Cement Curing Autoclave
User Manual

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Cement Curing Autoclave User Manual

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Contact FANN®

Phone

TELEPHONE:281-871-4482
TOLL FREE:800-347-0450
FAX:281-871-4358

Mail

Fann Instrument Company
P. O. Box 4350
Houston, Texas, 77210 USA

Location

Fann Instrument Company
14851 Milner Road, Gate 5
Houston, Texas 77032 USA

Online

www. fann. com
fannmail@fann. com

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1 Introduction

1.1 Cement Curing Autoclave

The Cement Curing Autoclave is an apparatus used to cure cement slurry samples under elevated hydrostatic pressure and temperature. The cement slurry samples are contained in one or two 2 inch cube molds, surrounded by water (or oil), within the pressure chamber. The autoclave includes a heating jacket which completely surrounds the cement curing pressure chamber, temperature controller, thermocouple, pressure gauge, adjustable pressure regulator, and manual fill and bleed valve.

The Cement Curing Autoclave requires an external pressure source, such as compressed nitrogen gas or a hydraulic pump, capable of providing pressure up to 3,000 PSI.

1.2 Function

The Cement Curing Autoclave cures cement slurry samples under elevated pressure and temperature to prepare them for destructive compressive-strength tests. These tests help determine compliance to American Petroleum Institute (API) Specification 10A, *Specification for Cements and Materials for Well Cementing*. This device meets the requirements for pressurized cement curing equipment found in API Specification 10A, and API Recommended Practice 10B, *Recommended Practice for Testing Well Cements*.

After the curing period, the samples are removed from the single-cube molds and tested to determine their compressive strength.

The pressure relief valve prevents the pressure chamber from exceeding 3,000 PSI (20.7 MPa).

The desired temperature for curing the cement samples is set on the temperature controller, which automatically maintains that temperature throughout the curing period. The maximum recommended curing temperature is 400 Degrees F (204 Degrees C). A thermostat in the heating jacket is set for an upper limit of 450 Degrees F (232 Degrees C) for safety.

The practice of removing the curing chamber and cooling it under water is very dangerous. It is not recommended because of the danger of severe burns if touched or accidentally dropped. Also use extreme caution when placing a hot chamber in water. Hot steam generated when the water hits the hot chamber can cause severe burns.

1.3 Features

- Single chassis contains all components in a durable stainless steel case.
- Insulated heating jacket reduces heating of the work area.
- Two two-inch cube molds and covers are included.
- Adjustable pressure relief valve.
- Programmable temperature controller.
- Removable chamber carrying handle.
- Adjustable support feet.

Figure 1-1
Cement Curing Autoclave, front view

Figure 1-2
Cement Curing Autoclave, back view

2 Safety

2.1 Machine Hazards

2.1.1 Pressure

Pressurized air and water lines present a hazard if not depressurized before maintenance or disassembly.

High pressure hydraulic lines are a hazard because they can hold up to 3,000 PSI (20.7 MPa). These lines are stainless steel or reinforced hose. Operators must ensure that the pressure in these lines has been reduced to zero before attempting to disassemble any high pressure lines. Open the pressure manifold valve. Confirm that all pressure in the system has been relieved by observing the pressure gauge on the top of the chamber.

2.1.2 Temperature

The pressure chamber has an electric heating jacket that can heat the cement slurry to 400°F (205°C). The metal jacket itself can be considerably hotter, even over 600°F (315°C). Before removing the pressure chamber, or performing any work on the heating jacket, allow it to cool to below 120°F (49°C). Monitor the temperature by observing the temperature controller display when the chamber is in the heating jacket.

2.1.3 Steam

Water is commonly used to pressurize the cement slurry being cured. When heat is applied, there is the potential for the water to become high temperature steam. Because of the risk of burn, body parts should be kept away from the manual pressure relief valve (needle valve) when it is being opened.

As the automatic pressure relief valve opens, small amounts of hot water and steam will be released, which are a burn hazard.

2.1.4 Electrical

The power source for the Cement Curing Autoclave is 115 or 230 Volts. There are electrically active terminals inside the instrument when the power switch is turned off. Physically disconnect the power cord from the outlet and instrument before attempting any electrical or mechanical maintenance. Refer to the electrical schematic before performing any maintenance or troubleshooting.

2.2 Ergonomic Considerations

After the Cement Curing Autoclave is installed, it is uncommon for it to be frequently moved. The physical location needs to have access to the required electric power source, pressure source (compressed gas or hydraulic pump), and be sufficiently sturdy to support the combined weight of the Cement Curing Autoclave, pressure chamber, and cube molds, which is approximately 137 pounds (64 kg).

In routine cement slurry curing, the combined weight of the pressure chamber, cement molds, cement, pressurizing water or oil, manifold, and handle must be lifted fully from the heating jacket a distance of 8-1/2 inches (21.6 cm). This weight varies with the number of molds and the cement slurry being cured, and approaches 69 pounds (31.4 kg). Placing the top surface of the Cement Curing Autoclave at 24–36 in (61–91 cm) from the floor is an appropriate height for most people to lift the cement curing chamber.

3 Features and Specifications

Table 3-1 Cement Curing Autoclave Specifications

Category	Specification
Maximum Temperature	400°F (205°C)
Maximum Pressure	3,000 PSI (20.7 mega Pascal [MPa])
Heating Rate	8°F [4. 4°C] per minute maximum
Curing Chamber Volume (empty)	40.1 ounces (oz) (1,200 milliliters [ml])
Width	21.5 inches (in) (54.6 centimeters [cm])
Depth	16.5 in (41.9 cm)
Height	13.5-14.5 in (34.3-36.8 cm)
Weight	116 pounds (lb) (53 kilograms [kg])
Pressure Connection	1/8 Female NPT, located on the manual pressure release valve
Voltage and Current	Single phase, AC, 50–60 Hertz (Hz) - 115V, 15A, NEMA 5-20P plug or 230V, 10A, NEMA 6–15P plug

3.1 Cement Curing Autoclave Mechanical

The manual needle valve in the pressure manifold controls the pressure going into the curing chamber. During testing, the needle valve is normally closed. At the conclusion of a test, after the temperature is below 120 Degrees F (48.9 Deg C), the needle valve can be opened to completely release the pressure.

Pressures above 3,000 PSI (20.68 MPa) are automatically vented by the pressure relief valve, which functions as an over-pressure safety device.

The chamber pressure is shown on a pressure gauge installed directly into the top of the curing chamber.

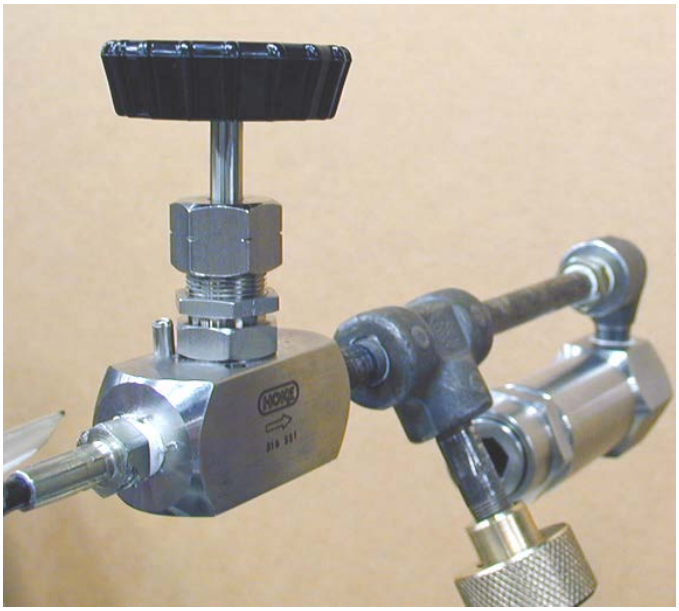


Figure 3-1
Manual Needle Valve and Pressure Relief Valve

Figure 3-2
Pressure Manifold, Thermocouple, Pressure Gauge

3.2 Cement Curing Molds

Two brass alloy molds, internally measuring 2 inches X 2 inches X 2 inches (5.08 cm X 5.08 cm X 5.08 cm) are provided with each Cement Curing Autoclave. The two mold halves are aligned with dowel pins, and clamped together with threaded sleeves. Two flat head screws fasten the bottom plate to the two mold halves. This arrangement allows the mold to be removed without damaging the cured cement specimen, and for thorough clean-up.

Figure 3-3
Cement Mold

Figure 3-4
Cement Mold Clamp

Figure 3-5
Cement Mold Base

3.3 Cement Curing Autoclave Controls and Indicators

The main power switch illuminates when electric power is applied to the cement curing autoclave circuits.

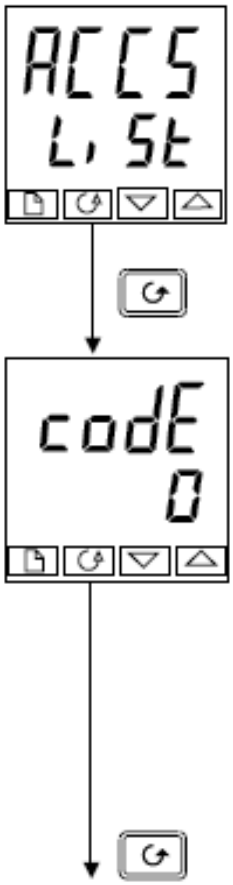
The heat switch, located below the main power switch on the front panel, enables and disables the heater circuit without interrupting power to the entire instrument.

The temperature controller regulates the power applied to the heater circuit to achieve and maintain the desired temperature inside the curing chamber. It constantly compares the desired temperature (set point) to the temperature reading from the curing chamber thermocouple and adjusts the heating cycle to achieve and/or maintain the desired temperature. It continuously displays the current and set point temperatures.

Figure 3-6
Temperature Controller, Main Power, Heat switch

3.4 Temperature Controller Configuration

The tables in this section contain the factory settings for the Eurotherm Model 2404 temperature controller when it is configured for the Cement Curing Autoclave. It is rare that the majority of these settings will need to be changed. They are provided for reference should the temperature controller respond in an unexpected manner, and incorrect settings are suspected.



Access list header

Press [S] until you reach the access list header 'ACCS'.

Press [⟳]

Password entry

The password is entered from the 'codE' display.
Enter the password using [▲] or [▼]. Once the correct password has been entered, there is a two second delay after which the lower readout will change to show 'PASS' indicating that access is now unlocked.
The pass number is set to '1' when the controller is shipped from the factory.

Note; A special case exists if the password has been set to '0'. In this case access will be permanently unlocked and the lower readout will always show 'PASS'.

Press [⟳] *to proceed to the* 'Goto' *page.*

1. Press  until the display shows 

2. Press  to select the **Config** password (**2**)
3. **'Pass'** is displayed momentarily.

Press  **to** Configuration (**ConF**)

Name  to select	**Parameter Description**	**Value**  or  to change
Ctrl	Control Type	**PID**
Act	Control Action	**ReU**
Cool	Type of Cooling	**Lin**
Ti.Td	Integral & derivative time units	**SEc**
dtYP	Derivative type	**PU**
m-A	Front panel Auto/Man button	**EnAb**
r-h	Front panel Run/Hold button	**EnAb**
PwrF	Power feedback	**on**
Fwd.t	Feed forward type	**nonE**
Sb.tr	Sensor break output	**Sb.OP**
FOP	Forced manual output	**no**
bcd	BCD input function	**nonE**
GSch	Gain schedule enable	**no**
LC.HI		**0**

Press  to Process Value (PU) Configuration

Name to select	Parameter Description	Value or to change
uniT	Instrument units	ºF
dEc.P	Decimal places in the display	nnn.n
rnG.L	Range low	-199.9
rnG.h	Range high	999.9

Press  to Input (iP) Configuration

Name to select	Parameter Description	Value or to change
inPt	Input type	J.tc
CJC	Cold junction compensation	Auto
imP	Sensor break impedance	Auto

Press  to Set Point (SP) Configuration

Name to select	Parameter Description	Value or to change
nSP	Number of setpoints	2
rm.tr	Remote tracking	OFF
m.tr	Manual track	OFF
rmP.U	Setpoint rate limit units	PSec
rmt	Remote setpoint configuration	nonE

Press  to Alarm (AL) Configuration

Name to select	Parameter Description	Value or to change
AL 1	Alarm 1 Type	OFF
Ltch	Latching	no
bLoc	Blocking	no
AL 2	Alarm 2 Type	OFF
Ltch	Latching	no
bLoc	Blocking	no
AL 3	Alarm 3 Type	OFF
Ltch	Latching	no
bLoc	Blocking	no
AL 4	Alarm 4 Type	OFF
Ltch	Latching	no
bLoc	Blocking	no

Press  to Program (PROG) Configuration

Name to select	Parameter Description	Value or to change
PtYP	Programmer type	1
HbAC	Holdback	SEG
Pwr.F	Power fail recovery	cont
Srvo	Starting setpoint of a program (Servo point)	To.PU

Press  to Digital Input (LA) Configuration

Name to select	Parameter Description	Value or to change
iD	Identity	LoG.i
Func	Function of input	nonE

Press  to Digital Input (Lb) Configuration

Name to select	Parameter Description	Value or to change
iD	Identity	LoG.i
Func	Function of input	nonE

Press  to Comms 1 Module (HA) Configuration

Name to select	Parameter Description	Value or to change
iD	Identity of the module installed	nonE
Func	Function of input	nonE

Press  to Comms 2 Module (JA) Configuration

Name to select	Parameter Description	Value or to change
iD	Identity of the module installed	nonE
Func	Function of input	nonE

Press  to Module 1 (1A) Configuration

Name to select	Parameter Description	Value or to change
id	Identify of module installed	LoG
Func	Function	HEAt
UAL.L	%PID demand signal giving minimum output	0
UAL.H	%PID demand signal giving maximum output	100
Out.L	Minimum average power	0.0
Out.H	Maximum average power	100.0

Press  to Module 2 (2A) Configuration

Name to select	Parameter Description	Value or to change
id	Identify of module installed	nonE
Func	Function	nonE

Press  to Module 3 (3A) Configuration

Name to select	Parameter Description	Value or to change
id	Identify of module installed	nonE
Func	Function	nonE

Press  to Module 4 (4A) Configuration

Name to select	Parameter Description	Value or to change
id	Identify of module installed	nonE
Func	Function	nonE

Press  to Calibration (CAL) Configuration

Name to select	Parameter Description	Value or to change
rcAL	Calibration point	nonE
UCAL	User calibration enable	no
Pt1.L	Low calibration point for Input 1	0.0
Pt1.H	High calibration point for Input 1	999.9
OF1.L	Offset Low for Input 1	0.0
OF1.H	Offset High for Input 1	0.0

Press  **to EXIT**

Press  **to select YES**
UNIT WILL RESTART

Access list header

Press  until you reach the access list header 'ACCS'.

Press 

Password entry

The password is entered from the 'codE' display.
Enter the password using  or  . Once the correct password has been entered, there is a two second delay after which the lower readout will change to show 'PASS' indicating that access is now unlocked.
The pass number is set to '1' when the controller is shipped from the factory.

Note; A special case exists if the password has been set to '0'. In this case access will be permanently unlocked and the lower readout will always show 'PASS'.

Press  *to proceed to the 'Goto' page.*

Press  **to select FuLL**

Press  to Program run list (run)

Name to select	Parameter Description	Value or to change
StAt	Program status	OFF
FASt	Fast run through program	no
SEG.d	Flash active segment in the lower readout of the home display	YES

Press  to Program Edit List (ProG)

Name to select	Parameter Description	Value or to change
Hb U	Holdback value	10.0
rmP.U	Ramp units	min
dwL.U	Dwell units	min
CYC.n	Number of program cycles	1
SEG.n	Segment number	1
tYPE	Segment type	rmPr
Hb	Holdback type	OFF
tGt	Target setpoint	135
rAtE	Ramp rate	.3
SEG.n	Segment number	2
tYPE	Segment type	rmPr
Hb	Holdback type	bAnd
tGt	Target setpoint	190
rATe	Ramp rate	0.3
SEG.n	Segment number	3
tYPE	Segment type	End
End.t	End of program	dwEll

Press  to Alarm List (AL)

Name to select	Parameter Description	Value or to change
Lbt	Loop break time in minutes	OFF
diAG	Enable Diagnostic alarms	no

Press  to PID list (Pi d)

Name to select	Parameter Description	Value or to change
SEt	Pid.1 Or Pid.2 selected	Pid.1
Pb	Proportional Band	0.8
Ti	Integral Time in seconds	1700
Td	Derivative Time in seconds	65
rES	Manual Reset (%)	0.0
Hcb	High cutback	OFF
Lcb	Low cutback	0.1
Pb2	Proportional Band Pid 2	0.8
Ti2	Integral Time in seconds Pid2	1700
Td2	Derivative Time in seconds Pid2	65
rES2	Manual Reset (%) Pid 2	0.0
Hcb2	High cutback Pid2	OFF
Lcb2	Low cutback Pid2	0.1

Press  to Setpoint list (SP)

Name to select	Parameter Description	Value or to change
uniT	Instrument units	°F
dEc.P	Decimal places in the display	nnn.n
rnG.L	Range low	-199.9
rnG.h	Range high	999.9

Press  to Input list (iP)

Name to select	Parameter Description	Value or to change
uniT	Instrument units	°F
dEc.P	Decimal places in the display	nnn.n
rnG.L	Range low	-199.9
rnG.h	Range high	999.9

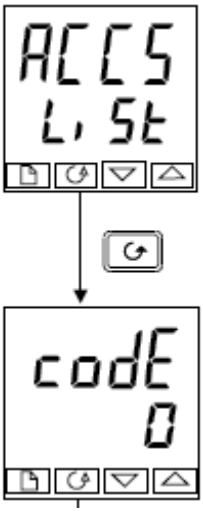
Press  to Output list (oP)

Name to select	Parameter Description	Value or to change
uniT	Instrument units	°F
dEc.P	Decimal places in the display	nnn.n
rnG.L	Range low	-199.9
rnG.h	Range high	999.9

Press  **to Information list (info)**

Name  to select	**Parameter Description**	**Value**  or  to change
uniT	Instrument units	**ºF**
dEc.P	Decimal places in the display	**nnn.n**
rnG.L	Range low	**-199.9**
rnG.h	Range high	**999.9**

Press  **to Page to ACCS list**



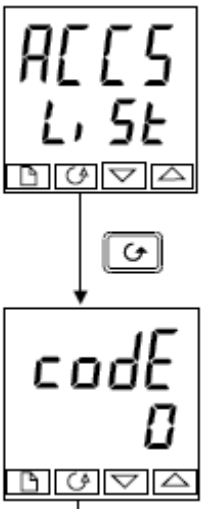
'Pass' is displayed momentarily.

Press  to **Edit**

Press  **to Program Read**

Name  to select	Parameter Description	Value  or  to change
uniT	Instrument units	**°F**
dEc.P	Decimal places in the display	**nnn.n**
rnG.L	Range low	**-199.9**
rnG.h	Range high	**999.9**

Press  **to Page to ACCS list**



'Pass' is displayed momentarily.

Press  **to OPEr**

Press  **to Home View**

3.5 Pressurizing the Cement Curing Autoclave

Cement samples being cured in the Cement Curing Autoclave are pressurized by a hydraulic fluid, normally water. The initial pressure can be provided by a hand or electric pump, or by an inert compressed gas, such as nitrogen. For either pressurizing method, the pressurizing chamber and manifold should be filled as much as possible with a non-compressible fluid, such as water. This minimizes the time required to pressurize to the desired pressure and increases safety.

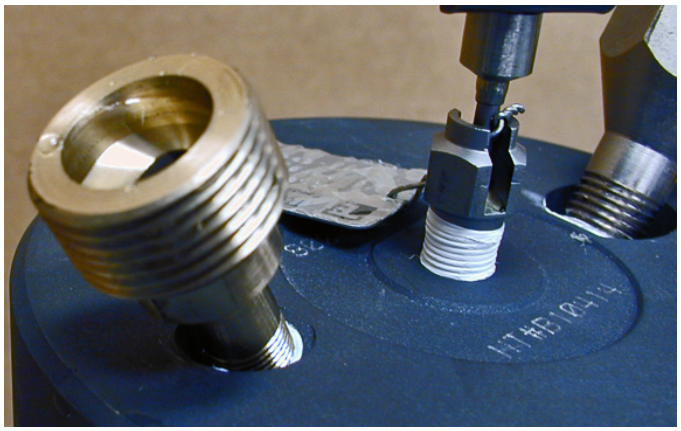


Figure 3-7
Water Expelled as Lid is Closed

Either pressure source is connected to the open 1/8 NPT port on the needle valve. After reaching the desired pressure, the needle valve can be closed and the pressure source disconnected.

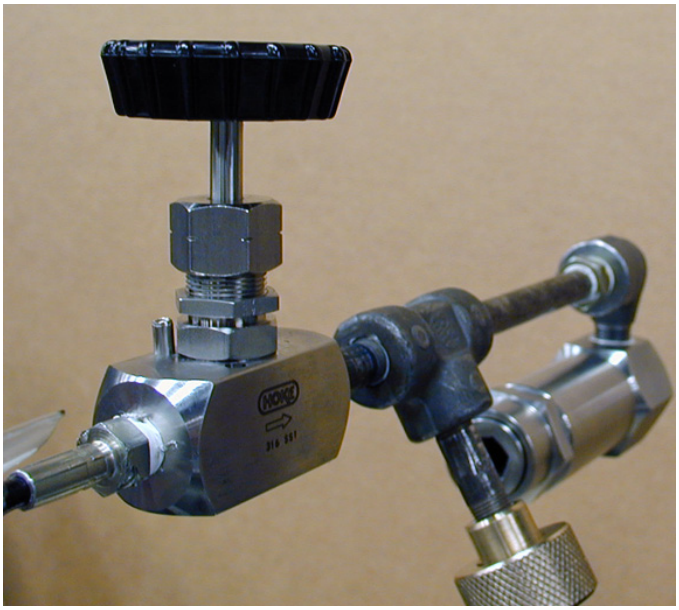


Figure 3-8
Pressure source connected to needle valve

As the curing temperature increases during the curing process, an automatic pressure relief valve prevents the chamber internal pressure from exceeding 3,000 PSI. This spring loaded valve releases small amounts of the pressurizing fluid (water).

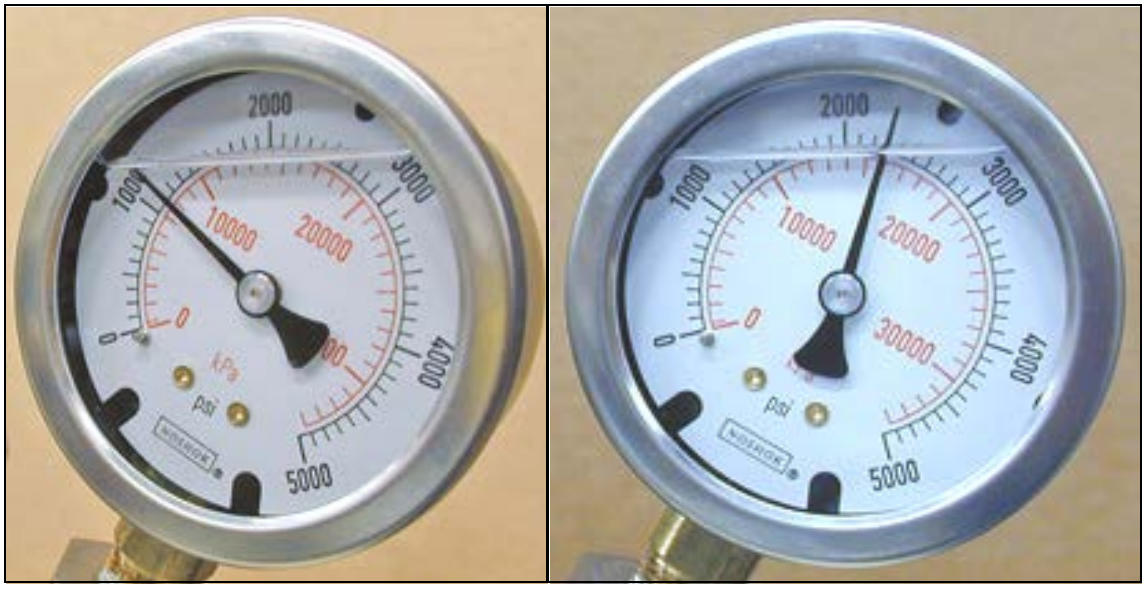


Figure 3-9
Initial pressure (left), increased pressure from temperature rise (right)

4 Installation

4.1 Parts of the Cement Curing Autoclave

4.1.1 Reference: see *1 Introduction*.

4.2 Other Parts

4.2.1 Several smaller items are packed separate from the Cement Curing Autoclave, to protect them during shipping. When unpacking the Cement Curing Autoclave, verify that you have received the pressure chamber, thermocouple cable, power cable, two cement molds and two covers, mold handling tool, chamber wrench, Vise Grip chain tool, and instruction manuals.

4.3 Locating the Cement Curing Autoclave

4.3.1 Locate the Cement Curing Autoclave(s) relative to the cement sample preparation area, as desired.

4.3.2 Locate a compressed, inert gas cylinder, or hydraulic pump, near the Cement Curing Autoclave, or where the pressure chamber will be pressurized.

4.3.3 The tools to fully close and open the chamber cap should be located near either the cement sample preparation area, near the Cement Curing Autoclave, or in a work area which is convenient to both. The cement mold handling tool should be in the same area.

4.3.4 A water source should be nearby, if water will be used to surround and pressurize the cement samples.

4.3.5 Tools for disassembling and cleaning the molds, and properly disposing of the sample debris, should be nearby.

4.3.6 Adjust the four feet beneath the cabinet to level the Cement Curing Autoclave from side-to-side, and front-to-back. Once the cabinet is level, secure the locking nuts on the adjustable feet to prevent inadvertent changes.

4.4 Electric Power Supply

4.4.1 The Cement Curing Autoclave is supplied with a 5-ft power cord, with either a NEMA 5-20P (115V) or 6–15P (230V) plug, depending upon the voltage ordered. Because of the diversity in types of electrical outlets throughout the world, it may be necessary to replace this plug. Alternatively, the Cement Curing Autoclave can be directly wired into an

electrical disconnect switch. Regardless of the connection, ensure that proper power is provided.

4.4.2 The electric power supply must be single-phase and 50-60 Hz.

4.4.2.1 115 VAC, 15 A for 115 VAC Cement Curing Autoclaves

4.4.2.2 230 VAC, 10 A for 230 VAC Cement Curing Autoclaves

4.4.3 Connect the power cord to the Cement Curing Autoclave, and then connect the power cord to the power source.

5 Operation

5.1 Sample Preparation

5.1.1 Preparation of the cement slurry, curing, and strength testing of the cured sample should be done by following the procedures in the latest edition of the API Recommended Practice for Testing Oil Well Cements and Cement Additives (API RP 10B). This publication is available from the American Petroleum Institute, Division of production, 300 Corrigan Tower Building, Dallas, Texas, 75201, USA. These procedures should be reviewed prior to using the Cement Curing Autoclave.

5.2 Prepare the Cube Mold

5.2.1 One or two, 2 inch, cube molds are used with the Cement Curing Autoclave chamber. To prevent the cement slurry from seeping into the joints between the sides and base plates, apply a thin coat of grease to the bottom edges of the mold. Keep and use like numbered cement mold halves together.

Figure 5-1
Pins align the mold halves

Figure 5-2
Clamps hold mold halves together

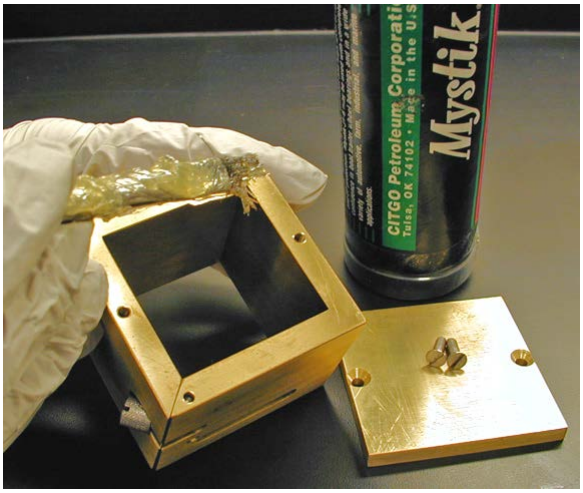


Figure 5-3
Grease mold for base plate

5.2.2 Attach the base plate to the mold using two flat head machine screws.

Figure 5-4
Tighten base plate to mold

5.2.3 Apply a thin coat of grease on the mold interiors and the base plates to keep the cement slurry from sticking. Excess grease at the inside joints of the molds will decrease the actual volume of the cement cube and can result in inaccurate compressive strength tests.

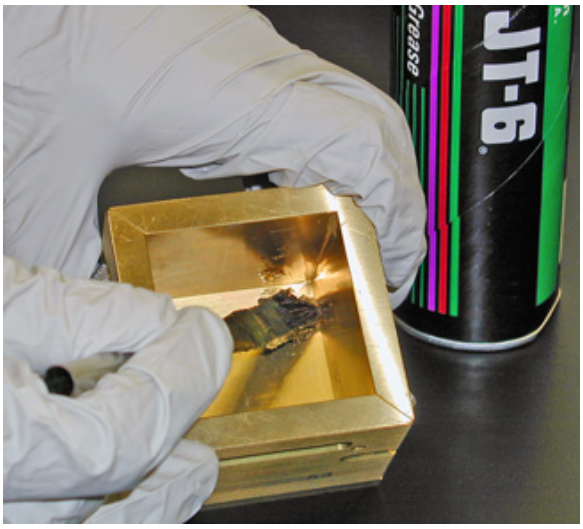


Figure 5-5
Grease mold interior

5.3 Prepare the Cement Slurry

5.3.1 Mix the cement slurry according to API RP 10B.

Figure 5-6
Mixing Cement Slurry

5.4 Fill the Molds

5.4.1 Pour the cement slurry into the assembled mold. Repeatedly puddle and stir the slurry, then remove the excess with a straight edge to level the slurry with the top of the molds. See API RP 10B.

Figure 5-7
Filling mold

Figure 5-8
Leveling cement

5.4.2 To keep the pressurizing water from contaminating the slurry, apply a thin layer of grease to the top edges of the mold, and to the edges of the mold cover plate.

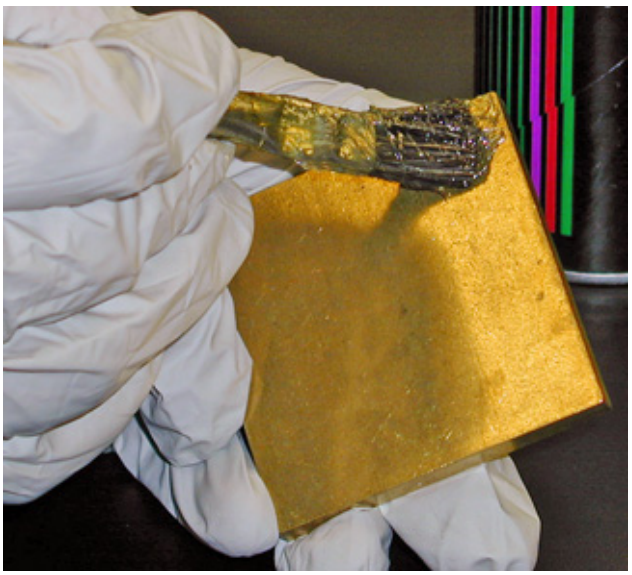


Figure 5-9
Grease cover plate

5.4.3 Put the cover plate on the mold.

Figure 5-10
Cover plate

5.5 Place molds into chamber

5.5.1 Use the cube mold removal tool to lower one or both molds into the Cement Curing Autoclave Chamber. Once the molds are in the chamber, avoid tipping the chamber, which may displace the covers.

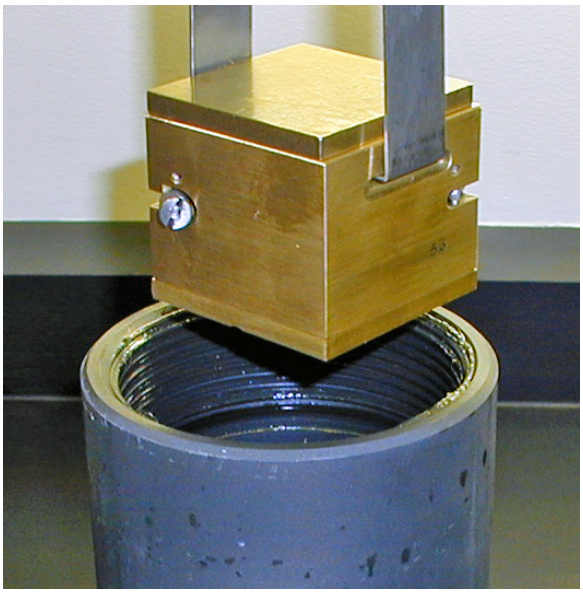


Figure 5-11
Lower mold into chamber – 1

Figure 5-12
Lower mold into chamber – 2

5.5.2 Coat the chamber threads with grease.

Figure 5-13
Grease chamber threads

5.5.3 Fill the chamber with water to halfway up the threads. This ensures all air will be removed from the chamber when the lid is installed. See API RP 10B.

5.5.4 Inspect the chamber lid O-ring for cuts or other damage. If it is damaged, it should be replaced.

5.5.5 Grease the lid O-ring and lid threads.

5.5.6 Install the lid onto the chamber. Fully tighten the lid into the chamber using the pressure vessel wrench and Vise Grip chain clamp. When the lid is fully seated, loosen it 1/8 to 1/4 turn. This helps to ensure the lid does not become jammed.

Figure 5-14
Tighten lid

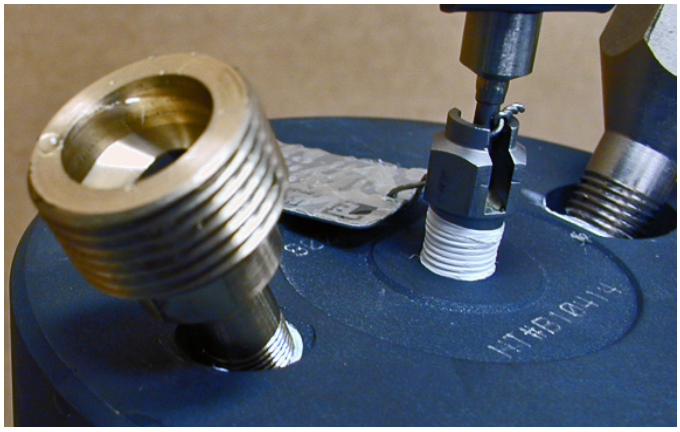


Figure 5-15
Water expelled as lid tightened

5.5.6.1 Attach the removable chamber handle by pulling the spring loaded pins away from the handle. Place the handle over the lid, and release the spring loaded pins to engage the holes in the lid.

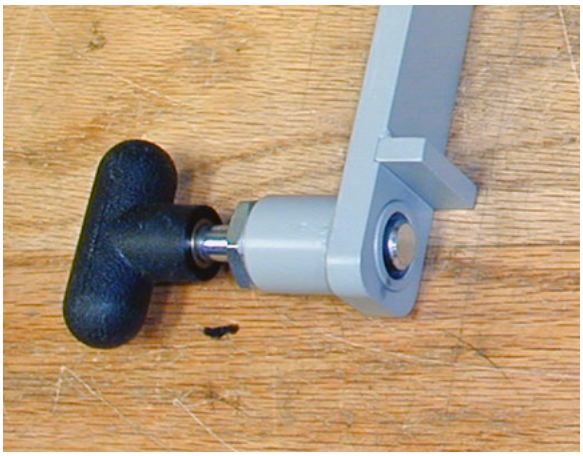


Figure 5-16
Handle spring loaded pin retracted

Figure 5-17
Handle and manifold on chamber

5.6 Place chamber in heating jacket.

5.6.1 Using the handle, carefully carry the assembled chamber to the autoclave.

5.6.2 Carefully lower the chamber into the heating jacket.

Figure 5-18
Place chamber into autoclave, remove handle

5.6.3 Remove the carrying handle.

5.6.4 Connect the pressurizing manifold to the brass coupling on the chamber lid. Tighten the manifold coupling nut using hand force only.

Figure 5-19
Attach valve and manifold

5.6.5 Connect the thermocouple cable to the thermocouple in the curing chamber lid.

Figure 5-20
Connect thermocouple cable

5.7 Pressurize the chamber

5.7.1 Connect the pressure source to the manual valve.

5.7.2 Open the manual valve at least one (1) and not more than two (2) full turns.

5.7.3 Operate the pressure source to increase the pressure inside the curing chamber to the desired initial value as required for the test. See API RP 10B.

5.7.4 Close the manual valve to retain the chamber pressure.

5.7.5 If desired, the pressure source may be disconnected.

Figure 5-21
Set initial chamber pressure

5.8 Running a test

5.8.1 Adjust the set point of the temperature controller to the desired maximum temperature. See API RP 10B for settings.

5.8.2 Program Temperature Control for a Test

5.8.2.1 From the home display, press [ ] until you reach **'ProG LiSt'**. Press. [ ]

5.8.2.2 Use the arrow keys to select the number of the program to be changed. Press. [ ]

5.8.2.3 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.

5.8.2.4 Continue to press [CA] until you have reviewed or changed the desired program values and return to the **'ProG LiSt'** display.

5.8.2.5 Press the Run/Hold button.

5.8.3 Turn the heater control switch to the on position.

5.8.4 Observe the temperature controller for flashing of the OP1 indicator and the temperature increasing. The temperature controller will continually turn on and off the heater until the slurry thermocouple reaches the desired temperature.

5.8.5 Frequently monitor the chamber pressure gauge as the slurry curing progresses. As the water inside heats up, it will expand and increase the pressure. Reduce the pressure by slowly opening the needle valve so the maximum pressure specified in API RP 10B is not exceeded. The automatic relief valve will bleed off potentially hazardous pressure (if it is properly adjusted).

CAUTION

Hot water and/or steam may be violently expelled when the needle valve is opened. Keep all body parts clear of the valve outlet when it is being opened.

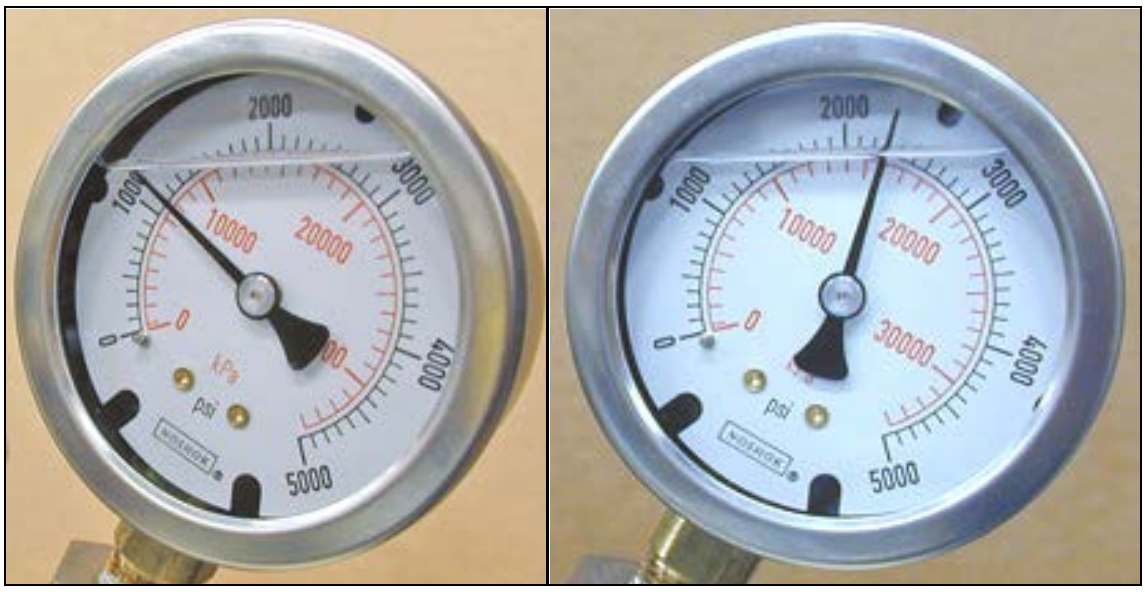


Figure 5-22
Initial pressure (left), increased pressure from temperature rise (right)

5.9 Ending the test

5.9.1 When the required curing period has ended, cool the sample and chamber, maintaining pressure, according to “Curing at Pressures Above Atmospheric” in API RP 10B.

5.9.2 At the specified time (see “Curing at Pressures Above Atmospheric” in API RP 10B), when the chamber has cooled, slowly release all remaining pressure by opening the needle valve.

CAUTION

Hot water and/or steam may be violently expelled when the needle valve is opened. Keep all body parts clear of the valve outlet when it is being opened.

5.9.3 Turn the heat switch to the OFF position.

5.10 Remove the chamber

5.10.1 Disconnect the cable from the thermocouple and lay the cable aside.

5.10.2 Remove the pressure manifold assembly and lay it aside.

5.10.3 If previously removed, re-attach the carrying handle and lift the chamber clear of the heating jacket and move it to the desired work area.

5.10.4 Unscrew the chamber lid using the wrenches provided. Remove the chamber lid and set it aside.

5.10.5 Remove the molds from the chamber using the mold lifting tool.

5.10.6 Follow the procedures in “Curing at Pressures Above Atmospheric” in API RP 10B to remove the cured cement specimens from the molds, process, and test them.

5.11 Cleaning the molds, pressure chamber, and autoclave

5.11.1 Wipe all cement remnants and grease from the molds, lid and inside of the chamber body. Pay particular attention to clean the threads and the O-ring groove in the lid.

5.11.2 Remove cement particles using a metal spatula or wire brush.

5.11.3 Remove any cement film by dipping the part in 15-20 percent hydrochloric acid. Let the parts sit for several minutes, then brush clean and rinse the parts thoroughly with water. Properly disposed of the waste acid.

5.11.4 Remove grease film with a solvent

5.11.5 Carefully dry the parts.

5.11.6 Inspect the lid O-ring for damage, and replace those which are damaged.

5.11.7 Clean and wipe all surfaces on the Cement Curing Autoclave.

6 Analyzing Results

The Cement Curing Autoclave cures cement slurry specimens for compressive strength testing by other instruments.

7 Troubleshooting and Maintenance

7.1 Eurotherm 2404 Temperature Calibration

The basic calibration of the Eurotherm 2404 temperature controller is highly stable and set for life. Rarely, it may be desired to offset the factory calibration to set the controller to another reference standard, to suit the characteristics of a particular installation, or to remove long term drift in the factory set calibration.

Should re-calibration be desired, see the Eurotherm 2404 thermocouple instruction manual for the detailed procedure.

7.2 Troubleshooting Tables

These tables are provided to assist in troubleshooting when a variety of problems arise while operating the Cement Curing Autoclave. Included in the tables are symptoms of the problem, possible causes of the problem, and possible solutions to the problem. The tables are grouped according to topic. The following troubleshooting tables are provided in this section:

- General troubleshooting
- Temperature troubleshooting
- Pressure troubleshooting
- Chamber lid troubleshooting

Table 7-1 Problems with General System

Problem or Symptom	Possible Cause	Corrective Action
The system does not power up.	The power fuses are blown.	Check/replace the power fuses located on the back of the unit. See Figure 7-4.
	The power switch has malfunctioned or failed.	Check/replace the power switch.
	The power wiring is faulty.	Check/repair the power wiring. Refer to the wiring diagram.
	The power source is disconnected or turned off.	Check the power source.

Figure 7-1
Power fuse holders

Table 7-2 Temperature Problems

Problem or Symptom	Possible Cause	Corrective Action
The system does not heat up, but the heater indicator in the temperature controller is on.	The heater wiring is faulty.	Check/repair the heater wiring. Refer to the wiring diagram.
	The over temperature switch has failed.	Check and/or replace the over-temp switch
	The heater malfunctioned or failed.	Check and/or replace the heater.
	Solid state heater relay has failed.	Check/replace, if necessary.
The system does not heat up, and the heater indicator in the temperature controller is off.	The heater fuses are blown.	Check/replace the heater fuses.
	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 (<1,000°F).	Possible open circuit in thermocouple or thermocouple cables.	Look for and repair the broken wire or loose connection.
The temperature reading is about room temperature even though the chamber is hot.	Possible short circuit in thermocouple or thermocouple cable.	Look for and repair the short in the thermocouple or thermocouple cable.

Table 7-3 Pressure Problems

Problem or Symptom	Possible Cause	Corrective Action
The system does not hold pressure.	The manifold has a leak.	Check, repair, or replace the manifold.
	The lid or chamber has a leak.	Check the lid O-ring seal for damage or debris on the surfaces, and clean or replace.
The pressure gauge does not zero.	The pressure gauge is faulty.	Test the pressure gauge, and replace if found faulty.

Table 7-4 Chamber Lid Problems

Problem or Symptom	Possible Cause	Corrective Action
The lid is difficult to install.	The lid and/or chamber threads are dirty.	Clean the lid and/or chamber threads.
	The O-ring is damaged or not properly lubricated.	Check and/or replace, and lubricate the lid O-ring.
	The O-ring seal area in chamber is dirty.	Clean the chamber.

8 Accessories

8.1 Hand Pressure Pump

An optional-purchase hand-operated pump can pressurize the sample up to 3,000 PSI.

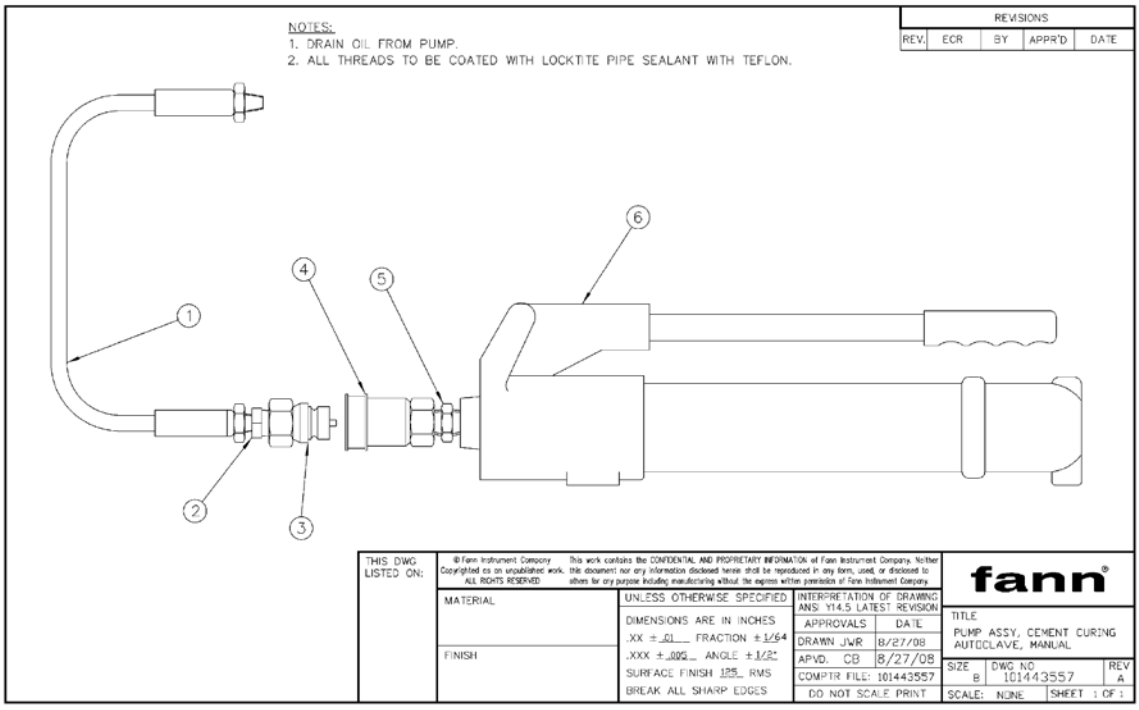


Figure 8-1
101443558 PUMP ASSY HYD CEMENT CURING AUTOCLAVE, HAND OPERATED

9 Parts Lists

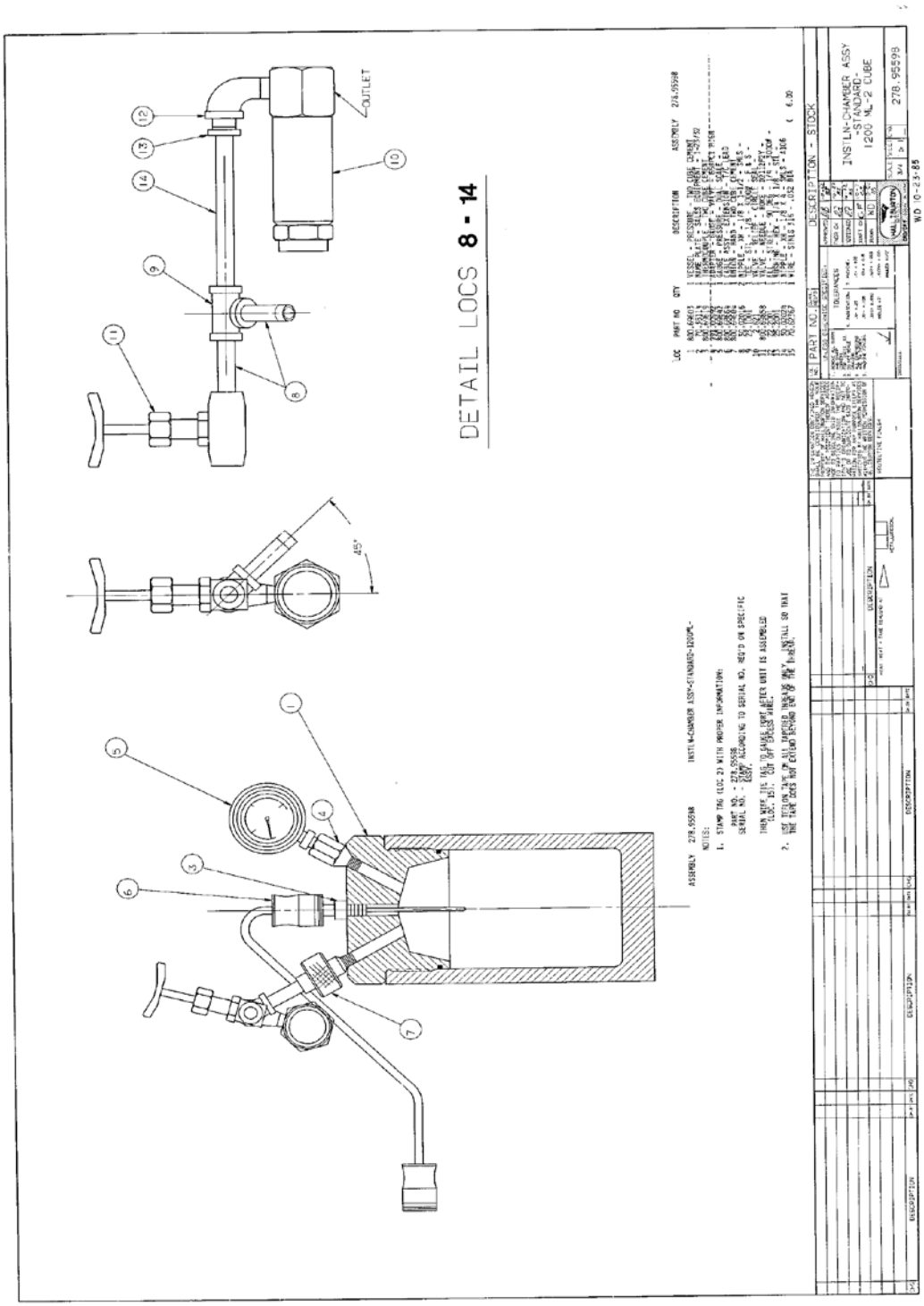


Figure 9-1
100053968 – Installation, Chamber Assembly, Standard, 1200ML, 2 Cube

Table 9-1 100053968 NX INSTALLATION, CHAMBER ASSEMBLY, STANDARD, 1200ML, 2 CUBE

Find#	Part/Mat'l#	Qty	Description
1	100072595	1	VESSEL, PRESSURE, TWO CUBE CEMENT AUTOCLAVE
2	100027334	1	NAME PLATE, SALES EQUIPMENT, 1-23/32X 2 3/4, BLANK, STAINLESS STEEL
3	100072610	1	THERMOCOUPLE, TWO CUBE CEMENT AUTOCLAVE, SPEC
4	100079376	1	ADAPTER, GAUGE, VALVE, 65HPC1, HIGH PRESSURE CHAMBER
5	101313632	1	GAUGE, PRESSURE, 0-5000 PSI, 2 1/2 INCH, DUAL SCALE PSI/KPA, STEM MOUNT WITH 1/4 NPT, STAINLESS STEEL CASE, SILICON FILLED, TOP CASE SAFETY RELIEF, SPECIFICATION D00092428
6	100072570	1	CABLE ASSEMBLY, EXTENSION, T/C LEAD WIRE, PLUG N, TYPE J, SPEC
7	100072596	1	UNION, HAND, TWO CUBE CEMENT AUTOCLAVE MANIFOLD, 5000 PSI
8	100016823	2	NIPPLE, EXTRA HEAVY, 1/8 X 1 1/2, SEAMLESS, A106
9	100016424	1	TEE, STEEL, 1/8, 3000#, F & S, SPEC 21.0003
10	100015197	1	VALVE, RELIEF, 1/4 MPT, 3000 PSI
11	100072631	1	VALVE, NEEDLE, HOKE, D2112F2Y, 1/8, 5000#, STR, 316 STAINLESS STEEL
12	100016381	1	ELBOW, 90 DEG, STREET, 1/4, 3000#, STEEL, F & S, SPEC 21.0003
13	100016494	1	BUSHING, HEXAGON, 1/4 X 1/8, FORGED STEEL, SPEC 21.0003
14	100016825	1	NIPPLE, EXTRA HEAVY, 1/8 X 4, SEAMLESS, A106
15	100030591	1	WIRE, STAINLESS STEEL 316, 0.032 DIA

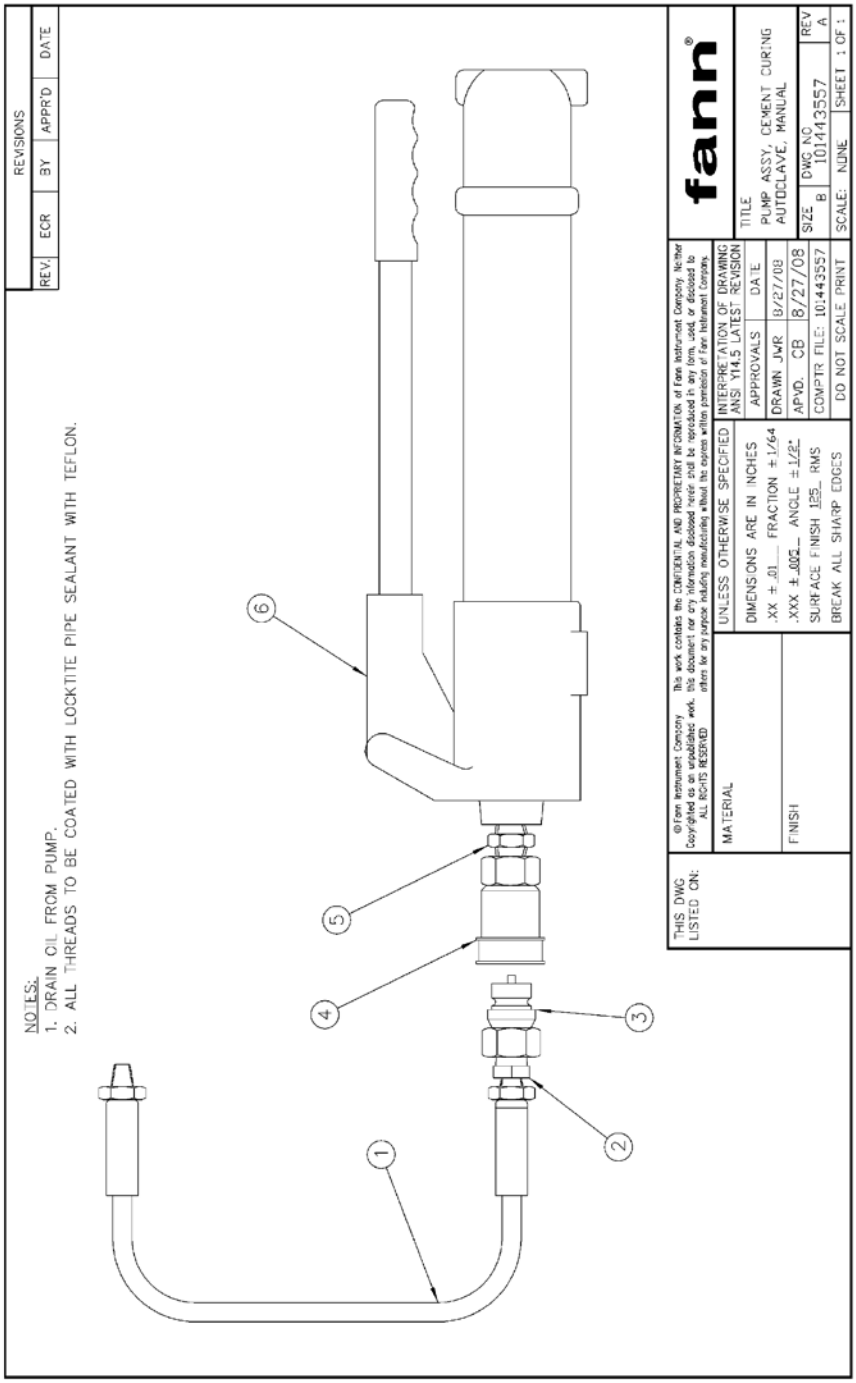


Figure 9-2
101443557 A PUMP ASSY HYD CEMENT CURING AUTOCLAVE, HAND OPERATED

Table 9-2 101443557 A PUMP ASSY HYD CEMENT CURING AUTOCLAVE, HAND OPERATED

Find#	Part/Mat'l#	Qty	Description
0001	209474	1.0	HOSE 3000 PSI 3 FT X 3/16in.
0002	206606	1.0	BUSHING 1/4 NPT X 1/8 NPT STAINLESS
0003	204008	1.0	COUPLING QUICK-DISCONNECT PLUG
0004	204009	1.0	COUPLING QUICK-DISCONNECT SOCK
0005	205583	1.0	NIPPLE 1/4 NPT HEX STAINLESS
0006	205204	1.0	PUMP HYDRAULIC HAND 10-000 PSI

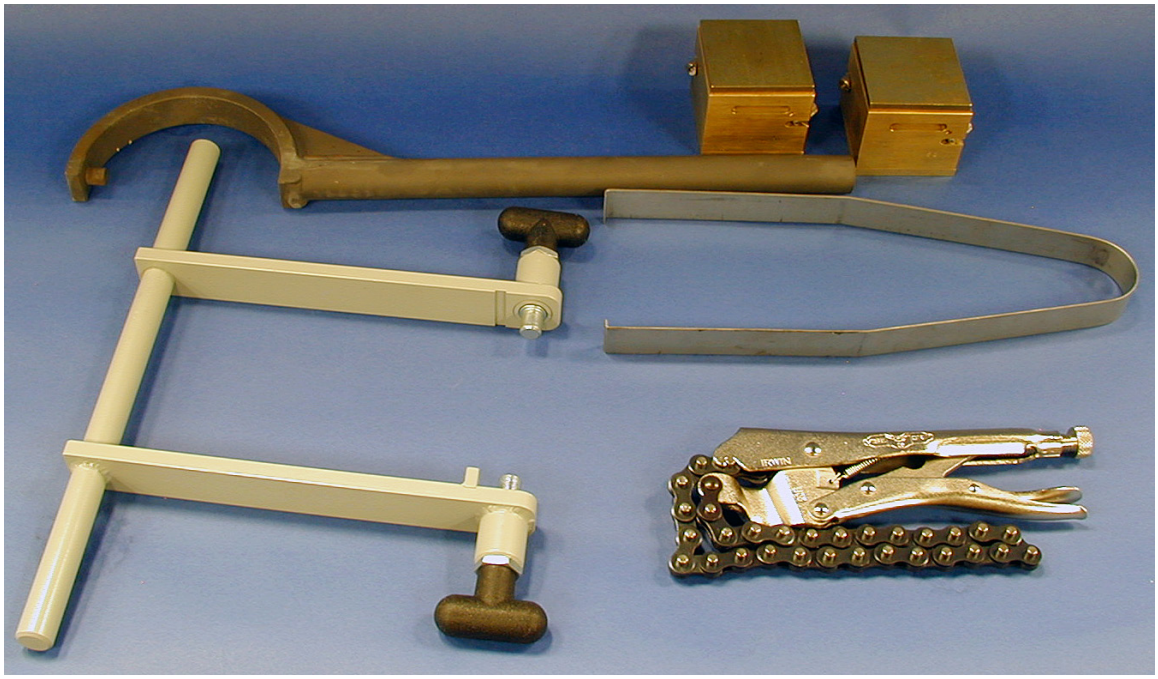


Figure 9-3
100053968 Kit, Installation, Tools & Manual (not shown)**, Autoclave, Standard, 1200ml**

Table 9-1 00053968 NX KIT, INSTALLATION, TOOLS & MANUAL, AUTOCLAVE, STANDARD, 1200ML

Find#	Part/Mat'l#	Qty	Description
1	100072605	1	WRENCH, PRESSURE VESSEL
2	100072577	1	MANUAL, OPERATORS, AUTOCLAVE, CEMENT CURING, 2 CUBE
3	100029847	1	VISE GRIP, CHAIN CLAMP, WITH 19 IN EXTENSION CHAIN, PETERSON MFG CO 20R
4	100012374	2	MOLD, CUBE, 2 IN, SINGLE CAVITY, MACHINED
7	100020334	1	CLAMP, CUBE MOLD, REMOVAL TOOL
8	101520490	1	HANDLE, CHAMBER, CEMENT CURING AUTOCLAVE

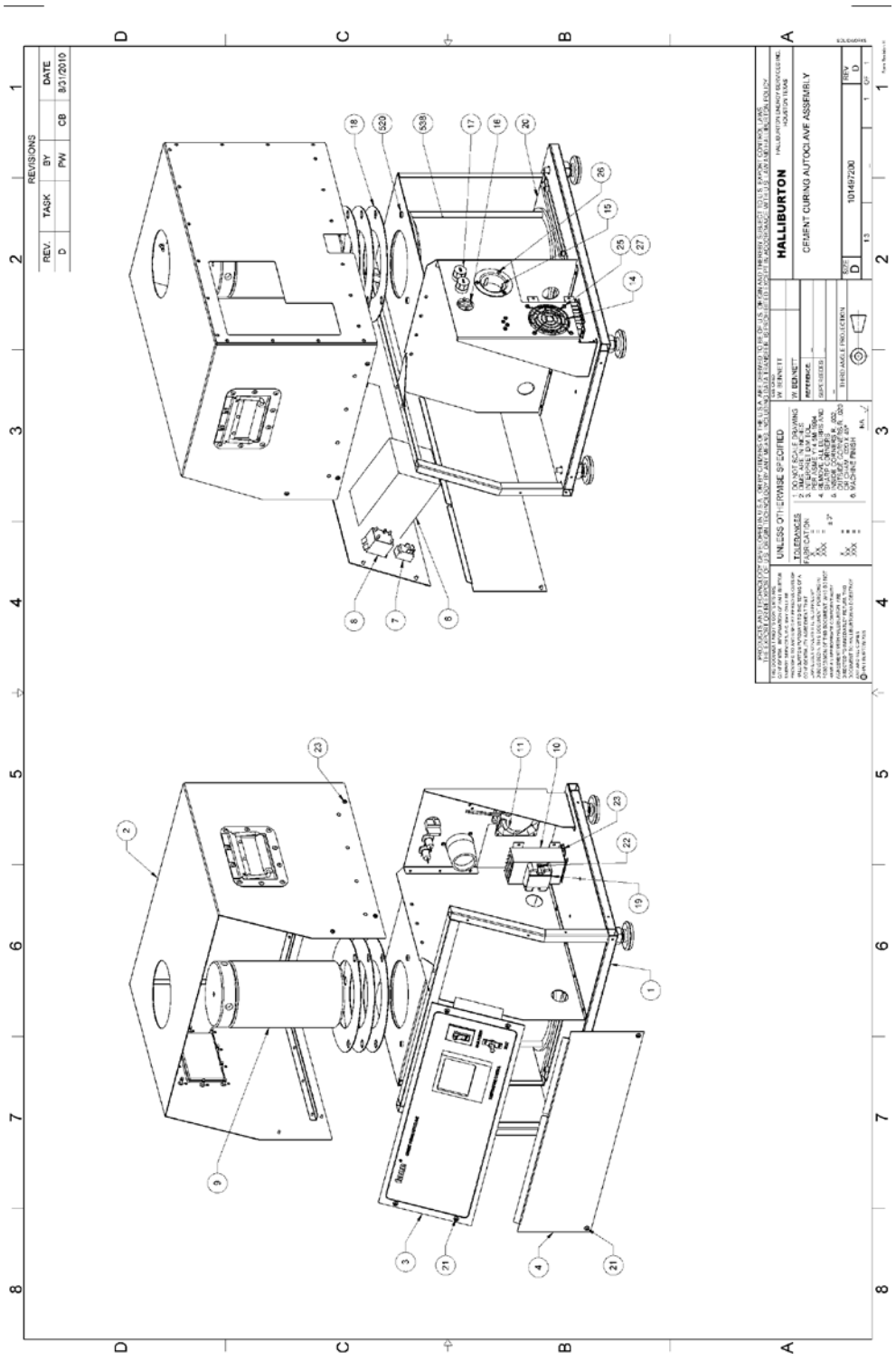


Figure 9-4
Assembly, Cement Curing Autoclave

Table 9-3 101497200 K CEMENT CURING AUTOCLAVE 115V TWO 2-INCH CUBE MOLDS

Find#	Part/Mat'l#	Qty	Description
0001	101497195	1.0	CHASSIS, CEMENT CURING AUTOCLAVE
0002	101497196	1.0	COVER, CEMENT CURING AUTOCLAVE
0003	101497201	1.0	FRONT PANEL, CEMENT CURING AUTOCLAVE
0004	389597	1.0	PANEL, ACCESS, UCA AUTOCLAVE
0005	100053966	1.0	KIT, INSTALLATION, TOOLS & MANUAL, AUTOCLAVE, STANDARD, 1200ML
0006	101848657	1.0	TEMP CONTROLLER EUROTHERM 2404. STANDARD PID WITH NON-ISOLATED LOGIC OUTPUT (CEMENT CURING AUTOCLAVE SETTINGS).
0007	100029446	1.0	SWITCH, TOGGLE, DPST, 0.468 DIA BUSHING, WITH SCREW LUGS, 3 AMP AT 250 VAC, 7590K4, CUTLER-HAMMER
0008	100034198	1.0	SWITCH, CIRCUIT BREAKER, DPST, 250 VAC, 50/60 HZ, 15 AMP, WITH NEON BULB
0009	100053968	1.0	INSTALLATION, CHAMBER ASSEMBLY, STANDARD, 1200ML, 2 CUBE
0010	100072627	1.0	HEAT SINK, FOR MODEL A1225 AND A2425 SOLID STATE RELAY, MODEL HS-2, CRYDOM CONTROLS
0011	204415	1.0	FAN 3.1in SQ X 1.5in. THK 115V 27 CFM
0014	204400	1.0	GUARD FAN FINGER 3 1/8in. f/80MM METAL
0015	101513739	1.0	CONNECTOR, FLANGED INLET, 20A 125V AC, 2 POLE 3 WIRE GROUNDING, NEMA L5-20P, WITHOUT PROTECTIVE BOOT
0016	100072391	1.0	PANEL MOUNT, SINGLE CIRCUIT, THERMOCOUPLE, JX CALIBRATION
0017	100002384	2.0	HOLDER, FUSE, PANEL MOUNTING, WATER TIGHT
0018	101497199	3.0	GASKET, HEATING JACKET, CEMENT CURING AUTOCLAVE
0019	101443970	1.0	SOLID STATE RELAY, DUAL OUTPUT, 25 A, OUTPUT 24-280 V AC, INPUT 17-32 V DC
0020	101497198	1.0	HEATER MOUNT, CEMENT CURING AUTOCLAVE
0021	101260861	6.0	SCREW, MACHINE, PAN HEAD, PHILLIPS, 10-32 UNF x 0.25, STAINLESS STEEL, 18-8
0022	101260665	2.0	SCREW, MACHINE, PAN HEAD, PHILLIPS, 8-32 UNC x 0.375, STAINLESS STEEL, 18-8
0023	101260661	8.0	SCREW, MACHINE, PAN HEAD, PHILLIPS, 8-32 UNC x 0.25, STAINLESS STEEL, 18-8
0025	101260800	4.0	SCREW, MACHINE, PAN HEAD, PHILLIPS, 6-32 UNC x 0.50, STAINLESS STEEL, 18-8

Find#	Part/Mat'l#	Qty	Description
0026	101260792	3.0	SCREW, MACHINE, PAN HEAD, PHILLIPS, 6-32 UNC x 0.25, STAINLESS STEEL, 18-8
0027	207632	3.0	NUT 6-32 HEX REGULAR STAINLESS
0028	101201164	3.0	WASHER - SPLIT LOCK - HELICAL SPRING - HI-COLLAR - #6 - STNLS
0029	100123894	4.0	SCREW, CAP, SOCKET HEAD, 1/4-20 NC X 3/8 STAINLESS STEEL
0030	120170188	6.0	SCR 5/16-18 X 1 LG LOW HEAD
0032	101520489	1.0	SPACER, CHAMBER, CEMENT CURING AUTOCLAVE
0034	100026189	7.0	CORD, PORTABLE, 3 X 1.5 SQ MM, VDE APPROVED TO HD-22, 450 V, 16.5 AMP, RUBBER JACKET, 9.6-12.5 MM OD, 60 DEG C, BROWN, BLUE, YELLOW/GREEN
0035	101513726	1.0	CONNECTOR, TWIST_LOCK, 20A, 125V, 2 POLE 3 WIRE GROUNDING, NEMA L5-20R
0036	402161	1.0	PLUG ELEC NEMA 5-20P 115V 20A
0037	100028609	3.0	SCREW, BIND HEAD, NUMBER 6-32 NC X 1/2, STAINLESS STEEL
0100	100031552	5.0	WIRE, 12 GA, STRANDED, WHITE/RED, TEFON,
0105	100031551	5.0	WIRE, 12 GA, STRANDED, WHITE/BLACK, TEFLON
0110	206214	3.0	WIRE 18 AWG TEFLON STRANDED GREEN
0119	100027842	1.0	RESISTOR, 68000 OHM, 1/2 WATT, 10%, OHMITE
0120	208521	3.0	WIRE 18 AWG PVC STRANDED BROWN
0121	208528	1.0	WIRE 18 AWG PVC STRANDED GRAY
0122	208529	1.5	WIRE 18 AWG PVC STRANDED WHITE
0123	101889599	3.0	Wire, Lead, High Temperature 842F/450C, Wire Gauge 18 AWG, Cable Type MG, Conductor Material Nickel Clad Copper, Stranding 16/30
0124	101889598	5.0	Wire, Lead, High Temperature 842F/450C Wire Gauge 12 AWG, Cable Type MG, Conductor Material Nickel Clad Copper, Stranding 65/30
0130	208522	2.0	WIRE 18 AWG PVC STRANDED BLACK
0150	204294	20.0	TIE WRAP 1/16in. TO 2in. DIAMETER
0152	205296	20.0	TIE WRAP ADHESIVE PAD
0155	208450	6.0	TERMINAL FORK 1/4 10-12 AWG
0165	203754	1.0	CONNECTOR HOUSING 4 COND 0.1
0166	203696	4.0	PIN CONNECTOR MOLEX
0175	208538	3.0	TERMINAL RING 1/4 TONGUE 18-14
0200	100033128	0.292	RAIL, MOUNTING, 35MM, X 1 METER, DIN,46277, SYMMETRICAL

Find#	Part/Mat'l#	Qty	Description
0205	100008175	10.0	BLOCK, MODULAR TERMINAL, SINGLE CONNECTOR, FEED THROUGH, GRAY, TYPE 9700A/6 S35
0210	100032909	1.0	PLATE, 6MM, END, TYPE 9701/6, SINGLE
0215	205166	2.0	CLAMP END 35mm DIN RAIL
0220	100032225	1.0	STRIP, RAPID MARKING, NUMBERS 1 THRU10, ELECTROVERT, P/N 9705A/6/10
0300	100072651	1.0	INSULATION, FIBROUS GLASS, 1200 DEGREE MAXIMUM, 1/2 INCH THICK X 60 INCH WIDE X 75 FEET LONG ROLL, VENDOR REF: INSULATION SERVICES, INC; TULSA, OK, TEMPERATURE MAT OR CLAREMAT 1200
0305	100030591	96.0	WIRE, STAINLESS STEEL 316, 0.032 DIA
0320	101475559	2.0	GROMMET, CIRCUIT CARD RESTRAINT BRACKET, SYSTEL 4232 COMPUTER
0325	365255	4.0	TERMINAL RING 10-12 AWG 10 HI TEMP HIGH TEMPERATURE RING TERMINAL NON-INSULATED 10 STUD SIZE 900 DEGREES F MAX
0340	100027339	1.0	NAME PLATE, ON, OFF, TOGGLE SWITCH, 15/32 SHANK, SPEMCO 1132
0350	100032008	4.0	TERMINAL, FEMALE, SLIP ON, FULLY INSULATED, FOR #10-12 GA WIRE, XS09788, HOLLINGSWORTH
0360	100032006	3.0	TERMINAL, FEMALE, SLIP ON, FULLY INSULATED, FOR 18-22 GA WIRE, XS09770S, HOLLINGSWORTH
0370	100032290	6.0	TERMINAL, CRIMP, SNAP SPADE, 22-16 AWG, RED, #8 STUD, TYPE 5, TOOL 1D, SPEC
0380	204299	4.0	TERMINAL FEMALE Q.C .25X.032 1
0390	203858	6.0	FERRULE INSUL 12 AWG WIRE
0400	100001414	14.0	TERMINAL, PIN, CRIMP, 16 AWG (1.5 SQ MM), WITH INSULATING COLLAR, SPEC
0410	100030882	3.0	SCREW, BIND HEAD, #10-32 UNF X 3/4, STAINLESS STEEL
0420	100032227	1.0	CONNECTOR, CROSS, 9703/6M, P/N Z7.211.0027, 1 METER, ELECTROVERT
0430	203428	4.0	6-32 X 2 RHMS STAINLESS
0505	100082949	2.0	CLAMP, HOSE, SAE #88, 4 11/16-6 OD, SPEC 70.15929
0510	100072612	5.0	HEATER, STRIP, 300 WATT, 120V, CHROMALOX, SNH09
0515	100072609	1.0	JACKET, HEATING, TWO CUBE CEMENT AUTOCLAVE
0525	100028760	3.0	SCREW, ROUND HEAD, MACHINE, NO 10-32 NF X 7/8, PL, SPEC 70.44247

Find#	Part/Mat'l#	Qty	Description
0530	100072603	1.0	BOTTOM, HEATING UNIT, TWO CUBE CEMENT AUTOCLAVE
0535	100072608	3.0	SPACER, SHORT, TWO CUBE CEMENT AUTOCLAVE
0538	100072607	3.0	SPACER, LONG, TWO CUBE CEMENT AUTOCLAVE
0540	100028683	3.0	SCREW, FLAT HEAD, MACHINE, 1/4-20 NC X 1 1/2
0545	100072600	1.0	BOTTOM, CASE, HEATING UNIT, TWO CUBE CEMENT AUTOCLAVE
0550	101886176	1.0	THERMOSTAT DISC 125/250 VAC 15/10 A 0.250 in. QUICK CONNECT TERMINALS
0565	100031352	30.0	WIRE, BUS BAR, 0.5W X 0.032 THK, PERFORATED, 23 AMP, MANGANESE, NICKEL
0570	100072601	1.0	COVER, CORE, HEATING UNIT, TWO CUBE CEMENT AUTOCLAVE
0580	203392	2.0	6-32 X 1/4 RHMS STAINLESS
0585	207487	2.0	6-32 X 1/4 BHMS STAINLESS
0590	203410	1.0	10-32 X 3/8 RHMS STAINLESS
0595	207633	1.0	NUT 10-32 HEX REGULAR STAINLESS
0598	207871	2.0	WASHER FLAT 10 STAINLESS STEEL
0599	208428	2.0	FUSE 3 AMP SLOW-BLOW 3AG

Table 9-4 101533369 J CEMENT CURING AUTOCLAVE 230V TWO 2-INCH CUBE MOLDS

Find#	Part/Mat'l#	Qty	Description
0001	101497195	1.0	CHASSIS, CEMENT CURING AUTOCLAVE
0002	101497196	1.0	COVER, CEMENT CURING AUTOCLAVE
0003	101497201	1.0	FRONT PANEL, CEMENT CURING AUTOCLAVE
0004	389597	1.0	PANEL, ACCESS, UCA AUTOCLAVE
0005	100053966	1.0	KIT, INSTALLATION, TOOLS & MANUAL, AUTOCLAVE, STANDARD, 1200ML
0006	101848657	1.0	TEMP CONTROLLER EUROTHERM 2404. STANDARD PID WITH NON-ISOLATED LOGIC OUTPUT with CEMENT CURING AUTOCLAVE settings.
0007	100029446	1.0	SWITCH, TOGGLE, DPST, 0.468 DIA BUSHING, WITH SCREW LUGS, 3 AMP AT 250 VAC, 7590K4, CUTLER-HAMMER
0008	100013123	1.0	SWITCH, CIRCUIT BREAKER, DPST, ELECTROMAGNETIC, 10 AMP, 220 V, 50/60 HZ, TYPE 203, NEON BULB

Find#	Part/Mat'l#	Qty	Description
0009	100053968	1.0	INSTALLATION, CHAMBER ASSEMBLY, STANDARD, 1200ML, 2 CUBE
0010	100072627	1.0	HEAT SINK, FOR MODEL A1225 AND A2425 SOLID STATE RELAY, MODEL HS-2, CRYDOM CONTROLS
0011	100032888	1.0	FAN, INSTRUMENT, 37 CFM, 50/60 HZ, 230VAC
0014	204400	1.0	GUARD FAN FINGER 3 1/8in. f/80MM METAL
0015	100031587	1.0	INLET, ELECTRICAL, FLANGED, 3 WIRE, 20 AMP, 250 VAC, TWIST LOCK, NO 2325, HUBBELL
0016	100072391	1.0	PANEL MOUNT, SINGLE CIRCUIT, THERMOCOUPLE, JX CALIBRATION
0017	100002384	2.0	HOLDER, FUSE, PANEL MOUNTING, WATER TIGHT
0018	101497199	3.0	GASKET, HEATING JACKET, CEMENT CURING AUTOCLAVE
0019	101443970	1.0	SOLID STATE RELAY, DUAL OUTPUT, 25 A, OUTPUT 24-280 V AC, INPUT 17-32 V DC
0020	101497198	1.0	HEATER MOUNT, CEMENT CURING AUTOCLAVE
0021	101260861	8.0	SCREW, MACHINE, PAN HEAD, PHILLIPS, 10-32 UNF x 0.25, STAINLESS STEEL, 18-8
0022	101260665	2.0	SCREW, MACHINE, PAN HEAD, PHILLIPS, 8-32 UNC x 0.375, STAINLESS STEEL, 18-8
0023	101260661	8.0	SCREW, MACHINE, PAN HEAD, PHILLIPS, 8-32 UNC x 0.25, STAINLESS STEEL, 18-8
0025	101260800	4.0	SCREW, MACHINE, PAN HEAD, PHILLIPS, 6-32 UNC x 0.50, STAINLESS STEEL, 18-8
0026	101260792	3.0	SCREW, MACHINE, PAN HEAD, PHILLIPS, 6-32 UNC x 0.25, STAINLESS STEEL, 18-8
0027	207632	3.0	NUT 6-32 HEX REGULAR STAINLESS
0028	101201164	3.0	WASHER - SPLIT LOCK - HELICAL SPRING - HI-COLLAR - #6 - STNLS
0029	100123894	4.0	SCREW, CAP, SOCKET HEAD, 1/4-20 NC X 3/8 STAINLESS STEEL
0030	120170188	6.0	SCR 5/16-18 X 1 LG LOW HEAD
0037	100028609	3.0	SCREW, BIND HEAD, NUMBER 6-32 NC X 1/2, STAINLESS STEEL
0100	100031552	5.0	WIRE, 12 GA, STRANDED, WHITE/RED, TEFON, SPEC 70.73453
0105	100031551	5.0	WIRE, 12 GA, STRANDED, WHITE/BLACK, TEFLON, SPEC 70.73453
0110	206214	3.0	WIRE 18 AWG TEFLON STRANDED GREEN
0119	100027804	1.0	RESISTOR, 100000 OHM, 1 WATT, 5%

Find#	Part/Mat'l#	Qty	Description
0120	208521	3.0	WIRE 18 AWG PVC STRANDED BROWN
0121	208528	1.0	WIRE 18 AWG PVC STRANDED GRAY
0122	208529	1.5	WIRE 18 AWG PVC STRANDED WHITE
0123	101889599	3.0	Wire, Lead, High Temperature 842F/450C, Wire Gauge 18 AWG, Cable Type MG, Conductor Material Nickel Clad Copper, Stranding 16/30
0124	101889598	5.0	Wire, Lead, High Temperature 842F/450C Wire Gauge 12 AWG, Cable Type MG, Conductor Material Nickel Clad Copper, Stranding 65/30
0130	208522	2.0	WIRE 18 AWG PVC STRANDED BLACK
0150	204294	20.0	TIE WRAP 1/16in. TO 2in. DIAMETER
0152	205296	20.0	TIE WRAP ADHESIVE PAD
0155	208450	6.0	TERMINAL FORK 1/4 10-12 AWG
0165	203754	1.0	CONNECTOR HOUSING 4 COND 0.1
0166	203696	4.0	PIN CONNECTOR MOLEX
0173	100024819	2.0	FUSE, 1 AMP, AGC1
0200	100033128	1.0	RAIL, MOUNTING, 35MM, X 1 METER, DIN,46277, SYMMETRICAL
0205	100008175	10.0	BLOCK, MODULAR TERMINAL, SINGLE CONNECTOR, FEED THROUGH, GRAY, TYPE 9700A/6 S35
0210	100032909	1.0	PLATE, 6MM, END, TYPE 9701/6, SINGLE
0215	205166	2.0	CLAMP END 35mm DIN RAIL
0220	100032225	1.0	STRIP, RAPID MARKING, NUMBERS 1 THRU10, ELECTROVERT, P/N 9705A/6/10
0300	100072651	1.0	INSULATION, FIBROUS GLASS, 1200 DEGREE MAXIMUM, 1/2 INCH THICK X 60 INCH WIDE X 75 FEET LONG ROLL, VENDOR REF: INSULATION SERVICES, INC; TULSA, OK, TEMPERATURE MAT OR CLAREMAT 1200
0305	100030591	96.0	WIRE, STAINLESS STEEL 316, 0.032 DIA
0325	365255	4.0	TERMINAL RING 10-12 AWG 10 HI TEMP HIGH TEMPERATURE RING TERMINAL NON-INSULATED 10 STUD SIZE 900 DEGREES F MAX
0330	208538	3.0	TERMINAL RING 1/4 TONGUE 18-14
0400	100023312	2.0	CLAMP, HOSE, 5 1/8-6 IN, STAINLESS STEEL
0405	100072615	5.0	HEATER, STRIP, 300 WATT, 240V, CHROMALOX, S-903
0410	100072609	1.0	JACKET, HEATING, TWO CUBE CEMENT AUTOCLAVE

Find#	Part/Mat'l#	Qty	Description
0415	100072601	1.0	COVER, CORE, HEATING UNIT, TWO CUBE CEMENT AUTOCLAVE
0420	100072608	3.0	SPACER, SHORT, TWO CUBE CEMENT AUTOCLAVE
0425	100072603	1.0	BOTTOM, HEATING UNIT, TWO CUBE CEMENT AUTOCLAVE
0430	101886176	1.0	THERMOSTAT DISC 125/250 VAC 15/10 A 0.250 in. QUICK CONNECT TERMINALS
0435	100031352	60.0	WIRE, BUS BAR, 0.5W X 0.032 THK, PERFORATED, 23 AMP, MANGANESE, NICKEL
0500	101520489	1.0	SPACER, CHAMBER, CEMENT CURING AUTOCLAVE
0530	100072235	1.0	CORD SET ASSEMBLY, ELECTRIC, 230V, CEMENT ANALYZER
0595	207633	8.0	NUT 10-32 HEX REGULAR STAINLESS
0610	100027339	1.0	NAME PLATE, ON, OFF, TOGGLE SWITCH, 15/32 SHANK, SPEMCO 1132
0620	100032008	4.0	TERMINAL, FEMALE, SLIP ON, FULLY INSULATED, FOR #10-12 GA WIRE, XS09788, HOLLINGSWORTH
0625	101475559	2.0	GROMMET, CIRCUIT CARD RESTRAINT BRACKET, SYSTEL 4232 COMPUTER
0630	100032006	3.0	TERMINAL, FEMALE, SLIP ON, FULLY INSULATED, FOR 18-22 GA WIRE, XS09770S, HOLLINGSWORTH
0640	100032290	6.0	TERMINAL, CRIMP, SNAP SPADE, 22-16 AWG, RED, #8 STUD, TYPE 5, TOOL 1D,
0650	204299	4.0	TERMINAL FEMALE Q.C .25X.032 1
0660	203858	6.0	FERRULE INSUL 12 AWG WIRE
0670	100001414	14.0	TERMINAL, PIN, CRIMP, 16 AWG (1.5 SQ MM), WITH INSULATING COLLAR,
0680	100028683	3.0	SCREW, FLAT HEAD, MACHINE, 1/4-20 NC X 1 1/2, PL
0690	100072600	1.0	BOTTOM, CASE, HEATING UNIT, TWO CUBE CEMENT AUTOCLAVE
0700	100030882	3.0	SCREW, BIND HEAD, #10-32 UNF X 3/4, STAINLESS STEEL
0710	100032227	1.0	CONNECTOR, CROSS, 9703/6M, P/N Z7.211.0027, 1 METER, ELECTROVERT
0720	203428	4.0	6-32 X 2 RHMS STAINLESS
0730	100072607	3.0	SPACER, LONG, TWO CUBE CEMENT AUTOCLAVE

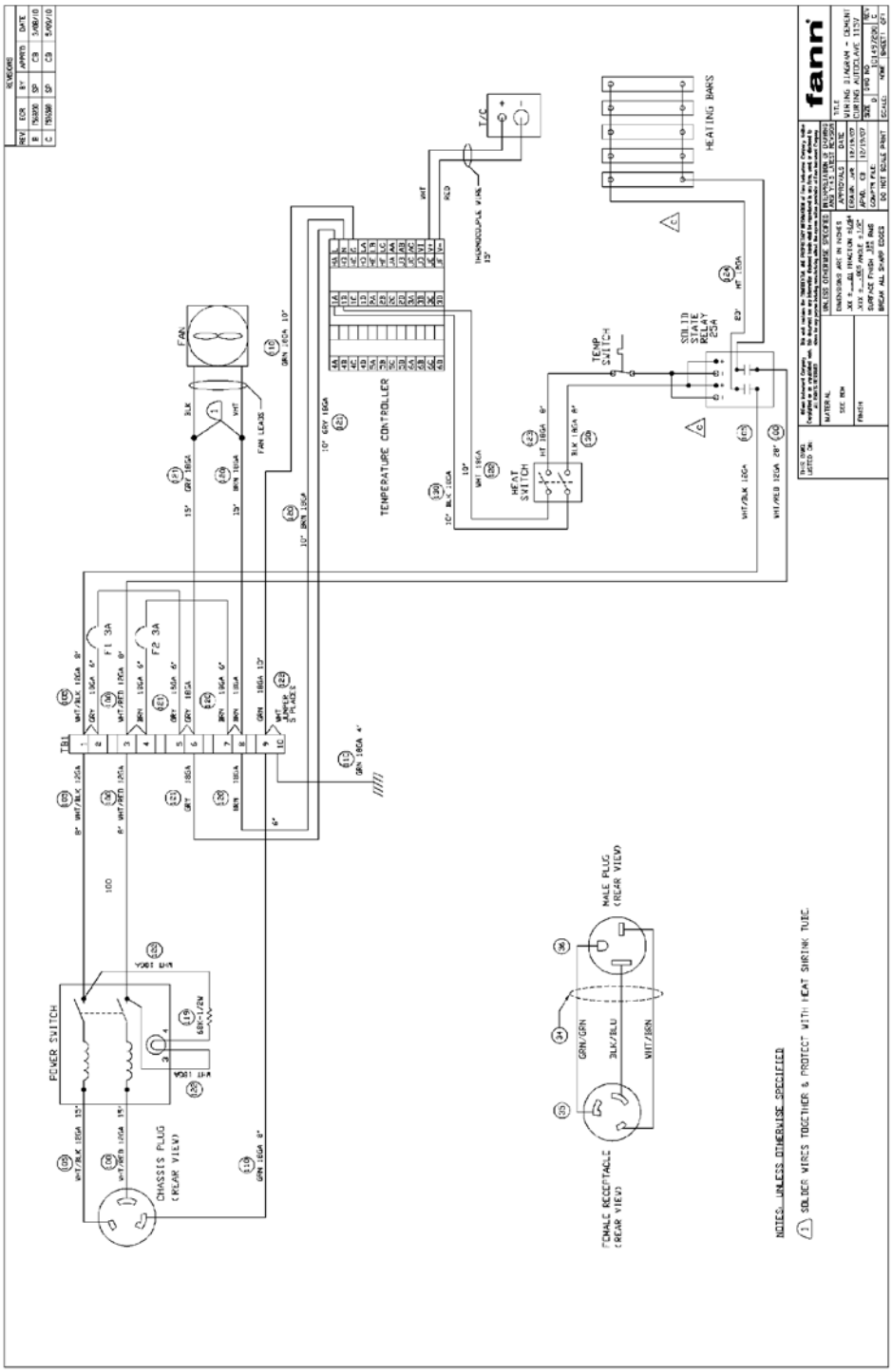


Figure 9-5
Electrical Schematic – 115V Cement Curing Autoclave

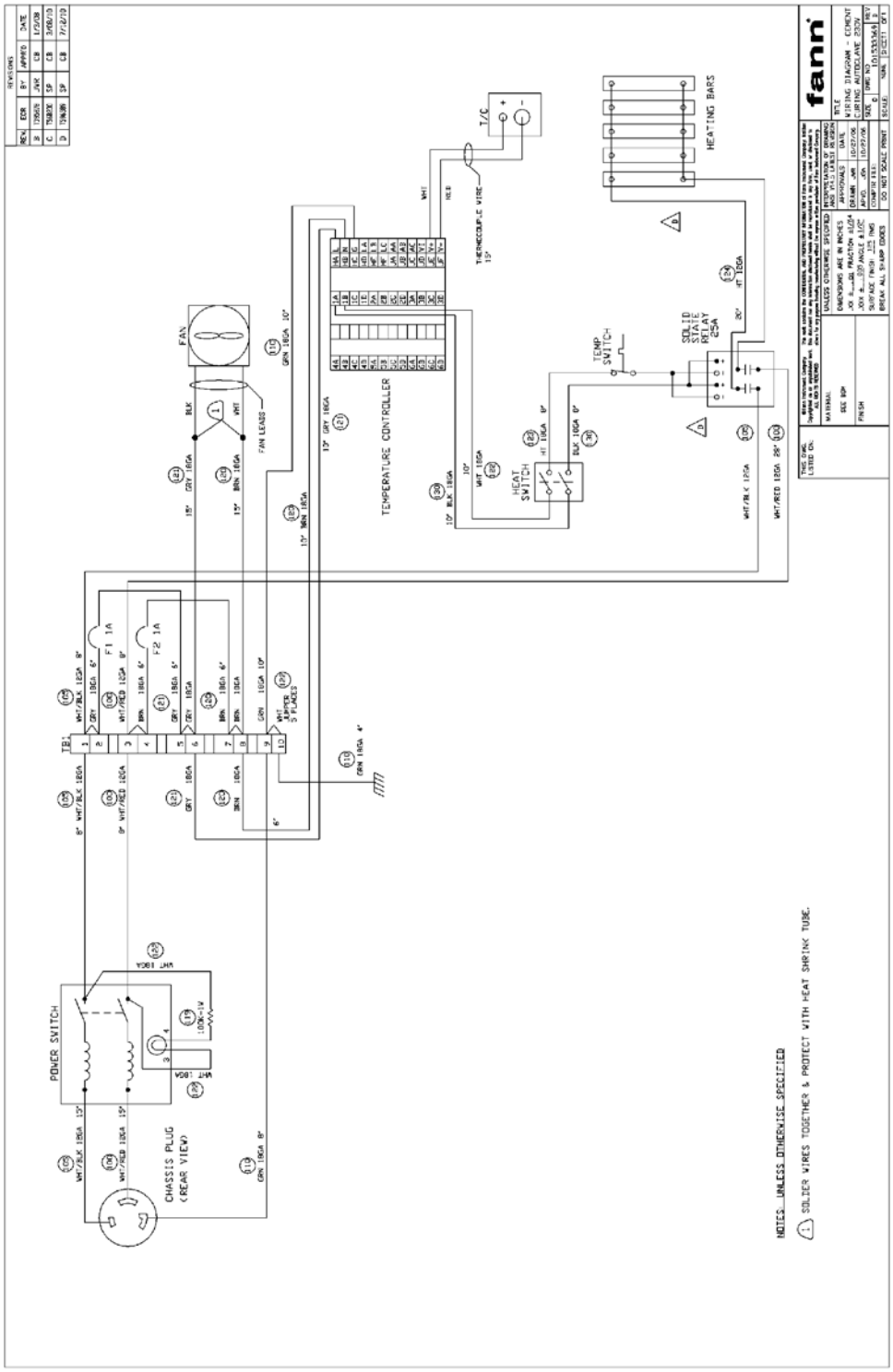


Figure 9-7
Electrical Schematic – 230V Cement Curing Autoclave

10 Warranty and Returns

10.1 Warranty

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® is not 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, include information regarding the reason the item is being returned.

See the Contact FANN® section at the front of this manual to obtain correspondence and shipping addresses.