MAK-4 HYDRACLOSE® CYLINDER TEST SYSTEM

OPERATION INSTRUCTIONS

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EDITOR : Linda Carson

PART 1) INTRODUCTION

The Galiso MAK-4 Hydraclose test system is a sophisticated manually operated hydrostatic test system which is designed for testing of compressed gas cylinders at pressures up to 6,000 PSI. The MAK-4 features the patented, self sealing Hydraclose Test Head which speeds the test procedure by automatically sealing the test jacket as well as the connection between the cylinder neck and test head.

Test pressure is supplied by an air driven intensifier pump, which features a pump speed control valve and a non-relieving regulator to allow accurate control of cylinder pressurization. Test pressure is measured by a high quality six inch gauge. The test pressure gauge includes a mirror dial face and needle pointer for increased accuracy and easier readability. Cylinder expansion is measured by a movable burette rack with three etched glass burettes. Our exclusive "C-TRU" zero line indicator eliminates reading errors caused by parallax distortion.

An air driven pressure recorder provides a permanent record of each test to verify that tests were performed according to the required specifications. The test pressure gauge(s) and the pressure recorder also include pulsation dampening systems to prevent damage from line surges and shocks.

The MAK-4 Hydraclose Test System is also available with optional accessories which expand the testing capabilities of the system. The MAK/OTS test system includes a special bleed system which allows the testing of both oxygen service cylinders and cylinders which may be contaminated with oil or petroleum products. MAK-DP test systems include a special pressure recorder which allows accurate testing in two separate pressure ranges.

In addition, two different models of the Hydraclose test head are also available. The "G" Style Hydraclose test head (GHH-6G) features Quick-Change test spuds, which snap in place to reduce the time spent changing test spuds. The "H" Style Hydraclose test head (GHH-6H) features standard threaded test spuds which have a 1" NPT male thread for attachment to the test head. When the MAK-4 test system is supplied with a "G" style Hydraclose test head, the model number is designated as MAK- 4G. When the MAK -4 test system is supplied with an "H" style Hydraclose test head, the model number is designated as MAK-4H. All Hydraclose test heads are available with a 12", 14", 18", 24", or 30" nominal diameter.

The MAK-4 Test System is designed to provide safe, rapid testing and extremely accurate measurement of test results. In order to achieve a maximum degree of safety, efficiency and accuracy, the correct operation procedures must be followed. For this reason, it is recommended that each person who will operate the MAK-4 reads this instruction manual and becomes thoroughly familiar with the correct operation procedure before attempting to operate the system.

PART 1a) INTRODUCTION, HYDROSTATIC TESTING

In accordance with D.O.T. regulations, certain compressed gas cylinders must be periodically re-qualified and certified safe for use. The re-qualification procedure and regulations are discussed in detail in the Code of Federal Regulation (CFR), Title 49, Section 173.34. Copies of the CFR may be obtained from Galiso or by writing to the following address :

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

The Galiso MAK-4 Hydraclose Test System will perform water jacket (hydrostatic) testing of compressed gas cylinders. The specifications and procedure for hydrostatic testing are outlined in Compressed Gas Association Pamphlet C-1, "Methods for Hydrostatic Testing of Compressed Gas Cylinders". Copies of Compressed Gas Association (CGA) pamphlets are available from Galiso or by writing to the following address :

Compressed Gas Association
1235 Jefferson Davis Highway
Arlington, Virginia 22202

In general, the water jacket method for hydrostatic testing consists of loading a water filled cylinder into a sealed chamber (the test jacket), which is also filled with water and is connected to a calibrated glass tube (burette). The burette is first zeroed, and the cylinder is then pressurized to 5/3 of its DOT or ICC rating, which is stamped on the shoulder of the cylinder. In most cases, the test pressure is held for thirty seconds.

As pressure is applied to "inflate" the cylinder, the cylinder expands and forces water out of the test jacket and up into the burette. The burette is then read to determine the **Total Expansion** (in cubic centimeters) of the cylinder under test pressure. After the test time (usually thirty seconds) has elapsed, the test pressure is then released and the cylinder "deflates". As the cylinder shrinks to its approximate original size, water is allowed to drain back into the test jacket from the burette. In most cases, the cylinder will not return to its exact original size, having been slightly stretched by the pressurization process. This post-test stretching is called the **Permanent Expansion**. The difference between the Total Expansion and the Permanent Expansion is called the **Elastic Expansion**.

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PART 1a) INTRODUCTION, HYDROSTATIC TESTING, (Continued)

The **Percent Expansion** of the cylinder is determined by the following formula :

Percent Expansion = (Permanent Expansion / Total Expansion) X 100

When the Percent Expansion is excessive, the cylinder must be condemned and removed from service. A high percent expansion value is an indication that the cylinder metal has lost its elasticity, or that there has been excessive thinning of the cylinder wall and that the cylinder is no longer safe for use.

All test data, such as test pressure, cylinder serial number, expansion results and etc. should be recorded on a Hydraclose Test Log. The chart from the pressure recorder should be stapled to the test log and filed. All test records must be saved and maintained for the life of the test, in the event that there is any future problem with the cylinder.

Cylinders which will receive a plus (+) stamp or a star (*) stamp require additional test specifications and calculations. Plus (+) stamping allows the cylinder to be filled to an additional 10 percent beyond the rating which is stamped on the cylinder shoulder. Star (*) stamping makes the cylinder eligible for an extended ten year retest interval. The procedure and requirements for plus stamping and star stamping are discussed in Compressed Gas Association Pamphlet C-5, "Cylinder Service Life, Seamless High Pressure Cylinders". CGA pamphlet is available from Galiso, or from the Compressed Gas Association at the address indicated previously.

PART 2) HYDRACLOSE TEST SYSTEM COMPONENTS

The MAK-4 Hydraclose Test System consists of four major components which are shown below.

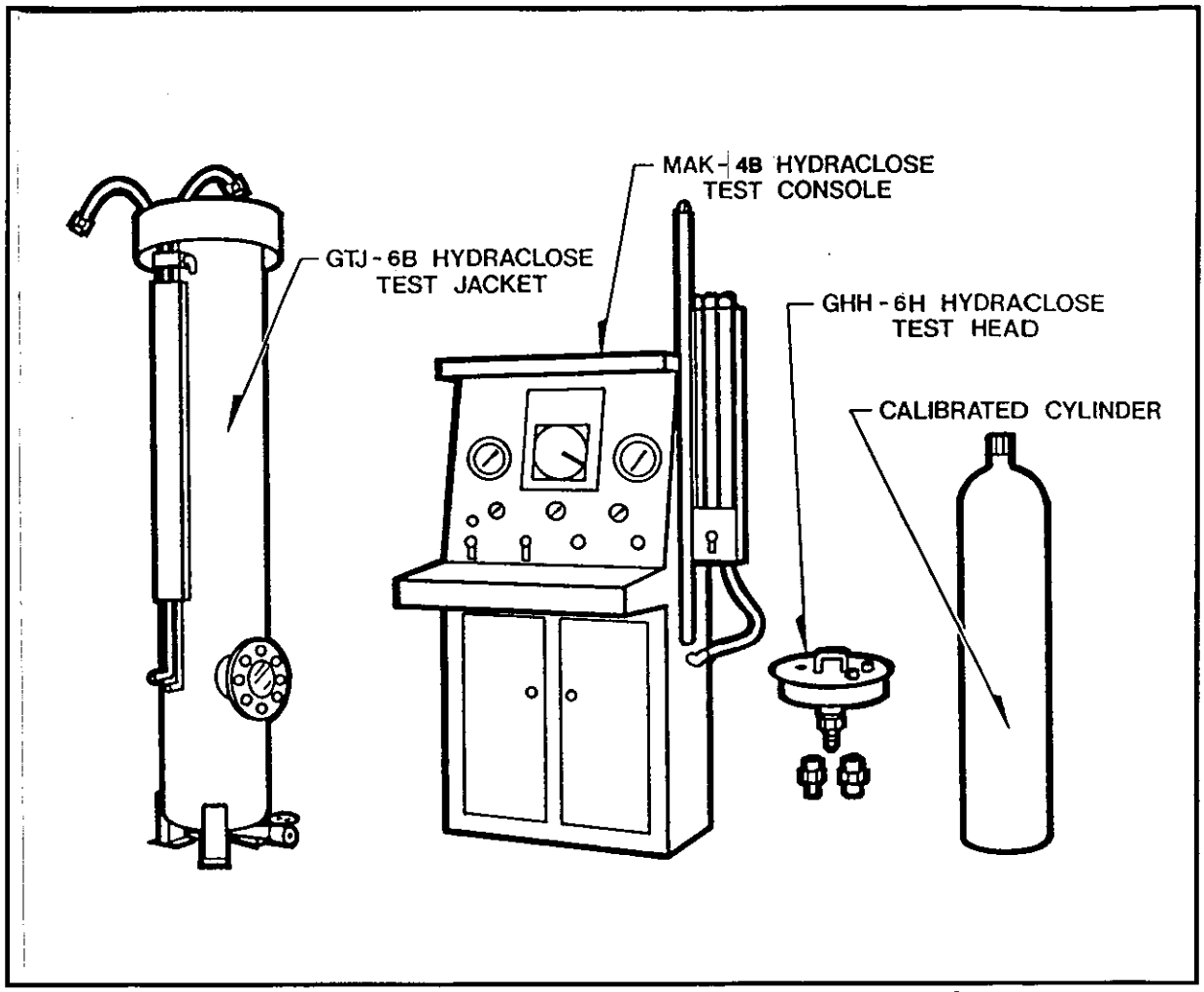

FIGURE 1) MAK-4 HYDRACLOSE TEST SYSTEM COMPONENTS

Following is a description of the components that are included with the MAK-4 Hydraclose Test System.

1. **HYDRACLOSE TEST CONSOLE :** The MAK-4B Hydraclose Test Console supplies test pressures up to 6,000 PSI, controls test pressurization, and measures cylinder expansion. The MAK-4B console includes an air driven intensifier pump, gauges, control valves, a pressure recorder, and a counter-balanced burette rack. The burette rack includes 25 cc, 125 cc, and 350 cc burettes unless otherwise noted.

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PART 2) HYDRACLOSE TEST SYSTEM COMPONENTS, (Continued)

2. **HYDRACLOSE TEST HEAD :** The patented Hydraclose Test Head is a remote controlled closure for the test jacket that automatically seals itself within the test jacket and also seals the connection between the cylinder neck and the test head. When ordered as a system component, all Hydraclose test heads include test connections for 1/2", 3/4", and 1" NPT cylinder neck threads. The MAK-4 test system is available with either a "G" style Hydraclose test head (Quick-Change test spuds) or an "H" style Hydraclose test head (threaded test spuds).

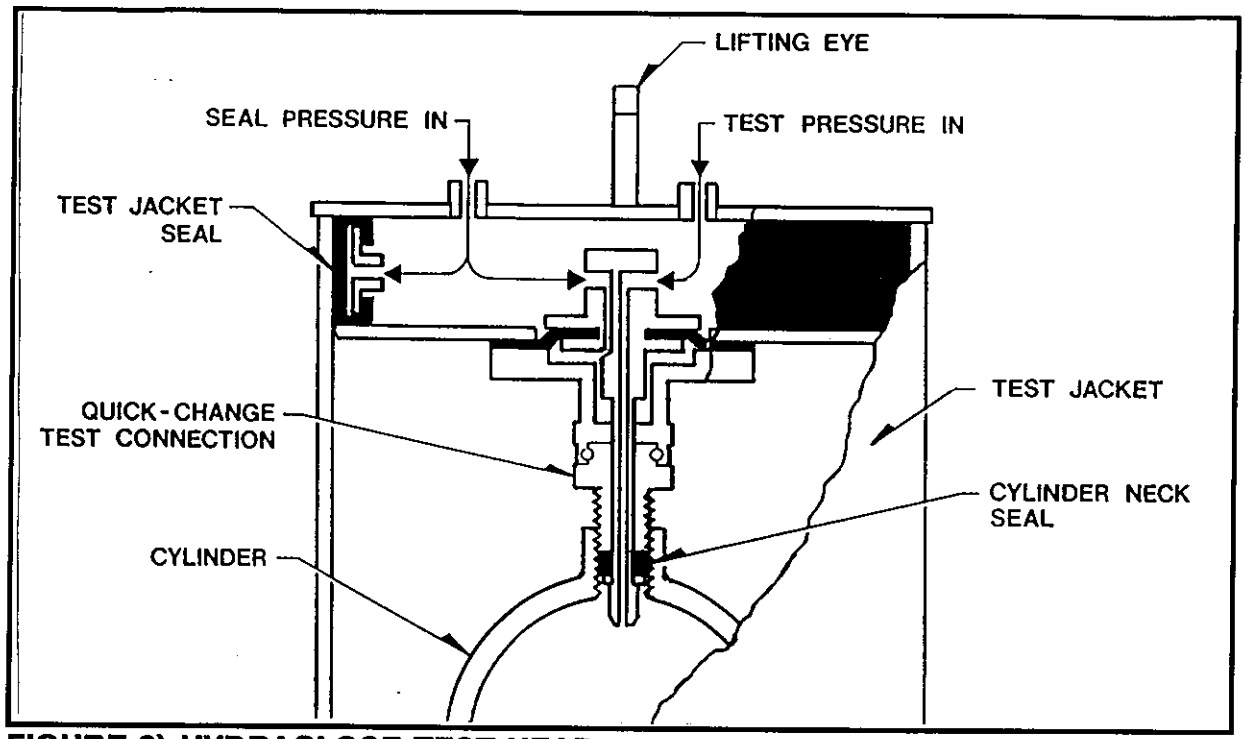

FIGURE 2) HYDRACLOSE TEST HEAD

3. **HYDRACLOSE TEST JACKET :** The Hydraclose Test Jacket is used with the Hydraclose Test Head to enclose the hydrostatic test. The test jacket includes a splash shield, burst disc, and drain valve as well as the pressurization hoses required for operation of the Hydraclose Test Head.

4. **CALIBRATED CYLINDER :** The Calibrated Cylinder is a special steel cylinder which is used for daily expansion reading calibration per D.O.T. specifications. Calibration points are stamped on the cylinder shoulder and a 3/4" NPT adapter is included to protect cylinder neck threads. The calibrated cylinder includes a calibration certificate which is an accurate record of the amount of expansion that can be expected at a given set of test pressures.

PART 3) SAFETY

1. Read all instructions before attempting to install or operate the MAK-4 Hydraclose Test System. **Galiso, Inc. cannot be responsible for damage or injury caused by unsafe use, maintenance, or application of this machine.** Please contact Galiso for guidance when you are in doubt as to the proper safety precautions to be taken when installing, maintaining, or operating this system.

2. When connecting a cylinder to the test head, make certain that the cylinder neck threads are properly engaged with the test spud (see Figure 3 below). Before testing each cylinder, inspect the cylinder neck threads. Cylinders with excessively worn neck threads must be re-tapped or condemned. The test spud must engage with at least five (5) neck threads in order for the cylinder to be safely tested. If the cylinder is not properly attached to the test head, the cylinder may be blown off of the test head during pressurization. If you have any doubts about the connection between the cylinder neck and the test head, do not test the cylinder.

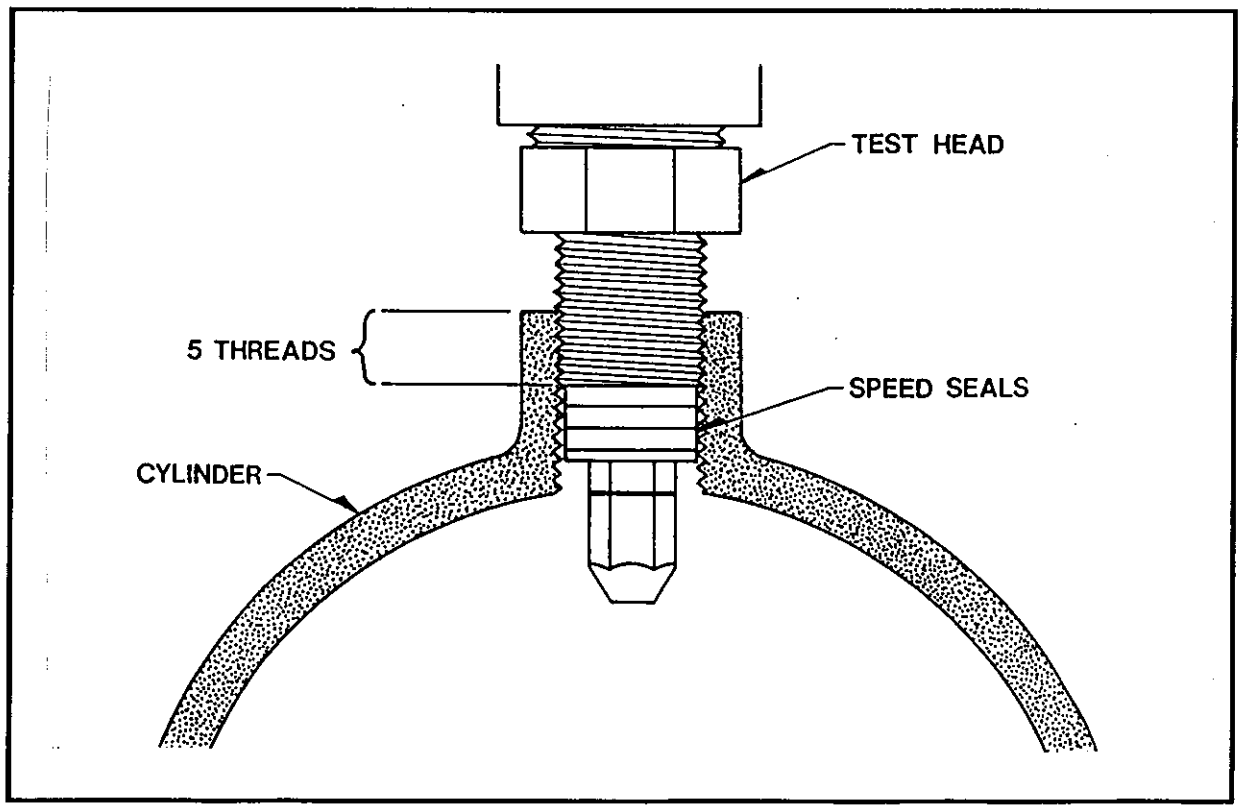

FIGURE 3) HYDRACLOSE SEAL, CYLINDER NECK

(continued)

PART 3) SAFETY, (Continued)

3. Make certain that you are using a test spud that is appropriate for the neck threads of the cylinder which is being tested (see Figure 4 below). Certain types of cylinders (such as cylinders with oversize neck threads or double tapered neck threads) will appear firmly attached when screwed on to an incorrect test spud, without properly engaging the threads of the test spud. If you have any questions concerning the appropriate test spud to be used with a particular type of cylinder, contact Galiso.

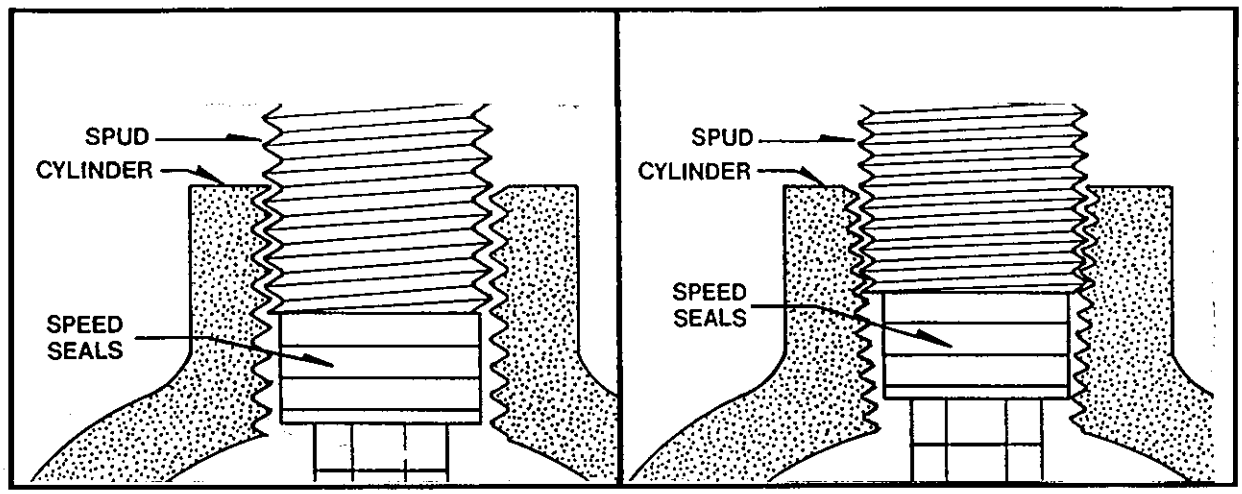

FIGURE 4) CYLINDER NECK THREAD DETAIL

4. Your test jacket must include a suitable explosion port, which is equipped with a Galiso crystal glass burst disk. Although Hydraclose test jackets include an appropriate explosion port and burst disk, the Hydraclose test head may also be used with other models of test jackets. If you intend to use the Hydraclose test head with another manufacturer's test jacket, the following criteria must be observed.

   A. The explosion port must be at least 4 inches in diameter and must include a suitable flange for installation of a Galiso crystal glass burst disk.

   B. If you are unsure of the suitability of the explosion port or burst disk, contact Galiso for further information. Detailed blueprints and specifications are available upon request.

   C. The purpose of the explosion port and burst disk is to protect the operator in the event of catastrophic failure of the cylinder while it is under pressure. The burst disk is designed to shatter in the event of an explosive release of pressure into the test jacket. When the burst disk shatters, excess pressure is released through the explosion port, preventing the Hydraclose test head from being forced out of the test jacket.

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PART 3) SAFETY, (Continued)

5. In the event that you must replace the Test Jacket Burst Disk, make certain that you use a replacement burst disk from Galiso. Never operate the test system with an improper burst disk in place. The burst disk is designed to fail at a specific pressure to prevent the test head from being blown out of the jacket in the event that an improperly mounted cylinder comes off of the test spud while under test pressure.

6. Regularly inspect the condition of the fittings which attach the pressure connection hoses to the Hydraclose test head. The pressure hose fittings must fit snugly with the connection fittings on the Hydraclose test head. Worn or loose fittings should be replaced immediately.

7. Wear eye protection, gloves, and foot protection while operating the MAK-4 Hydraclose Test System.

8. Take care to keep the work area around the test system clean, dry, and free of debris. This will decrease the chance of operator injury due to slips or falls.

PART 4) INSTALLATION

1. Read all instructions and familiarize yourself with the installation drawings before attempting to install or operate the MAK-4 Hydraclose Test System.

2. Carefully uncrate the components of the test system and remove all banding and padding materials. Be sure to remove the protective cover from the test jacket burst assembly.

3. Select an installation location for the test system. The installation location should allow sufficient drainage to prevent water from accumulating around the test system.

   A. The test system must be installed in a location that does not allow direct sunlight to shine on the Control Console.

4. Construct a suitable test pit as described in the installation drawings.

5. Install the Hydraclose Test Jacket in the test pit as described in the installation drawings. Bolt the test jackets to the floor of the test pit.

6. Move the Control Console to the installation location. Bolt or clip the Control Console to the shop floor.

7. Install an appropriate I-Beam and Hoist assembly as shown in the installation drawings. The Hoist assembly must be capable of safely lifting the weight of the water filled cylinder with the attached Hydraclose Test Head.

8. Plumb the console to the test jacket as shown in Figures 5 and 6. Raise the burette rack from the shipping position to the operating position as shown in the installation drawings.

9. Connect the water and air supplies to the console as shown in the installation drawings and in Figure 5. Make certain that the supply line sizes are adequate to prevent excessive pressure drop.

10. Fill the test jacket with water and prepare the Calibrated Cylinder as described in Part 7, Calibrated Cylinder Preparation.

11. Install the test pit grating as shown in the installation drawings.

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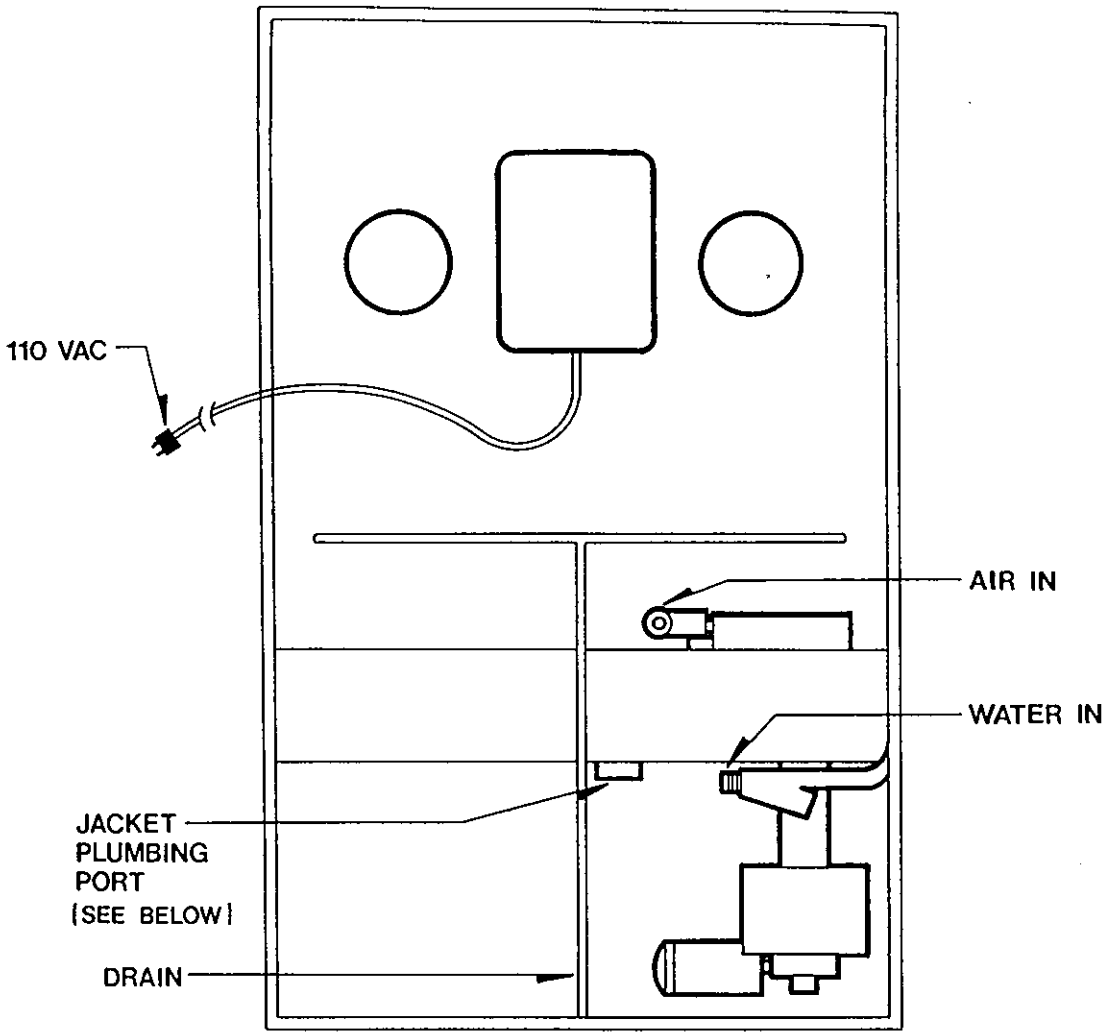
PART 4) INSTALLATION, (Continued)



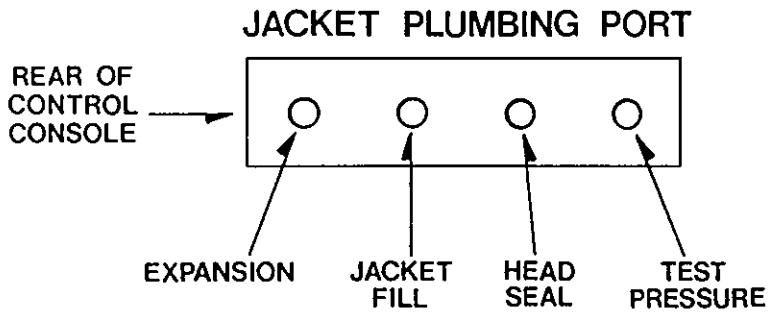


FIGURE 5) HYDRACLOSE TEST CONSOLE, PLUMBING CONNECTIONS

(continued)

PART 4) INSTALLATION, (Continued)

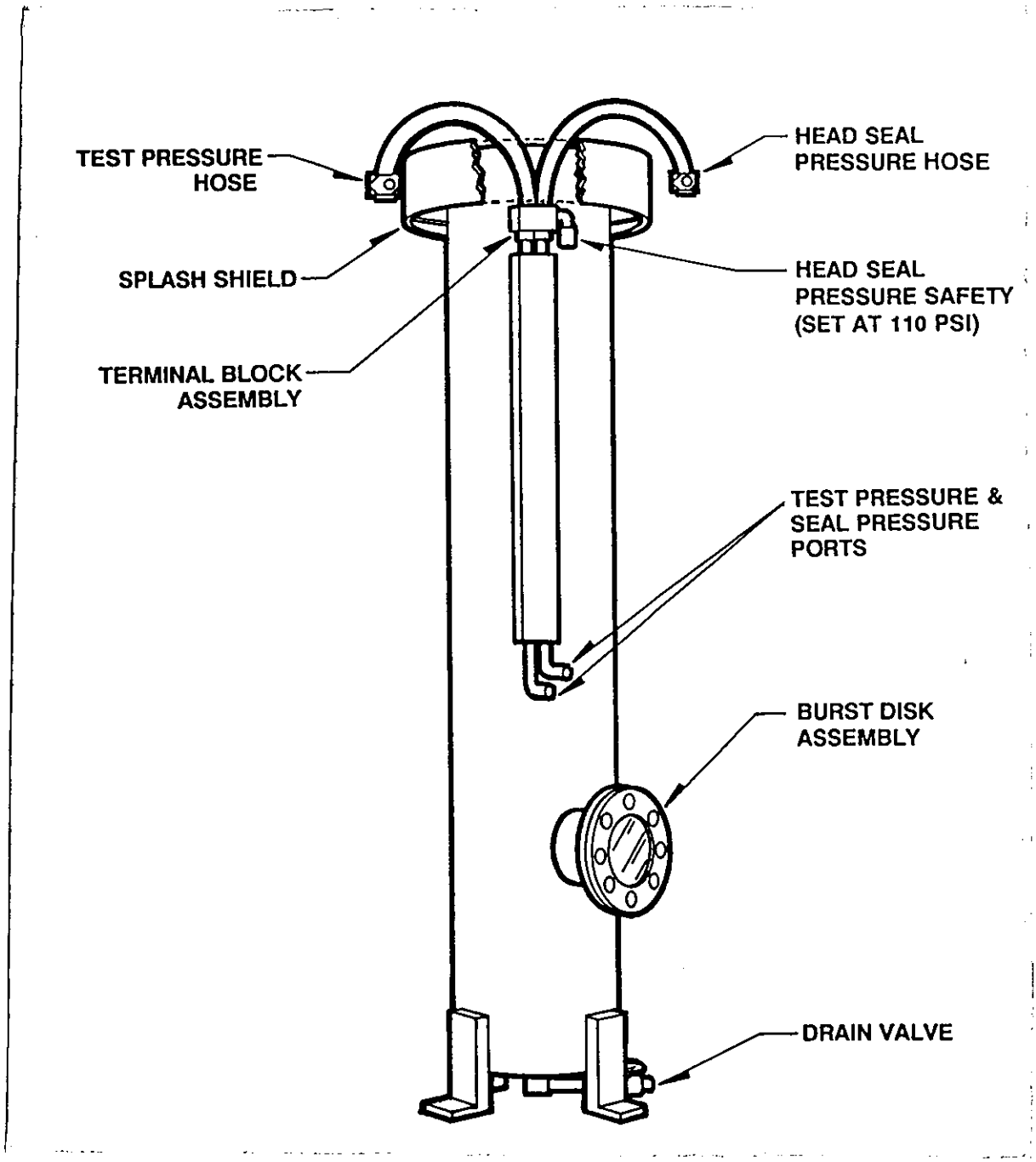


FIGURE 6) HYDRACLOSE TEST JACKET, PLUMBING CONNECTIONS

(continued)

PART 4) INSTALLATION, (Continued)

12. Attach the Hydraclose Test Head to the Calibrated Cylinder and load it into the test jacket as described in Part 5, Hydraclose Test Head Information. Attach the Test Pressure Hose and the Seal Pressure Hose to the test head.

    A. **CAUTION :** The Hydraclose Test Head must be correctly attached to the cylinder neck as described in Part 3, Safety and Part 5, Hydraclose Test Head Information.

13. Plug the Control Console Pressure Recorder into a 110 volt AC power source. The power source should be equipped with a separate 15 amp breaker and the Control Console should be the only electrical device operating on this circuit.

14. Turn on the air supply to the system. The air supply should provide 90 PSI clean, filtered, lubricated air.

15. Turn on the water supply to the system.

PART 5) HYDRACLOSE TEST HEAD INFORMATION

1. The top end of the test spud must be securely attached to the Hydraclose Test Head.

   A. With GHH-6H and GHH-6B Hydraclose Test Heads, Teflon tape must be used to seal the connection between the threaded portion of the test spud and the spud plate on the bottom of the test head.

   B. With GHH-6G Hydraclose Test Heads, the "Quick-Change" test spud snaps into place on the Hydraclose Test Head. Before attaching the GHH-6G Hydraclose Test Head to a cylinder, grasp the Quick-Change Test Spud and check to make certain that the test spud is securely attached to the Test Head.

   C. Do not over-tighten the test spud. The top end of the test spud seals 100 PSI maximum.

2. Install the proper size Speed Seals on the end of the test spud. Next, the Retainer Washer fits over the Speed Seals to hold them in place, followed by the Jam Nut and then the Brass Protective Nut, as shown in Figure 7 and in Form No. GSO8204-9. The Speed Seals and Retainer Washer must be of the proper size to match the Test Spud and cylinder neck that they are being used with, otherwise the spud seal may leak and the head sealing mechanism may be damaged.

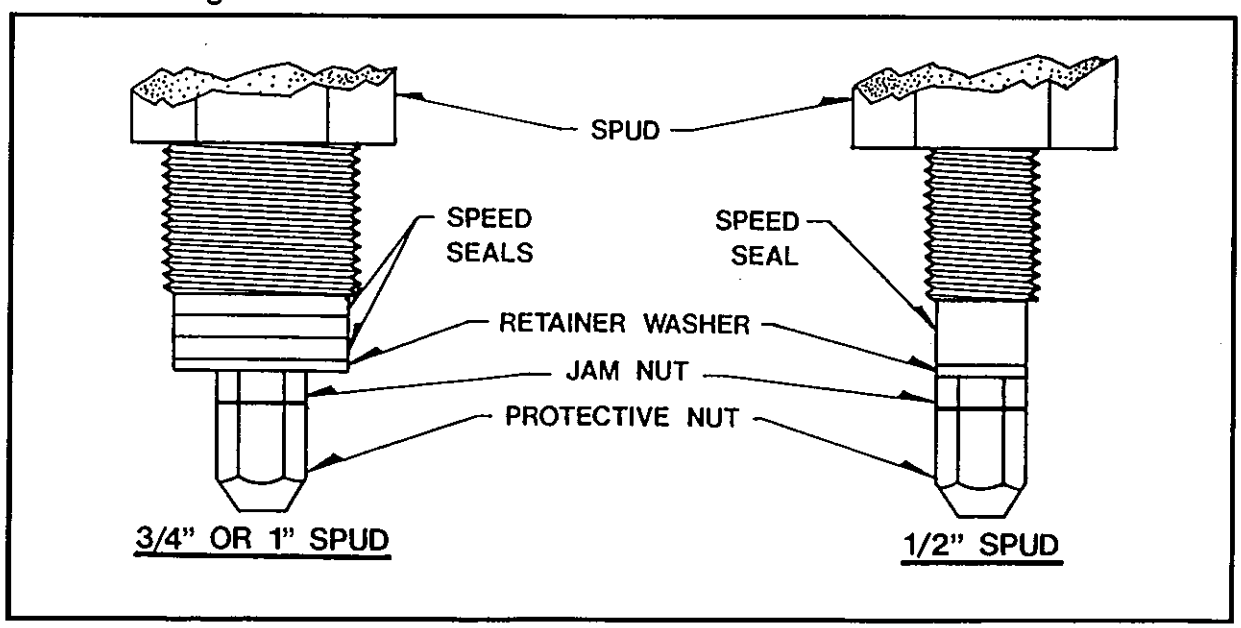


FIGURE 7) SPEED SEAL DETAIL

PART 5) HYDRACLOSE TEST HEAD INFORMATION, (Continued)

3. The 1/2 inch spud requires only one 1/2 inch Speed Seal. The 1/2 inch Speed Seal is manufactured as one unit since 1/2 inch cylinder neck threads are generally shorter than 3/4 inch and one inch neck threads.

4. The 3/4" and 1" spuds require three Speed Seals to properly seal. If the cylinder neck threads are short, the spud can be sealed with two or even one Speed Seal, providing that spacer washers of the appropriate diameter and height are used adjacent to the Retainer Washer to maintain the proper stack-up.

5. Change the Speed Seals when they become excessively thin or ragged to avoid leakage and damage to the sealing mechanism.

6. Inspect the threads on the bottom of the test spud regularly. If the threads become excessively worn, replace the test spud.

7. Lock the Jam Nut and the Brass Protective Nut together so that they will not unscrew. Do not use the test head without the Brass Protective Nut in place, the stem threads will be damaged, resulting in unnecessary repairs.

8. Protect the Spud Stem from being bent or twisted. A bent or twisted Spud Stem will interfere with sealing action.

9. Protect the Head Boot from cuts and gouges that could damage the sealing surface. If the head boot is properly cared for, it should last for years. If the test head is damaged, it can either be sent to the factory for repairs or you can repair it yourself with Galiso replacement parts. Loan heads are available from Galiso to allow you to continue testing while your Test Head is being repaired.

10. The quick Connect Fittings should be inspected for wear periodically and replaced as needed. The hose couplers should fit snugly on the Quick Connect Fittings.

11. The "O"-ring seal in the Quick Connect Fittings should be changed when wear prevents proper sealing.

12. The metal surfaces of the Hydraclose Test Head should be kept clean and free of corrosion. Metal surfaces should be painted with a high quality, cold galvanizing, metal primer. The inside upper 12 inches of the test jackets should be painted with cold galvanizing metal primer to protect the sealing area.

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PART 5) HYDRACLOSE TEST HEAD INFORMATION, (Continued)

13. **Never** pressurize the Test Head without providing an adequate constraint for the Speed Seals and the test boot. The Speed Seals can be constrained by screwing them into a cylinder neck or appropriate test blank (available from Galiso). The test boot can be constrained with either the test jacket or with a snug fitting metal band at least 2" wide and 1/16" thick which is slipped over the head boot to prevent rupturing. At 50 PSI sealing pressure, there is over 3000 pounds force exerted by the sealing boot on the test head. Hydraclose head testing and maintenance systems are available from Galiso.

14. The test jacket terminal block is equipped with a safety relief valve for seal pressure set at 100 PSI to prevent over-pressurization of the sealing apparatus.

15. **CAUTION :** The Hydraclose Test Head must be securely engaged with at least five (5) threads in the cylinder neck in order to safely seal (see Part 3, Figure 4). All cylinders should be inspected before testing to insure that the neck threads are not excessively worn or damaged. Cylinders with inadequate neck threads should be re-tapped or condemned.

16. Make certain that you are using a test spud that is appropriate for the neck threads of the cylinder that is being tested (see Part 3, Figure 4). Certain types of cylinders (such as UCC cylinders with oversize neck threads or Airco cylinders with double tapered neck threads) will appear firmly attached when screwed on to an incorrect test spud. If you have any questions concerning the appropriate test spud to be used with a particular type of cylinder, contact Galiso.

17. In the event that you must replace the Test Jacket Burst Disk, make certain that you use a replacement burst disk from Galiso. Never operate the MAK-4 Test System with an improper burst disk in place. The burst disk is designed to fail at a specific pressure to prevent the test head from being blown out of the test jacket in the event that an improperly mounted cylinder comes off of the test spud while under pressure.

18. Following is a brief description of the operation procedure for the Hydraclose Test Head.

    A. The Hydraclose Test Head is screwed into the cylinder neck, engaging with at least five (5) neck threads (see number 15 above).

    B. A hoist is attached to the Hydraclose Test Head and the test head with attached cylinder is loaded into the Hydraclose Test Jacket. After the test head is in place in the test jacket, the Test Pressure Hose and the Seal Pressure Hose are attached.

PART 6) CYLINDER PREPARATION

1. Cylinders to be tested must be subjected to an external visual examination in accordance with CGA pamphlet C-6, "Standards for Visual Inspection of Compressed Gas Cylinders".

   A. The inspector should check the entire exterior surface, including the bottom of the cylinder, for any damage such as dents, arc or torch burns, bulges, serious corrosion or any other damage that could appreciably weaken the cylinder.

   B. Any cylinders that do not pass the inspection should be removed from further service. It is not necessary to test obviously defective cylinders.

2. **CAUTION :** The Hydraclose Test Head must be securely engaged with at least five (5) threads in the cylinder neck in order to safely seal. All cylinders should be inspected before testing to insure that the neck threads are not excessively worn or damaged. If the cylinder has inadequate neck threads, either the neck threads should be re-tapped or the cylinder should be condemned. There is no need to test an obviously defective cylinder.

3. Prior to hydrostatic testing, each cylinder should be tapped with a 1/2 pound machinist's hammer. If the cylinder has a dull or dead ring, it should be internally cleaned by tumbling or other suitable means. If the dull or dead ring persists after the cylinder has been internally cleaned, the cylinder must be condemned.

   A. Internal cleaning of the cylinder should be performed prior to hydrostatic testing. Internal cleaning methods such as tumbling with abrasives or shot blasting can slightly weaken the cylinder wall.

4. Remove the cylinder valve and tag it with the cylinder serial number so that the valve may be re-installed in the same cylinder. Cylinder valves generally conform themselves to the particular neck threads of the cylinder in which the valve is first installed and may not seal as well in cylinders with a slightly different neck thread configuration.

5. If the cylinder has contained a flammable gas, it must be washed prior to internal visual inspection. Either fill the cylinder with water and then dump it out, or purge the cylinder with clean, dry air or Nitrogen.

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PART 6) CYLINDER PREPARATION, (Continued)

6. Use a Galiso Opti-Lite, fiber optic inspection light or low voltage bulb (to prevent the possibility of electrical shock) to inspect the interior of the cylinder per CGA pamphlet C-6, "Standards for Visual Inspection of Compressed Gas Cylinders". Carefully check the interior of the cylinder for excessive corrosion, dirt, scale or sludge which must be removed prior to hydrostatic testing.

7. Cylinders that pass visual inspection should be filled with clean, filtered water and allowed to stand for at least three (3) hours to allow trapped air bubbles to escape and to allow the temperature of the water in the cylinder to stabilize.

   A. The Galiso ACF Automated Cylinder Filling Station rapidly fills the cylinder with water and shuts off when the cylinder is full.

   B. Add water as needed to completely fill the cylinder before testing.

   C. The temperature of the water in the cylinder should be within five (5) degrees Fahrenheit of the temperature of the water in the test jacket. A large variation of the two water temperatures will cause inaccurate test results.

8. The exterior of each cylinder should be cleaned of dirt, scale, grease, oil and any other contamination before the cylinder is loaded into the test jacket. The test jacket should be cleaned periodically to remove any accumulation of dirt or debris as needed, or at least once every three months.

PART 7) CALIBRATED CYLINDER PREPARATION

1. Fill the Calibrated Cylinder with clean, filtered water and allow it to stand for at least three (3) hours before using, to enable trapped air bubbles to escape and to allow the temperature of the water in the cylinder to stabilize. Add water as needed to completely fill the cylinder before testing.

2. Water should be left in the Calibrated Cylinder at all times. If the cylinder is emptied, it should be dried immediately to prevent corrosion.

3. The Calibrated Cylinder should be protected from freezing temperatures, the force generated by the freezing water can permanently damage the calibration of the cylinder and possibly rupture the cylinder wall.

4. Keep a copy of the Cylinder Calibration Report close to the system to be used during calibration of the test pressure reading and the expansion reading.

PART 8) START UP PROCEDURE

1. Carefully read this instruction manual and the enclosed manufacturer's literature covering the various components in the unit. Do not attempt to operate the equipment until you have a thorough understanding of the principle of operation and the requirements for accurate hydrostatic testing.

2. Start with the water and air supply valves to the console closed. Make certain that all console valves are closed or in the Off position.

3. Turn on the water and air supply valves. The air supply should provide at least 100 PSIG and water supply should provide at least 50 PSIG. Both the air and water supply to the unit should be reasonably clean and corrosion free. Inlet connections to the console are equipped with filtration units but will be unable to cope with extremely contaminated or corrosive water or air supplies. Check the console for any signs of leakage.

4. Fill the test jacket about 2/3 full using an auxiliary water hose. Put the Test Pressure Hose and the Seal Pressure Hose in the test jacket, then open head seal and pressurization valves momentarily to bleed air out of the lines. During normal test procedure, the Water Level Control Valve can be used to add a small amount of water to the test jacket.

5. Close the Pump Speed Control Valve and open the Pressurization Valve. Adjust the Pump Speed Control Valve so that the pump is stroking very slowly, then close the Pressurization Valve. A slow pump speed is recommended when you are first learning to operate the system and for testing small cylinders. You will find this speed control capability very useful.

6. Setting the pressure regulator (see step 11) so that the Air To Pump Gauge reads approximately 75 PSIG, will provide approximately 4,300 PSI test pressure. The regulator is of the relieving type. This allows pressure to be backed down by backing off the regulator adjusting knob. When the required air pressure is reached, the adjusting knob should be locked in place, as shown in the component instructions.

   A. The maximum system pressure is a direct ratio with the Air To Pump pressure. The maximum system pressure should be set 300 to 500 PSI above the highest test pressure required in order to assure rapid pump-up. If the maximum test pressure is too close to the required test pressure, there may be excessive time spent reaching the required test pressure.

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PART 8) START UP PROCEDURE, (Continued)

7. Plug in the recorder. The chart drive stops automatically when the test pressure drops below 2,000 PSI. Add ink to the recorder pen as needed to provide legible diagrams. For test timing purposes, each radial space on the graph is 30 seconds. Load a blank chart into the recorder.

8. Slightly open the test gauge Isolation Valve and Recorder Isolation Valve located under the console desk. The second high pressure test gauge (if provided) is used as a master reference gauge or spare. The Isolation Valve for the second gauge should remain closed until the gauge is needed.

9. Prepare the Calibrated Cylinder as described in Part 7, Calibrated Cylinder Preparation.

10. Attach the Hydraclose head to the calibrated cylinder and load them into the test jacket as described in Part 5, Hydraclose Test Head Information.

11. Reset the regulator at approximately 60 PSI. This will set the maximum test pressure at approximately 3,400 PSI, preventing the possibility of over-pressurizing the calibrated cylinder. The calibrated cylinder should not be pressurized above 6,000 PSI since this could damage its calibration.

12. Once the water temperature has stabilized, make some practice runs (as described in Part 10, Test Procedure, steps 7 through 16). Practice testing the cylinder to a pressure of 3,000 PSI. Once you have mastered the technique, reset the regulator to 75 PSI.

13. Calibrate the system as described in Part 9, Calibration Procedure.

PART 9) CALIBRATION PROCEDURE

The purpose of the Calibration Procedure is to check and, if necessary, adjust the accuracy of the high pressure gauge. In accordance with D.O.T. regulations, the accuracy of the system should be checked at the beginning of each work day.

1. If the calibrated cylinder is not already loaded into the test jacket, attach the water-filled calibrated cylinder to the test head (as described in Part 5, Hydraclose Test Head Information) and load the cylinder and test head into the test jacket.

2. Select a pressure point from the Calibration Record. Carefully pressurize the cylinder to the calibration point and then check the expansion reading. The expansion reading indicated by the control console burette rack should match the expansion value from the Calibration Record.

3. The calibrated cylinder is to be used at the start of each day's testing to make certain that the system is operating properly. The test gauge must be adjusted to agree with the expansion value indicated by the burette. The burette should not be adjusted to match the gauge.

4. If the test gauge cannot be adjusted to match the calibration sheet within one percent, then there is reason to suspect that something is either wrong with the system or that the test gauge has been thrown out of calibration. In such cases, the gauge should be checked against a master gauge or a dead weight type gauge tester to determine its accuracy.

5. Dead weight testing of pressure gauges is a very precise operation and should only be performed by experienced personnel with equipment whose accuracy is traceable to the Bureau of Standards. Contamination of gauges with oils normally used in dead weight testers is a potential problem and gauges tested with such equipment must be cleaned prior to re-installation in the test unit.

6. Once you have become proficient in the testing procedure and have met certification requirements, you may then proceed to the testing of cylinders.

PART 10) TEST PROCEDURE

1. Record the cylinder serial number and its ICC or DOT rating on the hydrostatic test log. Enter all pertinent information regarding the cylinder as noted on the test log.

2. Attach the Hydraclose head to the cylinder (as described in Part 5, Hydraclose Test Head Information). The head should be suspended from a swivel type hoist hook. Only hand tight insertion is required.

3. When testing cylinders up to 5" in diameter and shorter than 16" long, it is often simpler to spin the head on the hoist hook swivel and then feed the cylinder on to the thread spud.

4. **CAUTION :** When connecting a cylinder to the Hydraclose Test Head, make certain that the cylinder neck threads are properly engaged with the test spud. Before testing each cylinder, inspect the cylinder neck threads.

   A. The test spud should engage with at least five (5) neck threads in order for the cylinder to be safely tested. Cylinders with excessively worn neck threads should be retapped or condemned.

   B. If the cylinder is not properly attached to the Hydraclose Test Head, the cylinder may be blown off of the test head during pressurization.

   C. If you have any doubt about the connection between the Test Head and the cylinder, do not test the cylinder.

5. Using the hoist, load the Test Head and cylinder into the test jacket. The position of the buttonhead fittings should line up with the terminal block assembly and pressurization hoses.

6. Attach the pressurization hoses to the buttonhead fittings on the Hydraclose head. The small fitting is for test pressure and the large fitting is for seal pressure.

   A. Turn the Water Level Control Valve to the On position until the jacket runs over, then return the valve to the Hold position. This will make certain that all the air is removed from the test jacket. Since the Hydraclose seal is below the top edge of the test jacket, no air will be trapped under the head. No other venting or bleeding of the test jacket is required.

   B. When testing a smaller cylinder than previously tested, you may need to add a substantial amount of water to the test jacket using an auxiliary hose.

PART 10) TEST PROCEDURE, (Continued)

7. Turn the Head Seal Valve to the On position. This seals and locks the Hydraclose head and actuates the automatic spud seal. Turn the head seal valve to the Hold position.

   A. The seal pressure gauge may drop 1 to 3 PSI but should then remain steady. If pressure continues to drop, stop the test, locate and correct the leakage.

   B. Do not attempt to test if the head seal does not hold. To do so may result in unnecessary damage to the head.

8. Slide the burette rack to the highest position. This should line up the burette zeroes with the "C-TRU" zero line indicator.

9. Bring the water level in the burette up to zero by adding water to the test jacket with the Water Level Control Valve. The burette water level is always read at the bottom curve of the meniscus.

10. Close the Bleed Valve. Open the Pressurization Valve and bring the cylinder up to the required test pressure. Watch the test pressure gauge. When the cylinder reaches the appropriate test pressure. Close the Pressurization Valve. Hold the test pressure for 30 seconds. Check to make certain that the test pressure and water level in the burette remain constant.

    A. If the pressure continues to drop, there is a possibility of a leak. Recheck the system, then re-test the cylinder at 100 PSI higher per CGA pamphlet C-1.

11. **Never** pressurize the Test Head without providing an adequate constraint for the Speed Seals and the test boot. The Speed Seals can be constrained by screwing them into a cylinder neck or appropriate test blank (available from Galiso). The test boot can be constrained with either the test jacket or with a snug fitting metal band at least 2" wide and 1/16" thick which is slipped over the head boot to prevent rupturing.

12. Slide the burette rack down until the water level in the burette lines up with the "C-TRU" zero line indicator. Record the Total Expansion reading in cubic centimeters.

13. Record the cylinder test number in the graph scribed on the recorder chart for easy identification of the test, or number the test diagrams consecutively per the test log for that day. Date the recorder charts and staple them to each day's test logs prior to filing them away. Maintain these records for the life of the test.

PART 10) TEST PROCEDURE, (Continued)

14. Slowly open the Bleed Valve and allow all test pressure to be released from the cylinder. When all pressure has escaped, close the Bleed Valve.

15. Raise the burette rack until the water level in the burette lines up with the "C-TRU" zero line indicator. Record the Permanent Expansion, if any.

    A. If the water level falls below zero, leakage or temperature change has occurred and the test is incorrect. Re-check the system and repeat the test at a higher test pressure of not more than 100 PSI or 10% of cylinder ICC or DOT rating, whichever is less.

    B. Permanent expansion must not exceed 10% of the total expansion. If the cylinder will be tested at the "Plus" 10% rating, Elastic Expansion must not exceed 10% of the Total Expansion.

    C. If cylinders are found which fail such tests, mark them, set them aside, and contact the manager for instructions regarding disposition.

16. Turn the Head Seal Valve to the Off position, to release the head seal pressure.

17. Disconnect the pressurization hoses from the Hydraclose head. Remove the cylinder from the test jacket. Remove the Hydraclose head from the cylinder.

18. Stamp the date of the test on the cylinder. The date should include the number of the month, followed by the symbol or registration number and the last two digits of the year. June 88 would be stamped 6 - (Reg. No.) - 88.

    A. In addition to the month, symbol and year, add any additional markings as may be required, such as the five pointed star (*) signifying 10 year test or the plus mark (+) indicating that the cylinder is suitable for filling to the plus 10% pressure after the date.

19. Put the cylinder in a dump rack or Galiso PCT-ADW cylinder inverter. Invert the cylinder and allow it to drain completely. Dry the cylinder with clean, hot air or Nitrogen.

20. Cylinders which will be filled with high purity gases should have a vacuum of 28" of Mercury drawn. The vacuum should then be relieved with the gas the cylinder is to be filled with. Re-draw the vacuum once prior to refilling.

PART 10) TEST PROCEDURE, (Continued)

21. Cylinders that are to be filled with gases that do not have stringent purity requirements can use a modified purging procedure as purity requirements allow.

22. While cylinders are being filled, soap check threads to check for leaks.

23. The fine safety record enjoyed by the compressed gas industry is due in no small part to the Department of Transportation regulation requiring re-qualification of cylinders on a scheduled basis.

    A. Every person and/or company engaged in the re-testing of cylinders should carefully adhere to these regulations so this safety record will not be marred by failure of defective cylinders that could cause serious loss of life and property.

    B. Galiso is proud to bring to the compressed gas industry a hydrostatic testing system that makes possible more rapid hydrostatic testing, requiring considerably less effort.

PART 11) USE OF CARBON DIOXIDE TO POWER INTENSIFIER PUMP

Companies not having air compressors, but having Liquid Carbon Dioxide storage units, may use the vapor gas from the storage unit to operate the intensifier pump providing that the following points are observed.

1. A high volume Carbon Dioxide regulator must be installed at the storage unit connection to reduce the pressure to between 100 and 125 PSIG.

2. Approximately 20 to 30 feet of 1/2" to 3/4" pipe or tubing should be run between the regulator and the connection to the intensifier pump or the test console. The purpose of the line is to allow the Carbon Dioxide gas to warm up to ambient temperatures to prevent the pump regulator from freezing or sticking.

3. In the event that ambient temperature is too low to provide adequate warm-up of the gas prior to entering the pump regulator, auxiliary heat of some type should be used to warm the gas to at least 60 degrees before it enters the intensifier pump or the test console.

4. Adequate ventilation must be provided, or the exhaust from the intensifier pump be run outdoors, to prevent the accumulation of dangerous concentrations of Carbon Dioxide gas in the work area. This is especially important in places where the work area is sealed off during cold or inclement weather.

When the foregoing rules are observed, the system will operate very nicely on Carbon Dioxide gas if an air compressor is not available.

PART 11a) ACCURATE READING OF TEST GAUGES AND BURETTES

1. It is very easy to misread ordinary hydraulic gauges, since the angle of view and width of the needle can cause wide variations of the apparent reading of the gauge. All Galiso hydrostatic test systems are equipped with 1/2% accuracy test gauges, which have mirror dials and needle pointers. Only 1% accuracy is required by regulations.

2. To read the Galiso test gauge, position your view so that the needle pointer is over its reflection in the mirror band. This cancels out all parallax distortion to give you the true reading.

3. The test gauge chart gives the actual gauge readings at various pressures at the time of manufacture. The gauges used by Galiso are much more expensive than ordinary hydraulic pressure gauges, but give you the maximum accuracy.

4. Surge dampening is built into all Galiso test systems to further protect the readability and accuracy of the test gauge. This may prevent the needle from dropping down to zero immediately, but in no way affects accuracy in the high pressure ranges.

5. Galiso test systems are equipped with a "C-TRU" Plexiglas zero line indicator. This makes seeing and controlling the rising burette water level and reading the expansion results much easier.

   A. The "C-TRU" Plexiglas zero line indicator has a scribed line on either side. When reading the water level, the two scribed lines are lined up with the bottom of the curve (meniscus) of the water in the burette tube.

   B. This will eliminate errors from viewing the water level from different angles (parallax errors) that could cause inaccurate interpretation of the test results.

PART 12) MAINTENANCE

1. MAK-4B CONTROL CONSOLE

A. Keep the Control Console clean and dry and free of dirt and debris.

B. Regularly inspect the plumbing components of the Control Console for leaks. Also inspect the lines which connect the Control Console to the test jacket and pressure supply.

2. HYDRACLOSE TEST HEAD

A. Change the Speed Seals when they become excessively worn or ragged to avoid leakage and damage to the sealing mechanism.

B. Regularly inspect the threads on the bottom of the test spud. If the threads become excessively worn or damaged, replace the test spud.

C. The Quick Connect Fittings should be inspected for wear periodically and replaced as needed. The hose couplers should fit snugly on the Quick Connect Fittings.

D. The "O"-Ring seal in the Quick Connect Fittings should be changed when wear prevents proper sealing.

E. The metal surfaces of the Hydraclose Test Head should be kept clean and free of rust and corrosion. Metal surfaces should be painted with a high quality, cold galvanizing metal primer.

3. HYDRACLOSE TEST JACKETS

A. The inside upper 12 inches of the test jacket should be painted with cold galvanizing metal primer to protect the sealing area.

B. The Test Jacket should be cleaned periodically to remove any accumulation of dirt or debris as needed or at least once every three months.

C. Test Jacket water that has become stagnant or brackish should be drained from the test jacket and replaced with fresh water.

4. CALIBRATED CYLINDER

A. The water-filled Calibrated Cylinder must be protected from freezing temperatures. The force generated by the freezing water can permanently damage the calibration of the cylinder and possibly rupture the cylinder wall.

NOTES