Ultrasonic Cement Analyzer (UCA) System
User Manual

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Revision B

Ultrasonic Cement Analyzer (UCA) System User Manual

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Houston, Texas, USA

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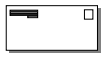

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1 Introduction

1.1 Functional subsystems:

The UCA Autoclave contains the cement slurry sample, heating and cooling jacket, temperature controller, pressure gauge, and ultrasonic transducers. This device is the subject of this user manual. Each UCA Autoclave connects to the UCA Processor by data, trigger, and temperature cables.

The UCA Processor contains the computer, pulse trigger, data acquisition, storage, and display. The Processor connects to up to eight UCA Autoclaves through data, trigger, and temperature cables.

The UCA Pressure Source provides the hydraulic pressure to the cement slurry sample chamber contained in the UCA Autoclave. Each UCA Autoclave must be connected to a pressure source independently or through a common pressure system manifold. Two Sources are available; 6,000 psi and 20,000 psi.

The UCA System is designed for conformance with relevant standards and practices as published by API Subcommittee 10 on Well Cements.

1.2 Function

The UCA System performs nondestructive compressive-strength tests on cement slurry samples. These tests are conducted under simulated down-hole pressure and temperature conditions to determine the initial set time and the wait-on-cement (WOC) time of a slurry sample.

The initial set time is the time required for freshly mixed cement slurry to reach a compressive strength of 50 pounds per square inch (psi). This test helps provide an indication of the compressive-strength behavior of a sample.

The WOC time is the time required for the slurry to reach a compressive strength of 500 psi. This test helps to determine how much time should be allowed for the slurry to set during one stage of a cementing operation before the next stage can begin.

The UCA System is used to determine not only these two specific times, but also a continuous trend in the development of compressive strength in a sample.

In a compressive-strength test, the UCA System applies an ultrasonic (high-frequency sound) pulse to a cement slurry sample and measures the length of time required for the sound wave to travel completely through the sample. As the cement hardens, the wave travels faster and takes a shorter time to reach the other end of the sample. The UCA System converts this length of time, called transit time, to compressive strength for many sample points during a test. The UCA System records the compressive strengths and the times at

which they occur to compile a set of data that can then be analyzed to help plan a cementing schedule for a well.

1.3 UCA Processor

The Ultrasonic Cement Analyzer provides a non-destructive method for determining the relative strength development of a cement sample under down-hole temperature and pressure conditions. The theory of operation is based on the correlation between ultrasonic pulse velocity in the cement sample and its compressive strength. Strength indications are determined by measuring the change in velocity of an ultrasonic signal transmitted through the cement sample as it cures.

The UCA controller software is at the heart of ultrasonic cement testing system. The software controls the computer which in turn controls the autoclave.

The UCA controller software controls the ultrasonic subsystem. It triggers the sending of the ultrasonic pulse through the sample inside the autoclave and in return measures the ultrasonic waveform at the other end of the sample. The software then analyzes this to calculate the transit time.

Because the software knows the initial transit time, the software can calculate the compressive strength for each subsequent transit time measurement.

At the same time, the software also measures the current temperature and setpoint and plots all the information on an easy-to-see results graph.

The software also communicates with the temperature controller in the autoclave to read and write the desired temperature profile information.

1.3.1 Features

1.3.1.1 UCA Controller List of Features

- Up to eight autoclaves can be controlled and monitored independently.
- Temperature Profile on the autoclave can be read or written to by the controller.
- Results graph can be maximized to any size up to full screen.
- Cursor can be put on the results graph to read out any point on the graph.
- Graph can be zoomed into to view more details.
- Start Test Wizard walks the user through starting a test.
- Fool-proof wizard prevents starting a test before all steps are completed.

- Up to four strength events can set by the user to trigger and record the resultant time.
- Up to four time events can be set by the user to trigger and record the resultant strength.

1.3.1.2 Data Manager List of Features

- Full recharacterization of data is possible if the operator makes an error at initial data entry. This includes cement type and units of measurement.
- Print to printer or PDF file in accompanying data manager software.
- Data can be saved to spreadsheet file formats, such as TXT and CSV.
- Strength and time events can be recast for any value.
- Print with or without a user-defined cursor.
- Zoom to an area of interest.

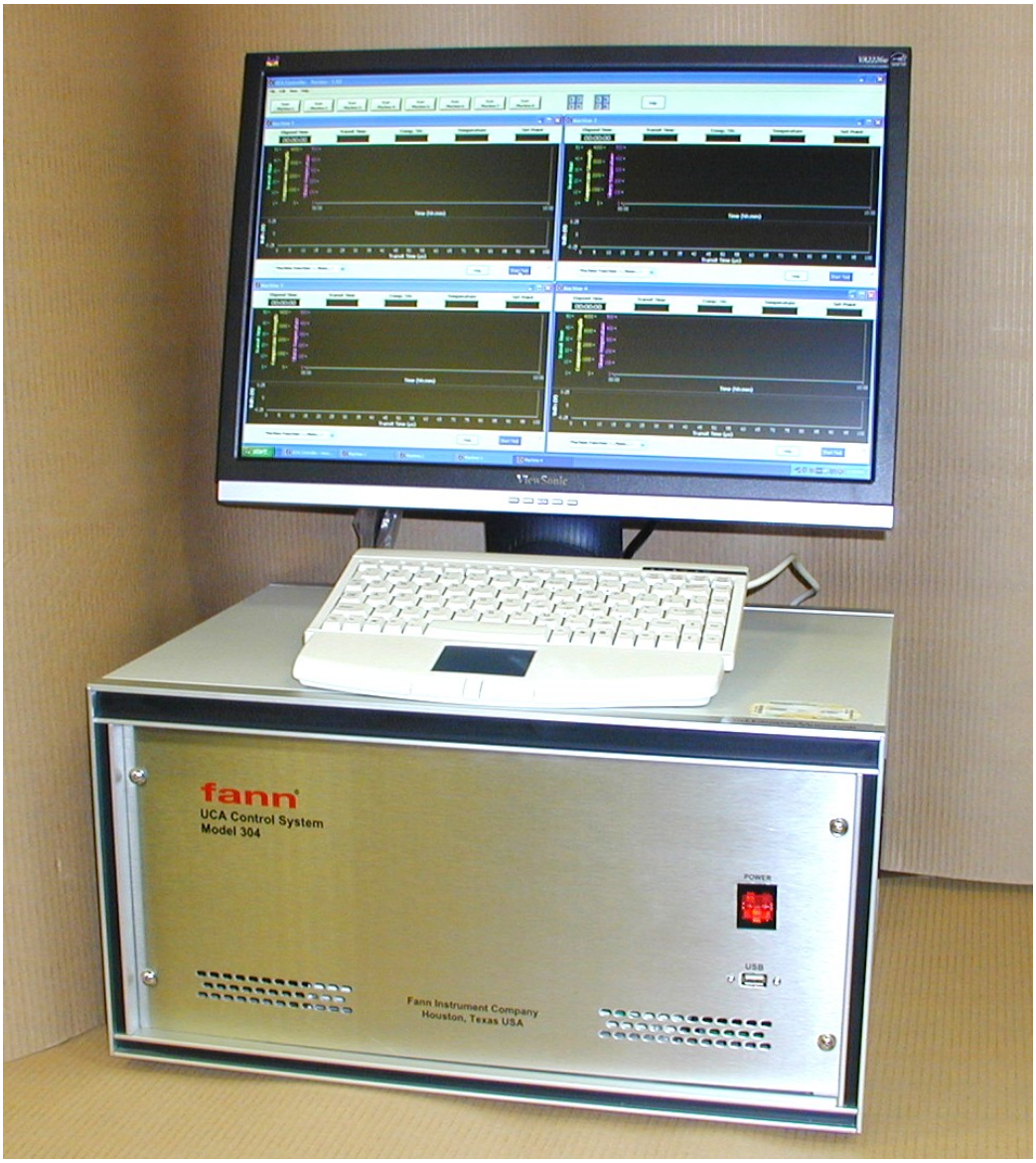


Figure 1-1
UCA processor front view

Figure 1-2
UCA processor back view

1.4 UCA Autoclave

The UCA Autoclave contains the cement slurry sample under test in a high strength steel test chamber, suitable for tests up to 20,000 psi and 400°F. This test chamber holds a metal-sheathed thermocouple in direct contact with the cement slurry or in the water surrounding the sample. Two ultrasonic transducers are centrally located above and below the sample to permit transit time measurement.

A spring loaded heating jacket maintains physical contact with the test chamber to maximize heat transfer to the sample. Cooling tubes are cast into the heating jacket for end-of-test cooling.

Each UCA Autoclave contains a dedicated temperature controller to individually regulate the sample heating rate. The temperature data is passed to the UCA Processor for display and recording with other test data. A switch turns off the heating system while the temperature controller is programmed before a test begins.

The Chamber Supply valve allows hydraulic pressure from the UCA Pressure Source to enter the test chamber. After the chamber is at the desired pressure, this valve is normally closed during a test.

The Chamber Vent valve allows hydraulic pressure in the test chamber to be released. This valve is normally closed during a test.

A front-mounted pressure gauge constantly provides immediate information about the pressure inside the sample chamber.

The Coolant Supply valve allows coolant, normally water, to flow through the cooling coils that are integral to the heating jacket. During a test, this valve is normally closed.

Two coaxial cables (labeled Data and Trigger) connect the UCA Autoclave to the UCA Processor. An 8-conductor cable between the UCA Autoclave and UCA Processor permits the sample temperature to be recorded during a test.

Figure 1-3
UCA autoclave front view

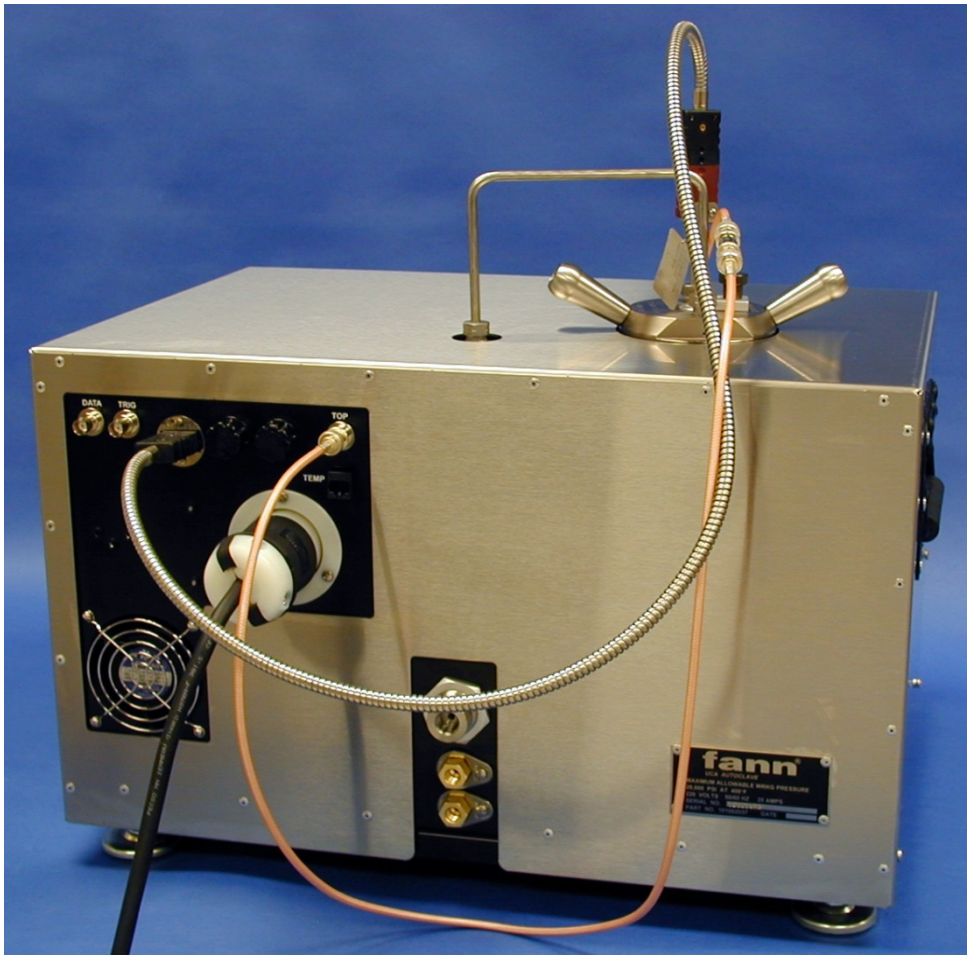


Figure 1-4
UCA autoclave back view

1.5 UCA Pressure Source

Two different models of the UCA Pressure Source provide hydraulic pressure to the UCA Autoclave(s). This pressure can be supplied directly to a single UCA Autoclave, or through a manifold to supply pressure to a maximum of four (4) UCA Autoclaves.

Figure 1-5
UCA pressure source front view

Figure 1-6
UCA pressure source back view

2 Safety

2.1 Machine Hazards

2.1.1 Pressure

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

Domestic water is often used to cool the instrument. In some labs, a closed loop chilled water system is used for cooling. Internal to the instrument, the coolant supply and drain lines are copper. Externally, these may be plastic or copper. Shut off the cooling supply line external to the instrument before working on it. The drain line does not have pressure in it, and it does not need to be disconnected, unless it is connected to a chilled water return line. The external cooling supply lines may be plastic.

The high pressure lines present the greatest hazard as they can hold as much as 20,000 psi. These lines are ¼ in. OD stainless steel. Operators must ensure that the pressure in these lines has been reduced to zero before attempting to disassemble any high pressure lines. Open the Chamber Vent valve shown in the section on Controls and Indicators. Confirm that all pressure in the system has been relieved using the pressure gauge on the front panel.

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. Before removing the pressure chamber or performing any work on the heating jacket, use the cooling system to lower the temperature to at least 120°F (49°C). Monitor the temperature by observing the temperature controller display when the chamber is in the heating jacket. The coolant return line can be very hot [212°F (100°C)] at the beginning of a post-test cool down.

2.1.3 Electrical

The power source for the UCA Autoclave is 230 Volts. There are still electrically active terminals inside the instrument when the power switch is turned off. Disconnect the power from the plug before attempting any electrical or mechanical maintenance. Refer to the electrical schematic before performing any maintenance or troubleshooting.

2.2 Ergonomic Considerations

After the UCA Autoclave is installed, it is uncommon for it to be frequently moved. The physical location needs to have access to the required electric,

hydraulic, and cooling lines, and be sufficiently sturdy to support the combined weight of the UCA Autoclave and sample chamber, which can approach 150 pounds lb (68 kg).

In routine cement slurry testing, the 25–30 lb (11. 4–13. 6 kg) sample chamber must be lifted fully from the heating jacket a distance of about 10 in (25 cm). Placing the top surface of the UCA Autoclave at 24–36 in (61–91 cm) from the floor is an appropriate height for most people to lift the sample chamber.

3 Features and Specifications

Table 3-1 UCA Autoclave Specifications

Category	Specification
Maximum Temperature	400°F (205°C)
Maximum Pressure	20,000 psi (138 mega Pascal [MPa])
Heating Rate	8°F (4. 4°C) per minute maximum
Cup Volume	7 ounces (oz) (200 milliliters [ml])
Width	21 inches (in) (53 centimeters [cm])
Depth	16 in (41 cm)
Height	14 in (36 cm)
Weight	115 pounds (lb) (52 kilograms [kg])
Pressure Connection	F250C Autoclave, located on the rear
Cooling Supply and Drain	⅛FNPT located on the rear
• Water	• 30 psi min. (0. 21 MPa), Filtered - 250 micron/60-mesh
• Water Drain	• 212°F (100°C)
• Coolant	• 10 psi min. (0. 07 MPa). (can be water)
• Coolant Drain	• 212°F (100°C). (can be connected to water drain if water is used as coolant)
Voltage and Current	230 Volts (VAC), single phase, 50–60 Hertz (Hz), 20 ampere (amp) service, National Electrical Manufacturers Association (NEMA) 6–15P plug provided

Table 3-2 UCA Processor Specifications

Category	Specification
Width	21 inches (in) (53 centimeters [cm])
Depth	13 in (33 cm)
Height	21. 6 in (55 cm)
Weight	30 pounds (lb) (14 kilograms [kg])
Voltage and Current	115 or 230 Volts (VAC), single phase, 50–60 Hertz (Hz), 15 ampere (amp) service, National Electrical Manufacturers Association (NEMA) 5-15P and 6–15P plugs provided

Table 3-3 UCA Pressure Source Specifications

Category	Specification
Maximum Pressure	6,000 psi (42 mega Pascal [MPa]) or 20,000 psi (138 MPa)
Width	21 inches (in) (53 centimeters [cm])
Depth	16 in (41 cm)
Height	14 in (36 cm)
Weight 6,000 psi 20,000 psi	100 pounds (lb) (45 kilograms [kg]) 70 pounds (lb) (32 kg)
Pressure Connection	F250C Autoclave, located on the rear
Air, Cooling Supply and Drain	1/4FNPT located on the rear
• Air	• 80-120 psi (0. 55-0. 83 MPa)
• Coolant Supply	• 30-80 psi (0. 21-0. 55 MPa), Filtered - 250 micron/60-mesh
• Coolant Drain	• can be connected to water drain if water is used as coolant
Voltage and Current	Not required

3.1 UCA Autoclave Mechanical

The Chamber Supply and Chamber Vent are manual valves that control the pressure going into and coming out of the sample chamber. During testing, the Chamber Supply valve is normally open.

The Chamber Pressure is a pressure gauge that indicates the pressure applied by the pressure source.

The Coolant Supply is a manual valve that allows coolant (normally water) to flow through the heating and cooling jacket. During testing, this valve is normally closed.

The high pressure sub-system is protected by a burst disc that limits the pressure and safely controls the release of over-pressure.

3.2 UCA Autoclave Controls and Indicators

The Main Power switch illuminates when electric power is applied to the UCA 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 apparatus.

The Temperature Controller regulates the power applied to the heater circuit to achieve and maintain the desired temperature inside the sample chamber. It constantly compares the desired temperature (set point) to the temperature reading from the sample chamber thermocouple.

3.3 UCA Processor

When the UCA Control System Software is first started, it displays the main screen as shown in Figure 3-1.

3.3.1 Main Screen

This is the first screen that displays when the program is opened. Descriptions of some of the components of this screen follow.

Figure 3-1
UCA processor main screen

3.3.1.1 Menu Bar

The menu bar allows the user to access some of the overall functions of the program. Use the menu bar to set the system configuration, display windows, and view the various machines. The menu bar of the program has following items:

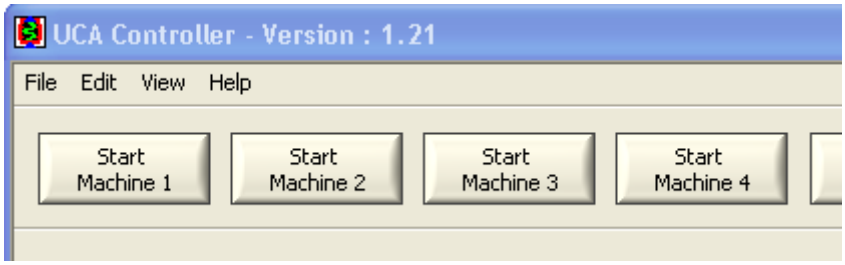


Figure 3-2
Menu bar

3.3.1.2 File

The File menu currently has only one menu item called Exit. The Exit menu item closes the program.

3.3.1.3 Edit

The Edit menu has two menu items. These two menu items are explained below:

3.3.1.3.1 Screen Layout

Use this item to set up the visualization of various machine windows. Refer to *4.8 Select Machine Quadrants* for detailed information on how to set up the screen layout.

3.3.1.3.2 System Configuration

Use this item to set system parameters. The system parameters are set up once at the time of the machine installation. Refer to *4.7.1 Configure System* for detailed information about setting up system parameters.

3.3.1.4 View

Use the items under the View menu to generate windows for each machine or use the two Tile menu items to open windows for four machines at a time. All the functionality of the View menu is available on the tool bar for quick access.

3.3.1.5 Help

The item called Online Help opens this help file. The About menu item opens the about dialog box that shows the current revision of the software.

3.3.1.6 Tool Bar

The tool bar gives access to all the day-to-day functionality of the program. From here, the user can open the machine interface for individual machines or view a set of four user-defined machines in neatly arranged tile form.

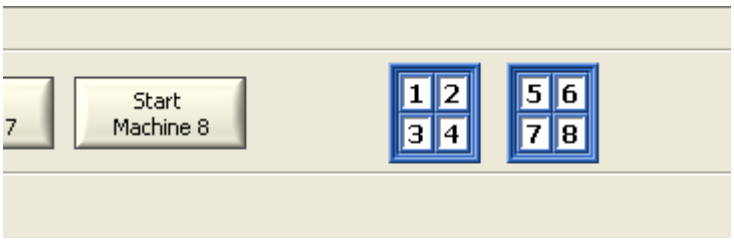


Figure 3-3
Start machine buttons and tile buttons

3.3.1.7 Start Machine Buttons

There are eight Start Machine buttons which are used to bring up the user interface for machines 1 to 8 respectively. Clicking these buttons will open a window for each machine. If the machine window is already open, then clicking the button will bring it to front and make it active.

3.3.1.8 Tile Buttons

There are two tile buttons on the tool bar that, when clicked, will open a set of four machines according to the layout depicted on each of the tile buttons. All four machines opened will be neatly tiled according to the position reflected on the tile. Refer to *4.8 Select Machine Quadrants* to understand how to configure each of these tile buttons.

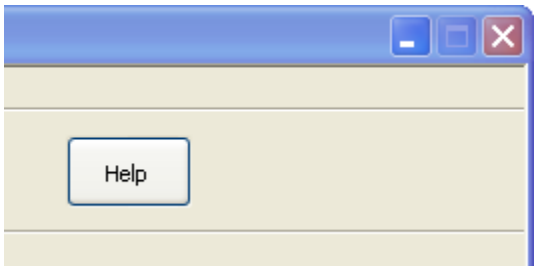


Figure 3-4
Help button

3.3.1.9 Help Button

Clicking the Help button brings up this particular section of online help.

To exit this software, use the close button or use the menu item **File** > ☐Exit

NOTE

The software cannot be closed or exited if any of the machine windows are open. Please close each machine window before trying to exit the program.

NOTE

The machine windows cannot be closed or exited if any of the machines has a test running. Please stop the test before trying to close the machine windows.

Related Topics: *4.7.1 Configure System, 4.8 Select Machine Quadrants, 3.3.2 Machine Interface*

3.3.2 Machine Interface

Clicking on any of the buttons in the Main Screen (see *3.3.1 Main Screen*) opens up the respective machine interface. The machine interface window can be resized by clicking the maximize button or by dragging the edge of the window to the desired size. The respective plots will scale according to the size of the window.

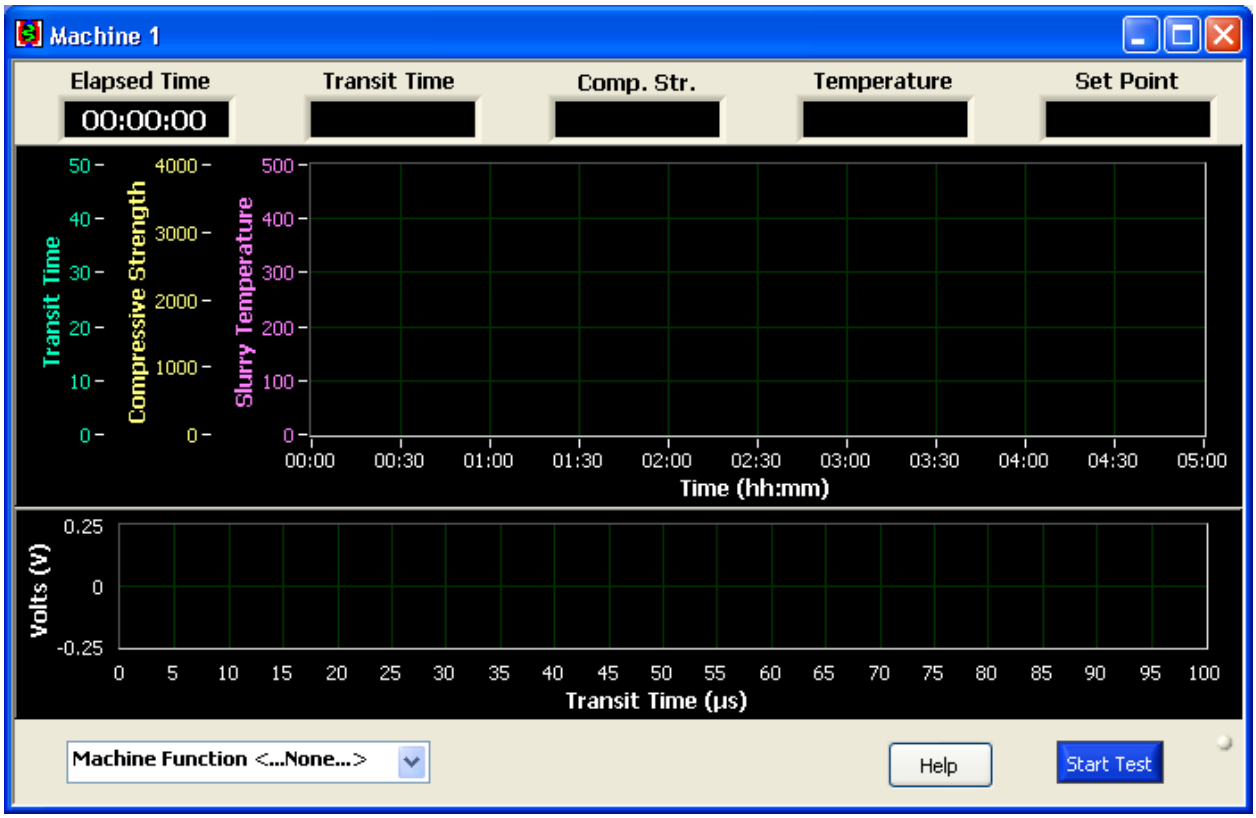


Figure 3-5
Machine interface window

3.3.2.1 Machine Interface Window

3.3.2.1.1 Title Bar

The window title bar indicates which machine the window is referring to. For example, if Machine 1 is idle, the window says “Machine 1”. If a test has been started on this machine, it will change to “Machine 1 Test Started <Date> <Time>”, where <Date> and <Time> refer to when the test was started.

Figure 3-6
Title bar

Double clicking on the title bar will maximize the window so that it occupies the entire screen space. If the window is already maximized, it will restore it to previous position and size.

3.3.2.1.2 Elapsed Time

This indicator displays elapsed time in HH:MM:SS format. The elapsed time is reset at the beginning of the test and counts upward to indicate the total amount of time the test has run. This parameter is plotted along the x-axis of the Results Graph (see *Figure 5-12 Results graph and signal graph*).

3.3.2.1.3 Transit Time

This indicator displays transit time in µs. The transit time is the amount of time it takes for the ultrasonic waves to travel through the cement sample. The transit time is plotted along one of the three y-axes of the Results Graph (see *Figure 5-12 Results graph and signal graph*).

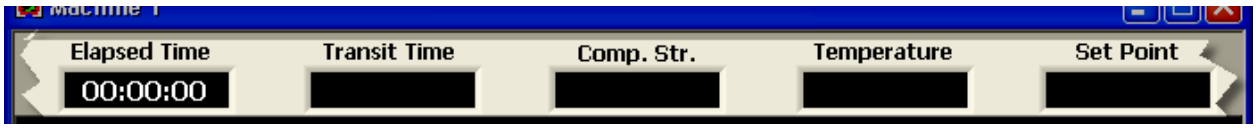


Figure 3-7
Indicators

3.3.2.1.4 Comp. Str.

The compressive strength derived from ultrasonic analysis is displayed in this screen. The units of measurement for compressive strength can be PSI or MPa. Refer to *4.7.1 Configure System* on how to set up the desired units. Compressive strength is plotted on one of the three y-axes of the Results Graph (see *Figure 5-12 Results graph and signal graph*).

3.3.2.1.5 Temperature

This indicates the current temperature of the system. The temperature is read directly from the temperature controller on the autoclave unit. Use *Configure System* to set up the units of temperature measurement.

Temperature is also plotted on the y-axis of the Results Graph (see *Figure 5-12 Results graph and signal graph*).

3.3.2.1.6 Changing Parameter Color

Right clicking on transit time, compressive strength, or temperature and selecting Color opens up a color selection box. Users may choose the color of their choice for each of these parameters. Clicking a color changes the plot, scale, and indicator color to the color selected.

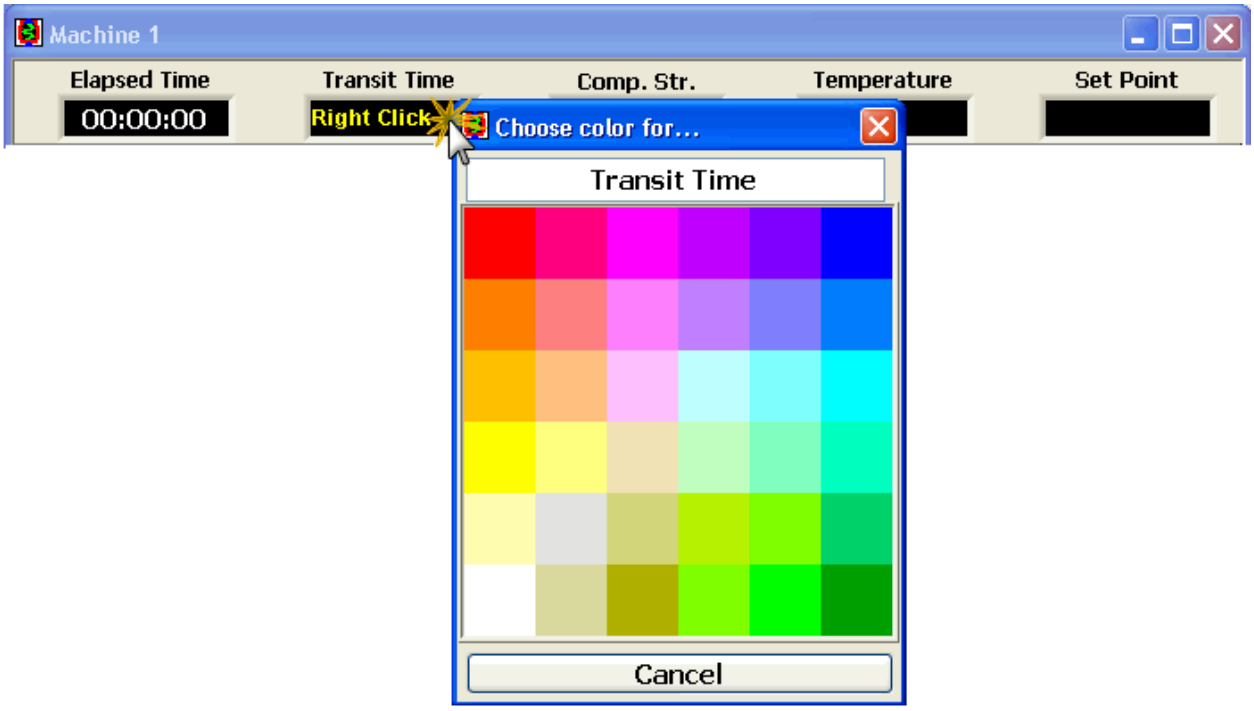


Figure 3-8
Color selection box

3.3.2.2 Set Point

Set point is the current target temperature, which the temperature controller on the autoclave is using to ramp up to in the specified time. Refer to *5.7.7 View/Edit Test Profile* section to understand how set points are used. The Set Point display is for reference only and is not plotted on the graph.

3.3.2.3 Results Graph

As the test progresses, the current results are displayed in their respective indicators. At the same time the values are plotted on the results graph.

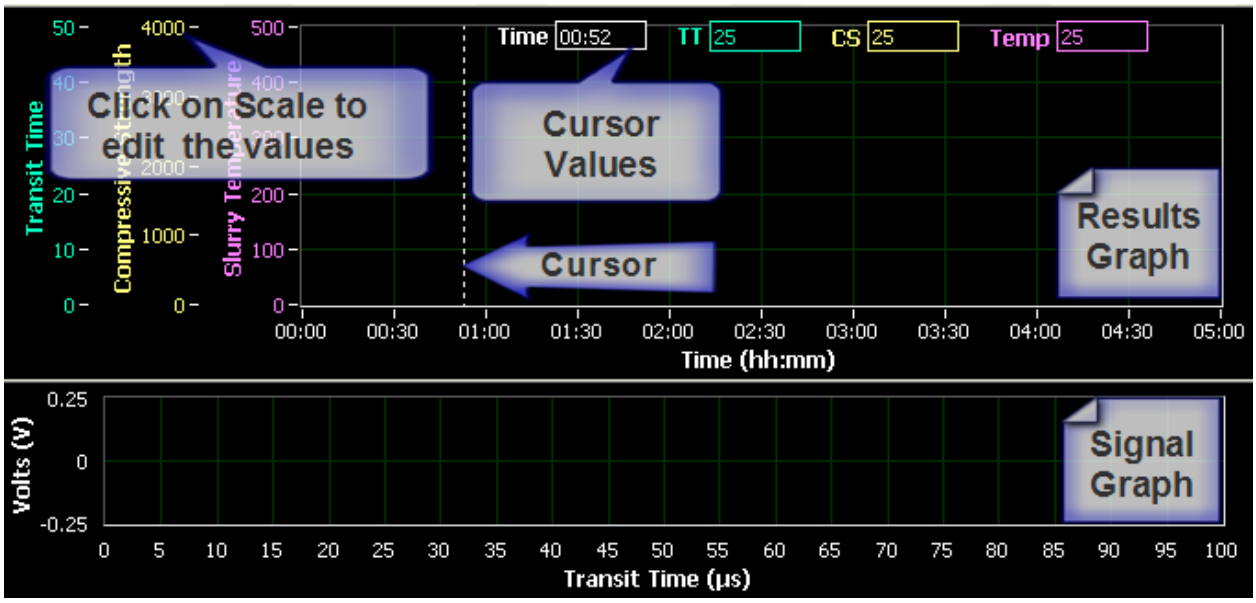


Figure 3-9
Results graph and signal graph

The graph plots elapsed time on the x-axis and Transit Time, Compressive Strength, and Slurry Temperature on three different y-axes in their respective units.

The x- and y-axis scales can be changed to show any range of values by clicking on the scale values and entering a new desired value. This positions and scales the respective parameter graph to the new scale.

The user can right click on the graph to access the context-sensitive menu that provides additional functionality to the graph.

- Enlarge/Reduce—By selecting this menu item, the user can enlarge the graph to occupy all of the viewing space. If the Results graph is enlarged, the Signal graph will be hidden. If the results graph is already enlarged, then this menu selection will reduce the graph to its default state. The signal graph will now be visible.
- Show/Hide Cursor —Cursor visibility is toggled by selecting this item. The cursor is a thin, vertical dotted line that can be dragged by the mouse to a desired position. When the cursor is visible, associated cursor indicators are also made available on top which display the current cursor position in its associated x- and y-axis

scale values. Any parameter can be read out for any particular value of elapsed time.

- Zoom— There are three kinds of zooms available. Pick the desired zoom tool to dig deeper into the graph. The area zoom tool will allow the user to draw a rectangular area on the graph to zoom to. The continuous zoom feature allows the user to pick a point on the graph and, by continuously holding the left mouse button, to progressively zoom to it. The zoom extents menu discards the zoom tool and reverts the graph back to show the complete graph in its default state.

Figure 3-10
Context sensitive menu

NOTE

The x-axis auto-scales to current elapsed time, so even any user-desired scaling will be overridden as new data becomes available approximately in the next 10 seconds.

3.3.2.4 Signal Graph

Just below the results graph is the signal graph. This graph displays the ultrasonic signal as being measured by the system. It plots the recovered signal as transit time on x-axis against its amplitude on y-axis. This signal provides a good measure of system check to ensure that everything is progressing as desired. This graph can be hidden when the results graph is enlarged. Except for viewing and diagnostic reasons, this graph does not have any more functionality and can be hidden if so desired.

3.3.2.5 Machine Function

The machine function drop down list allows the user to select any particular machine function. Some of the items from this list of machine functionality are also a part of *Start Test Wizard*.

3.3.2.5.1 Pulser Calibration

This brings up the pulser calibration window. Refer to *5.4 Pulser Calibration* for more details.

3.3.2.5.2 Test Signal

This brings up the test signal window. Refer to *5.7.6 Test Signal* section for more details.

3.3.2.5.3 Temperature Profile Editor

This opens a window for editing temperature profile. Refer to *5.7.7 View/Edit Test Profile* for more details

3.3.2.5.4 View Test Information

This shows information about the current test. Refer to *5.7.8 View Test Information* for more details.

3.3.2.5.5 View Alarms

This brings up the current state of alarms for the respective machine. Refer to Alarms for more details.

3.3.2.5.6 Data Manager

This brings up external program. Refer to data manager help for more information.

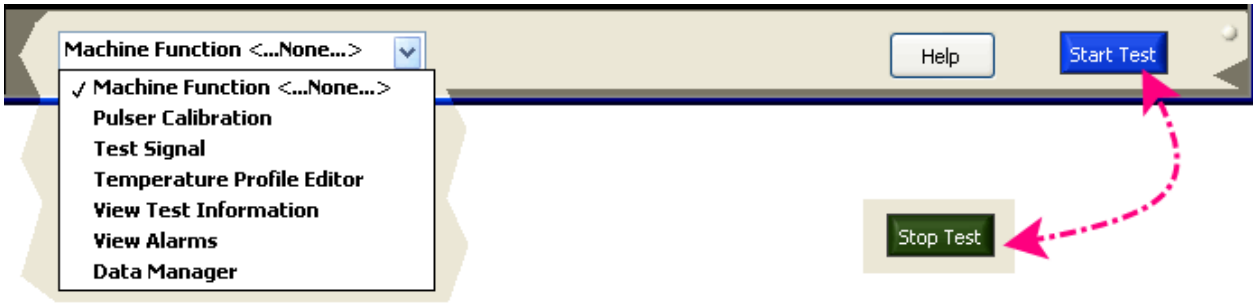


Figure 3-11
Start test

3.3.2.5.7 Start Test

Click the Start Test button to start a test. The start test button will bring up the *Start Test Wizard*. The user will

be walked through a series of steps to start test. Once all the steps have been completed, the test can be started. When the test starts, the button becomes dark green and can be used to stop the test.

3.3.2.6 Help

This brings up the relevant online help.

Related Topics: *3.3.1 Main Screen, 5.7.9 Start Test Wizard*

3.4 UCA Autoclave Temperature Controller Software

3.4.1 The tables in this section contain the factory settings for the Eurotherm Model 3504 temperature controller when it is configured for the UCA Autoclave. It is rare that the majority of these settings will need to be changed. They are provided for reference should the temperature controller is responding in an unexpected manner, and incorrect settings are suspected.

3.4.2

3.4.3 Press and hold  until the display shows

3.4.4

3.4.5

3.4.6

3.4.7 Press  to select Config

3.4.8 Press  again to enter a security code. This is defaulted to 4. If an incorrect code is entered the display reverts to that shown in above. If the default of 4 is not accepted this means that the code has been changed on your particular controller.

3.4.9 'Pass' is displayed momentarily. You are now in Config Level.

3.4.10 The '▲▼' symbol indicates further sub-headers are available.

3.4.11 To select these press  

Inst ▲▼ Enab		
Name  to select	**ParameterDescription**	**Value**  or  to change

AnAlm En	Analogue alarms	←←←←←←←←←
BCDIn En	BCD switch input	←←
Counter En	Counters	←←
DgAlm En	Digital alarms	←←←←←←←←←
Humidity En	Humidity control	←
IO Exp En	IO expender	←
IP Mon En	Input monitor	←←
Lgc2 EN1	Logic operators	←←←←←←←←←
Lgc2 EN2		←←←←←←←←←
Lgc2 EN3		←←←←←←←←←
Lgc8 EN	Logic 8 operator	←←
Lin16Pt En	Input linearization	←←
Load En	Load enable	√←
Loop En	Loop enable	√
Math2 En1	Analogue Operators	√←←←←←←←←
Math2 En2		←←←←←←←←←
Math2 En3		←←←←←←←←←
MultiOper En	Multi-input operator block	←←
Mux8 En	Multiplexer	←←←←
Poly En	Polynomial linearization	←←
Progr En	Programmer	√
RTClock En	Real time clock	←
SwOver En	Switch over block	←
Timer En	Timers	←←←←
Totalize En	Tantalizers	←←
TrScale En	Transducer scaling	←←
UsrText En	User text	←←←←←←←←←
UsrVal En1	User values	←←←←←←←←←
UsrVal En2		←←←←←←←←←

Inst ⬍ Opt		
Name  to select	**ParameterDescription**	**Value**  or  to change
Units	Instrument display units	F
ProgMode	Type of programmer	SingleChn
PVStart?	Enable PV start.	Yes
ImmSP?	Writes SR immediately.	No

Inst ⬍ Dis		
Name  to select	**ParameterDescription**	**Value**  or  to change
Home Page	Configures Home Page	Loop
Home Timeout	Revert to the HOME display after a fixed time	0:01
Loop Summary	Summary of the Loop	On
Prog Summary	Summary of the Program	On
Bar Scale Max	Upper limit of the vertical bar graph	100
Bar Scale Min	Lower limit of the vertical bar graph	0
Main Bar Val	Main bar graph value	0
Aux1 Bar Val	First auxiliary bar graph value	0
Aux2 Bar Val	Second auxiliary bar graph value	0
Language	Language	English
Prog Edit	Level in which a program may be edited	Level1
Control1 Page	Level in which the control page 1 is shown	Off
Control2 Page	Level in which the control	Off

	page 2 is shown	
Alarm Page	Level in which the alarm page is shown	Level1
Alarm Summary	alarm summary	On
OP1 Beacon	Output 1 beacons	Off
OP2 Beacon	Output 2 beacons	Off

PV Input		
Name  to select	**ParameterDescription**	**Value**  or  to change
IO Type	PV input type	ThermoCpl
Lin Type	Input linearization	J
Units	Units	AbsTemp
Res'n	Resolution	xxxx. x
CJC Type	Cold junction compensation	Internal
SBrk Type	Sensor break type	Low
SBrk Alarm	Sensor break alarm	NonLatch
SBrk Out	Sensor break alarm status	Off
Fallback	Fallback strategy	Upscale
Fallback PV	Fallback value	32. 0
Filter Time	Input filter time	0:01. 6
Meas Value	Current electrical value of the PV input	
PV	Current value of the PV input after linearization	

PV Input		
Name  to select	**ParameterDescription**	**Value**  or  to change
Offset	Constant offset to the PV Allows a two point offset to be applied to the	0. 0
Lo Point		0. 0
Lo Offset		0. 0

	controller to compensate for sensor or connection errors between sensor and the input to the controller.	
Hi Point		0. 0
Hi Offset		0. 0
CJC Temp	Temperature of the rear terminals	
SBrk Value	Sensor break Value	
Lead Res	lead resistance	
Cal State	Calibration state	Idle
Status	PV Status	OK

LgcIO ⬍ LA		
Name  to select	**ParameterDescription**	**Value**  or  to change
IO Type	IO Type	OnOff
Invert	Logic input or output	No
SbyAct	Standby action	Off
Meas Val	Current output value	0
PV	Desired output value	1

LgcIO ⬍ LB		
Name  to select	**ParameterDescription**	**Value**  or  to change
IO Type	IO Type	Input
Invert	Logic input or output	No
PV	Desired output value	0

Rly AA		
Name  to select	**ParameterDescription**	**Value**  or  to change
IO Type	Relay function	OnOff
Invert	Change operating state	No
SbyAct	Standby action	Off
Meas Val	Output status	0
PV	Current output value	0

Module ID		
Name  to select	**ParameterDescription**	**Value**  or  to change
Module 1	Module	SingLogic
Module 2		No Module
Module 3		No Module
Module 4		No Module
Module 5		No Module
Module 6		No Module

Mod		
Name  to select	**ParameterDescription**	**Value**  or  to change
Ident	Channel type	Logic Out
IO Type	Relay function	Time Prop
Min OnTime	The minimum logic on time	0. 01
Disp Hi	Max output signal	100
Disp Lo	Min output signal	0
Range Hi	Electrical output high	100
Range Lo	Electrical output low	0
SbyAct	Standby action	Off
Meas Value	Digital output status	0
PV	PID output	0. 0

Alarm Summary		
Name  to select	**ParameterDescription**	**Value**  or  to change
New Alarm	New Alarm	No
Any Alarm	Any Alarm	No

Comms ⬍ H		
Name  to select	**ParameterDescription**	**Value**  or  to change
Ident	Comms module	Comms
Protocol	Communications protocol	EIBISYNCH
Baud Rate	Baud Rate	9600
Parity	Parity	Even
Addres	Instrument address	*1*
Comms Delay	Delay time	No
Msg Format	Format	Free

Comms ⬍ J		
Name  to select	**ParameterDescription**	**Value**  or  to change
Ident	Comms module	None
Protocol	Communications protocol	MODBUS
Baud Rate	Baud Rate	19200
Parity	Parity	None
Addres	Instrument addres	1
Comms Delay	Delay time	No
Msg Format	Format	No

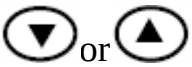
Comms Table		
Name  to select	**ParameterDescription**	**Value**  or  to change

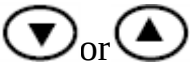
Dest	Modbus destination	Not Used
Source	Source parameter	
Native	Native data format	Integer
ReadOnly	Read only	ReadWrite
Minutes	Minutes	Seconds

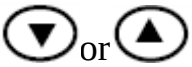
Load		
Name  to select	**ParameterDescription**	**Value**  or  to change
Type	Load type	Oven
Res'n	Output resolution	xxxxx
Units	PV units	None
Gain	Load gain	12. 00
TC1	Time constant	10
TC2	Time constant	20
Ch 2 Gain	Relative gain	1. 0
PVFault	Sensor fault	None
PV Out1	First process value	22
LoopOP CH1	Loop output channel 1	0. 0
LoopOP CH2	Loop output channel 2	0
Noise	Noise added to PV	Off
Offset	Process offset	22

LP1 ⬍ Main		
Name  to select	**ParameterDescription**	**Value**  or  to change
AutoMan	Auto or Manual operation	Auto
PV	Process variable input value	
Inhibit	Stop loop controlling.	No
Target SP	Value of set point	32. 0
WSP	Current setpoint value	32. 0

Work OP	actual output of the loop	0. 0
IntHold	Stop integral action	No

LP1 ⬍ Setup		
Name  to select	**ParameterDescription**	**Value**  or to change
Ch1 Control	Selects control algorithm	PID
Ch2 Control		OFF
Control Act	Control Action	Rev
PB Units	Proportional band units.	Eng
Deriv Type	Derivative Type	PV

LP1 ⬍ Tune		
Name  to select	**ParameterDescription**	**Value**  or to change
Enable	Start self tuning	Off
High Output	Maximum % output power	100. 0
Low Output	Minimum % output power	0. 0
State	Self tuning is in progress	Off
Stage Time	Time in the particular stage	0

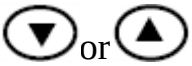
LP1 ⬍ PID		
Name  to select	**ParameterDescription**	**Value**  or to change
Sched Type	Gain scheduling	Off
PB	Proportional band	50. 0
Ti	Integral term	3500
Td	Derivative term	500
CBH	Cutback high	9999. 0
CBL	Cutback low	9999. 0
MR	Manual reset	0. 0

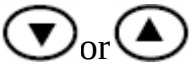
LBT	Loop break time	4615
OPHi	Output high limit	100. 0
OPLo	Output low limit	0. 0

LP1 ⬍ SP		
Name  to select	**ParameterDescription**	**Value**  or  to change
Range Hi	Range limits	435. 0
Range Lo		32. 0
SP Select	Local or alternate set point	SP1
SP1	Primary set point	32. 0
SP2	Secondaryset point	32. 0
SP HighLim	SP maximum limit	435. 0
SP LowLim	SP minimum limit	32. 0
Alt SP En	Alternative set point enable	No
Alt SP	Alternative source	
Rate	Maximum rate limits	Off
RateDone	Changing or completed set point	Yes
SP Trim	SP offset	0. 0
SP Trim Hi	Set point trim high limit	0. 0
SP Trim Lo	Set point trim low limit	0. 0
Man Track	Manual tracking	Off
SP Track	Set point tracking	Off
Track PV	Track PV	
Track SP	Track SP	32. 0

LP1 ⬍ OP		
Name  to select	**ParameterDescription**	**Value**  or  to change
Output Hi	Maximum output power	100. 0

Output Lo	Minimum output power	0. 0
Ch1 Output	Channel 1 output	0. 0
Rate	Output rate from PID	10. 0
Rate Disable	Output rate disable	No
Sbrk Mode	Action taken if sensor failed	SbrkOP
Sbrk OP	Output power if sensor failed	0. 0
Safe OP	Output level when loop inhibited	0. 0
Man Mode	Manual operation	Track
ManOP	Manual loop output	0. 0
ForcedOP	Forced manual output	0. 0
Pff En	Power feed forward	No
Pwr In	Measured power input	
FF Type	Feed forward type	None
Track OP	Loop output value	0

LP1 ⬍ OP		
Name  to select	**ParameterDescription**	**Value**  or to change
Track En	Loop output enabled	Off
RemOPL	Remote output low limit.	-100. 0
RemOPH	Remote output high limit.	25. 0

Math2		
Name  to select	**ParameterDescription**	**Value**  or to change
Operation	Operator type	Sub
Input1 Scale	Scaling factor input 1	1. 0
Input2 Scale	Scaling factor input 2	1. 0

Output Units	Output units	None
Output Res'n	Output resolution	xxxxx
Low Limit	Low limit	25
High Limit	High limit	100
Fallback	Fault condition	Clip Good
Fallback Val	Fault output value	0
Input1 Value	Input 1 value	32. 0
Input2 Value	Input 2 value	32. 0
Output Value	Analog output value	25
Status	Operation status	Good

Program Set Up		
Name  to select	**ParameterDescription**	**Value**  or  to change
Units	Units	AbsTemp
Resolution	Resolution	xxxx. x
PV Input	PV Input	
SP Input	SP Input	0. 0
Servo	Start from PV or SP	PV
Power Fail	Power fail recovery	Ramp
Rate Res	display resolution	xxxx. x
Max Events	maximum number of output	0
PVEvent?	Enable PV event	No
UserVal?	Enables analogue value	No
Gsoak?	Enable Guaranteed soak	Yes
DelayedStart?	Enables a time period	No
PID Set?	Enables PID set	No
Prog Reset	Program reset	Yes

Program Set Up		
Name  to select	**ParameterDescription**	**Value**  or  to change
Prog Run	Program run	No
Prog Hold	Holds the program	No
Prog RunHold	Program run hold	No
Prog RunReset	Program run reset	No
Advance	Set the program SP equal target	No
SkipSeg	Skip to the next segment	No
End of Seg	End of segment state	Off
Sync Input	Synchronized start input	0
Sync1	Synchronized start output	0
PrgIn1	Program input 1	Off
PrgIn2	Program input 2	Off
PVWaitIP	PV wait input	0

Program Edit		
Name  to select	**ParameterDescription**	**Value**  or  to change
Program	Program number or name	1
Segments Used	Number segment	4
PVStart	Starting point	Off
HldBk Value	Deviation between SP and PV	10. 0
Ramp Units	Ramp units	Min
Cycles	Number of repeats	1
Segment	Segment to set up	1
Segment Type	Type of segment.	Rate
Target SP	Setpoint value	125. 0

Ramp Rate	Ramp Rate	5. 0
Hldbck Type	Type of holdback	Off
Segment	Segment to set up	2
Segment Type	Type of segment.	Rate
Target SP	Setpoint value	135. 0
Ramp Rate	Ramp Rate	0. 1
Hldbck Type	Type of holdback	Off
Segment	Segment to set up	3
Segment Type	Type of segment.	Rate
Target SP	Setpoint value	150. 0
Ramp Rate	Ramp Rate	0. 1
Hldbck Type	Type of holdback	Band
Segment	Segment to set up	4
Segment Type	Type of segment.	End
End Type	End Type	Dwell

Access

Press ▲ or ▼ to change **Goto** to **Level1**

3.5 UCA Pressure Source

The hydraulic fluid, normally water, is pressurized by an air powered Maximator® piston pump.

The output pressure is controlled by a manual air pressure regulator on the input side of the pump. Front panel mounted gauges show the air and hydraulic pressures. A filter on the air supply removes debris and condensation before reaching the regulator and pump.

Individual valves at each UCA Autoclave in a manifold system allow complete isolation of an autoclave for maintenance or when different pressures are used simultaneously.

An internal rupture disk prevents over-pressurizing the system.

4 Installation

4.1 Parts of the UCA Autoclave

4.1.1 Reference: see *1 Introduction*.

4.2 Other Parts

4.2.1 Several smaller items are packed separate from the UCA Autoclave to protect them during shipping. When unpacking the UCA Autoclave, verify that you have received the test chamber, BNC connectors, Category (CAT) 5 network cable, high-pressure U-tubing, calibration core, and spare parts kit.

4.3 Electric Power Supply

4.3.1 The UCA Autoclave is supplied with a 5-ft power cord, with a NEMA 6–15P plug. Because of the diversity in types of electrical outlets throughout the world, it may be necessary to replace this plug. Alternatively, the UCA Autoclave can be directly wired into an electrical disconnect switch. Regardless of the connection, ensure that proper power is provided.

4.3.2 The electric power supply must be 230 VAC, single-phase, 20 amp, and 50–60 Hz.

4.4 Hydraulic Supply

4.4.1 Three hydraulic connection ports are located on the back of the UCA as shown in Figure 1-4. The two ⅛inch female National Pipe Thread ports are for cooling water inlet and drain. Flexible tubing is recommended for the cooling water inlet and drain connections. The upper of the two ports is the cooling water inlet, and the lower is the drain.

4.4.2 The F250C Autoclave high-pressure port connects the UCA Autoclave to an external pressure source and/or manifold.

4.4.3 Reference: See *3 Features and Specifications* for the specifications of the cooling supply and drain.

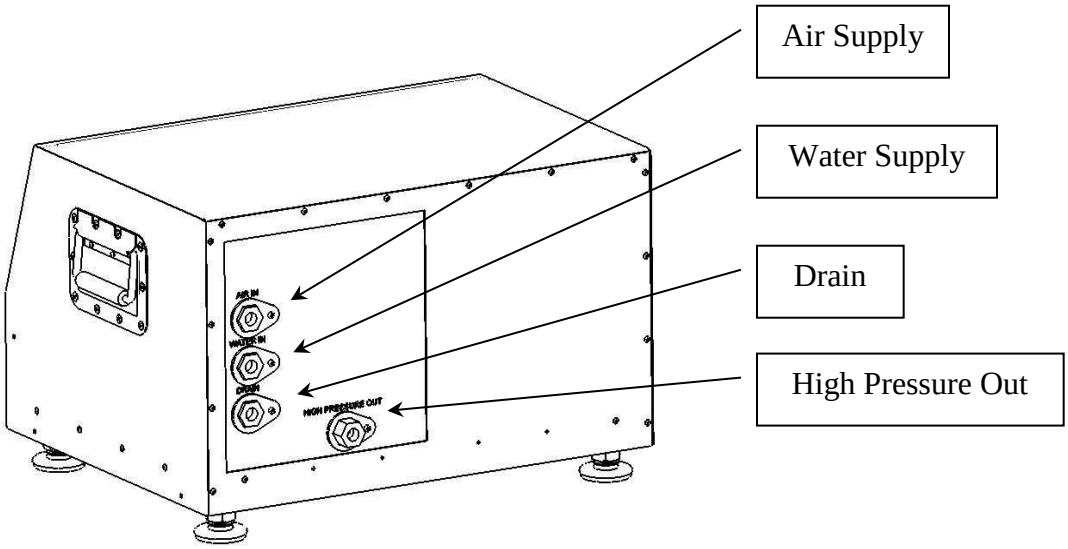
4.5 UCA Pressure Source

4.5.1 Locate the UCA Pressure Source relative to the UCA Autoclave(s) as desired. Depending on the distance, high pressure tubing and fittings in addition to those provided may be necessary. The UCA Pressure Source should be lower than the UCA Autoclave(s).

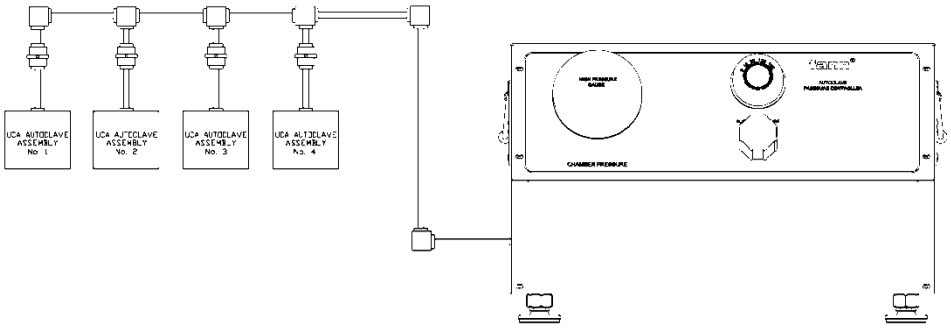
4.5.2 Connect a source of compressed air to the AIR IN port on the rear of the UCA Pressure Source.

4.5.3 Connect a source of coolant (water) to the WATER IN port on the rear of the UCA Pressure Source.

4.5.4 Connect a drain to the DRAIN port on the rear of the UCA Pressure Source.



4.5.5 Connect high pressure tubing to the HIGH PRESSURE OUT port on the rear of the UCA Pressure Source. This tubing may be connected directly to a UCA Autoclave, or to multiple UCA Autoclaves through a manifold system.



4.5.6 Purge air from the system.

4.5.6.1 On each UCA Autoclave, close the high pressure valve nearest the UCA Autoclave, and the Chamber Supply valve on the UCA Autoclave.

4.5.6.2 Turn on the air and water supply to the UCA Pressure Source.

4.5.6.3 Adjust the UCA Pressure Source air regulator until the pressure is just high enough to operate the pump.

4.5.6.4 Starting with the UCA Autoclave that is closest to the UCA Pressure source, open the high pressure valve(s) until a solid stream of fluid flows from the open connection. Close the valve.

4.5.6.5 Repeat the process in 4. 5. 6. 4, working away from the pressure source, until all the air has been removed from the supply manifold.

4.5.6.6 Adjust the UCA Pressure Source air regulator until the pump stops.

4.5.6.7 The UCA Pressure Source is ready for use.

4.6 UCA Autoclave and UCA Processor Connections

4.6.1 Two coaxial cables, labeled Data and Trigger, connect the corresponding jacks on the rear of the UCA Autoclave and UCA Processor. Any available channel (1–8) on the UCA Processor may be used. The UCA Processor and UCA Autoclave Temperature Control must both be set to the same channel number used for the coaxial cables.

4.6.2 Configure temperature controllers for Model 304 processor.

4.6.2.1 For autoclaves with Eurotherm Model 818P

Follow the following steps and configure the 818P to work with Model 304.

1. Switch off power to the unit and remove it from the sleeve. To remove the unit, Unscrew the screw located inside the door and the unit should slide out.
2. Set the configuration Jumper to ENABLED (Short) position to put the unit in Config. Mode. Refer to the figure below.

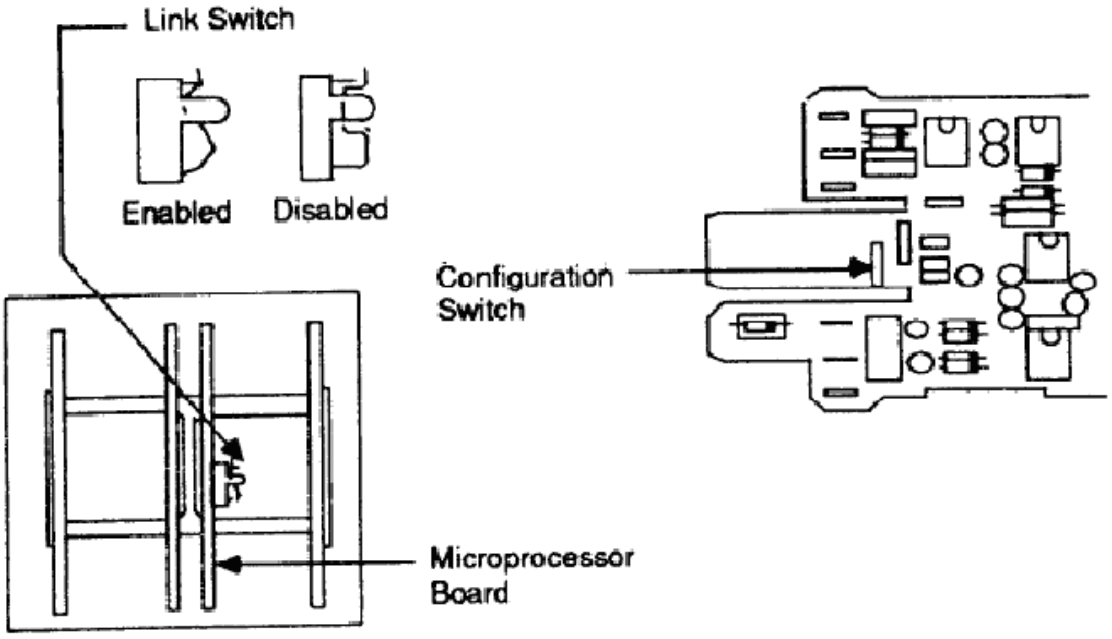


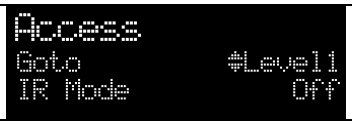
Figure 4-1
Configuration jumper

3. Put the unit back in the sleeve. Use the Screw located inside the door to Slide the unit in fully. Make sure it is sitting flush with the sleeve. Switch on the power.
4. The upper display now reads **CONF** and lower display reads **C1**.
5. Pressing **P** button allows you to scroll through Config Items C1, C2, C3, etc. The P button is located inside the door on the right.
6. Once a particular Config Item is selected, Press the **UP** arrow to access its value and then use the **UP/DN** arrow buttons to change the value.
7. Once the value is changed to what is desired press the **P** button to go to next item.
8. Set the Config items to the values identified as per steps 9 through 16 below.
9. C1 = 4100
10. C2 = 0000
11. C3 = 0000
12. C4 = 1555
13. C5 = 0000
14. C6 = 1105
15. C7 = 0500
16. C8 = 4003
17. ADD = **Respective address of the unit** from 1 to 8. The address entry will take the form of 0. 1, 0. 2, 0. 3… etc. for addresses 1, 2, 3, etc., respectively. Do not use 1. 0, 2. 0 etc. for addresses.
18. Scroll to **Clr** using the P button.

19. Press both **UP/DN** arrows simultaneously, till you see the **Clr** blink twice. This is Important to save all changes.
20. Switch off the controller and remove from sleeve
21. Move jumper back to DISBALED (Open) to put the unit in Run mode.
22. Put the unit back in the sleeve and switch on. Make sure the unit is sitting flush with the sleeve by tightening the screw located inside the door. Switch on the power. You are in Normal mode.

4.6.2.2 For autoclaves with Eurotherm Model 3504

	Do this	Display
1	Press and hold 📄. After a few seconds the display will show Goto ⬍ Level 1.	
2	Press ▲ button till you see Config. After a second, it will prompt to enter Pass Code.	 
3	Press ▲ button and change Pass code of 4.	
4	The Controller will now be in Configuration Level.	
5	Press 📄, 8 times to go to ‘Comms’ Menu.	
6	Press ↺ to scroll to different items. Press ▲ button to change the value of these items.	
7	Set the value of following items as follows: Protocol : MODBUS Baud Rate : 9600 Parity : None Address : 1 for Machine 1, 2 for Machine 2 and so on… Comms Delay : None Broadcast : No	

8	Press , 9 times to get back to ‘Access’ menu.	
9	Press ▲ button to change ‘Goto’ to ‘Level 1’. This will cause the system to reboot.	
10	The machine is ready to communicate with the UCA controller program.	
11	Open UCA Controller program.	
12	Open the respective machine for which all the steps 1 to 10 were performed.	
13	Open ‘Temperature Profile Editor’ on this machine. The editor will read a profile that is not correct.	
14	Create a new Profile with Target Set Point of 80 degF and Time of 1 Hour.	
15	Click Write to download this new profile to the controller.	
16	If any more machines need to be configured, repeat steps 12 to 15 above for those machines.	
17	Exit out of the UCA Controller Program.	
18	Restart all the autoclaves for which the setup was performed.	
20	Your system is set up to work with the Autoclaves.	

4.7 UCA Processor System Configuration

4.7.1 Configure System

Configuring the system during initial installation is essential and must be performed for reliable operation. The software recalls user settings so they do not have to be re-entered each time.

To configure your system, click on menu item **Edit** > **Configure System**.

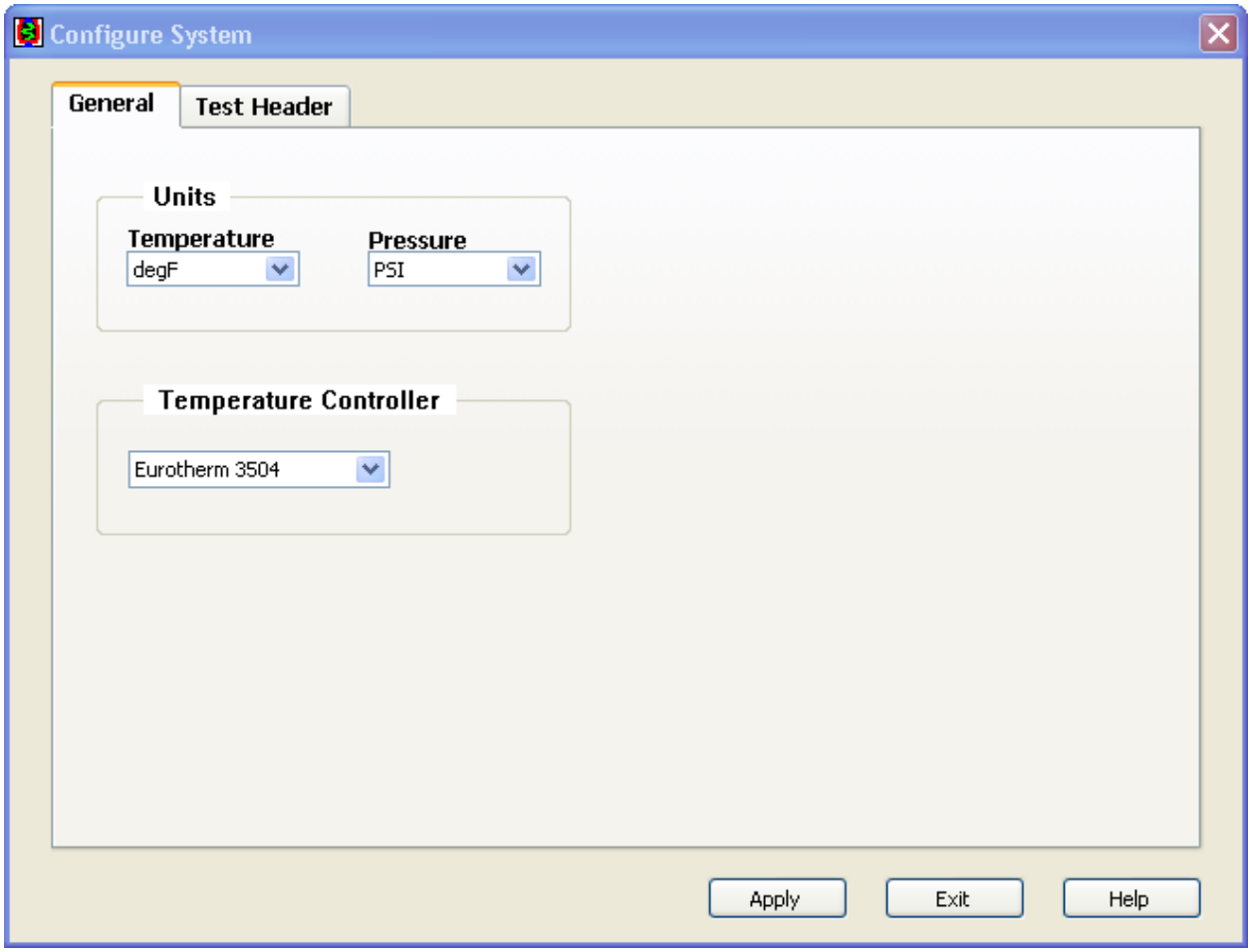


Figure 4-2
General tab

4.7.2 General Tab

This is where the user can set the machine parameters. The temperature controller and units of measurement can be set for each individual machine. Using this tabular format, the user can set up a mix and match of the temperature controllers and measurement units for the eight machines

4.7.2.1 Temperature Controller

The software communicates with autoclave units that have a temperature controller. This is where the users can select the temperature controller that is used on the autoclave. Currently, only Eurotherm models 818P and 3504 are supported.

NOTE

When using model 3504, the Temperature units can be set to °F, °C, or °K. If model 818P is selected, the temperature unit selection is limited to °F only.

4.7.2.2 Units

The machine can operate in different units of measurement. Generally, the users will set the units in which they want to work. The machine will remember these settings until the time system is reconfigured.

4.7.2.2.1 Temperature Units

Temperature Units can be °F (Fahrenheit), °C (Celsius) or °K (Kelvin).

4.7.2.2.2 Strgth. Units

Pressure Units can be PSI (pounds per square inch) or MPa (megapascal).

Once a suitable selection is made, the user can navigate to the next tab.

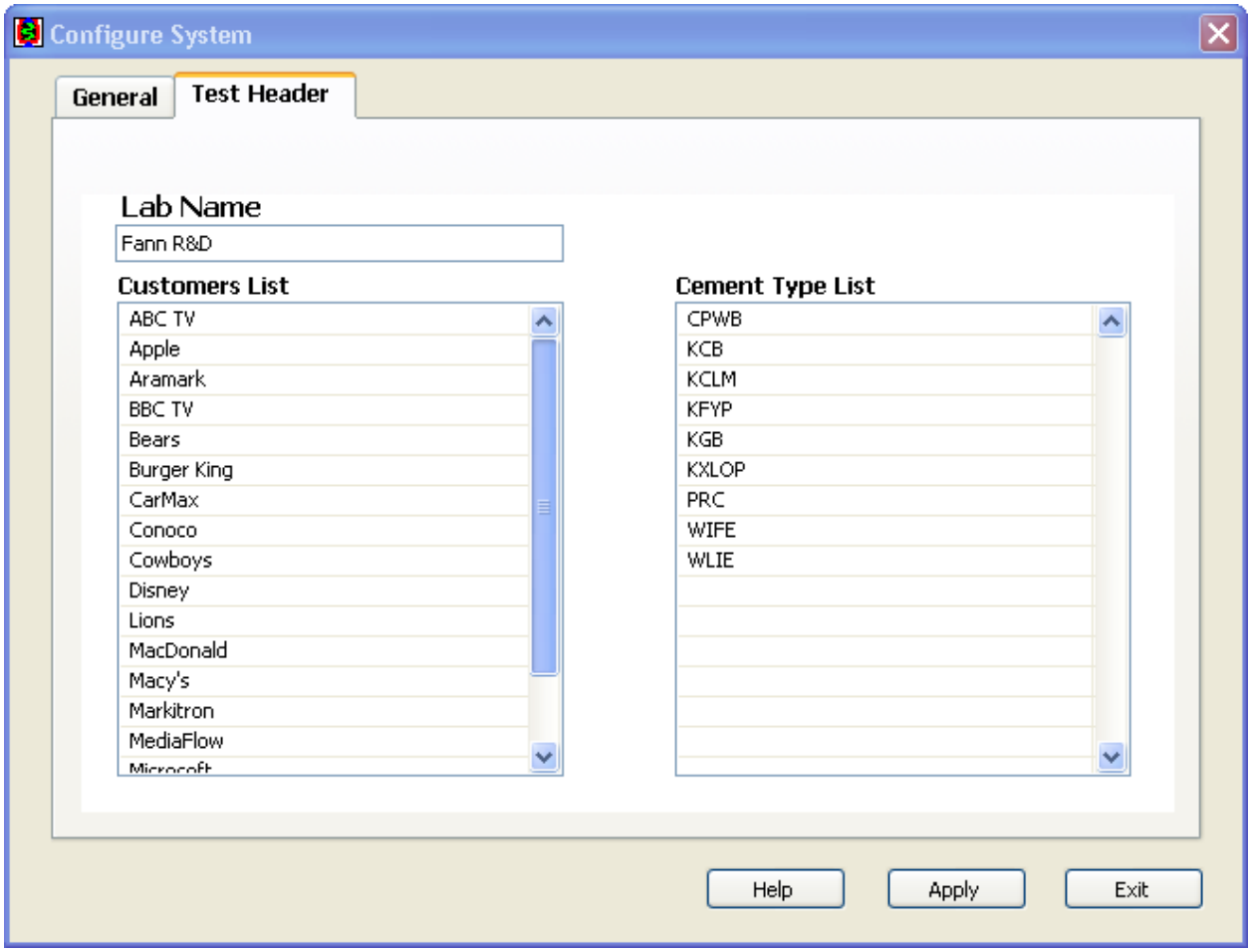


Figure 4-3
Test Header tab

4.7.3 Test Header

The test header tab is a convenient place where the users can enter the lab name, a list of frequently used customers, cement types, and events. The software uses this list to populate and prompt when filling the relevant test information dialog. Refer to *5.7.9 Start Test Wizard* for more details.

4.7.3.1 Lab Name

The lab name is set up here. Once it is entered, it need not be entered again. The entry here is used to populate the relevant field when starting a test.

4.7.3.2 Customers List

This list of customers will be used to prompt the user for a customer during test setup. A new customer is added to

the bottom of this list and is sorted alphabetically when the **OK** button is clicked.

4.7.3.3 Cement Type List

This list stores the cement types in use and those most frequently tested at a particular lab. This list also alphabetizes the entries after the **OK** button is clicked.

4.7.3.4 Events–Strength (PSI)

The user has four events that are triggered by the strength value reached. The user can set up default values of strength here. By doing so, every test will start with these default values to trigger an alarm when these strength results are achieved. These default values can be overridden for individual machines before starting a test. Refer to *5.7.9 Start Test Wizard* for more details.

NOTE

The default events for strength can only be entered in PSI. Because the machines can be set to run in any units, the default units will be converted to correct units for each machine.

4.7.3.5 Events–Time(HH:MM)

The user has four events that are triggered by time. The user can set up default values for the time alarm here. By doing so, every test will start with these default values and trigger an alarm when a particular time has elapsed. These default values can be overridden for individual machines before starting a test. Refer to *5.7.9 Start Test Wizard* for more details.

4.7.3.6 Help

Clicking the **Help** button brings up relevant online help.

4.7.3.7 OK

Clicking the **OK** button saves the settings, closes the Configure System window, and returns the user to main screen.

NOTE

The Configure System window can only be opened when all eight machine windows are closed.

NOTE

A machine window can only be closed if no test is running.

Related Topics: *3.3.1 Main Screen*, *5.7.9 Start Test Wizard*

4.8 Select Machine Quadrants

The software generates an individual window for each of the machines the users want to view and control. Each of these windows is fully resizable and can be positioned anywhere the users want to place them. The two tile buttons on the Main Screen (see *3.3.1 Main Screen*) provide a means for the users to open any of the four windows in tile fashion. Using the two tile buttons, the user can quickly view all eight machines easily. The tiles can be configured as the user wishes as explained below.

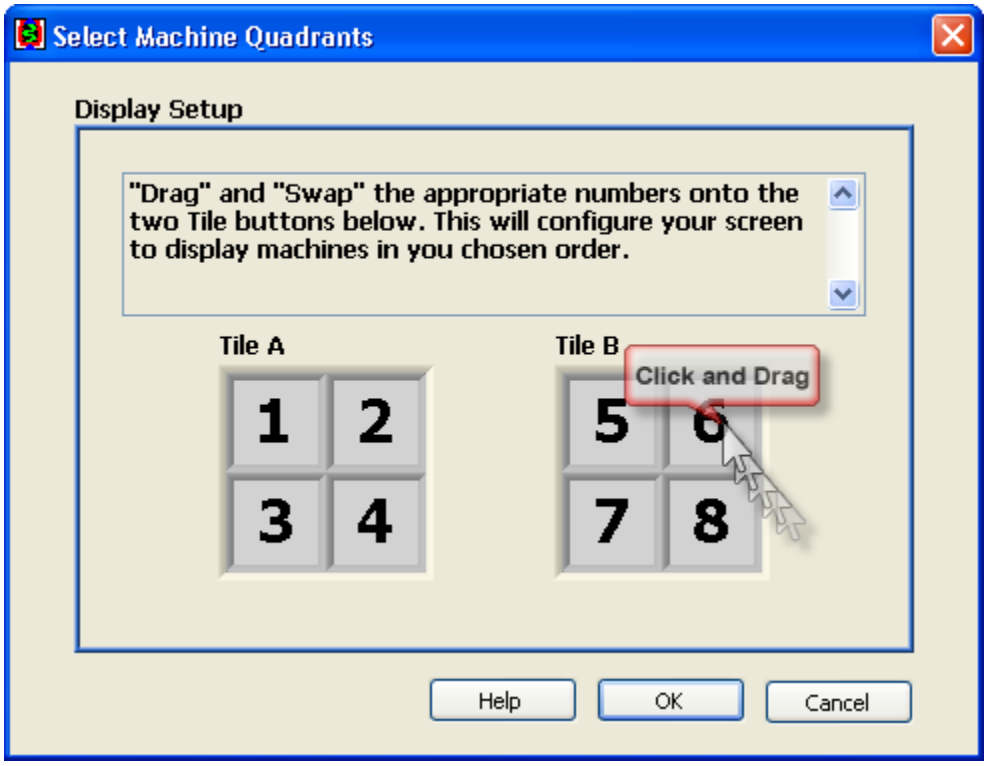


Figure 4-4 Select Machine Quadrants window

4.8.1 Tile A

Tile A displays four of the eight machines that are controlled by this tile.

The four numbers indicate which machines will open when the users click on Tile A. The location where the machines will open is determined by the location of the four numbers. In the case above, Machine 1 will open in the left top corner of the screen.

4.8.2 Tile B

The Tile B button functionality is identical to that of Tile A above.

4.8.3 Repositioning Machine Screens

To reposition the machine screens, drag any one of the desired machine numbers from either of the tiles to a new location within either of the tiles. This will swap the desired machine to the new location selected.

For example, Machine 1 in Tile A above is dragged and dropped on Machine 6 in Tile B. The two machines will swap places. Now, Machine 6 will open from Tile A when the left top position is clicked. Machine 1 will open from Tile B in the right top position.

4.8.4 Help

Clicking help brings up relevant online help.

4.8.5 OK

Press this button to make the program accept and save the current settings and close this screen.

4.8.6 Cancel

Press **Cancel** to revert back to initial settings and exit this screen. All changes made are voided by this button.

Related Topics: *3.3.1 Main Screen*

5 Operation

5.1 Calibration

5.1.1 Calibration is an important part of preparing the UCA Autoclave and UCA Processor for use. Calibrations must be performed when the UCA Autoclave and UCA Processor are first set up, when the ultrasonic transducers or cables are replaced, or every three months. Calibration may be performed any time there is uncertainty about the test results. Without proper calibration, the UCA System provides inaccurate data.

During the calibration process, the UCA Processor sends a trigger signal to the UCA Autoclave and the return data pulse is measured. A sample point is established by applying a known quantity to the transducers. The UCA Processor measures the return signal's amplitude and frequency, and records the measurements. The known quantity value is altered, sent to the transducer, and the return data again measured.

5.2 Transit Time Calibration

5.2.1 The compressive-strength calibration is performed to zero the time delays that may be present in the electronics associated with the ultrasonic transducers.

Before a compressive-strength calibration can be performed, the UCA System test chamber must be assembled with the calibration rod installed.

5.3 Assemble the Sample Chamber for Calibration

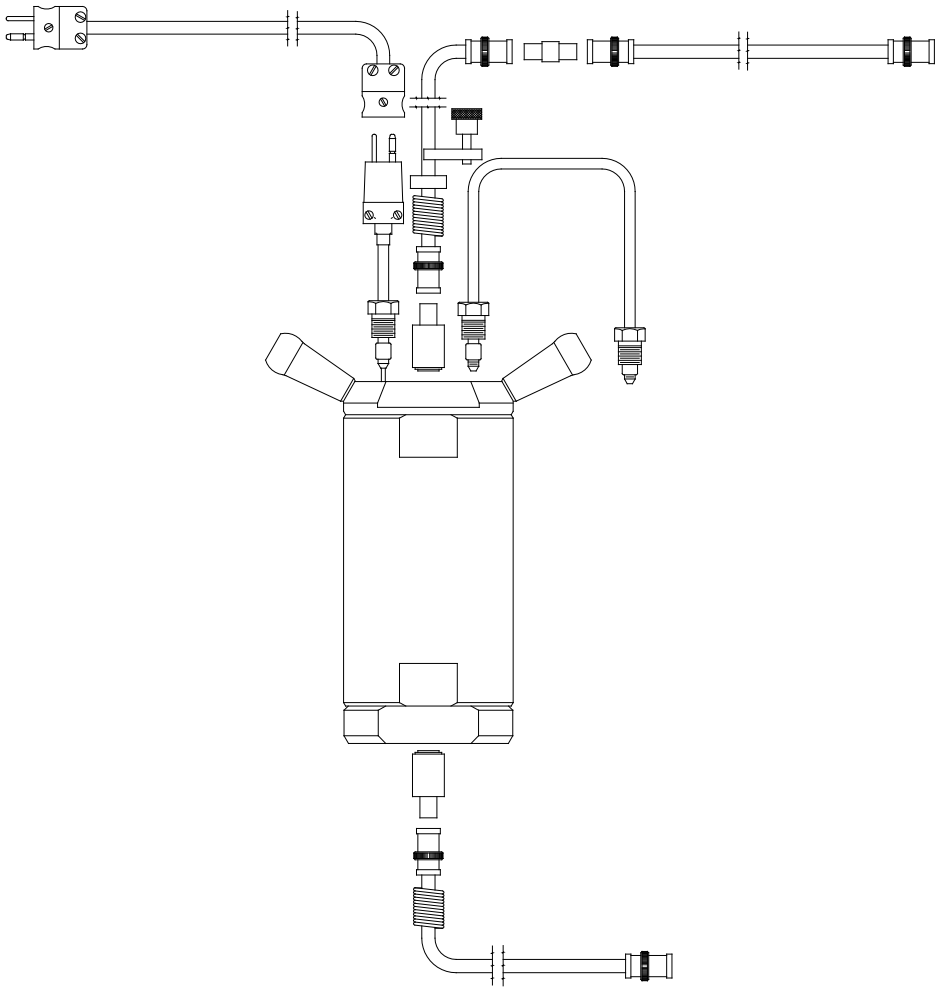


Figure 5-1
Test chamber

5.3.1 To assemble the test chamber for calibration, perform the following steps:

NOTE **The top end of the test chamber body is marked.**

5.3.1.1 Check the sealing components of the upper and lower covers of the test chamber. The sealing components are the O-rings, metal sealing rings, and retaining rings. Verify that they are in good condition; if not in good condition, replace them.

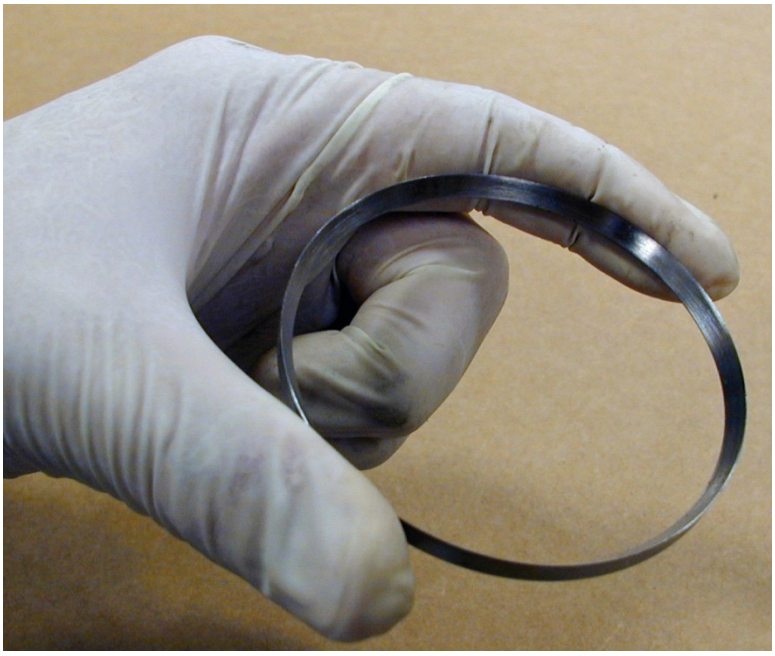


Figure 5-2
Inspecting metal seal ring

5.3.1.2 Lightly lubricate the two covers and the O-rings by applying a high-temperature grease or Hitempco coupling agent.

5.3.1.3 Place the lower cover (base) in a vise with the threaded end pointing up.

5.3.1.4 Screw the test-chamber body, bottom down, partially onto the base, leaving about ¾ in (2 cm) of threads exposed. The test-chamber body cannot be completely screwed on because the calibration rod would not fit into the test chamber if the covers were screwed on completely.

Figure 5-3
UCA Autoclave chamber

NOTE

Be certain the bottom side of the test-chamber body is screwed onto the base. The inside of the test-chamber body is tapered from the bottom to top, so that the bottom has a greater inner diameter than the top. The top of the test-chamber body is labeled “top”; if this marking is obscured, compare the inner diameters of the ends of the chamber body to determine which is the top.

5.3.1.5 Apply a thin layer of high-temperature ultrasonic coupling gel to the ends of the calibration rod, and place the rod into the sleeve, using a foam centering ring.

Figure 5-4
Calibration rod and foam centering ring

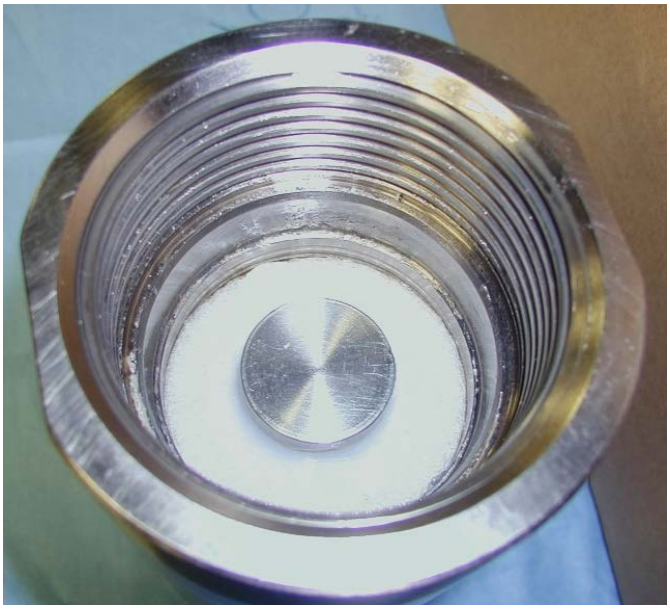


Figure 5-5
Calibration rod and foam centering ring in chamber

5.3.1.6 Apply a thin layer of high-temperature ultrasonic coupling gel to the ultrasonic transducer in the lid of the test chamber.

CAUTION

Verify that the ultrasonic transducers are free of debris and are not chipped or cracked. One small grain of contaminant can ruin a test.

5.3.1.7 Screw on the lid of the test chamber until it comes into contact with the calibration rod. Both the lid and the base of the test chamber should be protruding about ¾ in (2 cm) to accommodate the calibration rod.

Figure 5-6
Chamber assembly with calibration rod

5.3.1.8 Apply a thin layer of high temperature ultrasonic coupling gel to the ultrasonic transducer in the bottom of the chamber.

5.3.1.9 Lift the test chamber by the handles and place it into the chamber of the UCA Autoclave. The test chamber will not fit all the way into the chamber because of the calibration rod. Rotate the test chamber clockwise a full revolution to ensure that the chamber is firmly seated in the chamber, to fully engage the bottom transducer.

5.3.1.10 Connect the thermocouple and the BNC connector to the test-chamber lid.

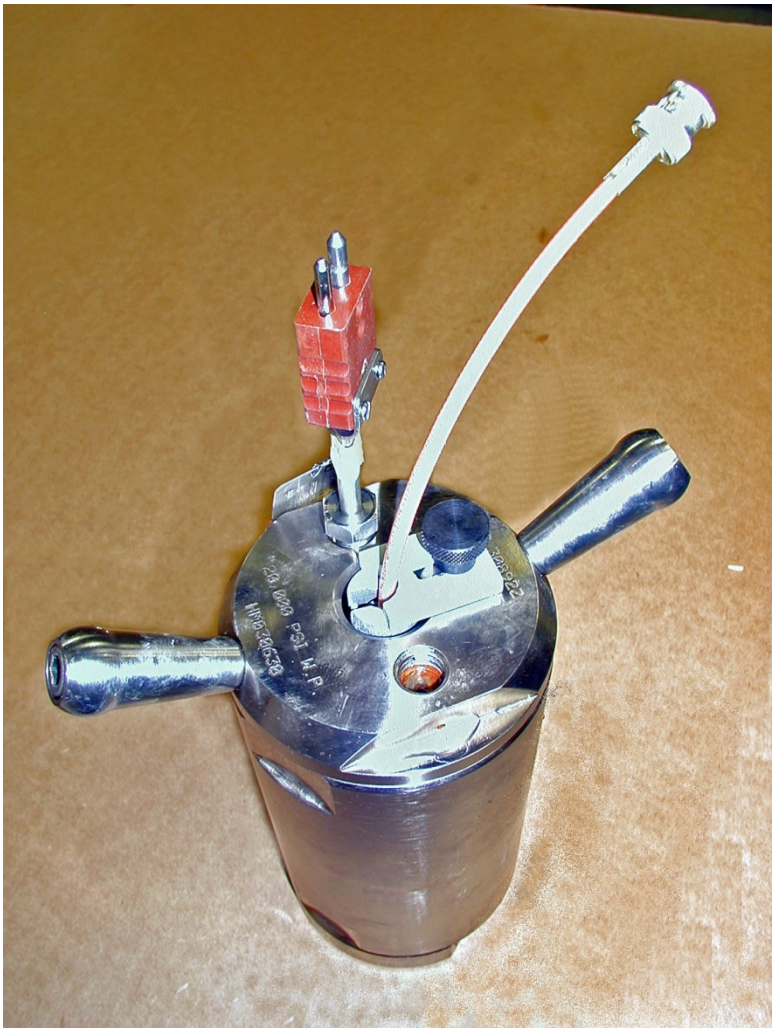


Figure 5-7
Assembled test chamber with thermocouple and transducer

5.3.1.11 Make sure the Heat switch is turned OFF, and do NOT turn it on during calibration. Doing so causes the foam centering ring to melt.

5.4 Pulser Calibration

Before ultrasonic testing can begin, the user must establish a base line for ultrasonic signal. The concept of calibrating the cell is to zero the time delays that may be present in electronics associated with ultrasonic transducers. The pulser calibration window relates to software portion of the calibration. There are physical steps that need to be accomplished before invoking this window and proceeding with the calibration. Refer to appropriate documentation to learn about steps that need to be taken for performing pulser calibration.

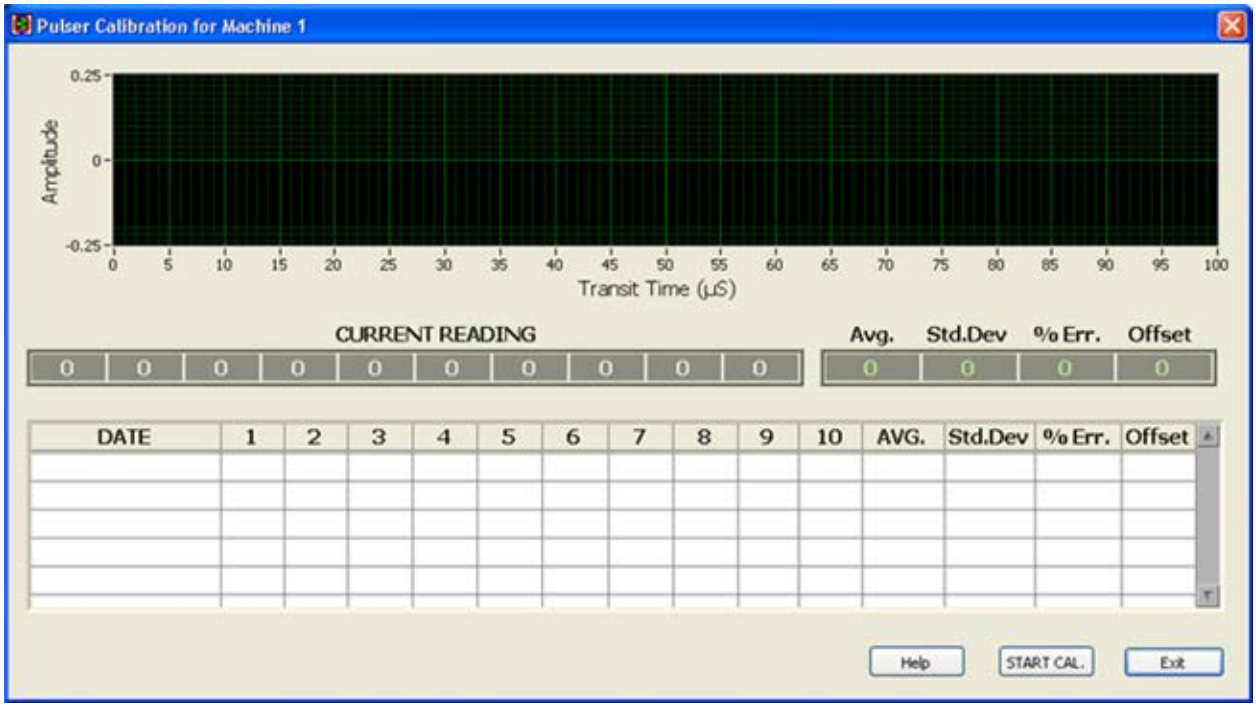


Figure 5-8
Pulser Calibration window

5.4.1 Title Barb

The title bar indicates for which machine the pulser calibration is being performed.

5.4.2 Signal Graph

The ultrasonic signal is pulsed as part of calibration. The received signal is plotted on the signal graph. The graph plots transit time (µs) against the signal amplitude. The signal shown on this graph

is for reference and all the relevant calculations necessary for calibration are performed automatically by the program.

5.4.3 Current Reading

When calibration is begun, the system sends ultrasonic pulses through the calibration cell and measures the transit time. This process is repeated 10 times. As the calibration progresses through each iteration, the transit time values in µs recovered by the system are displayed in the current reading window.

5.4.4 Avg.

The average (arithmetic mean) of all values read during calibration process is shown here. The average should not be too far off the values displayed in the current reading indicator.

5.4.5 Std. Dev.

The standard deviation of all values read is indicated here. The standard deviation indicates how far off the individual iteration values are form each other. The closer to each other the individual transit time values are, the lower the standard deviation. This is a great way to determine if the system is consistent and repeatable.

5.4.6 %Err.

Percentage error is another way of determining that the system is performing reliably. Percentage error is calculated by comparing the average vale to each of the individual values and calculating the error.

5.4.7 Offset

The offset is the actual calibration number we are interested in. By using a steel calibration bar, we know what the transit time of the ultrasonic signal should be. By measuring the actual transit time and comparing it to the theoretical value, we calculate the offset associated with the cell walls and all associated electronics. This offset is used in determining the correct transit time of a cement sample.

5.4.8 History

The history window shows the results of all past calibrations. The 10 transit time values, average, standard deviation, percentage error, and offset values are shown as well as the date this calibration was performed. The program uses the latest value of offset from this calibration list to calculate the compressive strength.

5.4.9 Help

This opens the relevant online help documentation.

5.4.10 Start Cal.

Pressing this button starts the actual calibration process. This button then gets disabled as the actual calibration progresses. At the end of the calibration, the user will be prompted with the option to save the current calibration. Refer to *5.5 Save Calibration* for more details.

5.4.11 Exit

Pressing this button lets the user close this window.

Related Topics: *5.5 Save Calibration* , *3.3.2 Machine Interface*

5.5 Save Calibration

The save calibration window appears when the calibration process has finished and the program reaches its conclusion. The window allows you to accept any calibration value. It warns you however about the quality of the calibration readings.

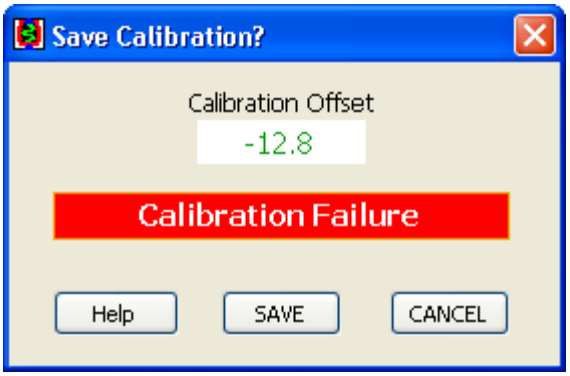


Figure 5-9
Save calibration window

5.5.1 Calibration Offset

The calibration offset calculated at the end of calibration is displayed here. Depending on the value of this offset, the calibration is judged as follows:

- If the offset value is between 1. 5 and 3. 0, the calibration is a success.
- If the offset value is outside the success limits but falls between 1. 0 and 4. 0, then such a calibration is marginal.

- If the offset value falls outside the marginal limits, the calibration is a failure.

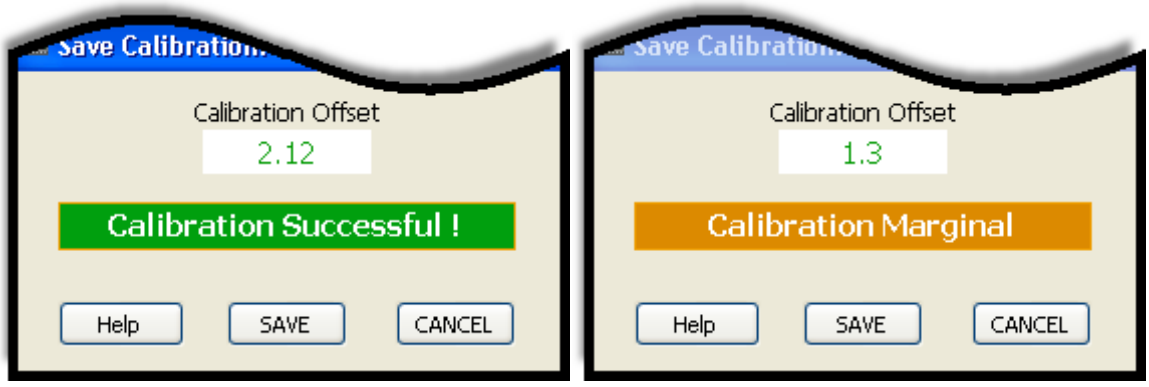


Figure 5-10
Calibration offset

5.5.2 Calibration Status

The status of the calibration is indicated here and appropriately messaged and color coded. The user should use the status message to save or cancel the calibration.

5.5.3 Help

Clicking Help brings up relevant online help.

5.5.4 Save

Use this button to accept the offset value from current calibration and use it for future tests. Pressing this button will also close this window and return you to *Pulser Calibration* window. It is recommended that a calibration should only be saved if its status is successful. A marginal or failed calibration should be investigated and another attempt at calibration should be made.

5.5.5 Cancel

Use this button to discard the current calibration. The offset from last calibration will then be used. Pressing this button will also close this window and return you to *Pulser Calibration* window. If the calibration is marginal or failed, use this button to discard it and attempt another calibration.

NOTE

Closing the window using the standard windows close button in the top left corner of the window is akin to using the cancel button and discarding the calibration.

Related Topics: *5.4 Pulser Calibration*

5.6 Remove the Test Chamber

5.6.1 To remove the test chamber, perform the following steps:

5.6.1.1 Disconnect the thermocouple, and BNC connector from the test-chamber lid.

5.6.1.2 Remove the test chamber from the chamber.

5.6.1.3 Place the chamber in a vise, with the vise clamped around the base.

5.6.1.4 Unscrew and remove the lid and the test-chamber body. Remove the calibration bar and the sleeve.

5.6.1.5 Clean transducers with a clean, dry cloth only. Many solvents will damage the transducer.

5.6.1.6 Clean all the parts in a solvent appropriate for the high-temperature grease used when assembling the chamber.

5.6.1.7 Inspect the O-rings, metal sealing rings, and retaining rings for damage or corrosion. Replace them if necessary.

5.7 Running a Test

5.7.1 After all configurations and calibrations have been completed, tests may be run using the UCA Controller. The followings are an outline of steps that are involved in running a test.

Program the Eurotherm Temperature Controller for a test.

Setting Time and Cement Strength alarms: This is an optional step. If you are using the default alarm setting values or you have previously defined the alarm settings for this channel then you don't have to perform this step.

Prepare the slurry and test cell. Please refer to the UCA Manual section for slurry preparation.

Taking channel On-Line: When a channel is taken on-line, the system software loads various types of configuration data for this channel, such as pulser calibration value, alarm setup data, etc. into the system memory, making it ready to run a cement test on this channel.

Test Signal: In this optional step, you check to see if system setup, cable connections, and pressure line on this channel are

setup properly. This is done by having the UCA Control System software apply an ultrasonic pulse to the cement slurry sample and graphically displays the shape of the sound wave that travels through the sample. By visually inspecting the characteristic of this wave form, you can see if everything is working properly. For more information, see *7 Troubleshooting and Maintenance*.

Selecting an existing Test Schedule or creating a new Test Schedule: When the UCA Control System runs a test, it progresses through a sequence of user-specified pressures and temperatures that are planned to occur at a specific time during test. This sequence of parameters is called test schedule. In this step, you can select a pre-created test schedule or to create a new one. For detailed information on creating a new schedule, please refer to the section *5.7.7 View/Edit Test Profile*.

Starting the Test.

Ending the Test.

The following sections describe these steps in detail.

5.7.2 Program Temperature Control for a Test

5.7.2.1 From the home display, press until you reach **'Program Edit'**. Press.

5.7.2.2 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.

5.7.2.3 Continue to press until you have reviewed or changed the desired program values.

5.7.2.4 Press the **PROG** button to return to the **'Program Status'** display.

5.7.3 Setting Time and Cement Strength Alarms.

The setting time and cement strength alarms may only be changed when the user interface level is set to default. Switching between simple and default user interface levels is done on the system settings panel, and requires restarting the program after the change.

During step 1 of *Start Test Wizard* the user can enter certain events or alarms which trigger a dialog box and beep to let the user know that the user defined events have occurred.

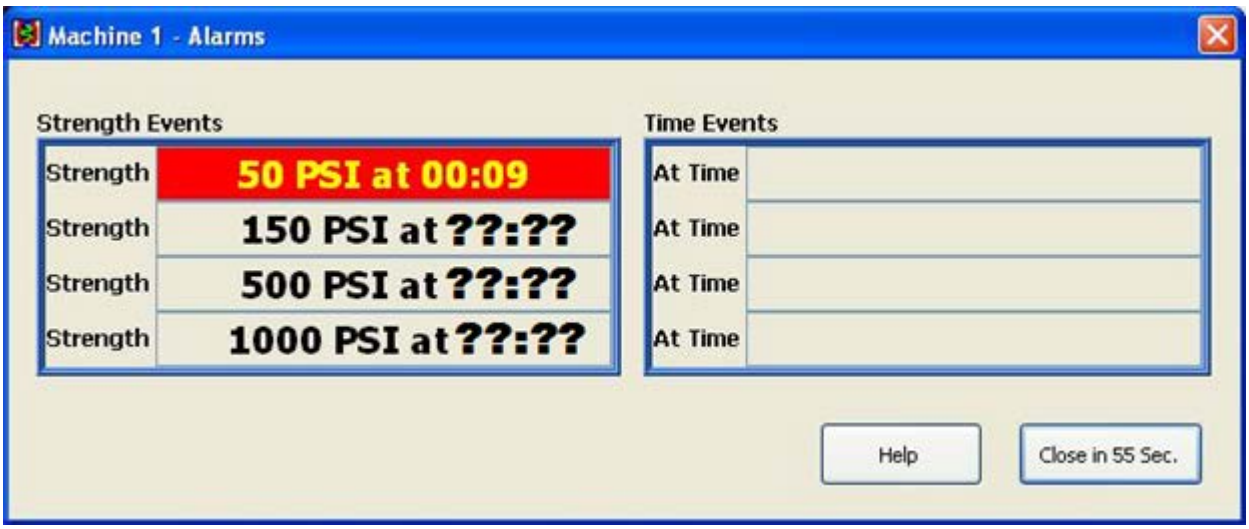


Figure 5-11
Strength events

In the above example, a 50 PSI event has occurred. So at 50 PSI, the time recorded is 9 minutes. The rest of the strength events have not occurred yet as shown by ??:??. At the same time, none of the time events have occurred yet. The event that has triggered the alarm is the one that is flashing.

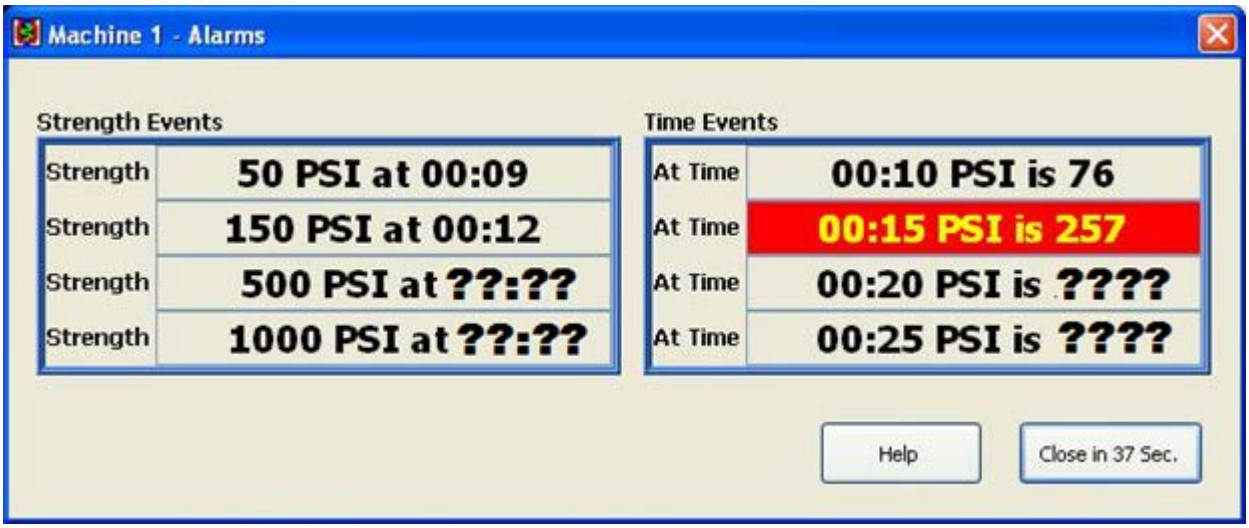


Figure 5-12
Time events

In the above case, strength events of 50 PSI and 100 PSI have already been recorded. The time event of 00:10 minutes has already been recorded earlier. A time event of 00:15 minutes is the one that has triggered the alarm. There are two strength and two time events that have yet to occur as evident by ??:?? and ???? in their results.

At any time the user can view this alarm window for any of the machines as explained in *3.3.2 Machine Interface*. The title bar of the alarm window shows the machine for which the alarms are displayed.

Related Topics: *3.3.2 Machine Interface*, *5.7.9 Start Test Wizard*

5.7.4 Assemble the Chamber for a Slurry Test

5.7.4.1 Assembling the test chamber (test cell) for a slurry test is similar to assembling the chamber for calibration, except the calibration rod and foam centering ring are not used.

5.7.4.2 Check the sealing components of the upper and lower covers of the test chamber. The sealing components are the O-rings, metal sealing rings, and retaining rings. Verify that they are in good condition; if not in good condition, replace them.

5.7.4.3 Apply a very light film of high-temperature grease to the inside of the two covers up to the O-rings. Apply a light film of Hitempco coupling agent or high-temperature grease to the O-ring surface.

5.7.4.4 Apply a very light film of high-temperature grease throughout the inside of the test-chamber body up to the threads.

5.7.4.5 Place the lower cover (base) in a vise with the threaded end pointing up.

5.7.4.6 A reusable sleeve is available to create samples suitable for a crush tests on a cured cement slurry sample. If used, grease the sleeve heavily on all surfaces and then insert the sleeve firmly into the base.

Figure 5-13
Groove in bottom test chamber lid for sample sleeve

5.7.4.7 Apply a heavy layer of grease to the threads of the upper and lower lids.

5.7.4.8 Screw the test-chamber body, bottom down, fully onto the base.

NOTE

It may be necessary to use the O-ring Seating Tool and Feed Sleeve to keep the bottom lid O-ring from becoming displaced while threading on the test chamber body. See *9 Parts List* for instructions.

Figure 5-14
Seating sample sleeve into bottom lid groove

NOTE

Be certain the bottom side of the test-chamber body is screwed onto the base. The inside of the test-chamber body is tapered from the bottom to the top, so that the bottom has a greater inner diameter than the top. The top of the test-chamber body is labeled “top”; if this marking is obscured, compare the inner diameters of the ends of the chamber body to determine which is the top.

5.7.4.9 Mix the cement slurry and pour cement into the sample sleeve.

Figure 5-15
Pouring cement slurry into sample sleeve

Figure 5-16
Fill the sample sleeve to the top

CAUTION

Do not overfill the sample sleeve so cement spills outside the sleeve.

5.7.4.10 Slowly fill the chamber with water up to the top of the chamber to about ⅜ in from threads.

Figure 5-17
Pouring water around sample sleeve

Figure 5-18
Water just covers the cement slurry

5.7.5 Alternate Fill Method without the Sample Sleeve

5.7.5.1 Place a slurry level gauge on top of the open UCA Autoclave test chamber.

5.7.5.2 Pour slurry into the chamber between the “wet” and “dry” levels marked on the gauge.

Figure 5-19
Slurry level gauge

5.7.5.3 Pour water over the top of the slurry until the volume reaches the “Fill water to this level” mark.

CAUTION

When performing tests without the sample sleeve, the thermocouple MUST be fully removed BEFORE attempting to unscrew the test chamber lid. Failure to remove the thermocouple results in it becoming bent and possibly unusable.

5.7.5.4 Screw the sample chamber cap into the chamber. Observe for water to be displaced through the high pressure connection or thermocouple hole in the cap. The presence of water at either or both of these openings indicates the chamber is properly filled with water, and excess air is displaced from the chamber.

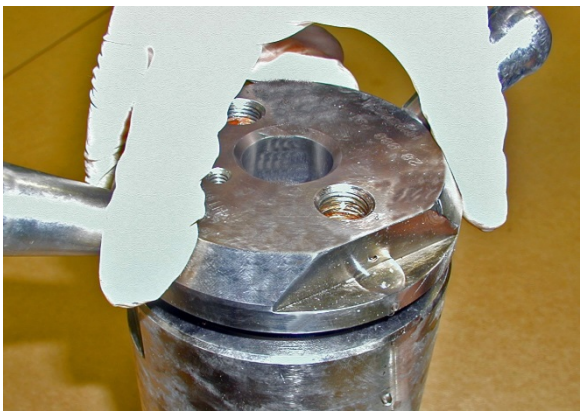


Figure 5-20
Tightening top lid, water expelled through open port

Figure 5-21
Water coming out of test chamber lid

Figure 5-22
Top lid fully tightened

5.7.5.5 Insert a thermocouple into the cap and fully tighten it.

5.7.5.6 Connect a transducer to either end of the short coax cable. Apply ultrasonic coupling gel to a transducer, approximately 1/4 inch diameter by 1/8 inch thick. Insert the transducer into the pocket in the sample chamber cap.

Figure 5-23
Coupling gel on transducer

Figure 5-24
Inserting the transducer into the top lid

5.7.5.7 Slide a compression spring over the coax cable and up to the back of the transducer.

5.7.5.8 Secure the transducer into the sample chamber cap with the spacer washer, retaining bracket, and thumb screw.

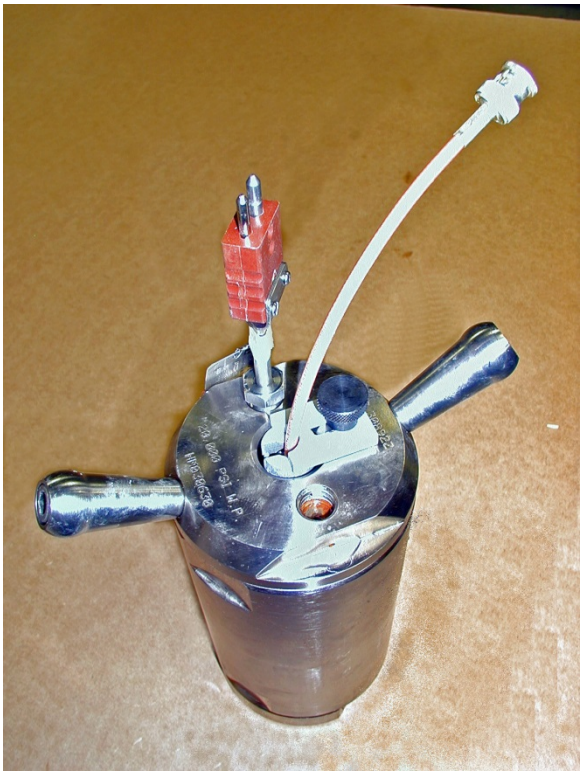


Figure 5-25
Assembled test chamber with thermocouple and transducer

5.7.5.9 Look inside the heating jacket to verify that the bottom transducer and compression spring are in place. Apply ultrasonic coupling gel to a transducer, approximately 1/4 inch diameter by 1/8 inch thick. Place the transducer and spring into the tube extending upwards from the heating jacket base.

Figure 5-26
Bottom transducer in heating jacket

5.7.5.10 Lift the assembled test chamber by the handles and slowly lower it into the UCA Autoclave heating jacket. Rotate the test chamber clockwise one full revolution to ensure that the chamber is firmly seated in the heating jacket.

5.7.5.11 Connect the high pressure U-Tube to the test chamber cap and to the bulkhead connection on the top of the UCA Autoclave, and securely tighten both connections.

5.7.5.12 Connect the top transducer coax cable to the top connector on the rear of the UCA Autoclave.

5.7.5.13 Connect the top cap thermocouple to the thermocouple connector on the rear of the UCA Autoclave.

5.7.5.14 Fully close the Chamber Vent and Chamber Supply valves on the UCA Autoclave front panel.

5.7.5.15 Increase the pressure on the UCA Pressure Source to the desired pressure.

5.7.5.16 Open any manifold valves between the UCA Pressure Source and the UCA Autoclave.

5.7.5.17 Slowly open the Chamber Supply valve on the front panel of the UCA Autoclave.

5.7.5.18 Observe the pressure gauge and verify that the pressure increases to the desired value.

5.7.5.19 Check for leaks at all high pressure fittings. Release all pressure from the UCA Autoclave before attempting to resolve any leaking fittings.

5.7.5.20 If not done already, set the desired temperature, heating ramps, and dwell time on the Temperature Control (see 5.6), and press the Run button.

NOTE

The basic heating ramp programmed into the temperature controller may be unsuitable for all tests. Experiential knowledge indicates a slower heating rate is required for lower temperature tests to prevent overshooting the target temperature.

5.7.6 Test Signal

Test the system before starting any test. The test involves sending an ultrasonic pulse to measure the transit time and check the signal amplitude. This prevents errors and assures that the signal is adequate for testing.

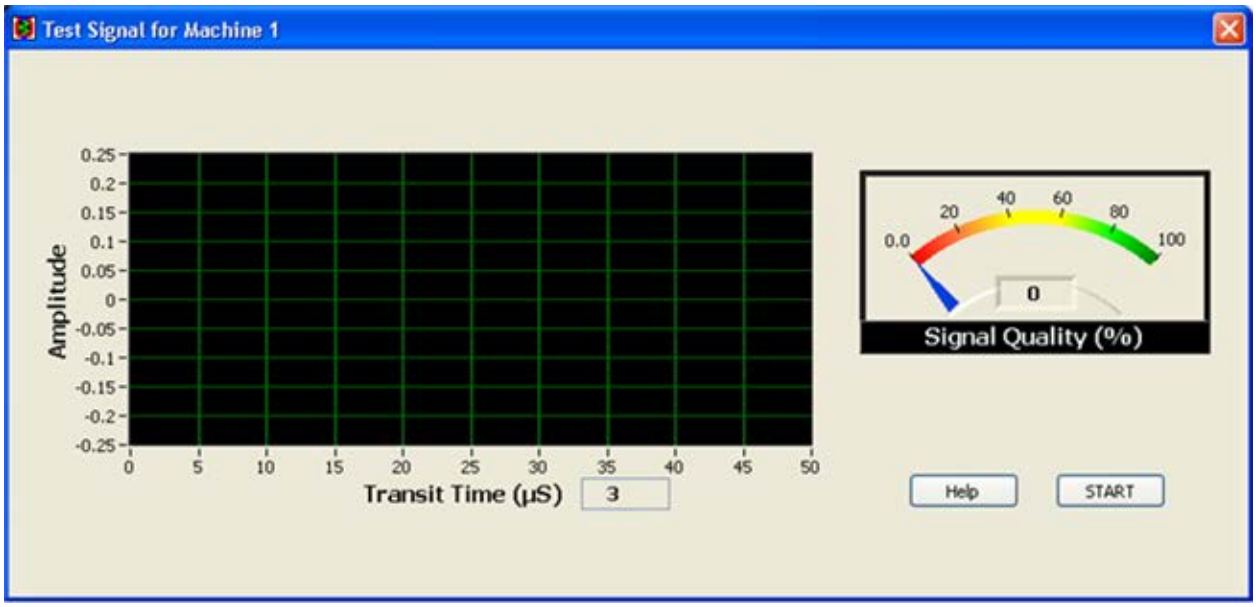


Figure 5-27
Test signal

5.7.6.1 Signal Graph

The signal graph shows the actual ultrasonic signal recovered by the system. This graph is used to determine the transit time and the quality of the signal.

5.7.6.2 Signal Quality

The signal quality meter shows the quality as in a percent form. The quality of the signal is judged based on the measurement resolution of the system. If the signal has sufficient amplitude, it can be measured with high fidelity and the meter will go in the yellow green zone (> 40%). If the signal is poor and measurement accuracy is degraded, then the signal will be in red zone (< 30%).

NOTE

It is recommended that a test should be started only if the signal quality is more than 30%. Below this, the system cannot consistently and accurately measure the ultrasonic signal.

5.7.6.3 Help

Clicking help brings up relevant on-line help.

5.7.6.4 Start/Stop

Pressing this button starts the process of testing the signal. If the testing has already been started, then press this button to stop the test. The signal graph displays the signal, and the meter shows the calculated signal quality. This process is repeated continuously until the user stops the testing.

5.7.6.5 Close

Use the standard windows close button to close this window.

Related Topics: *3.3.2 Machine Interface, 5.7.9 Start Test Wizard*

5.7.7 View/Edit Test Profile

The UCA controller software facilitates communication with the temperature controller in the autoclave. The view/edit test profile screen allows the user to read or write a test profile to the temperature controller. The test profile is a schedule for temperature and time

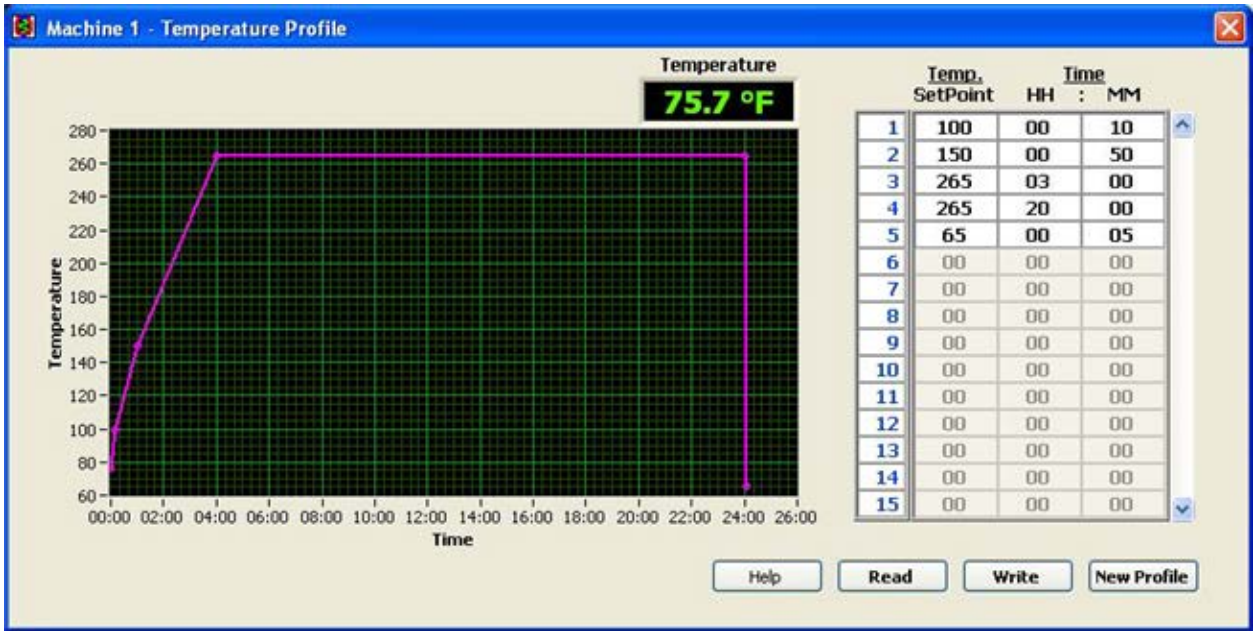


Figure 5-28
Temperature profile

5.7.7.1 Temperature

The temperature indicator shows the current temperature at the autoclave. This temperature is used as baseline for all temperature calculations. The temperature units are same as what was set during the *4.7.1 Configure System* step.

5.7.7.2 Time-Temperature graph

This graph plots the profile in graphical form. The temperature profile graph updates in real time as the profile is being created. This allows the user to see the temperature with respect to time when the test is run.

5.7.7.3 Temp. Setpoint

The test profile comprises of steps. Each step consists of a target temperature and time in which this target temperature is to be reached. This column lists all the target temperatures to be attained in sequential steps.

5.7.7.4 Time (HH:MM)

These two columns list the times in which the target temperature must be reached. The left column lists the hours, and the right column is for minutes. The time of each step is independent of previous and next steps. If step 2 has target temperature of 150 deg and time of 50

minutes, the step will last 50 minutes and it will take all of these 50 minutes to reach 150 deg.

The steps in time-temperature table can be quickly edited by right clicking on any step of the table and accessing the context menu for that step.

5.7.7.4.1 Copy row

By selecting this item, the user copies the current step and holds it in memory.

5.7.7.4.2 Paste row before

By selecting this menu, any step that is held in the memory is inserted before the current step on which right click operation was performed. This menu item becomes available only after the "Copy row" item has been clicked. Once a row has been pasted, this menu item is disabled and becomes available only after the "Copy row" menu item is clicked again.

5.7.7.4.3 Delete row

This deletes the step on which this context menu item is clicked.

5.7.7.4.4 Insert row before

This inserts a step of all zeroes before the current selected step.

5.7.7.4.5 Empty Table

This clears the entire table and user will have to start over again.

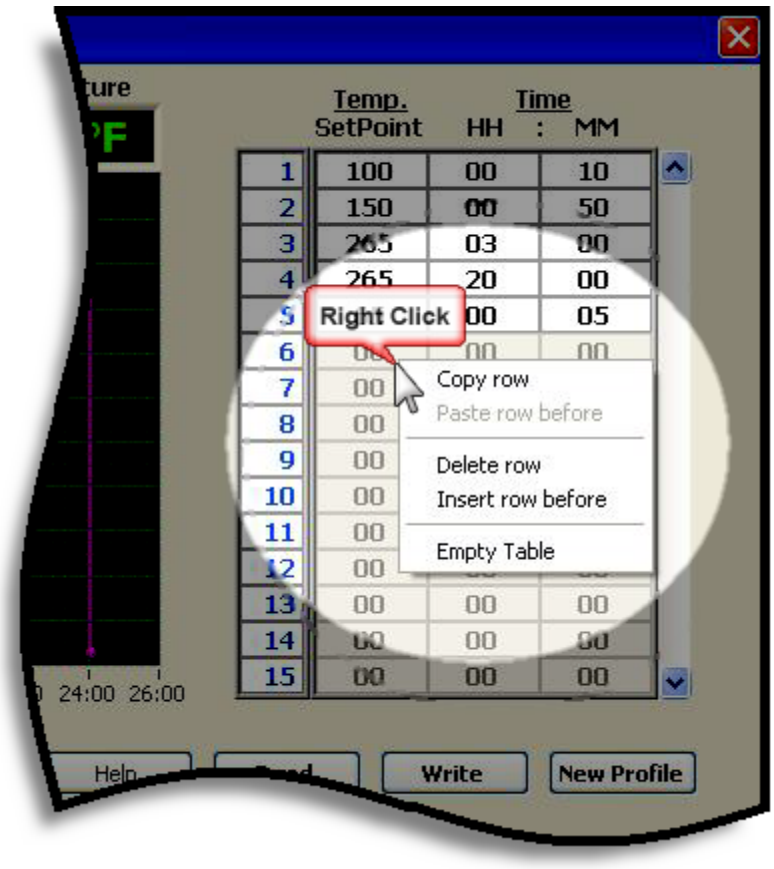


Figure 5-29
Right click to edit steps

5.7.7.5 Help

This brings up the relevant on-line help.

5.7.7.6 Read

This reads the current temperature profile stored on the temperature controller on the autoclave. This button is used for verifying that current temperature profile is correct for the test and can be used as part of the *Start Test Wizard*.

5.7.7.7 Write

Once the user enters all the steps that make up the test profile, he can send this test profile to the temperature controller on the autoclave by clicking this button. The temperature controller will now hold the new profile and test will proceed according to the latest profile sent to the autoclave.

5.7.7.8 New Profile

This button clears the current test profile and allows the user to create a new profile from scratch.

NOTE

If the test profile in the table does not match the profile on the machine, a warning appears inside the time-temperature graph telling the user that the profile being seen is not the profile that will run when test is started. The two ways to address this are to write the current profile in the table to temperature controller or read the existing profile in the temperature controller.

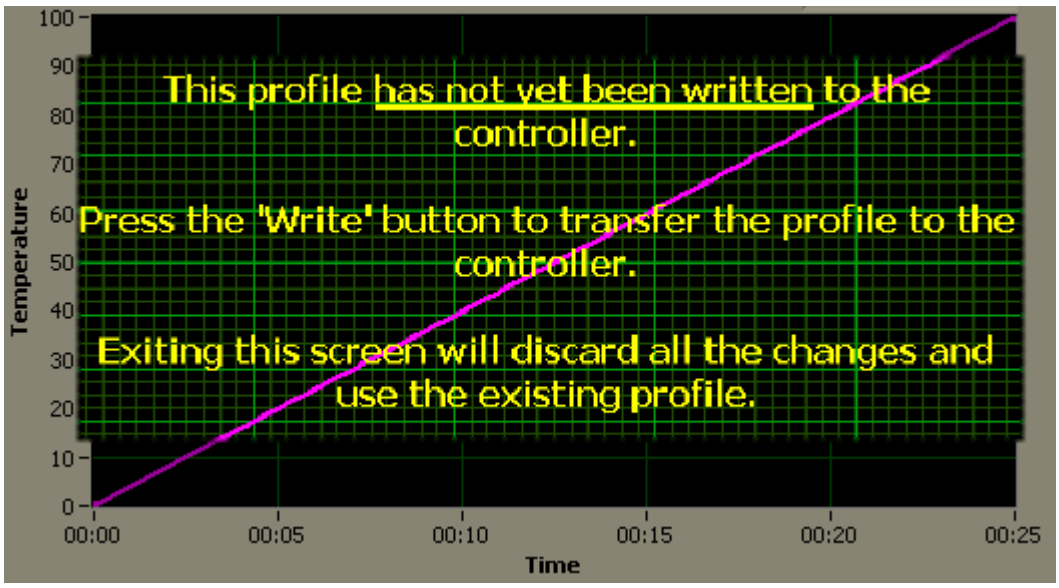


Figure 5-30
Warning

NOTE

If a machine uses Eurotherm 818P controller, then the number of steps in the profile is limited to 8. This is the limitation of Eurotherm 818P controller.

5.7.7.9 Temp. Profile Tricks.

5.7.7.9.1 Dwell for Limited time

Step	Temperature Setpoint	Time HH	Time MM
1	100	00	30
2	150	00	30
3	150	3	00
4	265	2	00
5			

Table 5-1 Dwell for limited time and unlimited time

In the above example, the temperature stays at 150 deg for 3 hours as part of step 3. Since there is no change in temperature between steps 2 and 3, the temperature does not change, only time does.

5.7.7.9.2 Dwell for Unlimited time.

In the above example, the target temperature is 265 deg. in 6 hours. There are two ramps of 30 minutes and a dwell time at 150 deg for 3 hours. Then ramp again for 2 hours to reach the target temperature. Since there is no further step (step 5 is empty), the program tries to maintain the 265 deg in the last step indefinitely. The only way to stop the temperature control is to stop the test. Dwelling for unlimited time is only possible on the last step of the temperature profile.

5.7.7.9.3 Cooling at end of test.

Step	Temperature Setpoint	Time HH	Time MM
1	100	00	30
2	150	00	30
3	150	3	00
4	265	2	00
5	265	18	00
6	50	00	05

Table 5-2 Cooling at end of test

In the above example, the test dwells twice, and after 24 hours, the test is done. It is

designed to cool down automatically after the test is over. In this case, enter a step which ramps the temperature down to 50 deg in 5 minutes. The machine will not reach 50 deg in 5 minutes but it will turn off the heater and begin a natural cool down. Since any temperature entered in the last step dwells indefinitely, the autoclave heat will never turn on, and the heat is effectively shut off. The test, however, will continue until the user physically stops it in the machine interface (see *3.3.2 Machine Interface*).

Related Topics: *3.3.2 Machine Interface*, *5.7.9 Start Test Wizard*, *4.7.1 Configure System*

5.7.8 View Test Information

Anytime during the test, the user can see all the pertinent test information that was entered as part of step 1 of the *Start Test Wizard*.

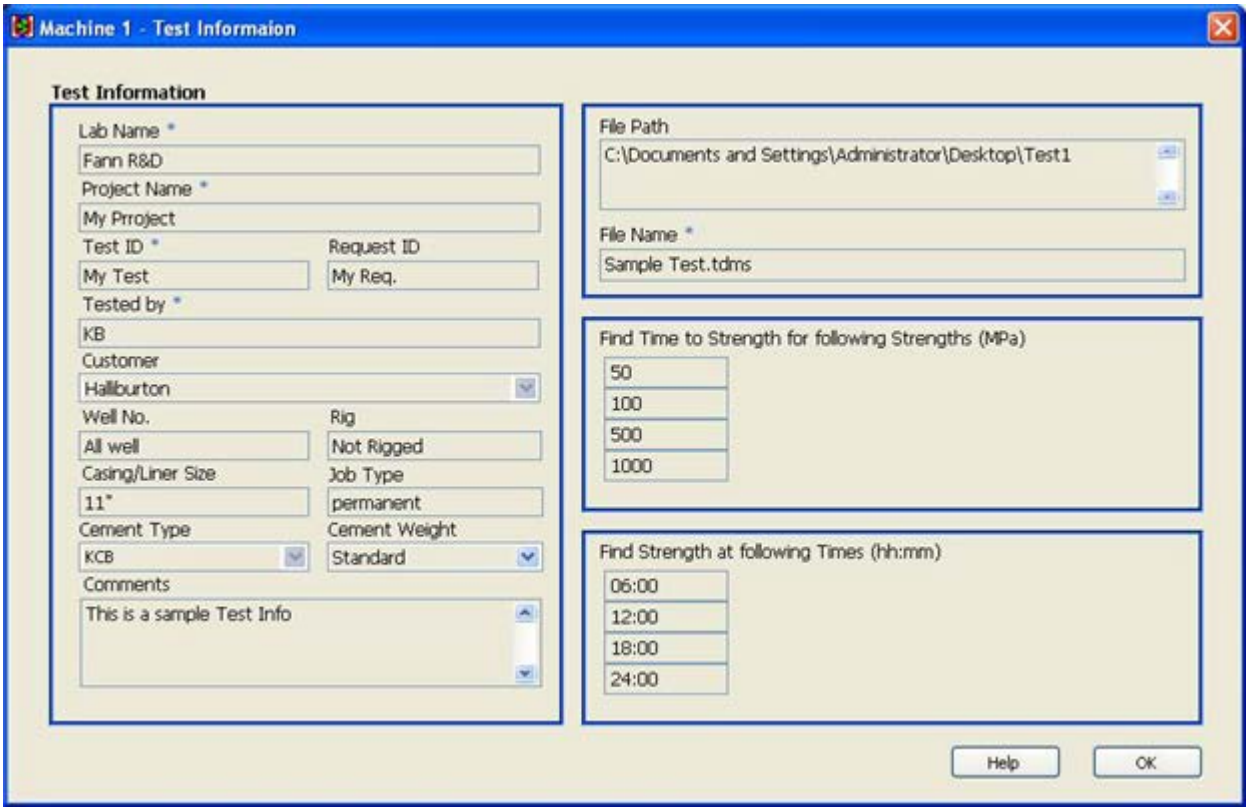


Figure 5-31 Test information

Refer to *5.7.9 Start Test Wizard* to understand the meaning of all the fields in this box. None of the fields in this box can be edited. This information is for viewing only.

5.7.8.1 Help

This brings up the relevant on-line help

5.7.8.2 OK

This closes the window.

Related Topics: *3.3.2 Machine Interface*, *5.7.9 Start Test Wizard*

5.7.9 Start Test Wizard

The feature that makes the UCA controller software perform consistent testing—whether one is a novice or an expert user—is the start test wizard. The wizard walks the user through a series of steps to ensure all significant procedures are performed as a test begins. The wizard is like a check list which assures that the user has indeed completed the relevant steps.

The four buttons at the bottom of the wizard help in navigating through the wizard.

5.7.9.1 Back

Press this button to go back one step. At the first step, this button is disabled.

5.7.9.2 Next

Press this button to advance to the next step. At the last step, this button will say Finish instead indicating this is the last step.

5.7.9.3 Cancel

This button exits the wizard without starting any test. The wizard must be used to start a test.

5.7.9.4 Help

This brings up the relevant online help.

5.7.9.5 Step 1 of 4

The first step in the process is to ensure all the relevant information about the test.

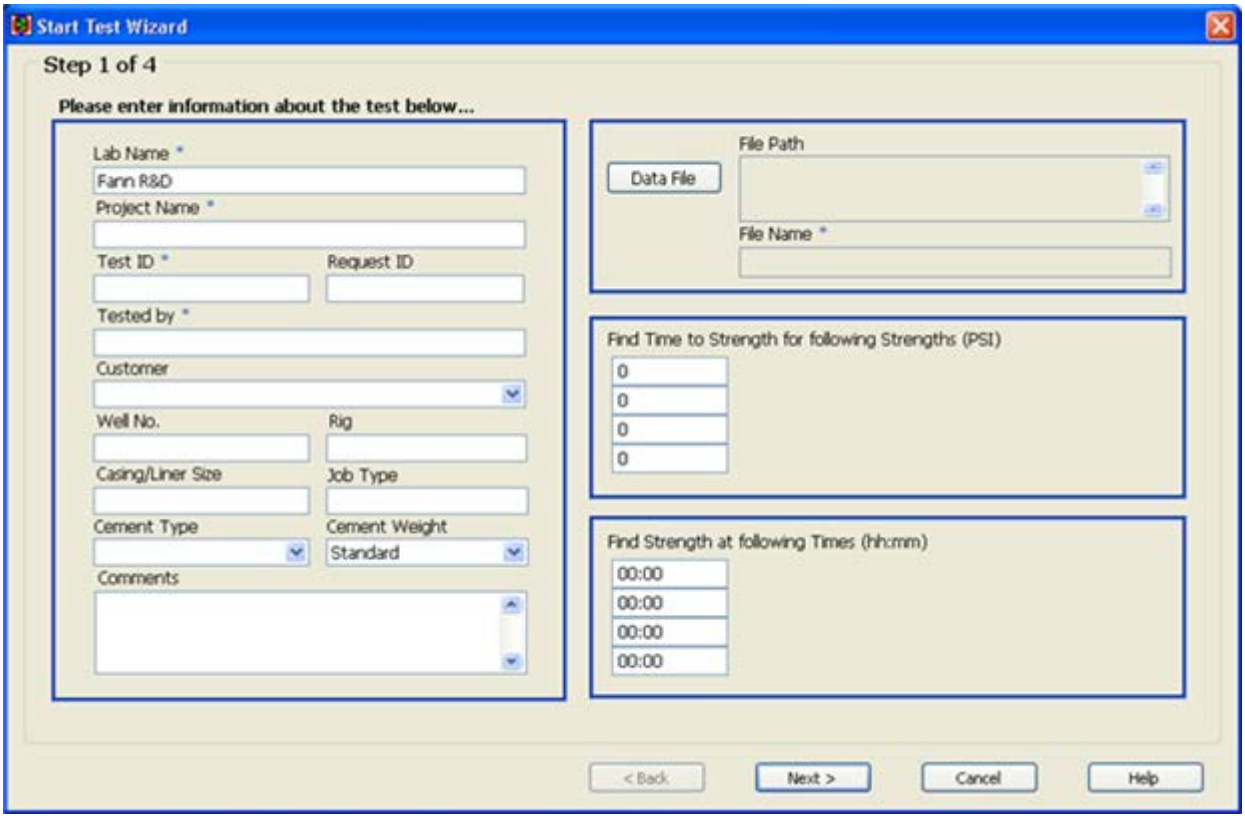


Figure 5-32 Step 1 of 4

5.7.9.5.1 Test Information

The user must enter all relevant information about the test here. The following fields are necessary:

- Lab Name
- Project name
- Test ID
- Tested By
- File name

  This field cannot be directly typed in. Use the Data File button to open a standard window file dialog and navigate to the folder where you want to save the data file. Enter the desired file name and click OK.

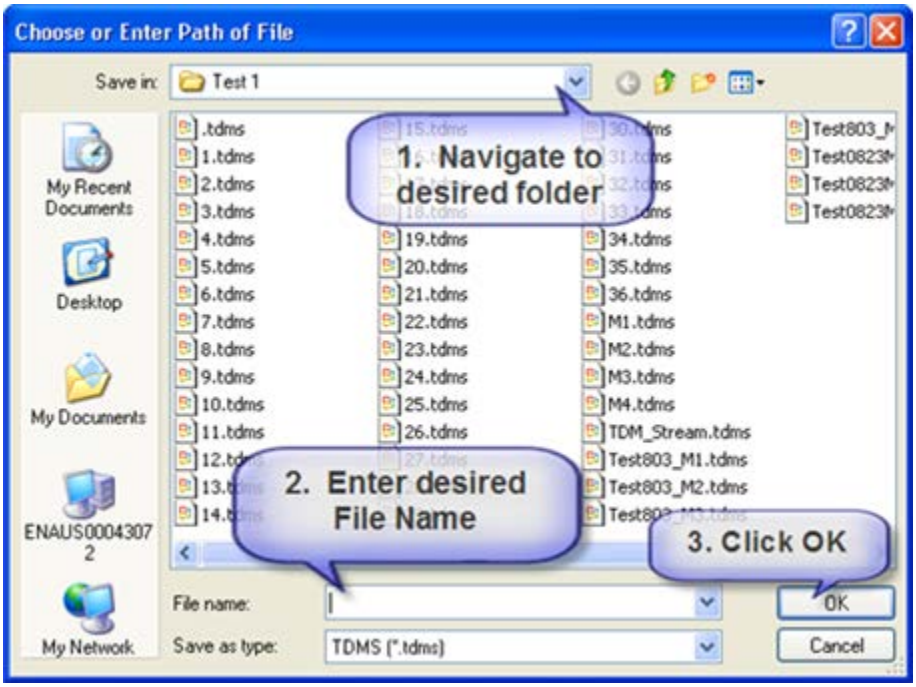


Figure 5-33
Test information

Other fields in the test information step are:

- Request ID
- Customer

  The customer field is a free text field with a drop down list. The drop down list allows the user to pick a customer from the list.

- Rig
- Casing/Liner Size
- Job Type
- Cement Type

  The Cement type is identical to Customer field above.

- Cement Weight

  Pick from standard, light weight, or high density.

- Comments
- Well No.
- File Path

This field is entered using the Data file button as explained above.

- Find time to strength for following strengths.

  Enter the strengths at which you want to record the time.

- Find strength at following times

  Enter times in hh:mm format at which you want to record the strength.

NOTE

The default values for Customer List, Cement Types, Strength and Time Events can be set by using the *Configure System* menu item from the Main Screen (see *3.3.1 Main Screen).*

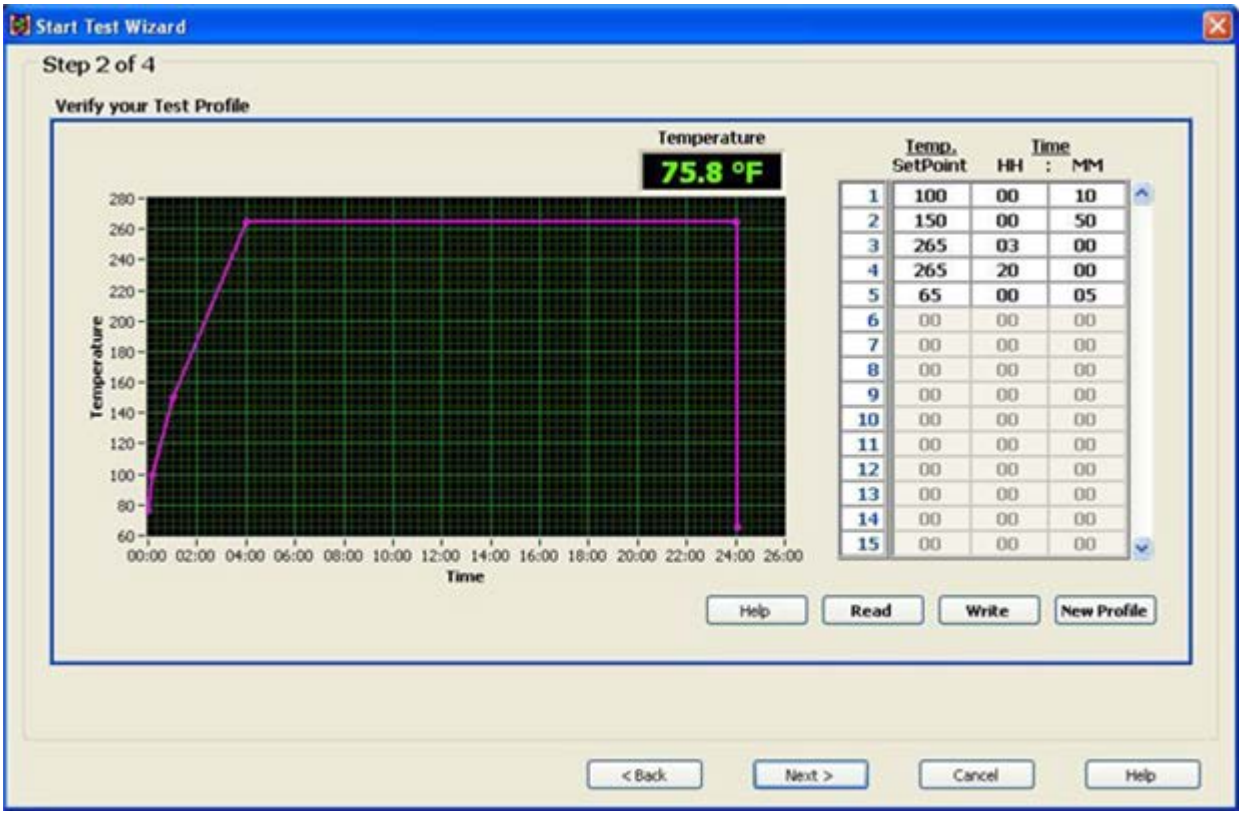


Figure 5-34
Step 2 of 4

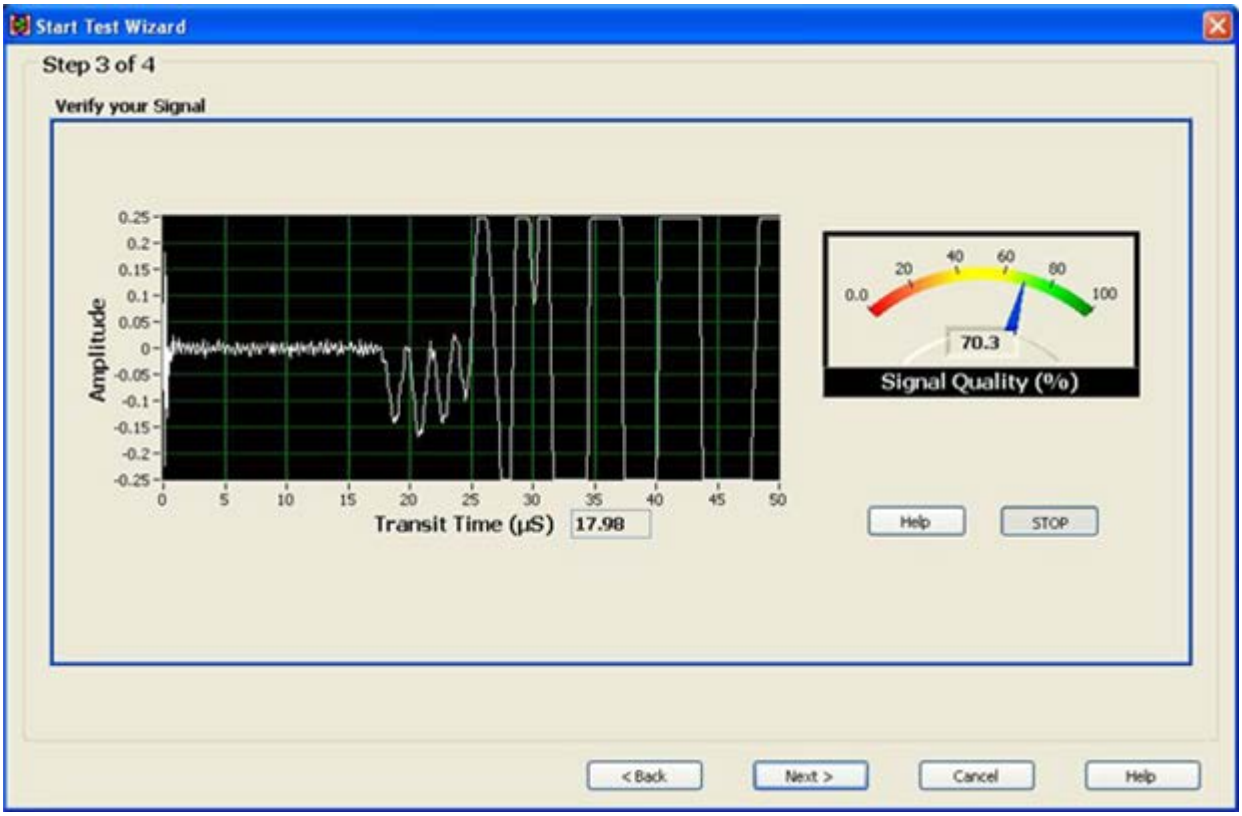


Figure 5-35
Step 3 of 4

5.7.9.6 Step 2 of 4

This step prompts the user to check the temperature profile that will be used to run the test. This step encapsulates all the functionality of *View/Edit Test Profile* section. Follow the explanation in that section to understand this step. The user may read, edit, and write a profile to the temperature controller, from within the wizard.

5.7.9.7 Step 3 of 4

This step prompts the user to test the signal before starting the actual test. The user has an opportunity to verify the signal and if the signal is not adequate to correct the system before proceeding. This step encapsulates all the functionality of the *Test Signal* section. Follow the explanation in that section to understand this step. The user can verify and test his signal from within this step of the test wizard.

5.7.9.8 Step 4 of 4

When the user reaches this step, the test can be started. However, before starting the test the user needs to ensure that certain physical actions are completed before the test begins.

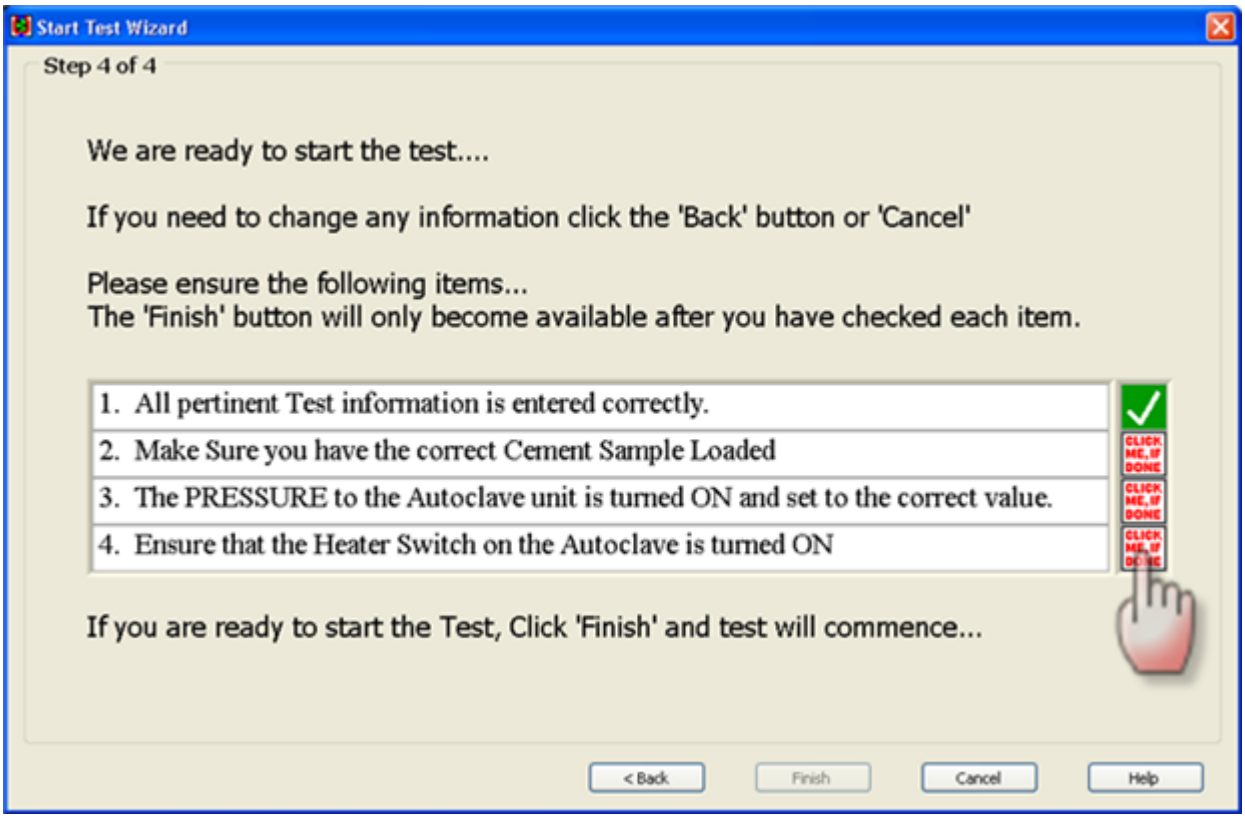


Figure 5-36
Step 4 of 4

In this step the check items will have to be checked by the user. If all the items are checked the finish button will become available. When the user clicks on the finish button the test will start.

NOTE

The only way to start a test is to go through the Start Test Wizard.

NOTE

The user can navigate freely between the steps using ‘Back’ and 'Next' buttons. Use 'Cancel' button anytime to abort the starting of a test.

Related Topics: *3.3.2 Machine Interface, 5.7.7 View/Edit Test Profile, 5.7.6 Test Signal, 4.7.1 Configure System*

5.8 Disassembly and Cleaning of the Chamber at the Conclusion of a Test

WARNING

At the conclusion of a test, the test chamber and contents are hot and may contain high pressure. Thermal protective gloves should be worn if handling the hot chamber. The integral cooling system is designed to remove the heat from the test chamber and lower the pressure before it is fully released. Rapidly releasing the pressure while the temperature is above 212°F (100°C) could result in the water in the chamber flashing to super heated steam and becoming a burn hazard.

5.8.1 Shut down the Temperature Control.

5.8.1.1 Stop the temperature control program.

5.8.1.2 Turn the Heat switch OFF.

5.8.1.3 Inspect the UCA Autoclave for leaks and proper working conditions.

5.8.1.4 Check the temperature of the unit, and perform one of the following:

If the temperature is greater than 120°F, open the cooling valve and allow the unit to cool to below 120°F. Also ensure that the pressure drops. Close the valve before moving on to the next step.

If the temperature is less than 120°F, proceed to the next step.

5.8.1.5 Turn the Main Power switch OFF.

5.8.2 Disconnect the test chamber.

5.8.2.1 Close the Chamber Supply valve.

5.8.2.2 Open the Chamber Vent valve, and perform one of the following:

If the pressure drops, the high-pressure lines are not plugged. Keep the valve open briefly to purge the line from the supply through the vent valve to the drain; then close the valve.

If the pressure does not drop (vent to drain), the high-pressure lines are probably plugged, and the UCA Autoclave needs to be repaired before it can be safely used again.

5.8.2.3 Close the Chamber Vent valve to prevent coolant spilling when the high-pressure U-Tube is disconnected.

5.8.2.4 Wrap a cloth around the high-pressure U-Tube connected to the top of the test chamber and disconnect the high-pressure line from the pressure vessel. It is not necessary to fully disconnect it from the bulkhead fitting in the top of the UCA Autoclave.

5.8.2.5 Wipe up spills or drips and clean the connector ends.

5.8.2.6 Place a disposable cup under the disconnected high-pressure line, or place a cloth around its open end to collect the flush water.

5.8.2.7 Open the Chamber Supply valve briefly to flush water through the disconnected high-pressure line to remove any residue in the line.

5.8.2.8 Close the Chamber Supply valve.

5.8.2.9 Ensure the following settings on the UCA Autoclave:

- The power is OFF.
- The Chamber Vent valve is closed.
- The Chamber Supply valve is closed.
- The Coolant Supply is closed.

5.8.3 Remove the test chamber from the UCA Autoclave.

5.8.3.1 Disconnect the cable from the transducer in the test chamber lid.

5.8.3.2 Loosen the thumbscrew which retains the transducer in the top cap by no more than one full turn. Use caution to keep the spring on top of the transducer from abruptly slipping from under the spacer washer.

5.8.3.3 Carefully slide the metal retaining clip away from the coax cable. Remove the spacer washer and spring, and then withdraw the transducer from the lid.

5.8.3.4 Using one hand on each of the test chamber handles and proper lifting techniques slowly lift the sample chamber assembly fully from the heating jacket.

5.8.4 Disassemble the test chamber.

5.8.4.1 Place the test chamber in a vise, clamping the bottom lid securely.

5.8.4.2 Remove the thermocouple from the lid (not required if the sample sleeve was used).

5.8.4.3 Unscrew the top lid from the test chamber body.

5.8.4.4 Remove the test chamber body and bottom lid from the vise, pour out the water, and remove the hardened cement slurry and sample sleeve (if used).

5.8.4.5 Properly dispose of the water and cement slurry.

5.8.4.6 Unscrew the bottom lid from the test chamber body.

5.8.4.7 If the sleeve was not used, press out the cement from the top end of the test chamber.

5.8.4.8 Wipe all cement remnants and grease from the top and bottom chamber lids, paying particular attention to clean the large flat surfaces on each lid, and the groove in the bottom lid.

5.8.4.9 Wipe all cement remnants and grease from the inside of the sample chamber body.

5.8.4.10 Properly dispose of the cleaning materials used.

5.8.4.11 Inspect the seal rings for damage, discarding those which are damaged.

5.8.4.12 Clean and wipe all surfaces on the UCA Autoclave, and protect the transducers from mechanical damage.

6 Analyzing Results

The data manager software allows the user to view, print, save and re-characterize any of the test data. The software supports an easy to use interface and allows the user to view the data for any test past or currently in progress.

The user may decide to print reports, preliminary or final or save the data as PDF or in spreadsheet file formats.

The data manager is a stand alone utility and can be used to view test data on any computer or on the network.

Currently the data manager supports viewing of data written by UCA controller only.

Data Manager List of Features

- Full re-characterization of data is possible. This includes cement type, units of measurement.
- Printing to printer and to a PDF file. (PDF printer must be installed)
- Saving data to spreadsheet file formats TXT and CSV.
- Strength and time events can be recast for any value.
- Print with or without a user defined cursor.
- Zoom to area for interest for viewing as well as printing.

6.1 Main Screen

The data manager program allows the user to view, re-characterize and recast their data in a variety of ways. It affords a simple user interface and has simple options to view, print, and export data to other file formats.

NOTE

If the program is opened, directly by the user, it opens with no data loaded. The program can be opened from within the UCA Controller Software. In such cases, the program opens with the current data of a test in progress.

The software can be maximized to occupy the entire screen, and if he results graph is enlarged, the user can see the graph in its entirety on the full screen.

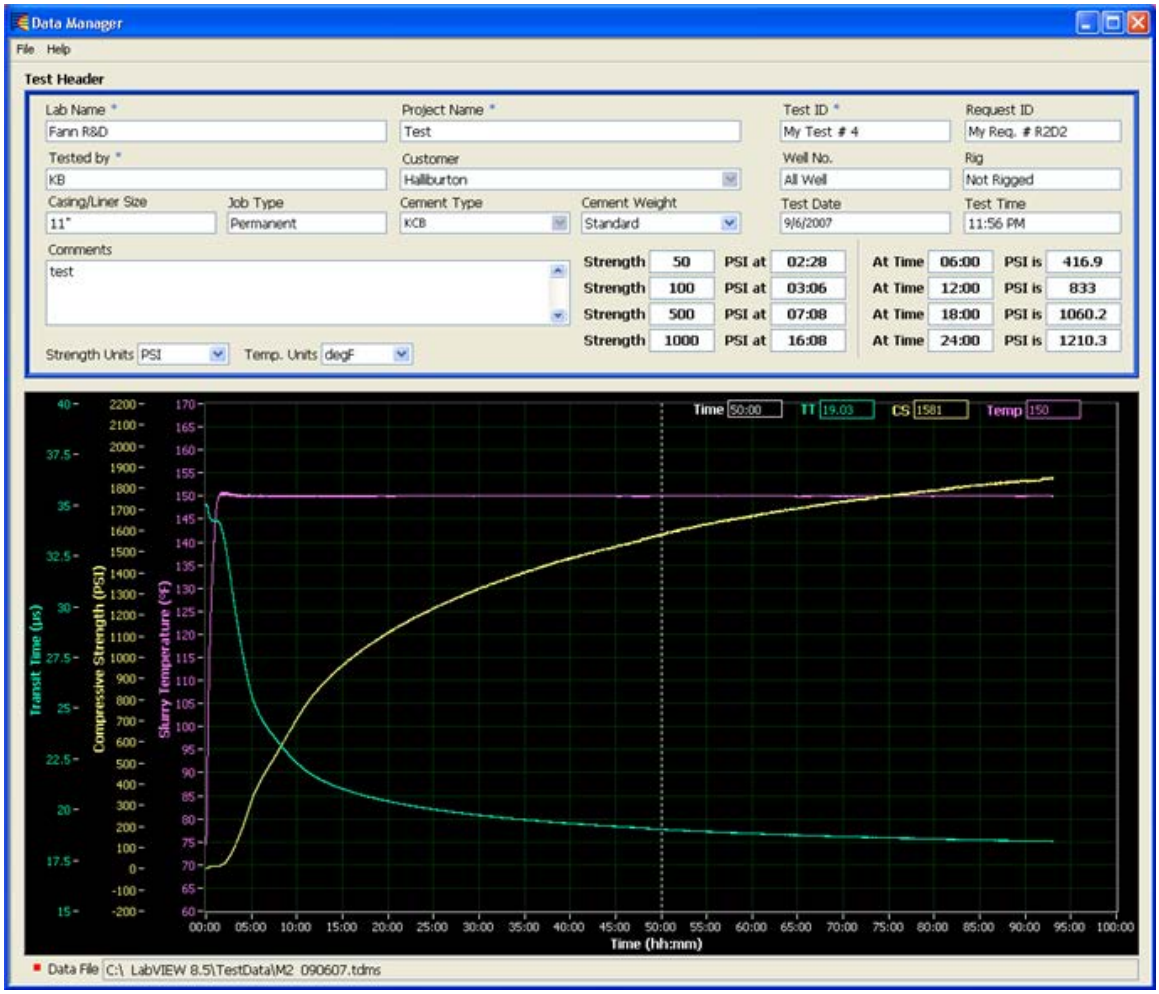


Figure 6-1
Main screen, full screen view

6.1.1 Menu Bar

Menu bar allows the user to access some of the overall functions of the program. Use the menu bar to perform a variety of functions with the data you want to view. Refer to *6.3 Recharacterizing Data*.

6.1.1.1 File

6.1.1.1.1 Open

This opens a standard windows dialog box through which the user can navigate to a folder and pick a data file to view in the data manager.

6.1.1.1.2 Save

Use this option to save data to a file for viewing later in a spreadsheet program. Refer to *Saving for Spreadsheet* section for more details

6.1.1.1.3 Print

Use this option to print a report about the test. Refer to *6.4 Printing Data* for more details. Also refer to *6.5 Printing to PDF* for using PDF printers.

6.1.1.1.4 Exit

Selecting this menu item exits the program

6.1.1.2 Help

6.1.1.2.1 Online Help

This brings up the online help for this program

6.1.1.2.2 About

This brings up an about this program dialog box which lists the copyright and version information about the program.

6.2 Test Header

The test header box displays all the relevant information about the test that was conducted. It lists all the fields and their values which were filled in at the time the test was begun. In addition it also lists all the strength and Time events and results which were recorded as part of the test.

The following fields are part of the test header. Any of the fields here can be changed by the user. Refer to *6.3 Recharacterizing Data* for more details

- Lab Name
- Project name
- Test ID
- Tested By
- Request ID
- Customer
- Well No.
- Rig
- Casing/Liner Size
- Job Type
- Cement Type
- Cement Weight - Pick from Standard, Light Weight or Hi-Dense
- Comments
- Strength Units

- Temp. Units
- Strength Events (4)
- Strength Results (4)
- Time Events (4)
- Time Results (4)

6.2.1 Results Graph

The results graph holds all the test data in graphical form. The graph plots elapsed time on X-axis and transit time, compressive strength and slurry temperature on three different Y-axes in their respective units.

6.2.1.1 The X and Y axes scales can be changed to show any range of values by clicking on the scale values and entering a new desired value in. This positions the respective parameter graph to the new scale.

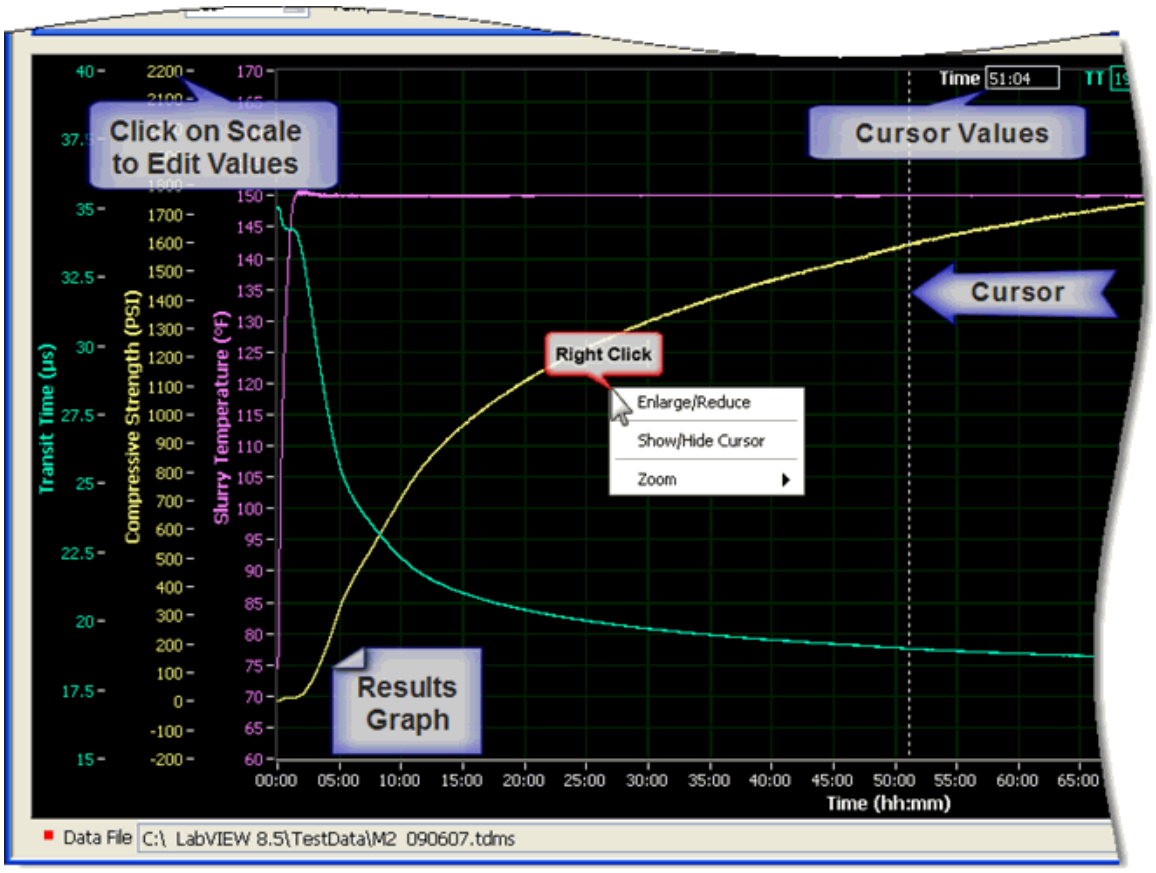


Figure 6-2
Results graph

6.2.1.2 The user can right click on the graph to avail of the context sensitive menu which provides additional functionality to the graph.

6.2.1.2.1 Enlarge/Reduce

By selecting this menu item, the user can enlarge the graph to occupy all of the viewing space. If the results graph is enlarged, the test header will be hidden. If the results graph is already enlarged, then this menu selection will reduce the graph to its default state. The test header will now be visible.

6.2.1.2.2 Show/Hide Cursor

Cursor visibility is toggled by selecting this item. The cursor is a thin vertical dotted line which can be dragged by the mouse to a desired position. When cursor is visible, an associated cursor indicators are also made available on top which display the current cursor position in its associated X and Y axes scale values. In this manner any parameter can be read out for any particular value of elapsed time

6.2.1.2.3 Zoom

There are three kinds of zoom available. Pick the desired zoom tool to dig deeper into the graph. The area zoom tool will allow the user to draw a rectangular area on the graph to zoom into. The continuous zoom feature allows the user to pick a point on the graph and by continuously holding the left mouse button at this point to progressively zoom into it. The zoom extents menu discards the zoom tool and reverts the graph back to show the complete graph in its default state.

NOTE

When a data file is opened, the X-axis and Y-axis of the result graph are automatically scaled such that the data fits cleanly and occupies optimum space for ease of reading.

6.2.2 Data File

This indicator shows the path and file name of the test data file currently loaded in the data manager. This field cannot be edited.

Related Topics: *6.5 Printing to PDF*, *6.6 Saving for Spreadsheet*, *6.4 Printing Data*, *6.3 Recharacterizing Data*

6.3 Recharacterizing Data

The data manager allows the user to change any of the test header information and creating a test report with modified information.

There are two impacts that result due to any change in the test header information.

1. Changes to certain fields do not have any impact on test results. The field itself is changed but data remains intact. For example, changing the customer name changes the name of the customer on the test report but has no impact on the test data.
2. There are fields which when changed will have impact on the results graph and also on event data.

- Changing cement type and strength units will change the results graph and event data and event results/
- Changing temperature units only changes the results graph.
- Changing strength events will cause a corresponding change in its event results only.
- Changing time events will cause a corresponding change in its event results only.

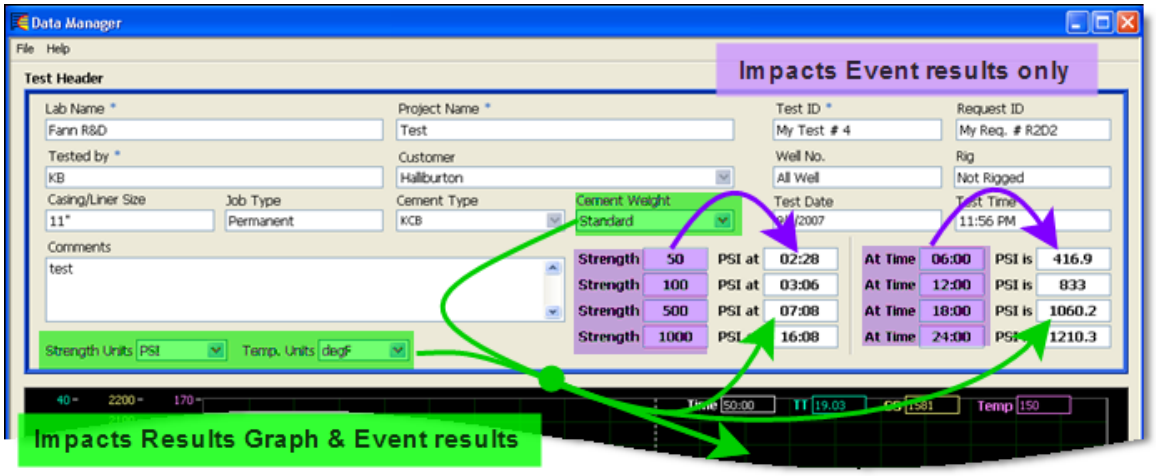


Figure 6-3
Test header impacts

The user may decide to alter any of the hest header parameters. The user can tweak the event results if so desired and then decide to print a report or save data to other file formats.

The user may also decide to turn on the cursor and print the report. If the cursor is on, it will appear on the test report.

NOTE

Recharacterizing the test data does not change any of the raw data collected during the test. The recast test data is held in

computers volatile memory. If it is not saved or printed, it will be lost upon program exit or when new data is loaded.

Related Topics: *6.1 Main Screen*

6.4 Printing Data

Once the user is satisfied with all the information presented in the data manager, a test report can be printed out of the results including any changes made by the user to test header.

The printed test report will contain the following information:

- All the information as present in the test header.
- All events and their results.
- The units of measurement.
- The results graph will be printed as seen on the main screen.
- If the cursor has been enabled on the result graph, it will print.
- The name of the data file will be printed.

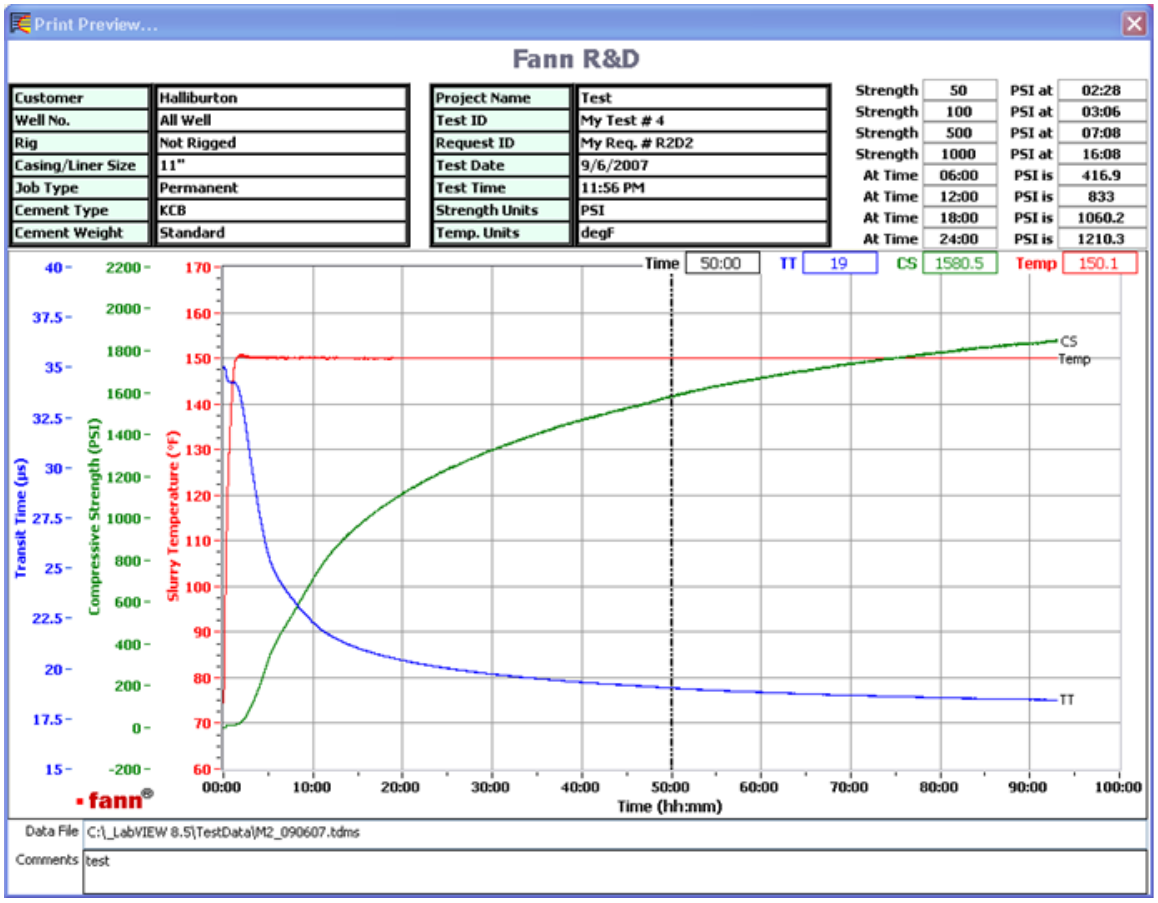


Figure 6-4
Print preview screen

The print preview screen is shown above. This screen cannot be edited. In fact a print dialog window will open on top of this window where the user can choose to print or cancel the process. If canceled, both windows will close.

As can be seen the items in the printed test report are identical to that of the test header. The items are however repositioned to fit on a single page of paper and the printing is optimized to save ink.

NOTE

It is recommended that a color printer be used to print the test report.

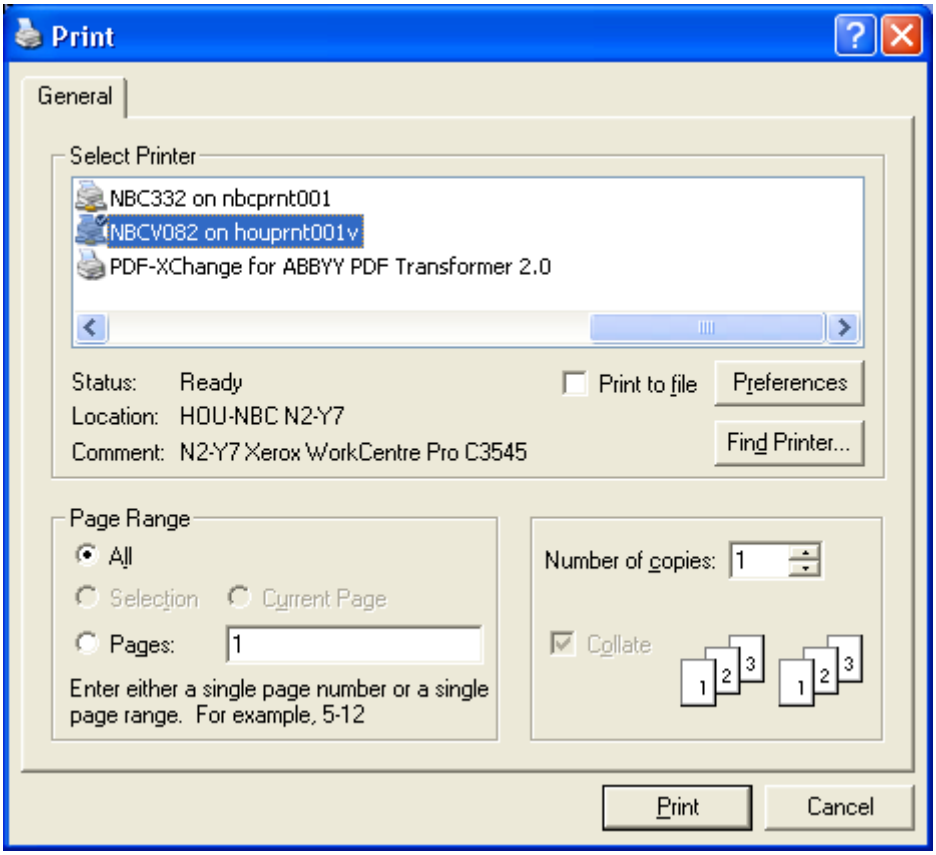


Figure 6-5
Print dialog window

The print dialog window allows the user to choose the printer of their choice to print to. In most cases, the default settings will work and should not be changed. Click print to print the report or cancel to return back to the main screen of the data manager.

Related Topics: *6.1 Main Screen, 6.5 Printing to PDF*

6.5 Printing to PDF

If the computer has a PDF printer installed, it is possible to save the test report as PDF file. This is just like printing data to a printer (refer to *6.4 Printing Data*). Instead of a regular printer, the user will choose a PDF printer print.

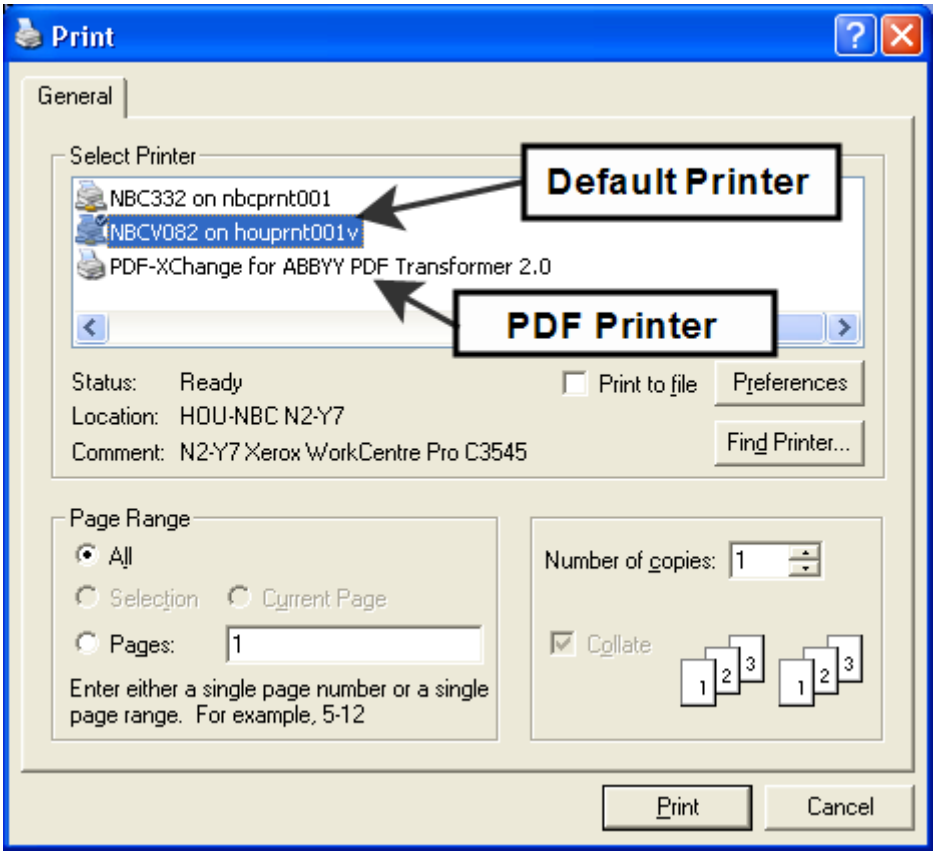


Figure 6-6
Printer and PDF printer

To save as PDF, perform the following steps.

6.5.1 In main screen, choose menu item **File** > **Print**.

This will open the print preview and print dialog boxes.

6.5.2 In the print dialog box, choose the PDF printer installed on your computer. (See above.)

6.5.3 Click the **Print** button.

6.5.4 This will open a dialog for the user to choose the path and provide a file name of the PDF file to which to save the report. Provide appropriate path and file name.

6.5.5 This will print the test report as seen in the print preview dialog to a PDF file.

6.5.6 If so configured, the PDF file will open in the PDF viewer for user preview.

Related Topics: *6.4 Printing Data*, *6.1 Main Screen*

6.6 Saving for Spreadsheet

Once a file has been opened in the data manager and any changes that a user desires has been made, the test data can now be printed or saved to a file.

The process of saving to a spreadsheet-compatible (excel et. al.) format is very easy.

Follow the following steps to save to file format of your choice.

6.6.1 In main screen, choose menu item **File** > **Save**.

Then choose **As CSV file** or **As TXT file** based on which type of spreadsheet format the user desires.

6.6.2 This will open a standard windows dialog box. Navigate to the desired folder and provide a file name in which to save the data.

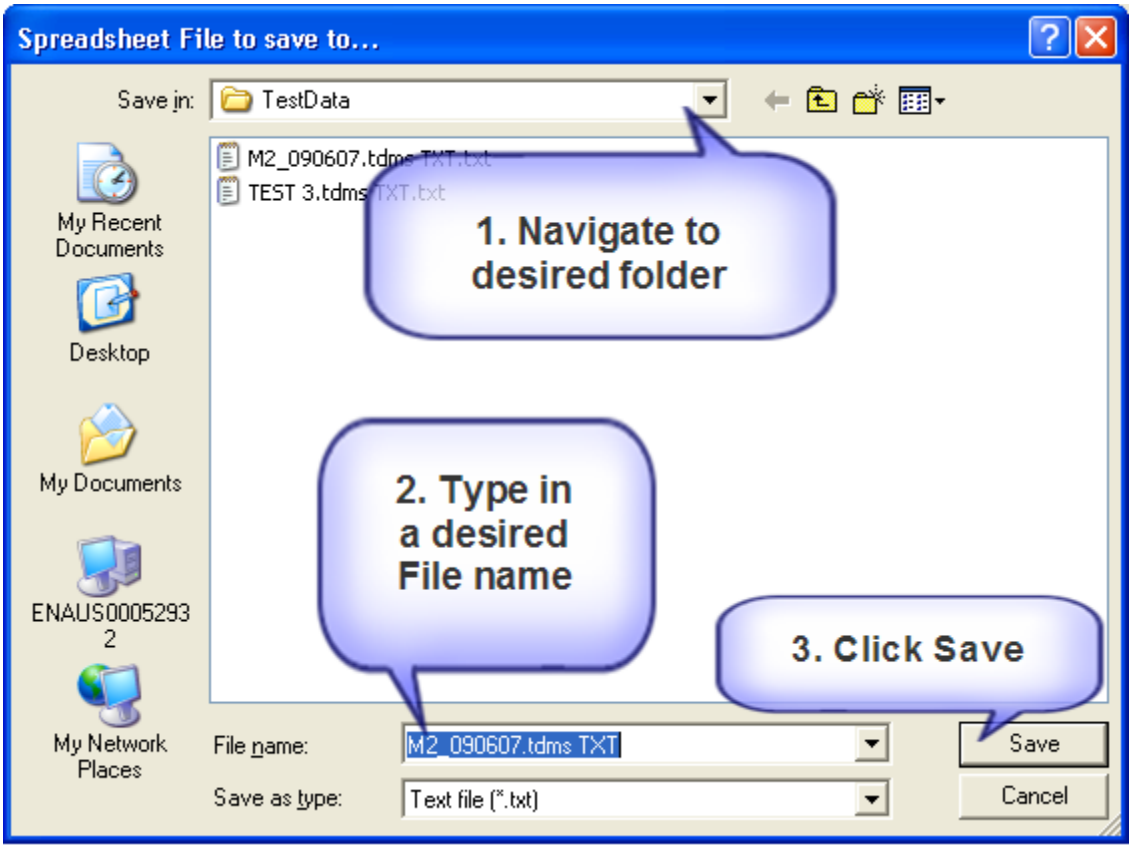


Figure 6-7
Windows dialog box

6.6.3 Click **Save** and the file will be saved.

Related Topics: *6.1 Main Screen*

7 Troubleshooting and Maintenance

7.1 Restoring Interrupted Tests

There are times when a running test is terminated abnormally. This is usually caused by power supply related problems or a software related failure. The UCA Controller System's electronic components are affected by the followings problems listed in the following paragraphs. Any of these problems will cause data error, data loss, keyboard lockup and system lockup in the system. Please note that these problems are common to all electronic devices.

Power surge: The most common cause is heavy electrical equipment in you labs (or other equipment that are drawing power on the same electrical circuit) being turned off.

High voltage spikes, switching transients: These spikes occur when there is a sudden, rapid voltage peak. High voltage spikes are usually the result of nearby lightning strikes, but there can be other causes as well. Switching transients are commonly caused by arcing faults and static discharge. In addition, major power system switching disturbances initiated by the utilities to correct line problems may happen several times a day.

Power sags: These are caused by voltages drop below normal for short periods of time. Possible causes are heavy equipment being turned on, large electrical motors being started, and the switching of power mains (internal or utility).

Electrical line noise: Also defined as Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI) and causes undesirable effects in the circuits of computer systems. Sources of the problem include electric motors, relays, motor control devices, broadcast transmissions, microwave radiation, and distant electrical storms, etc.

Frequency variation: These are changes in frequency from the normally stable utility frequency of 50 Hz to 60 Hz, depending on the geographic location. This may be caused by erratic operation of emergency generators or unstable frequency power sources.

Brownout: This is caused a steady lower voltage state. An example of a brownout happens during peak electrical demands in the summer, when utilities can't always meet the requirements and must lower the voltage to limit maximum power.

Power failure or ***blackout:*** It may be caused by the tripping of a circuit breaker, power distribution failure or utility power failure.

The UCA Controller System is configured with an external uninterrupted power supply (UPS) that provides protection against most of the problems listed above, but not all.

To restore an abnormally terminated cement test, do the following:

1. Restart the UCA Controller: On your keyboard, depress and hold **Ctrl+Alt** keys and tap the **delete** key one time. *Window Security* Dialog box appears. Click on **Shut down…** button. *Shutdown Windows* Dialog appears. Select *Restart* option from the list box then click **OK** button to restart your UCA Controller System.
2. When you see the computer desk top screen, wait for an additional one or two minutes to allow time for the UCA database software engine to get started then click on the shortcut UCA icon to start the software.

7.2 Test Ultrasonic Signal

Before running a cement test on a particular channel, you should make sure that various tasks such as BNC cable, ultrasonic transducer, and high-pressure tubing connections are setup properly. In addition to visually inspecting these components, you should also perform an ultrasonic signal test as well. In this test, the UCA Control System applies an ultrasonic pulse to the cement slurry sample and graphically displays the sound wave that travels through the sample. By visually inspecting this sound wave, you will know if a cement test is setup properly before running the test.

7.3 Test Eurotherm Controller Communication

The UCA Control System communicates with the Eurotherm Controller on each autoclave via a communication card installed on each autoclave. The UCA Control System identifies each Eurotherm Controller by an ID called *Eurotherm Communication Card address*. To avoid communication conflicts, each communication card should have a unique address. There are up to eight autoclaves that can be connected to an UCA Control System so there should be eight different address settings for these communication cards. The recommended settings are address no. 1 for channel no. 1, address no. 2 for channel no. 2 and so on.

7.3.1 Error Message

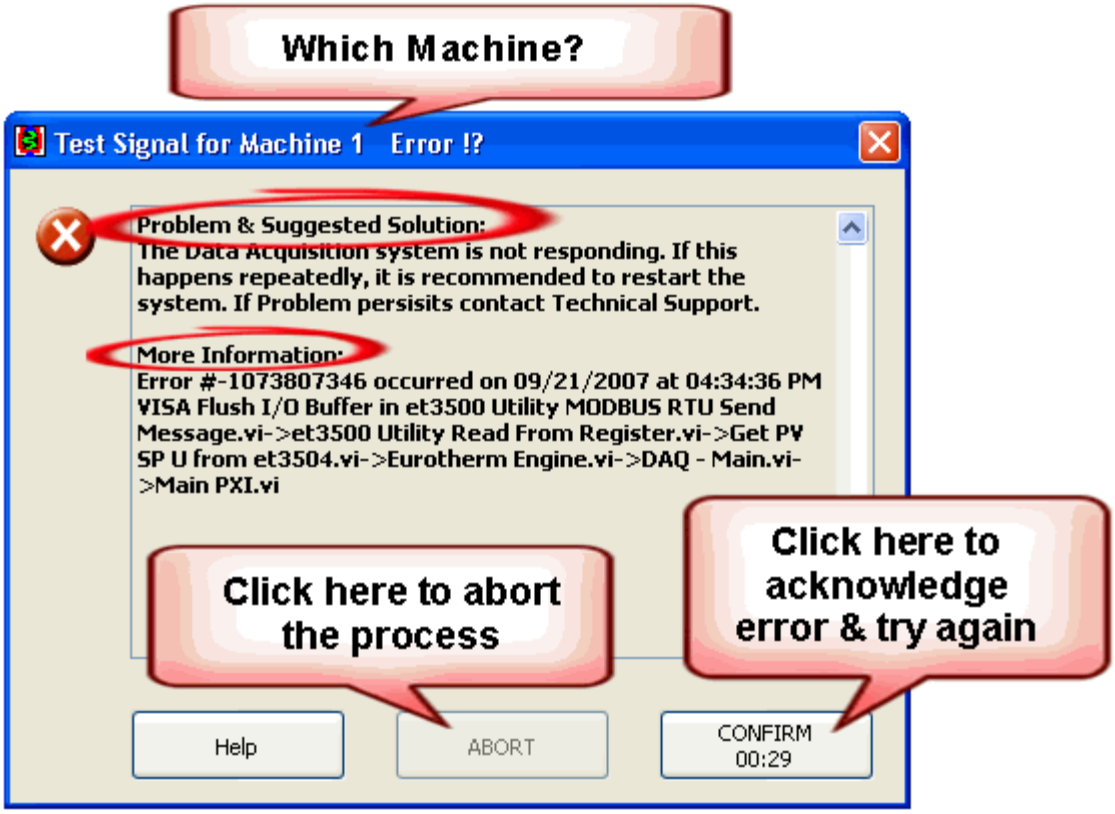


Figure 7-1 Error message

In case of any malfunction, the machine will prompt the user with an error dialog. There are a few things to note about the error dialog:

- It indicates where the error is originating from in the Title Bar.
- It tells you what the problem is and what action can be taken to correct the error.
- It provides additional information. Most of this information may be helpful to technical support personnel to diagnose the problem.
- The dialog box is self closing. The user can acknowledge the error by pressing the Confirm button. If the user decides not to close the error box, it will close itself in one minute and try another attempt to do whatever it was doing.

- The user can actually decide to abort the process which resulted in the error. Not all processes can be aborted. If the process cannot be aborted, the button will be unavailable to the user.

7.4 Eurotherm 3504 Temperature Calibration

The Eurotherm 3504 temperature controller should be periodically checked and adjusted per standard laboratory practice. The following procedures are specific to the Eurotherm 3500 series controllers. A thermocouple calibrator must be used when checking the controller.

7.4.1 To Check Thermocouple Input Calibrations

Connect a milli-volt source, traceable to national standards, to terminals V+ and V- as shown in the diagram below. The mV source must be capable of simulating the thermocouple cold junction temperature. It must be connected to the instrument using the correct type of thermocouple compensating cable for the thermocouple in use.

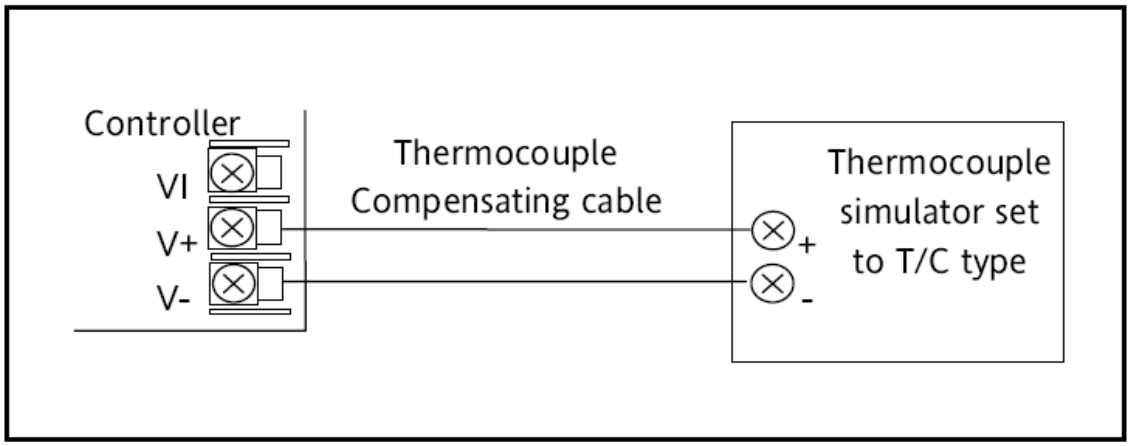


Figure 7-2
Connection for thermocouple calibration

Set the mV source to the same thermocouple type as that configured in the controller. Adjust the mV source to the minimum range. For a type J thermocouple, for example, the minimum range is –210°C. However, if it has been restricted using the Range Low parameter then set the mV source to this limit. Check that the reading on the display is within ±0.25% of reading ± 1LSD.

Adjust the mV source for to the maximum range. For a type J thermocouple, for example, the maximum range is 1200°C. However, if it has been restricted using the Range High parameter

then set the mV source to this limit. Check that the reading on the display is within ±0.25% of reading ± 1LSD.

Intermediate points may be similarly checked if required.

7.4.1.1 Thermocouple Calibration

Thermocouples are calibrated, firstly, by following the previous procedure for the mV ranges, then calibrating the CJC.

This can be carried out using an external CJC reference source such as an ice bath or using a thermocouple mV source. Replace the copper cable shown in the previous diagram with the appropriate compensating cable for the thermocouple in use.

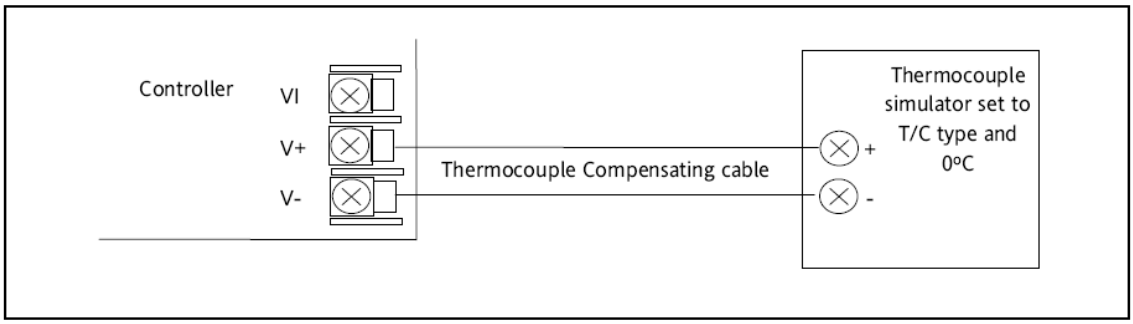


Figure 7-3
Connections for thermocouple calibration

Set the mV source to internal compensation for the thermocouple in use and set the output for 0mV.

Then complete the following steps.

Do This	The Display You Should See	Additional Notes
1. This example is for PV Input configured as a type K thermocouple		
2. From the **'Cal State'**, press ▲ or ▼ to select **'CJC'**		
3. Press ▲ or ▼ to select **'Go'** 4. The remaining procedure is the same as described in the previous section		The controller automatically calibrates to the CJC input at 0mV. As it does this the display will show 'Busy' then 'Passed', assuming a successful calibration. If it is not successful then 'Failed' will be displayed. This may be due to an incorrect input mV

Figure 7-4
Thermocouple calibration

7.5 Troubleshooting Tables

These tables are provided to assist in troubleshooting when a variety of problems arise while operating the UCA 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
- End caps 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 Figures 7-5 and 7-6.
	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.

Table 7-2 Problems with Temperature

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 light is off.	The heater fuses are blown.	Check/replace the heater fuses.
	The heater's 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.

Problem or Symptom	Possible Cause	Corrective Action
The temperature reading is about room temperature even though the chamber is hot.	Possible short circuit in thermocouple or thermocouple cables.	Look for and repair the short in the thermocouple or thermocouple cables.
System does not cool.	The water control valve is closed.	Open the water control valve.
	The water supply plumbing lines are obstructed or kinked.	Check and clear the water supply plumbing lines.
	The water source is disconnected or turned off.	Check the water source.

Table 7-3 Problems with Pressure

Problem or Symptom	Possible Cause	Corrective Action
The system does not pressure up.	The high-pressure plumbing lines are obstructed.	Check/clear the high-pressure plumbing lines.
	The rupture disc pressure limit was exceeded.	Replace the rupture disc.
	The pressure system plumbing has a leak.	Check, repair, or replace pressure system plumbing. Refer to schematic.
The system does not hold pressure.	The pressure system plumbing has a leak.	Check, repair, or replace the pressure system plumbing. Refer to the plumbing diagrams.
The pressure gauge does not zero.	The pressure gauge is faulty.	Test the pressure gauge.

Table 7-4 Problems with End Caps

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

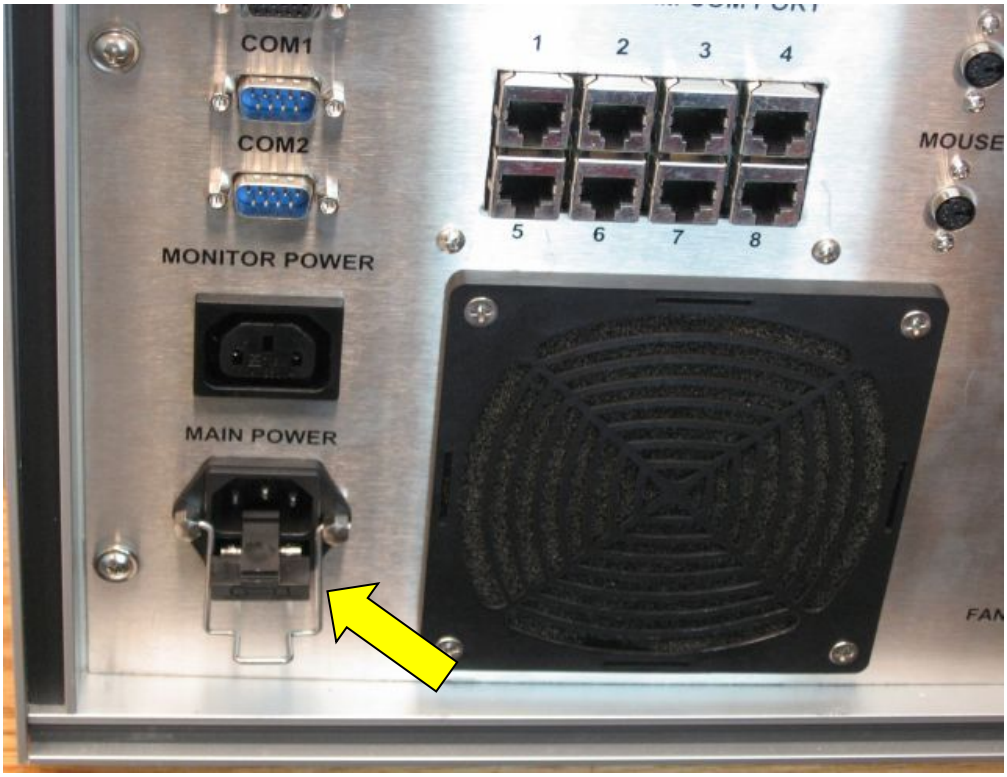


Figure 7-5
Fuse Location

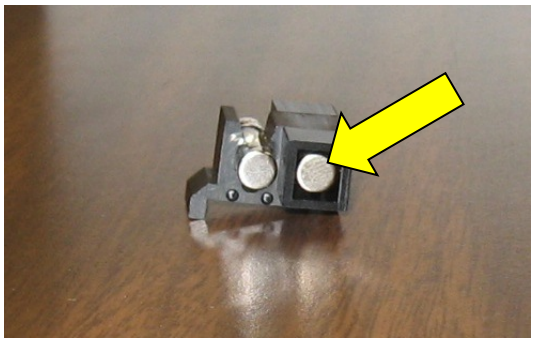


Figure 7-6
Spare Fuse

8 Accessories

9 Parts List

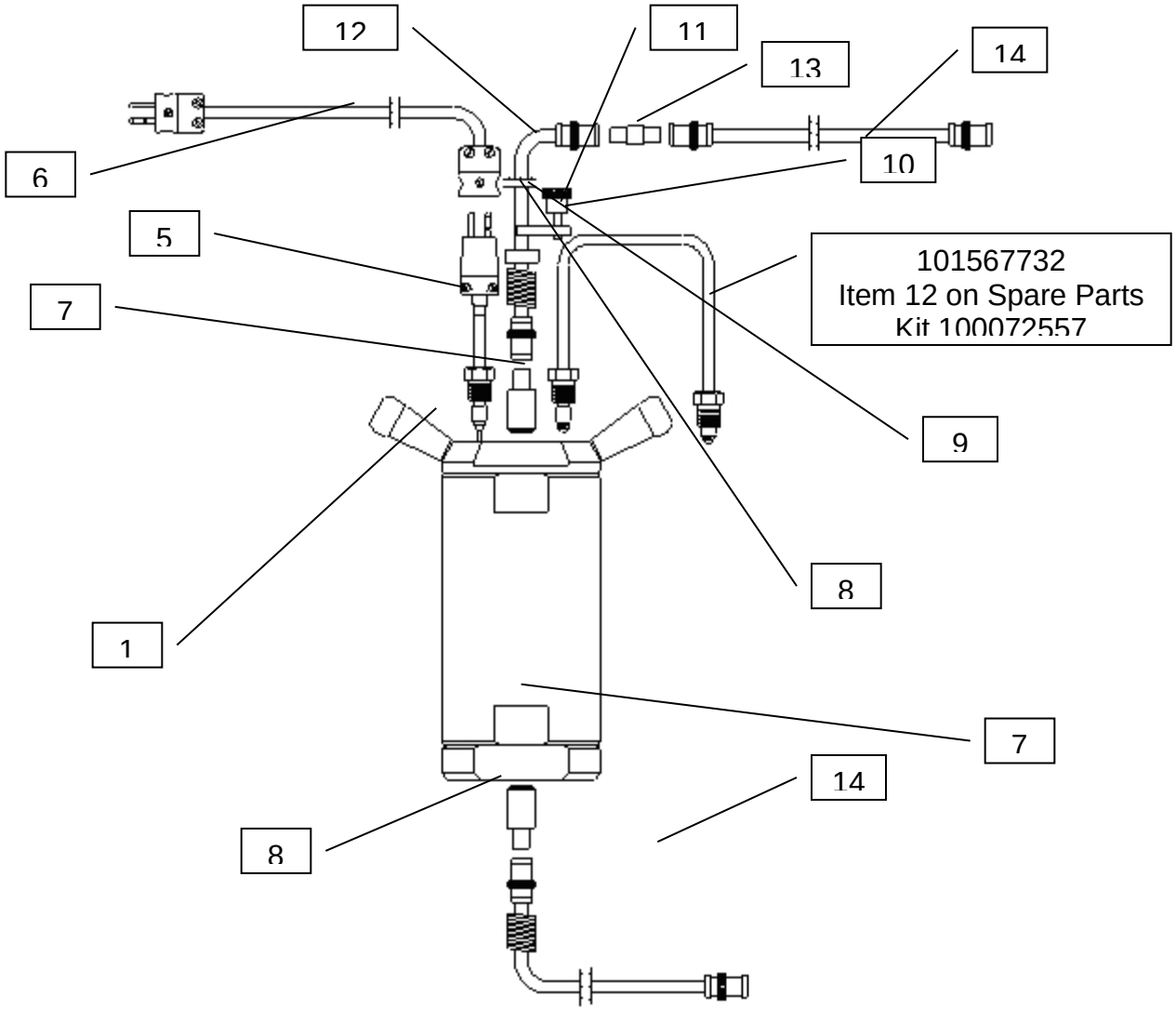


Figure 9-1
Test chamber assembly

Table 9-1 100053514 C INSTALLATION, CHAMBER, AUTOMATIC ULTRASONIC CEMENT ANALYZER

Find#	Part/Mat'l#	Drawing#	Qty	Description
0001	100072152	800. 3089	1. 0	PRESSURE CHAMBER ASSEMBLY, UCA, HIGH PRESSURE, HIGH TEMPERATURE

0005	100004319	800. 30843	1. 0	THERMOCOUPLE, TYPE J, 20KPSI, SPEC
0006	100072570	800. 68664	1. 0	CABLE ASSEMBLY, EXTENSION, T/C LEAD WIRE, PLUG N, TYPE J, SPEC
0007	100009519	70. 75933	1. 0	TRANSDUCER, ULTRASONIC, HIGH TEMP, AUTOMATION INDUSTRIES, SPEC E15480 AUTOMATION INDUSTRIES 57A9658
0008	100033505	70. 83164	2. 0	SPRING, COMPRESSION, 0. 72 OD × 0. 072 WIRE DIA × 3. 00 LG, 0. 94SH, 11. 7 LB/IN, STAINLESS STEEL E10838 ASSOCIATED SPRING C-072-072-3000S
0009	100072172	800. 4027	1. 0	SPACER, COMPRESSION, SPRING, TOP, 20K PSI UCA
0010	100072129	800. 30844	1. 0	RETAINER, TRANSDUCER, TOP, CMT ANALYZER
0011	100031981	70. 76046	1. 0	KNOB ASSEMBLY, STEEL, KNURLED, ¼-20 NC ¾-STUD, SKA-3, REID
0012	100013730	800. 30879	1. 0	CABLE ASSEMBLY, COAXIAL, TOP TRANSDUCER, SIX IN, CEMENT ANALYZER
0013	100031975	70. 76017	1. 0	ADAPTER, 31-219, STRAIGHT, JACK-JACK, BNC, FEMALE × FEMALE, AMPHENOL E10445 AMPHENOL 31-219
0014	100013729	800. 30852	1. 0	CABLE ASSEMBLY, COAXIAL, TOP/BOTTOM TRANSDUCER, 40 IN, CEMENT ANALYZER

Table 9-2 100072557 QKIT SPARE PARTS UCA AUTOCLAVE

Find#	Part/Mat'l#	Drawing#	Qty	Description
0002	100072156	800. 30894	2. 0	RING, SEALING, PRESSURE CHAMBER- UCA
0003	100002386	70. 79352	3. 0	COUPLING AGENT, ULTRASONIC,

				HIGH TEMPERATURE, HITEMPCO 1000, 2 OZ TUBE, KB AEROTECH
0005	100002001	70. 34027	20. 0	O-RING, 90 DURO, 2 3/4 X 2 1/2 X 1/8 568-230, SPEC 599. 33001 SPEC, 70. 72000
0006	100003926	600. 34027	20. 0	O-RING, SOUR GAS, 2 3/4 X 2 1/2 X 1/8, SPEC 600. 33001 568-230 SPEC, 70. 72000
0007	100033247	70. 82067	2. 0	RING, RETAINING, RS-250, EXTERNAL, SPIROLOXE10466 SPIROLOX RS-250
0008	100034509	70. 88448	1. 0	GREASE, MULT-PURPOSE, MYSTIK JT-6, 14 OZ, CATO OIL & GREASE
0009	100072165	800. 31031	3. 0	SLEEVE, SAMPLE, 2 1/8 OD X 2 ID X 2 1/2 LENGTH, ULTRASONIC CEMENT ANALYZER, SPECE10258 INDUSTRIAL GASKET 800. 31031 - SPEC.
0010	100013730	800. 30879	1. 0	CABLE ASSEMBLY COAX TOP XDUCER 6 in.
0011	101002196	70. 23705	2. 0	FU,3 AMP,3AG,SLW BLW E10556 LITTLEFUSE 313003
0012	101567732	D00274161	1. 0	U-TUBE ASSEMBLYUCA AUTOCLAVE

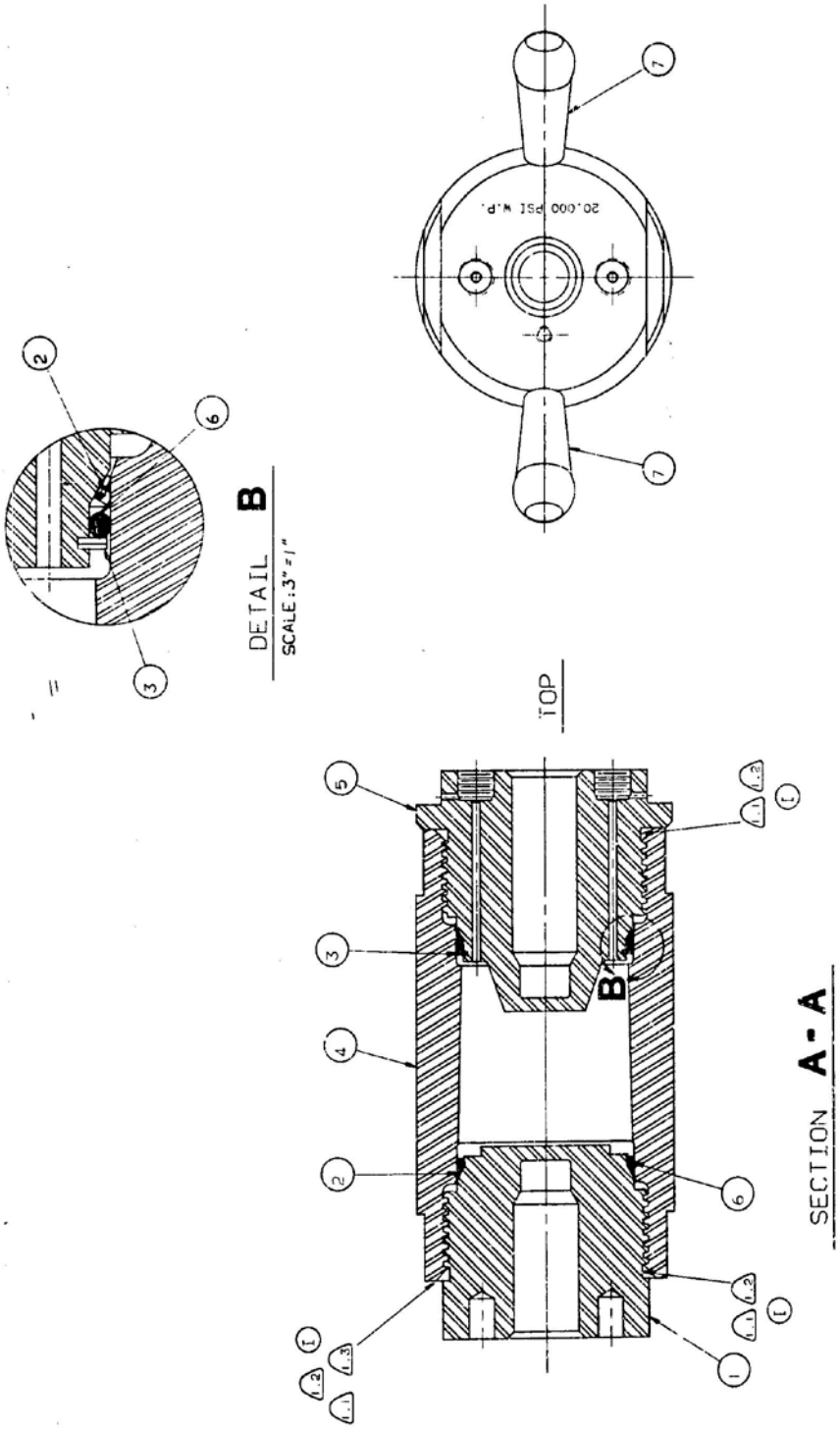


Figure 9-2
100072152 K pressure chamber assembly, UCA, high pressure, high temperature

Table 9-3 100072152KPRESSURE CHAMBER ASSEMBLY, UCA, HIGH PRESSURE, HIGH TEMPERATURE

Find#	Part/Mat'l#	Drawing#	Qty	Description
0001	100072155	800. 30893	1. 0	BOTTOM, PRESSURE CHAMBER, UCA
0002	100072156	800. 30894	2. 0	RING, SEALING, PRESSURE CHAMBER- UCA
0003	100033247	70. 82067	1. 0	RING, RETAINING, RS-250, EXTERNAL, SPIROLOXE10466 SPIROLOX RS-250
0004	100072153	800. 30891	1. 0	CHAMBER, PRESSURE, UCA
0005	100072154	800. 30892	1. 0	TOP, PRESSURE CHAMBER, UCA
0006	100002001	70. 34027	2. 0	O-RING, 90 DURO, 2 3/4 X 2 1/2 X 1/8 568-230, SPEC 599. 33001 SPEC, 70. 72000
0007	100072128	800. 30842	2. 0	HANDLE, PRESSURE CHAMBER, CMT ANALYZER
0010	100034509	70. 88448	1. 0	GREASE, MULT-PURPOSE, MYSTIK JT-6, 14 OZ, CATO OIL & GREASE

Table 9-4 100071996 AKIT, TOOL, AUTO ULTRASONIC CEMENT ANALYZER

Find#	Part/Mat'l#	Drawing#	Qty	Description
0001	100072130	800. 30847	1. 0	BAR, CALIBRATION, ULTRASONIC CEMENT ANALYZER
0002	100072125	800. 30830	1. 0	SLEEVE, CENTERING, CALIBRATION BAR, ULTRASONIC CEMENT ANALYZER
0003	100072434	800. 61725	1. 0	GAUGE, SLURRY LEVEL, 20K PSI CHAMBER-ULTRASONIC CEMENT ANALYZER
0004	100072165	800. 31031	5. 0	SLEEVE, SAMPLE, 2⅛ OD × 2 ID × 2½ LENGTH, ULTRASONIC CEMENT ANALYZER, SPEC E10258 INDUSTRIAL GASKET 800. 31031 - SPEC.
0005	100072157	800. 30896	1. 0	WRENCH, BOX END, BOTTOM LID, UCA
0006	100030677	70. 63931	1. 0	WRENCH, SPANNER, FACE, ADJUSTABLE, 3. 0 MAX SPAN BETWEEN CENTERS, ¼ DIAPINS, 8. 25 LG E10301 McMASTER-CARR 5481A2 E11245 WILLIAMS 483-030755 E11403 ARMSTRONG BROS. TOOL CO 34-154
0007	100029847	70. 58394	1. 0	VISE GRIP, CHAIN CLAMP, WITH 19 IN EXTENSION CHAIN, PETERSON MFG CO 20R

0008	100072159	800. 30900	1. 0	TOOL, O-RING SEATING, PRESSURE CHAMBER, UCA
0009	100002001	70. 34027	20. 0	O-RING, 90 DURO, 2¾ × 2½ × ⅛ 568-230, SPEC 599. 33001 SPEC, 70. 72000
0010	100002386	70. 79352	3. 0	COUPLING AGENT, ULTRASONIC, HIGH TEMPERATURE, HITEMPCO 1000, 2 OZ TUBE, KB AEROTECH

Table 9-5 101002024 HINSTLN-FRAME-UCA AUTOCLAVE

Find#	Part/Mat'l#	Drawing#	Qty	Description
0001	390448		1. 0	ASSY, UCA CHASSIS, SS COVER
0002	393443		4. 0	LEVELING MOUNT,⅜-16,150 LOAD,W/PAD X10301 MCMASTER-CARR 6167K18
0007	380232		4. 0	¼ - 20 FHMS × 1¾ LONG STAINLESS
0009	100028936	70. 45212	8. 0	SCREW, SELF TAPPING, #10 × ½, TRUSS HEAD, SLOT, SPEC 70. 45219
0010	100072119	800. 30822	1. 0	PLATE, SUPPORT, HEATING, JACKET, CMT ANALYZER
0011	100021990	70. 09912	2. 0	PIN, ROLL, ⅛ × 1, STAINLESS STEEL
0012	100072171	800. 4023	1. 0	HOLDER, BOTTOM TRANSDUCER, AUTOCLAVE ASSEMBLY, HIGH PRESSURE, CEMENT ANALYZER
0013	100072169	800. 31035	1. 0	THERMOSTAT ASSEMBLY, TEMPERATURE OVER-RUN PROTECTION, AUTOCLAVE, ULTRASONIC CEMENT ANALYZER
0014	100028427	70. 43770	2. 0	SCREW, HEX CAP, ¼ -20 NC × ¾, STAINLESS STEEL, 316
0015	100072118	800. 30821	1. 0	STAND, MOUNTING, HEATING JACKET, CMT ANALYZER
0016	100072122	800. 30825	2. 0	GASKET, BOTTOM, HEATING JACKET, CMT ANALYZER, SPEC, 70. 72000
0017	100072651	800. 86558	2. 0	INSULATION, FIBROUS GLASS, 1200 DEGREE MAXIMUM, 1/2 INCH THICK × 60 INCH WIDE × 75 FEET LONG ROLL VENDOR REF: INSULATION SERVICES, INC; TULSA, OK, TEMPERATURE MAT OR CLAREMAT 1200 E13536 THE CLAREMONT COMPANY, INC CLAREMAT 1200
0018	100033598	70. 83601	4. 0	SCREW, HEX CAP, ¼-20 NC × 1, STAINLESS STEEL

Find#	Part/Mat'l#	Drawing#	Qty	Description
0019	100072112	800. 30813	1. 0	JACKET, HEATING/COOLING, CAST, 110V, 50/60 HZ, 2000 WATT, SPECIAL
0020	100029318	70. 49981	4. 0	SPRING, 1/2 OD × 16½ LG, SCREEN DOOR, LAID LAW, JAPAN BLACK 6-J
0022	100072121	800. 30824	1. 0	RING, CENTERING, HEATING JACKET, CMT ANALYZER
0023	100072120	800. 30823	2. 0	GASKET, END, HEATING JACKET, SPEC, 70. 72000
0024	100028661	70. 44275	3. 0	SCREW, FLAT HEAD, MACHINE, #6-32 NC × ⅞, PL, SPEC 70. 44247
0025	101002214	70. 70245	4. 0	SCREW - SELF TAP - #6 × ⅝- FH - SLOT - STNLS
0027	100029058	70. 45579	2. 0	SCREW, BIND HEAD, #6-32 NC × ⅜, STAINLESS STEEL
0029	101002213	70. 70243	2. 0	SCREW - SELF TAP - #8 × ⅝- PAN HD - SLOT - STNLS
0030	100004321	800. 4025	2. 0	COUPLING, BULKHEAD, CMT ANALYZER, ULTRASONIC, HIGH PRESSURE
0031	100004318	800. 30836	2. 0	NUT, BULKHEAD, FEMALE HALF UNION, 20KPSI
0032	100028659	70. 44263	1. 0	SCREW, FLAT HEAD, MACHINE, #6-32 NC × ½, STAINLESS STEEL
0033	100032888	70. 80377	1. 0	FAN, INSTRUMENT, 37 CFM, 50/60 HZ, 230VAC
0034	203428		4. 0	6-32 × 2 RHMS STAINLESS
0035	207632		4. 0	NUT 6-32 HEX REGULAR STAINLESS
0036	100027083		1. 0	POWER SUPPLY, +5V/+24V/-12V/+12V, 55W, 90-132V AC, 175-264V AC INPUT, 47-63 HZ
0037	100024317	70. 20557	1. 0	CONNECTOR, HOUSING, 5 PIN, 0. 156 CENTER, WITH LOCKING RAMP, USE 70. 92185 PIN E10647 MOLEX 2139-09-50-3051
0038	100035432	70. 94414	1. 0	CONNECTOR, HOUSING, 10 PIN, 0. 156, WITH LOCKING RAMP, USE 70. 92185 PIN E10647 MOLEX 2139-09-50-3101

Find#	Part/Mat'l#	Drawing#	Qty	Description

0039	100035064	70. 92185	5. 0	TERMINAL, CRIMP, #18-24 WIRE, DOUBLE CANTILEVER CONTACT, 2478 SERIES E10647 MOLEX 08-50-0106
0040	100028909	70. 45082	4. 0	SCREW, SELF TAPPING, #6 × ½, PAN HEAD, SLOT, PL, SPEC 70. 45219
0041	100032223	70. 77405	0. 292	RAIL, ZIN, PLATED DI-CHROMATED, TYPE 9006 #98. 190. 0000, 6 1/2, ELECTROVERT E10329 WIELAND-ELECTROVERT 98. 190. 0000
0042	100008175		10. 0	BLOCK, MODULAR TERMINAL, SINGLE CONNECTOR, FEED THROUGH, GRAY, TYPE 9700A/6 S35 E10329 WIELAND-ELECTROVERT 54. 004. 7553. 0
0043	100032909	70. 80512	1. 0	PLATE, 6MM, END, TYPE 9701/6, SINGLE E10329 WIELAND-ELECTROVERT 07. 310. 3153
0044	205166		2. 0	CLAMP END 35mm DIN RAIL
0045	100032225	70. 77412	1. 0	STRIP, RAPID MARKING, NUMBERS 1 THRU10, ELECTROVERT, P/N 9705A/6/10 E10329 WIELAND-ELECTROVERT 04. 846. 0153
0046	100031975	70. 76017	1. 0	ADAPTER, 31-219, STRAIGHT, JACK-JACK, BNC, FEMALE × FEMALE, AMPHENOL E10445 AMPHENOL 31-219
0047	100013729	800. 30852	1. 0	CABLE ASSEMBLY, COAXIAL, TOP/BOTTOM TRANSDUCER, 40 IN, CEMENT ANALYZER
0048	100013072	70. 62668	1. 0	WIRE, THERMOCOUPLE, 3W2P6, 20 GA, POLYVINYL OVER POLYVINYL, I/C
0049	204400		1. 0	GUARD FAN FINGER 3⅛ IN f/80MM METAL
0050	373809	FI. 373809	4. 0	WIRE HOOK, UCA AUTOCLAVE
0051	204950		1. 0	RESISTOR 25 OHM-5 WATT-5%

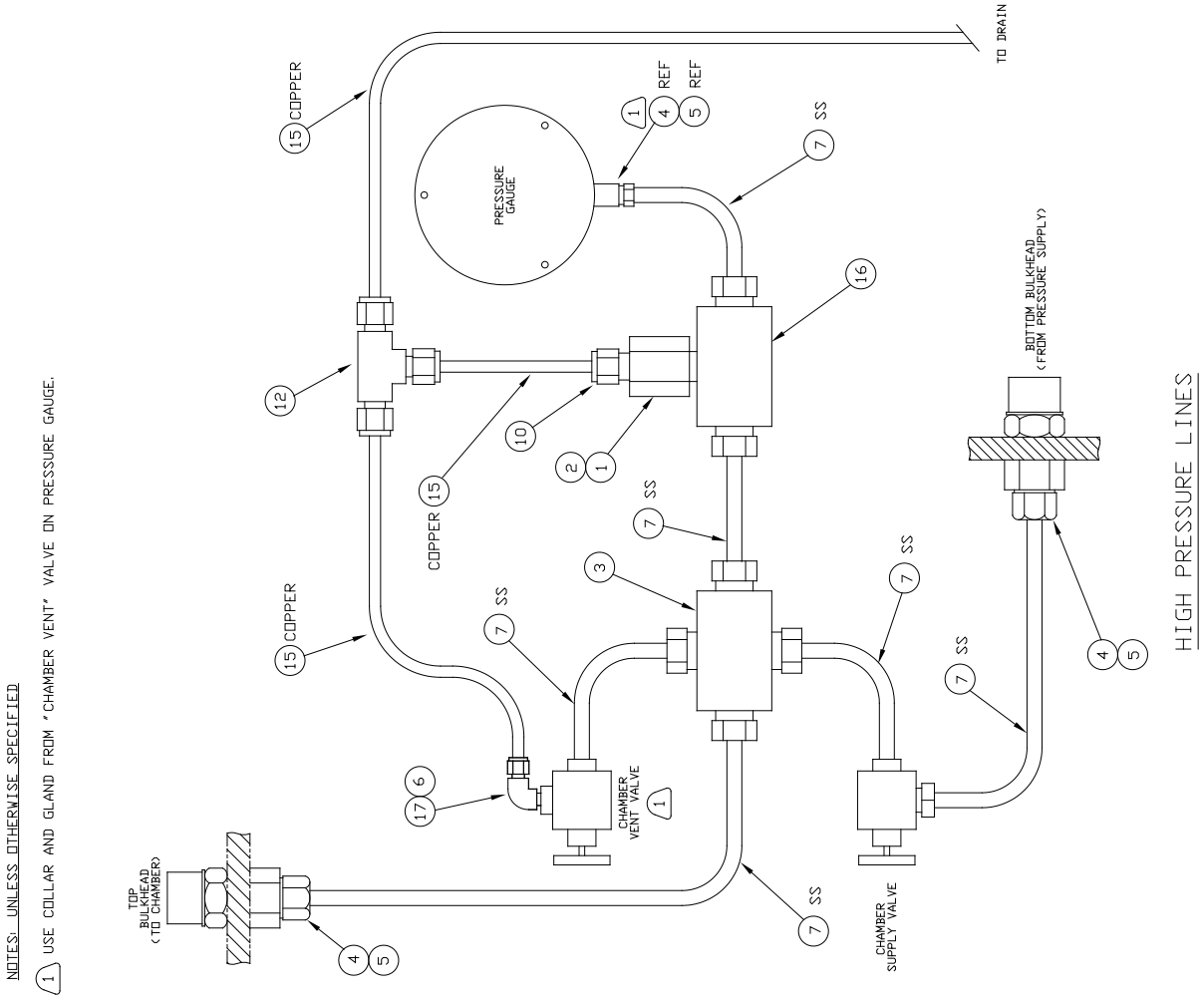


Figure 9-2
101002025EInstIn-Hydraulics/Pneumatics-UCA Autoclave

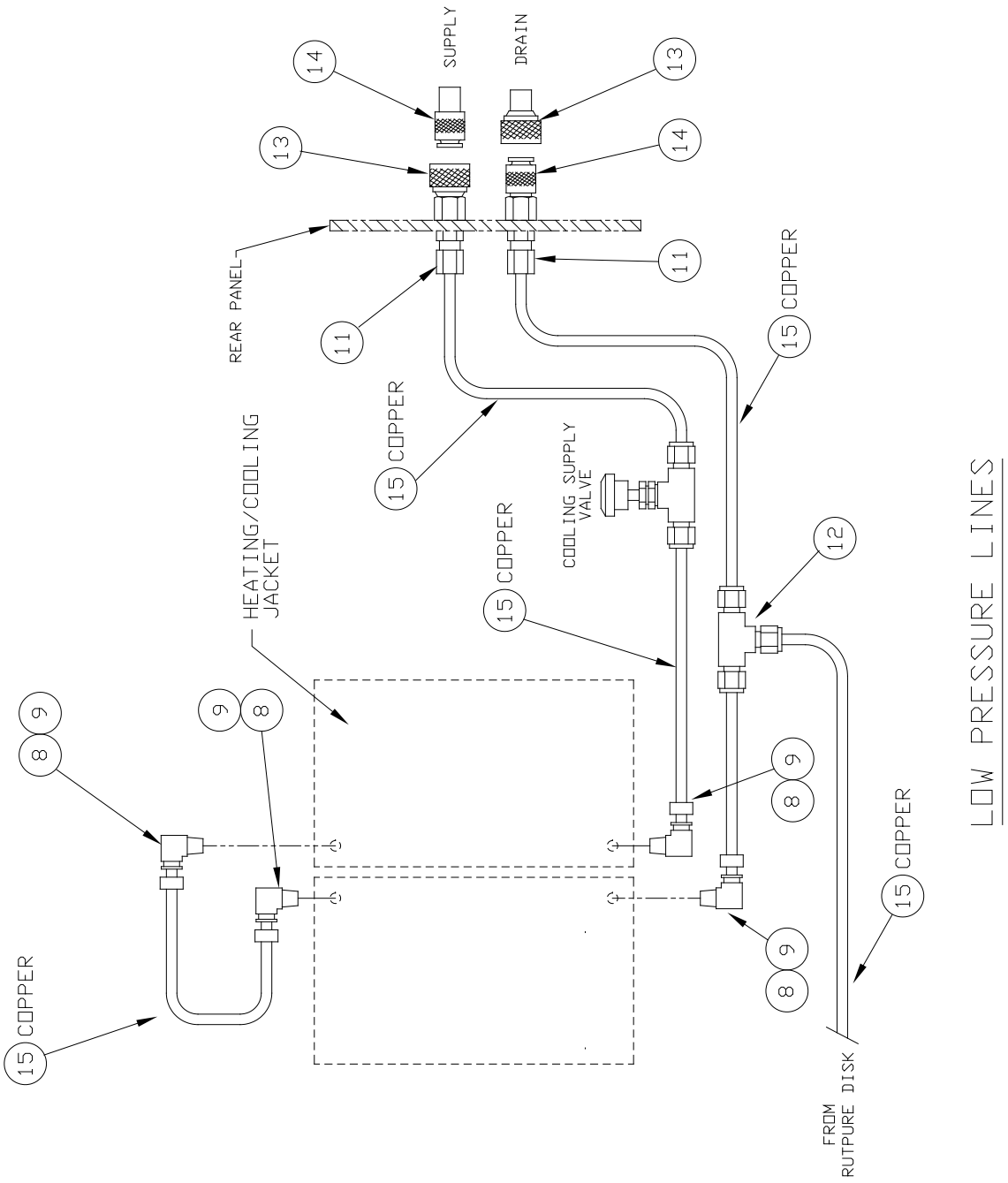


Figure 9-3
101002025EInstIn-Hydraulics/Pneumatics-UCA Autoclave

Table 9-6 101002025EINSTLN-HYDRAULICS/PNEUMATICS-UCA AUTOCLAVE

Find#	Part/Mat'l#	Drawing#	Qty	Description
0001	100072640	800. 86480	1. 0	HEAD ASSEMBLY, SAFETY, ¼ 50,000 PSI RUPTURE DISC, HIGH PRESSURE EQUIPMENT, CO 60-63HF4
0002	100072461		1. 0	DISC, RUPTURE, INCONEL 600, ¼ DIA ANGLE SEAT, 24,000 PSI @ 400 DEG F RATED PRESSURE, BS&B SAFETY SYSTEMS
0003	100033092	70. 81424	1. 0	CROSS, AUTOCLAVE ENGINEERS, CX4444-PM, 60 KPSI @RT, WITH F250C FEMALEHIGH PRESSURE EQUIPMENT CO: 60-24HF4-SP1 E10164 AUTOCLAVE CX4444 HIGH PRESSURE EQUIPMENT COMPANY HIGH PRESSURE EQUIPMENT COMPANY 60-24HF 4-SP1
0004	100001771	70. 24702	2. 0	GLAND, AUTOCLAVE, ANGLE 40, 60,000 POUNDS PER SQ IN, FOR ¼ TUBE, F250C FEMALE THREAD E10164 AUTOCLAVE AGL40
0005	100001646	70. 16576	2. 0	COLLAR, AUTOCLAVE, ACL40, ¼ TUBE, 60,000 PSI, STAINLESS STEEL X14292 AUTOCLAVE ENGINEERS ACL40 HIGH PRESSURE EQUIPMENT COMPANY HIGH PRESSURE EQUIPMENT COMPANY 60-2H4.
0006	100072134	800. 30853	1. 0	ADAPTER, AUTOCLAVE, 6M42B8, ⅛ NPT FEMALE × ¼F250C, MALE
0007	380718	FI. 380718	1. 0	TUBING SET - HIGH PRESS - UCA AUTOCLAVE
0008	100032388	70. 78072	4. 0	ELBOW, FITTING, TUBE, SWAGELOC, 90 DEG, UNION, ⅜ TUBE, SS-600-9
0009	100024705	70. 22930	4. 0	FITTING, TUBE, B-400-R-6, REDUCER, ⅜ × ¼ OD TUBE, SWAGELOC
0010	100024718	70. 22962	1. 0	FITTING, TUBE, MALE CONNECTOR, 1/4TUBE × ⅜ MALE PIPE, BRASS E12480 SWAGELOK CO 400-1-6
0011	397184		2. 0	FITTING, TUBE, B-400-71-2, UNION, BULKHEAD, ¼ TUBE × ⅛ FNPT, BRASS, SWAGELOK
0012	100024754	70. 23255	2. 0	TEE, ¼ OD TUBE, ALL TUBE E12480 SWAGELOK CO 400-3
0013	100029298	70. 49168	2. 0	SOCKET, LL1-S10, ⅛ MPT, STAINLESS STEEL, HANSEN
0014	100027418	70. 36759	2. 0	PLUG, MALE, LL1-T10,⅛ MALE PIPE THREAD, STAINLESS STEEL, HANSEN

Find#	Part/Mat'l#	Drawing#	Qty	Description
0015	207377		72. 0	TUBING SOFT COPPER ¼ × . 032
0016	207707		1. 0	TEE ¼ IN HP TUBE CONN 60K PSIA
0017	100024751	70. 23249	1. 0	ELBOW, ⅛ MALE PIPE THREAD × ¼ OD TUBE E12480 SWAGELOK CO 400-2-2

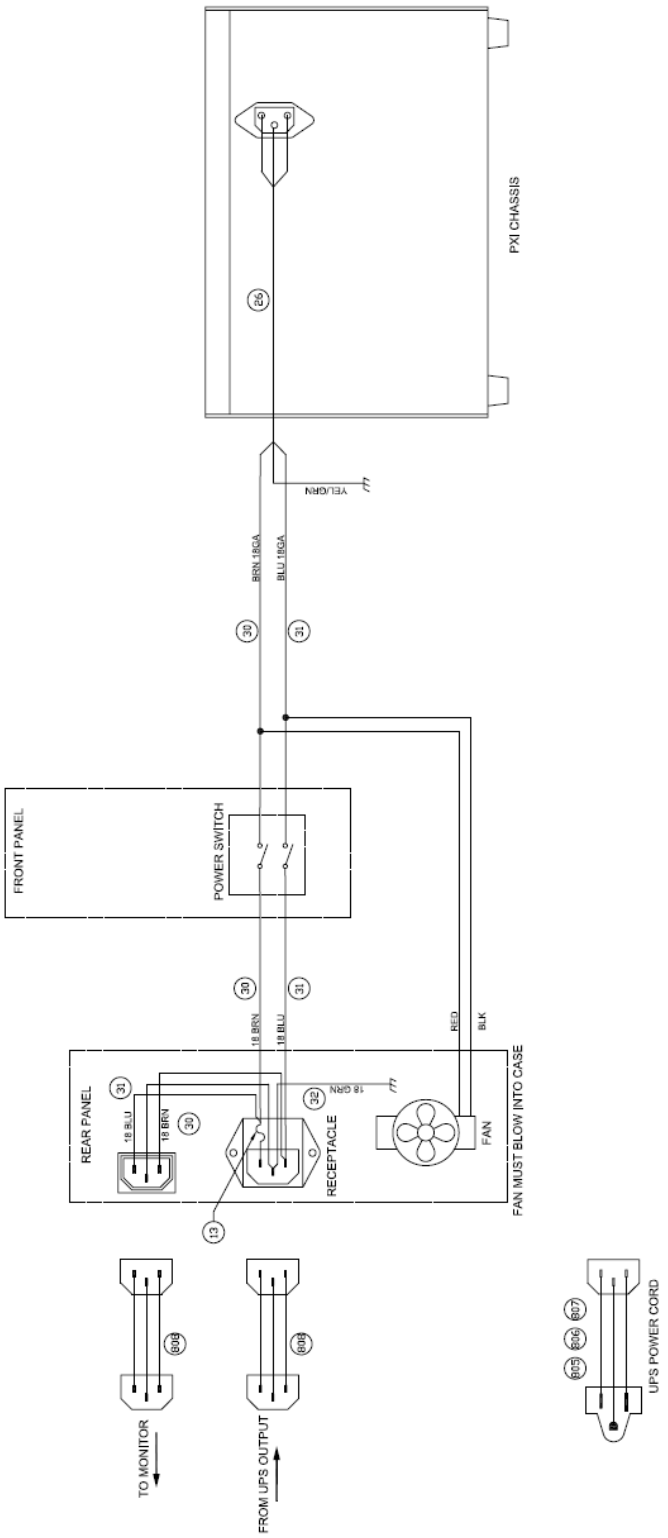


Figure 9-4
Electrical schematic

Table 9-7 101002026FINSTLN-ELECTRICAL PANEL-UCA AUTOCLAVE

Find#	Part/Mat'l#	Drawing#	Qty	Description
0002	100031978	70. 76023	3. 0	ADAPTER, BULKHEAD, BNC, JAN TYPE UG, 492 A/U, 31-220, AMPHENOL
0003	100072391	800. 61604	1. 0	PANEL, SINGLE CIRCUIT, THERMOCOUPLE, JX CALIBRATION
0004	100002384	70. 79016	2. 0	HOLDER, FUSE, PANEL MOUNTING, WATER TIGHT E10556 LITTLEFUSE 342006
0005	101002196	70. 23705	2. 0	FUSE – 3A – 3AG – SLO-BLO E10556 LITTLEFUSE 313003
0006	100031587	70. 73543	1. 0	INLET, ELECTRICAL, FLANGED, 3 WIRE, 20 AMP, 250 VAC, TWIST LOCK, NO 2325, HUBBELL
0007	100028609	70. 44135	3. 0	SCREW, BIND HEAD, NUMBER 6-32 NC × ½, STAINLESS STEEL
0011	100013136	70. 80037	1. 0	RELAY, SOLID STATE, 240 VAC, 25 AMP, 3-32 VDC CONTROL E11057 CRYDOM D2425 E14173 OPTO 22 240D25
0012	100007784	70. 45604	2. 0	SCREW, BIND HEAD, 6-32 NC × ¼, STAINLESS STEEL
0013	207307		2. 0	6-32 × ⅜FHMS STAINLESS
0014	207632		2. 0	NUT 6-32 HEX REGULAR STAINLESS
0015	207819		2. 0	WASHER SPLIT 6 STAINLESS STEEL
0016	100029508	70. 53835	7. 0	TERMINAL, CRIMP, 12-10 GA, #10 STUD, RING TYPE, INSULATION CRIMP

Table 9-8 101002035DINSTLN-CONTROL PANEL-UCA AUTOCLAVE

Find#	Part/Mat'l#	Drawing#	Qty	Description
0002	390450		1. 0	GAUGE, PANEL MOUNT, 0-20K, SS MFG:McDANIEL MFG P/N:GRU 1/4 HPF-GF
0003	100029053	70. 45569	3. 0	SCREW, BIND HEAD, #10-24 NC × ½, STAINLESS STEEL
0004	100032016	70. 76237	1. 0	VALVE, PANEL MOUNT, ¼, BRASS, STRAIGHT PATTERN, VEE STEM, 1/4 SWAGELOCK CONNECTIONS, B-4JN-PM, NUPRO E10341 NUPRO B-4JN-PM
0005	100013114	70. 76232	2. 0	VALVE, ANGLE, AUTOCLAVE, 30VM4072 - ¼ TUBE, 30000 PSI, STAINLESS STEEL E10164 AUTOCLAVE 30VM4072
0006	100002163	70. 43297	4. 0	SCREW, HEX SOCKET, #10-24 NC × ½, STAINLESS STEEL
0007	101485669		1. 0	TEMP CONT 3504 PROG FOR UCA AUTOCLAVE
0008	100029446	70. 52051	1. 0	SWITCH, TOGGLE, DPST, 0. 468 DIA BUSHING, WITH SCREW LUGS, 3 AMP AT 250 VAC, 7590K4, CUTLER-HAMMER E10370 CUTLER HAMMER 7590K4
0009	100027339	70. 36189	1. 0	NAME PLATE, ON, OFF, TOGGLE SWITCH, 15/32 SHANK, SPEMCO 1132
0010	100013123	70. 77561	1. 0	SWITCH, CIRCUIT BREAKER, DPST, ELECTROMAGNETIC, 10 AMP, 220 V, 50/60 HZ, TYPE 203, NEON BULB E10295 AIRPAX 203-22-1-62F-103-4-3-13
0011	100027804	70. 38961	1. 0	RESISTOR, 10,0000 OHM, 1 WATT, 5% E10188 ALLEN BRADLEY RC32GF104J

Table 9-9 101002037FAUTOCLAVE ASSY - ULTRASONIC CEMENT ANALYZER

Find#	Part/Mat'l#	Drawing#	Qty	Description
0001	101002024	278. 52301	1. 0	INSTLN-FRAME-UCA AUTOCLAVE
0002	101002025	278. 52302	1. 0	INSTLN-HYDRAULICS/PNEUMATICS-UCA AUTOCLAVE
0003	101002026	278. 52303	1. 0	INSTLN-ELECTRICAL PANEL-UCA AUTOCLAVE
0004	101002035	278. 52304	1. 0	INSTLN-CONTROL PANEL-UCA AUTOCLAVE
0005	101002036	278. 52305	1. 0	INSTLN-PULSER BOX-UCA AUTOCLAVE
0006	101002214	70. 70245	2. 0	SCREW - SELF TAP - #6 × ⅝ - FH - SLOT - STNLS
0007	100053514	278. 52006	1. 0	INSTALLATION, CHAMBER, AUTOMATIC ULTRASONIC CEMENT ANALYZER
0010	101002039	800. 02302	1. 0	NAME PLATE - UCA AUTOCLAVE
0011	207460		4. 0	RIVET POP AL ⅜ LG ¼ GRIP
0012	100072235	800. 59107	1. 0	CORD SET ASSEMBLY, ELECTRIC, 230V, CEMENT ANALYZER
0013	100071996	800. 02005	1. 0	KIT, TOOL, AUTO ULTRASONIC CEMENT ANALYZER
0015	100001372	70. 00307	1. 0	BAG, VINYL, 12 IN × 15 IN × 0. 006 THK, PRESTITE ZIPPER E14162 ASSOCIATED BAG 61-36 E14163 CHISWICK 06-1215 E14164 CONSOLIDATED PLASTICS 90150SD
0016	100031552	70. 73458	8. 0	WIRE, 12 GA, STRANDED, WHITE/RED, TEFLON, SPEC 70. 73453
0017	100031551	70. 73457	12. 0	WIRE, 12 GA, STRANDED, WHITE/BLACK, TEFLON, SPEC 70. 73453
0018	206214		2. 5	WIRE 18 AWG TEFLON STRANDED GREEN
0019	208521		2. 5	WIRE 18 AWG PVC STRANDED BROWN
0020	208528		2. 5	WIRE 18 AWG PVC STRANDED GRAY
0021	208523		1. 0	WIRE 18 AWG PVC STRANDED RED
0022	208522		1. 5	WIRE 18 AWG PVC STRANDED BLACK
0023	208529		1. 5	WIRE 18 AWG PVC STRANDED WHITE

Find#	Part/Mat'l#	Drawing#	Qty	Description
0024	204294		20. 0	TIE WRAP 1/16 IN. TO 2 IN. DIAMETER
0025	100029508	70. 53835	26. 0	TERMINAL, CRIMP, 12-10 GA, #10 STUD, RING TYPE, INSULATION CRIMP E10222 PANDUIT PNF10-10R E10387 AMP 35109
0026	208450		14. 0	TERMINAL FORK ¼ 10-12 AWG
0027	349301		4. 0	TERMINAL FEMALE Q. C,. 25×. 032 12-10GA THOMAS & BETTS TNF10-250FD NYLON FULLY INSULATED FEMALE DISCONNECT WIRE RANG 12/10 AWG TAB SIZE . 250 × . 032 25 PER PACKAGE
0028	100001414	70. 02372	18. 0	TERMINAL, PIN, CRIMP, 16 AWG (1. 5 SQ MM), WITH INSULATING COLLAR, SPEC E13276 TELEMECANIQUE INC DZ5-CE015 E13285 WEIDMULLER 144631 E13724 PHOENIX TERMINAL BLOCKS 3200043
0029	203858		4. 0	FERRULE INSUL 12 AWG WIRE
0030	204401		14. 0	TERMINAL FORK 8 22-18 AWG
0031	203428		4. 0	6-32 × 2 RHMS STAINLESS
0032	207632		4. 0	NUT 6-32 HEX REGULAR STAINLESS
0033	207638		4. 0	WASHER EXTERNAL TOOTH 6 STAINLESS
0034	208058		1. 0	RESISTOR 100K OHM ¼W 5% 39&5
0035	205296		30. 0	TIE WRAP ADHESIVE PAD
0036	100024819	70. 23633	2. 0	FUSE, 1 AMP, AGC1
0037	209648	FI. 39276	1. 0	NETWORK JUMPER ASSEMBLY, UCA
0038	365255		4. 0	TERMINAL RING 10-12 AWG 10 HI TEMP HIGH TEMPERATURE RING TERMINAL NON-INSULATED 10 STUD SIZE 900 DEGREES F MAX
0039	204288		2. 0	DISCONNECT FEMALE . 110 TAB 22-

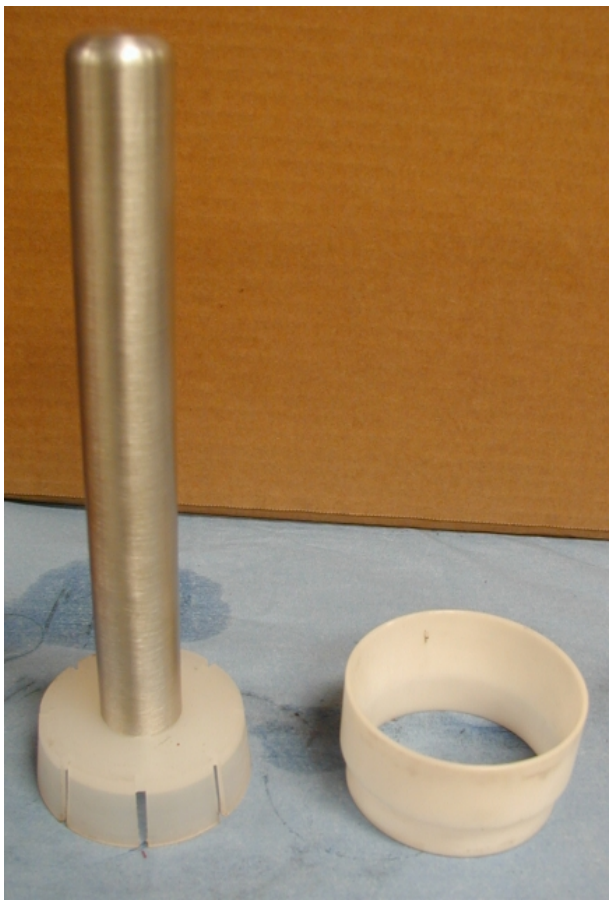


Figure 9-6
O-ring seating tool

The O-ring seating tool consists of two parts: the seating tool with handle, (left) and the feed sleeve (right).

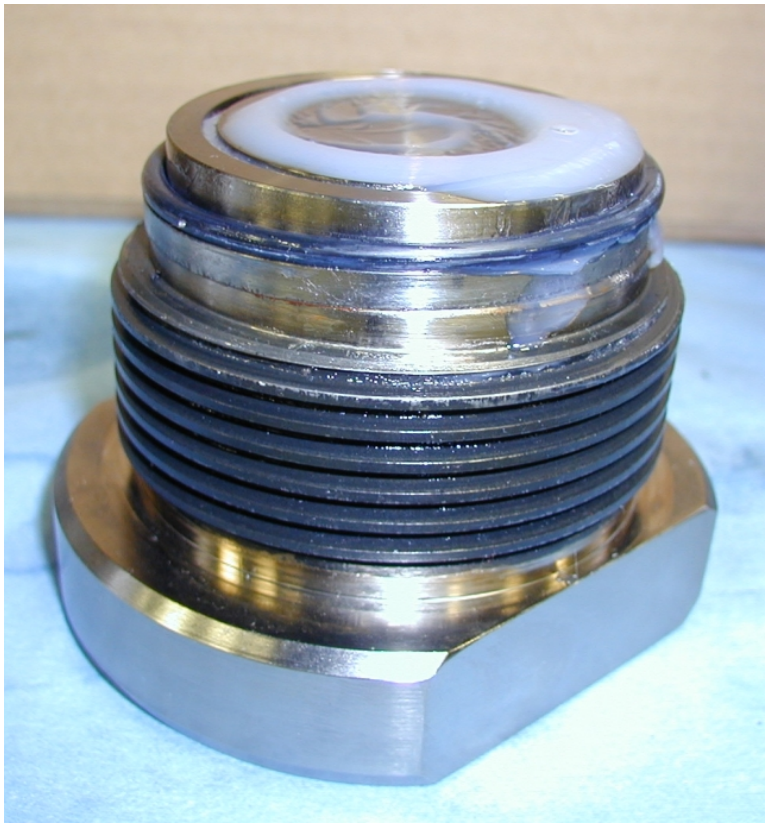


Figure 9-7
Bottom chamber lid

Unlike the top chamber lid, the bottom chamber lid does not have a ring to retain the O-ring. When the test chamber is being threaded onto the bottom lid, the O-ring can become displaced or twisted. The O-ring seating tool retains the O-ring in the proper location while the lid and chamber are being assembled.

Figure 9-8
Tool on O-ring

The O-ring seating tool shown against the bottom lid O-ring.

Figure 9-9
Feed sleeve

The feed sleeve is inserted into the top end of the test chamber to compress the seating tool fingers as it is inserted.

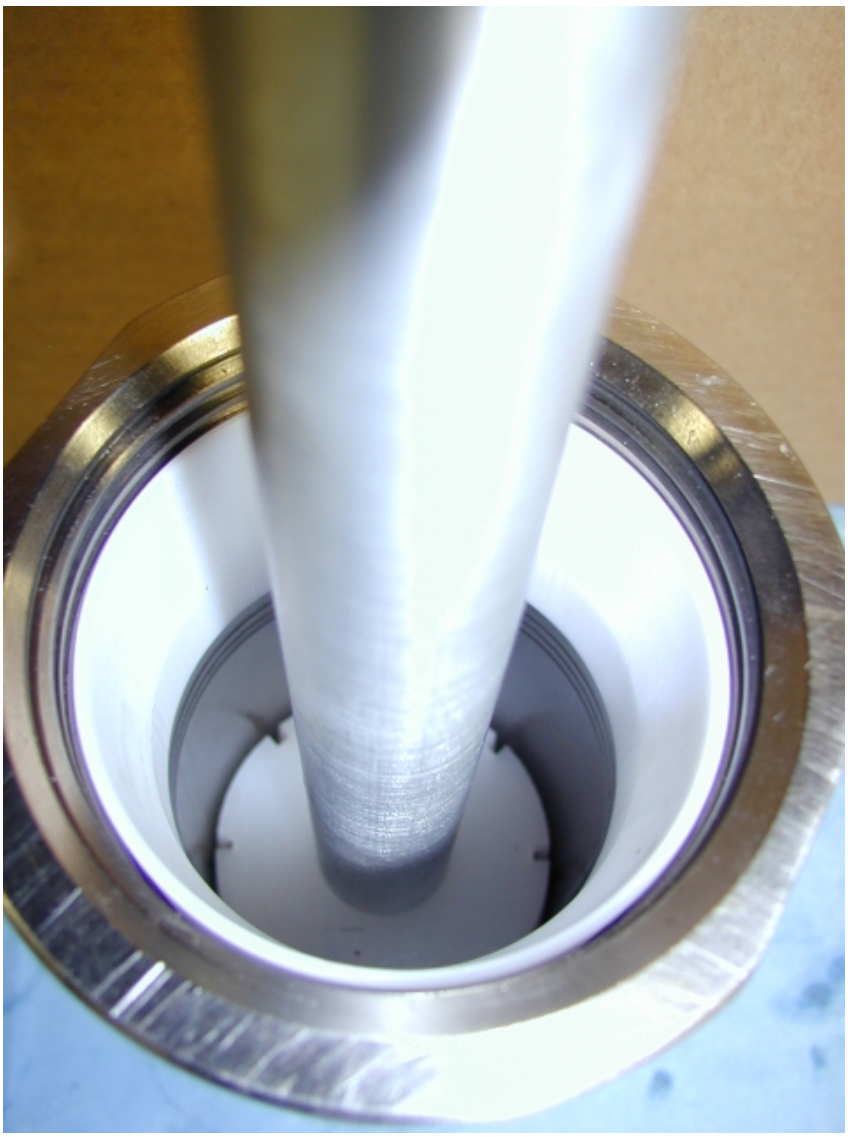


Figure 9-10
Feed sleeve – cup

Push the O-ring seating tool through the feed sleeve and onto the bottom lid O-ring. Firmly press down on the handle while making up the lid-chamber completely. Remove the tool and sleeve.

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.