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Fluid Loss Test Instrument

Dual Cell

Instruction Manual



Instruction Manual Part No. 101443606 Revision C

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Dual Cell Fluid Loss Test Instrument

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1 Introduction to the Fluid Loss Test Instrument

Fluid Loss Test Instruments are used to perform a fluid loss test. This test determines the effectiveness of a cement slurry composition in preventing the loss of water from the slurry to a formation in the well bore.

The sample cells can be operated up to 1,500 psi (10.3MPa) from an external Nitrogen (N₂) source. The desired pressure is maintained during heating by a self-relieving pressure regulator.

The fluid loss instruments may be operated at temperatures up to 200°F (93.3°C). Temperatures above 212°F (100°C) will vaporize the fluid, making the test readings inaccurate. The temperature is measured by a 1/16 inch (1.6 mm) diameter thermocouple that is inserted into the side of the slurry sample cell, and is controlled by a microprocessor-based electronic PID temperature controller. An aluminum heating jacket surrounds the non-ferrous slurry sample cell, assuring filtration at the desired temperature. The power consumption of the cell heating jacket is 1,600 watts.

A 2-1/2 inch (6.35 cm) stainless steel filter screen simulates the formation permeability. Two screens are available, 325 & 60 mesh or 600 & 60 mesh, both of which are laminated to a perforated stainless steel backing. The 600 & 60 mesh screen is for testing Micro Matrix® cement slurries only.

Valves at top and bottom of the cell are manually opened and closed as necessary to pressurize the cell, and to release the fluid during the measurement phase of the test.

A graduated cylinder is used to collect the filtrate (the fluid loss amount).

A stand mounted on the base plate securely holds the slurry sample cell (reservoir) while the top and bottom lids are being installed or removed.

1.1 Document Conventions

The following icons are used in this manual to distinguish elements of text.



NOTE

Contains additional information for the reader that is not safety related.



CAUTION

Describes a situation or practice that if ignored, will result in equipment damage or loss of data.



WARNING

Describes an unsafe condition or practice that, if not corrected, will result in personal injury, possibly death.

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2 Safety

Safe operation of the Fluid Loss Test Instrument requires the operator understand and practice the correct assembly and operation of the equipment. Improper assembly, operation, or the use of defective parts, poses the possibility of cell leakage or failure which could result in serious injury and damage.

The slurry sample cell (reservoir) and the heating jacket are hot during operation. The operator should be aware of these hot areas and avoid contact with them. Burns can result from touching hot parts of the equipment during normal operation.

These instruments are electrically heated. As with any electric device, the wiring should be regularly checked for bad connections. These instruments should always be used on a grounded circuit.

Following is a list of suggestions that should be observed to assure safe operation and maintenance of the Fluid Loss Test Instrument.

2.1 Safe Pressurization

1. Always use nitrogen (N₂) gas. Never connect the Fluid Loss Test Instrument to compressed air, oxygen or other non-recommended gas. If nitrogen is used it must be supplied in an approved nitrogen gas cylinder or the nitrogen supply system must be built into the laboratory. Nitrogen cylinders must be secured to meet safety standards.
2. Maintain pressure regulators in good condition. Never use oil on pressure regulators. Leaking pressurizing systems should be repaired or replaced. Gauges, fittings and hoses should be kept in good condition and any leaks should be promptly located and corrected.
3. When pressurizing the cell, always open the supply pressure first, and then adjust the regulator. Do not attempt to pressurize higher than the equipment is rated. Follow the procedure as outlined in Section 5.4. When de-pressurizing, shut off the supply pressure, bleed the system of pressure, and then back out the regulator knob, following the procedures in Section 5.6.
4. The threaded end caps on the cell assemblies can indicate pressure is trapped inside the cell, such as by a cement plug. Following a test, if greater than normal force is required to turn a cap for removal, this could indicate that pressure is trapped inside the cell.

2.2 Safe Heating

1. Caution should be exercised by all personnel working with or working in the area where the Fluid Loss Test Instrument is in operation to avoid accidental injury caused by touching the heating jacket or cell assembly while these are hot. The heating jacket can operate at a temperature which will cause burns if touched. Safeguard the equipment after the test ends long enough for it to cool. Even after it has been turned off, it can still be hot enough to cause burns.
2. The practice of removing the cell and cooling it under water is a very dangerous procedure. It is not recommended because of the danger of severe burns if touched or accidentally dropped. Also use extreme caution when placing a hot cell in water. Hot steam or water generated when the water hits the hot cell can cause severe burns. Thermally insulated gloves are recommended to be worn when handling the cell assembly and removing it from the heating jacket.

**CAUTION**

NEVER operate the heating jacket without a thermocouple and reservoir. Doing so will result in the loss of temperature feedback and severe over-heating of the heating jacket, possibly to the point of melting.

2.3 Safe Electrical Operation

1. Make sure the electrical source is fused and grounded. Verify the power cord on the Fluid Loss Test Instrument is in good condition and that it has the proper ground connection.
2. Electrical problems in the wiring or heaters may not be obvious by looking at the equipment. If a malfunction is suspected by the unit blowing fuses or tripping breakers, the heating time seems longer than normal or the temperature controller does not reliably maintain temperature, then electrical repair may be indicated. Refer to Section 7.7 for repair of the heating jacket.

**WARNING**

Always disconnect the power cable before attempting any repair.

2.4 Safe Test Cell (Reservoir) Maintenance

The assembled reservoir body, end caps and valves constitute a pressure vessel. These safety precautions should be followed to assure safe operation.

1. The cell body and cap material should be compatible with the test sample.
2. Cell bodies with signs of cracking, severe pitting, or have damaged threads, must not be used.
3. Cell caps with damaged threads must not be used.

3 Features and Specifications

Table 3-1 Dual Cell Fluid Loss Test Instrument Specifications

Category	Specification
Maximum Temperature	200°F (93.3°C)
Maximum Pressure	1,500 PSI (10.3 MPa)
Heating Rate	8°F - 4. 4°C per minute maximum
Slurry Reservoir (2)	
Diameter x Length (excludes valves)	3.25 x 5.12 inches (in) – 8.26 x 13.00 centimeters (cm)
Volume	9.75 ounces (oz) - 160 milliliters (ml)
Weight	8.80 pounds (lb) – 4.40 kilograms (kg)
Frame	
Width x Depth x Height	28.0 x 14.0 x 25.75 inches (in) 71.1 x 35.6 x 64.4 centimeters (cm)
Weight	77.0 pounds (lbs) – 34.93 kilograms (kg)
Pressure Connection	Nitrogen, CGA-584
Temperature Controller (2)	
Height x Depth x Height	11.0 x 19.0 x 9.5 inches (in) 27.9 x 48.3 x 24.1 centimeters (cm)
Weight	16.25 pounds (lb) - 7.37 kilograms (kg)
Voltage and Current	Single phase, AC, 50–60 Hertz (Hz) 115V, 15A, NEMA 5-20P plug or 230V, 10A, NEMA 6–15P plug

The Fluid Loss Test Instrument is available in two configurations. Figure 3-1 shows the dual cell style covered by this instruction manual. It is available for either 115 or 230 volt, and both will operate on 50 or 60 Hertz AC power.

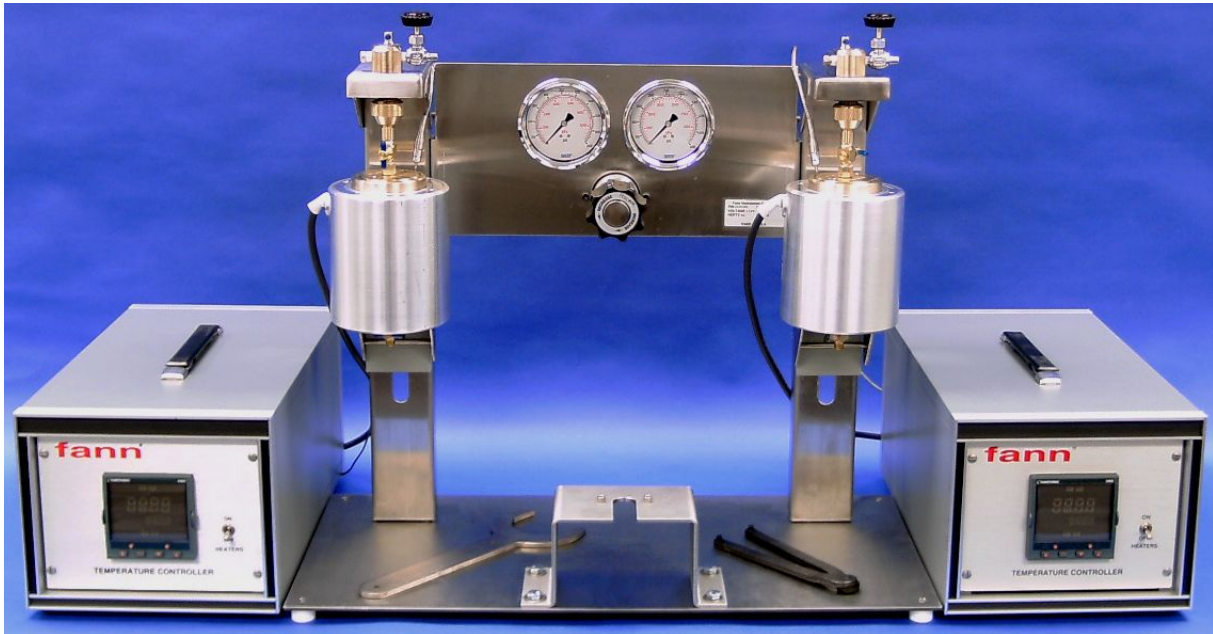


Figure 3-1 Dual Cell Fluid Loss Test Instrument

3.1 Fluid Loss Mechanical

A durable, all stainless steel, base plate and frame supports the pressure gauges, pressure regulator, pressure manifold and heating jackets. The heating jackets are attached to an adjustable bracket, allowing easy and efficient insertion and removal of the reservoirs. A simple hand nut couples the reservoirs to the pressure manifolds, without tools. A stand is located at the front of the base plate to hold the reservoirs upright when filling and cooling.

3.2 Fluid Loss Controls and Indicators

Temperature Controller

The desired temperature is regulated by an electronic temperature controller, which senses the temperature through a Type J thermocouple placed in the wall of the test cell (reservoir). It controls the temperature by rapidly turning on and off the power applied to the heating jacket heaters. The relationship between the "ON" time and the "OFF" time per cycle determines the temperature.

A manual switch is located on the front panel to enable and disable the heating jacket independent of the temperature controller. This is both a convenience and safety feature.

3.3 Pressure

Nitrogen (N₂) is the preferred pressurization gas for fluid loss testing. An inlet nipple and CGA-584 nut is provided at the end of a 5-foot (1.5 meter) long stainless steel tube. The external nitrogen gas source connects to the panel mounted, self-relieving, pressure regulator. Separate front panel gauges indicate the pressures of both the supply and output to the frame-mounted pressure manifolds, located above each heating jacket and reservoir.

**WARNING**

Fluid loss tests performed with the provided reservoir should not be performed with pressures exceeding 1,500 psi (10.3 MPa).

To increase the output pressure, the pressure regulator knob is rotated clockwise (CW). To decrease the output pressure, the pressure regulator knob is rotated counter-clockwise (CCW). Reducing the regulator output pressure will reduce the pressure in the manifold. It will also reduce the pressure in the reservoir only if the manifold valve above the reservoir is open. Similarly, pressure increases caused by heating will be released through the regulator, only when the manifold valve above the reservoir is open.

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4 Installation

4.1 Fluid Loss Test Instrument Installation

The Fluid Loss Test Instrument's functional components and accessories can generally be arranged to suit the available space and the desires of the lab personnel, consistent with any established work processes. Some environments encourage a right-to-left flow, while others a left-to-right. Consideration should be given to the location of the sample preparation area and cleaning the cells following test completion. The pressurizing system may also dictate installation-specific requirements, such as having a large compressed gas cylinder secured nearby. There should be sufficient storage area nearby for commonly used tools and consumable items.

The Dual Cell Fluid Loss Test Instrument has a dedicated temperature controller for each heating jacket. Each of the temperature controllers has a power cord approximately 5 feet (1.5m) long. They must each be located no farther than 5 feet (1.5m) from their corresponding heating jacket, and from an appropriate electrical outlet. Because of the diversity in types of electrical outlets throughout the world, it may be necessary to replace the power cord's plug. The power cords should be kept away from the un-insulated surface of the heating jacket while the jacket is in use, and immediately afterwards.



NOTE

Customer installed wiring, electrical connectors, and power cords are excluded from the warranty.

4.2 Heating Jacket

The heating jacket has a power cord approximately 5 feet (1.5m) long, which must be connected to the locking receptacle on the temperature controller. On the dual cell instrument, each heating jacket is controlled by a dedicated temperature controller, with the locking receptacle on the cabinet rear.

4.3 Pressurizing System

The pressurizing system may also dictate installation requirements, such as having a large compressed gas cylinder secured nearby. When a compressed gas cylinder is used, it should be located within reach of the tubing attached to the pressure regulator; typically 5 feet (1.5m).

4.4 Tools

Storage space near the cell preparation area should be provided for the wrenches used to install, tighten, loosen and remove the end caps.

4.5 Consumables

Consumables, such as filter screens and replacement O-rings, should be near the cell preparation area.

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5 Operation

The Fluid Loss Test Instrument, if completely assembled, must have the slurry cell (reservoir) removed from the heating jacket before starting the test procedure as is described below. For easy identification of the major components, reference is made to Figure 5-1 for the reservoir, Figure 5-2 and Figure 5-3 for the temperature controller, and Figure 5-4 for the frame.

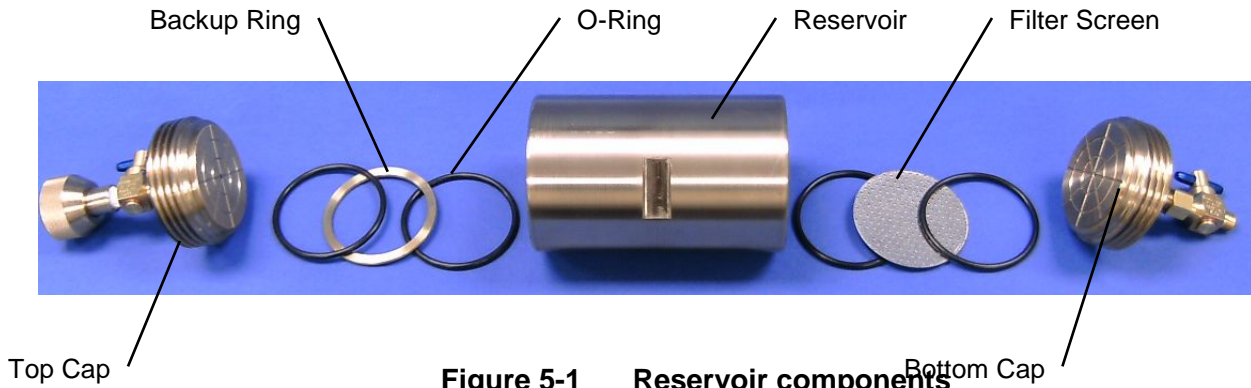


Figure 5-1 Reservoir components



Figure 5-2 Temperature controller (front)



Figure 5-3 Temperature controller (rear)

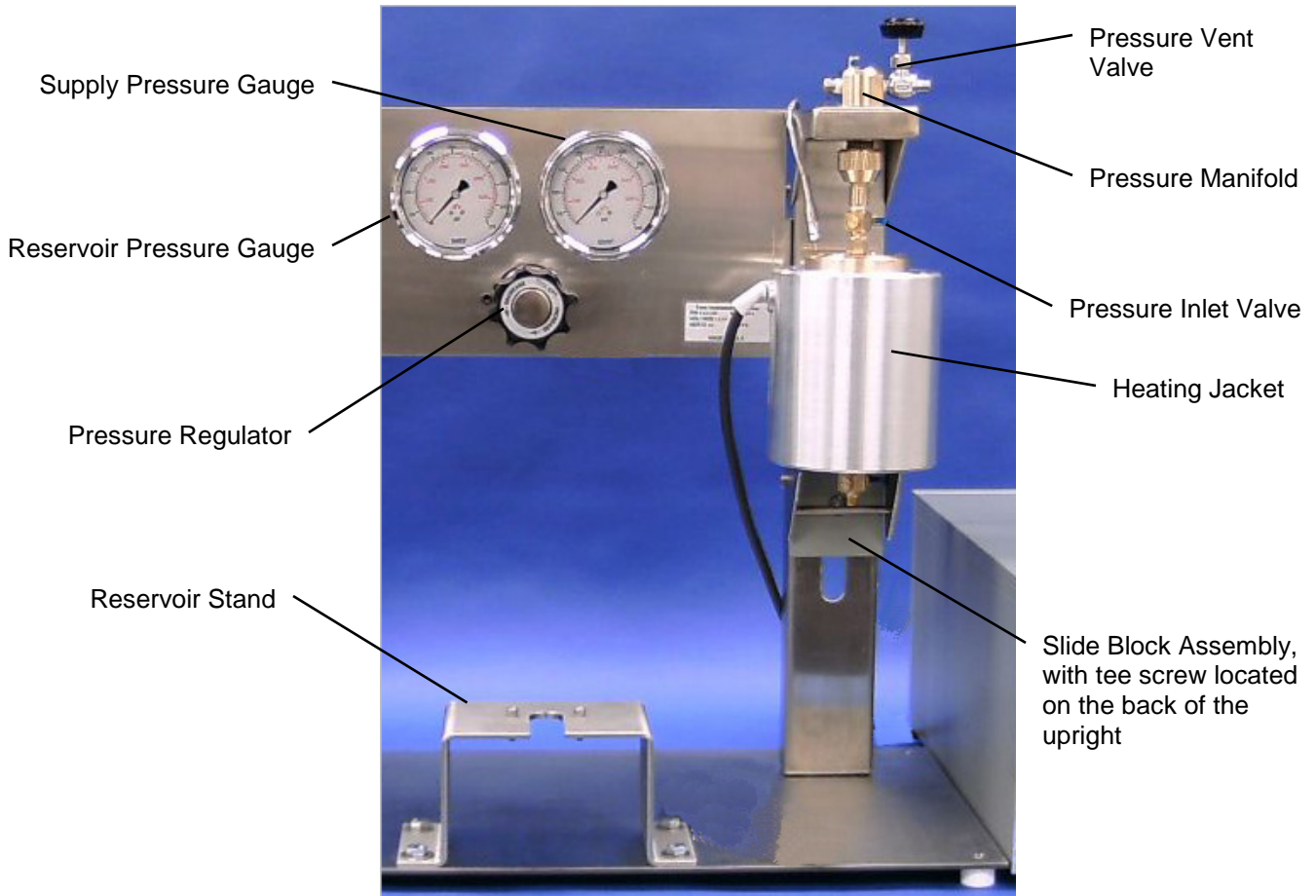


Figure 5-4 Major frame components

5.1 Prepare the Fluid Loss Reservoir

1. Inspect the O-rings to be used for damage, cement contamination and brittleness. Remove cement contaminants, and replace those which are damaged or brittle.
2. Insert an O-ring into the bottom (filter) end of the reservoir.



Figure 5-5 O-ring in reservoir bottom



NOTE

The bottom (filter) end of the reservoir does not have a small hole for the thermocouple.

3. Select the desired filter screen (325 or 600 mesh) and place the screened side against the O-ring in the reservoir.

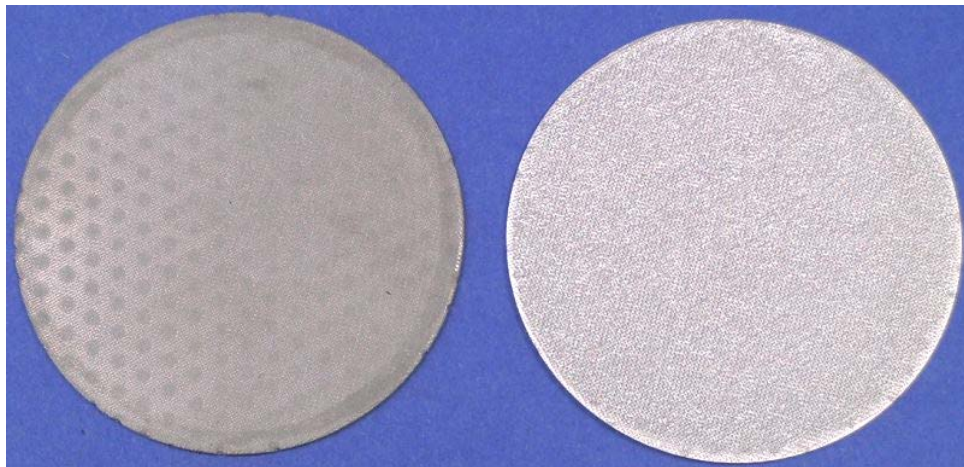


Figure 5-6 Filter Screen (325 on left, 600 on right)

- Place an O-ring against the perforated side of the filter screen.



Figure 5-7 Screen and O-ring in reservoir bottom

- Insert a grooved end cap into the reservoir and hand-tighten it.



A grooved cap must be used in the reservoir bottom (filter end).
A plain or grooved cap may be used in the reservoir top.

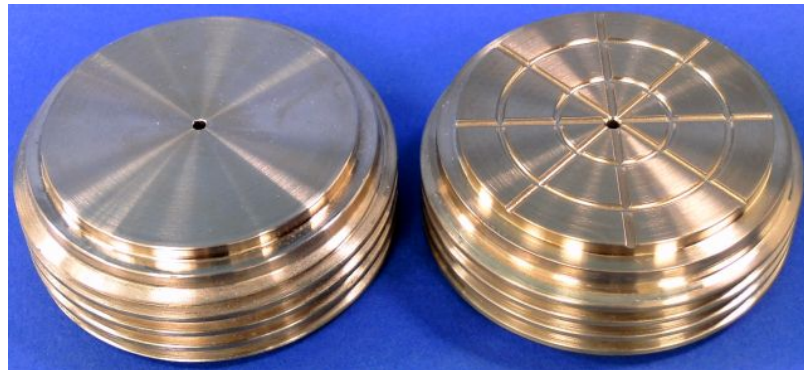


Figure 5-8 Plain cap (left) and grooved cap (right)



Figure 5-9 Install the bottom (grooved) reservoir cap

6. Place the reservoir on the reservoir stand, aligning the cap holes with the stand pins.

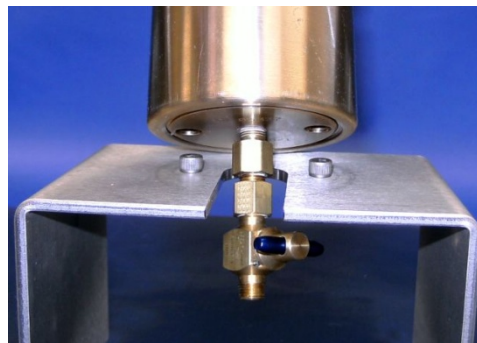


Figure 5-10 Align reservoir cap holes with pins in stand

7. Place the reservoir wrench on the reservoir flats and fully tighten the cap and reservoir.

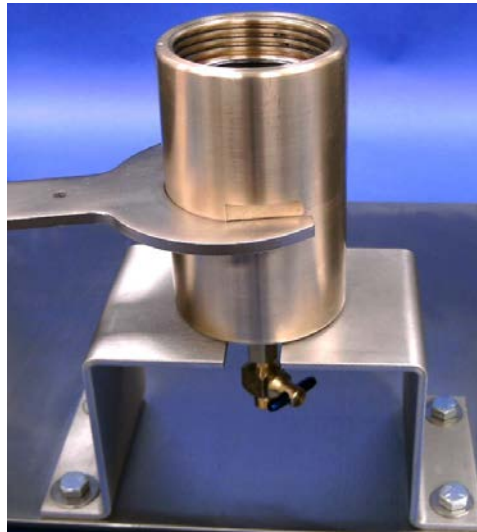


Figure 5-11 Tighten bottom cap with reservoir wrench

8. Use an adjustable wrench to check that the valve and adapters are tight in the bottom cap.

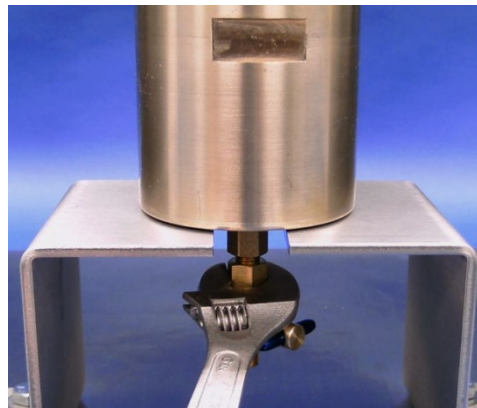


Figure 5-12 Tighten bottom valve with adjustable wrench

9. Insert an O-ring into the opposite (top) end of the reservoir.
10. Place the brass backup ring on top of the O-ring.
11. Place an O-ring against the brass backup ring.

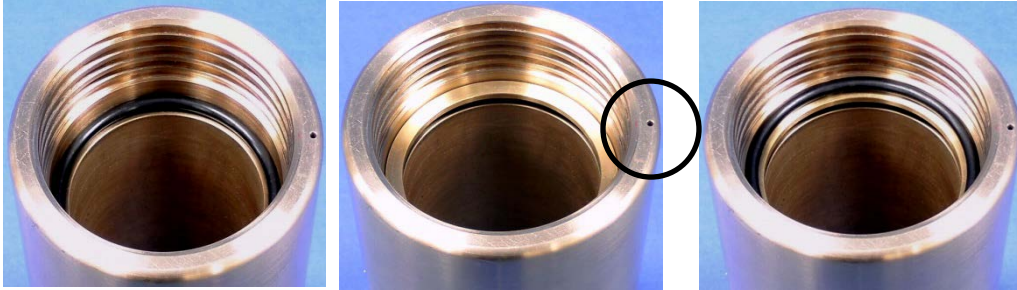


Figure 5-13 O-rings (2) and brass backup ring in reservoir top



NOTE

The upper end of the reservoir has a small hole for the thermocouple.

12. Insert a plain (non-grooved) or grooved cap into the open reservoir end and tighten it no more than two full turns.



Figure 5-14 Install top reservoir cap (non-grooved or grooved)

13. If not present, install and tighten a valve adapter, valve, coupling and hand nut into the top cap, using an adjustable wrench. Place the adjustable face spanner wrench in the cap holes to hold it while tightening the valve, valve adapter, and coupling.



Figure 5-15 Tighten top valve with adjustable wrench

5.2 Preheating the Heating Jacket and Reservoir

1. Close the valves in the top and bottom caps.

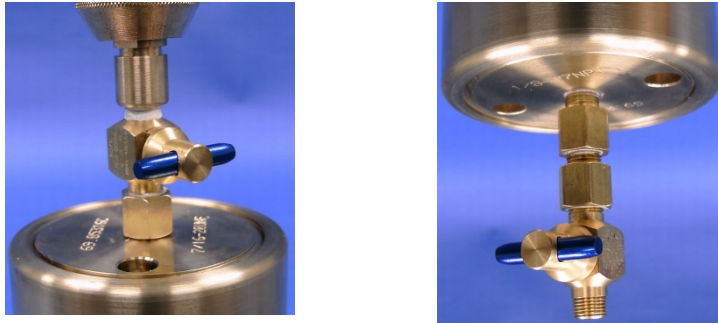


Figure 5-16 Top and bottom valves closed



WARNING

DO NOT HOLD THE SLURRY CYLINDER NEAR THE SIDE WRENCH SLOTS WHEN PLACING IT INTO THE HEATING JACKET. YOUR FINGERS MAY BE CUT.

2. Insert the empty fluid loss reservoir into the heating jacket with the non-filter end (the end with the coupling and hand nut) up.
3. Connect a 1/16 inch (1.59 mm) diameter Type J thermocouple to the thermocouple jack on the rear of the temperature controller. Insert the thermocouple into the hole in the upper end of the fluid loss reservoir.



Figure 5-17 Thermocouple plugs in at the rear of the temperature controller



Figure 5-18 Thermocouple partially inserted in reservoir



Figure 5-19 Reservoir in heating jacket for pre-heating



NOTE

The heating jacket and fluid loss reservoir do not have to be vertical for proper heating to occur.



CAUTION

NEVER operate the heating jacket without a thermocouple and reservoir. Doing so will result in the loss of temperature feedback and severe over-heating of the heating jacket, possibly to the point of melting. Keep the front panel heater control switch in the off position until ready to pre-heat the jacket or conduct a fluid loss test.

4. Turn on the main power switch, located on the rear of the temperature controller cabinet.




Figure 5-20 Main Power Switch (on position)



NOTE

The maximum temperature is 212°F (100°C). Any test run above that temperature will make the test readings inaccurate.



5. Adjust the temperature controller to the desired temperature.


5.2.5.1 From the home display, press  until you reach 'ProG LiSt'.

5.2.5.2 Press. 

5.2.5.3 Use the arrow keys to select the number of the program to be changed.

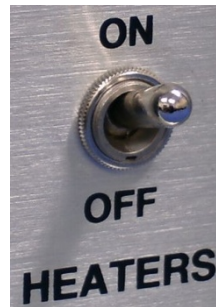
5.2.5.4 Press. 

5.2.5.5 For each program setting, use  or  to change the displayed value. After releasing the button, the display will blink to show the controller has accepted the new value.

5.2.5.6 Continue to press  until you have reviewed or changed the desired program values and return to the 'ProG LiSt' display.

5.2.5.7 Press the Run/Hold button.

6. Turn the heater control switch to the on position.



7. Observe the temperature controller for flashing of the OP1 indicator and the temperature increasing. The temperature controller will continually turn power on and off to the heating jacket until the thermocouple reaches the desired temperature.
8. Heating the empty fluid loss reservoir to the desired temperature will take approximately 20 to 30 minutes.
9. Prepare and precondition the slurry according to the test procedures.

5.3 Loading the Fluid Loss Reservoir



WARNING

THE FLUID LOSS RESERVOIR ASSEMBLY CONSTITUTES A PRESSURE VESSEL. THE SAFETY PRECAUTIONS LISTED IN SECTION 2.1 SHOULD BE FOLLOWED TO ASSURE SAFE OPERATION.



WARNING

THE RESERVOIR MATERIAL SHOULD BE COMPATIBLE WITH THE TEST SAMPLE.



WARNING

RESERVOIR CYLINDERS AND CAPS WHICH SHOW SIGNS OF CRACKING, SEVERE PITTING, OR HAVE DAMAGED THREADS MUST NOT BE USED.



WARNING

WEAR THERMALLY PROTECTIVE GLOVES WHEN REMOVING OR INSERTING THE HEATED FLUID LOSS RESERVOIR. THE RESERVOIR AND HEATING JACKET WILL BE HOT.

1. After the slurry has been preconditioned, and the fluid loss reservoir and heating jacket have reached the desired temperature, turn the heater control switch to the off position.
2. Remove the thermocouple from the reservoir assembly.
3. Remove the empty heated reservoir from the heating jacket. Place it on the reservoir stand with the top (loose) end cap up.
4. Fully remove the non-filtered (top) end cap.
5. Pour the prepared slurry into the cylinder, to 3/4 inch (1.9 cm) below the O-ring ledge.

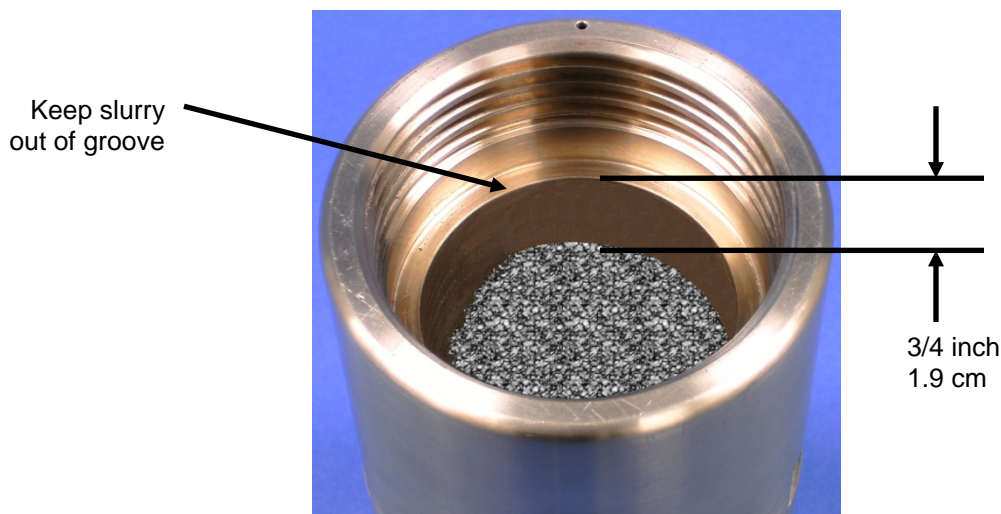


Figure 5-21 Amount of slurry

**CAUTION**

DO NOT take more than two minutes to transfer the slurry and begin the test!

6. Screw the top cap back and tighten it firmly with wrenches.



Figure 5-22 Tighten top cap with wrenches

**CAUTION**

DO NOT turn the cylinder over after the slurry has been poured into it! Hold it upright.

7. Insert the slurry cylinder into the heating jacket, and fully insert the thermocouple.
8. Turn the heater control switch to the on position.
9. Completely tighten the hand nut to the bottom of the valve head assembly. When fully tightened, the reservoir will lift out of the heating jacket by about 1/4 inch (0.6 cm).

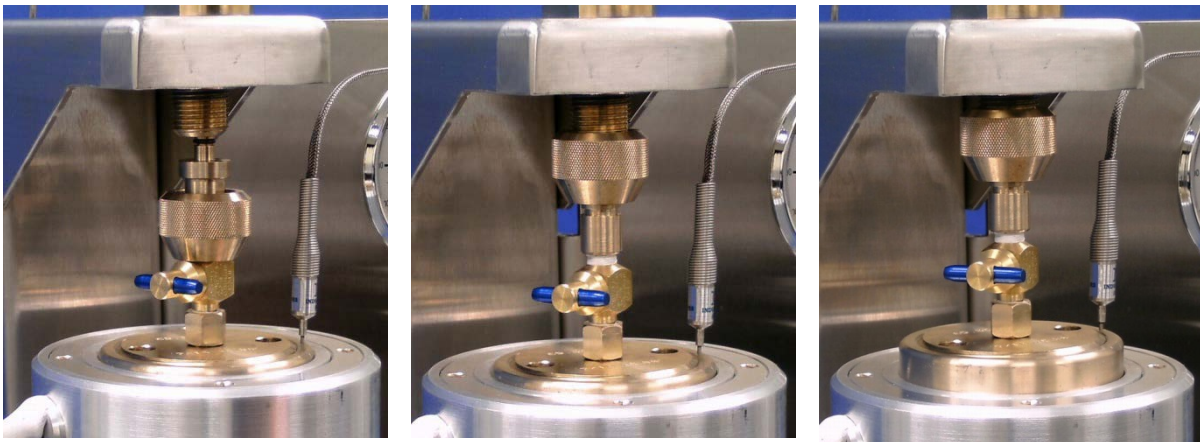


Figure 5-23 Hand nut tightened to valve head assembly

- Place the fluid loss measuring cylinder under the bottom valve.

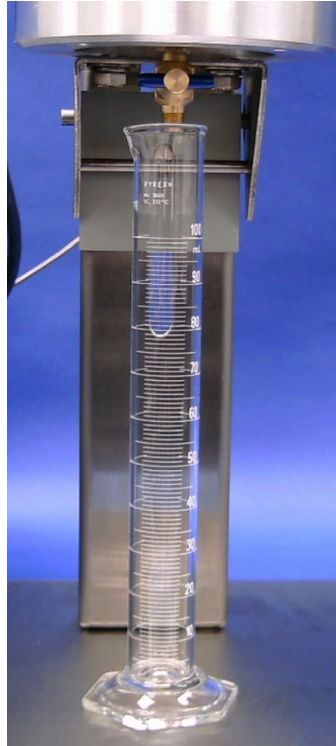


Figure 5-24 Graduated cylinder below bottom valve

- Open the top cylinder valve by turning the valve handle until it is in line with the inlet.

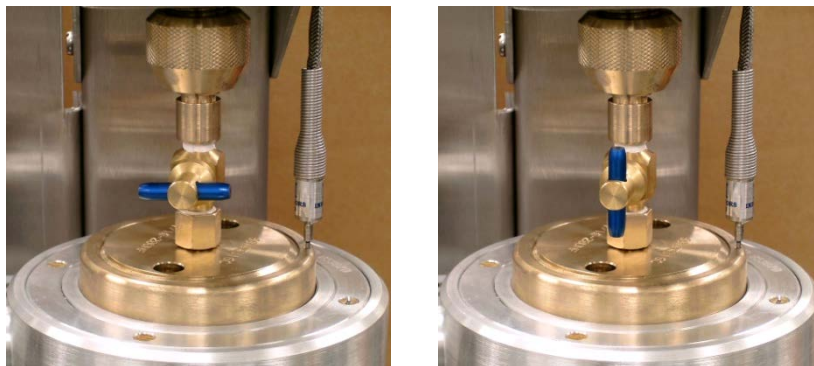


Figure 5-25 Top reservoir valve (closed on left, open on right)

5.4 Setting the Test Pressure

- Close the pressure vent valve and inlet valve on the pressure manifold. See Figure 5-4.
- Turn the pressure regulator knob fully counter-clockwise.
- Connect the pressure source (nitrogen, compressed air, or other safe gas) to the instrument's gas supply connection.

4. Slowly open the valve at the pressure source, and observe the gauge to indicate the pressure in the source.
5. Slowly rotate the pressure regulator knob clockwise to increase the pressure to be applied to the test sample. API RP10B recommends 1000 +/- 50 psig (6895 +/- 345 kPag) be maintained during the test.

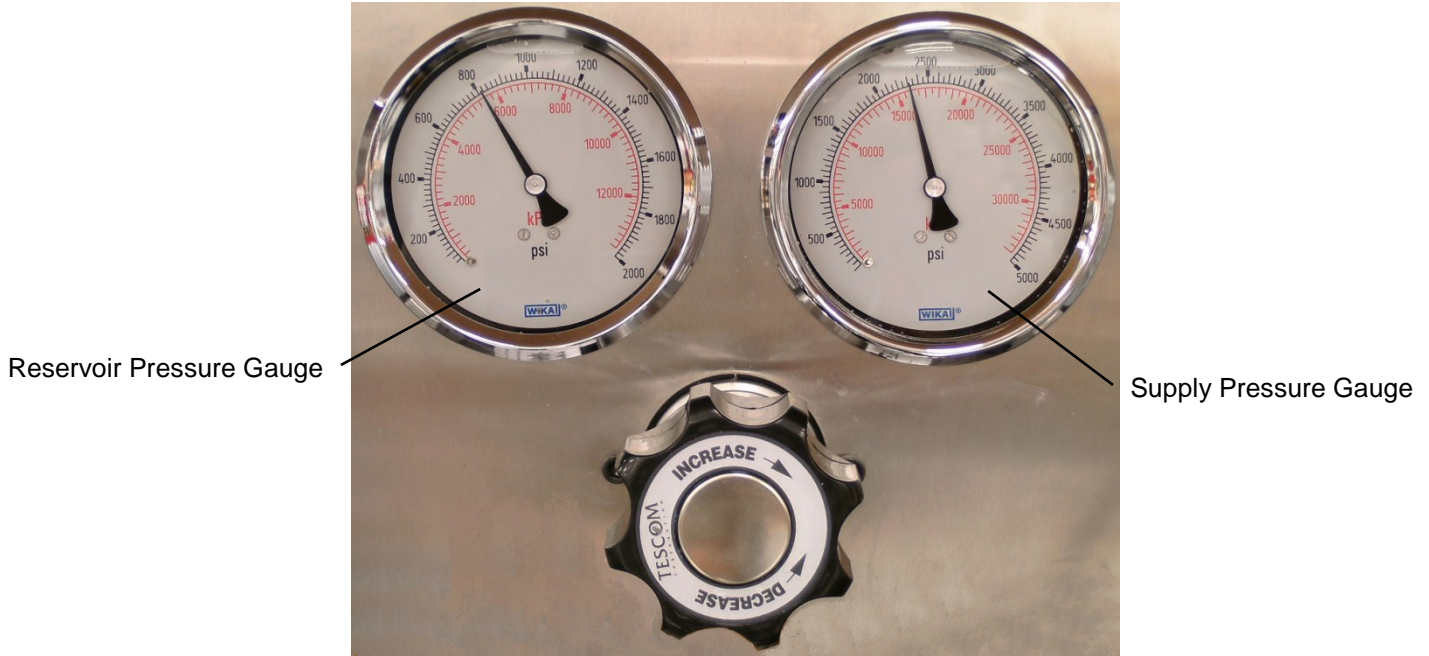


Figure 5-26 Pressure Gauges (reservoir on left, supply (tank) on right) and Regulator

6. Open the pressure inlet valve on the top of the pressure manifold. When open, the valve handle should be in line with the valve inlet and outlet.

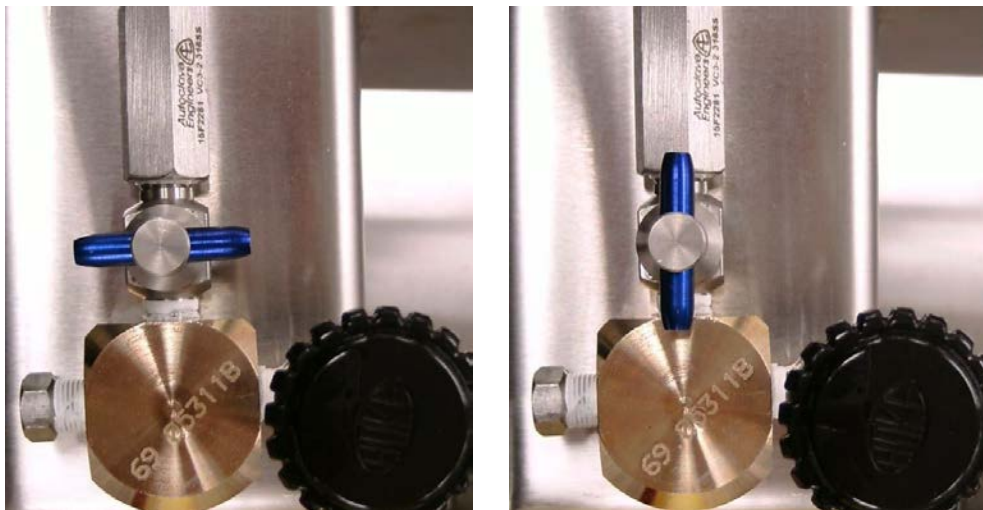


Figure 5-27 Pressure Manifold Inlet Valve (closed on left, open on right)

5.5 Start the Fluid Loss Test

1. When you are ready to pressurize the slurry, open the top reservoir inlet and bottom reservoir outlet valves by turning them 90 Degrees. When open, the valve handle should be in line with the valve inlet and outlet.

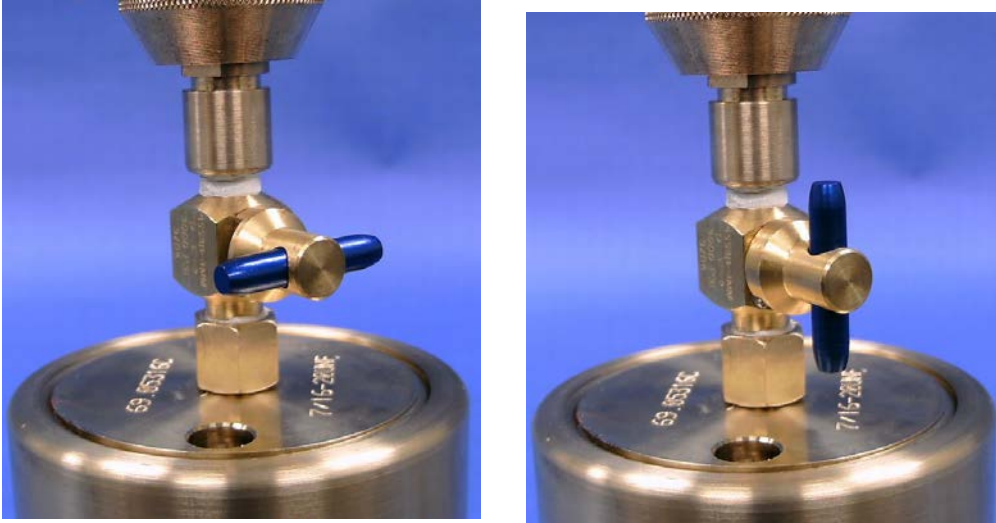


Figure 5-28 Top reservoir inlet valve (closed on left, open on right)

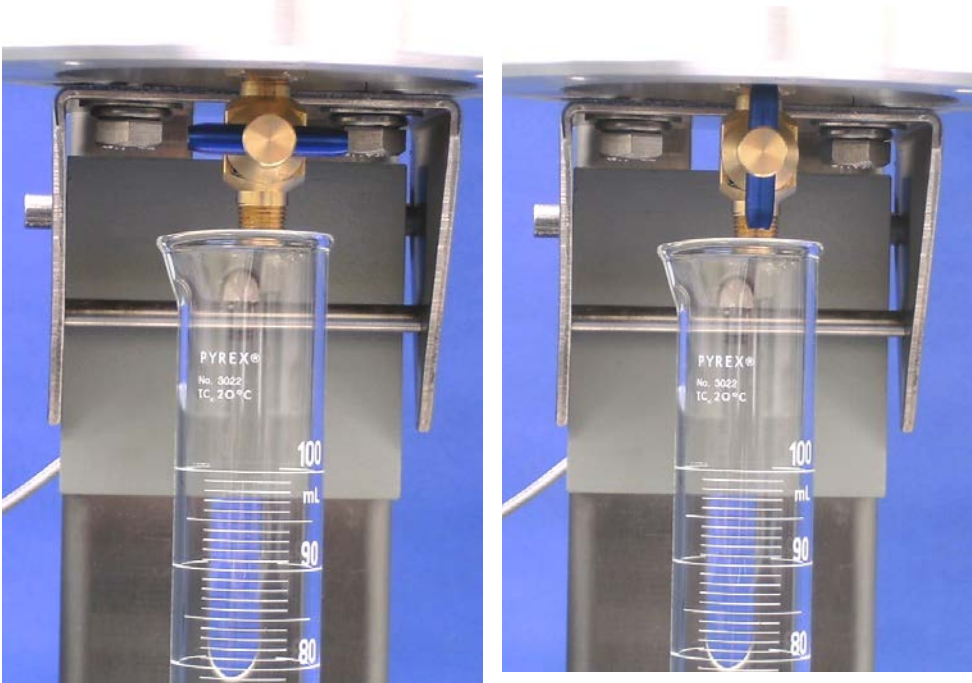


Figure 5-29 Bottom reservoir outlet valve (closed on left, open on right)

2. Start the timer or stopwatch by pressing the start button.
3. Record the filtrate collected in the graduated cylinder at the required time intervals according to the test requirements.

5.6 Test Conclusion and Disassembly

**WARNING**

WEAR A FACE SHIELD AND THERMALLY PROTECTIVE GLOVES WHEN CLOSING VALVES, RELEASING PRESSURE AND REMOVING THE HEATED FLUID LOSS RESERVOIR. THE RESERVOIR AND HEATING JACKET WILL BE HOT.

**WARNING**

KEEP ALL BODY PARTS AWAY FROM THE PRESSURE RELEASE VALVE OUTLET WHEN RELEASING PRESSURE.

1. If additional tests are not to be immediately started, turn the heater control switch to the off position.
2. Close the bottom (outlet) reservoir valve by turning it 90 Degrees. When closed, the valve handle should be perpendicular to the valve inlet and outlet.
3. Close the pressure manifold inlet valve by turning it 90 Degrees. When closed, the valve handle should be perpendicular to the valve inlet and outlet. This valve is located on the frame above the top of the fluid loss reservoir.
4. If additional tests are not to be immediately started, turn off the pressure source at the supply (tank, manifold, or wall).
5. If additional tests are not to be immediately started, release the pressure regulator by turning it fully counterclockwise.
6. SLOWLY open the pressure release needle valve by turning it counter-clockwise (CCW). This releases pressure in the fluid loss reservoir.
7. When all pressure has been released, loosen the hand nut and allow the heating jacket to tip outward to permit the reservoir to be removed.
8. The reservoir may be left in the heating jacket or it may be removed to another location, such as the reservoir stand, for air cooling.

**WARNING**

Be extremely careful if removing the hot reservoir from the heating jacket. It can cause severe burns if accidentally touched.

**WARNING**

The practice of removing the fluid loss reservoir and cooling it in water is not recommended because of the danger of severe burns if touched or accidentally dropped.

**CAUTION**

DO NOT turn the reservoir over. It is full of slurry. Hold it upright.

9. After the reservoir is cool, open the valves in the top and bottom caps.
10. Disassemble the reservoir in the reverse order of assembly.
11. Clean all parts with water.
12. Force water through the valves in both caps.
13. Clean and inspect all parts for damage.

5.6.13.1 Hold the screen up to a light. Shadowed areas indicate plugging and need to be cleaned.

5.6.13.2 Screens with scratches or holes must be replaced.

5.6.13.3 O-rings which are cut or deformed must be replaced. Do not store o-rings between tests with grease applied to them. Stop cock grease should only be applied to the o-rings immediately before use.

5.7 Reservoir Storage

1. The slurry reservoir may be stored either assembled or disassembled.



CAUTION

Do not store the slurry reservoir in the heating jacket. The two dissimilar metals will cause a reaction and may bond together.

Table 5-1 Standard API Well Simulation Cement Test Outline

TEMPERATURE	194°F (90°C)
PRESSURE	100 psi (689 kPa) during heating, 1100 psi (7585 kPa) +/- 10 psi (69 kPa) with 100 psi (689 kPa) back pressure
SAMPLE PREPARATION	Mix cement per API RP10B, Section 5 Process sample in Consistometer See API RP10B, Section 10 Static Fluid Loss Test for filtrate times
EXPANSION ALLOWANCE	3/4" (19.05 mm)
SAMPLE VOLUME	175 cc cell - 130 cc
FILTER	No. 325 (45 micrometer) U S Sieve with 60 mesh backing screen, stainless steel
TIME	Sample Heating - 15 minutes from time pressure is applied Duration of test - 30 minutes Take filtrate volume readings 1/4, 1/2, 1, 2, and 5 minutes after test starts, then every 5 minutes. (Back pressure not being used)
FILTRATE COLLECTOR	100 ml graduated cylinder

6 Analyzing Results

6.1 References:

- Recommended Practice for Testing Well Cements (API RP 10B-2/ISO 10426-2)

6.2 Testing Results

Test results will vary.

Fluid loss tests which do not run a full 30 minutes have an increased potential error as the length of the test becomes shorter. Fluid loss tests which run the full 30 minutes typically show 5 percent variability. Tests which run less than 5 minutes may have a variability of more than 30 percent.

A fluid-loss test performed in a single laboratory, on a cement slurry with a fluid-loss control additive and water, and having an average fluid-loss value of approximately 350 cm³/30 min, typically has a standard deviation of approximately 84 cm³/30 min and 2V_c (variability coefficient) of approximately 47%.

6.3 Minimize Variations

Variations in the procedures, the involvement of numerous people and laboratories, and the presence of multiple additives in the slurry can considerably increase test result variations. When one person performs the test on one instrument (or the fluid-loss value is low), the variation usually decreases.

To help keep testing variations to a minimum, do the following:

- Keep the testing equipment in good condition, clean, and accurately calibrated.
- Perform the tests according to the prescribed procedures.
- Keep the test conditions within the acceptable limits (API or customer-specified).
- Minimize oil contamination in slurries that have been preconditioned in an HPHT Consistometer.

6.4 Filtrate Volume

The volume of liquid filtrate collected is measured in milliliters (mL), to the nearest 1.0 mL. The volume is recorded at 30 seconds, and 1, 2, 5, 7.5, 10, 15, 25, and 30 minutes after the test begins.

Alternatively, the filtrate may be continuously weighed and recorded. When weighed, the filtrate specific gravity must be measured and reported at 80°F (26.7°C), and the recorded filtrate volumes corrected for specific gravity.

When a condenser is used, the filtrate volume in the condenser should be accounted for.

If nitrogen blows through in less than 30 minutes, record the filtrate volume collected and time at which the blow-through occurs. Calculate the API Fluid Loss by the formula:

$$\text{Calculated API Fluid Loss} = 2 Q_t \frac{5.477}{\sqrt{t}}$$

Q_t is the volume (mL) of filtrate collected at the time t (min) of the blowout.

6.5 Reporting

When reporting the fluid loss of cement slurries, those for which the fluid loss was measured for a full 30 minutes will be reported as “API Fluid Loss.” Those for which the fluid “blew out” in less than 30 minutes will be reported as “Calculated API Fluid Loss.”

7 Troubleshooting and Maintenance

Standard laboratory procedures apply to the cleaning of the Fluid Loss Test Instrument. After each test, the caps, reservoir body and valves should be thoroughly cleaned and dried of all sample and other contaminants, with particular attention to o-rings and o-ring grooves.

Wash and dry the filter screens.

Wipe spilled sample and other debris from the heating jacket and stand. Some sample materials may damage the finish of these parts if allowed to remain on them for a long period of time.

7.1 Fluid loss reservoir maintenance

O-rings

Inspect all o-rings as they are being cleaned for cuts or nicks and for distortion. Check for hardening or brittleness. Replace any damaged o-rings. It is permitted to lubricate the o-rings immediately before they are installed with laboratory stop cock grease. Since the o-rings may come into contact with the sample, care should be taken that the lubricant is compatible with the sample.

Valves

When properly tightened, the tapered pipe threads make a metal to metal, pressure tight, seal between the valve and the cap. Leaks can occur if the threads of either the valve or cap are damaged.

Valves should be inspected for possible plugging of the passages by dried sample. A small drill or wire can be used to insure the main passage bore is clear.

Corrosion

Slurry samples under the temperature and pressure conditions used in this type testing can cause corrosion of the reservoir and caps. Visually inspect the inside of the reservoir for evidence of corrosion should be made periodically. Light corrosion may be removed using 320 or finer wet or dry sand paper. Deeper corrosion pitting may be removed by sand blasting the area of the corrosion. More severe corrosion will require re-machining or re-surfacing the inside of the reservoir. If machining to 0.020" (0.5 mm) oversize does not remove all corrosion, it is recommended the reservoir be replaced. If corrosion cracks are evident, the reservoir should be replaced.



CAUTION

Corrosion, pitting, and cracking can cause rupture of cells.

7.2 Pressurize regulator, manifold and valves

Safety Considerations of Pressure Systems

The safe operation of pressurized equipment requires the pressurizing system be properly maintained. Specific procedures for the safe use of pressure regulators are listed below.

1. Never subject a regulator to inlet pressure greater than its rated inlet pressure, as shown on the regulator body.
2. Never use the regulator for gases other than those for which it is intended.

3. All connections to the regulator must be clean. Remove oil, grease, or other contaminants from external surfaces of the regulator and metal connecting parts.
4. Before attaching high pressure tubing to the pressure source (tank, manifold, or wall-mounted valve), remove any dirt or foreign matter that may be in the mating surfaces by wiping them with a clean, lint free, cloth.



The valve on the pressure source may be opened momentarily to blow the outlet clean. Make sure no one is near the opening before it is opened.

5. Never pressurize a regulator that has loose or damaged parts or is in questionable condition. Never loosen or attempt to tighten a connection or a part until the gas pressure has been relieved. Under pressure, gas can dangerously propel a loose part.
6. Check regulator and all connections for leaks after installation, periodically thereafter, and after any service in which parts or connections were disconnected and reconnected, using a soap solution around fittings to find small leaks. Bubbles will indicate a leak.

7.3 **Pressurization system troubleshooting**

The primary causes of pressurization system problems are caused by leaking fittings, dirt in the regulators, or faulty seats in the regulator. Rarely does a diaphragm rupture. If a regulator will not hold pressure:

1. Check for leakage around fittings.

Pressure the system and look for escaping gas in the form of bubbles. This can be done by applying soap suds to the possible leak areas. Repair fitting leaks by disassembling, cleaning the threads, and then applying a good thread sealant or Teflon® tape thread sealant before re-installing fitting.

2. Check for a faulty regulator.

A faulty seat is often evidenced by leakage through the regulator to the down stream side as opposed to external leakage. Check for bubbles coming out of the regulator when the regulator knob is turned fully counterclockwise.

7.4 **Faulty pressure regulator**

One or more of the following conditions will be evidenced when a Regulator is faulty

1. Gas leaking at the regulator outlet when the adjusting knob is turned completely counterclockwise and all pressure is released.
2. With no flow through the system (downstream valves closed and pressure showing on the reservoir gauge), the reservoir gauge pressure is steadily increasing.
3. Gas leakage from the regulator case at any point.
4. Excessive drop in the reservoir pressure with the regulator flow open.

7.5 **Pressure regulator repair**

If it is determined a regulator is faulty, it must be removed from service and professionally repaired or replaced.

7.6 Temperature controller troubleshooting

The electronic temperature controller senses the temperature through a Type J thermocouple placed in the wall of the reservoir. It controls the temperature by rapidly turning on and off the power applied to the heating jacket heaters. The relationship between the "ON" time and the "OFF" time per cycle determines the temperature. A manual switch is located on the front panel to enable and disable the heating jacket independent of the temperature controller. The main power switch is located on the rear of the temperature controller. Malfunctioning of any of these sub-systems or components can cause improper heating of the slurry sample. Refer to Table 7-1 for assistance in troubleshooting problems with the temperature controller.

Table 7-1 Temperature controller problems

Problem or Symptom	Possible Cause	Corrective Action
The controller does not power up.	The power source is disconnected or turned off.	Check the power source.
	The main power switch has malfunctioned or failed.	Check or replace the main power switch.
	The power wiring is faulty.	Check/repair the power wiring. Refer to the wiring diagram.
The system does not heat up, but the heater indicator in the temperature controller is on.	The heater control switch is turned off.	Turn the heater control switch on.
	The heating jacket is not plugged into the temperature controller.	Plug the heating jacket into the temperature controller.
	The heater fuse has blown	Check/replace if necessary. See Figure 7-1.
	Solid state heater relay has failed.	Check/replace, if necessary. See Figure 7-1.
	The heating jacket wiring is faulty.	Check/repair the heating jacket wiring.
The system does not heat up, and the heater indicator in the temperature controller is off.	The heater fuse has blown.	Check/replace the heater fuse. See Figure 7-1.
	The heater control electronics malfunctioned or failed.	Check the heater solid-state relay, and the heater circuit wiring. Refer to the wiring diagram.
The temperature reading is unreasonably high (over 500°F).	Possible open circuit in thermocouple or thermocouple cables.	Look for and repair the broken wire or loose connection at the thermocouple connector.
The temperature reading is about room temperature, and the heating jacket is hot.	Possible short circuit in thermocouple or thermocouple cable.	Look for and repair the short in the thermocouple connector.

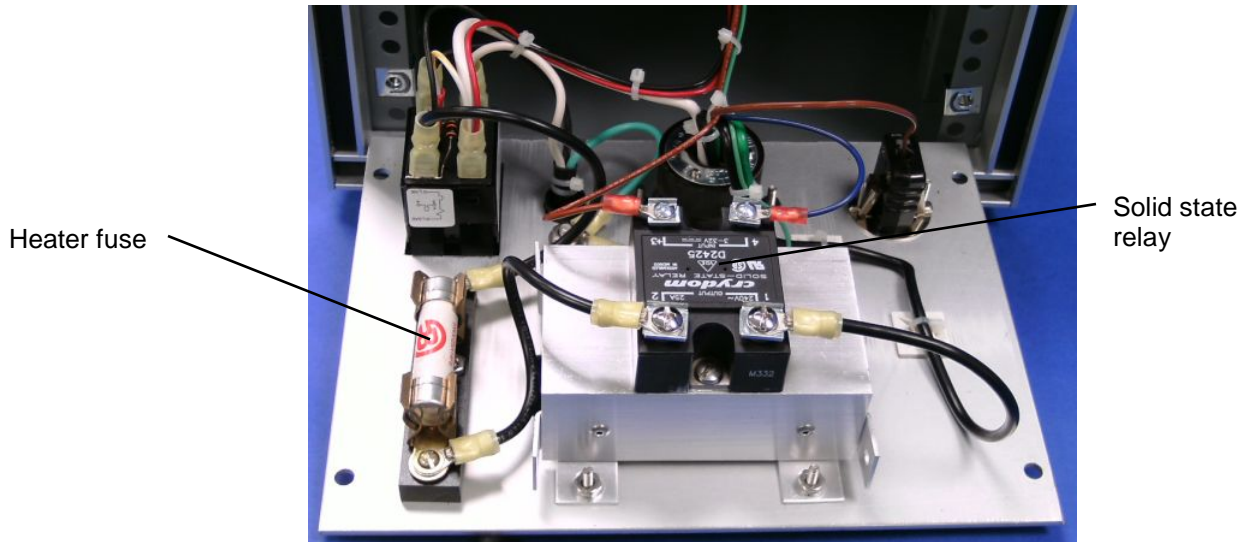


Figure 7-1 Temperature controller (inside rear panel)

7.7 Heating jacket assembly

The aluminum heating jacket contains four heater elements for both 110 and 220V operation. The heater elements may be tested for proper operation by measuring across the heating jacket plug terminals with an ohmmeter. See Table 7-2 below.



WARNING Always disconnect the power cable and allow the heating jacket to cool before attempting any repair.

Table 7-2 Heater element measurements

Model	Ohmmeter Measurement	Fault
110V	9 Ohms +/- 1 Ohm	None, all elements are good
	18 Ohms +/- 1 Ohm	One element bad, any combination
	27 Ohms +/- 1 Ohm	Two elements bad, any combination
	36 Ohms +/- 1 Ohm	Three element bads, any combination
	Infinity (open)	Four elements bad, any combination
220V	36 Ohms +/- 1 Ohm	None, all elements are good
	72 Ohms +/- 1 Ohm	1 or 2 heater elements on a single leg are bad
	Infinity (open)	1 or 2 heater elements on the first leg are bad, and 1 or 2 heater elements on the second leg are bad.

7.8 Remove the heating jacket from the frame

1. Unplug the heating jacket from the temperature controller.
2. Use a wrench to loosen the two 3/8-24 hex head cap screws holding the heating jacket to the slide block assembly. These are located on the bottom side of the heating jacket.
3. Fully remove the two 3/8-24 hex head cap screws to completely release the heating jacket.

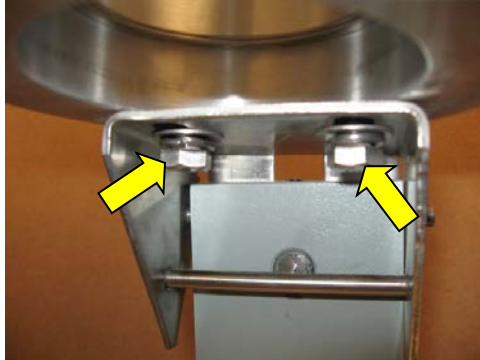


Figure 7-2 Heating jacket bolts

7.9 Replace the heating elements

1. Remove four flat head screws and pry off the ring to gain access to the four heater elements.

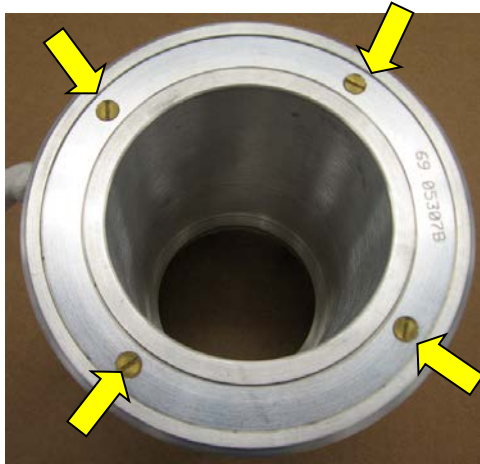


Figure 7-3 Heating element cover screws



Figure 7-4 Heating elements and wiring exposed

2. Before disconnecting any wires, determine if the heating jacket is wired for 110 or 220 Volts. See Figure 7-5 below.

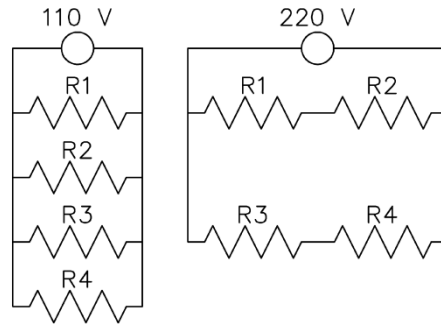


Figure 7-5 Heating elements wiring diagrams

3. Disconnect and test each heating element with an ohmmeter for an open or short circuit. The measured resistance of functioning heating elements is 36 +/- 1 Ohms.
4. It may be possible to drive out the defective heating element with a slim punch inserted through four bottom holes.

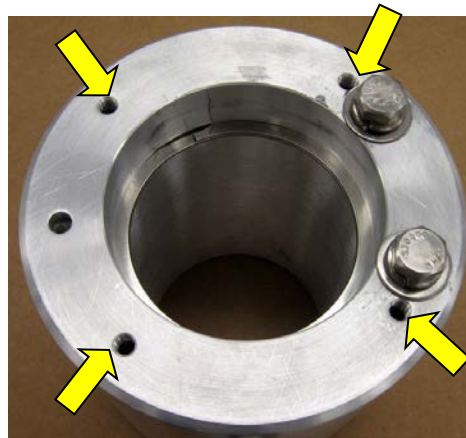


Figure 7-6 Holes to drive out heating elements

5. If driving them out fails, it may be necessary to drill them out from the top. Use a drill no larger than 5/16 (0.312) inch, or 7.9 mm.
6. After the defective elements have been replaced, reconnect them according to the correct wiring diagram in Figure 7-5.
7. Re-assemble the heating jacket, being careful not to damage the wire insulation when replacing the heating element cover. Do not over tighten the retaining screws. See Figure 7-3.

7.10 Re-mount the heating jacket on the frame

1. Attach the heating jacket to the pivot slide block assembly. Use two 3/8-24 hex head cap screws inserted through the slide block and into the heating jacket bottom. See Figure 7-2.



NOTE

The heating jacket power cord should be on the left side.

2. Place an empty, unheated, slurry reservoir and top cap with valve, into the heating jacket.
3. Loosen the slide block assembly tee screw (located on the back side of the frame).
4. Adjust the slide block, heating jacket, and slurry reservoir to where the hand nut just clears the bottom of the valve head assembly.



Figure 7-7 Correct height of heating jacket

5. Tighten the slide block tee screw firmly to hold the assembly in place.
6. Tighten the heating jacket screws to hold the assembly in place.

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8 Accessories

The accessories listed in Table 8-1 consist of various items that are not furnished with the fluid loss test instrument, but which may be needed to perform some tests with it.

Table 8-1 Accessories

PART NO.	DESCRIPTION
206897	Stopwatch, analog
206898	Stopwatch, digital, electronic

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9 Parts List

9.1 BASIC UNIT, FLUID LOSS CELL ASSY - DUAL CELL - 115VAC/240VAC

Table 9-1 101776010 BASIC UNIT, FLUID LOSS CELL ASSY - DUAL SHORT CELL - 115VAC/240VAC

Item No.	Part No.	Quantity	Description
0001	210197	1	MAINFRAME ASSY - DUAL FLUID LOSS
0007	100030677	1	WRENCH, SPANNER, FACE, ADJUSTABLE, 3.0 MAX SPAN BETWEEN CENTERS, 1/4 DIAPINS, 8.25 LG
0008	100020419	1	WRENCH, RESERVOIR
0009	101733741	2	Thermocouple, type J, .062 dia x 3.88 LG, 36 in leads
0016	101443606	1	INSTRUCTION MANUAL, FLUID LOSS INSTRUMENT, DUAL CELL, ON CD
0070	100033342	1	SCREEN, FLUID LOSS, FILTER PRESS, 600 MESH
0071	101776831	2	CELL ASSEMBLY, FLUID LOSS, SHORT CELL
0080	205872	2	Graduated Cylinder, 100 ml capacity, TC, 1.0 ml marking, Class B
0090	208654	1	Wrench, Adjustable, 6 inch, chrome plated

9.2 FLUID LOSS CELL ASSY - DUAL CELL - 115V & 230/240V

Table 9-2 210195 FLUID LOSS CELL ASSY - DUAL SHORT CELL - 115V (Figure 9-1)

Item No.	Part No.	Quantity	Description
0002	100020402	2	JACKET ASSEMBLY, HEATING, OPEN, 3.26ID X 6.0, 120V
0012	100028324	4	SCREW, HEX CAP, 3/8-24 NF X 3/4, PL
0013	206206	4	WASHER FLAT 3/8 STAINLESS STEEL
0014	206207	4	WASHER SPLIT 3/8 STAINLESS STEEL
0015	100072579	2	TEMPERATURE CONTROLLER ASSEMBLY, PROGRAMMABLE, WITH SCR, 115VAC, 50/60HZ
0020	101776010	1	BASIC UNIT, FLUID LOSS CELL ASSY - DUAL - SHORT CELL - 1115VAC/240VAC

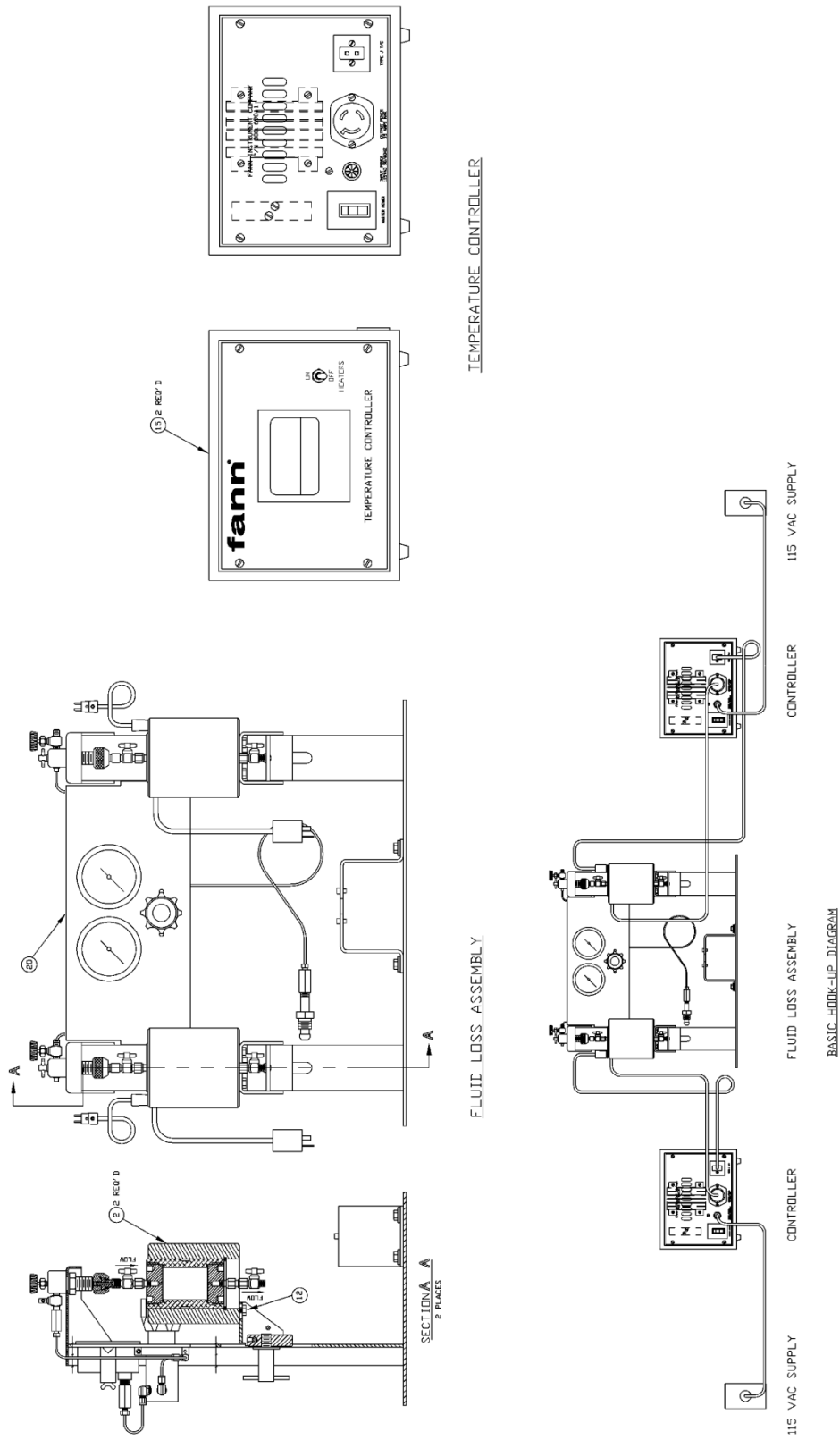


Figure 9-1 Dual Cell Fluid Loss Instrument, 115V

Table 9-3 210199 FLUID LOSS CELL ASSY - DUAL SHORT CELL - 240V (Figure 9-2)

Item No.	Part No.	Quantity	Description
0002	100020424	2	JACKET ASSEMBLY, HEATING, 240V
0012	100028324	4	SCREW, HEX CAP, 3/8-24 NF X 3/4, PL
0013	206206	4	WASHER FLAT 3/8 STAINLESS STEEL
0014	206207	4	WASHER SPLIT 3/8 STAINLESS STEEL
0015	100072579	2	TEMPERATURE CONTROLLER ASSEMBLY, PROGRAMMABLE, WITH SCR, 230VAC, 50/60HZ
0020	101776010	1	BASIC UNIT, FLUID LOSS CELL ASSY - DUAL - SHORT CELL - 1115VAC/240VAC

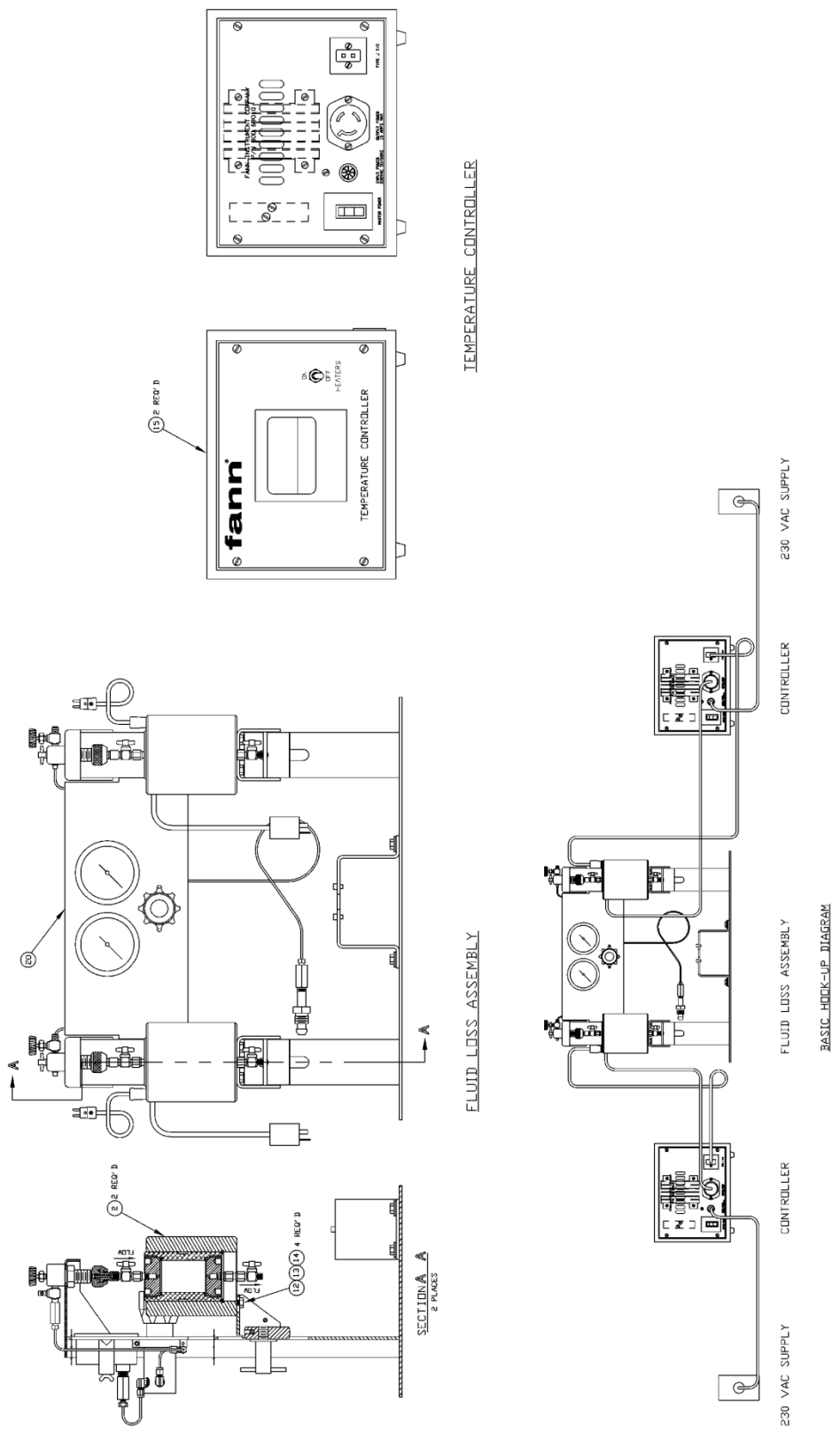


Figure 9-2 Dual Cell Fluid Loss Instrument, 230V

9.3 Fluid Loss Test Instrument, Manifold Assembly

Table 9-4 100020406 MANIFOLD ASSEMBLY, HIGH PRESSURE, FILTER PRESS
(See Figure 9-3)

Item No.	Part No.	Quantity	Description
0001	100026516	1	NUT, HEX, 7/8-14 UNF
0002	100029879	1	WASHER, FLAT, 7/8 NOM, STEEL, 0.93 IDX 2.25 OD X 0.165 THK
0003	100020408	1	TEE, 1/8 NPT, HIGH PRESSURE MANIFOLD, FILTER PRESS
0004	100032963	1	VALVE, PLUG, OFF, 9559T, 1MM, 303 STAINLESS STEEL
0005	100016570	1	PLUG, PIPE, 1/8, STAINLESS STEEL, HEX SOC HEAD
0009	100032964	1	VALVE, NEEDLE, 1/8 NPTM CONNECTOR, BRASS BODY

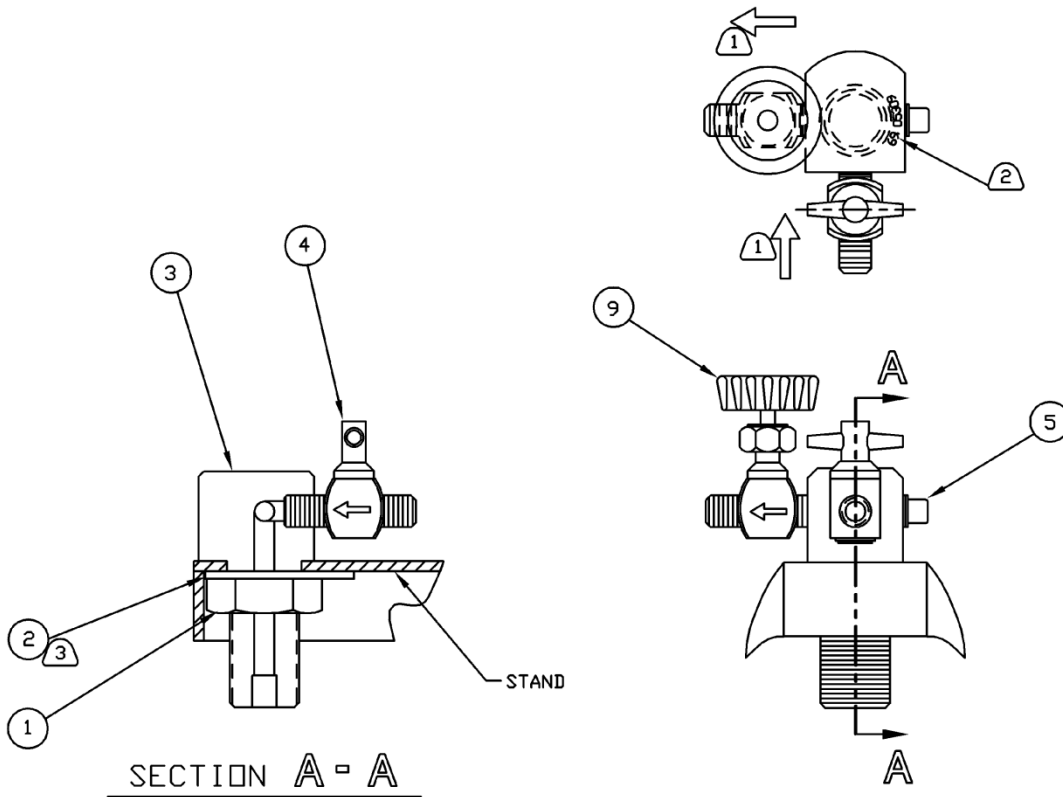


Figure 9-3 Manifold Assembly

9.4 MAINFRAME ASSEMBLY – DUAL FLUID LOSS

Table 9-5 210197 MAINFRAME ASSY - DUAL FLUID LOSS (See Figure 9-4)

Item No.	Part No.	Quantity	Description
0001	100020407	2	BOLT, T-HANDLE, STATIC FLUID LOSS
0002	100029878	2	WASHER, FLAT, 5/8 NOM, STEEL, 0.69 IDX 1.75 OD X 0.134 THK
0003	205372	2	ROD STEEL CF 1018 .313 X 3.75
0004	100028807	2	SCREW, SET, 1/4-20 NC X 3/8, CUP PORT, HEX SOCKET, PL
0007	100020399	2	BLOCK, SLIDE, FLUID LOSS TESTER
0008	210196	1	STAND - HP MANIFOLD - DUAL SHORT CELL FILTER PRESS
0009	100020400	2	BRACKET, HP MANIFOLD CORE FILTER PRESS
0010	100032968	2	COUPLING, 1/8 NPT FEMALE, 1/8ERMETO W12
0011	100026081	1	TEE, UNION, 1/8 TUBING X 1/8 TUBING X 1/8 TUBING, BRASS
0012	100029698	15	TUBING, STAINLESS STEEL, 1/8 OD X 1/16 ID
0013	100032365	1	GAUGE, PRESSURE, DUAL SCALE, 4 INCH, 0-2000 PSI/0-13800 KPA, 1.5%, SC BOURDON TUBE/316 STAINLESS STEEL, 1/4 NPT LBM, U-CLAMP, CAST BRASS CASE, GLYCERIN FILLED TOP CASE RELIEF
0014	100032362	1	GAUGE, PRESSURE, DUAL SCALE, 4 INCH, 0-5000 PSI/0-34, 500 KPA, 1.5%, SC BOURDON TUBE/COPPER ALLOY, 1/4 NPT, LBM, U-CLAMP, CAST BRASS CASE, GLYCERIN FILLED SAFETY BLOW OUT DISC
0015	100032967	3	COUPLING, 1/4 NPTF, 1/8 ERMETO W125, 6F4281, AUTOCLAVE
0016	100032969	1	NIPPLE, INLET, 1/4 NPT-15-4
0017	100032970	1	NUT, INLET, ARGON NITROGEN, CGA-584
0018	100032366	1	REGULATOR, PRESSURE, 0-2500 PSI OULET, SELF RELIEVING, STAINLESS STEEL, 1/4 NPT PORTS, PANEL MOUNTING
0019	100032370	4	FITTING, TUBE, B-200-2-4, ELBOW, 90 DEG, BRASS, 1/8 TUBE X 1/4MALE PIPE THREAD
0020	100020401	1	BASE, PLATE, FILTER PRESS
0021	100007781	2	SCREW, HEX SOCKET, 1/4-20 NC X 3/8
0022	100028451	4	SCREW, HEX CAP, 3/8-16 NC X 1/2, PL

Item No.	Part No.	Quantity	Description
0023	100029874	8	WASHER, FLAT, 3/8 NOM, STEEL, 0.44 ID X 1.0 OD X 0.104 THK
0027	100020406	2	MANIFOLD ASSEMBLY, HIGH PRESSURE, CORE FILTER PRESS
0028	100123899	2	SCREW, CAP, SOCKET HEAD, 1/4-20 NC X 3/4, STAINLESS STEEL

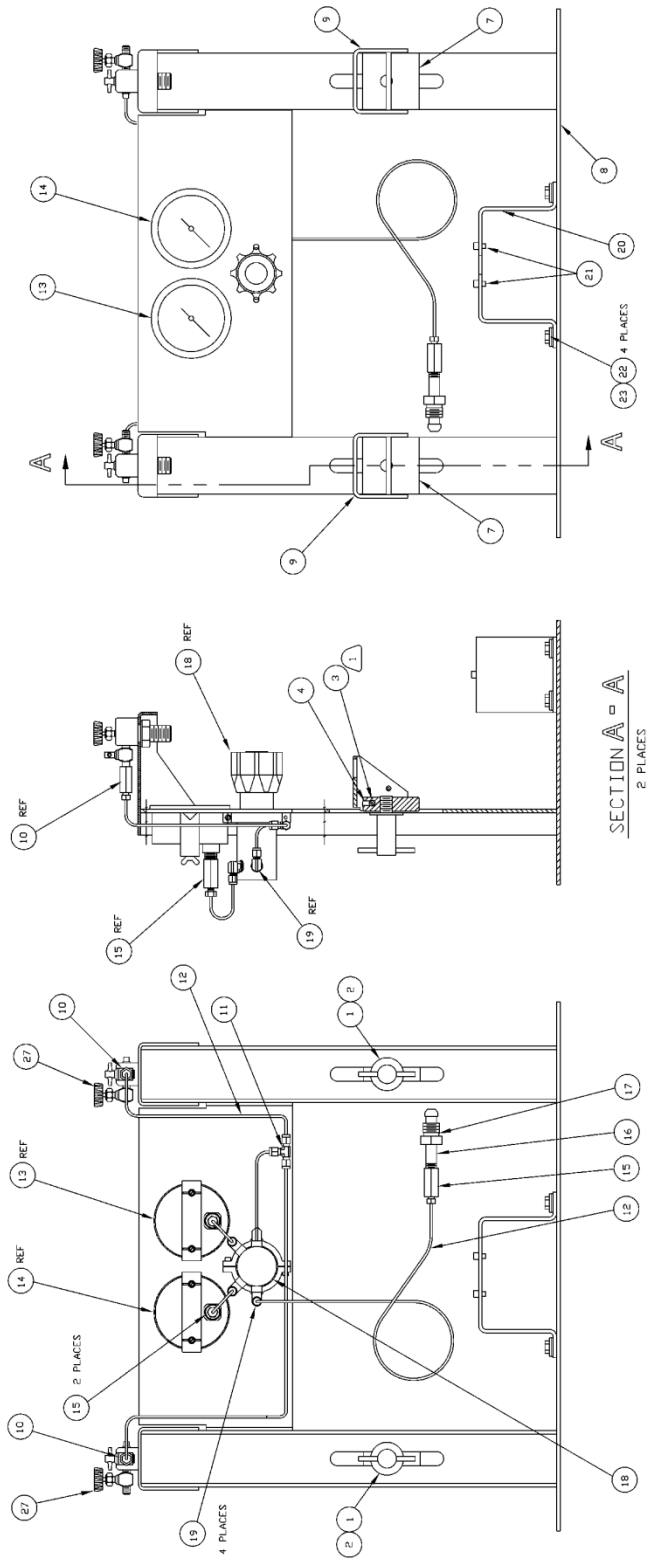


Figure 9-4 Frame Assembly

9.5 **Temperature Controller, 115V & 230/240V**

Table 9-6 100072579 TEMPERATURE CONTROLLER ASSEMBLY, PROGRAMMABLE, WITH SCR, 115VAC, 50/60HZ (See Figure 9-5 & Figure 9-6)

Item No.	Part No.	Quantity	Description
0001	100072581	1	PANEL, FRONT, TEMPERATURE CONTROLLER ASSEMBLY, WITH SCR
0003	100072580	1	PANEL, BACK, TEMPERATURE CONTROLLER ASSEMBLY, WITH SCREW, 115VAC
0004	100072391	1	PANEL, SINGLE CIRCUIT, THERMOCOUPLE, JX CALIBRATION
0005	203403	8	10-32 X 3/4 BHMS STAINLESS
0006	100032781	8	NUT, CLIP, NO.10-32, MULTIPLE THREAD, 0.375 CENTER TO EDGE MAX
0007	100029446	1	SWITCH, TOGGLE, DPST, 0.468 DIA BUSHING, WITH SCREW LUGS, 3 AMP AT 250 VAC
0008	207949	8	6-32 X 5/8 BHMS STAINLESS
0009	207632	9	NUT 6-32 HEX REGULAR STAINLESS
0011	100034198	1	SWITCH, CIRCUIT BREAKER, DPST, 250 VAC, 50/60 HZ, 15 AMP, WITH NEON BULB
0012	100032732	1	BUSHING, ISOLATION, HEYCO, 2077, 0.625 DIA HOLE, BLACK PLASTIC
0013	100013087	1	RECEPTACLE, FLANGED, 15 AMP, 125 VAC, /DC, TWIST LOCK
0014	100072627	1	HEAT SINK, FOR MODEL A1225 AND A2425 SOLID STATE RELAY
0015	100013136	1	RELAY, SOLID STATE, 240 VAC, 25 AMP, 3-32 VDC CONTROL
0017	100035052	1	ENCLOSURE, INSTRUMENT, 9.5 IN X 7 IN PANEL, 17 IN PANEL DEPTH, TEXTURED FINISH, DARK GRAY
0018	100034709	1	HOLDER, FUSE, 30 AMP, 250 VAC
0019	100013236	1	FUSE, 25 AMP, 250 VAC, CURRENT LIMITING FOR SEMICONDUCTOR PROTECTION, 2 IN L X 9/16 IN DIA
0020	1018814265	1	TEMP CONTROLLER EUROTHERM 2404. STANDARD PID WITH NON-ISOLATED LOGIC OUTPUT (STATIC FLUID LOSS SETTINGS)
0021	205768	1	CABLE POWER 115V 16 AWG MALE PLU
0022	208485	24 in	WIRE THERMOCOUPLE DUPLEX TYPE
0025	100031033	1	RESISTOR, 30000 OHM, 1/2 WATT, 5%

Item No.	Part No.	Quantity	Description
0026	206246	2.5 ft	WIRE 12 AWG PVC STRANDED 600V BLACK
0027	206248	2 ft	WIRE 12 AWG PVC STRANDED 600V GREEN
0028	206247	2.5 ft	WIRE 12 AWG PVC STRANDED 600V RED
0029	206229	2 ft	WIRE 22 AWG PVC STRANDED GREEN
0030	208527	3.25 ft	WIRE 18 AWG PVC STRANDED BLUE
0031	208516	3.25 ft	WIRE 22 AWG PVC STRANDED BROWN
0032	206242	2 ft	WIRE 22 AWG TEFLON STRANDED BLUE
0033	207336	2	8-32 X 3/8 BHMS STAINLESS
0034	208454	13	TERMINAL FORK 6 22-16 AWG
0035	207307	2	6-32 X 3/8 FHMS STAINLESS
0036	207632	2	NUT 6-32 HEX REGULAR STAINLESS
0037	207819	2	WASHER SPLIT 6 STAINLESS STEEL
0038	207753	1	WASHER SPLIT 1/4 STAINLESS STEEL
0039	100029075	1	SCREW, BIND HEAD, #10-32 NF X 1, STAINLESS STEEL
0040	208704	1	WASHER SPLIT 10 STAINLESS STEEL
0041	207633	2	NUT 10-32 HEX REGULAR STAINLESS
0042	204299	4	TERMINAL FEMALE Q.C .25X.032 1
0043	100029508	50	TERMINAL, CRIMP, 12-10 GA, #10 STUD, RING TYPE, INSULATION CRIMP
0044	204304	2	TERMINAL FORK 6 16-14AWG BLUE
0045	208512	7	TIE CABLE 1/16 TO 5/8 DIA 3.6
0046	204291	3	TERMINAL RING 6 SM-14-16AWG
0047	101267867	6	WASHER, FLAT (US) - NO. 6 SAE - 18-8 SS

Table 9-7 100072578 TEMPERATURE CONTROLLER ASSEMBLY, PROGRAMMABLE, WITH SCR, 230/240VAC, 50/60HZ (See Figure 9-5 & Figure 9-6)

Item No.	Part No.	Quantity	Description
0001	100072581	1	PANEL, FRONT, TEMPERATURE CONTROLLER ASSEMBLY, WITH SCR
0003	100072582	1	PANEL, BACK, TEMPERATURE CONTROLLER ASSEMBLY, WITH SCR, 230VAC
0004	100072391	1	PANEL, SINGLE CIRCUIT, THERMOCOUPLE, JX CALIBRATION
0005	203403	8	10-32 X 3/4 BHMS STAINLESS
0006	100032781	8	NUT, CLIP, NO.10-32, MULTIPLE THREAD, 0.375 CENTER TO EDGE MAX
0007	100029446	1	SWITCH, TOGGLE, DPST, 0.468 DIA BUSHING, WITH SCREW LUGS, 3 AMP AT 250 VAC
0008	207949	8	6-32 X 5/8 BHMS STAINLESS
0009	207632	8	NUT 6-32 HEX REGULAR STAINLESS
0011	100034198	1	SWITCH, CIRCUIT BREAKER, DPST, 250 VAC, 50/60 HZ, 15 AMP, WITH NEON BULB
0012	100032732	1	BUSHING, ISOLATION, HEYCO, 2077, 0.625 DIA HOLE, BLACK PLASTIC
0013	100031172	1	RECEPTACLE, FLANGED, 15A 250 VAC/DC, TWIST LOCK
0014	100072627	1	HEAT SINK, FOR MODEL A1225 AND A2425 SOLID STATE RELAY
0015	100013136	1	RELAY, SOLID STATE, 240 VAC, 25 AMP, 3-32 VDC CONTROL
0017	100035052	1	ENCLOSURE, INSTRUMENT, 9.5 IN X 7 IN PANEL, 17 IN PANEL DEPTH, TEXTURED FINISH, DARK GRAY
0018	100034709	1	HOLDER, FUSE, 30 AMP, 250 VAC
0019	100013236	1	FUSE, 25 AMP, 250 VAC, CURRENT LIMITING FOR SEMICONDUCTOR PROTECTION, 2 IN L X 9/16 IN DIA
0020	101881426	1	TEMP CONTROLLER EUROTHERM 2404. STANDARD PID WITH NON-ISOLATED LOGIC OUTPUT (STATIC FLUID LOSS SETTINGS)
0021	100072621	1	CORD SET ASSEMBLY, ELECTRIC, 240V, 2 CUBE AUTOCLAVE
0022	208485	24 in	WIRE THERMOCOUPLE DUPLEX TYPE
0025	100027804	1	RESISTOR, 100000 OHM, 1 WATT, 5%
0026	206246	2.5 ft	WIRE 12 AWG PVC STRANDED 600V BLACK

Item No.	Part No.	Quantity	Description
0027	206248	2 ft	WIRE 12 AWG PVC STRANDED 600V GREEN
0028	206247	2.5 ft	WIRE 12 AWG PVC STRANDED 600V RED
0029	206229	2 ft	WIRE 22 AWG PVC STRANDED GREEN
0030	208527	3.25 ft	WIRE 18 AWG PVC STRANDED BLUE
0031	208516	3.25 ft	WIRE 22 AWG PVC STRANDED BROWN
0032	206242	2 ft	WIRE 22 AWG TEFLON STRANDED BLUE
0033	207336	2	8-32 X 3/8 BHMS STAINLESS
0034	208454	13	TERMINAL FORK 6 22-16 AWG
0035	207307	2	6-32 X 3/8 FHMS STAINLESS
0036	207632	2	NUT 6-32 HEX REGULAR STAINLESS
0037	207819	2	WASHER SPLIT 6 STAINLESS STEEL
0038	207753	1	WASHER SPLIT 1/4 STAINLESS STEEL
0039	100029075	1	SCREW, BIND HEAD, #10-32 NF X 1, STAINLESS STEEL
0040	208704	1	WASHER SPLIT 10 STAINLESS STEEL
0041	207633	2	NUT 10-32 HEX REGULAR STAINLESS
0042	101267867	6	WASHER, FLAT (US) - NO. 6 SAE - 18-8 SS

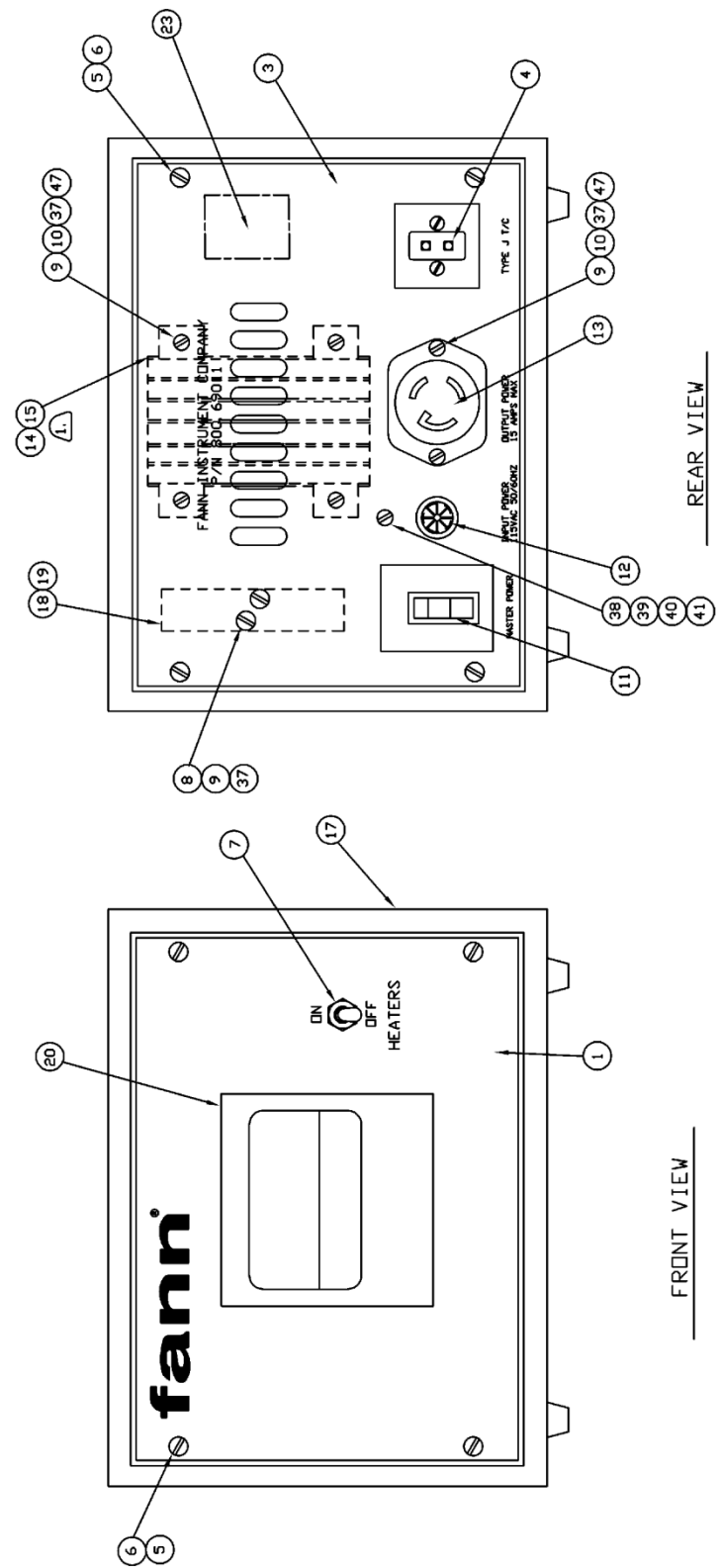


Figure 9-5 Temperature Controller Assembly

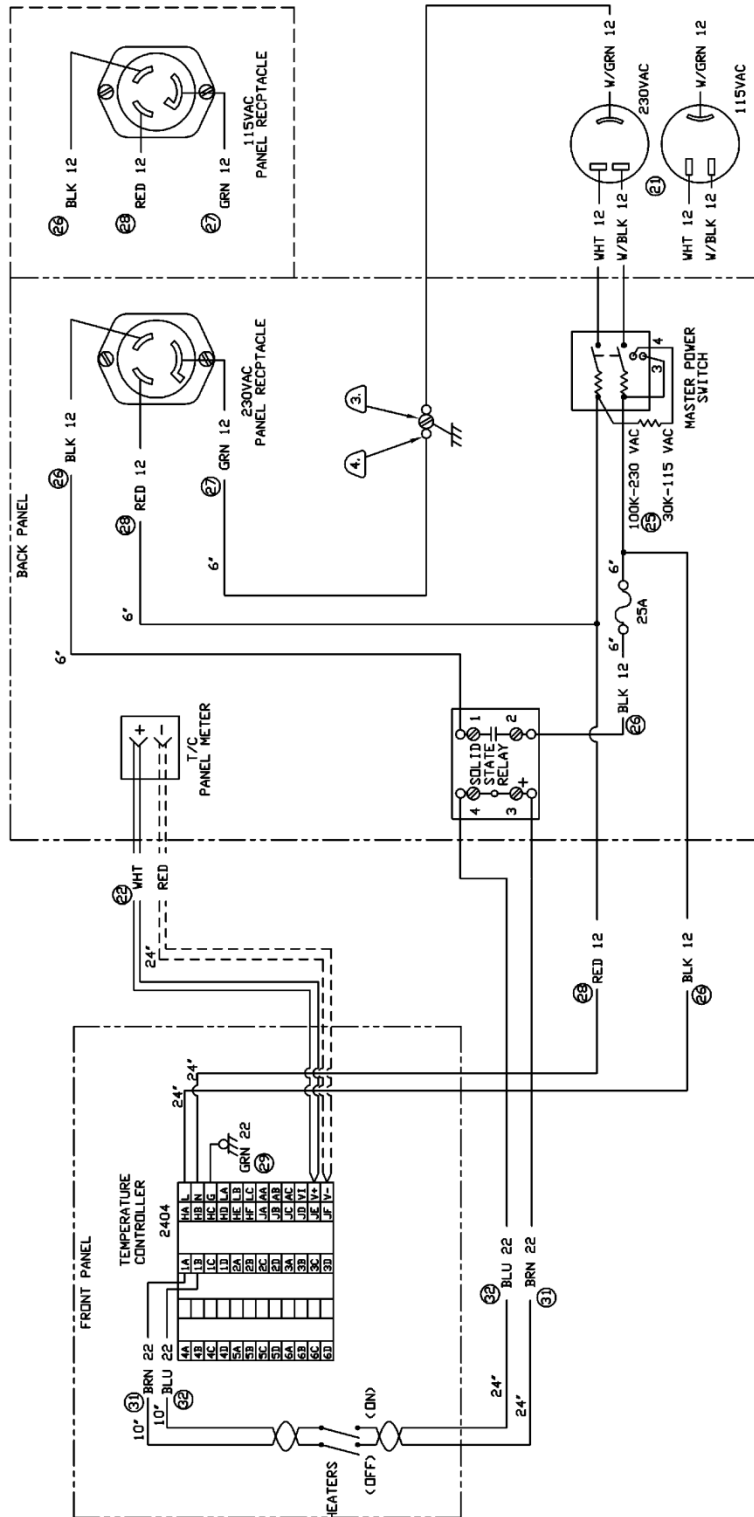


Figure 9-6 Wiring Diagram, Temperature Controller Assembly

9.6 Fluid Loss Test Instrument, Cell Assembly

Table 9-8 101776831 CELL ASSEMBLY, FLUID LOSS, SHORT CELL (Figure 9-8)

Item No.	Part No.	Quantity	Description
0001	100020409	1	COUPLING, HIGH PRESSURE MANIFOLD, FLUID LOSS CORE FILTER PRESS
0002	100020410	1	NUT, HP MANIFOLD, FILTER PRESS
0003	100002402	1	SCREEN, FLUID LOSS, FILTER PRESS, 325 MESH
0004	100026664	1	O-RING, 70 DURO, 5/16 X 3/16 X 1/16 568-008
0005	100001882	4	O-RING, 70 DURO, 2 1/2 X 2 1/4 X 1/8 568-228
0006	100020411	1	RESERVOIR, 5 1/8 FILTER PRESS
0007	100020425	1	CAP, FILTER FLUID LOSS
0008	100020426	1	BASE, CAP, FILTER FLUID LOSS
0009	100001364	1	RING, BACK-UP, FILTER PRESS ASSEMBLY
0010	100000593	2	VALVE, PLUG, 1/8 NATIONAL PIPE THREAD, MALE
0011	100033660	3	ADAPTER, HOSE, 2AP, STRAIGHT, 1/8 MALE PIPE THREAD X 1/8 IFPT, BRASS, HOKE

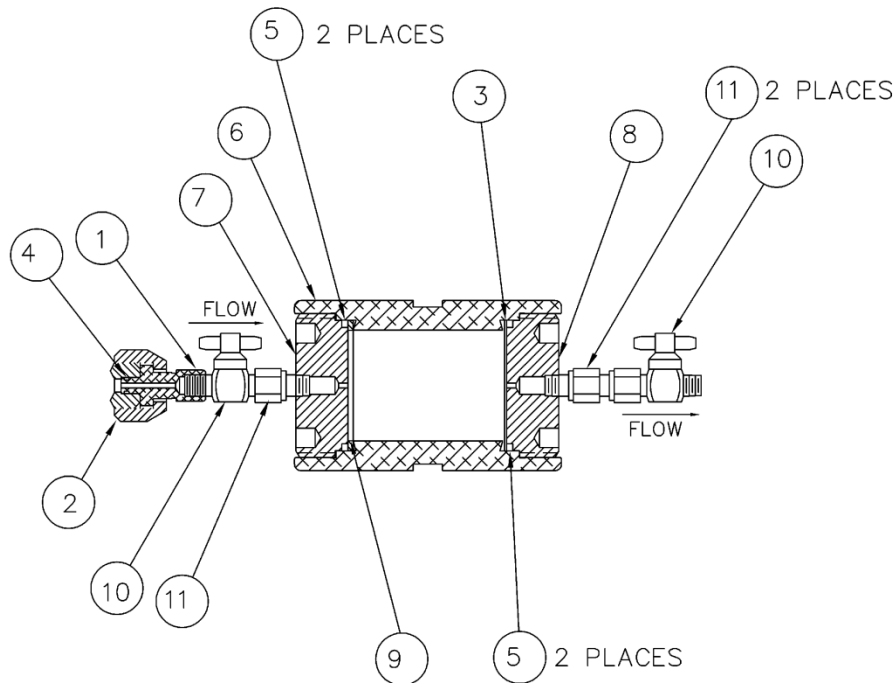


Figure 9-8 Cutaway Drawing of Cell Assembly

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10 Warranty and Returns

10.1 Warranty

Fann Instrument Company warrants its products to be free from defects in material and workmanship for a period of 12 months from the time of shipment. If repair or adjustment is necessary, and has not been the result of abuse or misuse within the six-month period, please return, freight prepaid, and correction of the defect will be made without charge.

Out of warranty products will be repaired for a nominal charge.

Please refer to the accompanying warranty statement enclosed with the product

10.2 Return of Items

For your protection, items being returned must be carefully packed to prevent damage in shipment and insured against possible damage or loss. Fann will not be responsible for damage resulting from careless or insufficient packing.

Before returning items for any reason, authorization must be obtained from Fann Instrument Company. When applying for authorization, please include information regarding the reason the items are to be returned.

Our correspondence address is:

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Houston, Texas USA 77210

Telephone: 281-871-4482

Toll Free: 800-347-0450

FAX: 281-871-4446

Email fanmail@fann.com

Our shipping address is:

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