of an aliphatic polyurethane paint. The standard protective coating is applied to all environmentally-exposed carbon-steel or aluminum surfaces. Consult ATI at time of order placement for specific details on the specification(s) to be used for protective coating(s).
4.3.9	Warranty	Warranty terms and conditions are included in section 10 of this manual. ATI actuators are warranted against defects in material and workmanship for a period of two (2) years after the date of factory shipment. Refer to Product nameplate for serial number to confirm date of shipment. NON-WARRANTY CLAUSE: Contents of this publication are periodically checked for compliance with the associated Products, and corrections are made as necessary for subsequent publications. ATI also modifies the Product in this publication to meet special requirements for specific customer orders. Therefore, ATI cannot exclude the possibility of discrepancies between this publication and the Product and special documentation that is prepared for a particular shipment, and ATI does not accept liability for discrepancies between information in this publication and the Product.



5 Safety Warnings

THIS MANUAL COVERS GENERAL INSTRUCTIONS AND DOES NOT CLAIM TO ADDRESS ALL SAFETY FACTORS ASSOCIATED WITH ATI PRODUCTS OR THE ACCESSORIES THAT MAY BE MOUNTED TO ATI PRODUCTS. FOLLOWING THESE INSTRUCTIONS AND GUIDELINES WILL HELP IN PREVENTING PERSONAL INJURY, PROPERTY DAMAGE, AND DAMAGE TO THE PRODUCT.

SPRING MECHANISMS CONTAIN STORED ENERGY FROM ONE OR MORE COMPRESSION SPRINGS. DO NOT ATTEMPT TO ADJUST OR DISMANTLE ANY PART OF A SPRING MECHANISM WITHOUT CONSULTING THE MANUFACTURER, AS DOING SO MAY RESULT IN SEVERE INJURY OR DEATH. WHEN OPERATING PRODUCT, ENSURE THAT ALL BODY PARTS, TOOLS, AND FOREIGN OBJECTS ARE CLEAR OF THE ACTUATOR ADAPTION BRACKET AND ANY EXTERNAL LINKAGES THAT MOVE DURING THE SPRING STROKE.

ACTUATORS AND VALVES COME INTO CONTACT WITH CAUSTIC GASES AND FLUIDS IN MANY APPLICATIONS. AS A RESULT, ALL TOXIC OR FLAMMABLE FUMES MUST BE VENTED AND LIQUIDS MOVED TO A SAFE LOCATION TO ENSURE SAFETY.

5.1 Personnel Requirements

DO NOT INSTALL, OPERATE, OR MAINTAIN AN ATI PRODUCT UNLESS TRAINED AND QUALIFIED IN PRODUCT AND ACCESSORY INSTALLATION, OPERATION AND MAINTENANCE.

PROPER INSTALLATION OF THE PRODUCT IS CRITICAL TO PERFORMANCE AND SAFETY. DUE TO THE MANY VARIATIONS OF ACTUATORS, VALVES, AND RELATED CONTROLS, THE GENERAL INSTRUCTIONS IN THIS MANUAL MAY NOT ADDRESS SPECIFIC ISSUES AT A PARTICULAR INSTALLATION. EACH TECHNICIAN FOLLOWING THESE INSTRUCTIONS MUST BE COMPETENT, TRAINED, AND HAVE A WORKING KNOWLEDGE OF VALVES, VALVE ACTUATORS, ACTUATOR CONTROLS, AND THE SPECIFIC APPLICATION FOR THE INTENDED PRODUCT(S).

IT IS THE RESPONSIBILITY OF THE USER TO ENSURE PROPER SAFETY. ALWAYS TAKE NECESSARY PRECAUTIONS AND UTILIZE PROPER PERSONAL PROTECTIVE EQUIPMENT (PPE) WHEN DEALING WITH COMPRESSED GAS, PRESSURIZED HYDRAULIC FLUID, PINCH POINTS, AND ELECTRICITY. IT IS THE USER'S RESPONSIBILITY TO UTILIZE APPROPRIATE PROTECTION AGAINST HEARING DAMAGE WHEN WORKING NEAR THE ACTUATOR AND CONTROLS.

5.2 Potential Hazards

The Product has been designed in accordance with best practices for operational reliability, but as an industrial machine, it bears the risk of hazards if handled or operated improperly. Only trained, qualified personnel should work on or near the Product.

Some potential risks during use of this Product include stored energy hazards, pinch points, overpressure conditions, and ignition hazards.



Stored Energy Hazards & Noise

The Product controls supply pressure up to the maximum pressure defined in section 4.3.1. The Product permits release of this supply pressure. It is required that this pressure be released as part of test procedures with this Product, and it is required that all pressure be discharged before packaging the Product for transport.

The release of pressure can produce excessive noise caused by sudden discharge at sonic velocity. This sudden pressure discharge will exhaust at the Product vent. Users must be aware of exhaust ports and use appropriate personal protection equipment (PPE) to avoid injury from pressure discharge.

Spring mechanisms in pilot devices and in actuators contain stored energy from one or more compression springs. A compressed spring expands with great force when released. Sudden release of spring force will result from the loosening of spring containers. Do not attempt to adjust or dismantle any part of a spring mechanism without consulting the manufacturer, as doing so may result in severe injury or death.

Sharps & Pinch Points

Warning labels and tags located on the Products are made of metal foils that vary in thickness. Because the metal tags have sharp edges, personnel installing, handling, or working around the tags should protect against cuts or injury.

The Product cover is hinged. Closing the cover will create a pinch-point hazard.

Overpressure

The safe working pressure (MAWP) for the Product is defined in section 4.3.1.

The differential pressure gauge is rated for range of differential pressure on its dial, and it is desirable to follow a test procedure such that the differential pressure across this Product does not exceed the gauge maximum limit, but exceeding this differential limit is not an unsafe condition so long as total pressure remains under the limit defined in section 4.3.1.

Ignition Hazard

THE PRODUCT IS DESIGNED TO VENT NATURAL GAS, AND USERS MUST TAKE PRECAUTIONS TO CONSIDER SITE-SPECIFIC HAZARDS RELATED TO THE VENTING OF COMBUSTIBLE GAS WITH THIS DEVICE.

6 Handling and Storage

6.1 Receiving the Product

Proper care and precautions should be taken when unloading and handling the Product. Ensure that the Product is safely disconnected from all pressure connections before attempting to move.

- Check that the Product has not been damaged during transport.
- Check that the gauges are traceable to valid calibration records.

6.2 Storage and Preservation

ATI Products leave the factory in excellent working condition and with an excellent finish (these conditions are guaranteed by individual inspection certificates). To maintain these characteristics until the Product is installed, it is necessary to take appropriate measures during the storage period.

- Products contain resilient seals, and Products should not be stored in environments that are harmful to resilient seals.
- Plugs must be fitted in all exposed ports for connections and cable entries.



- In case of long-term storage, it is advisable to keep the Product in a dry place or to provide at least some means of weather protection. Care should be taken to keep foreign particles and moisture from entering the Product.
- Prior to operation, using a clean, soft cloth dampened with an appropriate oil-based solvent: Remove any dirt, dust, grease and/or other contaminants from exposed sealing surfaces (such as tube adapter connections).

7 Procedures for RoD Test Kit

Refer to Drawing T-0270 in Appendix A for Item # references throughout this section.

REVIEW ALL SAFETY INSTRUCTIONS BEFORE USING THIS PRODUCT. The sequence of operation for each procedure in this publication should be used only as a guideline. Job Safety Analysis should be conducted before use, and the procedure adjusted as appropriate for the conditions at each job site.

7.1 Adjusting the Differential Pilot Valve (DPV)

When adjusting the Differential Pilot Valve, consider that the trip point for the switch is 1.5 psi differential for each unit of the DPV scale.

DPV Scale

DPV SCALE	TRIP POINT (PSID*)
1	1.5
2	3.5
3	5.0
4	6.5
5	8.0
6	9.0
7	10.5
8	11.5
9	13.0
10	15.0

* PSI DIFFERENTIAL

7.2 RoD Test Kit Calibration of Linebreak

Refer to Drawing T-0270 in Appendix A for Item # references.

Refer to Schematic 1001-LB in Appendix C1 for reference to the "L.B. Device Test Ports."

7.2.1 Linebreak RoD Components

The components for performing a Rate of Drop test for the ATI Linebreak are:

- Suitable power gas supply capable of simulating pipeline pressure
- ATI Rate of Drop Test Kit
- Stopwatch
- Volume tank (optional 5 gallon tank, required if using 1 portable gas supply and 1 pressure regulator to supply pilot pressure and to simulate linebreak pressure).

7.2.2 Linebreak Set Point Calculation Chart

This section is included for calibration of a new or a re-purposed Linebreak control. This section should not be necessary for normal calibration in the field, unless substantial changes are made to the target RoD or unless substantial changes are made to nominal pipeline operating pressure.

During initial calibration, to estimate the orifice size and initial setting for the Differential Pilot Valve (DPV) for the particular Rate of Drop required by the customer, refer to the Chart in Appendix B.



The curves in the chart give the values of the pressure difference generated between the reference tank and the pipeline. The pipeline pressure is shown with three different values (35, 55, & 75 bar) and four separate orifice diameters (.5, .7, .9, & 1.25mm). Pressure gradients are calculated as an average value for one minute. These curves identify an approximate orifice diameter that will achieve the target setpoint for a specific Linebreak condition.

- Enter the chart along the bottom axis. Locate the appropriate Rate of Drop in (Bar/Minute).
- Move vertically until the specified Rate of Drop point intersects the curve corresponding to the pipeline pressure in (Bar).
- Use this line to also find the appropriate orifice size in (mm).
- At the intersection, move left to find the approximate set point of the DPV.

7.2.3 Connecting RoD Test Kit - Linebreak

1. Close Linebreak pressure source valve.
2. Open the drain valve on reference tank to exhaust all pressure.
3. Turn on digital test gauge (Item #1), reset to zero if needed.
4. Turn 3-way valve (Item #5) to LOW.
5. Connect HIGH side of Rate of Drop test kit (Item #9) to HIGH side of linebreak control (Reference tank).
6. Connect LOW side of Rate of Drop test kit (Item #8) to LOW side of Linebreak control (Pipeline).
7. Close drain valve on reference tank.
8. Slowly open Linebreak pressure source valve to pressurize system.
Note: Pressure should equalize and differential gauge (Item #2) should read"0". Digital test gauge (Item #5) LOW & HIGH pressure should be equal.
9. If pressure does not equalize, there is a leak in the system. Check for leaking valve, bad O-ring, diaphragm, tube fittings, etc. Pressure must equalize for test to be accurate.

7.2.4 Differential Test - Linebreak

1. After pressure has equalized, close Linebreak pressure source valve.
2. Slowly open DIFF. ADJ. (Item #4) until DPV trips.
3. Re-open stop valve to reset the system.
4. Close pressure source valve.
5. Record pressure at which DPV trips. (This is the DPV "trip point.")
6. Adjust DPV to obtain desired trip point.

7.2.5 Rate of Drop per Minute Test - Linebreak

1. Re-open Linebreak pressure source valve to equalize pressure.
2. Close Linebreak pressure source valve.
3. Turn 3-way valve (Item #5) to LOW.
4. Slowly open DIFF. ADJ. valve (Item #4) to 0.5 PSID below the trip point found in section 7.2.4.
5. Record start pressure and start stopwatch.
6. Record ending pressure after three minutes and stop stopwatch.
7. Close DIFF. ADJ. valve (Item #4).
8. Subtract ending pressure from starting pressure and divide by three to obtain the average Rate of Drop for one minute for the system.

$$\{ (\text{Ending pressure} - \text{Starting Pressure}) / 3 \} = \text{Average Rate of Drop for one minute.}$$

Example: Starting Pressure = 997 PSI
 After 1 minute, P = 948 PSI
 After 2 minutes, P = 916 PSI
 After 3 minutes, P = 886 PSI
 Pressure Drop, $\Delta P = 997 - 886 = 111$ PSI
 $\Delta t = 3$ minutes
 Average Rate of Drop, $\Delta P / \Delta t = 111 / 3 = 37$ PSI/min

9. If average Rate of Drop for one minute is not the required Rate of Drop, adjust DPV and repeat steps 1-7 above.



7.2.6 Disconnecting RoD Test Kit - Linebreak

1. Close all pressure source valves.
2. Open drain valve on the reference tank to exhaust all pressure in the system.
NOTE: Always relieve pressure from the reference tank side of the orifice block or the DPV will trip.
3. Disconnect Rate of Drop Test Kit from the panel.
4. Close drain valve on the reference tank
5. Slowly open the pressure source valve to re-pressurize the system.

7.3 *RoD Test Kit Calibration of Station Bypass*

Refer to Drawing T-0270 in Appendix A for Item # references.

Refer to Schematic 1022-RV2 in Appendix C2 for reference to "Test Ports" (Isolation Valves #9).

7.3.1 Station Bypass RoD Components

The components for performing a Rate of Drop test for the ATI Automatic Station Bypass are:

- Suitable power gas supply capable of simulating pipeline pressure
- ATI Rate of Drop Test Kit

7.3.2 Connecting RoD Test Kit - Station Bypass

1. Close both suction and discharge valves to the automatic control.
2. Turn on the digital test gauge (Item #1), reset to zero if needed.
3. Connect LOW side of Rate of Drop test kit (Item #9) to LOW side (suction side) of control.
4. Connect HIGH side of Rate of Drop test kit (Item #8) to HIGH side (discharge side) of control.
5. Slowly open suction and discharge valves on the automatic control to pressurize system.

7.3.3 Differential Test - Station Bypass

1. Once pressure has equalized, close discharge pressure source valve.
2. Slowly open DIFF. ADJ. (Item #4) until DPV trips.
3. Re-open pressure source valve to reset the system.
4. Close pressure source valve.
5. Record pressure at which DPV trips. (This is the DPV "trip point.")
6. Adjust DPV to obtain desired trip point.

7.3.4 Disconnecting RoD Test Kit - Station Bypass

1. Close both suction and discharge valves.
2. Disconnect Rate of Drop Test Kit from the panel.
3. Slowly open both the suction and discharge valves.

7.4 *RoD Test Kit Calibration of Emergency Shutdown (ESD)*

Refer to Drawing T-0270 in Appendix A for Item # references.

Refer to Schematic 1012-RV in Appendix C3 for the "Pilot" test port (N.O. ESD Pilot #13).

7.4.1 ESD RoD Components

The components for performing a Rate of Drop test for the ATI ESD Control are:

- Suitable power gas supply capable of simulating ESD pressure
- ATI Rate of Drop Test Kit
- Fittings as required to connect HIGH and LOW ports of RoD Test Kit to ESD Pilot.
- High-pressure instrument signal source may be required to simulate high-pressure condition



7.4.2 Connecting RoD Test Kit - ESD

1. Isolate the control panel from pipeline service (close all supply ports and the ESD pilot signal).
2. Connect LOW side and HIGH side of Rate of Drop Test Kit (Items #8 and #9) to the ESD pilot line. **LOW and HIGH side ports must be joined to bypass the differential gauge and avoid exceeding its rating.** This may require addition of a tee and fittings to connect the RoD hose to the pilot line. To test ESD pilot valves that trip in high-pressure conditions, the addition of a high-pressure source with a suitable regulator may be required; connect this regulated, high-pressure source to the test circuit that includes the ESD pilot and the LOW and HIGH ports of the RoD Test Kit.
3. Turn on the digital test gauge (Item #1), reset to zero if needed.
4. Close DIFF. ADJ. valve (Item #4).

7.4.3 Trip Point Test - ESD set for Low Pressure trip

1. Slowly open pilot pressure signal to ESD. The digital gauge in the RoD Test Kit will display the instrument pilot pressure to the ESD.
2. Close the pilot pressure signal to ESD. This will lock the pressure signal to the ESD pilot and to the RoD Test Kit.
3. Slowly open DIFF. ADJ. valve (Item #4) until ESD trips.
4. Record pressure at which ESD pilot trips. (This is the ESD "trip point.")
5. Adjust ESD if necessary to obtain desired trip point.
6. Repeat steps 1 - 5 until desired trip point is confirmed by the digital gauge reading.

7.4.4 Trip Point Test - ESD set for High Pressure trip

1. Adjust the pilot pressure signal to the high-pressure limit of the ESD pilot. The digital gauge in the RoD Test Kit will display the instrument pilot pressure to the ESD. If the instrument signal is not adjustable in the field, then keep the pilot pressure signal to the ESD closed and use the regulated, high-pressure instrument signal source described in 7.4.2 part 2.
2. Record pressure at which ESD pilot trips. (This is the ESD "trip point.")
3. Adjust ESD if necessary to obtain desired trip point.
4. Repeat steps 1 - 3 until desired trip point is confirmed by the digital gauge reading. If the ESD pressure must be reduced, the test circuit can be vented by opening the DIFF. ADJ. valve (Item #4). Close this DIFF. ADJ. valve before repeating steps 1 - 3.

7.4.5 Disconnecting RoD Test Kit - ESD

1. Isolate the control panel from pipeline service (close all supply ports and the ESD pilot signal).
2. Disconnect RoD Test Kit from the panel. Reconnect ESD pilot and check for leaks if changes were made in section 7.4.2.
3. Open all lines used to isolate controls in Section 7.4.2.



8 Maintenance

IMPORTANT: Before carrying out any maintenance operation, it is necessary to exhaust pressure from the unit, to ensure safety of maintenance staff.

Refer to Drawing T-0270 in Appendix A for Item # references throughout this section.

8.1 Safety Reminder

IMPORTANT: BEFORE CARRYING OUT ANY MAINTENANCE OPERATION, IT IS NECESSARY TO ISOLATE PNEUMATIC FEED LINES AND EXHAUST ALL PRESSURE FROM THE PRODUCT AND ALL CONTROL MANIFOLDS AND VESSELS, TO ENSURE SAFETY OF MAINTENANCE STAFF. ENSURE THAT ANY ELECTRICAL CONNECTIONS TO ACTUATOR CONTROLS ARE DE-ENERGIZED. IF PRODUCT OPERATION IS REQUIRED FOR TROUBLESHOOTING OR PARTIAL STROKE TESTING, THE MAINTENANCE PERSONNEL MUST ENSURE THAT ELECTRICAL AND PRESSURE CONNECTIONS ARE IN A CONTROLLED STATE (LOCKOUT/TAGOUT) FOR SAFE OPERATION.

8.2 Gauge Calibration

The RoD Test Kit contains a digital pressure gauge and a differential pressure gauge. Both gauges require periodic re-calibration. At a minimum, ATI recommends annual re-calibration using a qualified gauge calibration service. More frequent calibration may be necessary due to local requirements.

8.3 Routine Maintenance

The ATI RoD Test Kit is designed to work for long periods with little maintenance. It is advisable, however, to periodically inspect the following, and replace as necessary:

1. Disposable batteries in Digital Test Gauge (Item #1)
2. Filters (Items 6 & 7)
3. Hoses and Quick Disconnects (Items 8 & 9)
4. Adjustable Orifice (DIFF. ADJ. Item #4)

Filter elements and batteries are recommended for replacement during each scheduled maintenance of the RoD Test Kit, which includes any calibration testing of its gauges.

Hoses and connection fittings should be replaced if they show signs of wear.

The adjustable orifice (needle valve) should be replaced if it fails to hold pressure in its closed position.

Performance of gauges and of the adjustable orifice (DIFF. ADJ. Item #4) can be checked by following the test procedure in Appendix D.

8.4 Parts Ordering

In correspondence with ATI or your local ATI Authorized Representative, include the serial number from the ATI actuator nameplate. If documentation from the original order is available, include the ATI part number from the ATI Order Acknowledgement or ATI Shipping Documents.

Warning: To ensure compliance to certification requirements, use only genuine ATI replacement parts. Rebuilding an ATI Product with components that are not supplied by ATI may void the Product warranty, void the Product Certification, adversely affect Product performance, and/or cause personal injury and property damage.



9 Disposal

At the end of its functional life, users may carry out recycling or disposal of the Product and its accessories using these instructions as a guide.

1. Any disposal or recycling must be performed according to site requirements and local regulatory requirements.
2. It is the user's responsibility to ensure Product is safely depressurized and that cleaning and disposal of any fluids is performed in accordance to local regulations. Pneumatic actuators are lubricated internally with grease, which will separate into oil and its base soap over time. In some applications, the Product may have been in contact with caustic gases and fluids, which must be cleaned prior to Product disposal.
3. Product may be dismantled for part sorting. Read and follow the appropriate Product and accessory manual(s) before dismantling. Observe all warning instructions marked on the Product(s) and in the manual(s).
4. Sort dismantled parts according to their material. A majority of the material in the Product, more than 98% by weight, can be recycled. Forward sorted parts according to local practice for recycling or disposal.

Materials of construction may be noted in order documentation. If a list of materials is not available, the metal components may be sorted by using a magnet to inspect for ferrous content, as follows:

Carbon steel	may be recycled: Majority of material is carbon steel, ~90% by weight. Carbon steels are ferrous and will hold a magnet.
Stainless steel	may be recycled: Some materials, fittings and many fasteners are stainless steel, typically 300 series, which will not hold a magnet.
Bronze	may be recycled: Bearings are often made of bronze / brass. This material is dark yellow in color with perhaps a green oxide, and it is non-ferrous and will not hold a magnet.
Aluminum	may be recycled: Some special Product constructions many optional accessories contain aluminum components, less dense and lighter in weight than stainless steels, also non-magnetic.
Plastic	may be sorted for recycling or discarded with mixed waste: Optional accessory covers and some position indicators are made of plastic.
Electronics	must be disposed according to local regulations. Optional valve controllers, positioners, transmitters and some other electronic components are manufactured with solder and capacitors that can be harmful if allowed to leach into the environment. Recycling and disposal of electronics must be done according to applicable regulations.
Soft parts	such as elastomeric seals, engineered (PTFE) seals and some bearings throughout the assembly—are not recyclable. Soft goods that have been cleaned of caustic fluids may be discarded with mixed waste.

If local requirements disallow sorting for recycling or other disposal, contact ATI about returning Product to the manufacturer for recycling. ATI will only accept devices that have been cleaned of any caustic fluids, and a fee will be charged for labor and handling of the produce.



10 Terms and Conditions/Warranty

Except as otherwise expressly agreed to in writing by an authorized representative of Automation Technology, LLC. (hereinafter "ATI"), the following terms and conditions (these "Terms and Conditions") shall apply to all offers for the purchase or sale of products manufactured or supplied by ATI under brand names including, but not limited to "ATI", "Gevalco", etc.

A. **CONDITIONAL ACCEPTANCE; REJECTION OF PURCHASER TERMS** – All orders and acknowledgements of Purchaser shall constitute only consent to these Terms and Conditions and a representation that Purchaser is solvent. All quotations and offers of sale by ATI are expressly limited to these Terms and Conditions and are subject to written acceptance by ATI. Any such acceptance by ATI is expressly conditioned upon assent of Purchaser to these Terms and Conditions, and ATI hereby expressly objects to and rejects as material alterations to these Terms and Conditions any terms or conditions of Purchaser, whether contained in Purchaser's order, acknowledgement or otherwise, that are different from or in addition to these Terms and Conditions.

B. **PRICES** - ATI quotations are valid for thirty (30) days from date of issuance, unless otherwise stated by ATI in writing, and are subject to withdrawal or change at any time prior to acceptance by ATI. Prices are ex works, in United States Dollars, and firm for thirty (30) days from date of ATI's written acceptance of Purchaser's order and an unconditional authorization for the immediate manufacture based on customer supplied information. If for any reason authorization does not commence within such thirty (30) days, prices in effect at the time of release for manufacture will apply, unless otherwise stated in writing. All sales, use, excise, value-added, import, export and other taxes, duties, customs and the like (collectively "Taxes") are the responsibility of Purchaser and will be added to the price to the extent that ATI pays on Purchaser's behalf or is required by law to pay in connection with the sale. ATI reserves the right to invoice and be paid for any Tax at the time of shipment or any time thereafter. All orders are subject to laws and regulations that are in effect and that become effective prior to delivery. Typographical or clerical errors in quotations, orders and acknowledgements are subject to correction by ATI. Prices do not include installation or any other service, unless so stated expressly in the quotation or ATI's order acknowledgement. Prices include one (1) copy of any applicable manuals. Any additional manuals or other printed materials requested by Purchaser are subject to additional cost, to be quoted at or near the time that such materials are requested by Purchaser.

C. **PAYMENT** - Payment from Purchaser is due within thirty (30) days from date of first invoice, unless otherwise stated on ATI's quotation or order acknowledgement. For international orders, ATI reserves the right to require, before commencing filling the order, security in the form of a letter of credit or the like, in a form and from a bank or guarantor acceptable to ATI. Subject to any applicable usury law that would void or render invalid or unenforceable this sentence, in which case the specified rate will be deemed to be reduced to the maximum allowed by law, simple interest at the rate of 1.5 percent per month will apply to balances unpaid within 30 days from date of first invoice. ATI will invoice upon making available for shipment. ATI reserves the right to payment and Purchaser will be responsible for any cost associated with storage of products or delay in making products available for pickup that occurs at the request of Purchaser.

D. **FORCE MAJEURE** – In no event shall ATI be liable for non-delivery or delay in delivery, or for failure or delay in the performance of any obligation contained herein, that arises directly or indirectly from acts of God, unforeseeable circumstances, acts (including delays or failure to act) of any governmental authority (de jure or de facto), war (declared or undeclared), terrorism, riot, revolution, priorities, fires, floods, weather, strikes, labor disputes, sabotage, epidemics, factory shutdowns or alterations, embargoes, delays or shortages in transportation, delay in obtaining or procuring or inability to obtain or procure labor, materials or manufacturing facilities, delay in obtaining or inability to obtain timely instructions or information from the Purchaser, or any other cause or circumstance of any other kind beyond ATI's reasonable control. The foregoing provision shall apply even though such causes or circumstances may occur after ATI's performance has been delayed for other causes or circumstances.

E. **SHIPPING** – (a) Products are sold ex works. Risk of loss is the responsibility of and title transfers to Purchaser once products are made available at Seller's facility for pickup by Purchaser or its carrier.

(b) Acknowledged ship dates represent the estimated date of availability for pickup, rather than actual shipment or delivery at destination for which Purchaser is responsible. All indicated shipping dates are estimates, based on prompt receipt of all necessary information from Buyer necessary to process the order. ATI will use its best reasonable efforts to make products available for pickup by such dates, but there is no guarantee to do so. Indicated time periods for pickup availability are estimated from the latest to occur of: 1) ATI's acceptance of Purchaser's order, 2) ATI's receipt of valve dimensional information, if applicable, 3) ATI's receipt of Purchaser supplied components required to manufacture or supply the products, if applicable, or 4) ATI's receipt of drawings approved by Purchaser. Products ordered on an "in stock" basis are subject to prior sale to other customers. Acknowledged ship dates are subject to changes caused by additions to or modification of the original order agreed to by both Purchaser and ATI.

(c) Under no circumstances shall ATI have any liability whatsoever for loss of use or for any indirect or consequential damages as a result of delayed delivery.

(d) Purchaser is responsible for payment of carrier and all other shipping costs and for making all arrangements necessary for pickup, transport, export, import and delivery to Purchaser's destination. Without prejudice to any ex works rights of ATI and obligations of Purchaser, Purchaser consents in advance to ATI shipping collect any products that Purchaser fails to pick up, and Purchaser will remain responsible for all associated pickup, transport, export, import and delivery costs, including any unknown to ATI or Purchaser at the time of shipment.

F. **DESIGN** - Due to continuous product development, ATI reserves the right to modify designs, materials and specifications without prior notice.



G. CANCELLATION - Orders acknowledged by ATI are not subject to cancellation or suspension except with the advance written consent of ATI and upon terms which will compensate ATI for and indemnify ATI from and against loss or damage occasioned by such cancellation or suspension, including without limitation for all costs and expenses already incurred or commitments made by ATI in connection with the processing, purchasing, handling, and fabrication of equipment for the order and a reasonable profit thereon. ATI's determination of such termination charges shall be conclusive.

H. INSPECTION - Final inspection and acceptance of products must be made at ATI's facility and shall constitute a waiver by Purchaser of any claim for loss or damage, except for latent defects not reasonably discoverable by such inspection. Purchaser's representative may inspect products during normal business hours and must do so in a manner that does not interfere with ATI operations.

I. ATI WARRANTY; EXCLUSIVE PURCHASER REMEDY – All products manufactured by ATI are warranted against defects in material and workmanship for a period of two (2) years after the date that the products were made available for pickup by Purchaser. ATI's warranty excludes any defects resulting from improper or abnormal shipping, operation or maintenance. Purchaser must immediately, and in no event later than thirty (30) days after becoming aware of a suspected defect, notify ATI in writing of any such suspected defect. Within a reasonable time following ATI's receipt of such notice, investigation and confirmation of a defect, ATI will have the right and the obligation, in its sole discretion, to repair at no cost to Purchaser such defect or replace the defective product or component thereof with a non-defective product or component thereof. Repair or component replacement by non-ATI authorized agents WILL VOID all remaining warranty on the product. Products purchased by ATI from a third party for resale to Buyer ("Resale Products") shall carry only the warranty extended by the original manufacturer. ATI's repair or replacement obligations under this Paragraph I do not extend to any labor or other loss or damage occasioned by, incidental to, or in consequence of any such defect. Purchaser's sole and exclusive remedy and ATI's obligation and liability for breach of warranty are expressly limited to such repair or replacement. Goods repaired or replaced during the warranty period shall be in warranty for the remainder of the original warranty or ninety (90) days, whichever is longer. All other remedies of Purchaser are hereby expressly excluded. THE WARRANTY CONTAINED IN THIS PARAGRAPH I IS THE SOLE AND EXCLUSIVE WARRANTY PROVIDED BY ATI WITH RESPECT TO ITS PRODUCTS AND SUPERSEDES AND IS IN LIEU OF ANY AND ALL OTHER WARRANTIES, WHETHER EXPRESS, IMPLIED, STATUTORY OR OTHERWISE, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE, ALL OF WHICH ARE HEREBY EXPRESSLY DISCLAIMED. Purchaser acknowledges and agrees that ATI Manuals, printed materials and any other documentation do not constitute warranties of any kind, including with respect to quality or performance. Purchaser is expected to determine the suitability of ATI products for ordinary and Purchaser's particular purposes.

J. EXCLUSION OF CONSEQUENTIAL DAMAGES; LIMITATION OF DIRECT DAMAGES - ATI shall not be liable for and Purchaser shall have no right to recover from ATI for any indirect, special or consequential damages, even if ATI has actual notice of any special circumstances from which any such damages might arise. Moreover, subject to Paragraph I which would completely bar any such recovery of direct damages if ATI honors its warranty, in no event shall any recovery of direct damages against ATI exceed the amount of the order price attributable to the portion of the product or products that is determined to have caused any alleged loss, damage or injury that is compensable under these Terms and Conditions and not remedied by ATI.

K. RETURNS – No product may be returned for credit or adjustment without written permission and tagging instruction from ATI. Upon receipt of approved returns, any handling/restocking charges and/or cost to recondition for resale, will be the responsibility of Purchaser.

L. GOVERNING LAW; VENUE AND JURISDICTION - All sales of products by ATI and any disputes arising out of or related to such sales or products or these Terms and Conditions shall be governed by, and these Terms and Conditions shall be construed in accordance with, the laws of the State of Texas, without regard to its conflicts of law principles that would apply the law of another jurisdiction. The United Nations Convention on Contracts for the International Sale of Goods is expressly disclaimed by and excluded from these Terms and Conditions. ATI's offer of sale may only be accepted in Harris County, Texas and any resulting contract is performable in whole or in part in Harris County, Texas. Venue for any litigation arising out of such sale, products or contract shall be proper in the state or federal district courts of Houston, Harris County, Texas, U.S.A., to the exclusive jurisdictions of which Purchaser hereby expressly submits.

M. NON-WAIVER – Any waiver by ATI of any breach of any of these Terms and Conditions must be set forth in a writing signed by an authorized representative of ATI and shall not constitute a waiver of or otherwise prejudice ATI's right to demand strict performance of any other term or condition of these Terms and Conditions.

N. REMEDIES CUMULATIVE – ATI's remedies pursuant to these Terms and Conditions and applicable law are cumulative in nature and election or pursuit of any such remedy shall not prohibit ATI from electing or pursuing any other such remedy.

O. SEVERABILITY – In the event that any provision or portion of any provision of these Terms and Conditions is held void, invalid or unenforceable, such void, invalid or unenforceable provision or portion thereof shall be deemed severed from these Terms and Conditions, and the balance of these Terms and Conditions shall remain in full force and effect.

P. EXPORT / IMPORT - Buyer agrees that all applicable import and export control laws, regulations, orders, and requirements, including without limitations those of the United States will apply to the receipt and use of the Goods and Services provided by ATI. In no event shall Buyer use, transfer, release, import, export, re-export Goods in violation of such applicable laws, regulations, orders, or requirements.

Q. BUYER SUPPLIED DATA – To the extent that Seller has relied upon any specification, information, representation of operating conditions or other data or information supplied by Buyer to ATI, in the selection, or design of the Goods and the preparation of ATI's quotation, and in the event that actual operating conditions or other data differ from those represented by Buyer and relied on by ATI, any warranties or other provisions contained herein are null and void. To the degree such data errors cause re-design or re-manufacture of the Goods, Buyer shall be responsible for additional costs incurred by ATI.



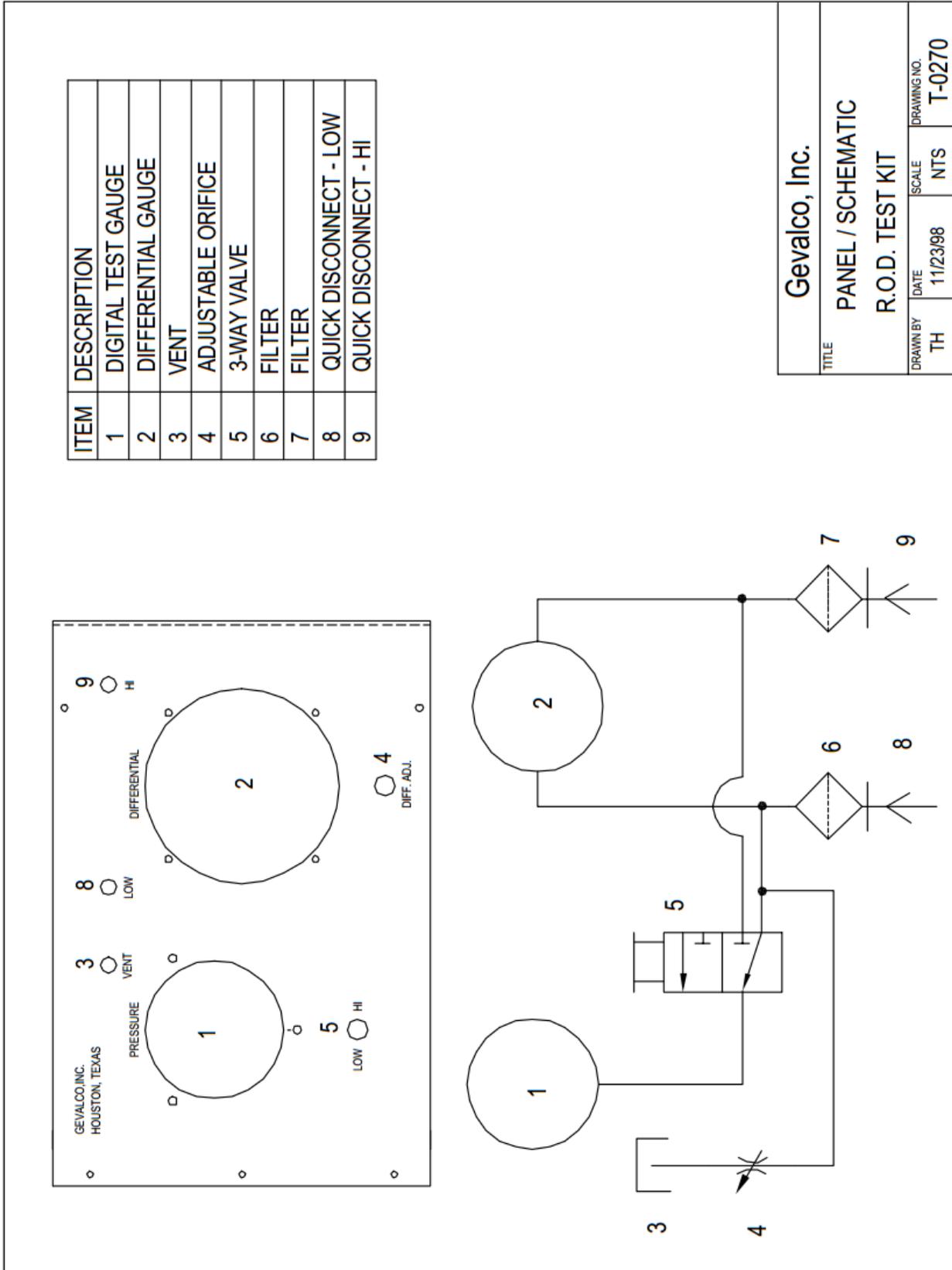
11 Revision Record

Refer to the NON-WARRANTY CLAUSE in section 4.3.9.

Rev #	Issue Date	Description	Reviewed By & Date	Approved By & Date
A	4/20/2011	Initial Release	TRH	TRH
B	2/09/2015	Update format to ATI standard, insert reference chart (App. B) to assist with orifice sizing and initial setup, add App. C1, C2, C3 and D.	CTL	DPL
C	3/09/2016	Update format to latest ATI standards. Insert examples of RoD pressures. Substantial additions to 4.1; insert 4.3, 5, 6, 8.4 and 9; Sections 7 & 8 were 5 & 6; align Appendix D 2 & 11 with 4.3.1.	DAR	DPL
D	9/30/2016	Update 7.3.2, 3 & 4, to correct HIGH side and LOW side labels.	TRH	DPL



APPENDIX A – ROD TEST KIT (DRAWING T-0270)

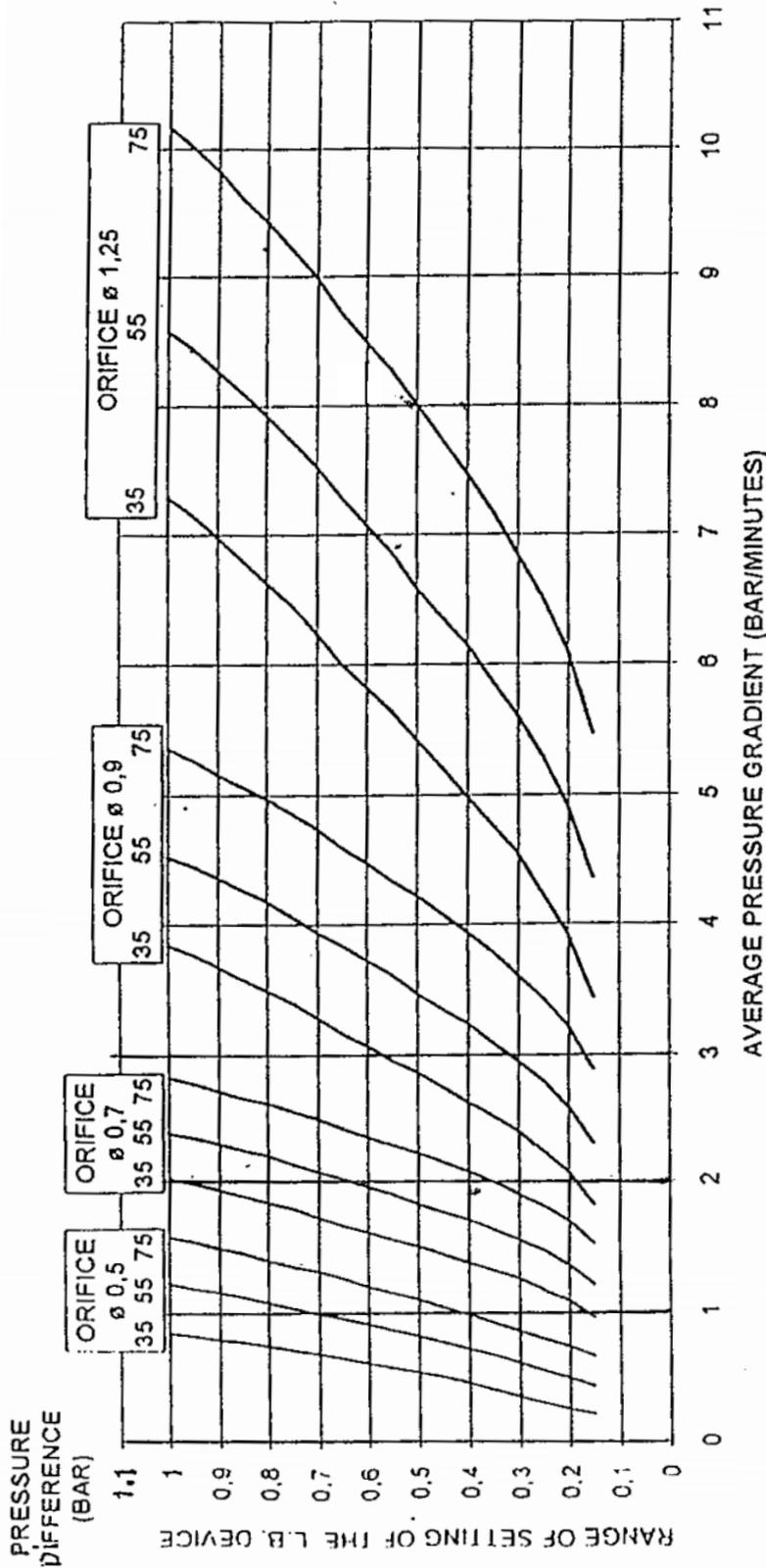


ITEM	DESCRIPTION
1	DIGITAL TEST GAUGE
2	DIFFERENTIAL GAUGE
3	VENT
4	ADJUSTABLE ORIFICE
5	3-WAY VALVE
6	FILTER
7	FILTER
8	QUICK DISCONNECT - LOW
9	QUICK DISCONNECT - HI

Gevalco, Inc.			
TITLE PANEL / SCHEMATIC			
R.O.D. TEST KIT			
DRAWN BY TH	DATE 11/23/98	SCALE NTS	DRAWING NO. T-0270



APPENDIX B – CHART FOR APPROXIMATE, INITIAL LINEBREAK SETTINGS



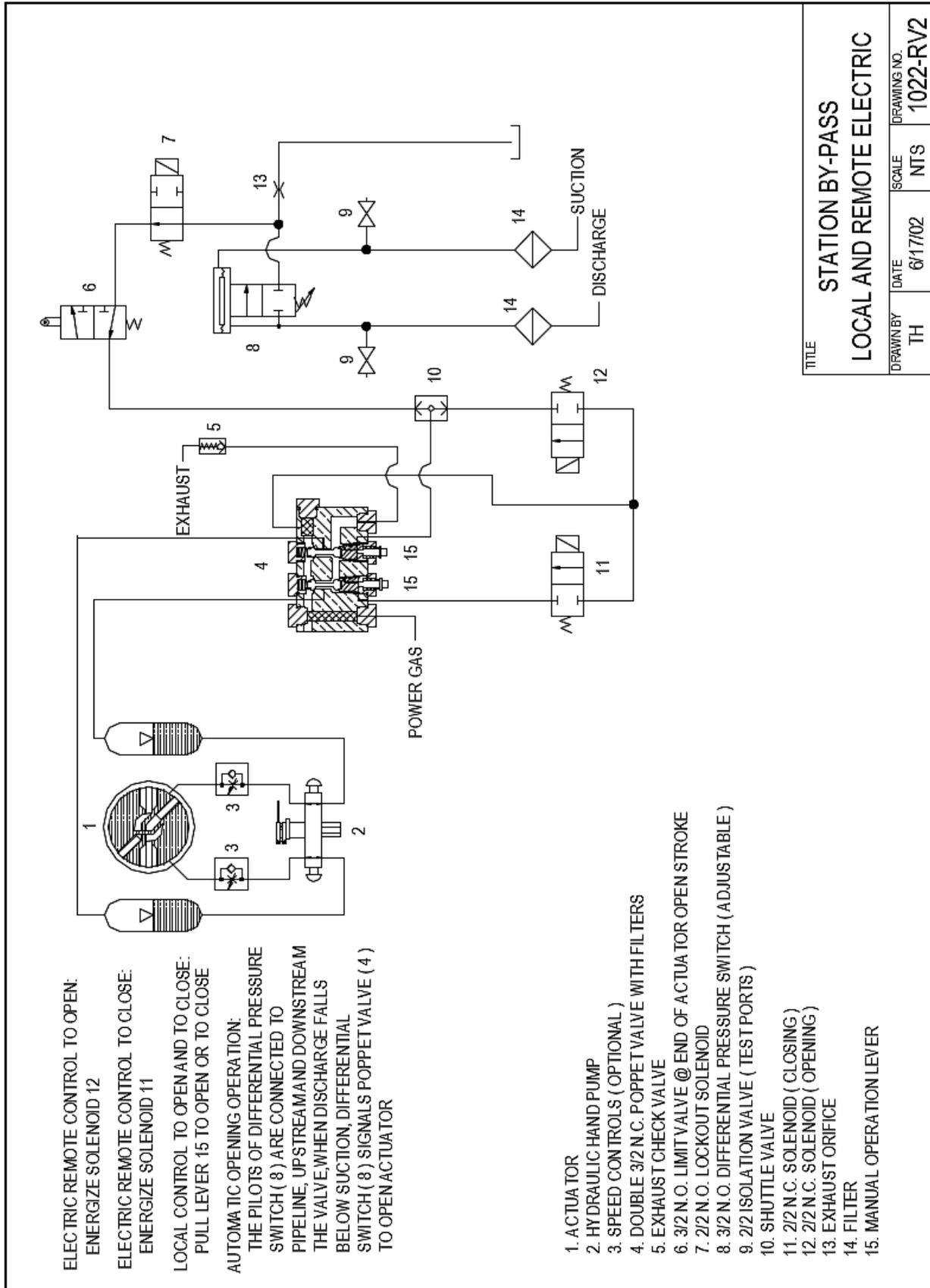
CURVES OF THE MAXIMUM DIFFERENTIAL PRESSURES FOR DIFFERENT INITIAL PRESSURES, FOR DIFFERENT ORIFICE DIAMETERS, FOR DIFFERENT PRESSURE GRADIENTS

Pressure Conversions
 1 bar = 14.5 psi
 35 bar = 508 psi
 55 bar = 798 psi
 75 bar = 1088 psi

Orifice Size Conversion
 .50 mm = .020 inch
 .70 mm = .028 inch
 .90 mm = .035 inch
 1.25 mm = .049 inch

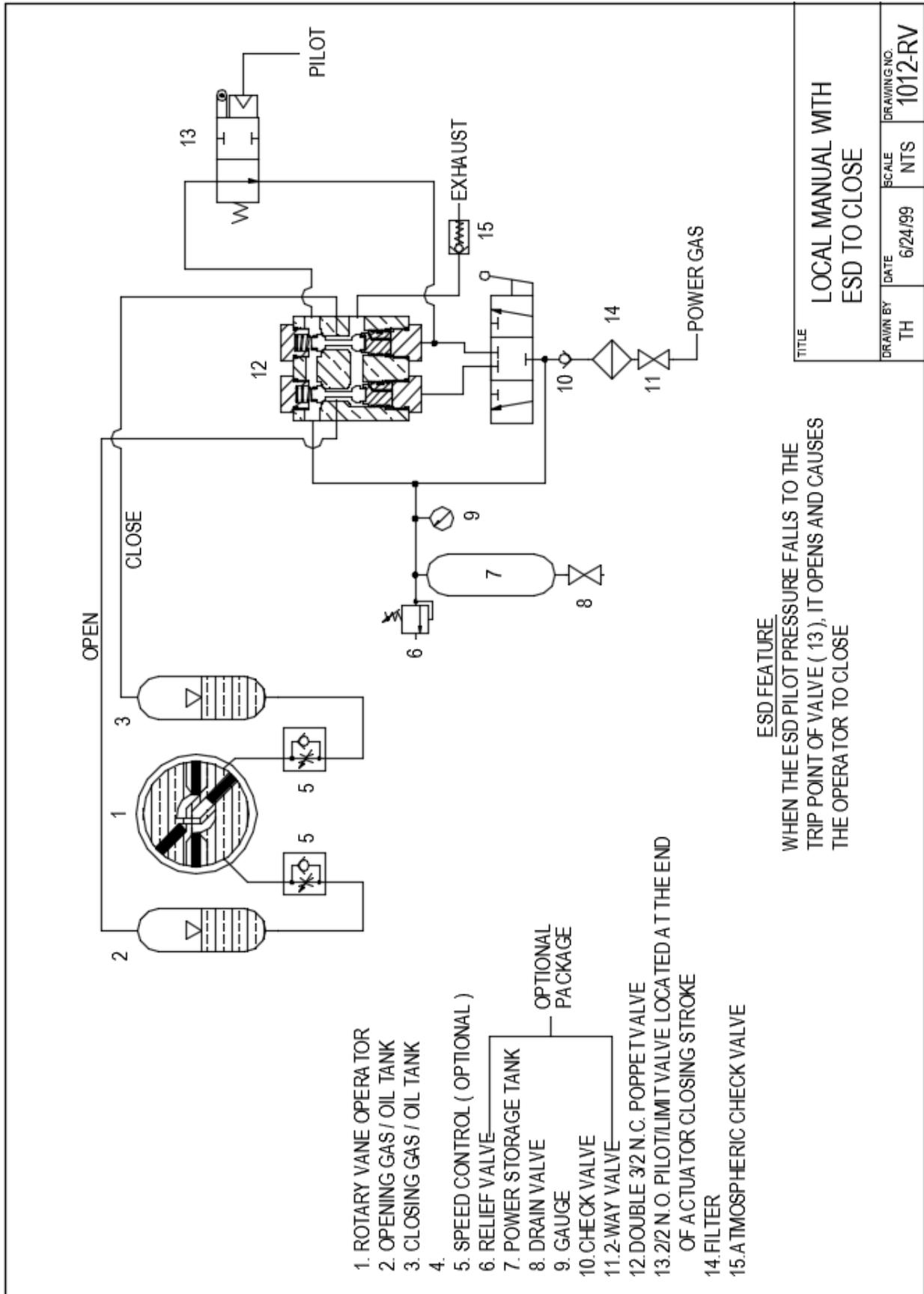


APPENDIX C2 – SCHEMATIC, STATION BYPASS





APPENDIX C3 – SCHEMATIC, EMERGENCY SHUTDOWN





APPENDIX D – BENCH TESTING THE ROD TEST KIT

The following bench test procedure may be used to check the performance of an RoD Test Kit.

Refer to Drawing T-0270 in Appendix A for Item # references throughout this appendix.

Bench Test Procedure for the RoD Test Kit

1. Check the calibration dates for the Digital Gauge (Item #1) and the Differential Gauge (Item #2). If gauges are not within an acceptable calibration time frame, have the gauges calibrated before proceeding.
2. Connect LOW and HIGH ports (Items #8 and #9) through a tee connection to one clean nitrogen supply with a regulator capable of controlling the pressure between 500 psig and 1,500 psig. The LOW side connection shall also include an orifice to restrict gas flow (~Ø.010 inch orifice). Note that 1,500 psig is the limit of the differential gauge (Item #2) in the RoD Test Kit.
3. Close Diff. Adj. valve (Item #4).
4. Set supply pressure regulator to 500 psig.
5. Inspect RoD Test Kit for leaks at all connections and at Vent (Item #3). If a leak at the Vent is detected, attempt to stop the venting by closing the Diff. Adj. valve (Item #4). If the leak continues at the Vent, stop this testing, repair or replace the Diff. Adj. valve, and restart from step 1.
6. Using 3-way valve (Item #5) to switch between LOW and HIGH side, confirm that the Digital Gauge (Item #1) produces the same result for both sides and that it is within the tolerance of the pressure regulator setting in step 4.
7. Confirm that the Differential Gauge (Item #2) displays zero (0) psi.
8. Slowly open Diff. Adj. valve (Item #4) until Differential Gauge (Item #2) displays approximately 15 psi. Note that this bleed operation must be carefully monitored. If low pressure drops more than the 60 psi rating of the Differential Gauge, gauge calibration will be lost, the gauge must be recalibrated and this test restarted from step 3.
9. Using 3-way valve (Item #5) to switch between LOW and HIGH side, confirm that the Digital Gauge (Item #1) produces an expected result (e.g. HIGH pressure reading – LOW pressure reading = 15 psi or the Differential Gauge display).
10. Close Diff. Adj. valve (Item #4) and confirm that the Differential Gauge (Item #2) displays 0 psi.
11. Set supply pressure to the lower of 1,500 psig or the maximum pipeline pressure that is expected in normal service.
12. Repeat steps 5 - 7.

Alternate Bench Test Procedure for the RoD Test Kit

If nitrogen supply flowrate is too high or too low, or a suitable orifice cannot be located, then steps 8 and 9 of the Bench Test procedure may be difficult to control. As an alternative procedure to test the differential gauge, follow all steps as previously described but substitute the numbered steps below (e.g. replace 2 with 2A, 8 with 8A-D, etc.):

- 2A. Connect LOW port (Item #8) to the regulated nitrogen supply through a small reference tank (>1 gallon, ≥5 gallon) and a block valve. The orifice mentioned in step 2 may be omitted.
- 8A. Close the block valve added in step 2A to trap pressure on the LOW side. This trapped pressure should equal the HIGH side pressure.
- 8B. Ensure that 3-way valve (Item #5) is switched to the LOW side, so the Digital Gauge displays the pressure trapped on the LOW side.
- 8C. Ensure that the Differential Gauge (Item #2) continues to display zero (0) psi. If the gauge indicates that differential pressure is increasing, the Diff. Adj. valve (Item #4) or the reference tank or block valve (from step 2A) may be leaking. Discontinue this testing until the source of the leak is confirmed and repaired.
- 8D. Using Diff. Adj. valve (Item #4), slowly open the valve to bleed pressure from the low side until pressure drops approximately 15 psi, then return the Diff Adj. valve to its close position to trap the lower pressure on the low side. Note that this bleed operation must be carefully monitored. If low pressure drops more than the 60 psi rating of the Differential Gauge, gauge calibration will be lost, the gauge must be recalibrated and this test restarted from step 1.
- 9A. Using 3-way valve (Item #5) to switch between LOW and HIGH side, confirm that the Digital Gauge (Item #1) produces an expected result (e.g. HIGH pressure reading – LOW pressure reading = Differential Gauge reading).