

HCS9000B / HCS9200B
Composite Repair Set; Hot Bonder
Operation and Maintenance Manual
with
Illustrated Parts Catalog

This Technical Manual Applies to HCS9000B and HCS9200B Revision 16
Composite Repair Sets (Hot Bonders) with Serial Numbers listed below:

Serial Numbers – 1611XXXX and Subsequent

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ABBREVIATIONS AND ACRONYMS

ASCII	American Standard Code for Information Interchange
AC	Alternating Current
bit	Binary digit (one bit of data - either 0 or 1)
CAGE	Contractor and Government Entity (Code)
CB	Circuit Breaker
CCA	Circuit Card Assembly
cfm	Cubic feet per minute
COM	Communication
COTS	Commercial off The Shelf
CPU	Central Processor Unit (Computer)
cu. ft.	Cubic foot/feet
DC	Direct current
DEG	Degree
Dev	Deviation
ENT	ENTER Key
ESC	ESCAPE Key
FIFO	First-In-First-Out
GUI	Graphical User Interface
HCS	HEATCON [®] Composite Systems
°F	Degree Fahrenheit
°C	Degree Celsius
Hi	High
Hz	Hertz (cycles)
In. Hg.	Inches of Mercury
ID	Identification
I/O	Input/Output
LCD	Liquid Crystal Display
LED	Light Emitting Diode
Lo	Low
mb	Millibars
KPa	Kilo Pascal
No.	Number
OEM	Original Equipment Manufacturer
PB	Proportional Bandwidth
P/N	Part Number
Par	Paragraph
PC	Personal Computer
PID	Proportional Integral Derivative
psi	Pounds per square inch
QD	Quick Disconnect
S/N	Serial Number
Sniffer	Vacuum through-bag- connector with check valve
SSD	Solid State Flash Disk
TC	Thermocouple
USB	Universal Serial Bus
V	Volt

WARNINGS AND CAUTIONS

WARNINGS and CAUTIONS are used throughout this manual to alert personnel to the hazards associated with the operation and use of the HCS9000B/HCS9200B Composite Repair Set (Hot Bonder), and with the materials and processes used to repair composite structures.

A **WARNING** statement is used where serious personal injury or death may result if the instructions are not observed.

A **CAUTION** statement is used where injury to personnel, damage to equipment or improper results might occur if the instructions are not observed.

Below are the **WARNINGS** and **CAUTIONS** used in this manual. Before operating this equipment read and understand these **WARNINGS** and **CAUTIONS**.

WARNING

USE OF THIS EQUIPMENT IN A MANNER NOT IN ACCORDANCE WITH THE MANUFACTURER'S PROCEDURES AND/OR DIRECTIVES SPECIFIED IN THIS MANUAL MAY IMPAIR OR NEGATE THE PERSONNEL AND EQUIPMENT PROTECTION FEATURES PROVIDED BY THIS EQUIPMENT.

WARNING

BEFORE CONNECTING ELECTRICAL POWER TO THE HOT BONDER/CONTROLLER, ENSURE THAT THE POWER PLUG INSTALLED ON THE INPUT POWER CABLE IS OF AN APPROVED TYPE, WITH PROPER RATINGS FOR THE INTENDED USE, AND IN ACCORDANCE WITH LOCAL ELECTRICAL CODES AND ACCEPTED INDUSTRY SAFETY STANDARDS. (REFER TO LOCAL CODES)

WARNING

BEFORE CONNECTING ELECTRICAL POWER TO THE HOT BONDER/CONTROLLER, ENSURE THE FACILITY SOURCE POWER IS RATED FOR THE REQUIRED AMPERAGE AND THAT THE HOT BONDER/CONTROLLER IS EQUIPPED WITH A POWER CABLE AND PLUG CAPABLE OF THAT AMPERAGE. (REFER TO LOCAL CODES)

WARNING

LETHAL VOLTAGES ARE PRESENT IN THE UNIT IS CONNECTED TO THE SOURCE POWER. ENSURE ALL ELECTRICAL POWER IS REMOVED FROM THE UNIT BEFORE ATTEMPTING ANY MAINTENANCE ACTION. ONLY PROPERLY TRAINED TECHNICAL PERSONNEL SHALL PERFORM INTERNAL CHECKS.

WARNING

THE POSSIBILITY OF FIRE AND/OR SERIOUS DAMAGE TO THE AIRCRAFT STRUCTURE MAY RESULT FROM IMPROPERLY PLACING THERMOCOUPLES OUTSIDE THE FOOTPRINT OF THE HEAT BLANKET. ALWAYS ENSURE THERMOCOUPLES ARE PLACED UNDER THE HEAT BLANKET AND INSIDE THE 2-INCH BOUNDARY OF THE USABLE AREA OF THE HEAT BLANKET.

CAUTION

USE CAUTION WHEN REMOVING THE CHASSIS FROM CASE. THE CHASSIS IS ATTACHED TO THE CASE BY THE VACUUM EXHAUST HOSE(S). ENSURE THAT VACUUM HOSES ARE DISCONNECTED AND ALL CABLES AND WIRES ARE CLEAR OF THE CASE FLANGE WHEN THE CHASSIS IS REMOVED.

CAUTION

USE CAUTION WHEN THE CHASSIS IS BEING INSTALLED TO ENSURE THAT ANY CABLES OR WIRES ARE CAREFULLY INSERTED INTO THE CASE AND NOT CAUGHT ON THE FLANGE, . ALSO ENSURE VACUUM EXHAUST HOSE(S) ARE NOT KINKED OR TRAPPED UNDER THE BASEPLATE. VACUUM SYSTEM PERFORMANCE WILL BE DEGRADED IF A HOSE IS RESTRICTED.

CAUTION

USE CAUTION WHEN REMOVING THE PRINTER COVER. APPLY GENTLE PRESSURE WHEN REMOVING COVER. EXCESSIVE FORCE MAY DAMAGE THE PRINTER ASSEMBLY AND BREAK THE RETAINING TABS.

CAUTION

TO PREVENT VACUUM BAG FAILURE AND POSSIBLE DAMAGE TO STRUCTURES, ALWAYS CONSULT THE ORIGINAL EQUIPMENT MANUFACTURER (OEM) STRUCTURAL REPAIR MANUAL (SRM) OR MATERIAL SUPPLIER'S TECHNICAL DATA SHEETS FOR SPECIFICATIONS AND CAPABILITIES OF ANY MATERIALS USED IN THE VACUUM BAGGING PROCESS.

TECHNICAL SPECIFICATIONS

Table 1. Technical Specifications

FEATURE	HCS9000B	HCS9200B
Power: (Voltage)	90 – 264 Volts AC, 47 – 63; 400 Hz	90 – 264 Volts AC, 47 – 63; 400 Hz
Current: (Amperage)	Maximum Input: 30 Amps Maximum Output 30 Amps	Maximum Input: 30 Amps (per zone) Maximum Output 30 Amps (per zone)
Operating Environmental Limitations: Temperature: Relative Humidity: (Non condensing)	32 – 122 °F 0 – 93%	32 – 122 °F 0 – 93%
Cure Temperatures Range:	Ambient to 1400 °F (Type J) Ambient to 2000 °F (Type K)	Ambient to 1400 °F (Type J) Ambient to 2000 °F (Type K)
Control Parameters: Internal System Control Resolution: Display Resolution: Program Resolution: Temperature Accuracy: Vacuum Resolution: Vacuum Accuracy:	½ °F 1 °F 1 °F ±1 °F 1 In/Hg ±1 In/Hg	½ °F 1 °F 1 °F ±1 °F 1 In/Hg ±1 In/Hg
Control Methods:	Hottest Thermocouple Coolest Thermocouple Thermocouple Average TC No. 1 or TC No. 2	Hottest Thermocouple Coolest Thermocouple Thermocouple Average TC No. 1 or TC No. 2
Electric Vacuum Pump Optional	90 – 264 Volts AC Facility Power Input Operates internal 12 Volt DC Pump. FLOW = 0.7 cfm at 27 In/Hg).	90 – 264 Volts AC Facility Power Input Operates 12 Volt DC Pump in Lid. Two-Position Switch Provides MAX FLOW (0.7 cfm) or MAX VAC (27 In/Hg).
Operator Interface:	Menu Selected / Real Language Screens on 6.75" X 5.125" display Languages Supported: English, French, Mandarin Chinese	Menu Selected / Real Language Screens on 6.75" X 5.125" display Languages Supported: English, French, Mandarin Chinese
Power Failure / Recovery	Programmable 1-15 Minute Auto- Recovery with Continued Program Operation. Default 2 Min.	Programmable 1-15 Minute Auto- Recovery with Continued Program Operation. Default 2 Min.
Alarm Volume:	90 dB, Adjustable Volume	90 dB, Adjustable Volume
Programs Stored to Memory:	30 Separate, Operator Entered Programs	30 Separate, Operator Entered Programs
Dimensions & Weight:	18" x 13" x 5.75" 457 mm x 355 mm x 203 mm 15 lb. (10 Kg)	21.75" x 14.25" x 6.5" 552.5 mm x 362 mm x 165.1 mm 28 lb. (12.7 Kg)

CHAPTER 1 GENERAL

1.0 INTRODUCTION

The HCS9000B/HCS9200B Composite Repair Set (Hot Bonder) is a computer monitored and controlled electrical heating composite repair system with multiple sensor inputs and various graphical status display screens with complete process documentation printout. The HCS9000B is a single zone unit and the HCS9200B is a dual zone unit. Each unit provides finite control of heat application, vacuum and time necessary to cure critically sensitive composite resins and adhesives. The controller is compact and portable.

1.1 RELATED PUBLICATIONS

HCS9000B-HCS9200B-R15-CAL; Calibration Manual.

1.2 OVERVIEW

The HCS9000B/HCS9200B Hot Bonder provides the world of composite repair and fabrication with the latest state-of-the-art process control technology. The equipment is extremely user friendly, using a high technology combination of hardware and software to provide the composite repair technician with complete control of the hot bond cure process. Control parameters are entered using straightforward English (foreign language versions available) with Graphic User Interface (GUI) display of the repair process. Hard copy documentation of the cure process is provided via dot matrix, plain paper printer in text and graphic format. Cure data is downloadable via Universal Serial Bus (USB) port at the back of the display.

All control features are accessible via a menu system with easy keypad input. The user has fingertip control over temperature, vacuum, time, alarm parameters, and units of measurement. All cure parameters can be modified at any time, including during the cure. Changes during a cure are not retained in the original program upon completion of the modified cure, thus maintaining the integrity of the cure profile library.

A brief explanation of the Menu System is provided below. A detailed explanation is provided in Chapter 3 (Operation) of this manual. It will also be found that the majority of menu operations and entries are self-explanatory, with instructions presented on the screen. The first screen presented upon power-up is a Welcome screen. Pressing the "ESC" key will bring the user to the Main Menu and Status Monitor Screen.

The MAIN MENU AND STATUS MONITOR SCREEN provides the operator with an immediate readout of the condition and temperature of all Thermocouples (TCs) and vacuum levels. The MAIN MENU AND STATUS MONITOR SCREEN provides options to access the PROGRAM SELECT SCREEN, USER SETTINGS SCREEN, and GRAPH SCREEN(S). It is from these screens that the process is controlled and monitored.

The PROGRAM SELECT SCREEN is used to run, enter and edit cure programs. After a program is selected for use, the user is presented with a screen for entry of operator identification, serial number, and part number associated with the cure to be executed.

The USER SETTINGS SCREEN is used to control the printer print interval, set the clock and date, select the display units of measurement, and turn on/off the segment completion signal. The methods of TC control and monitor modes are also selectable from this screen.

The GRAPH SCREEN shows the real-time presentation of the cure process. The program cure profile is displayed along with a plot of the actual cure cycle. Also presented are TC temperature readouts, vacuum level, time remaining, and alarm conditions. From this screen, the operator can start and stop the cure, initiate a "HOLD" condition, "EDIT" the running cure, printout the cure real time status, and "REPRINT THE CURE" hardcopy at the conclusion of the cure.

In addition to the above listed screens, there are submenu popup windows and screens that provide many more features than have previously been available on the HCS9000/HCS9200 series hot bonders. For detailed descriptions of these menus refer to Chapter 3, Operation.

1.3 QUICK START GUIDE

The following is a brief explanation of a simple cure scenario to familiarize a new user with the basic operation of the bonder. More detailed explanations of bonder functions and theory of operation are available in Chapter 3, Operation. The novice user should not feel intimidated by the bonder, as the Graphical User Interface (GUI) menu system is designed to be self-explanatory, with basic operation as a top priority. Advanced functions are available with a few additional keystrokes, but are not required to run the bonder under normal circumstances. The "ESC" key is used in all of the menu systems to take the user back out of an area without changing the current selections. Normal Quick Start operations are listed below:

CAUTION

ENSURE THAT ALL TCs ARE UNDER WITH THE HEATER BLANKET, INSIDE THE 2-INCH BORDER AROUND THE BLANKET PERIMETER. FAILURE TO PLACE TCs PROPERLY CAN CAUSE OVERHEATING AND DAMAGE TO THE PART OR EQUIPMENT. ADVANCED TC CONTROL OPTIONS MAY ALLOW ALTERNATE TC PLACEMENT, BUT ONLY BY TRAINED PERSONNEL UNDER THE DIRECTION OF SUPERVISORY AUTHORITY. ENSURE THAT TC ENDS ARE ELECTRICALLY INSULATED FROM THE REPAIR SURFACE AND EACH OTHER, THIS CAN BE ACCOMPLISHED BY USE OF A PIECE OF FLASH TAPE WRAPPED OVER THE END AND A PIECE OF TAPE BETWEEN THE PART SURFACE AND WHERE THE TC ENDS ARE PLACED

NOTE

Refer Paragraph 3.1.1, Setup and Figures 3-3 and 3-4 for additional information on vacuum bagging and equipment setup).

- a. Perform the composite lay-up in accordance with the established procedures for the repair provided by the Structural Repair Manual (SRM), engineering, or local authority.
- b. Ensure the vacuum bag has no leaks and is pulled down tight over the repair area (no bridging). A poor vacuum bag will not provide adequate contact between the thermocouples, heat blanket, and repair area to allow proper heat transfer for uniform heating and stable control. Special attention may be required at the areas where the electrical leads and TCs penetrate the vacuum bag sealant tape and pass-through at the perimeter.
- c. Connect the input power cable to the Zone 1 bonder faceplate connector and plug into the facility power outlet.

NOTE

On HCS9200B Dual-Zone units, a power cable MUST BE connected to the Zone 1 power input for the system to operate. If Zone 2 is to be used, a second power cable must be connected to the Zone 2 power input connection.

- d. Connect an Output Power Cable to the Zone 1 or Zone 2 output power connector on the faceplate as required. Ensure the Output Power Circuit Breaker is in the "ON" (UP) position.
- e. Plug heat blanket into the Output Power Cable receptacles(s). The standard output cable has receptacles for two (2) 15-amp blanket power plugs. If the heat blanket requires more than 15 amps, a single receptacle 30-amp output cable is required.

CAUTION

IF OPERATING TWO (2) ZONES, ENSURE THAT THE TCs FROM ONE ZONE ARE NOT CONNECTED TO THE OTHER ZONE. DAMAGE TO THE EQUIPMENT OR PART MAY RESULT IF TCs ARE CROSSED BETWEEN ZONES.

- f. Plug the TCs from the vacuum bag repair area into the TC jacks on the bonder faceplate.
- g. Energize the bonder by placing the POWER rocker power switch to the "ON" position. The bonder will present the WELCOME screen. Keypad instructions are displayed at the bottom of each screen. The WELCOME screen provides the software version installed in the unit and the Calibration Due Date. Press "ESC" to continue to the MAIN MENU AND STATUS MONITOR screen.
- h. The MAIN MENU AND STATUS MONITOR screen provides TC temperature readings, vacuum level display, zone status, and navigation keys to further operation. On the keypad, press the number "1" to RUN a cure program. A cure program can be selected for use by either entering the number of the program with the number keys or by using the UP/DOWN ("↑" or "↓") arrow keys to move the blue cursor to the desired program and pressing "ENT".
- i. A menu will appear for selecting to either Run (1), Edit (2) or Delete (3) the Program. Press 1 and the RUN PROGRAM screen will be displayed.
- j. The RUN PROGRAM Screens shows the program parameters, allows selection of the zone (if operating a two zone unit), and allows entry of data such as Part Number, Serial Number, and Operator Identification for records, tracking and quality control. Make the Zone selection (if required), and enter data as necessary.
- k. If the program parameters are correct and the data entry complete, the cursor will highlight the RUN command. Pressing the "ENT" key will initialize the program for final confirmation to run. If the program parameters are NOT correct, press the "ESC" key to return to the RUN PROGRAM screen and select another program, or select "EDIT" to modify the program.
- l. If "RUN" is selected, the GRAPH Screen for the zone in use (Zone 1 or Zone 2) will be displayed, with a line of the proposed cure displayed as a green trace. This screen provides a visual indication of the program to be run, along with TC and vacuum readings. The flashing cursor bar will be over the START THE PROGRAM selection, awaiting final confirmation to run the program. Press the "ENT" key to start the cure.
- m. The program will start and present a pop-up window showing the progress of the Pre-cure Lay-up Test. The Pre-cure Lay-up test checks a series of parameters before the cure is allowed to start. The test checks the electrical circuit to the heater blanket to make sure the circuit is complete. A power output test and TC RISE test checks for TC response to the heat blanket heat up. If either test fails, the operator has the option of aborting the cure to correct the problem or continuing the cure in spite of the test failure.
- n. Upon satisfactory completion of the Pre-cure Lay-up test, the cure will continue as programmed. The setpoint or desired temperature is displayed along with the actual temperature of the connected thermocouples. The setpoint and actual temperatures should remain close together. If they do not agree, temperature alarms will occur, which will put the cure in a HOLD status until the alarm conditions are corrected.
- o. The theoretical time for the cure to run (with no alarms) will be displayed, along with the time for the current step to complete and the total time remaining for the total cure. The menu in the lower right changes to provide control options during the running cure. The actual progress of the cure will be displayed as a yellow trace on the graph. In theory, the yellow trace should track very closely over the green trace.
- p. If the lay-up is satisfactory and normal ambient conditions prevail during the cure cycle, the program will progress as programmed and complete without intervention. The paper tape will print in accordance with the printer settings selected in the USER SETTINGS screen menus (Fig 3-8) and print the completed graph of the cure at the end of the tape.

CHAPTER 2

FUNCTIONAL DESCRIPTION

2.0 AC POWER CONTROL

Alternating Current (AC) source power is brought into the hot bonder through the front panel input power connector(s). AC power for the control circuitry is then routed through the front panel power switch to the Direct Current (DC) power supply (ref. par 2.1). The AC power used to operate the heating devices of each respective zone is routed from the input power connector through the output power Circuit Breaker (CB) on the front panel, to the power control mechanical safety backup relays. From the mechanical safety backup relay(s), AC power is routed to a solid-state relay. AC power is then sent to the output power connector on the front panel. Each output CB is a two-pole device used to break both sides of the AC line in case of an over-current condition. Each CB is rated at 30 Amps; the maximum power handling capability of each zone. If a fault condition causes the CB to trip, the breaker must be manually reset to restore output power.

2.1 DC CONTROL POWER

The HCS9000B/HCS9200B Hot Bonder utilizes an integrated multiple output DC power supply to provide the necessary voltages for operation of the internal electronics. The DC power supply has a universal AC input that allows operation with an input power voltage between 90 and 264 volts AC and a frequency between 47 Hz and 63 Hz. 400 Hz operation is also possible.

2.2 CENTRAL PROCESSOR UNIT

The computer Central Processing Unit (CPU) is a dedicated micro-controller that provides the intelligence behind the system. The CPU receives inputs from the keypad on the front panel. Printer control information is sent from the CPU to the printers via the parallel ports built into the CPU Carrier CCA. The flat panel display is driven by a video driver CCA.

The operational program, user settings, calibration information and cure profiles are stored in solid-state flash memory. Flash memory is non-volatile and does not need battery power backup to retain the information.

2.3 SENSOR INPUT AND SIGNAL CONDITIONING

The Thermocouples (TCs) and vacuum transducers produce analog voltages that must be amplified, buffered, and converted into digital data before the CPU can process the information. The TC signals are routed from the front panel jacks to the Zone 1 and Zone 2 Analog Input and Conversion Circuit cards which are interfaced to the CPU Carrier CCA via a high-speed serial communications link. Both vacuum transducers connect to the Carrier CCA for processing, similar to the TC readings.

2.4 OPERATOR INTERFACE AND DISPLAY

The operator interfaces with the system via a 16-key keypad on the front panel and Liquid Crystal Display (LCD) flat panel display screen. The operator enters commands and data via the keypad and views the information on the display screen. The keypad is interfaced to the computer through a ribbon cable to the CPU Carrier CCA. The display screen is a flat panel display with a resolution of 800 X 600 pixels. The display is an integrated package consisting of the actual display glass with a backlight inverter attached to the backside. The panel is driven from the LVDS Video Driver CCA, via a multi-conductor cable. A non-glare tempered glass window is bonded to the front surface of the actual display to protect it from damage and reduce reflections.

2.5 PRINTER

The HCS9000B/HCS9200B series Hot Bonders employ dot matrix, impact type printers to produce a hard copy record of the repair process. The HCS9200B has a printer for each zone. The printers are self-contained units mounted in the front panel assembly. The printer is interfaced to the CPU Carrier CCA parallel ports. Other connections are the +5 V DC power input and a PAPER FEED pushbutton located adjacent to the printer on the front panel assembly.

2.6 VACUUM SYSTEM

2.6.1 INTERNAL PNEUMATIC VACUUM SYSTEM

The internal pneumatic vacuum system consists of a single air inlet Quick-Disconnect fitting, a vacuum regulator needle valve, vacuum pump (Venturi vacuum generator), a check valve, a vacuum pressure transducer, and a VACUUM OUT Quick Disconnect. The internal vacuum system utilizes shop air at 90-100 pounds per square inch (psi) at 2-4 Cubic Feet (cu. ft.) Per Minute (cfm) to generate the desired vacuum for the repair. Each zone of the HCS9200B has its own independent vacuum system. Both zones receive shop air through one input, which is located on the zone 1 side of the unit.

Shop air is connected to the front panel air fitting and routed to the vacuum regulating needle valve(s). The pressurized airflow is metered by the regulator valve and piped to the input of the vacuum pump, producing the vacuum level desired for the repair. The pump has no moving parts. Vacuum is generated when the pressurized air passes through a venturi, which creates a low-pressure area. The exhaust air is then vented through an exhaust muffler enclosed in a vent box that is located on the back of the bonder. The muffler reduces the noise level of the air exhaust. The vent box directs the exhaust out of the case interior to prevent contamination of the interior components. The generated vacuum passes through a check valve and is routed to the front panel VACUUM OUT Quick Disconnect. The check valve is used to prevent the vacuum from being lost back through the pump if the shop air is turned off or lost.

The vacuum level transducer is attached directly to the VACUUM MONITOR fitting on the front panel assembly. The vacuum sensor is a solid-state, strain gauge, bridge type transducer. The input to the transducer is +5 V DC. The low-level electrical output signal is connected to the CPU Carrier CCA where it is amplified and converted into digital data.

2.6.2 INTERNAL ELECTRIC VACUUM PUMP SYSTEM (HCS9200B-EV OPTION)

The HCS9200B-EV series Hot Bonders are available with an internal electrical vacuum pump installed in the case lid as an option. When installed, vacuum is available at the VACUUM OUT Quick Disconnect located on the upper lid panel assembly when operating the electric vacuum pump. RETURN VACUUM MONITORING is the same as with the internal pneumatic vacuum system.

The internal vacuum pump is a two-head, 12 V DC electrical pump. The pump input power is connected to a universal power supply (90-264 VAC input) that is enclosed within the unit via a connector on the faceplate. A rocker switch on the electric pump panel assembly powers an electrical selector valve that allows the operator to switch between parallel head operation for maximum flow—approximately 0.7 cfm; or series head operation for maximum vacuum level—up to approximately 29 In/Hg.

2.6.3 INTERNAL ELECTRIC VACUUM PUMP SYSTEM (HCS9000B-EV ONLY)

The HCS9000B-EV Hot Bonder is designed with an internal electrical vacuum pump installed in the case. Vacuum is available at the VACUUM OUT Quick Disconnect on the front panel assembly the same as with the standard pneumatic vacuum system. RETURN VACUUM MONITORING is the same as with the internal pneumatic vacuum system.

The internal electric vacuum pump is a two-head, 12 V DC pump. The pump input power is connected to a universal power supply (90-264 V AC input) that is enclosed within the unit. A rocker switch on the front panel controls ON/OFF power to the electric pump. The pump provides a maximum vacuum level up to approximately 27 In/Hg.

2.7 PROPORTIONAL, INTEGRAL AND DERIVATIVE (PID) CONTROL

2.7.1 PID CONTROL BASICS

The heat control system used in the hot bonders is referred to as a Closed Loop System. This means that the heat output is controlled by feedback from the input thermocouples, which are in contact with the heat load. The controller constantly measures the difference (error) between the setpoint (expected) temperature and the actual (measured) temperature, attempting to correct for the difference. The amount and speed of the correction is regulated by PID control. As with any control system, too little or too much corrective action can result in poor system performance and stability. Properly selected PID parameters help to minimize undershoot and overshoot of the setpoint by the actual cure temperature.

Many variables can influence the performance of the heat control system. The major factors are, heat source, heat load, sensor placement and response, and environmental conditions. Heat sources can be heat blankets, infrared lamps, coil type air heaters, and fiberglass mesh type mat heaters. Each of these sources converts electrical energy into heat and applies that heat to the load. Heat loads vary by the type of material to be cured, the thermal mass of the part, the size and surface area of the part, and the ability of the part to transfer heat. Temperature sensor placement is critical to the control loop to accurately reflect the part temperature. Environmental conditions affect the amount of heat loss during the cure, the ability of the heat to be distributed evenly, and the stability of the process.

Properly selected PID control parameters can adjust for many of the variables encountered in the composite curing process. The basic PID parameters used in the standard hot bonder/controller configuration are suitable for the majority of composite cure situations, using silicone rubber heating blankets. When the hot bonder/controller is used to control a heat source other than blankets, the PID control parameters usually have to be adjusted to provide stable, accurate control of the cure process. Selection of the optional "SPECIAL PID CONTROL" mode of operation in the ADVANCED USER SETTINGS Screen allows an alternate set of PID parameters to be used by the bonder for heat output calculations.

The initials PID stand for PROPORTIONAL, INTEGRAL, and DERIVATIVE and are standard throughout the control industry. Explanations of the terms and their effect are listed below:

2.7.2 PROPORTIONAL — Also known as "gain". This is the amount of input change (error) required to produce a 100% change in the output of the controller. This is expressed in °F. The number of degrees assigned to the "P" value is called the proportional bandwidth. A proportional bandwidth of 10 degrees means that the controller output will change proportionally from 0 to 100% over a range of 10 degrees. If the setpoint is 250 °F, and the actual temperature is below 240 °F (more than 10° error), the output will be 100%. If the actual is 245 °F, the output will be 50%. At 250 °F actual (0° error), the output will be 0%. If the proportional bandwidth is too small, the process will oscillate around the setpoint and be unstable. The actual temperature will overshoot setpoint, and then undershoot. This will continue indefinitely. Making the proportional bandwidth wider will eventually eliminate the oscillation, but the process will never actually reach setpoint. The actual temperature would stabilize at some point below the setpoint. In order to reach setpoint, the next parameter, INTEGRAL, is used.

2.7.3 INTEGRAL — Integral is the "I" in PID, is also known as "reset". The term reset is actually more descriptive of the control action that occurs. The PID control attempts to "Reset" the setpoint to force the system to achieve the desired setpoint. In the bonder graphic displays (screens), the term reset is used, and is expressed as "Minutes per Reset". In effect, the reset action is applied every X number of minutes, depending on the number assigned to the reset value. Slow processes require long reset intervals and fast processes require shorter reset intervals. When using Proportional control with reset, the actual temperature will actually overshoot the setpoint by some amount before the reset becomes inactive and the process is allowed to stabilize. In a properly tuned system, the overshoot will be minimal and usually is tolerable. If overshoot is unacceptable, then the next parameter, DERIVATIVE, is used.

2.7.4 DERIVATIVE — Derivative is the “D” in PID, is more commonly known as “rate”. The function of rate is to prevent overshoot of the setpoint by the process. It does this by slowing the rate of approach of the actual temperature to the setpoint. The rate time is expressed in minutes and is how long the rate function is applied to the output. After the rate time is up, the rate function is removed from the output, returning control to the Proportional bandwidth and reset function. The higher the rate number, the longer the rate function is applied and the faster the output is reduced, thus preventing overshoot. Too high of a setting of the rate value will result in undershooting of the setpoint and sluggish control of the process.

All three parameters (PID) interact with each other and proper selection of the values may be difficult. Scientific determination of PID values is usually the work of process control engineers or other personnel familiar with temperature control processes. However, there are methods of tuning a PID system by experimentation and observation of trends and control action.

2.8 NETWORK OPERATION

The network connection port is located on the back of the screen bezel next to the USB port. This connection allows multiple hot bonders to be remotely operated from a common control point where multiple zones of control are required. Examples include large area repairs where a single bonder cannot supply the power required, or thermally complex repairs where multiple independent PID loops are required to run a common cure. Network operation requires no intervention or configuration from the bonder interface. Once a network controller is connected to the port, a connection will be established automatically.

While connected to a network controller, the bonder will still operate independently of the network until the controller initiates a cure program. Once a network cure program is started, the bonder display will be fixed on the MAIN MENU & STATUS MONITOR screen and the keypad will be disabled. The unit will not retain data from cures run in network mode. All data will be stored on the network controller.

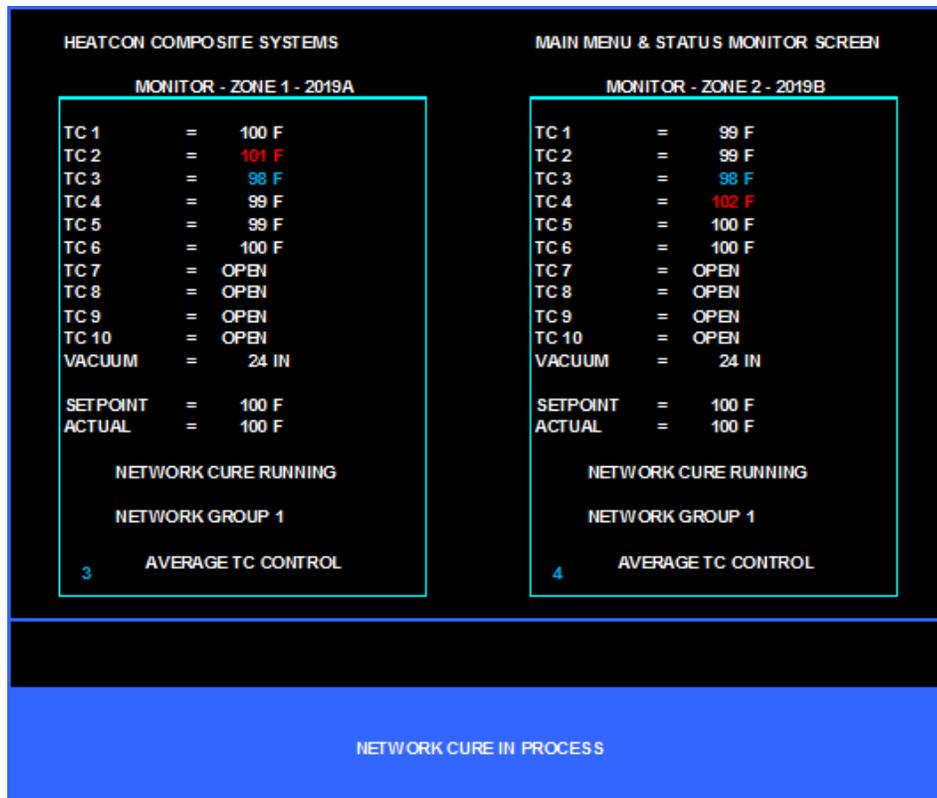


Figure 2-1. HCS9200B Display Screen under Network Control



Figure 2-2. Network Port Location (HCS9000B)



Figure 2-3. Network Controller (HCS9300NW)

CHAPTER 3 OPERATION

3.0 CONTROLS AND INDICATORS

All controls and indicators required to operate the HCS9000B/HCS9200B Composite Repair Set (Hot Bonder) are available from the faceplate on front of the unit. The controls and indicators for the HCS9000B and the HCS9200B are identical, except that the HCS9200B has two separate zones. The controls and indicators for the HCS9000B are shown in Figure 3-1 and the controls and indicators for the HCS9200B are shown in Figure 3-2. Additional controls for both units are available on the operator interface screens that are viewed on the Liquid Crystal Display (LCD) screen. These additional controls are described with their respective screens in Section 3.2 Operator Interface Screens.

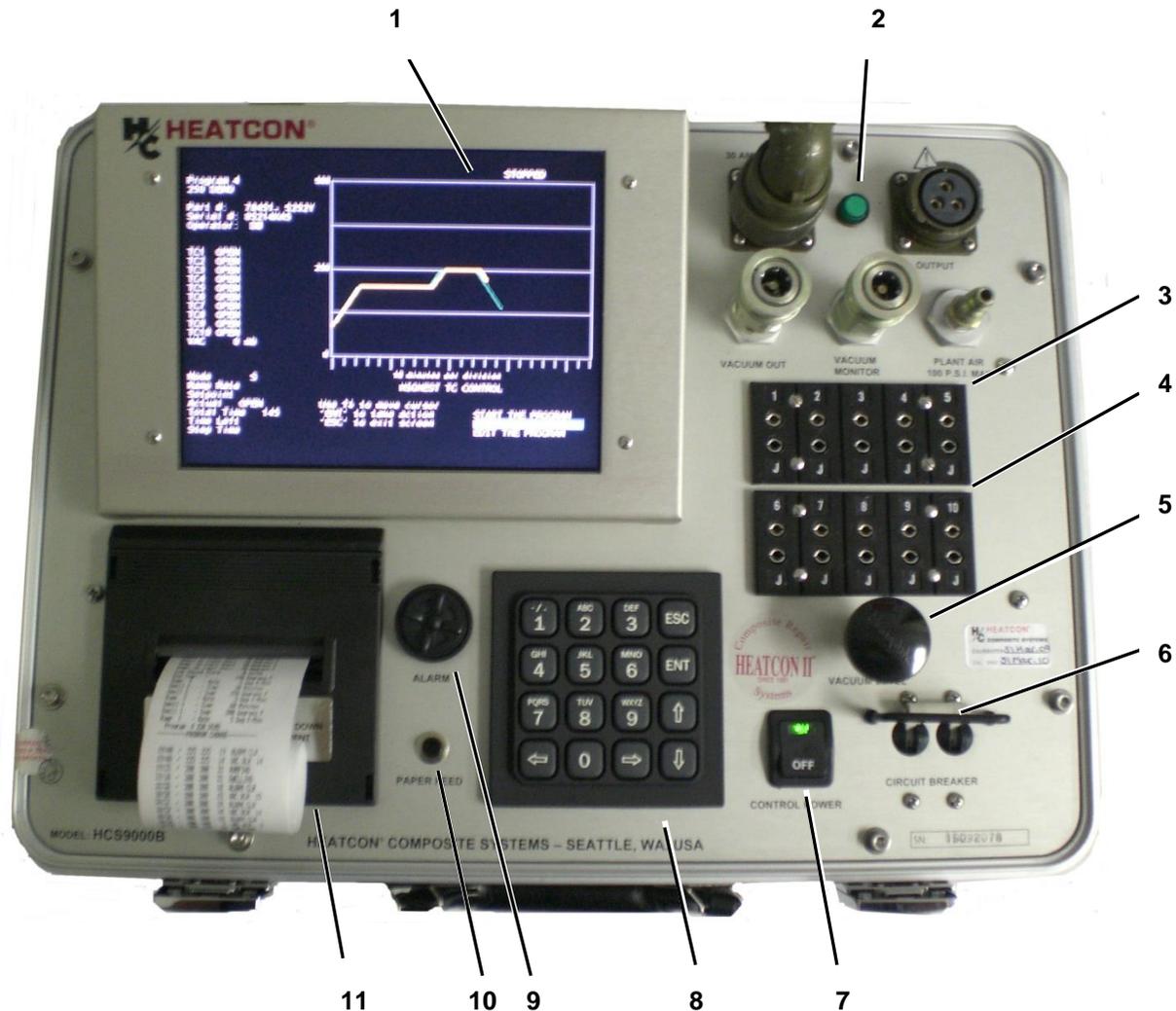


Figure 3-1. Controls and Indicators HCS9000B - Single Zone

Table 3-1. Controls and Indicators HCS9000B - Single Zone

Index	Control/Indicator	Function
1	LCD Display Panel	Viewing of operator interface screens/information
2	Output Power LED (Green)	Flashes in proportion to the rate of power output to circuit.
3	Thermocouple Jacks 1-5	Jacks for plugging-in thermocouples No. 1 thru No. 5.
4	Thermocouple Jacks 6-10	Jacks for plugging-in thermocouples No. 6 thru No. 10.
5	Vacuum Control Regulator	Turn counterclockwise to open and increase vacuum level. Turn clockwise to close and reduce vacuum level.
6	Circuit Breaker	In ON position, enables output power. In OFF position, power disabled. Automatically trips off when 30 Amps exceeded.
7	Control Power Switch	Controls power to unit.
8	16-Key Keypad	Inputs commands to operator interface, including cure programs and operating information.
9	Alarm	Adjustable audible alarm. Sounds when temperature or vacuum condition in the repair exceeds (\pm) set parameters, or other alarms occur.
10	Printer Paper Feed Pushbutton Switch	Press to advance paper. Release to stop.
11	Printer Assembly	Prints active cure program data.

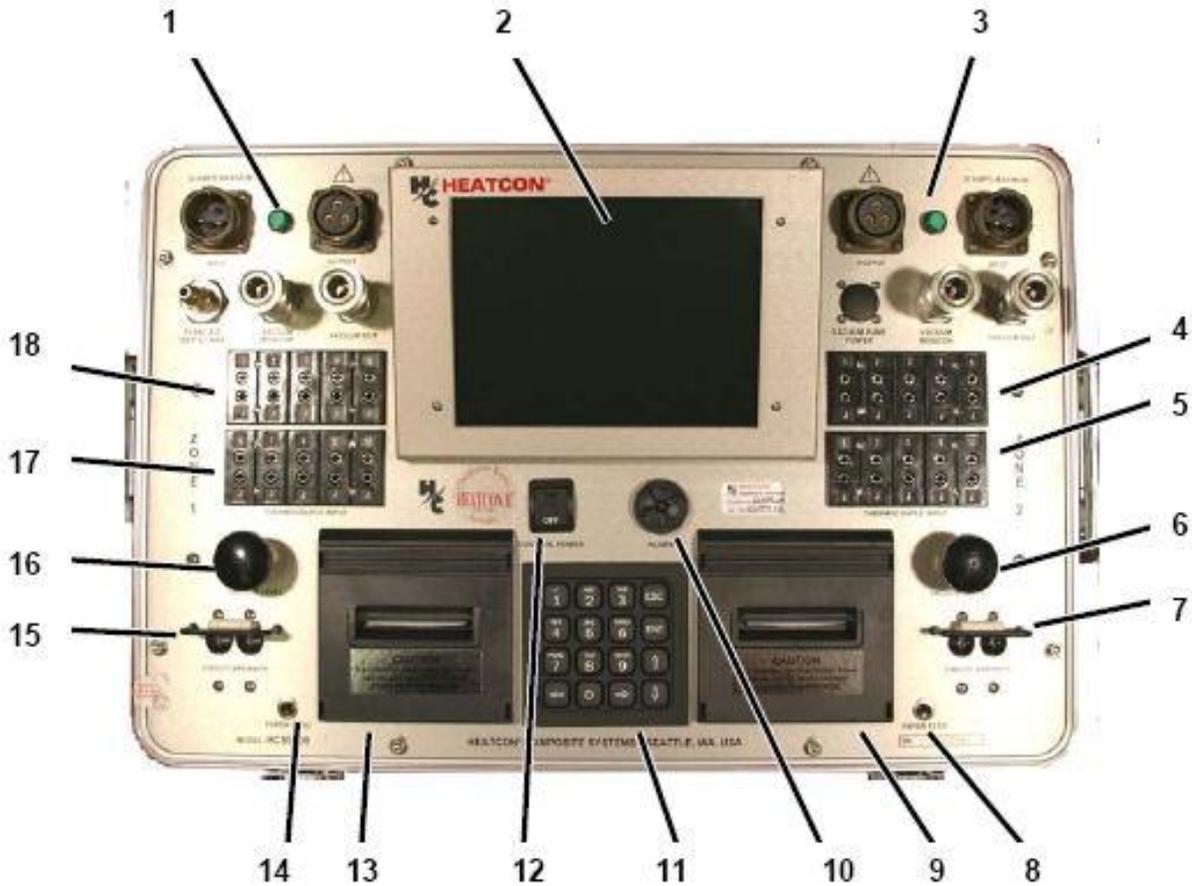


Figure 3-2. Controls and Indicators HCS9200B - Dual Zone

Table 3-2. Controls and Indicators HCS9200B - Dual Zone

Index	Control/Indicator	Function
1	Output Power LED (Green), Zone 1	Flashes in proportion to the rate of power output to circuit
2	LCD Display Panel	Viewing of operator interface screens/information
3	Zone 2 Output Power LED (Green)	Flashes in proportion to the rate of power output to circuit
4	Thermocouple Jacks 1-5, Zone 2	Jacks for plugging in thermocouples No. 1 thru 5
5	Thermocouple Jacks 6-10, Zone 2	Jacks for plugging in thermocouples No. 6 thru 10
6	Vacuum Control Regulator, Zone 2	Turn counterclockwise to open and increase vacuum level. Turn clockwise to close and reduce vacuum level
7	Circuit Breaker, Zone 2	In ON position, enables output power to Zone 2. In OFF position, output power is disabled. Automatically trips when 30 amps is exceeded.

Table 3-2. Controls and Indicators HCS9200B - Dual Zone (Cont'd)

Index	Control/Indicator	Function
8	Printer Paper Feed Pushbutton Switch, Zone 2	Press to advance paper. Release to stop.
9	Printer Assembly, Zone 2	Prints cure program data.
10	Alarm	Adjustable audible alarm. Sounds when temperature or vacuum condition in the repair is outside (+/-) cure parameters, or other alarms occur.
11	16-Key Keypad	Inputs alphanumeric commands to operator interface screens including cure programs and operating information.
12	CONTROL POWER Switch	Controls power to unit.
13	Printer Assembly, Zone 1	Prints cure program data.
14	Printer Paper Feed Pushbutton Switch, Zone 1	Press to advance paper. Release to stop.
15	Circuit Breaker, Zone 1	In ON position, enables output power to Zone 1. In OFF position, output power is disabled. Automatically trips when 30 amps is exceeded.
16	Vacuum Control Regulator, Zone 1	Turn counterclockwise to open and increase vacuum level. Turn clockwise to close and reduce vacuum level
17	Thermocouple Jacks 6-10, Zone 1	Jacks for plugging in thermocouples No. 1 thru 5
18	Thermocouple Jacks 1-5, Zone 1	Jacks for plugging in thermocouples No. 6 thru 10

3.1 EQUIPMENT SETUP AND POWER-ON

3.1.1 EQUIPMENT SETUP

The first step in equipment setup is to position the unit for safe use. Make sure the unit is placed on stable surface so that it will not fall or slide.

NOTE

Refer to Figure 3-3 for bonder connection points and Figure 3-4 for vacuum bag component connection points.

- a. Remove lid or accessory storage case (if included).
- b. Ensure all cables and hoses have sufficient slack and do not present a trip hazard.

NOTE

On the HCS9200B, each zone has its own primary power connection. The two zones are not interconnected. To operate both zones concurrently, two power sources are required. Maximum current handling capacity of each zone is 30 amperes. Ensure that supply circuits are sized accordingly. The power used to energize the internal electronics of the HCS9200B is tapped off of the Zone 1 power input. Therefore, Zone 1 must have power applied to the input connection to operate. The Zone 2 power input connection is used solely for application to the Zone 2 output.

- c. Locate and connect power cable(s) to unit. Zone 1 is the primary zone and must have input power applied to run the computer and operator interface screens as well as Zone 1 output.
- d. Locate and connect vacuum hoses.
 - (1) Connect one vacuum hose end to the VACUUM OUT port on the bonder and the other end to a vacuum through-bag connector (sniffer) in vacuum bag layout. If using another source for vacuum, connect this hose to the vacuum out of that pump.
 - (2) Connect the other vacuum hose end to the VACUUM MONITOR port on the bonder and the other end of this hose to the other vacuum through-bag connector (sniffer) in vacuum bag layout.

WARNING

THE POSSIBILITY OF FIRE AND/OR SERIOUS DAMAGE TO THE AIRCRAFT STRUCTURE MAY RESULT FROM IMPROPERLY PLACING THERMOCOUPLES OUTSIDE THE FOOTPRINT OF THE HEAT BLANKET. ALWAYS ENSURE THERMOCOUPLES ARE PLACED UNDER THE HEAT BLANKET AND INSIDE THE 2-INCH BOUNDARY OF THE USABLE AREA OF THE HEAT BLANKET.

NOTE

Refer to Vacuum Bagging Tips at end of this manual for tips for installing a vacuum bag to a typical repair.

- e. Determine size of heat blanket(s) required to accomplish the repair.
 - (1) Ensure heat blanket voltage rating matches input voltage to bonder (120 V or 240 V).
 - (2) Ensure heat blanket is of sufficient physical size necessary for the repair. Blanket should be at least 2-inches larger all around than repair area.
- f. Ensure heat blanket is within acceptable amperage, not to exceed 30 Amps per zone.
- g. Locate and connect the output power cable to the bonder. Up to two heat blankets may be plugged-in if total amperage does not exceed unit capability. Optional output junction boxes are available with four gang receptacles. Consult HEATCON® for ordering information.
- h. Locate and connect heat blanket(s) to output power junction box.
- i. Ensure printer has paper and it is not jammed.

WARNING

THE POSSIBILITY OF FIRE AND/OR SERIOUS DAMAGE TO THE AIRCRAFT STRUCTURE MAY RESULT FROM IMPROPERLY PLACING THERMOCOUPLES OUTSIDE THE FOOTPRINT OF THE HEAT BLANKET. ALWAYS ENSURE THERMOCOUPLES ARE PLACED UNDER THE HEAT BLANKET AND INSIDE THE 2-INCH BOUNDARY OF THE USABLE AREA OF THE HEAT BLANKET.

- j. Determine number of Thermocouples (TCs) needed for the repair and map their location for future reference during the cure.
 - (1) Ensure no bare TC wires make contact with any conducting surface.
 - (2) Wrap TC bare wire ends with flash tape.
- k. Locate and attach filter/separator to air fitting on unit.
 - (1) Ensure oil-free, water-free, 80–100 psi air pressure at 2 cfm minimum flow is used. Remove or bypass any in-line air tool lubricators in the air supply. A water/oil separator is recommended.
 - (2) Warranty may be voided if oil/water contaminates internal components.

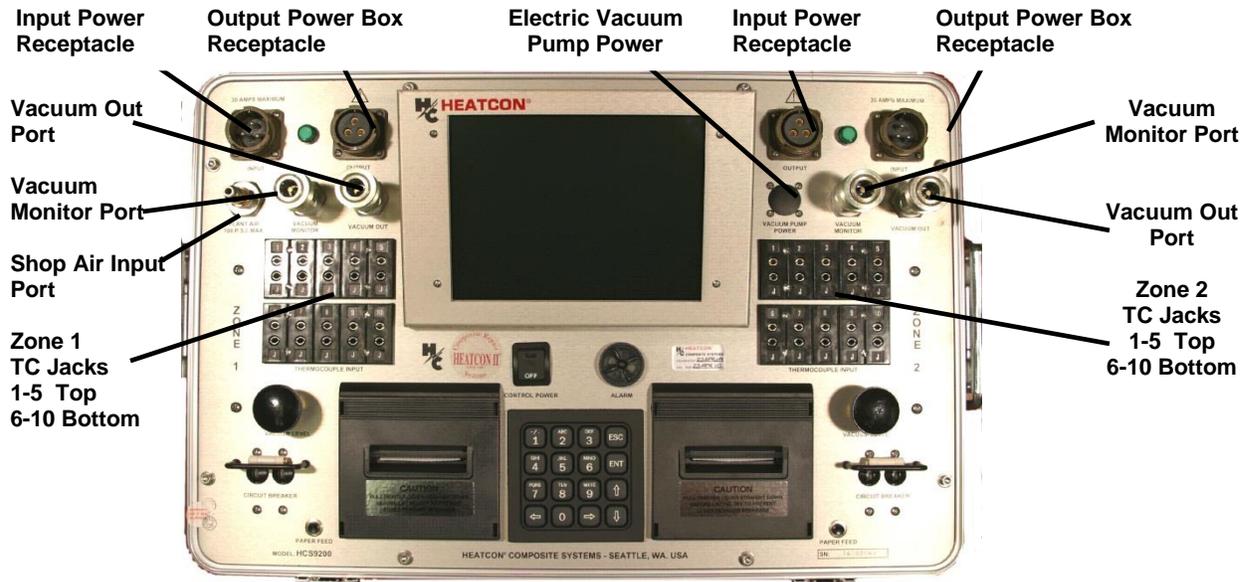


Figure 3-3. Bonder Connection Diagram

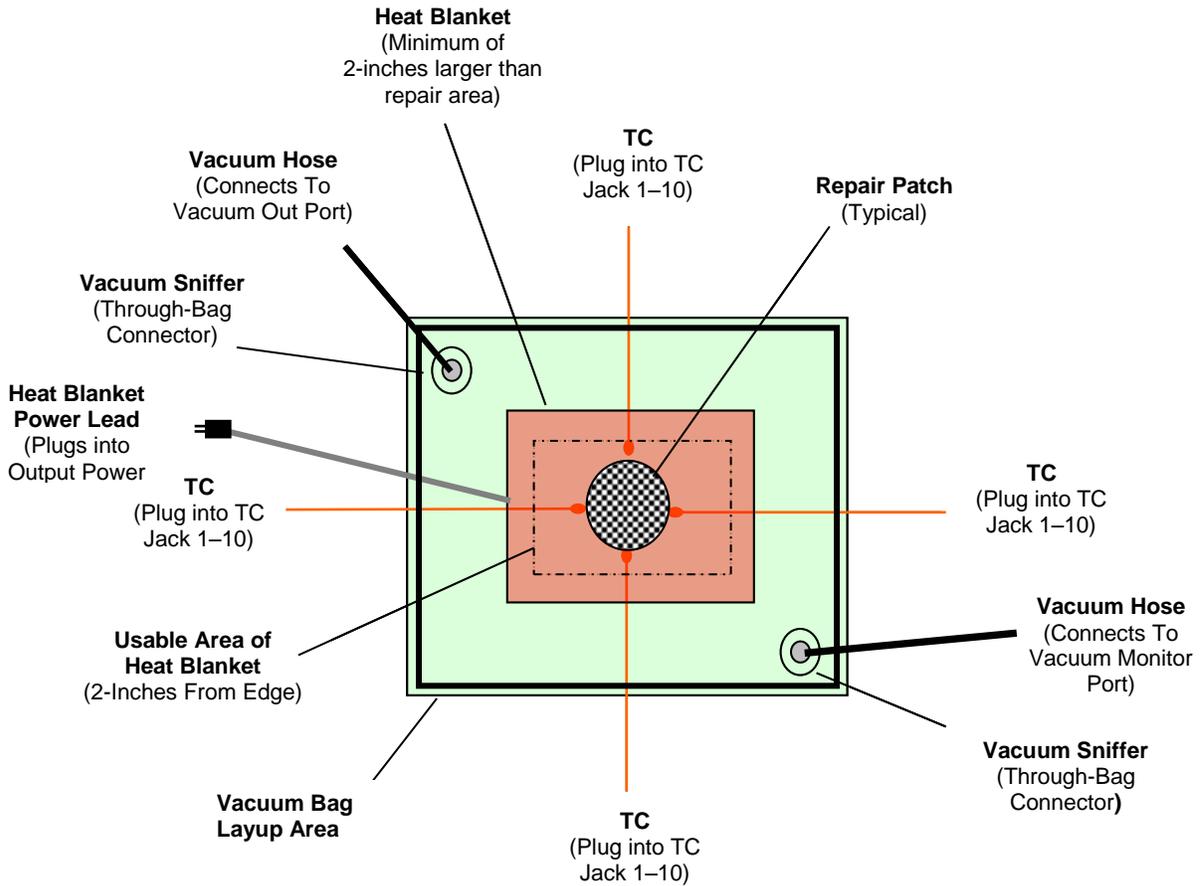


Figure 3-4. Vacuum Bag to Bonder Connection Diagram

3.1.2 POWER-ON PROCEDURE

WARNING

BEFORE CONNECTING ELECTRICAL POWER TO THE HOT BONDER/CONTROLLER, ENSURE THE FACILITY SOURCE POWER IS RATED FOR THE REQUIRED AMPERAGE AND THAT THE HOT BONDER/CONTROLLER IS EQUIPPED WITH A POWER CABLE AND PLUG CAPABLE OF THAT AMPERAGE. (REFER TO LOCAL CODES)

To apply power to the HCS9000B/HCS9200B Hot Bonder, after completing the Equipment Setup as described in par. 3.1.1, plug the power cable into the source power receptacle and place the Control Power switch in the ON position. The LCD Screen should illuminate and display the WELCOME SCREEN and the printer(s) will initialize. If the password option is enabled, the user will be prompted for a password before proceeding to the Main Menu.

3.2.1 SETUP - INTERNAL ELECTRIC VACUUM PUMP SYSTEM (HCS9200B-EV OPTION)

Connect the vacuum pump power cable to the jack on the hot bonder front panel labeled "VACUUM PUMP POWER". The power cable is contained in a small compartment on the left side of the pump enclosure in the lid of the unit. The cable is permanently attached to the pump assembly and connected to the hot bonder with an MS style connector. The connector is keyed, and will only connect in one direction. Connect the power cable before applying power to the unit.

The unit must have power applied and the equipment energized to provide power to the vacuum pump. The vacuum pump assembly has two rocker switches on the enclosure. The left switch is the "POWER ON/OFF" switch for the vacuum pump. This switch allows the operator to turn the pump ON and OFF as desired. The right hand "VACUUM MODE SWITCH" controls the vacuum pump operational configuration. When in the "MAXIMUM FLOW" position, the pump heads are connected in parallel to provide the highest cubic-feet-per-minute vacuum flow. When the switch is in the "MAXIMUM LEVEL" position, the heads are connected in series to provide the highest vacuum (maximum).

The vacuum pump has one quick disconnect fitting on the right side of the enclosure for vacuum out. This should be connected to the line that goes to the vacuum bag. If the pump is to provide vacuum to both zones, a tee adapter will be required for the vacuum out (supply) line. A second vacuum line is then connected to the second vac-valve installed in the vacuum bag and connected back to the "VACUUM MONITOR" fitting on the faceplate of the bonder for the appropriate zone. This connection allows the unit to monitor and display the vacuum reading inside the vacuum bag.

3.2.2 OPERATION - INTERNAL ELECTRIC VACUUM PUMP SYSTEM (HCS9000B-EV OPTION)

Prepare the vacuum bag as required and connect the hoses to the vac-valves as described above. Energize the vacuum pump by placing the "VACUUM PUMP POWER" switch to the "ON" position. Allow the vacuum bag to draw down and seal all leaks. With no leaks, the vacuum pump is capable of developing around 27 In/Hg (at sea level). If the vacuum bag has leaks, the pump may not be able to maintain the desired vacuum level.

The pump is rated for continuous duty and can be run for extended periods. A check valve is installed in the vacuum output, so that the pump can be turned off and the vacuum will not be lost through the pump system.

3.3 SECURITY PASSWORD PROTECTION (OPTION)

The HCS9000B/HCS9200B Hot Bonder may be equipped with password protection as an option. When a new machine is initially powered-up, a prompt will be displayed that instructs the operator to enter a password. To gain initial access to the PASSWORD SETUP Screen (Figure 3-5), **enter “12345” and press “ENT”**. The SUPERVISOR password has been assigned to position number 1 at the factory. The SUPERVISOR should change the password as soon as possible, since the initial password is commonly known. However, it is recommended that it not be changed until the SUPERVISOR is familiar with the password setup procedure.

PASSWORD ENTRY		
ENTER PASSWORD:	12345	
PRESS ESC TO EXIT WITHOUT ENTERING PASSWORD		
TO ENTER PASSWORD, CURSOR TO DESIRED POSITION AND PRESS # KEYS TO CYCLE THRU CHOICES. PRESS ENT TO CONTINUE		
1 - / .	2 ABC	3 DEF
4 GHI	5 JKL	6 MNO
7 PQRS	8 TUV	9 WXYZ
<- DEL	0	-> SPACE

Figure 3-5. Password Sign-In Screen

3.3.1 PASSWORD CONTROL LEVELS

The password control levels set the level of operator access to the various equipment functions. Passwords provide control for the level of access by EDITORS and USERS. The three levels of access are described below:

- SUPERVISOR Level — This level allows an assigned Supervisor to control access to the other levels by assigning passwords to the EDITOR and USER, and has full control of the bonder.
- EDITOR Level — This level allows an assigned EDITOR to enter, edit and run cure programs.
- USER Level — This level allows a USER/operator to run preset cure programs only, with no access to change any cure program parameters.

Individuals assigned a "USER" password (level 3 access) can execute cure programs, but cannot change any of the profile parameters. If a "USER" is operating the system and a change in the profile parameter is required, a "SUPERVISOR" or "EDITOR" must accomplish this action. The Password feature can be configured to allow a "USER" password to make changes to a running program and add new programs to the library, but not be able to edit or delete saved programs.

3.3.2 PASSWORD ASSIGNMENT

There are 20 password entries available in the system. The SUPERVISOR assigns passwords by accessing the PASSWORD SETUP SCREEN (Figure 3-6), entering a password number (1 through 20) and then following the prompts for data entry. More than one supervisor password may be active at the same time, but is not recommended.

Password position number is not the actual password, but rather, the number assigned to each password for reference. The position number is indicated by the flashing number on the EDIT PASSWORD line. Enter the desired password and then press "ENT". Existing numbers may be deleted by using the left arrow (←) key. After the password number is entered, the existing password, if any, will appear and will be flashing. Enter or change the password and then press "ENT". If the password is to be left unchanged, press "ENT". The final step is to assign an access level to the password entered in step c above. Press "1" to assign SUPERVISOR level, "2" for Editor level and "3" for USER level. Then press "ENT".

SET NEW PASSWORDS	
NUMBER OF PASSWORD TO EDIT:	1
ENTER PASSWORD:	12345
ENTER PASSWORD LEVEL:	1
1 - SUPERVISOR, 2 - EDITOR, 3 - USER	
PRESS ESC TO CONTINUE. TO ADD OR CHANGE PASSWORDS, ENTER THE PASSWORD NUMBER 1-20 AND PRESS THE DOWN ARROW KEY	

Figure 3-6. Set New Passwords

Upon entering the password level, the cursor will be placed back to the EDIT PASSWORD line. The process can be repeated. When all desired passwords have been entered or modified, press "ESC" to start normal operation. To get into the PASSWORD SETUP Screen again, cycle the power.

Whenever a SUPERVISOR level password is entered, the PASSWORD SETUP Screen will be presented. For normal operation, press "ESC" to bypass the password edit interface. It is recommended that the SUPERVISOR use an EDITOR Level password for everyday operations. When the EDITOR and USER level passwords are used, the MAIN MENU AND STATUS MONITOR Screen is displayed immediately after password entry.

Only a SUPERVISOR level password allows access to the PASSWORD SETUP Screen. Without a SUPERVISOR password, access to the PASSWORD SETUP Screen, is not possible. In the event of a lost password or other problem, contact HEATCON® Composite Systems for assistance.

By default, the system requires at least a USER level password upon startup to operate. The system can be optionally configured to only require a password for EDITOR or SUPERVISOR level actions, leaving USER actions open to anyone without a password requirement. This is configured in the Calibration and Setup Menu.

3.4 OPERATOR GRAPHIC USER INTERFACE SCREENS

The Graphic User Interface (GUI) screens provide a visual display for inputting, modifying, and observing information into the computer system to operate the HCS9000B/HCS9200B. A series of primary screens and secondary operator interface screens, sub-screens, windows and popup menus provide a graphic and text presentation that is extremely user friendly.

All primary screens are accessible from the MAIN MENU & STATUS MONITOR Screen. Each primary screen provides entry for specific information or access to additional sub-screens, window or menus. Initially a WELCOME Screen is displayed upon power-up. There are slight differences between the screens and menus of the HCS9000B single zone and HCS9200B dual zone units.

The primary screens are:

- a. MAIN MENU & STATUS MONITOR Screen
- b. PROGRAM SELECTION Screen with sub-screens and menus
- c. USER SETTING screen with associated sub-screens and menus
- d. GRAPH Screens (one for each zone)
- e. DATA EXPORT Menu
- f. REPRINT Menu

From the primary screens the secondary screen, sub-screens/windows and popup menus are displayed. Each sub-screen or popup menu is a subset from one of the primary or secondary screens and provides additional selections or options.

3.4.1 WELCOME SCREEN

The WELCOME Screen (Figure 3-7) is the first screen displayed when the unit is powered-up. This screen indicates that the unit is powered and functioning properly. The software version installed in the unit is identified on this screen, as well as the calibration due date. If calibration due date is within 30 days; a "Calibration Due In XX Days" message appears. If the calibration due date has passed, a "Calibration Date Has Expired" message appears. To access the MAIN MENU AND STATUS MONITOR Screen press the "ESC" key. The current date and time are displayed at the bottom of the screen.

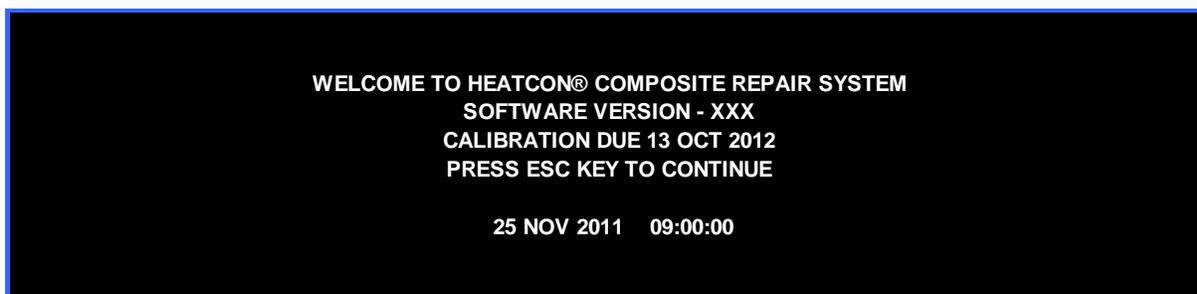


Figure 3-7. Welcome Screen

3.4.2 MAIN MENU AND STATUS MONITOR SCREEN

The MAIN MENU AND STATUS MONITOR Screen (Figure 3-8) is the first screen displayed after starting-up the unit and pressing "ESC" from the WELCOME Screen. This screen can be accessed from any other screen by pressing the "ESC" key. Display brightness may be adjusted from this screen by pressing the up and down arrow keys. The procedures for using this screen are described below:

- a. This is the top level menu and the access point to all other screens
- b. Displays real-time status for each zone:
 - TC 1 thru TC 10
 - ➔ Displays current temperature reading of each TC.
 - ➔ Shows "OPEN" - if TC is not installed or if wire broken.
 - ➔ The **HIGHEST TC** temperature will be displayed in "red"
 - ➔ The **LOWEST TC** temperature will be displayed in "blue".
 - VACUUM level
 - ➔ Vacuum level is sensed through a vacuum transducer in the vacuum monitor port.
 - ➔ Vacuum may be generated internally or by an external vacuum source.
 - SETPOINT
 - ➔ Moving setpoint during ramp – established at each threshold of cure process.
 - ➔ During dwell cycle, setpoint is the programmed temperature and repair surface or process target temperature.
 - ACTUAL Temperature
 - ➔ Shows the actual temperature of the controlling TC(s).
 - ➔ Temperature is taken from the preset TC control method.
 - STATUS
 - ➔ Displayed below the Actual Temperature line
 - ➔ Shows the current status of the program
 - ➔ DWELLING, RAMPING, HOLDING, ALARM, etc.
 - PROGRAM
 - ➔ Shows program currently running for the particular zone.
 - ➔ Program number and name displayed.
 - CONTROL MODE:
 - ➔ Displays the Control Mode in use.
 - ➔ AVERAGE = average temperature of all TCs.
 - ➔ HIGHEST = reads the hottest TC.
 - ➔ LOWEST = reads the coolest TC.
 - ➔ TC NO. 1 = reads temperature of TC plugged into TC 1 jack
 - ➔ TC NO. 2 = reads temperature of TC plugged into TC 2 jack.
 - DATE and TIME:
 - ➔ Displayed below the Zone Monitor(s)
 - ➔ Displays the actual date and time set in User Settings.

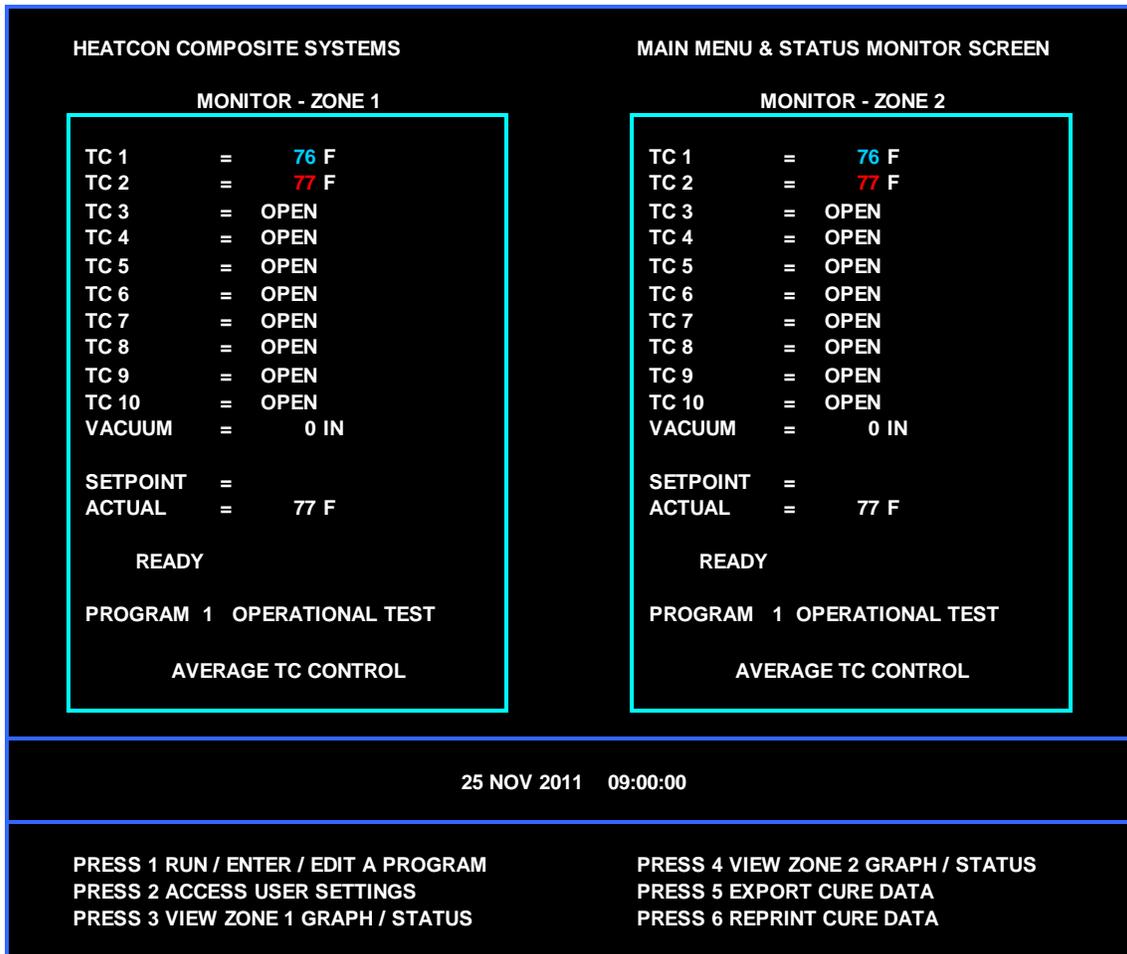


Figure 3-8. Main Menu and Status Monitor Screen

3.4.3 USER SETTINGS SCREEN

The USER SETTINGS Screen (Figure 3-9) is accessed by pressing "2" from the MAIN MENU AND STATUS MONITOR Screen. This screen provides a menu to establish thermocouple control settings, printer options, set the time and date, and select the values for displaying temperature and vacuum.

- a. At the MAIN MENU & STATUS MONITOR Screen, press "2" to display the USER SETTINGS Screen.
- b. Screens, menus and options available from USER SETTINGS Screen include:
 1. Temperature Control Modes
 2. Thermocouple Mode Options
 3. Printer Options
 4. Display Options
 5. Segment Completion Signal
 6. USB Import & Export Options
 7. Date and Time Settings
 8. Advanced Settings (If Enabled)

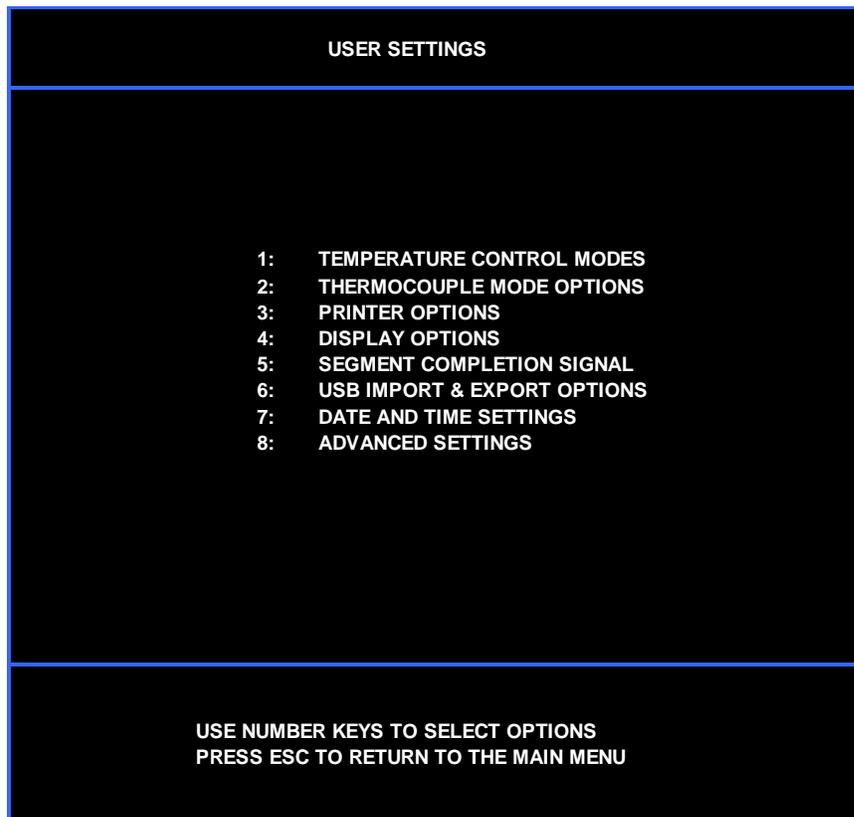


Figure 3-9. User Settings Screen

3.4.3.1 TEMPERATURE CONTROL MODES SCREEN

The TEMPERATURE CONTROL MODES Screen (Figure 3-10) is accessed by pressing "1" from the USER SETTINGS Screen. From this screen information is entered which establishes control methods for cure processing.

The available modes for each zone include:

- 1: Average of All Thermocouples
- 2: Highest Thermocouple
- 3: Lowest Thermocouple
- 4: Thermocouple Number 1
- 5: Thermocouple Number 2

Press the number key associated with the desired option (e.g. 1 thru 5).

Press "ENT" to confirm the selected option and return to the USER SETTINGS Screen

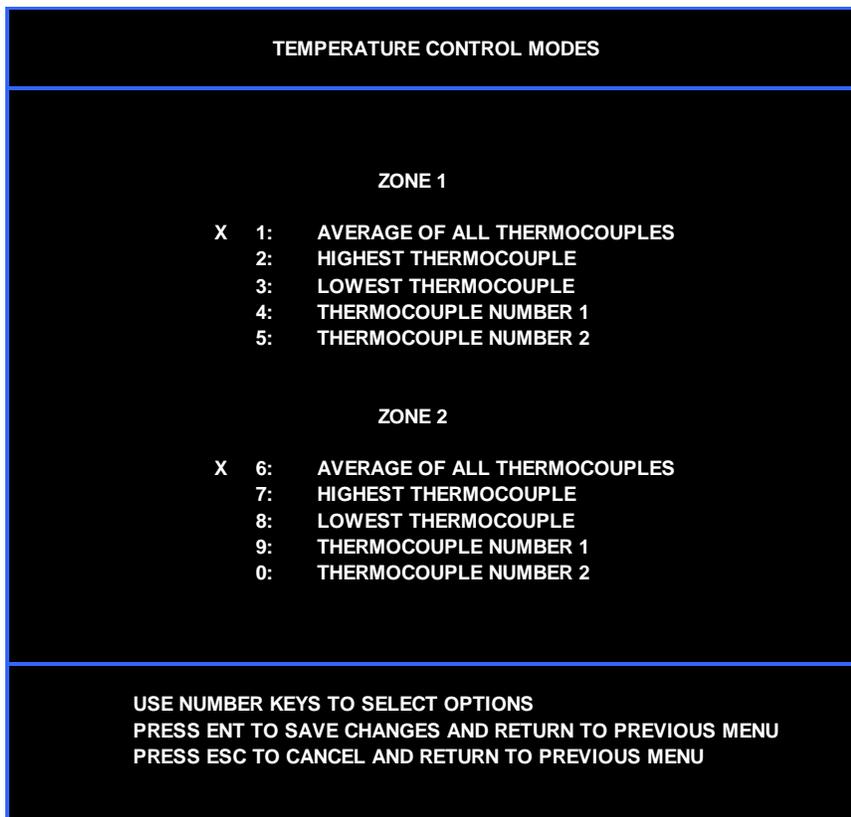


Figure 3-10. Temperature Control Mode Options Screen

3.4.3.2 THERMOCOUPLE MODE OPTIONS SCREEN

The THERMOCOUPLE MODE OPTIONS Screen (Figure 3-11) is accessed by pressing "2" from the USER SETTINGS Screen. From this screen the options are selected for each of the TCs to be included in the cure as controlling or Monitoring TCs and if they are included in the printout or not.

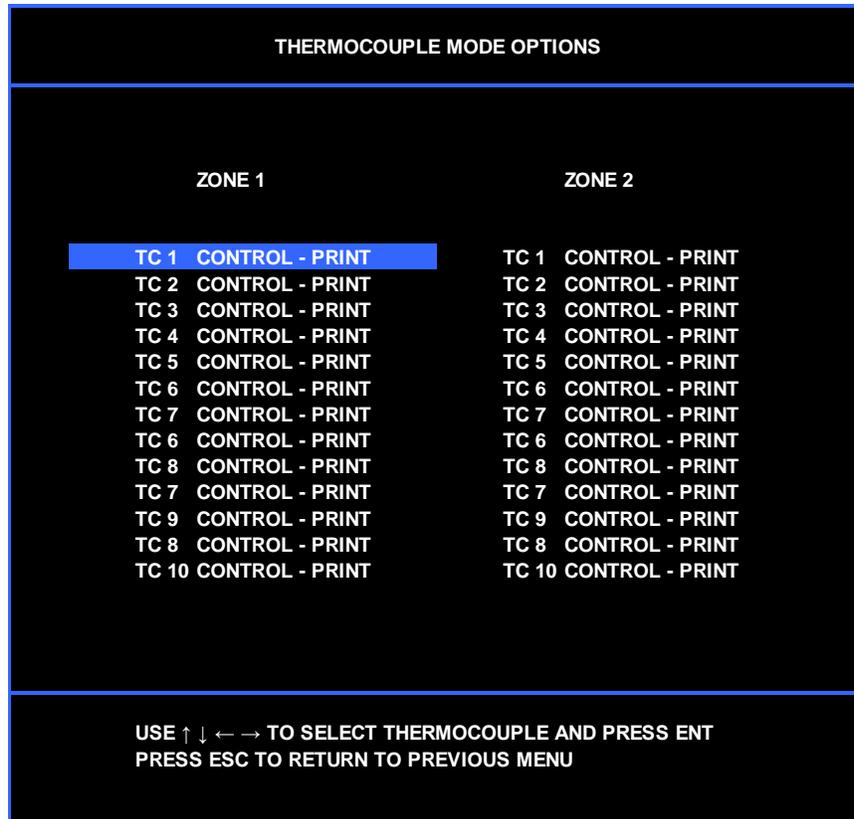


Figure 3-11. Thermocouple Mode Options Screen

3.4.3.3 THERMOCOUPLE CONTROL AND DISPLAY MODES SCREEN

The THERMOCOUPLE DISPLAY AND CONTROL OPTIONS Screen (Figure 3-12) is accessed from the THERMOCOUPLE MODE OPTIONS Screen. Highlight the desired TC to be changed by moving the cursor over the selection and press "ENT". This displays the THERMOCOUPLE DISPLAY AND CONTROL Screen. From this screen the options are selected for each of the TCs to be included in the cure as controlling or monitoring TCs, and whether they are included in the printout or not.

The available thermocouple mode options include:

- 1: Control and Print
- 2: Monitor and Print
- 3: Monitor and No Print

Press the number key for the desired selection and press the "ENT" key to confirm the selection and return to the THERMOCOUPLE DISPLAY AND CONTROL MODE Screen. To make further TC Control and Display selections, repeat paragraph 3.4.3.3.

Press "ENT" to return to the USER SETTINGS Screen.

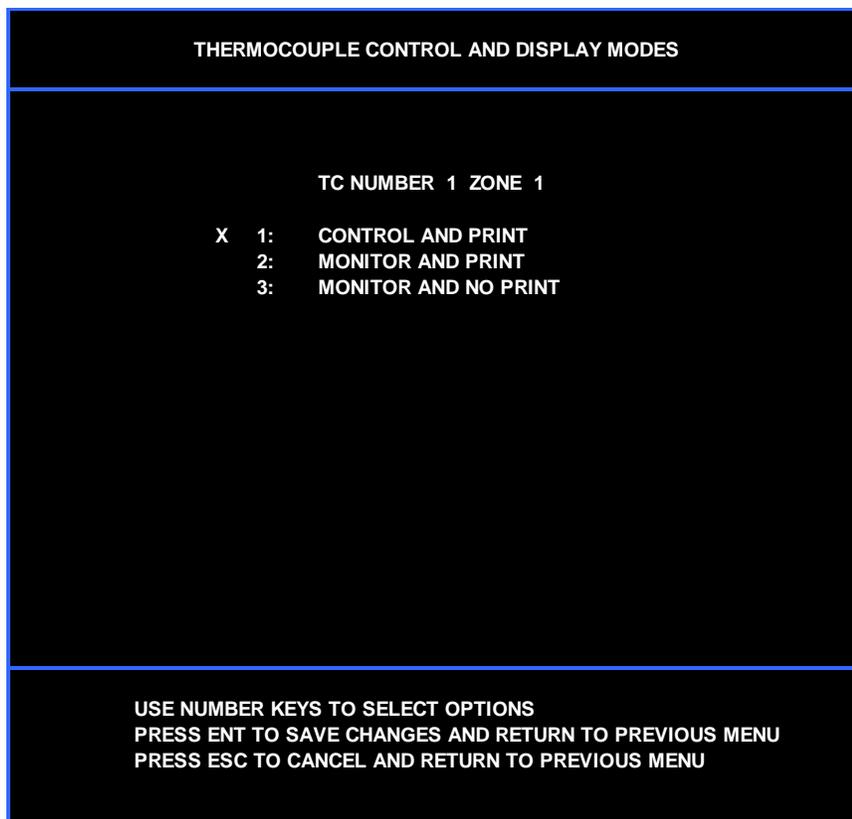


Figure 3-12. Thermocouple Control and Display Modes Screen

3.4.3.4 PRINTER OPTIONS SCREEN

The PRINTER OPTIONS Screen (Figure 3-13) is accessed by pressing "3" from the USER SETTINGS Screen. From this screen the options are selected for each zone printer operation. The available printer options include:

1. Selection of Printer ON/OFF (Zone 1 or Zone 2). When ON is selected, the printer will produce a live real-time copy of the cure data at the set print interval. When OFF is selected, no live printout will be provided, but a copy can be printed at a later time.
2. Summary Line Print – Prints time, setpoint, actual temperature, vacuum level, and status information
3. All Thermocouple Readings Print – Prints Time, Status, Temperature, Vacuum and status of all TCs and alarms.
4. Print Interval: Selectable from 0 to 99 minutes

Press the number key associated with the desired selection. The check mark will move to the indicated selection. Press "ENT" to confirm selection and return to the User Settings Menu. To return to the previous menu without saving changes, press the "ESC" key.

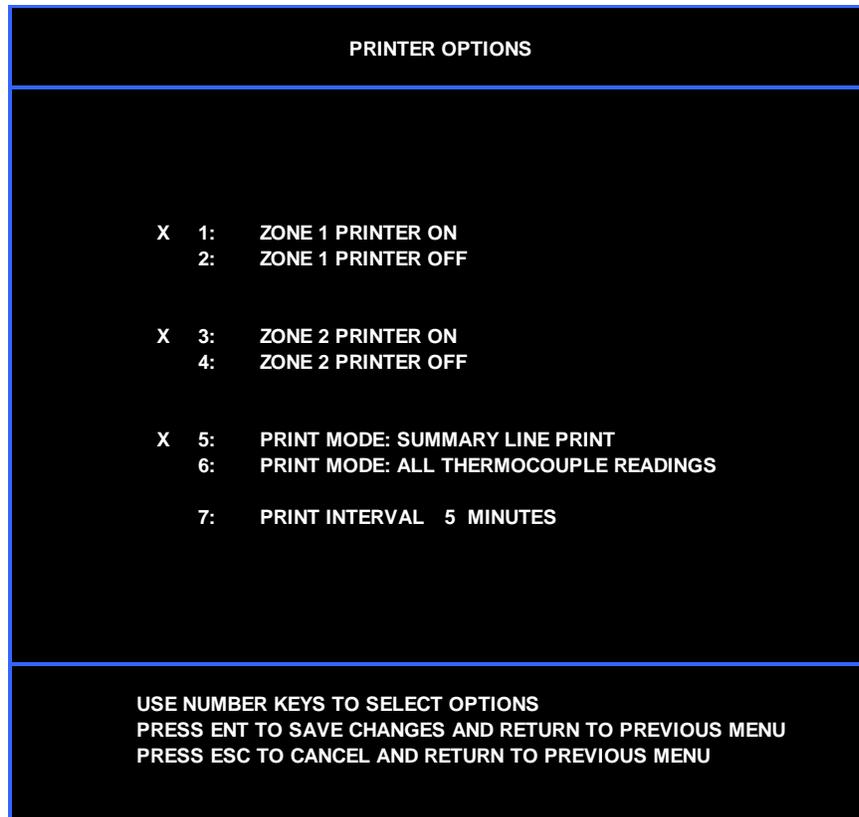


Figure 3-13. Printer Options Screen

3.4.3.5 DISPLAY OPTIONS SCREEN

The DISPLAY OPTIONS Screen (Figure 3-14) is accessed by pressing "4" from the USER SETTINGS Screen. From this screen the options are selected for how temperature and vacuum are displayed. The available display options include:

1. Temperature Degrees F (Fahrenheit)
2. Temperature Degrees C (Celsius).
3. Vacuum Level – In/Hg
4. Vacuum Level – mBars
5. Vacuum Level – kPa

Press the number key associated with the desired selection. The check mark will move to the indicated selection.

Display brightness can be adjusted from this screen by pressing the up and down arrow keys. The percentage of brightness is indicated on this screen. Display brightness may also be adjusted from the Welcome Screen and the Main Menu & Status Monitor Screen.

Press "ENT" to confirm selection and return to the User Settings Menu. To return to the previous menu without saving changes, press the "ESC" key.

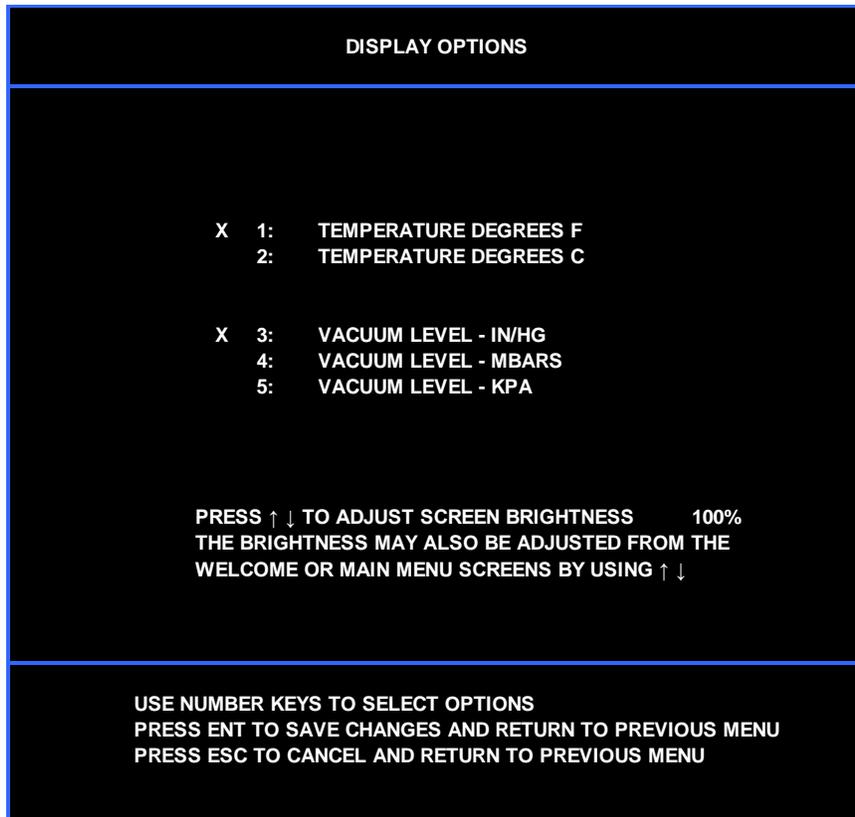


Figure 3-14. Display Options Screen

3.4.3.6 SEGMENT COMPLETION SIGNAL SCREEN

The SEGMENT COMPLETION Screen (Figure 3-15) is accessed by pressing "5" from the USER SETTINGS Screen. From this screen the options are available to turn the segment completion signal ON or OFF. The segment completion signal is an audible sound when the cure program transitions from one segment to another, e.g. ramp to dwell or dwell to another ramp. Disabling the Segment Complete alarm will only sound the alarm when an alarm condition has occurred. Press the number key associated with the desired selection. The check mark will move to the indicated selection. Press "ENT" to confirm selection and return to the User Settings Menu. To return to the previous menu without saving changes, press the "ESC" key.

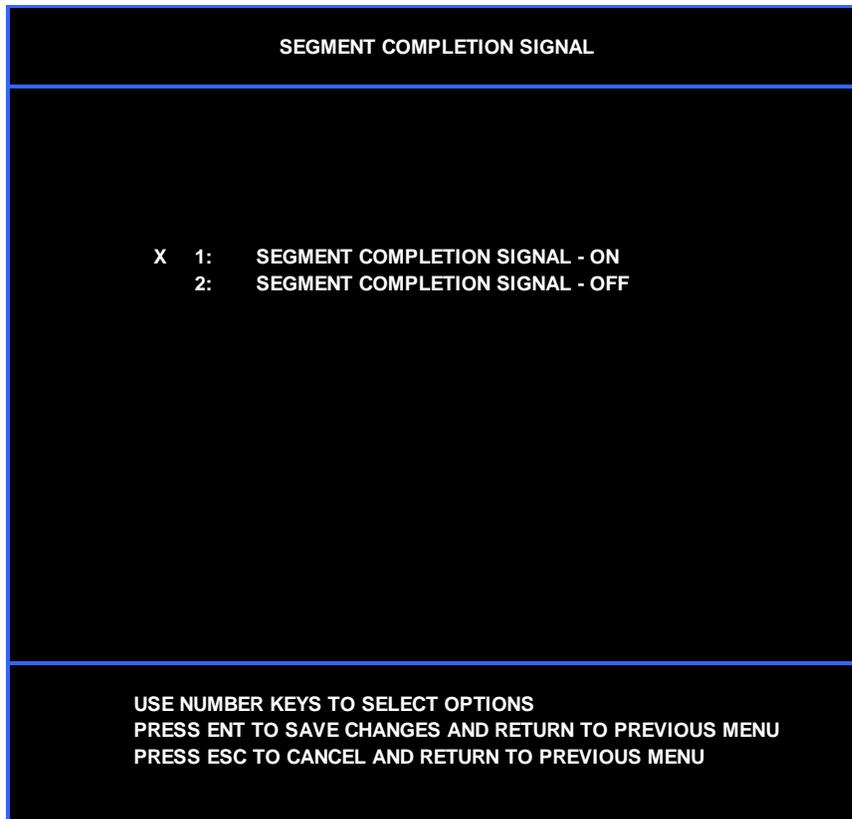


Figure 3-15. Segment Completion Signal Screen

3.4.3.7 USB IMPORT & EXPORT OPTIONS SCREEN

The USB IMPORT & EXPORT OPTIONS Screen (Figure 3-16) is accessed by pressing "6" from the USER SETTINGS Screen. This screen provides options for managing import and export of the data to the USB data port, including completed cure data and the program library. There are three selections from this screen:

- 1: Ask Before Overwriting Oldest Cure File
- 2: Do Not Ask Before Overwriting Oldest Cure File
- 3: Export / Import Cure Program (Profile) Library

The bonder onboard memory holds data for 12 completed cures. When the memory is filled with data, the oldest data has to be erased to make room for the new information from the latest cure. Normally, data is exported on a regular basis to a USB flash memory device so that the oldest cure data is not required to be retained on the bonder. When the data is exported to a flash memory device, it is not automatically erased. The data still present on the bonder serves as a backup copy until it is overwritten, in case of flash disk failure or other data corruption between devices. Multiple data exports are possible as long as the data is still listed on the data export screen.

The Data Export Options allow the user to set the bonder action when the onboard cure data storage is full and has not yet been exported to a USB device. When option "1" is selected, the user is asked to check if the data in the cure storage has been previously exported. This allows the user an opportunity to export the data before it is overwritten. If option "2" is selected, the oldest cure will be overwritten automatically, without requiring the user to respond. This selection should be used in cases where the user does not use the cure data export feature and does not want to be bothered by the overwrite question. Press the number key associated with the desired option. Press "ENT" to confirm the selected option and return to the User Settings screen

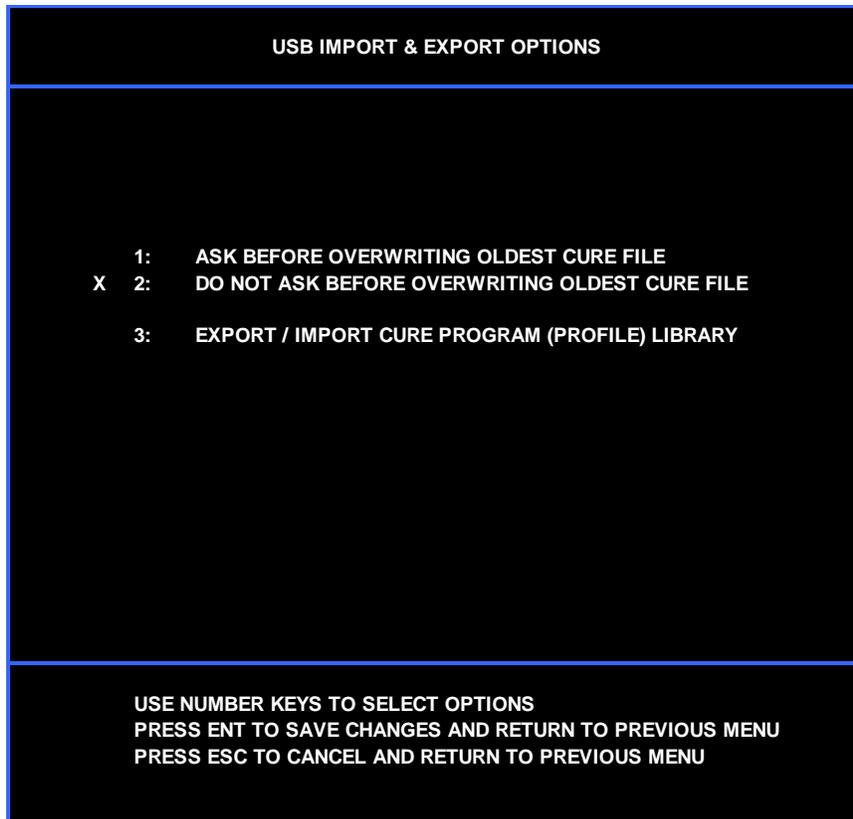


Figure 3-16. USB Import & Export Options Screen

3.4.3.8 IMPORT & EXPORT CURE PROGRAM LIBRARY SCREEN

The IMPORT & EXPORT CURE PROGRAM LIBRARY Screen (Figure 3-17) is accessed by pressing "3" from the USB IMPORT & EXPORT OPTIONS Screen. This screen provides options to import and export the library of cure programs to a USB device, for transfer between machines. Once a cure library is established on one Hot Bonder, the library can be exported to a USB device by pressing 1 on this menu. The USB device can then be connected to a different unit, and the cure library imported to that machine by pressing 2 on this menu. Press "ESC" to return to the USB IMPORT & EXPORT OPTIONS screen.

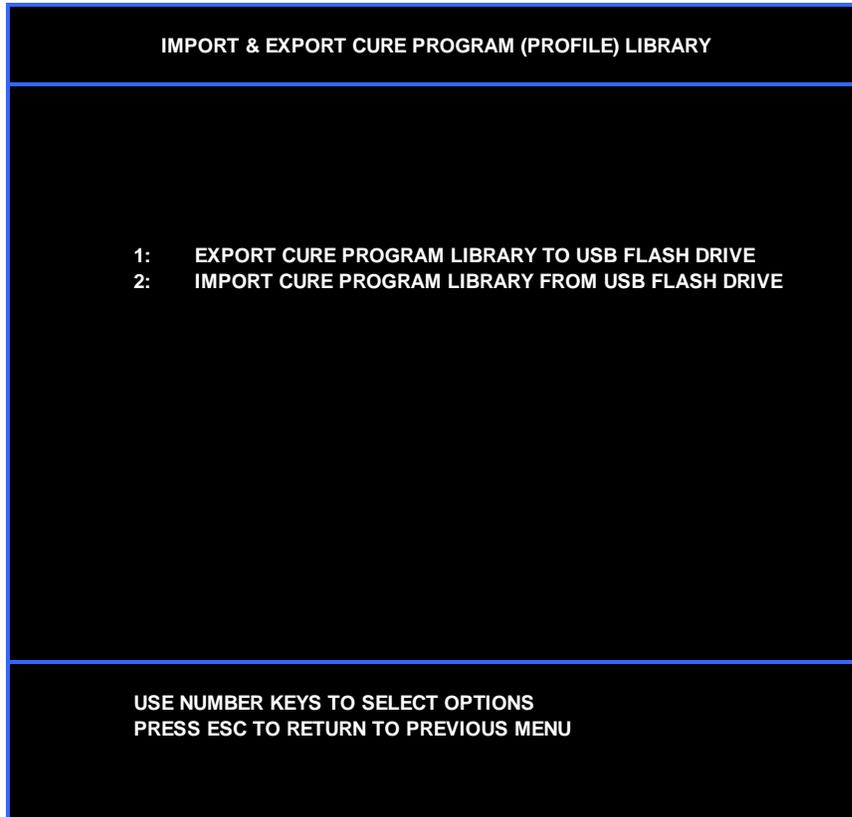


Figure 3-17. Import & Export Cure Program Library Screen

3.4.3.9 DATE AND TIME SETTINGS SCREEN

The DATE AND TIMES SETTINGS Screen (Figure 3-18) is accessed by pressing "7" from the USER SETTINGS Screen. This screen provides options to set the Date and Time. The date is set in the DDMMYY format. The clock is set in 24 Hour format and displayed as HHMM. Press "ENT" to confirm the Time and Date settings and return to the USER SETTINGS screen.

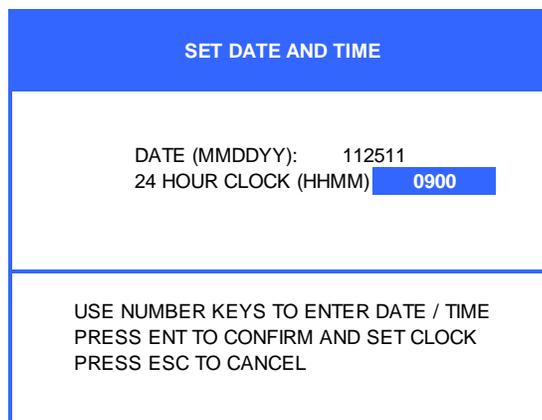


Figure 3-18. Date and Time Settings Screen

3.4.3.10 ADVANCED SETTINGS SCREEN

The ADVANCED SETTINGS Screen (Figure 3-19) is accessed by pressing "8" (Advanced Settings) from the USER SETTINGS Screen. The Advanced Settings Menu is only available when enabled by the factory. If enabled, not all options may be available depending on system configuration.

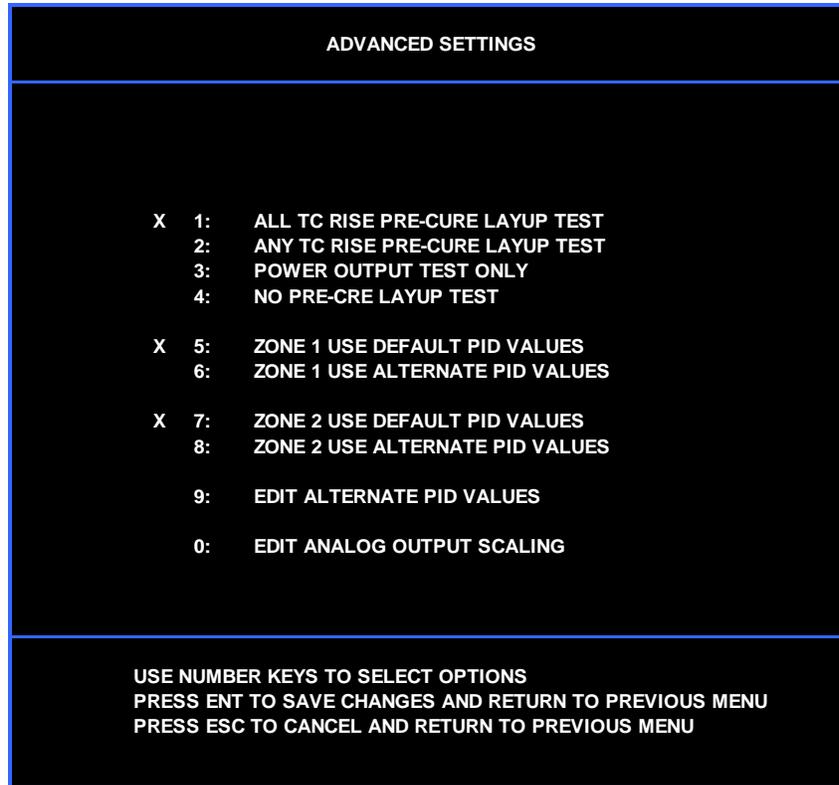


Figure 3-19. Advanced Settings Screen

The available options include:

1. All TC Rise Pre-Cure Layup Test (DEFAULT): Requires power output verification and all control thermocouples to rise during the Precure Layup Test.
2. Any TC Rise Pre-Cure Layup Test: Requires power output verification and at least 1 control thermocouple to rise during the Precure Layup Test.
3. Power Output Test Only: Requires only power output verification during the Precure Layup Test.
4. No Pre-Cure Layup Test: Disables the Pre-Cure Layup Test; begins program immediately upon start.
5. Zone 1 Use Default PID Values: Uses default PID values for zone 1, configured by the factory.
6. Zone 1 Use Alternate PID Values: Uses Custom PID values for zone 1, configured by the user.
7. Zone 2 Use Default PID Values: Uses default PID values for zone 2, configured by the factory.
8. Zone 2 Use Alternate PID Values: Uses Custom PID values for zone 2, configured by the user.
9. Edit Alternate PID Values: Allows the User to configure custom PID values for each zone.
0. Edit Analog Output Scaling: Scales output power down in increments of 10% (1 to 10). This allows operation of heating devices at less than the input voltage. (Example: Using a 120V heat blanket on 240V by reducing the output to 50%). This option applies only to Phase-Angle Controlled Units, which are indicated by a "P" in the part number suffix.

3.4.3.11 ALTERNATE PID SETTINGS

The ALTERNATE PID SETTINGS Screen (Figure 3-20) is accessed by pressing "9" (Edit Alternate PID Values) from the ADVANCED SETTINGS Screen. The Alternate PID Settings Menu is only available when enabled by the factory. PID Values are entered for each zone; Proportional Bandwidth, Integral, and Derivative. See Section 3.10 for detailed explanation of PID Adjustment. PID values are not effective until enabled on the Advanced Settings Screen.

WARNING

USE OF CUSTOM PID SOFTWARE OPTION BY INEXPERIENCED PERSONNEL MAY RESULT IN UNSATISFACTORY RESULTS, DANGEROUS CONDITIONS INCLUDING OVERHEATING OR FIRE, AND/OR DAMAGED OR UNSERVICEABLE PARTS

The screenshot shows a terminal-style interface with a black background and white text. At the top, the title 'ALTERNATE PID SETTINGS' is centered. Below it, 'ZONE 1' is centered. The settings for Zone 1 are listed as follows: 'PROPORTIONAL BAND: 15' (with '15' highlighted in blue), 'INTERGAL (RESET): 2', and 'DERIVATIVE (RATE): 10'. To the right of these values are the units: 'F', 'MIN / RESET', and 'MIN'. Below this, 'ZONE 2' is centered, followed by identical settings: 'PROPORTIONAL BAND: 15', 'INTERGAL (RESET): 2', 'DERIVATIVE (RATE): 10', and units 'F', 'MIN / RESET', 'MIN'. At the bottom of the screen, instructions are provided: 'USE NUMBER KEYS TO ENTER DATA', 'PRESS ENT TO CONFIRM', and 'PRESS ESC TO RETURN TO PREVIOUS MENU'.

Figure 3-20. Alternate PID Settings Screen

3.4.4 PROGRAM SELECTION SCREEN

The PROGRAM SELECTION Screen (Figure 3-21) is accessed by pressing "1" from the MAIN MENU AND STATUS MONITOR Screen. From the PROGRAM SELECTION Screen, programs may be RUN, ENTERED, EDITED or DELETED. This screen displays the 30 programs that are stored in memory. Each program is numbered 1 thru 30 and has space for entering program names up to 20 characters long. Programs without a profile entered are shown as empty.

Select the program to be RUN, ENTERED, EDITED or DELETED by either entering the program number and pressing the "ENT" key, or by highlighting the program with the cursor and pressing "ENT." Once a cure is selected, a popup menu (Figure 3-22) will prompt the user to select either RUN, EDIT, or DELETE.

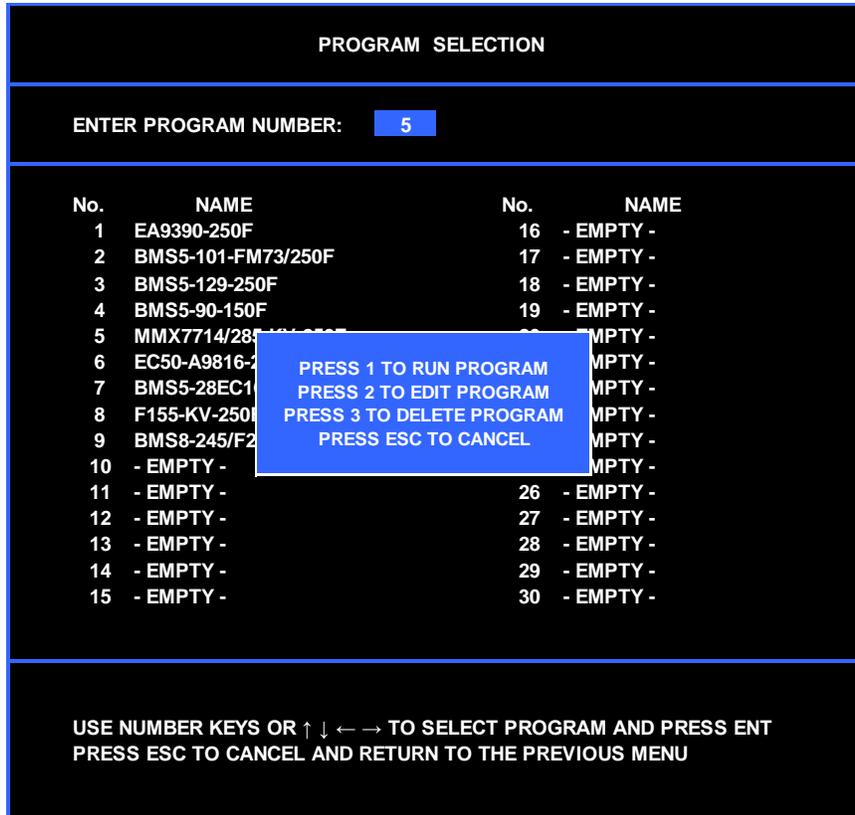


Figure 3-21. Program Selection Screen

If a program has not been entered into memory, the EDIT PRGRAM Screen (Figure 3-22) will be displayed. If a program has been entered and saved into memory, the RUN PROGRAM Screen (Figure 3-23) is displayed.

3.4.4.1 EDIT PROGRAM SCREEN

The EDIT PROGRAM Screen (Figure 3-22) is displayed by selecting a program number on the PROGRAM SELECTION screen that is empty, or by selecting an existing program and pressing '2' to edit the program. The edit screen can also be accessed by selecting "EDIT THE PROGRAM" in the lower right-hand corner on the GRAPH Screen (Figure 3-26). NOTE: When the EDIT selection is made from the GRAPH Screen, corrections or changes are made to the active program. These changes are not saved to the cure library and are discarded after the cure is completed. When a program is edited from the cure library or when a program is entered into an empty position in the table, the entries or edits become a permanent part of the cure library and are saved to memory for future use.

The EDIT PROGRAM screen allows the user to enter or change the program name, the ramp rate for a particular step, the dwell temperature and time, the vacuum alarm trigger level, and the temperature deviation alarm settings. Program steps with a zero will be skipped. Alarms with a zero will be disabled.

- a. Use the cursor keys to navigate through the screen as required and the number keys to enter data in the desired fields.
- b. When entry is complete, cursor to the SAVE prompt and press "ENT". After saving the program, the user will be returned to the PROGRAM SELECTION screen.
- c. If the program is to be RUN, select the program again and press '1' to RUN the program.
- d. The complete program can also be deleted by pressing '3' to DELETE the program.
- e. If no further action is desired, press "ESC" to return to the Main Menu.

EDIT PROGRAM		3
NAME:	BMS5-129-250F	
RAMP 1 RATE:	5 F / Min	
DWELL 1 TEMP:	200 F	
DWELL 1 TIME:	30 Min	
RAMP 2 RATE:	5 F / Min	
DWELL 2 TEMP:	250 F	
DWELL 2 TIME:	60 Min	
RAMP 3 RATE:	5 F / Min	
END TEMP:	120 F	
LOW VACUUM ALARM:	22 In / Hg	
RAMP HIGH LIMIT (+ / - DEV):	20 F	
RAMP LOW LIMIT (+ / - DEVI):	20 F	
DWELL HIGH LIMIT (+ / - DEV):	20 F	
DWELL LOW LIMIT (+ / - DEV):	20 F	
SAVE		
USE ↑ ↓ AND NUMBER KEYS TO ENTER DATA TO SAVE PROGRAM, SELECT AND PRESS ENT PRESS ESC TO CANCEL AND RETURN TO PREVIOUS SCREEN		

Figure 3-22. Edit Program Screen

3.4.4.2 RUN PROGRAM SCREEN

To access the RUN PROGRAM Screen (Figure 3-23), press "1" from the MAIN MENU AND STATUS MONITOR Screen. Select the desired program to be RUN by entering the program number, or selecting the program with the cursor and pressing "ENT". Press 1 to RUN the program.

At the top of the RUN PROGRAM screen the following data input selections are available:

1. Zone selection. (HCS9200B Only) This is where the zone is selected on which the cure will be run. The operator may enter 1 for zone 1, 2 for zone 2, 3 for slave mode, or 4 for 20 TC mode. Press "ENT" to move the cursor to the next selection. See Section 3.7 for more detail on SLAVE MODE and 20 TC MODE.
2. Part #: This field allows the operator to enter up to 14 alpha-numeric characters for the Part Number of the part being cured. Press "ENT" to move the cursor to the next selection.
3. Serial #: This field allows the operator to enter up to 14 alpha-numeric characters for the Serial Number of the part being cured. It can also be used to record a tracking number, work order number, etc. Press "ENT" to move the cursor to the next selection.
4. Operator ID: This field provides data space for recording the Operator or Technician who is performing the cure/repair up to 14 alpha-numeric characters.

The chart in the middle of the screen displays the program parameters for verification before running the program. Below the program parameters are the alarm settings for temperature and vacuum. Alarms that are set to zero will be marked "OFF" in red text. Upon pressing "ENT" key at the Operator ID selection, the cursor moves over the RUN selection. To run the program press "ENT" key and the GRAPH Screen (Figure 3-27) is displayed.

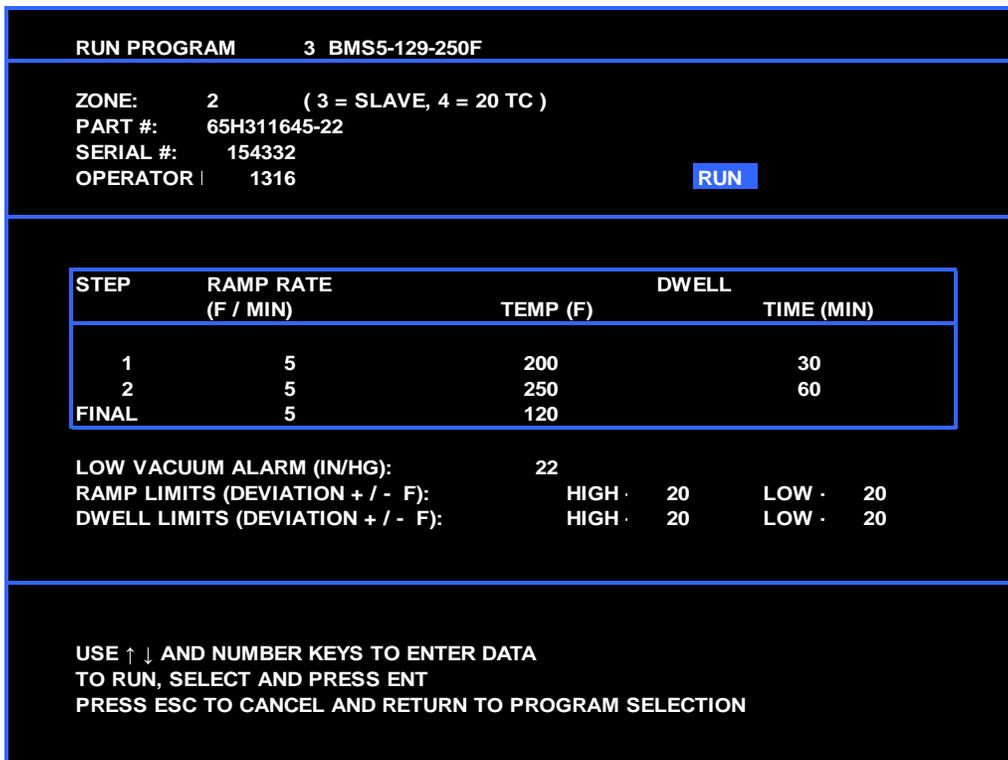


Figure 3-23. Run Program Screen

3.4.4.3 8 STEP CURE CONFIGURATION

EDIT PROGRAM 3

NAME: BMS5-129-250F

STEP	RAMP RATE (F / MIN)	TEMP (F)	DWELL TIME (MIN)
1	5	200	30
2	5	250	60
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
7	0	0	0
8	0	0	0
FINAL	5	120	

LOW VACUUM ALARM: 22 In / Hg
RAMP HIGH LIMIT (+ / - DEV): 20 F
RAMP LOW LIMIT (+ / - DEV): 20 F
DWELL HIGH LIMIT (+ / - DEV): 20 F
DWELL LOW LIMIT (+ / - DEV): 20 F

SAVE

FOR ALPHA ENTRY, PRESS ← → AND
NUMBER KEYS TO SELECT CHARACTERS
TO SAVE, SELECT AND PRESS ENT
PRESS ESC TO CANCEL

1 - / .	2 ABC	3 DEF
4 GHI	5 JKL	6 MNO
7 PQRS	8 TUV	9 WXYZ
<- DEL	0	-> SPACE

Figure 3-24. Edit Program Screen (8-Step)

Hot Bonders configured for multi-step programs will have a different interface for editing programs (Figure 3-24). Each step is selected from a list by highlighting with the cursor and pressing “ENT”. A popup menu (Figure 3-25) will allow entry of the Ramp Rate, Dwell Temperature and Dwell Time for that step. Press “ENT” to save the step, or “ESC” to abort step entry.

EDIT CURE STEP

RAMP 1 RATE:	5	F / MIN
DWELL 1 TEMP:	200	F
DWELL 1 TIME:	30	MIN

USE NUMBER KEYS TO ENTER DATA

PRESS ENT TO CONFIRM
PRESS ESC TO CANCEL

Figure 3-25. Edit Cure Step Popup (8-Step)

3.4.5 GRAPH SCREEN

The GRAPH SCREEN (Figure 3-26) presents a graphic representation of the cure. The GRAPH SCREEN is accessed from the MAIN MENU & STATUS MONITOR SCREEN by pressing "3" to view the Zone 1 Graph or "4" to view the Zone 2. The vertical ("Y") axis of the graph represents temperature and the horizontal ("X") axis represents time. The graph line of the profile as programmed in memory is displayed in "green" at the start of the cure.

As the cure progresses, the actual temperature sensed by the TCs will be drawn on top of the original graph as a "yellow" line. The actual graph should follow the programmed graph very closely, if the heat blanket(s) is/are sized correctly to the repair in process. Use of a heat blanket that provides insufficient wattage for the heat load required will cause the actual cure to lag behind the programmed profile.

If the cure program is changed during the execution of a cure, a revised theoretical graph is drawn based on the new program parameters. Depending on which steps are modified, the actual graph trace may not trace over the new theoretical graph, due to a time displacement caused by changing a step that has already executed or is in process.

The GRAPH SCREEN contains the following information:

- a. Program Number and Title
- b. Serial Number
- c. Operator ID – (Employee No., Badge No., Initials, Etc.)
- d. Ramp Rate.
- e. Setpoint.
- f. Actual – Temperature of the controlling TC(s).
- g. Total Time - Time to run the cure in progress.
- h. Time Left - Time remaining in the cure program.
- i. Step Time - Time remaining in the step in progress.
- j. Lower right side of the screen displays:
 - HOLD THE PROGRAM: Stops the program clock and holds the cure at current setpoint. Selecting RESUME THE PROGRAM releases the hold.
 - START/STOP THE PROGRAM: Starts and Stops the program. After selection, the cursor will begin to blink indicating that the system is ready to Start or Stop. Selecting once more will initiate action. Dual action is required to prevent accidental Start or Stop of a program.
 - PRINT A STATUS LINE / REPRINT THE CURE: While a program is running, selecting PRINT A STATUS LINE will send current status to the printer, if it is enabled. This also stores a status line in the cure log file for future reference. This does not affect the automatic print interval set in the Printer Options menu. While a program is not running, selecting REPRINT THE CURE will reprint the entire report of the previous cure.
 - EDIT THE PROGRAM: Accesses the EDIT PROGRAM screen to allow the operator to make changes to the active program parameters. These changes only affect the current cure, and are not stored to the cure library. Changes to the program can be made prior to starting the cure, or while the cure is running.

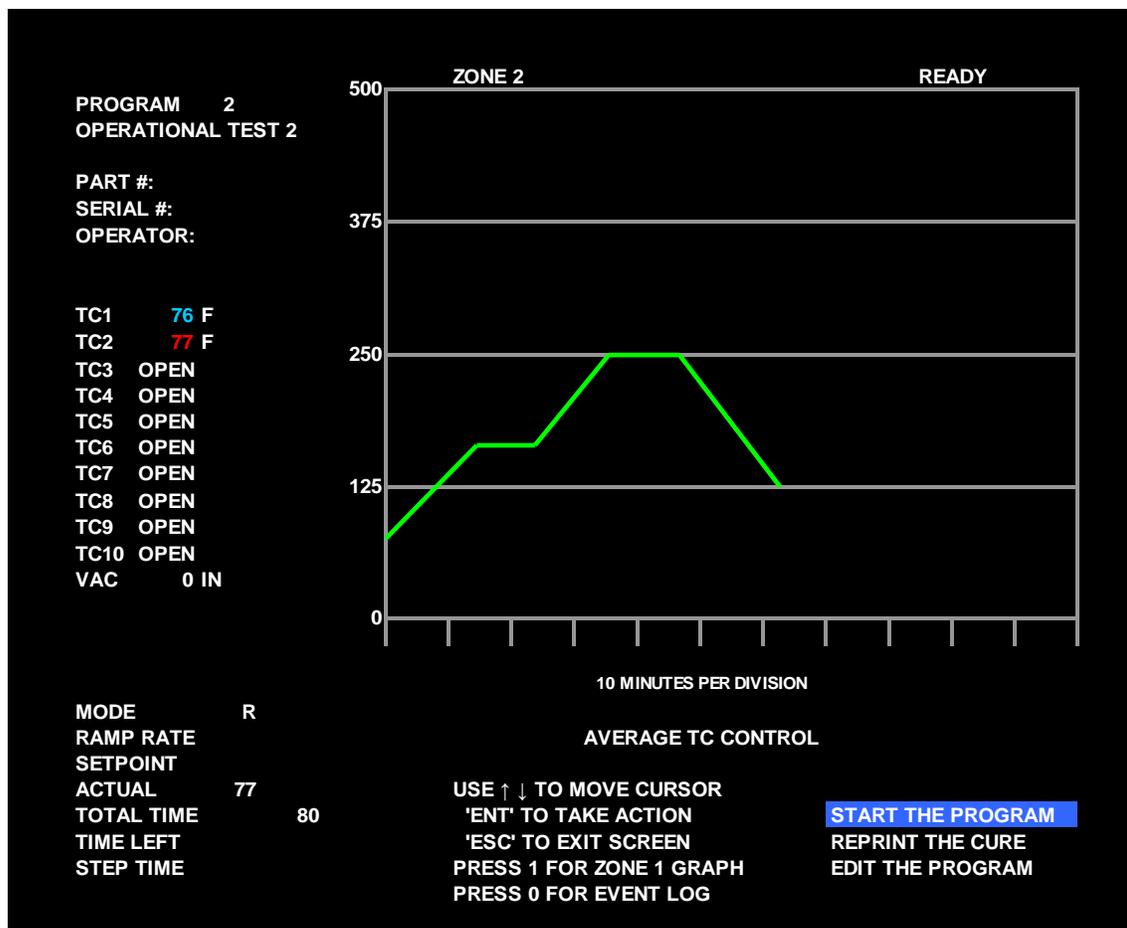


Figure 3-26. Graph Screen

3.4.6 PRECURE OPERATIONAL TEST

The PRECURE OPERATIONAL TEST Screen (Figure 3-27) is displayed initially when a cure is started. The HCS9000B/HCS9200B series Hot Bonders perform a pre-cure test of the composite layup and the controller system at the initial start of the cure cycle. This test allows the operator to receive preliminary verification that the system is functional and working properly at the beginning of the cure process. The test will identify TCs that are wired backward (reversed polarity), TCs that are not located properly under the blanket and within the heated area, a disconnected blanket, open lead wire, open power output circuit breaker, or a faulty power control relay. These tests are a function of the monitored output current flow and the temperature response inside the lay-up. The test checks the electrical circuit to the heater blanket to make sure the circuit is complete. A power output test and temperature rise test checks for TC response to the heat blanket heat up. If either test fails, the operator has the option of aborting the cure to correct the problem or continuing the cure in spite of the test failure. Alarms detected during this test are described in Alarms paragraph 3.7. The sequence of events is described below:

- The operator starts the cure from the GRAPH SCREEN, by placing the flashing menu bar over "START THE PROGRAM" and pressing the "ENT" key.
- The bonder checks all parameters of the program against startup conditions; then the bonder applies output power to the load for 4 seconds. During the power-on time, the unit monitors the output current flow.
- If no power output is sensed during the test, the bonder will indicate that the Power Output Test has failed on the display screen and an audible alarm will sound. If the Power Output Test passes, the system will proceed with the TC Rise Test.

d. The 4-second power application should produce a heat rise in the cure lay-up. The connected TC readings are monitored to detect any heat rise. The system allows 14 seconds for all of the TC readings to rise at least 2 °F. If any one TC drops in temperature, does not rise, or rises less than 2 °F, the bonder will indicate that the TC Rise Test has failed on the display screen and an audible alarm will sound. In addition to the indications listed above, an arrow will be displayed for each individual TC on the GRAPH Screen. This arrow indicates the status of each TC: a down arrow (↓) indicates a reversed polarity TC, a horizontal or flat arrow (←→) indicates that the TC temperature has not changed and an up arrow (↑) indicates that the TC temperature has risen by at least 2 °F and the sensor is functioning correctly.

Should either test fail, the alarm can be silenced by pressing “ENT” to allow the operator to make a decision on whether to stop or continue the cure. The cure can be aborted by pressing the “ESC” key. This allows the operator to stop the program rectify the problem and then restart the cure. The operator may choose to continue the cure without stopping by pressing the “1” key. If the precure layup test is completed successfully, the cure will automatically continue and proceed as programmed. This does not mean that there will be no further problems or alarms, but does indicate that the process started correctly.

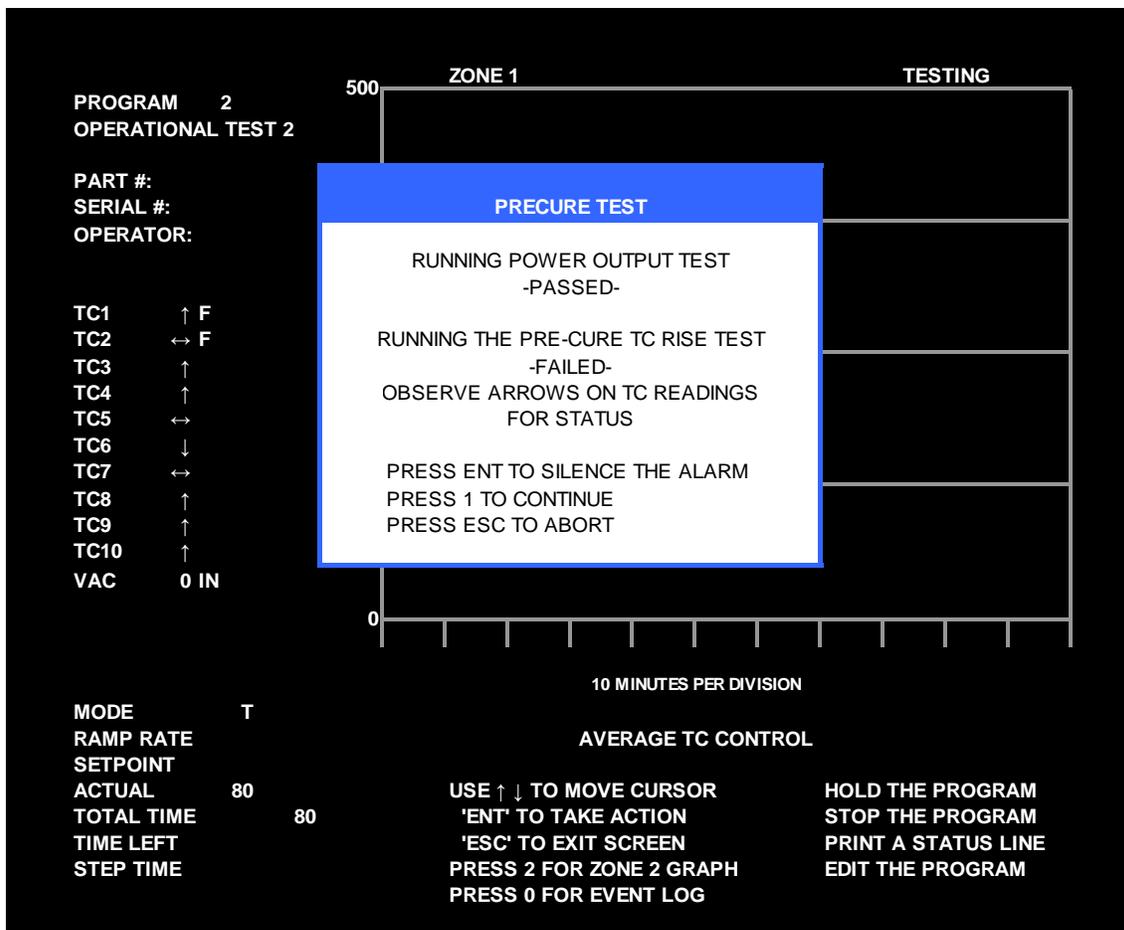


Figure 3-27. Precure Operational Test Screen

3.5 CHANGING AN ACTIVE PROGRAM

When a program is selected from the library and executed, a temporary working copy of that program is stored in memory. When changes are made to the active program by selecting EDIT THE PROGRAM on the graph screen, these changes affect only the cure in progress and not the original stored program. When the program is completed or is terminated, the changes are discarded. If permanent changes to the program are desired, access the Program Library, select a program and press 2 for EDIT. These changes will be stored to the program library, and will not affect any currently running programs. To change an active program:

- a. On the GRAPH SCREEN, move the lower right cursor bar over the EDIT THE PROGRAM selection and press "ENT" to access the EDIT PROGRAM Screen (Figure 3-23). The cursor highlight bar will be in position over the first step of the program.
- b. Use the up (↑) or down (↓) arrows to position the cursor on any steps or parameters requiring edit. Enter the new parameters and settings with the numeric keys. Use the "ENT" to confirm the entry.
- c. Once the desired changes have been entered, continue to press the down (↓) arrow key to move the cursor to the RUN selection at the bottom of the screen. Press the "ENT" key. The temporary change will be made, and the display will automatically return to the GRAPH SCREEN.

3.6.1 SLAVE MODE

The purpose of Slaved operation (Figure 3-28) is to allow both Zone 1 and Zone 2 to operate one cure program on both zones at the same time. By operating the two zones in the slaved mode, larger areas can be cured. Two or more heat blankets can be operated at the same time using the same cure profile.



ENSURE THAT THE THERMOCOUPLES CONNECTED TO ONE ZONE ARE NOT PLACED ON THE HEAT BLANKET OR BLANKET ZONE CONNECTED TO THE OTHER ZONE ON THE BONDER. THIS WILL RESULT IN UNSTABLE PID CONTROL

To operate the unit in slave mode, Zone 3 must be selected on the RUN PROGRAM SCREEN (Figure 3-24). When Zone 3 is entered, both Zone 1 and Zone 2 are controlled by the same program. When operating in Slave Mode, the TCs in each zone control only the blanket connected to that zone. Each zone retains a separate control identity, while maintaining a common setpoint. For example, if highest TC control is selected, the TCs connected to each zone will be scanned and the hottest TC will become the control TC, for that particular zone. The same is true for average control mode, where each zone will control to its own average temperature of the connected TCs on that zone. Both vacuum sensors must be connected to the repair area in this configuration. The vacuum sensor readings are printed in separate lines on the paper tape.

The graphic display will be presented on the Zone 1 GRAPH SCREEN (Figure 3-28), by selection "3" at the MAIN MENU AND STATUS MONITOR SCREEN. All 20 TCs will be listed on the left side of the screen. The graph will display a composite of temperature data from both zones. The paper tape printout will be from the Zone 1 printer, but will reflect conditions in both zones. The "Print All TCs" mode will print one block of TCs, numbers 1 through 20. The data exported from Slave Mode cures will be listed as a single cure on the DATA EXPORT and REPRINT CURE screens, but the data will be exported as separate files. HEATCON Data Capture and Analysis Software will display the two zones as separate sets of cure data.

3.6.2 20 TC MODE

The purpose of 20 TC operation is to allow Zone 1 to operate one cure program using all TCs from both zones. A single output is used (zone 1), but all available thermocouples are applied to a single zone cure. This is used in situations where only a single zone of control is needed, but more than 10 Thermocouples are required. To operate the unit in 20 TC mode, Zone 4 must be selected on the RUN PROGRAM SCREEN (Figure 3-24). Zone 2 is disabled, and all thermocouples are applied to zone 1. For example, if highest TC control is selected, the TCs connected to each zone will be scanned and the hottest TC of all 20 sensors will become the control TC for the entire repair area. The same is true for average control mode, where the average will be taken of all 20 sensors. Only the Zone 1 vacuum sensor must be connected to the repair area in this configuration; the Zone 2 vacuum sensor is disabled.

The graphic display will be presented on the Zone 1 GRAPH SCREEN (Figure 3-28), by selection “3” at the MAIN MENU AND STATUS MONITOR SCREEN. All 20 TCs will be listed on the left side of the screen. The graph will display a composite of temperature data from all sensors, depending on the control mode selected. The paper tape printout will be from the Zone 1 printer, but will reflect conditions for all sensors. The “Print All TCs” mode will print one block of TCs, numbers 1 through 20. The data exported from 20 TC cures will be listed as a single cure on the DATA EXPORT and REPRINT CURE screens, but the data will be exported as separate files. HEATCON Data Capture and Analysis Software will display the two zones as separate sets of cure data.

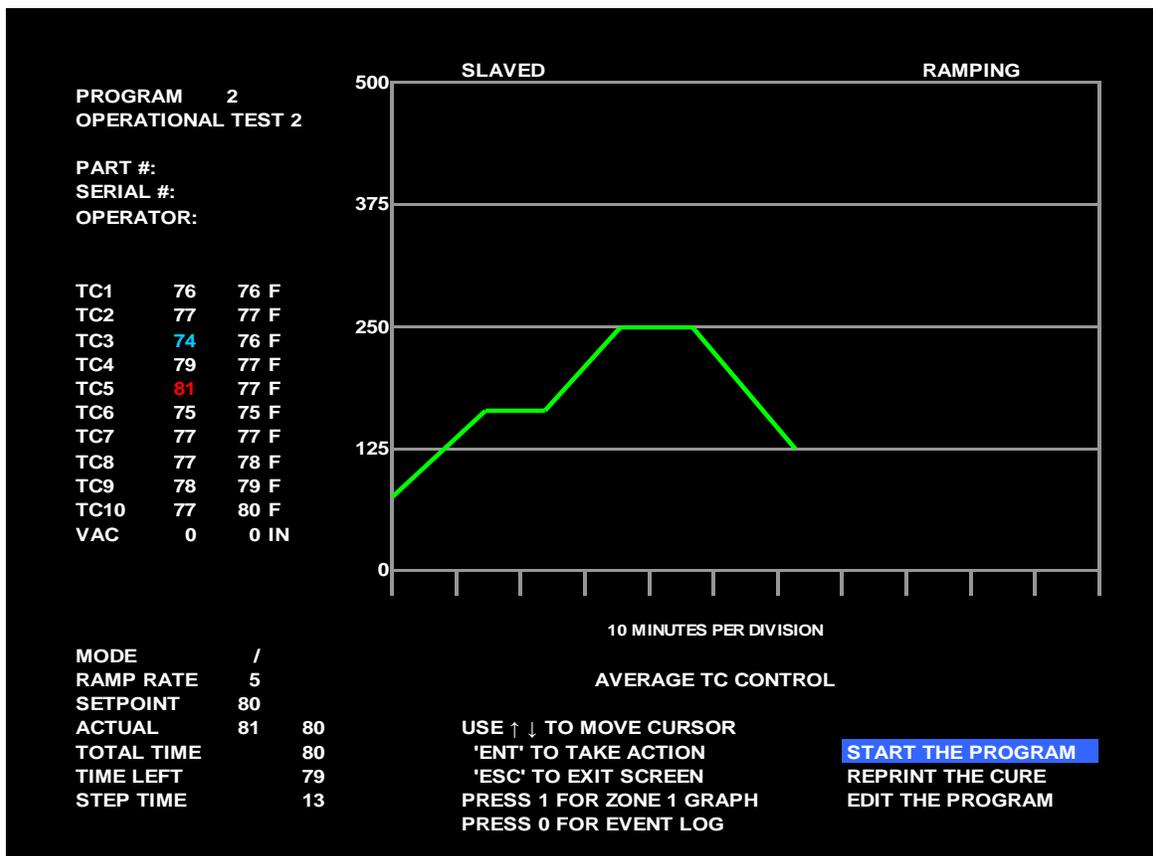


Figure 3-28. Slave Mode Graph Screen

3.7 ALARMS

The HCS9000B/HCS9200B has installed in the faceplate an adjustable volume, audible alarm. The alarm provides an audible indication that something in the cure process is outside of parameters established in the programmed cure. The alarm parameters are set up as deviation alarms, not absolute alarms.

Conditions that can cause an alarm are; over temperature, under temperature, and low vacuum. These alarm conditions are established in the cure profile when the operator programs the cure. The programmable deviations range from $\pm 1-99$ °F. Alarms set to zero degrees are disarmed. During the cure process, all connected TCs are continuously monitored and compared to the current control setpoint. If any TC deviates from the controlling setpoint by more than the programmed deviation setting, the unit will activate an alarm and the alarm condition will be displayed in a pop-up alarm widow.

Separate alarm settings are available for dwell (soak) segments and ramp segments. If necessary, alarm parameters can be changed during execution of the cure by accessing the EDIT PROGRAM SCREEN and changing the set parameters. Any changes made to an active program will be printed out with a "Program Change" message and the new parameters.

An alarm is silenced from the Alarm Popup window (Figure 3-29) by pressing the "ENT" key. The alarm will be silenced, but the condition that caused the alarm must be corrected before the program will continue. The program is placed on hold until the condition is corrected, or the program parameters are changed to accept the deviation. If the condition is corrected the unit will automatically continue the program.

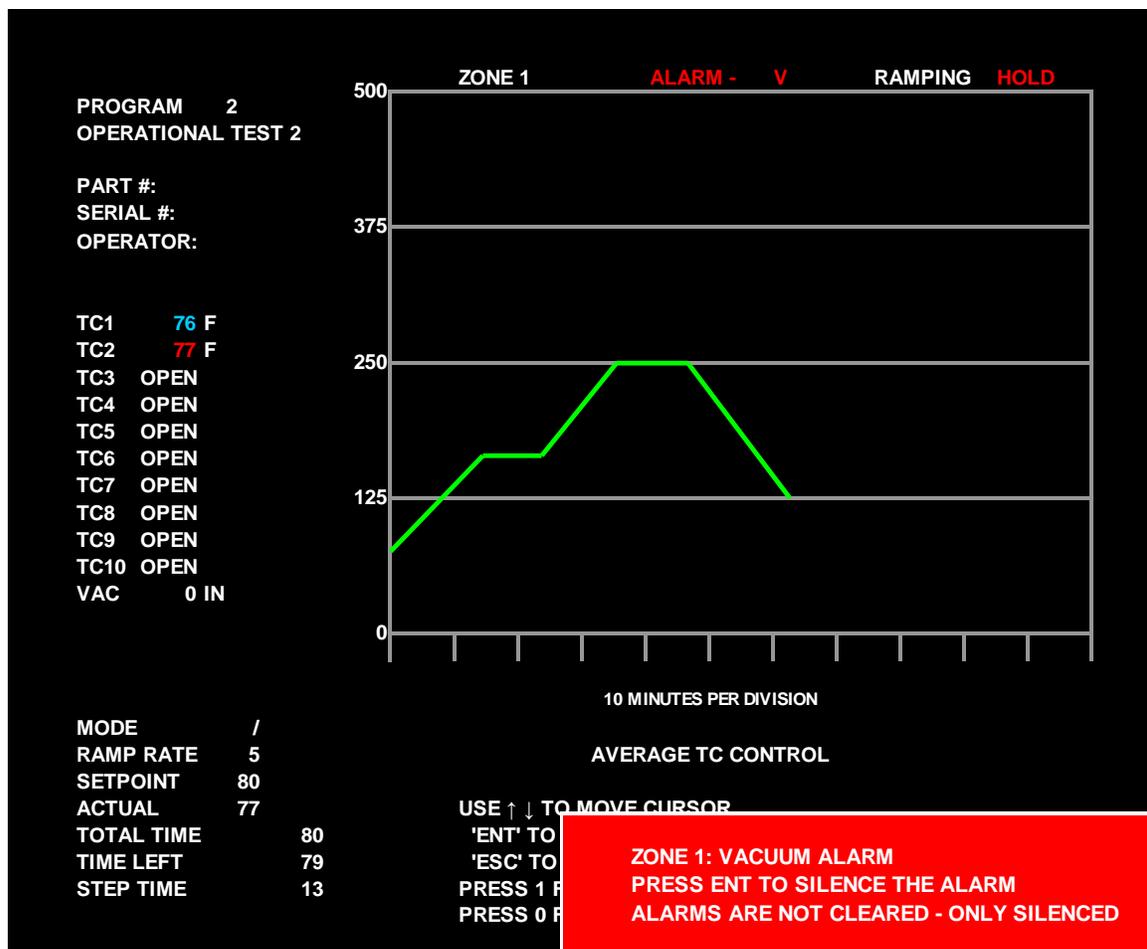


Figure 3-29. Alarms Popup Window

When an alarm condition is encountered, a popup window is presented in the lower right-hand corner of the currently displayed screen. This popup window displays the alarm condition and states how to silence the alarm, and also contains a warning that the condition is not corrected when the alarm is silenced. The box and text are displayed in red. Warnings are displayed in yellow. The possible popup alarm windows include:

Table 3-3. Alarms Popup Windows

No TCs Installed –

**ZONE 1: NO SENSORS
PRESS ENT TO SILENCE THE ALARM
ALARMS ARE NOT CLEARED - ONLY SILENCED**

Low Vacuum Fault –

**ZONE 1: VACUUM ALARM
PRESS ENT TO SILENCE THE ALARM
ALARMS ARE NOT CLEARED - ONLY SILENCED**

High Temperature Fault –

**ZONE 1: TC 10 H 400 F
PRESS ENT TO SILENCE THE ALARM
ALARMS ARE NOT CLEARED - ONLY SILENCED**

Low Temperature Fault –

**ZONE 1: TC 10 L 100 F
PRESS ENT TO SILENCE THE ALARM
ALARMS ARE NOT CLEARED - ONLY SILENCED**

Max Output Power Warning –

**ZONE 1: MAX OUTPUT POWER ALARM
PRESS 1 TO DISABLE THE MAX POWER ALARM
PRESS 2 TO SILENCE THE ALARM**

Max Output Power Alarm –

**ZONE 1: MAX OUTPUT POWER ALARM
PRESS 1 TO DISABLE THE MAX POWER ALARM
PRESS 2 TO CLEAR ALARM AND CONTINUE
PRESS 3 TO STOP THE CURE**

No Output Power Detected –

**ZONE 1: NO OUTPUT POWER DETECTED
CHECK ELECTRICAL CONNECTIONS
PRESS 2 TO CLEAR ALARM AND CONTINUE
PRESS 3 TO STOP THE CURE**

Failed Power Output Test –

PRECURE TEST

RUNNING POWER OUTPUT TEST
-FAILED-

PRESS ENT TO SILENCE THE ALARM
PRESS 1 TO CONTINUE
PRESS ESC TO ABORT

Failed TC Rise Test –

PRECURE TEST

RUNNING POWER OUTPUT TEST
-PASSED-

RUNNING THE PRE-CURE TC RISE TEST
-FAILED-
OBSERVE ARROWS ON TC READINGS
FOR STATUS

PRESS ENT TO SILENCE THE ALARM
PRESS 1 TO CONTINUE
PRESS ESC TO ABORT

3.7.1 MAX OUTPUT POWER WARNING & ALARM

The Maximum Output Power Warning (Figure 3-30) is displayed if the actual temperature falls below the setpoint temperature and the power output to the load fails to raise the temperature to the setpoint. If the bonder sends output power to the load at 90% duty cycle or greater for 60 seconds and a rise in temperature of at least 1 °F is not detected, the “MAX OUTPUT POWER” warning will be activated.

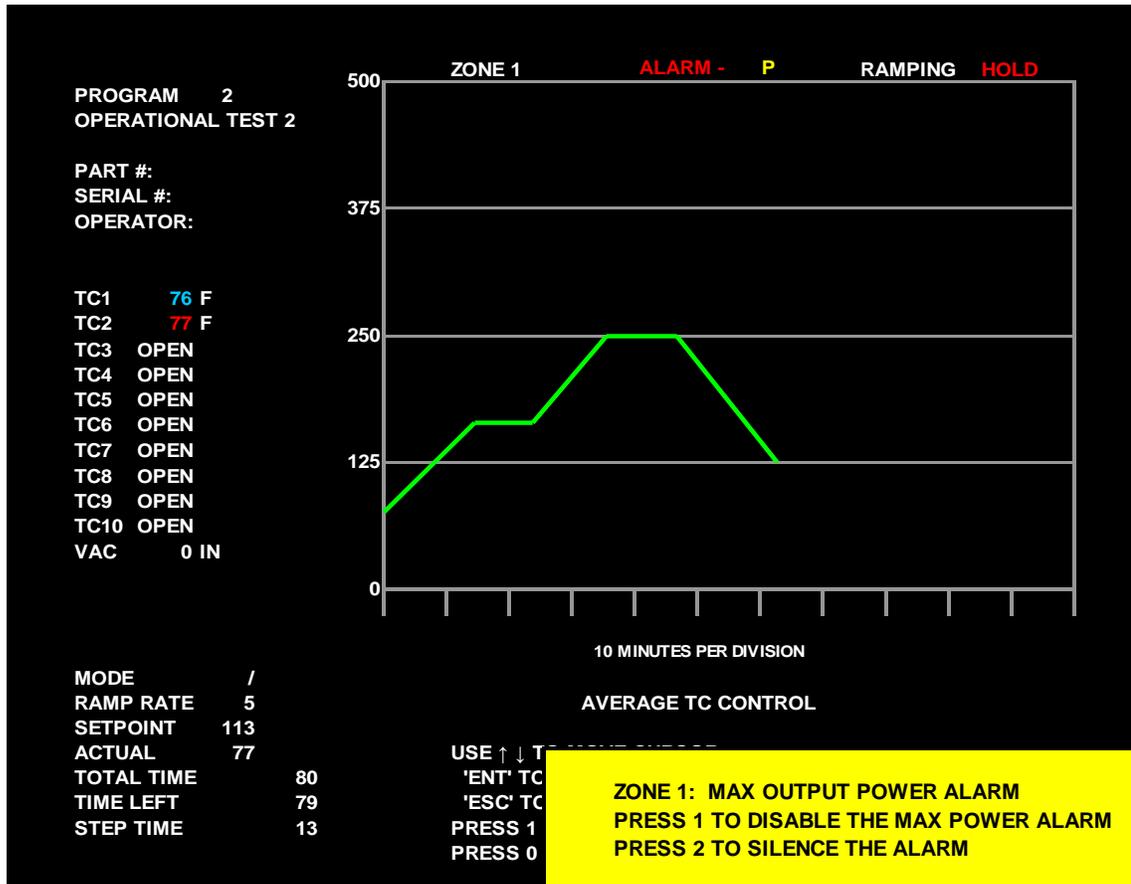


Figure 3-30. Max Output Power Warning Popup Window

The MAX OUTPUT POWER Warning is a popup window is a “Warning” and is not an “Alarm” at this time (the popup box is yellow, not red.). This does not stop output to the blanket, but does place a hold on the program until the operator responds. It gives the user a warning that if corrective action is not taken, the “MAX OUTPUT POWER ALARM” will be triggered. At the warning stage, the user can chose to disable the MAX POWER ALARM, or silence the alarm. If the alarm is disabled, it is only disabled for the current running cure. It does not affect the alarm settings, or the alarm for the other zone.

The MAX OUTPUT POWER ALARM (Figure 3-31) is displayed after an MAX OUTPUT POWER WARNING popup window has occurred (whether it has been silenced or not). The bonder will continue to send output power to the heater for another 30 seconds after the warning. If a rise in temperature of at least 2 °F is not detected within 30 seconds, the MAX OUTPUT POWER ALARM will be displayed. This alarm puts a HOLD on the program and stops all output to the heater.

The user may disable the MAX POWER ALARM and continue, clear the alarm and continue, or stop the cure. If the user disables the alarm, a recovery ramp is initiated to restore the temperature to setpoint at a controlled ramp rate. The alarm is disabled for the duration of the cure, for the current zone only.

WARNING

DISABLING THE MAX POWER ALARM WILL ALLOW THE BONDER TO APPLY OUTPUT TO THE LOAD WITHOUT MONITORING. THIS COULD RESULT IN AN OVERHEAT CONDITION IF THE SENSORS ARE IMPROPERLY PLACED ON THE REPAIR.

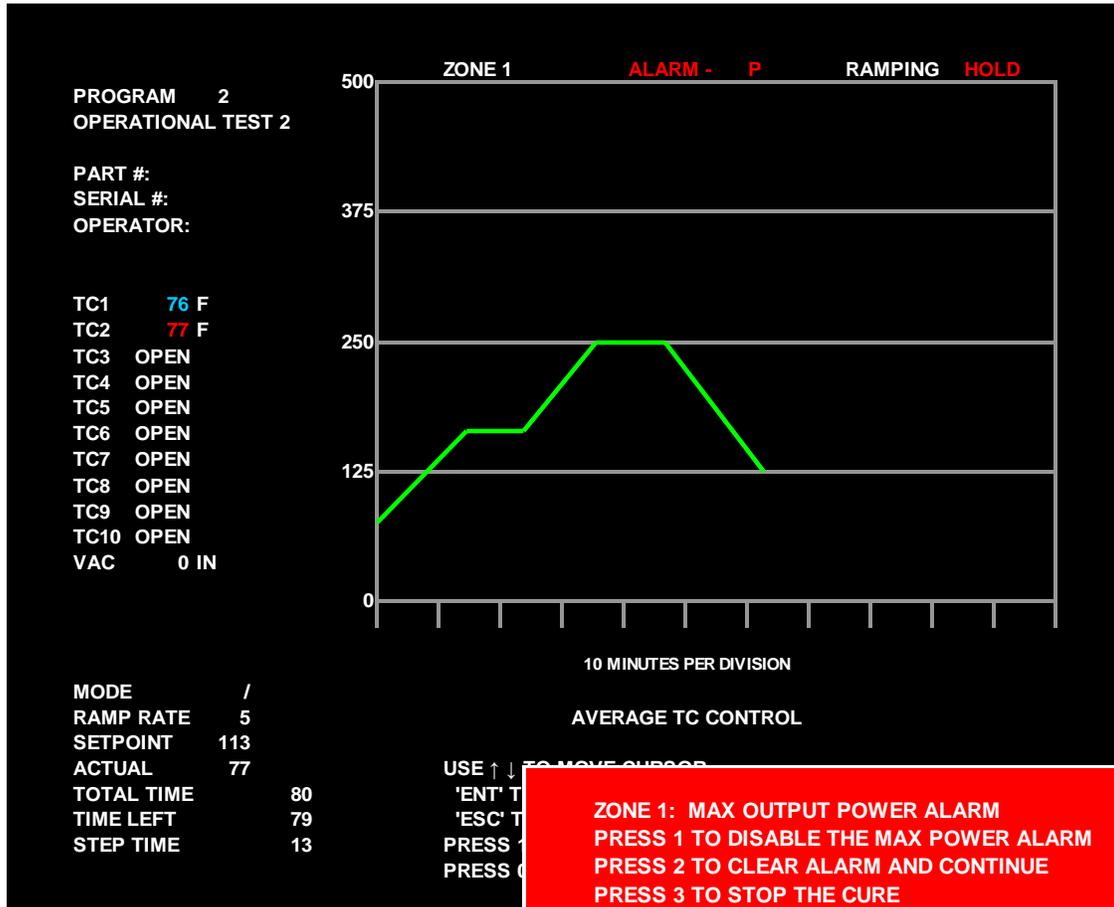


Figure 3-31. Max Output Power Alarm Popup Window

If the user clears and continues the alarm, a recovery ramp is initiated to restore the temperature to the setpoint temperature at a controlled ramp rate. The alarm will still be enabled and can be triggered again.

If the Max Power Alarm is triggered by a drop in actual temperature and no output current is detected, the NO OUTPUT POWER DETECTED alarm is displayed (Figure 3-32). This alarm assumes that output power to the load has been interrupted due to a tripped circuit breaker, unplugged cable, or broken wire. Once the condition causing the loss of power is cleared, the alarm can be cleared and the program will continue. A recovery ramp is initiated to restore the temperature to setpoint at a controlled ramp rate



Figure 3-32. No Output Power Alarm Popup Window

3.7.2 EVENT LOG

The EVENT LOG Screen (Figure 3-33) can be accessed by pressing '0' from the Graph Screen. The Event Log shows all events that occur during a cure beginning from the start of the cure (Time 00:00:00). The timestamp for each event indicates the time from the start of the program. The Event Log can be accessed while the cure is running, or after the cure is completed. Only the current or most recent cure can be viewed on the log screen; once another program has started the previous program cannot be viewed. However, all log data is retained for USB Export and Printing. Program Transitions (Ramp to Dwell, etc.) are displayed in WHITE text. Low Temperature and Vacuum Alarms are displayed in BLUE text. High Temperature alarms and all other alarms are displayed in RED text. Alarm Clears and Positive Test Results are displayed in GREEN text. Changes to the program are displayed in YELLOW text.

Depending on the length of the cure and the number of events, the Event Log may require more than one page to display all of the log data. The initial page will load the most recent cure event (at the top of the list) and then display events in reverse order to the start of the cure. Additional pages may be viewed by scrolling with the up and down keys. Very Long cures may require additional time to load the Event Log, and may display a flashing "Loading – Please Wait" message at the bottom right corner of the page. The Event Log will not refresh in real-time while being viewed. If an event occurs while the screen is being viewed, new events will not be displayed until the next time the screen is accessed. When an alarm occurs during a cure, an orange flag will appear on the Main Menu and Status Monitor Screen and the Graph Screen displaying either a "1" or a "2" to indicate that a log entry has been made that should be reviewed by the operator. The flag is cleared once the log screen is accessed.

EVENT LOG GROUP 1		PROGRAM 12 HEAT MAP 350F		START DATE : 04 NOV 13	
				START TIME : 0 : 47 : 11	
00 : 17 : 11	COMPLETE	S P =	125	TEMP =	127 VAC = 26
00 : 15 : 00	DOWN RAMP	S P =	150	TEMP =	147 VAC = 26
00 : 11 : 46	DWELLING	S P =	150	ALL ALARMS CLEAR	
00 : 11 : 46	DWELLING	S P =	150	TC 10 ALARMS CLEAR	
00 : 11 : 44	DWELLING	S P =	150	TC 10 LOW 106	
00 : 09 : 42	DWELLING	S P =	150	ALL ALARMS CLEAR	
00 : 09 : 42	DWELLING	S P =	150	TC 10 ALARMS CLEAR	
00 : 09 : 40	DWELLING	S P =	150	TC 10 HI 408	
00 : 07 : 06	DWELLING	S P =	150	TEMP =	156 VAC = 26
00 : 07 : 06	RECOVERY COMPLETE				
00 : 06 : 20	RECOVER	S P =	135	TEMP =	134 VAC = 26
00 : 06 : 19	POWER RESTORED - CURE RESUMED 09 : 48 : 41				
00 : 06 : 19	POWER LOSS				
00 : 04 : 20	DWELLING	S P =	150	TEMP =	146 VAC = 26
00 : 00 : 07	UP RAMP	S P =	66	ALL ALARMS CLEAR	
00 : 00 : 07	UP RAMP	S P =	66	VACUUM ALARM CLEAR	
00 : 00 : 00	UP RAMP	S P =	66	VACUUM ALARM 0	
00 : 00 : 00	UP RAMP	S P =	66	TEMP =	65 VAC = 0
00 : 00 : 00	CURE START	PRE-CURE TEST PASSED			

PRESS ESC TO EXIT EVENT LOG
PRESS UP TO PAGE ↑ , ↓ TO PAGE DOWN

Figure 3-33. Event Log Screen

3.8 Data Logging Mode

DATA LOGGING MODE allows recording of thermocouple and vacuum data without running a cure. Thermocouple and Vacuum data is recorded for display, data export and graphing just as it would be during a normal cure. Data Logging can be used to monitor another process, or can be used in conjunction with other hot bonders to record additional cure data. In a dual zone machine, one zone can be set to Log Data to supplement a cure running on the other zone.

Data Logging can be accessed by Pressing '1' from the Main Menu & Status Monitor Screen, then scrolling over to the right and selecting "LOG DATA" rather than entering a program number. A popup will appear on the screen. Press '1' to log data on zone 1, '2' to log data on zone 2, and '3' to log data on both zones (slave). The system will then display the Log Data Parameters Screen (Figure 3-34). At the top of the LOG DATA PARAMETERS screen the following data input selections are available:

1. Part #: This field allows the operator to enter up to 14 alpha-numeric characters for the Part Number of the part being monitored.
2. Serial #: This field allows the operator to enter up to 14 alpha-numeric characters for the Serial Number of the part being monitored. It can also be used to record a tracking number, work order number, etc.
3. Operator ID: This field provides data space for recording the Operator or Technician who is operating the Data Logger, up to 14 alpha-numeric characters.
4. Name: This field allows the operator to enter up to 20 alpha-numeric characters for a Name for the Data Log. This name appears on the display, printouts, and data export files for tracking.
5. Logging Duration: The number of minutes that the Data Logger will run before terminating the log.
6. Alarms (Low Vacuum, High Temperature, and Low Temperature): Optional alarm parameters for logged data. Alarms will give a visual and audio indication that can be cleared by the user. Alarms are recorded with the data log for printing and data export. All Alarm values are absolute values, rather than deviations from setpoint that would be used during a normal cure.
7. Printer (On/Off): Selects whether the printer will be active and printing a live record during the data log. Printer settings are configured in the User Settings menu.

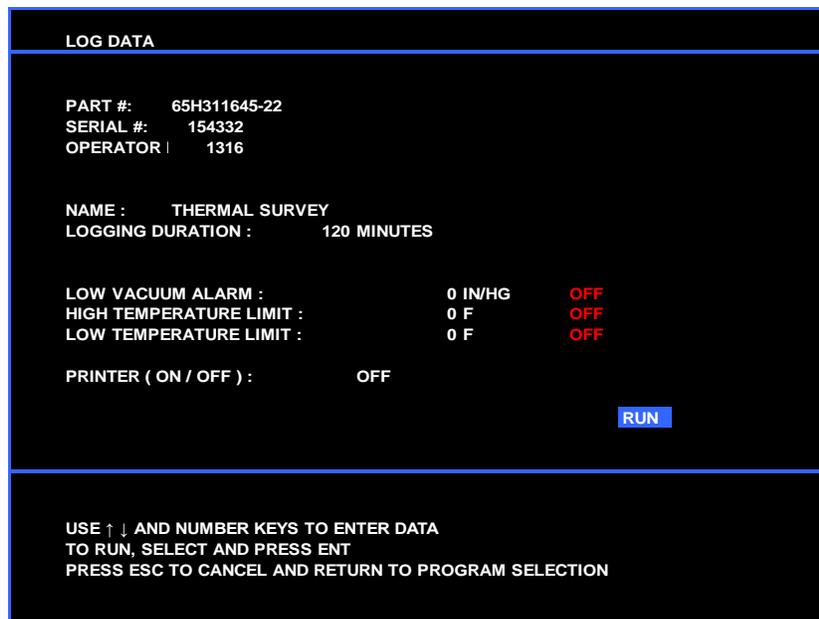


Figure 3-34. Log Data Parameters Screen

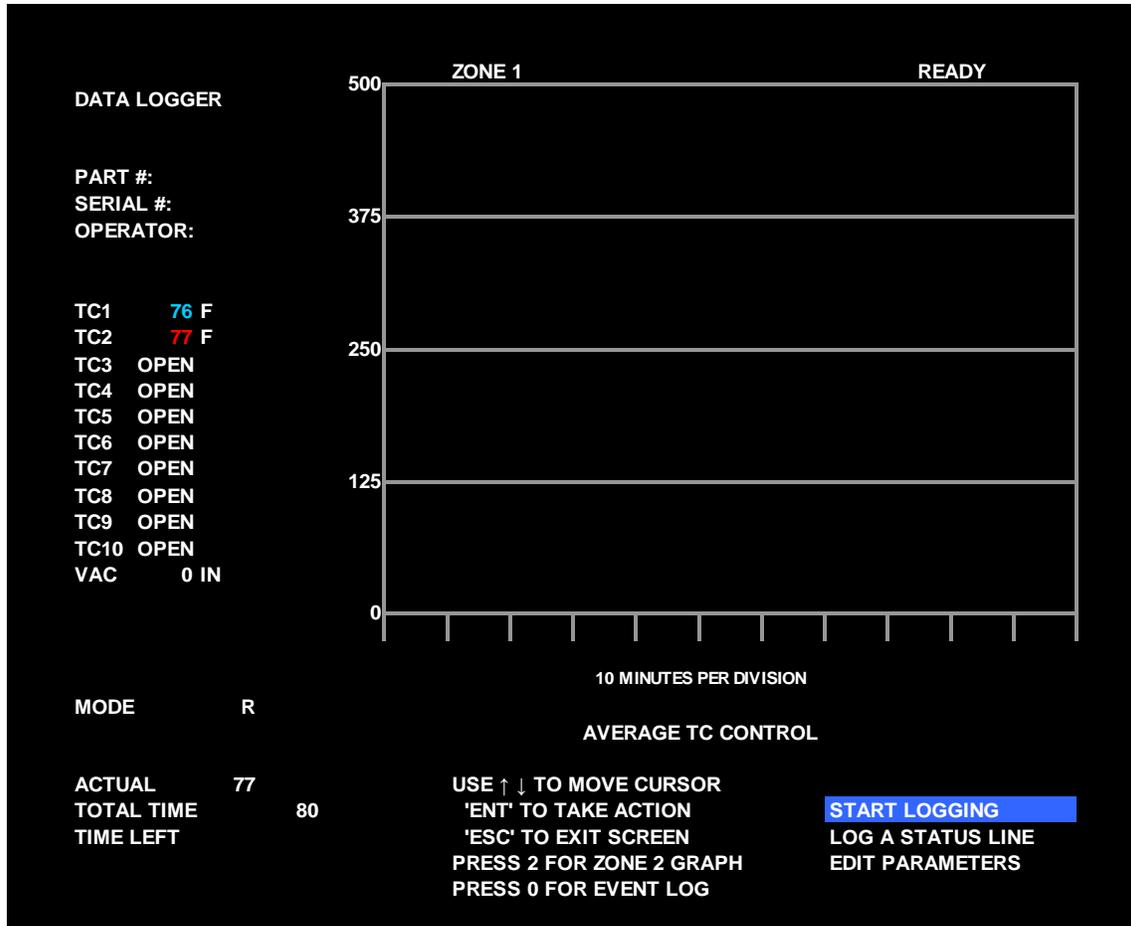


Figure 3-35. Data Logging Mode Graph Screen

After the Data Logging Parameters are entered, the graph screen is shown in Data Logging Mode (Figure 3-35). The graph screen is functionally the same as during a cure. All thermocouple and vacuum data is displayed, as well as actual temperature based on the control mode selected in User Settings. No setpoint data is shown and no green program graph is displayed, as there is no program to dictate these values. When logging both zones together, the display is similar to the display shown during a slave mode cure; all thermocouples and vacuum sensors are presented on one graph screen.

Logging is started and stopped in the same manner as starting and stopping a cure. Unlike a normal cure, Data Logging does not require that thermocouples be connected in order to start, although a warning will be presented to notify the user that no sensors are connected. No pre-cure layup test is done as there is no output required for logging. As data is logged, a yellow graph will be drawn on the graph screen to represent the logged temperature data.

Actual Time and Total time reflect the time configured in the Log Parameters. If Data Logging mode is used to monitor a process controlled by other equipment, it is suggested that additional time be considered for logging the process in order to account for program holds or alarm conditions. Unlike during a normal cure, alarm conditions will not place a hold on the countdown clock. The logging clock will continue to count down regardless of alarm conditions.

3.9 CURE DATA EXPORT

Cure data is exported via the USB port located on the back of the display screen bezel on the unit. A Solid State Flash Disk (SSD) is inserted into the USB port and the EXPORT CURE DATA TO USB FLASH DRIVE screen (Figure 3-36) is accessed by pressing the “5” key on the keypad from the MAIN MENU & STATUS MONITOR SCREEN. In order to fully utilize the Cure Data Extraction capabilities of the bonder data management system, HEATCON® Data Capture and Analysis Software must be installed on a Windows®-based computer.

The data extraction function exports data from the 12 most recent cures onto a USB Flash Drive via the USB port on the back of the screen bezel. Each bonder will create an individual directory on the flash drive based on its factory serial number, allowing multiple bonders to export to the same drive. Multiple exports onto the same drive from the same bonder will simply overwrite the same data again, and will not result in multiple copies of the same cure data. The bonder does not erase any data from the flash drive, so that the cure data can be archived indefinitely. It is recommended that a dedicated USB flash drive be used for this process, and that the data be backed up to another archive.

The zone and program name/number and displayed. To the far right of the screen, each cure is marked as either “NEW” or “EXPORTED.” “NEW” identifies a cure that has not yet been exported to a USB drive. “EXPORTED” identifies a cure that has previously been exported to a USB drive, but is still available to be exported again. The cure list is a First-In-First-Out (FIFO) system. When the 12 cures files are filled with data, the oldest data has to be erased to make room for the new information from the latest cure. In the user settings, the user can choose to be prompted when the files are full, as a reminder to export and back up all cure data. The user can also choose not to be prompted, in which case the oldest cure will automatically be erased to make room for new data. Data that has been overwritten cannot be recovered.

EXPORT DATA TO USB FLASH DRIVE				
DATE / TIME	ZONE	PROGRAM #	AND NAME	STATUS
19 MAY 11 09:22	1	2	EA9390-250F-120MIN	NEW
18 MAY 11 09:11	1	6	BMS5-201-250F-120MIN	NEW
17 MAY 11 08:22	1	5	BMS8-256-350F-90MIN	NEW
16 MAY 11 10:11	1	4	EA9396-250F-90MIN	NEW
16 MAY 11 09:44	1	3	EA9396-250F-120MIN	NEW
15 MAY 11 18:19	2	11	B757-SPOILER-250F	EXPORTED
14 MAY 11 09:10	2	12	B737-MLGDOOR-250F	EXPORTED
12 MAY 11 10:23	1	2	EA9390-250F-120MIN	EXPORTED
11 MAY 11 07:14	1	2	EA9390-250F-120MIN	EXPORTED
10 MAY 11 18:11	1	2	EA9390-250F-120MIN	EXPORTED
10 MAY 11 07:24	1	4	EA9390-250F-90MIN	EXPORTED
09 MAY 11 08:09	1	4	EA9390-250F-90MIN	EXPORTED

PRESS 1 TO EXPORT NEW COMPLETED CURE DATA
 PRESS 2 TO EXPORT ALL COMPLETED CURE DATA
 PRESS 3 TO EXPORT DATA FOR LAST CURE ON ZONE 1
 PRESS 4 TO EXPORT DATA FOR LAST CURE ON ZONE 2
 PRESS ESC TO EXIT EXPORT SCREEN

Figure 3-36. Export Data to USB Flash Drive Screen

CAUTION

DO NOT REMOVE THE FLASH DRIVE DURING THE EXPORT PROCESS.

Press “1” to export only cures that are marked as “NEW.” Press “2” to export all cures listed, whether they are new or not. If the flash drive has an activity light, it blinks during the export process. Press “3” to export data for the last cure ran on Zone 1 and press “4” to export data for last cure ran on Zone 2. When a cure is running, Option “3” and “4” change to export data for the cure running on Zone 1 or Zone 2. Running Cure Data is incomplete, and will be updated as the cure progresses.

Once Exporting is completed, insert the USB Flash Drive into a USB port on a PC with HEATCON® Data Capture and Analysis Software (DCAS), Version 3.0 or later. Launch the DCAS software and click on the “IMPORT CURE DATA FROM USB” button, located on the bottom right corner of the screen. This will automatically import any cure data from the USB drive. Previously imported data will be ignored, in order to avoid duplicate copies in the database. If the HEATCON® Composite Systems’ Data Capture and Analysis Software (DCAS) is not used, the data can still be accessed by using WordPad®, Notepad®, or through an Excel® import process.

3.10 CURE DATA REPRINT

The same cure data used for data export is also retained for reprinting paper copies of cure data. The REPRINT COMPLETED CURE screen (Figure 3-37) is accessed by pressing the “6” key on the keypad from the MAIN MENU & STATUS MONITOR SCREEN. The menu is only accessible while no cures are running.

The REPRINT COMPLETED CURE screen retains the same 12 cures listed in the CURE DATA EXPORT menu. To print a cure report, scroll to the desired cure file and press “ENT”. The cure report will reprint from the corresponding printer to the zone it was run on. Press ‘0’ to cancel all printing.

REPRINT COMPLETED CURE				
DATE / TIME	ZONE	PROGRAM #	AND NAME	
19 MAY 11 09:22	1	2	EA9390-250F-120MIN	
18 MAY 11 09:11	1	6	BMS5-201-250F-120MIN	
17 MAY 11 08:22	1	5	BMS8-256-350F-90MIN	
16 MAY 11 10:11	1	4	EA9396-250F-90MIN	
16 MAY 11 09:44	1	3	EA9396-250F-120MIN	
15 MAY 11 09:44	2	11	B757-SOILER-250F	
14 MAY 11 09:10	2	12	B737-MLGDOOR-250F	
12 MAY 11 10:23	1	2	EA9396-250F-120MIN	
11 MAY 11 07:14	1	2	EA9396-250F-120MIN	
10 MAY 11 18:11	1	2	EA9396-250F-120MIN	
10 MAY 11 07:24	1	4	EA9390-250F-90MIN	
09 MAY 11 08:09	1	4	EA9390-250F-90MIN	

USE ↑ ↓ TO SELECT CURE TO PRINT AND PRESS ENT
PRESS ESC TO EXIT PRINT SCREEN
PRESS 0 TO CANCEL ALL PRINTING

Figure 3-37. Reprint Completed Cure Screen

3.11 AUTOTUNE

The Autotune function regulates output power to the heating device by adjusting the PID control algorithm. PID enables the HCS9000B/HCS9200B to match the power output to the heat load required for the cure in process. Due to the varying conditions and heat requirements encountered during repairs, adaptive PID values are sometimes required. In order to compensate for varying conditions, the system contains an Autotune feature. The Autotune automatically senses the load requirement and adjusts the PID values accordingly.

The Autotune accomplishes its task by forcing a slight imbalance in the system and monitoring the rate of temperature change in the load. Based on the amount of deviation from setpoint and the time it takes for the changes to take place, the computer can calculate the correct control parameters to complete the cure cycle with minimal deviation from the ideal program.

These preset values are satisfactory for approximately 80% of the repair profile conditions encountered during normal use of the HCS9000B/HCS9200B. The temperature regulation will be stable, and tuning of the PID will not be necessary. Therefore, Autotune will not be active. The conditions for Autotune to activate are listed below:

- a. The cure cycle must be in the first ramp segment. This is because the temperature excursions caused by the Autotune must be complete and the system stabilized prior to the repair materials reaching a gel point or critical cure temperature.
- b. At a setpoint temperature of 135 °F, the actual process temperature must be more than ± 5 °F in error. Otherwise the system is considered to be in balance and no PID correction is required.

Since the GRAPH SCREEN displays the actual events as they occur during the cure cycle, any temperature excursions forced by the Autotune will be displayed on the GRAPH SCREEN and the Graphic Printout. Temperature deviations during the Autotune cycle can be expected. For this reason, all temperature deviation alarms are disabled during the Autotune process. There should be no cause for alarm if these conditions are observed, as the instability is intentional and occurring during a non-critical phase of the cure cycle. The actual temperature will make three excursions above and below setpoint, prior to stabilizing. If Autotune is not desired by the user, it can be aborted from the Graph Screen by selecting "ABORT AUTOTUNE."

Most Autotune cycles should be complete in less than five minutes. If for some reason the Autotune is not able to accomplish its task in a timely manner, there is a 10-minute timeout that will terminate the Autotune and re-assign the default PID values. The equipment will then attempt to continue the cure process in normal fashion.

NOTE

If an aborted Autotune cycle is observed, it may be indicative of a problem with the repair layout or configuration. Factors most likely to cause abnormalities are: defective or intermittent TCs, grounded TCs, shorted TCs either to the caul plate or each other, blanket size too small or large heat sink associated with the repair area.

Upon completion of the Autotune cycle, the cure will proceed as programmed. The Total Time Remaining and Time Remaining in Step readouts should remain accurate, as the countdown is placed on hold during the Autotune cycle.

3.12 POWER LOSS DURING A CURE

Electrical power may be lost during a cure due to a number of reasons including, facility power failure or someone tripping over the power cable pulling the plug from the socket. If electrical power is restored within the designated recovery time of the loss/failure (default: 2 minutes), the unit will execute a recovery ramp to return the cure back to the previous setpoint and then resume normal. The printer will print the time the power was lost/failed and the time that power was restored. If power is not restored within the designated time, the cure process will be terminated. Depending upon how long the power was off, and where in the cure cycle it occurred, the cure may be restarted.

3.13 SETTING PID VALUES FOR CUSTOM PID OPERATION

The HCS9000B/HCS9200B series Hot Bonders may be configured with a custom PID option to allow the bonder to control a heat application other than the standard silicone rubber heat blanket. Other applications may include ovens, heated debulking tables, or infrared lamps.

WARNING

USE OF CUSTOM PID SOFTWARE OPTION BY INEXPERIENCED PERSONNEL MAY RESULT IN UNSATISFACTORY RESULTS, DANGEROUS CONDITIONS INCLUDING OVERHEATING OR FIRE, AND/OR DAMAGED OR UNSERVICEABLE PARTS

The following procedure describes the operation for manually tuning PID values. It is not possible to change PID values while a cure profile is running. If adjustments to the PID values become necessary during the tuning process it is necessary to stop the cure, adjust the PID values, then re-start the cure to observe PID-tuning results:

- a. Access the Setup and Calibration Menu by pressing “8” then “0” from the Main Menu on the bonder display. This will display the Setup and Calibration Menu where settings can be accessed to modify PID values.
- b. Select menu option “9” this will access the ‘More Selections’ menu;
- c. Select menu option “6” this will allow the user to enable Dual PID Settings in the ADVANCED SETTINGS MENU. Press “ENT” to save changes and return to ‘Setup and Calibration’ menu;
- d. Press “ESC” to return to MAIN MENU AND STATUS MONITOR Screen.
- e. Press “2” to access the user settings menu.
- f. In the USER SETTINGS Screen menu press “8” to access the Advanced Settings menu.
- g. In the ADVANCED SETTINGS Screen menu the user may select to use default PID values, use alternate PID values, or to edit alternate PID values for each zone.

CAUTION

ONCE THE ALTERNATE PID VALUES ARE SELECTED THE ALTERNATE PID VALUES WILL BE APPLIED TO ALL CURES UNTIL THE DEFAULT PID VALUES ARE SELECTED.

- h. Press “ENT” to save changes and return to the USER SETTINGS Screen. Press “ESC” to return to the MAIN MENU AND STATUS MONTIOR Screen.

3.13.1. MODIFYING PID SETTINGS

To tune any modified PID settings, follow directions described in the below procedures:

- a. The first step is to set the Proportional Bandwidth (PB). Most processes will fall into the range of 10 to 25 °F. The RESET and RATE values should be left at zero. Experience shows from ambient (about 75 °F) to 400 °F cure temperature range, a setting of around 15 °F is a good starting point. The system is then allowed to heat up to a setpoint that is representative of the cure temperature (250 – 300 °F) and allowed to stabilize. The system temperature should settle out at some point below setpoint, with less than 15 °F error. If the RESET value is too high (long time period), the effect will be negligible and will not bring the actual process temperature up to setpoint in a reasonable amount of time.
- b. Once the system has stabilized and is not oscillating, or if the error is more than 15 °F, then the PROPORTIONAL bandwidth should be decreased by a few degrees and the results observed. In some large ovens or systems with a large thermal mass, the settling time or oscillation frequency may be quite long.

CAUTION

MANY PROCESSES OPERATE WELL WITH JUST P & I CONTROL. THE INTRODUCTION OF RATE CONTROL INTO THE THERMAL SYSTEM CAN LEAD TO UNEXPECTED RESULTS. THE THREE CONTROL FACTORS INTERACT WITH EACH OTHER AND PRODUCE A CUMULATIVE EFFECT. IF INSTABILITY IS ENCOUNTERED, SET THE RATE BACK TO ZERO AND INSURE THAT P & I ARE SET CORRECTLY BEFORE CONTINUING.

- c. Decrease the PB (lower P number) and observe the process until the system starts to oscillate, then increase the PB until the system becomes stable. If the system is already in oscillation, increase the PB (higher P number) until the system becomes stable. A slight oscillation of 1-2 degrees is permissible.
- d. At this point, the system should be relatively stable at a few degrees below setpoint. In order to achieve setpoint, some amount of RESET (I) value must be added. Experience shows that an interval between 0.5 and 10 minutes, with 2 minutes being typical, is a good starting place
- e. If the RESET number is too low (short time period), the RESET function will appear to dominate the process and be constantly trying to pull the process temperature over setpoint. This will produce instability, resembling the effect of a too narrow PB.
- f. If the RESET value is too high (long time period), the effect will be negligible and will not bring the actual process temperature up to setpoint in a reasonable amount of time.
- g. If overshoot of setpoint by the actual temperature is a real problem, then the addition of DERIVATIVE or RATE is required.
- h. The range that is considered normal is between 1 and 10 minutes

The above tuning procedure is based on the assumption that the system has the proper capacity for the cure profile required. In other words, the system can respond to setpoint change in the expected time interval. If the heater elements do not have enough capacity to maintain a high ramp rate (Example: over 5 °F / minute) or the thermal mass not allow it to cool fast enough to meet a particular down ramp, then no amount of PID manipulation will correct the situation.

Observation of the green output power indicator on the bonder will give a visual indication of the process. If the light is on constantly, or if the power is strongly applied, then reduced to minimum, and then reapplied, something is in error and the process needs to be re-examined. Ideally, the output power indicator should cycle at a fairly steady rate, with the on time becoming a little longer at higher temperature ranges.

An alternate method of PID determination is to place the bonder in "Normal Control" mode and run the desired profile. At 135 °F setpoint, the bonder will compare the actual temperature to the setpoint to determine if the process is "tuned" correctly. If the actual and the setpoint are within 2 °F of each other, then the process is considered to be tuned correctly and will continue without change. If the error is more than 2 °F, then the system will attempt to "Autotune" the PID parameters. The system will go to 100% output power until the actual temperature exceeds the setpoint. At this point, the output power will go to zero and the system allowed to cool until actual drops below setpoint. This cycle will occur three times. During the temperature excursions, the computer will monitor the amount of temperature overshoot and the time required between cycles. With this information, the system will compute a new set of PID values in an attempt to tune the system properly.

If the system cannot complete the three temperature cycles required to tune the system within a 10 minute period, the Autotune function will abort and the default PID values will be used. This may occur in slow systems with a large thermal mass, such as a large oven. At the completion of the Autotune process, the new PID numbers can be observed by pressing "8" – "0" from the Main Menu, then selecting option "6" 'Manage Autotune'. The new PID values will be displayed for each zone. These can be recorded and entered into the Custom PID Settings as described above. This should give a good starting point for subsequent PID adjustments

CHAPTER 4 MAINTENANCE

4.0 SCHEDULED MAINTENANCE

The HCS9000B/HCS9200B Composite Repair Set (Hot Bonder) requires only minimal scheduled maintenance. The unit has no moving parts that require periodic lubrication or adjustment. The only scheduled maintenance requirement is for periodic system calibration. HEATCON® Composite Systems recommends calibration of the HCS9000B/HCS9200B be accomplished on an annual basis. Additionally, calibration should be performed if there is any abnormal operation, shock to the unit (dropped, etc.) or if any significant differences in TC indications not attributable to the repair structural properties or heat sink areas.

4.1 PREVENTIVE MAINTENANCE

Although there are no scheduled preventive maintenance requirements, a physical inspection and operational test should be performed in conjunction with the annual system calibration. A physical inspection of the exterior and interior of the unit should include a thorough search to identify broken or improperly functioning components. The unit should be cleaned to remove external dirt and materials used in the repair process that may be present on the faceplate. The interior should be cleaned to remove any oil or foreign matter that may be present on the base plate or internal components. Cleaning should be accomplished using mild, non-abrasive cleaner or solvent such as isopropyl alcohol and a soft, lint free cloth

4.2 EQUIPMENT MAINTENANCE

Access to the equipment interior is accomplished in the following manner:

4.2.1 CHASSIS REMOVAL

WARNING

LETHAL VOLTAGES ARE PRESENT IN THE UNIT IS CONNECTED TO THE SOURCE POWER. ENSURE ALL ELECTRICAL POWER IS REMOVED FROM THE UNIT BEFORE ATTEMPTING ANY MAINTENANCE ACTION. ONLY PROPERLY TRAINED TECHNICAL PERSONNEL SHALL PERFORM INTERNAL CHECKS.

- a. Disconnect power cables from the equipment.
- b. Remove the hex screws located on the perimeter of the faceplate. Do not remove any other screws.
- c. Carefully lift chassis up and out of the equipment case. Set the chassis at an angle on the case flange to support the chassis before continuing.
- d. At the back of the unit, locate and disconnect the vacuum exhaust hose(s) quick disconnect fitting(s) — one on HCS9000B and two on HCS9200B.

4.2.2 CHASSIS INSTALLATION

The chassis installation procedure consists of reversing the chassis removal procedure.

CAUTION

USE CAUTION WHEN THE CHASSIS IS BEING INSTALLED TO ENSURE THAT ANY CABLES OR WIRES ARE CAREFULLY INSERTED INTO THE CASE AND NOT CAUGHT ON THE FLANGE, . ALSO ENSURE VACUUM EXHAUST HOSE(S) ARE NOT KINKED OR TRAPPED UNDER THE BASEPLATE. VACUUM SYSTEM PERFORMANCE WILL BE DEGRADED IF A HOSE IS RESTRICTED.

- a. Set the chassis at an angle on the case. Connect the vacuum exhaust hose(s) quick disconnects.
- b. Carefully insert the chassis into equipment case, ensuring the vacuum tubes are not kinked.

- c. Install the hex screws in the screw holes in the faceplate.
- d. Connect power cables to the equipment and apply power.
- e. Ensure the unit powers up and the screen information is displayed.
- f. Connect shop air to the unit and verify that at least 27 In/Hg is obtainable at the vacuum out port.

4.3 INSPECTION AND TEST PROCEDURES

The HCS9000B/HCS9200B is essentially operationally tested each time it is operated to perform a composite repair. A quick check of the equipment displays and paper tape printout during normal use will give a general indication of the equipment functionality. The operational test is described in par 4.4.1.

4.3.1 EQUIPMENT REQUIREMENTS

Test equipment required to perform the operational test procedure is shown in Table 4-1.

Table 4-1. Equipment Required for Testing

Equipment Description	Part Number	Manufacturer
Calibration Kit; Thermocouple - Type-J Simulator. Ambient Temperature Compensated	HCS2051-01-100 Model 840A *or Equivalent	HEATCON® Composite Systems Tegam
Precision Vacuum Gauge; 0-30 In/Hg (0-1000 Millibars), 0.1 In/Hg resolution, 0.5% or Better Accuracy.	HCS2051-01-002 * or Equivalent	HEATCON® Composite Systems Any
Vacuum Return Monitor Adapter Hose *	HCS2051-01-004	HEATCON® Composite Systems
Composite Repair Panel Minimum Size 12" X 12"	NA	Local Manufactured.
Heat Blanket, (8" X 8" Minimum)	HC080080E51 or Equivalent	HEATCON® Composite Systems
J-type Thermocouple (6 Ea.)	HCS2010 or Equivalent	HEATCON® Composite Systems

* Included in Kit (HCS2051-01)

4.4 OPERATIONAL TEST

The operational test should be performed to verify the unit operates correctly. It is recommended that an operational test be performed during the annual calibration or anytime there is an indication of abnormal equipment operation.

4.4.1 OPERATIONAL TEST PROCEDURE

The following is a brief test procedure that can be used by maintenance personnel to establish the operational status of the unit. If difficulty is encountered with any step, or the results of a procedure are not correct, refer to the Troubleshooting Guide in Table 5-1 to assist in identifying or isolating any problem and the possible corrective actions. Refer to Table 4-1 for test equipment required to perform the operational test.

NOTE

A printer test can be initiated by pressing and holding the paper advance button down when initially applying power to the equipment. Hold the button down for approximately 5 seconds while applying power and release. The printer should print the settings and then a full alphanumeric character set.

- a. Connect input and output power cables to the unit and turn on control power. The display screen will illuminate.
- b. The internal control computer will initialize and after a short time, the "WELCOME" screen will be displayed. Press the "ESC" key to advance the display to the "MAIN MENU AND STATUS MONITOR" screen.
- c. With no Thermocouples (TCs) connected to the unit, all TC indications should read OPEN. Vacuum should read "0" In/Hg (0 mb/KPa). If reading more than "0", depress the plunger in the vacuum QDs to bleed off any trapped vacuum.
- d. Using a J-type TC calibrator (Table 4-1) set temperature input to 400 °F and plug calibration TC into TC jack No. 1. The display should read 400 ± 1 °F. Perform the procedure for each TC jack in succession. As the calibration TC is moved from one jack to the next, the preceding TC readout should return to OPEN. For test purposes, if a TC calibrator is not available, a known good TC can be used and the readouts will read ambient temperature. However, a TC calibrator is required for the formal calibration.
- e. Obtain a simulated repair panel and prepare a typical lay-up with TCs, heat blanket, breather cloth, bagging film and vacuum thru-bag connector in accordance with standard repair procedures.
- f. Connect the vacuum hoses, TCs, and heating blanket to the hot bonder/controller. Apply vacuum and seal all vacuum leaks in the bag.
- g. Connect the air input filter and separator assembly to the air to Quick Disconnect and apply 80 to 100 psi shop air. Open regulator valve fully counterclockwise. The vacuum readout should read at least 22 In/Hg once the bag is under vacuum.
- h. All TCs must be at least two inches inside the heat blanket outside perimeter. The repair panel should be a minimum of 12" x 12" with a minimum 8" x 8" heating blanket. All connected TCs will read ambient or panel temperature and vacuum level should read at least 22 In/Hg.
- i. Ensure that the output power Circuit Breaker (CB) is in the "ON" position (handle toward rear) and the heat blanket is plugged into the output power cable assembly junction box.
- j. Following the procedures in Chapter 3, enter a short test profile and run it. Suggested parameters are as follows:
 - Ramp 1 = 5 °F per minute
 - Dwell 1 temperature = 250 °F
 - Dwell 1 time = 5 minutes
 - Ramp 2 = 5 °F
 - Dwell 2 = 300 °F
 - Dwell 2 time = 5 minutes

- Ramp 3 = 5 °F per minute
- End Temperature = 150 °F
- Vacuum Alarm Level = 22 In/Hg.
- Ramp Lo Alarm = 10 °F
- Ramp Hi Alarm = 10 °F
- Dwell Lo Alarm = 10 °F
- Dwell Hi Alarm = 10 °F

NOTE

If time is a concern, under certain circumstances a faster ramp rate and lower dwell temperature may be used if approved by responsible engineering authority.

- k. When the cure cycle is started the following will occur:
- The printer will print a record of the profile parameters.
 - The display screen will show a graph of the program profile.
 - The output power indicator will flash intermittently.
 - The temperature readouts will follow the setpoint reading in an orderly fashion.
 - The printer will print a status line at intervals selected in the "Printer Options" menu.
 - If the "Segment Completion" signal is enabled, the unit will emit three short beeps when it transitions between ramp and dwell segments.
- l. Reduce the vacuum level by closing the vacuum regulator valve. A small leak may have to be created in the bag to allow vacuum to bleed off.
- m. When the vacuum level drops below the alarm preset point (normally 22 In/Hg) the following will occur:
- An audible alarm will sound
 - A pop-up alarm window on the display screen will indicate an alarm condition
 - The printer will print the alarm condition
- n. Silence the alarm by either pressing the "ENT" key as stated in the popup alarm window.
- o. Restore full vacuum to the repair area. The display screen status indicator will return to RAMPING, and the paper tape prints "Alarm Clear."
- p. Remove one of the TC plugs from the unit and connect a TC calibrator in its place. Force alarm conditions by applying a temperature more than 10 °F above and below the setpoint to the unit. In each case, the display screen and printer will indicate the alarm condition. When the applied signal is within the deviation alarm window, the alarm will clear and indications return to normal.
- q. Repeat steps o and p during the dwell segment of the cure cycle.
- r. If additional high or low temperature alarms are encountered during the test procedure, it may be due to the condition of the heat blanket, TCs, or panel layout. The alarm parameters may have to be widened to accommodate existing conditions.
- s. When the setpoint reaches 135 °F, if the actual temperature is different by more than 2 °F, the unit will go into an "Autotune" cycle. Alarms are disabled during this phase and testing should be halted until "Autotune" is complete. Refer to par. 3.10 for a more detailed description of the Autotune cycle.
- t. At the completion of the test cure, the display screen status will read "COMPLETE". The following information will be printed on the paper tape:
- Program Complete
 - Operator ID Number
 - Serial Number
 - The Part Number

- Quality Stamp block
 - A graph of the actual cure profile
 - The green output indicator will also go out.
- u. Repeat the test process for zone 2.
- v. Upon completion of test procedure, remove electrical power from the unit, disconnect and stow power cables, TCs, vacuum hoses, and air hose.

4.5 PRINTER MAINTENANCE

CAUTION

USE CAUTION WHEN REMOVING THE PRINTER COVER. APPLY GENTLE PRESSURE WHEN REMOVING COVER. EXCESSIVE FORCE MAY DAMAGE THE PRINTER ASSEMBLY AND BREAK THE RETAINING TABS.

4.5.1 PRINTER RIBBON REPLACEMENT

To gain access to the paper and ribbon, remove the printer cover panel by gently sliding the cover toward the operator approximately 1/2 inch. This will disengage the panel retainers and allow easy removal of the cover.

- a. Gently lift the cover off the face of the printer to expose the paper and ribbon.
- b. To remove the ribbon, gently push down on the left side of the ribbon cartridge marked "PUSH" with one finger. Place a second finger over the ribbon to prevent it flying off the printer. This will cause the ribbon to snap free of the unit, and allow it to be lifted clear.
- c. If only the ribbon is to be replaced, insert a new ribbon into the printer, feeding the paper through the ribbon cartridge between the ribbon cartridge and the ribbon. Then gently snap both sides down of the ribbon cartridge into the printer. It is advisable to leave an inch or two of paper extending from the printer assembly to act as a guide for replacing the ribbon.
- d. Feed the paper end through the printer cover slot and install the paper cover by laying the cover face down on the printer about 1/2 inch below the normal closed position. Gently slide the cover up so that the retainers snap into place and secure the cover to the bezel.

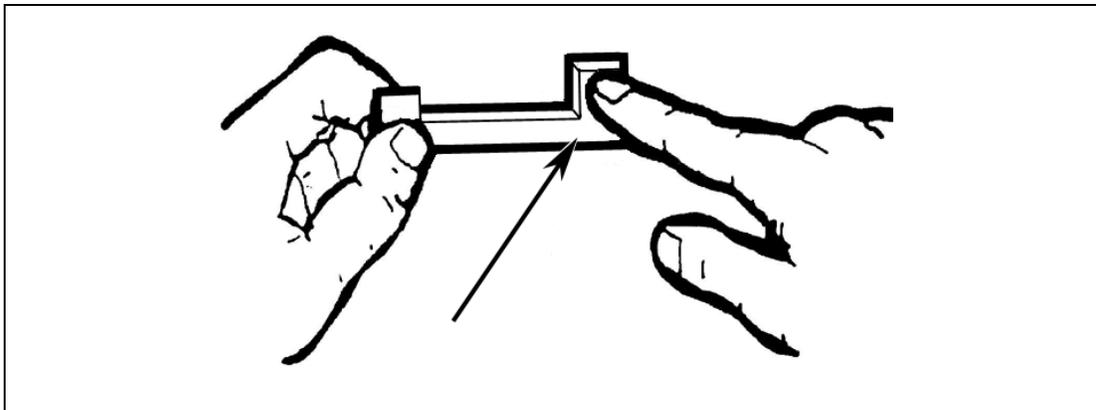


Figure 4-1. Printer Ribbon Installation

4.5.2 PRINTER PAPER REPLACEMENT

To replace the printer paper roll, remove printer ribbon as described in par 4.5.1.

- a. Gain access to the printer by gently sliding the printer cover down and lifting the cover off the face of the printer to expose the paper and ribbon.
- b. Remove printer ribbon cartridge (refer to par 4.5.1 above).
- c. Gently lift the left side of the spindle from the printer assembly (Figure 4-1).
- d. The paper roll spindle will snap free and allow the roll to be removed. If there any paper remains in the unit, **DO NOT** pull paper backward through the mechanism. Cut or tear the paper between the spool and the mechanism and pull the paper through the unit in the normal feed direction. If the unit has power applied, use the paper feed button to feed the paper through the printer.
- e. To install a new roll of paper, the equipment will require electrical power be applied to feed the paper through the printer mechanism.

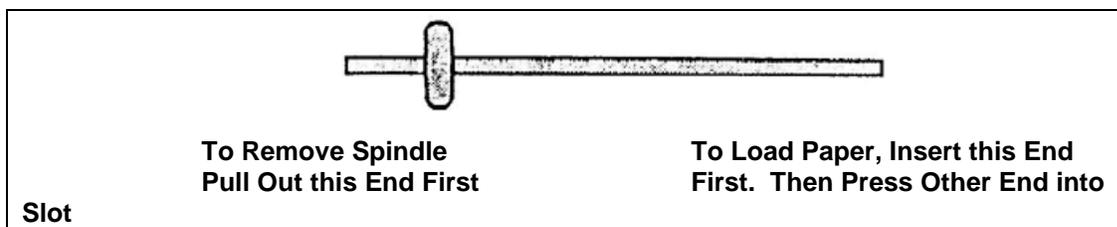


Figure 4-2. Printer Paper Installation

- f. Insert the paper spindle (figure 4-2) through the paper roll from the left side of the printer, with the spindle “Tee” head on the left side. The paper roll should be installed with the paper coming over the top of the roll away from the operator.
- g. Trim the end of the paper so that it forms an arrowhead and insert the paper into the mechanism. The paper must feed through the feed slot of the print head. This is the opening just on top of the silver plate inside the print mechanism.
- h. With the equipment energized, press the “Paper Feed” button. The paper should feed into the mechanism and out the top of the printer.
- i. Secure the paper roll by inserting the right end of the spindle into the case and gently snapping the left side into its retainer.
- j. Replace the ribbon as described in par. 4.5.1.

CHAPTER 5 TROUBLESHOOTING

5.0 GENERAL TROUBLESHOOTING

The most probable equipment failures are summarized in the troubleshooting guide (Table 5-1) with general corrective actions and some specific items to be examined. It is difficult to specifically address all problems that may be encountered during equipment operation, but generally the problems can be isolated to a particular area. Experience has shown that many fault conditions attributed to equipment are actually due to improper lay-up techniques, faulty TCs or heat blankets, and/or unusual repair situations requiring special considerations. The corrective actions listed in the troubleshooting guide (Table 5-1) are listed in order of most probable action. Perform each corrective action in order until the discrepancy has been corrected.

5.1 TEST EQUIPMENT REQUIREMENTS

The following test equipment required to perform troubleshooting procedures: Refer to Table 4-1 for a description of test equipment.

- Multi-meter, capable of measuring Alternating Current and Direct Current (AC/DC) volts and ohms.
- Thermocouple Calibration Unit

WARNING

LETHAL VOLTAGES ARE PRESENT IN THE UNIT IS CONNECTED TO THE SOURCE POWER. ENSURE ALL ELECTRICAL POWER IS REMOVED FROM THE UNIT BEFORE ATTEMPTING ANY MAINTENANCE ACTION. ONLY PROPERLY TRAINED TECHNICAL PERSONNEL SHALL PERFORM INTERNAL CHECKS.

Table 5-1. Troubleshooting Guide

Problem	Corrective Action
Unit Will Not Energize	<ol style="list-style-type: none"> 1. Check Power Connections 2. Check Facility Power Fuse or Circuit Breaker 3. Check DC Power Supply Output(s)
No Display on Screen	<ol style="list-style-type: none"> 1. Check Display Screen Cables 2. Possible Defective Display Screen or Video Driver Board
Improper Thermocouple or Vacuum Level Readouts	<ol style="list-style-type: none"> 1. Perform Calibration Procedure and Ensure Calibration Offsets are Set to Zero. 2. Check +5 V DC, +12 V DC Power to Analog Input Circuit Board. 3. Possible Analog Input Circuit Board, CPU Carrier Circuit board, or Main Computer Failure.
Unit Will Not Execute a Program	<ol style="list-style-type: none"> 1. Check That at Least One Thermocouple is Connected and Reading Properly. Unit Will Not Run Without at Least One TC Connected or With all TCs Indicating Open. Verify Thermocouple Control Mode. 2. Check Main Menu and Ensure That Another Program is not Running on That Particular Zone. 3. Check Program Parameters and Ensure That None are out of the Normal Range or Blank. 4. Perform Calibration Procedure and Ensure Calibration Offsets are Set Correctly. 5. Check +5 V DC, +12 V DC Power to CPU Carrier Circuit Board. 6. Possible CPU Carrier or Main Computer Failure.

Table 5-1. Troubleshooting Guide (Cont.)

Problem	Corrective Action
Cure Cycle Starts, But Will Not Progress or Terminate	<ol style="list-style-type: none"> 1. Check For Alarm Conditions. Unit Will Be in a “Hold” Status During Alarm Conditions, Including Vacuum Alarms. 2. Check Status Indicator on Graph Screen for an Operator Initiated “HOLD” Condition.
No Heat Output.	<ol style="list-style-type: none"> 1. Check Circuit Breaker Position. 2. Check Blanket connections. 3. Check For Voltage +5 V DC Depending on the System configuration) at Heat Control Relay and 12 V DC at the High Limit Relay Input Terminals. If Correct, Possible Relay Failure.
Frequent Temperature Alarms During Cure Cycle	<ol style="list-style-type: none"> 1. Check for Poor Quality or Intermittent Thermocouples, or TCs Positioned too Close to the Edge of the Blanket. 2. Repair Area is Composed of Multiple Density Materials or in Close Proximity to Structural Members, Causing Uneven Heat Distribution Due to Variable Heat Sinks Within the Repair Area. 3. Poor Quality Heat Blanket With Hot and Cold Spots. 4. Ramp Rate is too High. 5. Alarm parameters too narrow. 6. Verify correct PID settings.
Circuit Breaker Trips During Cure Cycle	<ol style="list-style-type: none"> 1. The Total Sum of the Wattage of Connected Heat Blankets Exceeds Rated Output of the Composite Repair System 2. Damaged Heat Blanket or Power Leads, Causing a Short Circuit Condition.
Low or No Vacuum Output From Unit (Vacuum Eductor Operation)	<ol style="list-style-type: none"> 1. Check Plant Air Input. Must be 80 to 100 psi, Minimum Volume of 2 cfm. 2. Check Equipment Air Filters. 3. Check Vacuum Exhaust Hose for Pinched or Crimped Condition. 4. Disassemble and Clean Venturi Vacuum Pump. 5. Replace Vacuum Pump
Low or No Vacuum Output From Unit (Internal Electrical Vacuum Pump Operation)	<ol style="list-style-type: none"> 1. Power Cable Not Securely Attached to Connection on Bonder Faceplate. 2. Vacuum Source Line Not Properly Connected. 3. Vacuum Monitor Line Not Properly Connected. 5. Replace Electrical Vacuum Pump

CHAPTER 6 PARTS LIST

6.0 USING THE PARTS LIST

The Parts Lists show components/parts that may be procured and replaced by the user. Each part is indexed to a location callout on the illustrations that are preceding each of the parts lists. The tables show each part index and identifies that part to the HEATCON® Composite Systems (HCS) Part Number (P/N), Part Nomenclature, and Quantities used per unit.

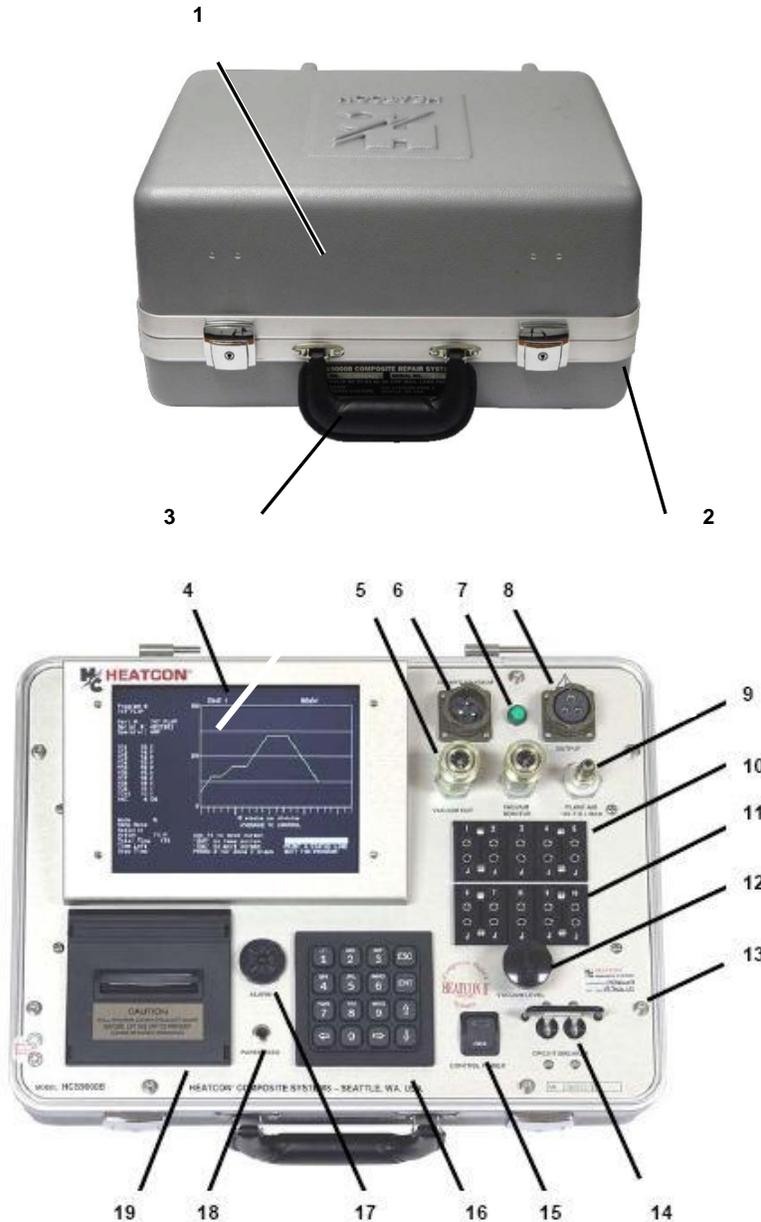
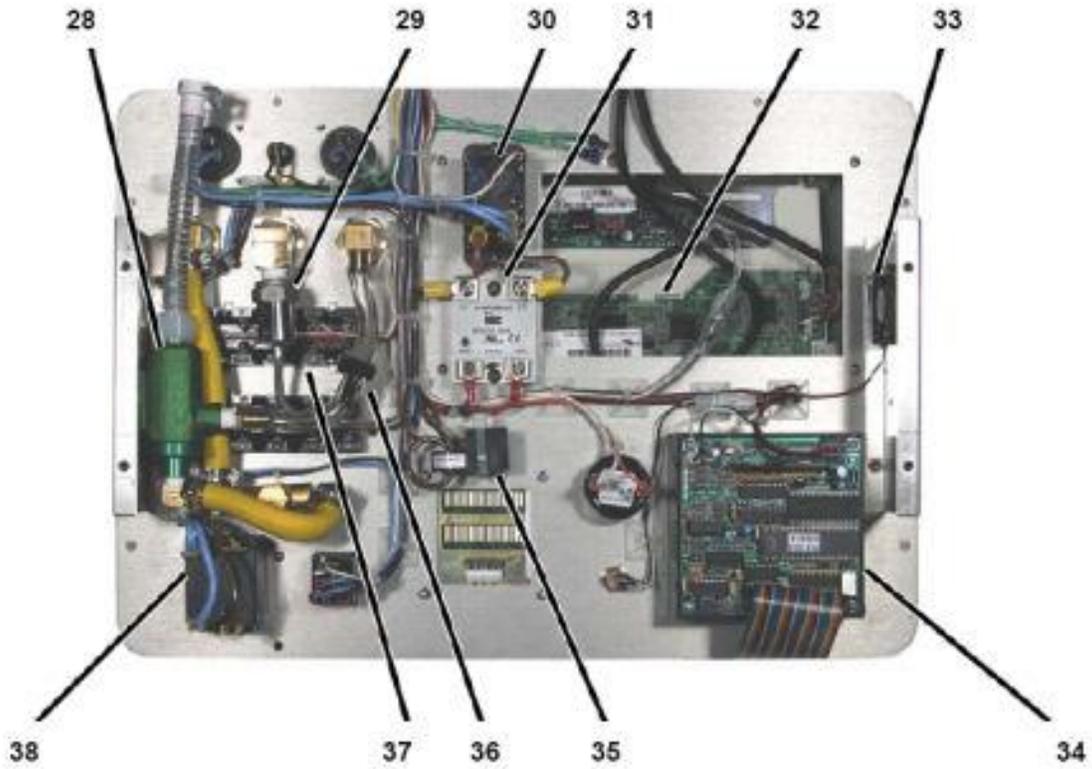
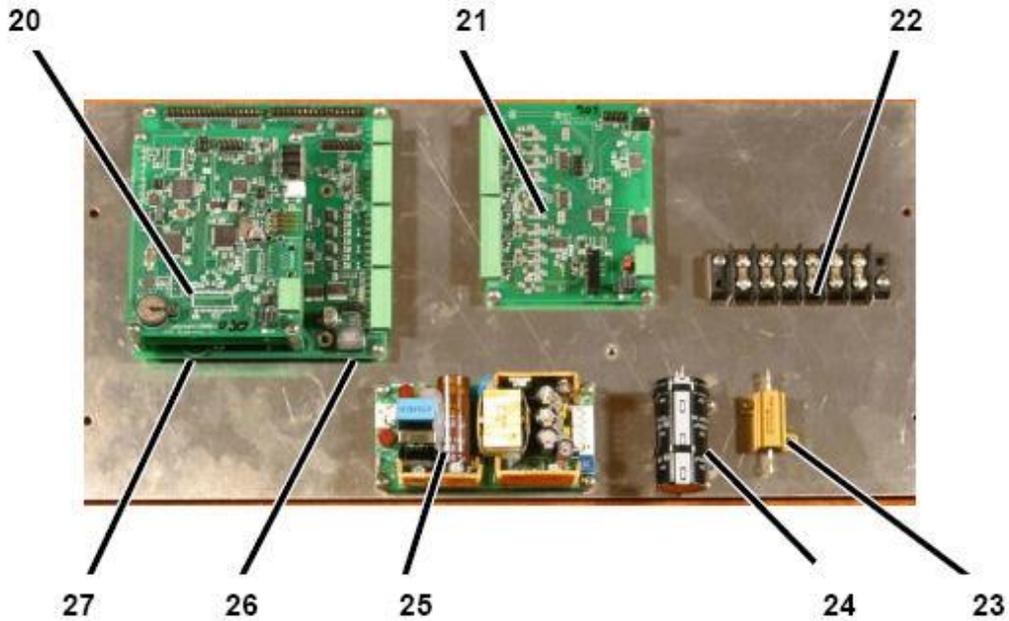


Figure 6-1. HCS9000B Replaceable Parts (Sheet 1)



HCS9000B FACEPLATE BACKSIDE



HCS9000B BASEPLATE

Figure 6-1. HCS9000B Replaceable Parts (Sheet 3)

Table 6-1. HCS9000B Replaceable Parts List

Index No.	HCS Part Number	Nomenclature	Units/ Assy
1	HCS1011-011	Case, HCS9000B with Standard Lid	1
	HCS1011-012	Case, HCS9000B with Accessory Lid	1
2	HCS9000-10-114	Latch Assembly	1
3	HCS1010-121	Placard, HCS9000B Nameplate	
4	HCS1012-043	Display, Liquid Crystal (LCD); 800 X 600 Resolution, LVDS	1
	HCS1012-045	. Driver Module, LED Backlight	1
	HCS1006-025	. Bracket, LED Driver Module Mounting	1
	HCS1008-255	. Bezel, Display Screen	1
	HCS1012-044	. Cable Assy, LCD Display To Video Driver	1
5	HCS1015-002	Vacuum Fitting, Female Quick Disconnect, 1/4 In. NPT	2
6	HCS1009-001	Connector, Panel, Input Power	1
7	HCS1012-003	Indicator, LED, Green, 12 V DC	1
8	HCS1009-002	Connector, Panel, Output Power	1
9	HCS1014-005	Air Fitting, Male, Quick Disconnect, 1/4 In. NPT	1
	HCS1014-011	. Bulkhead Fitting,	2
10	HCS1358-A	Thermocouple Jack 1-5	1
11	HCS1359-A	Thermocouple Jack 6 to 10	1
12	HCS1016-001	Valve, Needle, Air Regulator	1
13	COMMERCIAL	Screw, SS, 10-32 X 3/4", Allen Head,	8
14	HCS1004-001	Circuit Breaker, 30 Amp, 2 Pole	1
	HCS1008-002	. Guard, Circuit Breaker	1
	HCS1008-003	. Ferrule, Circuit Breaker Guard	2
15	HCS1002-014	Switch, Rocker, DPST, Control Power	1
16	HCS1013-007	Keyboard, 16 Key, Silicone Rubber	1
17	HCS1012-002	Alarm, Audio, Adjustable Output	1
18	NA	Switch, Pushbutton Paper Feed (Supplied as part of #19)	1
19	HCS9000-40-120	Printer Assembly, Dot Matrix, Impact	1
20	HCS1003-050	Circuit Board, Video Interface (Top)	1
21	HCS1003-024	Circuit Board, Sensor Interface	2
22	HCS1004-004	Terminal Strip, 6 Pole, Screw	1
23	HCS1003-020	Resistor, 20 Ohm, 25W, P/S Load	1
24	HCS1003-021	Capacitor, 27,000µF, P/S Filter	1
25	HCS1001-007	Power Supply, +5V, +12V, 60W	1
26	HCS1003-031	Circuit Board, Computer Carrier	1
27	HCS1003-030	Circuit Board, USB Host	1
28	HCS1408	Vacuum Pump, Venturi.	1
29	HCS1015-001	Vacuum Sensor Transducer 0-30 In/Hg.	1
30	HCS1004-003	Relay, DPST, N.O. 30 Amp, 12VAC Coil	1
31	HCS1004-002	Relay, Solid State (SSR), 48–660 VAC, 50 Amp, DC Control	1
32	HCS1012-043	Display, Liquid Crystal (LCD); 800 X 600 Resolution, LVDS	1
33	HCS1004-041	Fan, Cooling, 12 DC	1
34	HCS9000-40-120	Printer Assembly, Dot Matrix, Impact	1
35	HCS1003-003	Current Sensor, SW Contact Output	1
36	HCS1015-003	Check Valve, Vacuum 3/16 Barb	1
37	HCS1358 / HCS1359	Thermocouple Jacks	1
38	HCS1004-001	Circuit Breaker, 30 Amp, 2 Pole	1

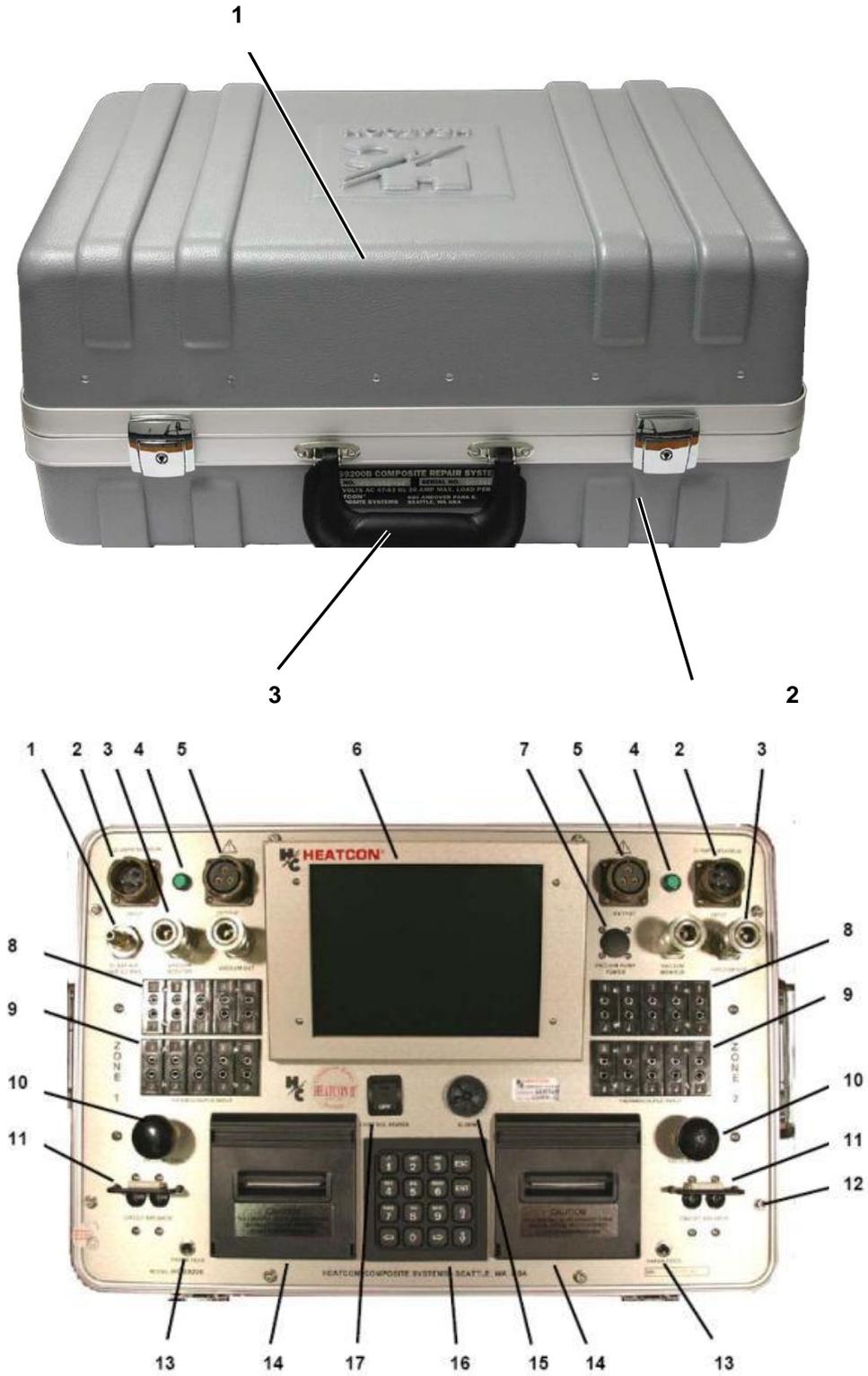
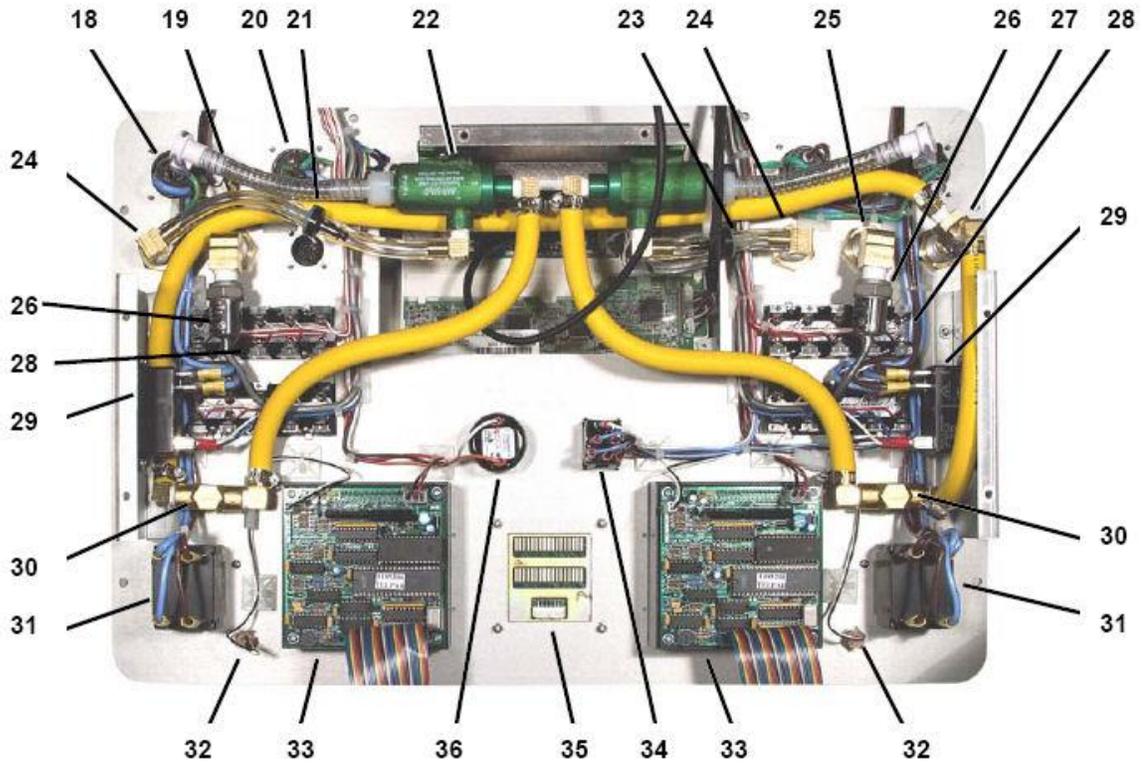
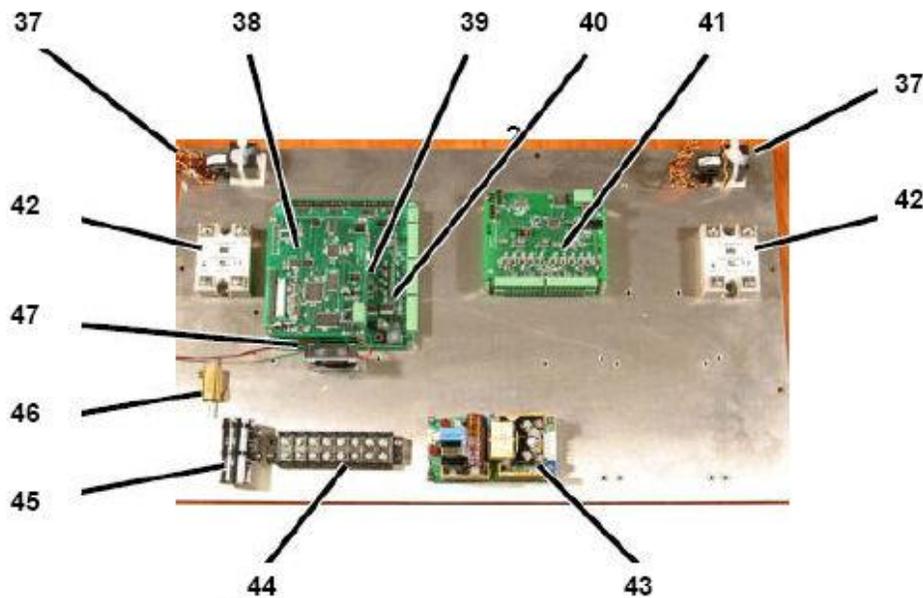


Figure 6-2. HCS9200B Replaceable Parts (Sheet 2)



HCS9200B FACEPLATE BACK



HCS9200B BASEPLATE

Figure 6-2. HCS9200B Replaceable Parts (Sheet 3)

Table 6-2. HCS9200B Replaceable Parts List

Index No.	HCS Part Number	Nomenclature	Units/ Assy
1	HCS1014-005	Air Fitting, Male, Quick Disconnect, 1/4 In. NPT	1
	HCS1014-011	. Bulkhead Fitting,	1
2	HCS1009-001	Connector, Panel, Input Power	2
3	HCS1015-002	Coupler, Quick Disconnect Vacuum Fitting, Female 1/4 In. NPT	4
	HCS1014-011	. Bulkhead Fitting,	4
4	HCS1012-003	Indicator, LED, Green, 12 VDC	2
5	HCS1009-002	Connector, Panel, Output Power	2
6	HCS1012-043	Display, Liquid Crystal (LCD); 800 X 600 Resolution, LVDS	1
	HCS1012-045	. LED Backlight Driver Module	1
	HCS1006-025	. Bracket, LED Driver Mounting	1
	HCS1008-255	. Bezel, Display Screen	1
7	HCS1009-011	Connector, Female, 2 pin, Optional Vacuum Pump Power	1
	HCS1009-016	. Connector, Male, 2 pin. Mates with Item #7	1
8	HCS1358-C	TC Block, Numbers 1 To 5	2
9	HCS1359-C	TC Block, Numbers 6 To 10	2
10	HCS1016-001	Valve, Needle, Air Regulator	2
11	HCS1004-001	Circuit Breaker, 30 Amp, 2 Pole	2
	HCS1008-002	. Guard, Circuit Breaker	2
	HCS1008-003	. Ferrule, Circuit Breaker Guard	4
12	COMMERCIAL	Screw, 10-32, 1/2 Inch, Allen Hex	8
13	NA	Switch, Pushbutton (Supplied as part of #14)	2
14	HCS9000-40-120	Printer Assembly, Dot Matrix, Impact	2
15	HCS1012-002	Alarm, Audio, Adjustable Output	1
16	HCS1013-007	Keyboard, 16 Key, Silicone Rubber	1
17	HCS1002-014	Switch, Rocker, DPST, Control Power	1
18	HCS1009-001	Connector, Panel, Input Power	2
19	HCS1424	Adapter, 1/4 NPT to 1/4 Tube, Male	2
20	HCS1009-002	Connector, Panel, Output Power	2
21	HCS1015-003	Check Valve, Vacuum 3/16 Barb	2
22	HCS1408	Vacuum Pump, Venturi.	2
	HCS1422	. Coupler, Quick Disconnect, Vacuum Tubing, M/F Set	2
23	HCS1015-003	Check Valve, Vacuum 3/16 Barb	2
24	HCS1014-011	Bulkhead Fitting, Alum 1/4 " NPT-Clear Anodized	2
	HCS1014-013	. Nut, 3/4-16, Brass	
	HCS1015-002	. Coupler, Vacuum, Female, 1/4" NPT, EA Series	2
25	HCS1014-011	Bulkhead Fitting, Alum 1/4 " NPT-Clear Anodized	2
	HCS1014-013	. Nut, 3/4-16, Brass	
	HCS1015-002	. Coupler, Vacuum, Female, 1/4" NPT, EA Series	2
26	HCS1015-001	Vacuum Sensor Transducer 0-30 In/Hg.	2
27	HCS1014-011	Bulkhead Fitting, Alum 1/4 " NPT-Clear Anodized	1
	HCS1014-013	. Nut, 3/4-16, Brass	1
	HCS1015-002	. Fitting, Air Input, Male, 1/4" NPT Male Type-M	1
28	HCS1358-C	TC Block, Numbers 1 - 5	1
	HCS1359-C	TC Block, Numbers 6 - 10	2
29	HCS1004-003	Relay, DPST, N.O. 30 Amp, 12VAC Coil	2
30	HCS1016-001	Valve, Needle, Air Pressure, Brass	2

Table 6-2. HCS9200B Replaceable Parts List (Cont'd)

Index No.	HCS Part Number	Nomenclature	Units/ Assy
31	HCS1004-001	Circuit Breaker, 30 Amp, 2 Pole	2
32	NA	Switch, Pushbutton (Supplied as part of #32)	2
33	HCS9000-40-120	Printer Assembly, Dot Matrix, Impact	2
34	HCS1002-014	Switch, Rocker, DPST, Control Power	1
35	HCS1013-007	Keyboard, 16 Key, Silicone Rubber	1
36	HCS1012-002	Alarm, Audio, Adjustable Output	1
37	HCS1003-003	Current Sensor, SW Contact Output	2
38	HCS1003-050	Circuit Board, Video Interface, LVDS(Top)	1
39	HCS1003-030	Circuit Board, USB Host (Middle)	1
40	HCS1003-031	Circuit Board, Computer Carrier (Bottom)	1
41	HCS1003-024	Circuit Board, Sensor Interface	2
42	HCS1004-002	Relay, Solid State (SSR), 48–660 VAC, 50 Amp, DC Control 3–32 VDC	2
43	HCS1001-007	Power Supply, +5V - +12V, 60W	1
44	HCS1004-045	Terminal Strip, 8 Pole	1
45	HCS1003-021	Capacitor, 27kuF	1
46	HCS1003-020	Resistor, 20 Ohm, 25 Watt	1

Figure 6-3. HCS9000B/HCS9200B Accessories

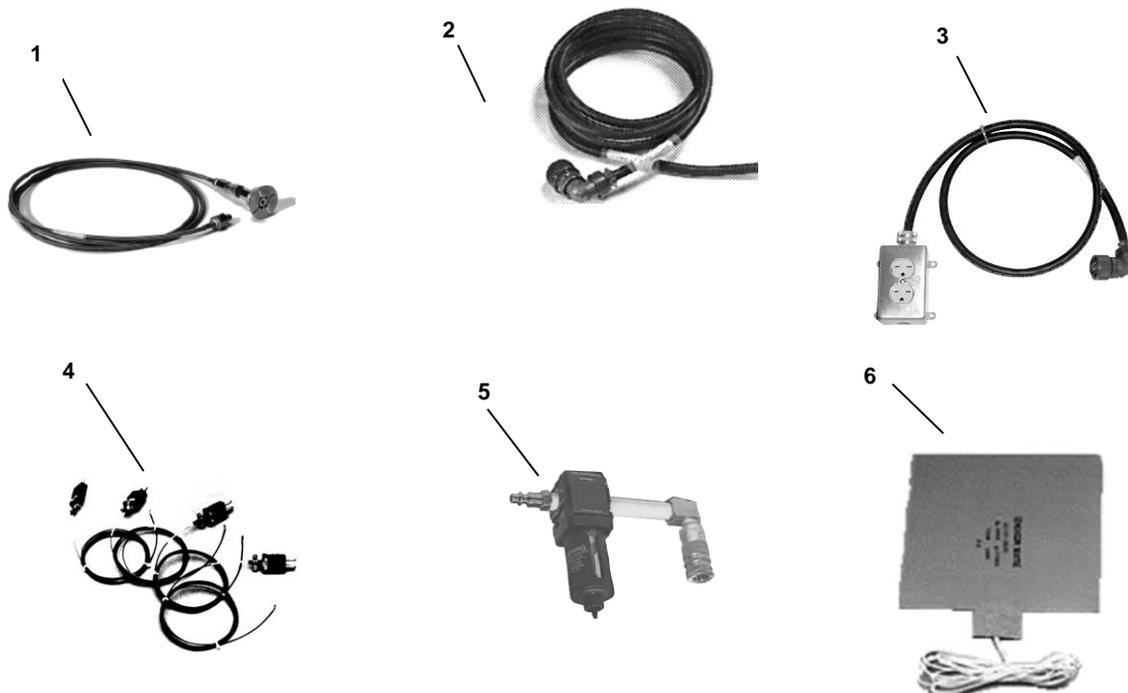


Table 6-3 HCS9000B/HCS9200B Accessories List

Index No.	Part Number	Nomenclature	Units/ Assy **
1	HCS2015-05	Vacuum Hose / Sniffer Assembly, 10 Foot	2/4
	HCS2015-06	. Vacuum Through-Bag Connector (Sniffer)	1
2	HCS9000-70-140	Input Power Cable 120V/240V, 30A, w/o Plug, US/Asia Color Code	1/2
	HCS9000-70-145	Input Power Cable 120V/240V, 30A, w/ 15A Plug, US/Asia Color Code	1/2
	HCS9000-70-150	Input Power Cable 120V/240V, 30A, w/o Plug, UK/Europe Color Code	1/2
3	HCS9000-71-170	Output Power Cable 120 Volt, 30 Amp, 2 Gang Outlet	1/2
	HCS9000-72-170	Output Power Cable 220 Volt, 30 Amp, 2 Gang Outlet	1/2
4	HCS2010-01	Thermocouple Assembly, 10 Foot, Repairable	10/20
	HCS2010-25	Thermocouple Assembly, 10 Foot, Disposable	10/20
5	HCS2021-01	Air Filter / Trap Assembly	1
	HCS1415	. Filter, Element, Air (Internal)	1
6	HC060060E51	Heat Blanket, 6X6, 120 Volt, 5-Foot Lead	1/2
	HC060060E52	Heat Blanket, 6X6, 240 Volt, 5-Foot Lead	1/2
	HC100100E51	Heat Blanket, 10X10, 120 Volt, 5-Foot Lead	1/2
	HC100100E52	Heat Blanket, 10X10, 240 Volt, 5-Foot Lead	1/2
	HC120120E51	Heat Blanket, 12X12, 120 Volt, 5-Foot Lead	1/2
	HC120120E52	Heat Blanket, 12X12, 240 Volt, 5-Foot Lead	1/2
	HC150150E51	Heat Blanket, 15X15, 120 Volt, 5-Foot Lead	1/2
	HC150150E52	Heat Blanket, 15X15, 240 Volt, 5-Foot Lead	1/2
7*	HCS2045-03	Printer Paper, Roll	2/4
8*	HCS2045-04	Printer Ribbon, Cartridge	2/4

* Not Shown ** Quantities shown for HCS9000B / HCS9200B

ADDENDUM A

VACUUM BAGGING TIPS

The following guide is provided to assist technicians in understanding how to design and build a typical vacuum bag used to cure a typical composite repair. This information is provided for informational purposes only. All repair layups, vacuum bagging materials and procedures should be accomplished in accordance with the Original Equipment Manufacturers (OEMs) Structural Repair Manual (SRM) or other approved data. HEATCON® Composite Systems will not be responsible for failure of a cure or damage to a part based on the information provided in this section.

CAUTION

TO PREVENT VACUUM BAG FAILURE AND POSSIBLE DAMAGE TO STRUCTURES, ALWAYS CONSULT THE OEM SRM OR MATERIAL SUPPLIER'S TECHNICAL DATA SHEETS FOR SPECIFICATIONS AND CAPABILITIES OF ANY MATERIALS USED IN THE VACUUM BAGGING PROCESS.

To correctly perform a repair, the technician must have a broad knowledge of materials and the knowledge of how these materials can and cannot be used.

VACUUM BAGGING MATERIALS

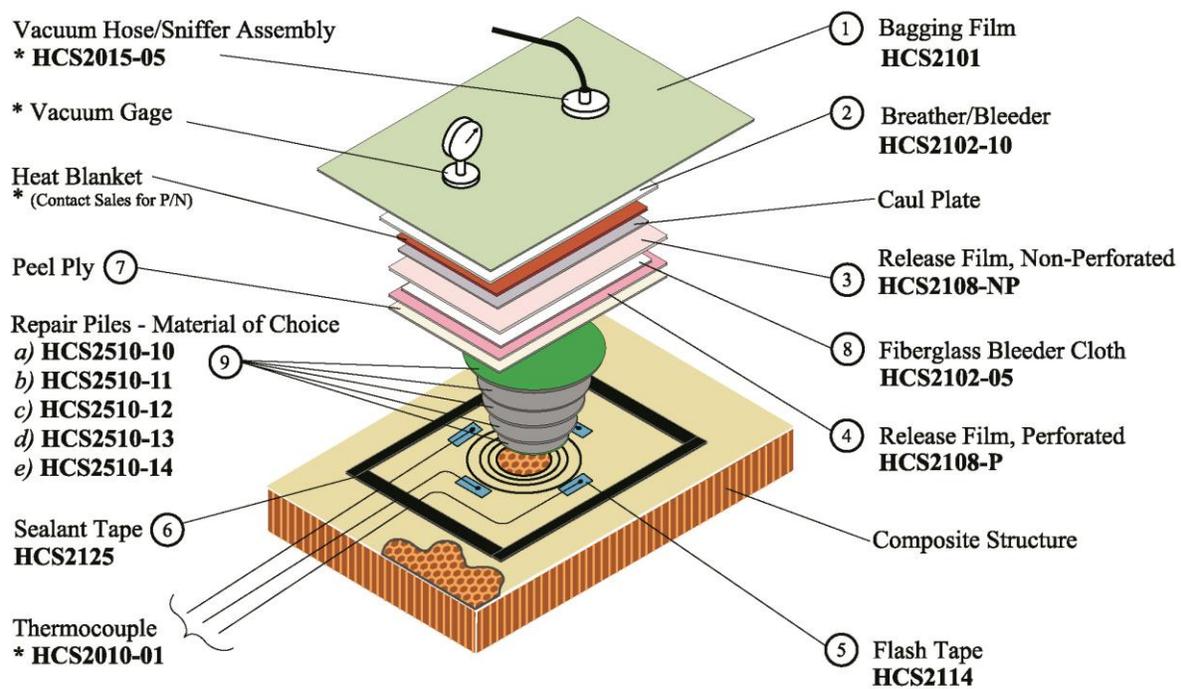
There are many ancillary materials that are used in a vacuum bag cure process. Ancillary materials are those materials that are used to aid and assist the curing process to achieve the required fiber-resin ratio and also provide the ability to produce a patch that bonds to the part and not to other materials. Refer to Figure B1 for typical vacuum bag layout for a cure.

The most common ancillary materials include; release films/fabrics, bleeder and breather cloths, vacuum bagging films, vacuum bag sealant (tacky) tape, and flash tape. Each of these materials is available in various composition, thickness, and temperature ranges.

- 1. Release Films (HCS2108-P or HCS2108-NP) / Release Fabrics (HCS2103-NP and HCS2103-P):**
A release film or fabric is used in direct contact with the resin/adhesive or where control of resin flow is desired. Non-porous release film/fabric (HCS2108-NP or HCS2103-NP) is often referred to as a separator, in that resin/adhesive contact can be made on one side, but it does not pass through. Porous or perforated release films/fabric (HCS2108-P or HCS2103-P) allows resin and air to pass through, yet it is easily removed from the part after the cure.
- 2. Bleeder/Breather Materials (HCS2102-04 or HCS2102-10):** — Bleeders and breathers may be the same material, but are used in different applications. Both are absorbent, highly porous and are typically made of polyester random mat type material (often referred to as baby blanket). Breather (HCS2102-10) is used where contact with the resin is not likely, usually between the vacuum bag film and the rest of the bagging materials to provide a chamber for air to be withdrawn from the layup. Bleeder (HCS2102-04) is typically placed on top of a porous release film/fabric next to the part so as to allow removal of excess resins, air and volatile gases from the patch. This aids compaction and helps to produce a void-free structure. Some OEMs allow fiberglass fabric to be used for both bleeder and breather applications.
- 3. Peel Ply Fabrics (HCS2112):** — Peel ply materials are fine, open-weave fabrics usually consisting of fiberglass, polyester, or nylon construction. Peel plies are layed-up in direct contact with an uncured part surface ply and cured with the part. Upon completion of the cure, the peel ply is bonded into the surface resin of the part. The peel ply is removed from the part immediately prior to secondary bonding leaving a clean surface that does not require sanding or cleaning prior to bonding.
- 4. Vacuum Bagging Film (HCS2101):** — Vacuum Bagging Film comes in many different types, materials, thickness and colors. Most common vacuum bagging film is a general-purpose film, which is a green nylon blown film and is suitable for temperatures up to 350 °F (176 °C). This material will perform satisfactorily in most applications.
- 5. Heat Blanket:** — The heat blanket provides the heat source during a vacuum bag cure. The blanket is typically made of silicone rubber with small Nickel-Chromium (NiChrom) wires are embedded inside the

rubber. These wires will heat due to the resistance of the material when electricity is passed through them. It is a good idea to use a release film/fabric on top and bottom of the heat blanket to protect it from any resins that might get through the layup. Cut the material the same size as the heat blanket or wrap the blanket in the material.

6. **Vac-Valve Through-Bag Connectors / Sniffer (HCS2015-06):** — These quick-lock and unlock connector that provides a method of sealing the vacuum bagging film where the connection between the vacuum bag and the bonder is made. The vac-valve consists of a base and a top with a check valve that attaches to the vacuum hose from the bonder. A high-temperature rubber gasket provides a vacuum-tight seal with the vac-valve on the top, the vacuum bag film in the middle, and the base inside the vacuum bag. This seal is necessary to ensure vacuum integrity of the vacuum bag. Two Vac-valves should be installed in each vacuum bag. One is connected to the vacuum out port and the other is connected to the vacuum return monitor port on the bonder. If vacuum is provided by a source other than the bonder, only the vacuum monitor port is connected to the bonder. The base should be positioned outside the repair area on top of the breather so that it does not leave an imprint on the repair.
7. **Caul Plate:** — A caul plate is a thin copper, aluminum or composite plate typically between 0.010 – 0.020 inch (0.254 – 0.508 mm) thick that is used to evenly distribute temperature and pressure over the repair area. Caul plates may or may not be used in repairs, depending on the contour of the part being repaired and SRM requirements.
8. **Vacuum Bag Sealant Tape (HCS2125):** — This sealant tape (tacky tape) is used to provide an air-tight seal between the part or tool and the vacuum bagging film, thus creating a vacuum chamber which allows atmospheric pressure (14.7 psi at sea level) to apply compacting pressure to the repair patch. Vacuum bag sealant tape is a putty-type extruded tape. The tape is typically 25 foot (3.04 m) long and ¼ inch (6.35 mm) wide.
9. **Flash Tape (HCS2114)** — Flash tape is a high-temperature Teflon tape that is used inside the vacuum bag to hold thermocouples and bagging materials in place during the vacuum bag layup process. It is especially helpful if the repair is not a flat surface such as on the side of an aircraft or when the repair is overhead.



Typical Composite Repair Lay Up

** Item available separately*

Figure A-1. Vacuum Bag Layup Materials