

Instruction Manual

TCU 40/80 Single Channel Temperature Control Unit



FOR SALES AND SERVICE PLEASE CALL:

PTB SALES

T :: 626.334.0500
service@ptbsales.com
www.ptbsales.com

DATE SERVICED: _____

VIEW OUR INVENTORY



EDWARDS

Edwards High Vacuum International

One Edwards Park 301 Ballardvale Street Wilmington, MA 01887

Telephone: (508) 658-5410 Telex: 710-347-7672 Fax: (508) 658-7969

Declaration of Conformity

We, Edwards High Vacuum International,
One Edwards Park
301 Ballardvale St.
Wilmington, MA 01887

declare under our sole responsibility that the product(s)

TCU 40/80 Temperature Control Unit
W95000000

to which this declaration relates is in conformity with the following standard(s)
or other normative document(s)

BS IEC1010-1	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use.
BS EN50081-1	Electromagnetic Compatibility, General Emission Standard. Generic Standard Class: Domestic, Commercial & Light Industry.
BS EN50082-1	Electromagnetic Compatibility, General Immunity Standard. Generic Standard Class: Domestic, Commercial & Light Industry

following the provisions of

89/392/EEC	Machinery Safety Directive
89/336/EEC	Electromagnetic Compatibility Directive
73/023/EEC	Low Voltage Directive

A. Troup

12/10/95 Crawley

Dr. A. P. Troup, Director of Technology

Date and Place

This product has been manufactured under a quality system registered to ISO9001



EDWARDS

CONTENTS

Section	Title	Page
1	PREFACE.....	1
1.1	Safety considerations	1
2	TCU 40/80	3
2.1	Scope of the manual.....	3
2.2	Description of the TCU 40/80	3
2.3	Lockout procedure	3
2.4	Safety features	4
3	QUICK START PROCEDURE	5
3.1	Power up.....	5
3.2	Setpoint verification.....	5
4	PRODUCT DESCRIPTION	6
4.1	Refrigeration and coolant circuits	6
4.2	Refrigeration.....	9
4.2.1	If cooling is required:	9
4.2.2	If cooling is <i>not</i> required:	10
4.3	Coolant circuit.....	10
4.4	Temperature monitoring	10
4.5	Front panel	11
4.6	Rear panel	13
4.7	Specifications	14
4.8	Dimensions.....	15
5	INSTALLATION.....	16
5.1	Receiving and unpacking.....	16
5.2	Location	16
5.2.1	Securing the unit	16
5.2.2	Installing the secondary containment receptacle	16
5.2.3	Floor levelers.....	16
5.3	Stacking	17
5.3.1	Tie-bolts.....	17
5.4	Facilities.....	17
5.4.1	Water and coolant connections	18
5.4.2	Water	19
5.4.3	Coolant	19
5.4.4	Remote connections.....	19
6	OPERATION	20
6.1	Preparation	20
6.2	Powering up the TCU 40/80.....	20
6.3	Changing the setpoint value (SV1)	21
6.4	Temperature controller Pid settings.....	21
6.5	Remote set-point.....	22
6.6	Flow rate adjustment.....	22

7	MAINTENANCE	23
7.1	Hazard warnings.....	23
7.2	Hazards	25
7.3	Filling the reservoir	26
7.4	Draining/bleeding the coolant reservoir	26
7.5	Temperature probe calibration	27
7.6	Preventive maintenance schedule.....	27
7.7	Semi-annual preventative maintenance.....	28
7.7.1	Required equipment	28
7.7.2	Preparation.....	28
7.7.3	Verify system status.....	28
7.7.4	Refrigeration leak check.....	28
7.7.5	Fluorinert leak check.....	28
7.7.6	Water leak check.....	28
7.7.7	Insulation repair.....	28
7.7.8	Lamp check/replacement.....	29
7.8	Annual preventative maintenance	30
7.8.1	Required equipment	30
7.8.2	Required supplies	30
7.8.3	Solenoid valve coil replacement.....	30
7.8.4	System check.....	32
7.9	Preventive maintenance checklist.....	41
8	TROUBLESHOOTING.....	42
9	ACCESSORIES AND SPARE PARTS	52
	APPENDIX.....	54
	Return of Edwards Equipment - Procedure (Form HS1).....	58
	Return of Edwards Equipment- Declaration (FormHS2).....	59
	Legal notices, limitations and disclaimers.....	60
	MSDS (material safety data sheet) - "SUVA" HP62.....	61

ILLUSTRATIONS

Figure	Title	Page
Figure 1-	Refrigeration and coolant components.....	6
Figure 2 -	Refrigeration and coolant components.....	7
Figure 3-	Refrigeration and coolant circuits.....	9
Figure 4 -	Front panel.....	11
Figure 5 -	Electrical rear panel	13
Figure 6 -	TCU dimensions	15
Figure 7-	Stacked TCU 40/80 systems	17
Figure 8-	System rear view	18
Figure 9	Water connections	19
Figure 10 -	Temperature controller.....	21
Figure 11 -	Lamp replacement.....	29
Figure 12 -	Solenoid coil replacement.....	31
Figure 13 -	Electrical drawer	51
Figure 14-	Electrical drawer schematic.....	54
Figure 15 -	Remote interface.....	56

Table	Title	Page
Table 1 -	Safety features	4
Table 2 -	Front panel Indicators.....	5
Table 3 -	Refrigeration and coolant components	8
Table 4 -	Front panel controls.....	11
Table 5 -	Front panel LED indicators.....	12
Table 6 -	Temperature controller	12
Table 7 -	Description of rear panel components and indicators	13
Table 8 -	Front panel power up indicator conditions	20
Table 9 -	Electrical hazards classifications.....	25
Table 10 -	Preventive maintenance schedule.....	27
Table 11-	Faults identified by front panel lamps	42
Table 12 -	Faults indicated by the front panel LED indicators.....	44
Table 13 -	Faults identified by rear panel indicators.....	48
Table 14 -	Miscellaneous fault conditions	49
Table 15 -	Accessories.....	52
Table 16	Spare parts.....	53

TRANSLATIONS

The TCU 40/80 Instruction Manual is available in the following translations:

Language	Edwards part number
English	W95900001
French	W95900004
German	W95900005
Italian	W95900006
Japanese	W95900007

For each TCU 40/80 purchased, you are entitled to one translated manual free of charge. This is in addition to the English version provided. Fax this completed form to the nearest Edwards location to receive your complimentary translation.

Name:	_____
Title:	_____
Company:	_____
Address:	_____

TCU serial number:	_____
Language: (circle one)	
	French
	German
	Italian
	Japanese

1 PREFACE

1.1 Safety considerations

Many safety features have been designed into the TCU 40/80 to protect the operator and the equipment.

The following symbols are used in this manual to indicate the various safety conditions.

General Alert



General Alert symbol denotes the potential of personal hazards or equipment failure.

Warnings are given when failure to observe the instruction could result in injury or death to persons.

Cautions are given where failure to observe the instruction could result in damage to the equipment, associated equipment and process.

Statement on avoiding the hazard.

Electric Shock



Electric Shock symbol denotes the presence of high voltage or current. It calls attention to the procedure, practice, or the like, which if not done correctly or adhered to could result in injury or death.

Statement on avoiding the hazard.

Eye Protection



Eye Protection symbol denotes a hazard which could cause injury or irritation to the eyes.

Statement on avoiding the hazard.

Toxic Gases



Toxic Gases symbol denotes a personal hazard.

It calls attention to the procedure, practice, or the like, which if not done correctly or adhered to could result in injury or death.

Statement on avoiding the hazard.

Hot Surfaces



Hot Surfaces symbol denotes a hazard which could cause injury or burns.

Statement on avoiding the hazard.

Hand Protection



Hand Protection symbol denotes a hazard which could cause injury or burns

Statement on avoiding the hazard.

High Pressure



High Pressure symbol denotes a personal hazard or equipment failure. It calls attention to the procedure, practice, or the like, which if not done correctly or adhered to could result in equipment damage, injury or death.

Statement on avoiding the hazard.

Extreme Temperature



Extreme Temperature symbol denotes a hazard which could cause injury or burns.

Statement on avoiding the hazard.

2 TCU 40/80

2.1 Scope of the manual

This manual provides information on the installation, start-up and operation of Edwards High Vacuum Model 40/80 Temperature Control Unit (TCU 40/80).

The **Quick Start Procedure** on page 5 is a step by step guide for the start up and use of an installed, working system.

Installation, starting on page 16, provides instructions and information for installing the system. The installer must have sufficient technical understanding of electrical and mechanical systems to properly use this information.

Operation, starting on page 20, provides more complete instructions on the preparation and use of the system.

2.2 Description of the TCU 40/80

The TCU 40/80 is a single-channel temperature control unit engineered for temperature control of remote heat loads.

From distances up to 50 feet, the TCU 40/80 can cool the heat load generated by the process equipment. The coolant circulates through the TCU 40/80, where it is cooled or heated as required, then is transferred to the process equipment, and returns in a closed loop. The TCU 40/80 maintains supply coolant at a temperature between -40°C and $+80^{\circ}\text{C}$, selectable in 0.1°C increments, with a tolerance of $\pm 1.0^{\circ}\text{C}$.

2.3 Lockout procedure

To prevent accidental or unauthorized starting of the TCU 40/80 during maintenance, disconnect the power cord from the receptacle and install an appropriate lock-out device (Hubbell Small Plugout™ or equivalent) on the end of the power cord.

2.4 Safety features

The safety features listed in Table 1 are designed into the TCU 40/80.

Table 1 - Safety features

Component	Ref. des.*	Function
EMERGENCY OFF button (EMO)	(PB1)	Shuts off power to major system components.
Remote EMERGENCY OFF	(J72J2)	Remote shut off of power to major system components.
Drawer safety switch	(LS1)	Upon opening the drawer, shuts off power to major system components.
Pressure switch	(PS1)	Protects the refrigeration system against high discharge pressure. Interrupts operation at 300 psig.
Condenser pressure relief valve	(W2)	Vents refrigerant to the atmosphere above 350 psig. Fail safe for PS1, works even if there is no power applied to the system.
Reservoir pressure relief valve	(W1)	Protects the reservoir from over-pressure.
Temperature switch	(TS1)	Protects the process fluid from exceeding 99 °C
Coolant flow switch	(FS1)	Protects the process equipment from inadequate coolant flow rates.
Coolant float switch	(LLS1)	Protects against low level in the coolant reservoir by stopping the equipment.
Coolant float switch	(LLS3)	Protects against overfill of the coolant reservoir. Indication on front and rear panels.
Thermal overload	(K3)	Protects the pump motor from excess current.
Surge suppression	VR1-4	Protects the TCU 40/80 against voltage surges and power line transients.
Line phase monitor	PMR1	Protects the equipment against incorrect wiring of the supply phases and low voltage burn-out.
Current sensor	CSR1	Protects the compressor against abnormal conditions.
Secondary containment		Captures fluids (internal to the TCU) in the event of a leak.

* See Figure 3 on page 9.

3 QUICK START PROCEDURE

This Quick Start procedure is for easy start up and operation of an installed and fully working TCU 40/80. If your TCU 40/80 is not installed, go to **Installation** on page 16. Detailed operating instructions are in **Operation** on page 20.

If at any time an alarm occurs, press **STOP** and correct the fault indicated by the display as directed in the **Troubleshooting Guide** on page 42. Press **RESET** and **START** to continue operation.

3.1 Power up

Before applying power, verify that all water and coolant lines are connected to the system. The handles on both coolant line valves should be in the open position. For the location of these connections, refer to Figure 8 on page 18.

To power up the TCU 40/80:

1. **READY** light should be on. If the ready light is not on see **Powering Up the TCU 40/80** on page 20.
2. Press **RESET**. Verify that front panel indicators are as shown in the **Reset** column of Table 2 on this page.
3. Press **START**. Verify that front panel indicators are as shown in the **Start Condition** column of Table 2 on this page.

If in steps two or three any front panel indicators do not match Table 2, refer to the **Troubleshooting Guide** on page 42 for corrective action.

4. Verify that the coolant pressure gauge (located on the front access panel) reads less than 100 psig.

Table 2 - Front panel Indicators

Indicator	Reset Condition	Start Condition
POWER ON	Green	Green
RESET	White	White
FACILITY POWER	Green	Green
FACILITY WATER	Green	Green
CIRCUIT BREAKERS	Green	Green
COMPRESSOR	Off	Green
TEMPERATURE	Green	Green
FLOW	Off	Green
NORMAL LEVEL	Green	Green
LOW LEVEL	Off	Off
REMOTE RTD (optional)	Green (if used)	Green (if used)

3.2 Setpoint verification

Verify that the manual mode setpoint value (SV1) displayed on the temperature control is the value desired. To change the Setpoint value see **Changing the Setpoint Value (SV1)** on page 21.

Do not to exceed the normal operating parameters. The system is designed to operate from -40 °C to +80 °C.

4 PRODUCT DESCRIPTION

4.1 Refrigeration and coolant circuits

Figure 1, Figure 2, and Table 3 on page 8 describe the refrigeration and coolant components of the TCU 40/80.

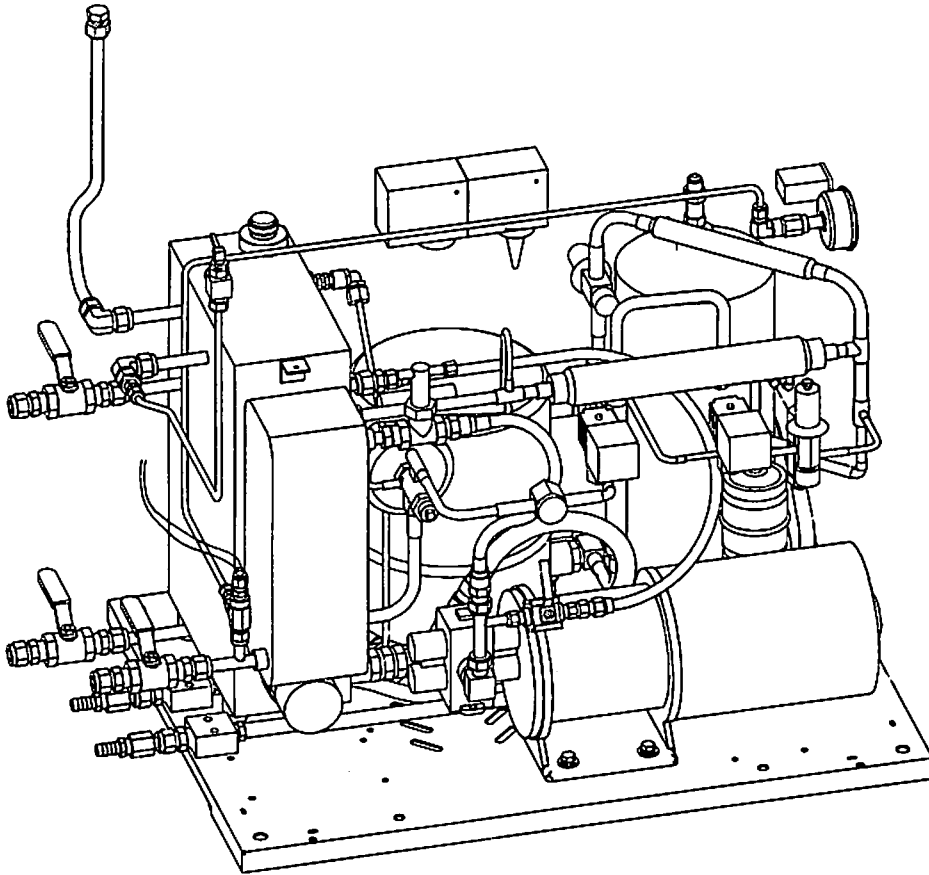


Figure 1- Refrigeration and coolant components

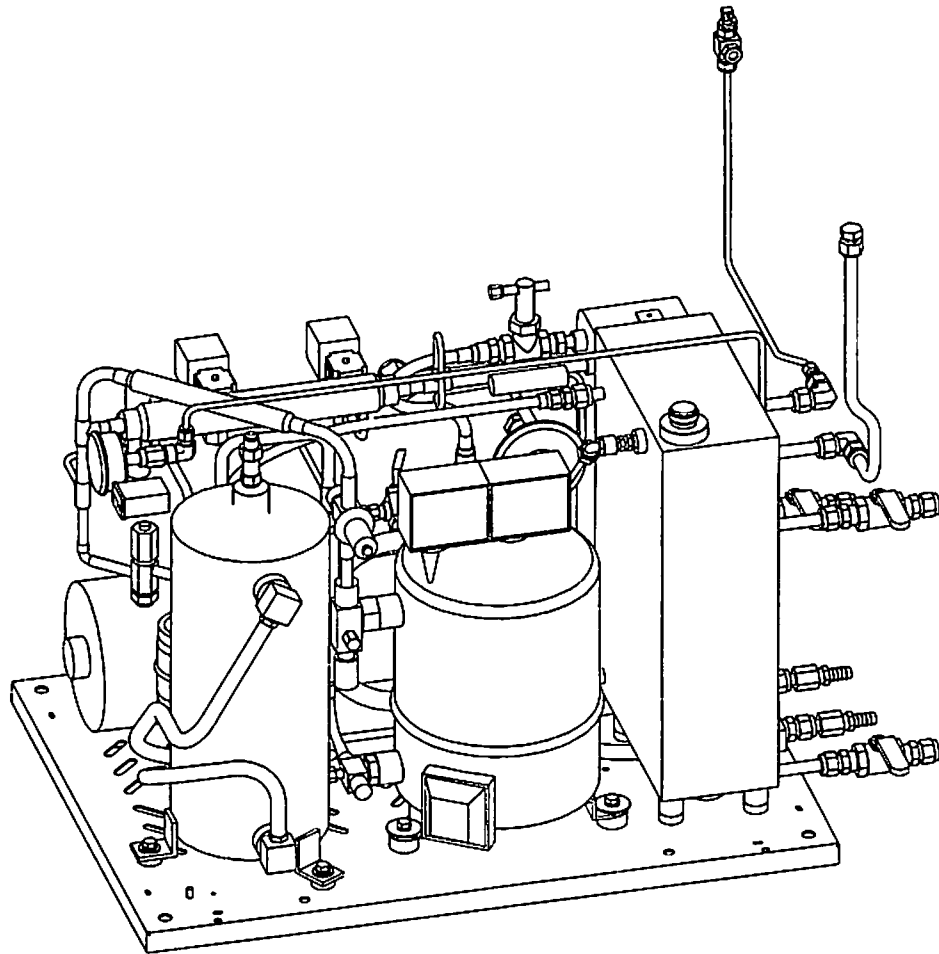


Figure 2 - Refrigeration and coolant components

Table 3 - Refrigeration and coolant components

Item	Component name	Function
1	Reservoir	A holding tank for the Fluorinert coolant.
2	Level switch	Monitors the coolant level in the reservoir.
3	Compressor	Compresses the refrigerant fluid.
4	Crankcase regulator	Protects the compressor against pressure overload.
5	Suction service valve	Allows isolation at the compressor.
6	Discharge service valve	Allows isolation at the compressor.
7	Temperature switch	High limit switch for reservoir heater.
8	Pressure switch	Limits maximum allowable discharge pressure.
9	Condenser	Transfers heat from the compressed refrigerant to the facility water.
10	Filter dryer	Removes contaminants and moisture from the refrigerant.
11	Safety cooling valve	Limits the discharge temperature.
12	Motor	Drives the coolant pump.
13	Pump	Circulates the Fluorinert coolant.
14	Bypass valve	Regulates coolant flow.
15	Hot gas bypass valve	Regulates cooling capacity.
16	Subcooler	Further cools the refrigerant that is returning to the compressor.
17	Solenoid valve SV2	Allows refrigerant to pass through the hot gas bypass valve, then to the compressor suction line when energized.
18	Solenoid valve SV1	Allows refrigerant to pass to the TEV when energized.
19	Sight glass	Allows visual inspection of the refrigerant charge and presence of moisture in the system.
20	TEV (Thermostatic expansion valve)	Allows the refrigerant to expand from a liquid to a gas.
21	Heater	Raises the temperature of the coolant when the process requires heating.
22	Flow switch	Monitors the flow rate.
23	Heat exchanger	Extracts heat from the coolant and transfers it to the refrigerant.
24	Pressure relief valve	Discharges refrigerant from the system to the atmosphere in the event of severe over-pressure condition.

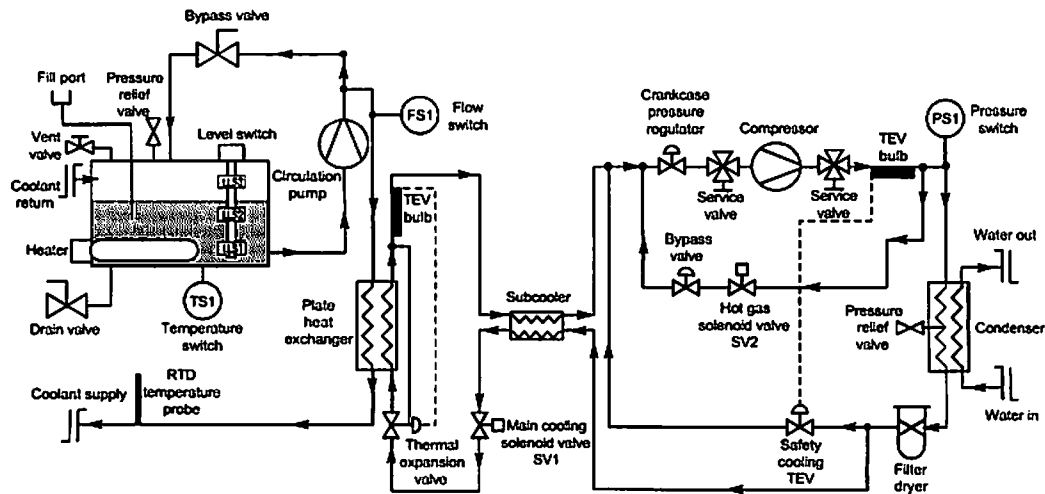


Figure 3- Refrigeration and coolant circuits

4.2 Refrigeration

(see figure 3 above)

1. Refrigerant gas enters the compressor at low temperature and pressure. It leaves the compressor at high pressure and temperature.
2. The gas passes into the condenser, where heat is removed by the external water supply, causing the gas to condense into a liquid.
3. The cool liquid refrigerant exits the condenser and passes through a filter dryer that removes any residual moisture or contaminants.

4.2.1 If cooling is required:

1. Solenoid valve SV1 opens (coil energized), allowing the refrigerant to flow into the Thermostatic Expansion Valve (TEV). The pressure drop across the TEV causes the refrigerant to change from a liquid to a mixture of liquid and gas.
2. The liquid and gas mixture enters the heat exchanger where it becomes entirely a gas. The process of expansion from a liquid to a gas reduces the temperature by absorbing energy.
3. The refrigerant leaving the heat exchanger returns to the compressor through the subcooler and a crankcase pressure regulator. The subcooler further cools the refrigerant entering the TEV.

4.2.2 If cooling is *not* required:

1. Solenoid valve SV1 closes (coil de-energized).
2. Hot refrigerant from the compressor is passed through SV2 (coil energized) and a hot gas bypass valve before returning to the compressor suction line. This bypassing allows the compressor to run continuously.
3. Cooling, required to prevent the compressor from overheating, is provided by allowing some of the liquid from the condenser to pass through the safety cooling automatic expansion valve into the suction line, thus maintaining the discharge gas temperature below 99 °C.

4.3 Coolant circuit

Coolant is pulled from the reservoir by the circulation pump and transferred to the heat exchanger where it is cooled by the refrigeration system as required. It then flows to the process equipment by means of the coolant supply hose.

The coolant returns to the TCU 40/80 reservoir by means of the coolant return hose.

The coolant system requires 8 liters of coolant for the reservoir, plus the volume of the circulation lines and any other spaces filled with coolant that are attached to the TCU 40/80.

To increase the coolant temperature, the reservoir uses an electrical resistance heater that is controlled by the temperature controller. The heater must be fully submerged at all times, and if the coolant in the reservoir falls below 3.5 liters, a level switch causes the status alarm signal to automatically shut down the TCU 40/80.

A three-float level switch, a thermostat, and a flow sensor provide coolant status signals to the TCU 40/80 control system.

4.4 Temperature monitoring

A Resistance Temperature Device (RTD) monitors the temperature of the coolant leaving the TCU 40/80 and transmits this information to the temperature controller. The TCU 40/80 compares the output of the RTD to the selected process temperature (SV1) and determines if the coolant needs to be cooled or heated. The temperature controller then operates the main cooling solenoid valve or heater.

The coolant temperature at the supply port on the rear panel is measured by a local, internally connected RTD. If sensing of process equipment temperature is needed, connect an RTD to J72J3 at the rear panel (see Figure 5 on page 13). For remote connection schematic details, see Figure 15 on page 56.

4.5 Front panel

Figure 4 shows the Front Panel. Table 4, Table 5 and Table 6 identify its controls and indicators.

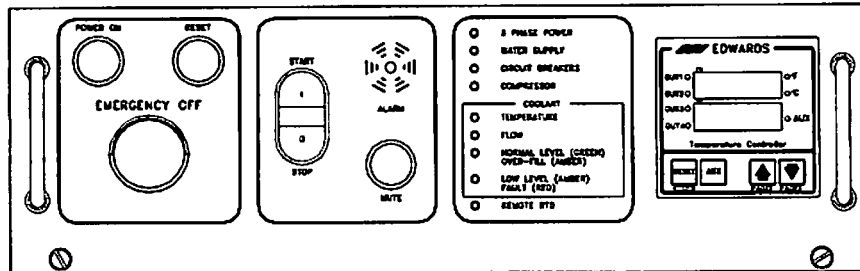


Figure 4 - Front panel

Table 4 - Front panel controls

Control name	Description
POWER ON	Lights green when power is being supplied to the TCU 40/80.
RESET	Resets alarms and makes the TCU 40/80 ready to operate. The white light indicates that the TCU 40/80 is ready to operate.
EMERGENCY OFF	Removes power from all TCU 40/80 circuits except the EMERGENCY OFF circuit. To shut off power, push EMERGENCY OFF (EMO). To reset, rotate the EMERGENCY OFF button clockwise as shown on the switch.
START/STOP	Starts and stops the operation of the TCU 40/80.
ALARM	Emits a high pitched sound when there is a fault condition which has caused the TCU 40/80 to stop operation.
MUTE	Silences the audible alarm.

Table 5 - Front panel LED indicators

LED name	Condition	Description
FACILITY POWER	Green	Power phases are normal.
	Red	Power phases are reversed or low line voltage.
FACILITY WATER	Green	Water pressure and flow are normal.
	Red	Water pressure or flow are not adequate. (See Specifications on page 14.
CIRCUIT BREAKERS	Green	Rear panel circuit breakers 2, 3, and 4 are on.
	Red	One or more of these breakers is tripped or off.
COMPRESSOR	Green	Compressor is operating normally.
	Red	Compressor has stopped operating.
COOLANT TEMPERATURE	Green	Coolant reservoir temperature is normal.
	Red	Coolant temperature is above the operating range.
COOLANT FLOW	Green	Coolant flow is normal.
	Red	Coolant flow is not adequate.
COOLANT NORMAL LEVEL	Green	Coolant level is normal .
	Amber	Coolant level is over filled.
COOLANT LOW LEVEL	Off	Coolant level is normal
	Amber	Coolant level is low.
	Red	Coolant level is very low.
REMOTE RTD	Off	Remote RTD not connected.
	Green	Remote RTD temperature probe is in use.

Table 6 - Temperature controller

Controls and indicators	Description
Process Value (PV)	The present temperature of the coolant, as indicated by the internal RTD or the remote RTD.
Setpoint Value (SP)	The TCU 40/80 regulates to this temperature, as set by the operator.
Pushbuttons	Used to program the controller.
Remote Mode LED (Aux)	Indicates mode of operation: Off indicates local operation. On indicates remote operation.

4.6 Rear panel

Figure 5 shows the rear panel. Table 7 identifies the controls and indicators on the rear panel.

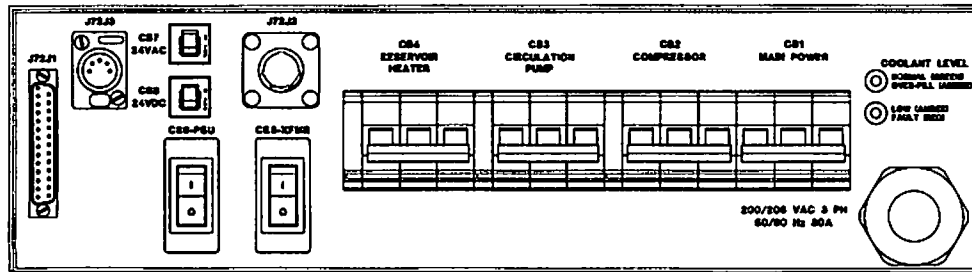


Figure 5 - Electrical rear panel

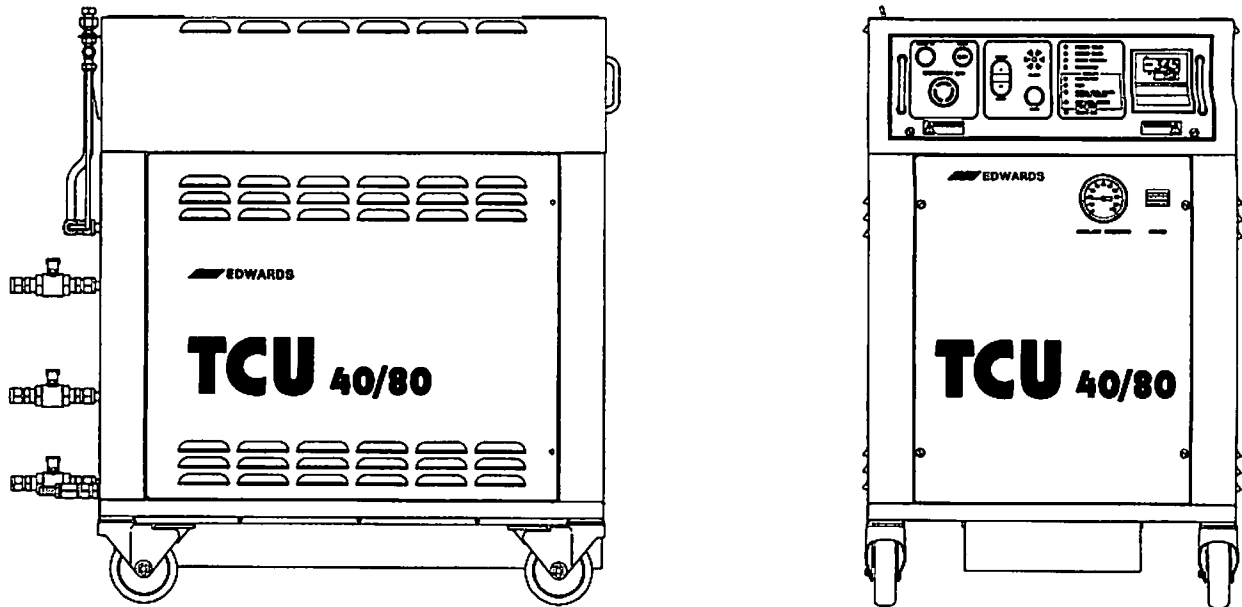
Table 7 - Description of rear panel components and indicators

Label	Description
J72J3	Five pin connector for remote RTD interface. See Figure 15 on page 56 for pinouts.
CB7 24 VAC	1-pole, 2 Amp circuit breaker. Isolates the 24 VAC transformer. Normally on (in).
CB8 24 VDC	1-pole, 2 Amp circuit breaker. Isolates the 24 VDC power supply output. Normally on (in).
J72J2	Nine pin connector for remote EMERGENCY OFF, start-stop operation, and remote setpoint operation enable. See Figure 15 on page 56 for pinouts.
CB4 reservoir heater	3-pole, 10 Amp circuit breaker. Normally on (up).
CB3 circulation pump	3-pole, 6 Amp circuit breaker. Normally on (up).
CB2 compressor	3-pole, 16 Amp circuit breaker. Normally on (up).
CB1 main power	3-pole, 25 Amp circuit breaker. Normally on (up).
normal/overfill	Normal, LED Green Overfilled, LED Amber
low/fault	Low, LED Amber Fault, LED Red
200/208 VAC 3 PH 50/60 Hz 30A	Mains input power connector.
CB5-XFMR	2-pole, 0.5 Amp circuit breaker. Isolates the equipment transformer.
CB6-PSU	2-pole, 0.3 Amp circuit breaker. Isolates the power supply.
J72J1	37 pin D-subminiature connector, for setpoint value signal, process value signal, and remote fail and warning signals. See Figure 15 on page 56 for pinouts.

4.7 Specifications

Parameter	Conditions	Specification
Temperature ramp	Coolant short circuit conditions	
	+25 °C to +80 °C	Elapsed time: <25 minutes
	+25 °C to -30 °C	Elapsed time: <20 minutes
Cooling capacity @ process equipment 150 watt coolant line losses; coolant water @ 15 °C	Process coolant @ -40 °C	350 watts
	Process coolant @ -20 °C to +80 °C,	2000 watts
Heating element		2800 watts
System flow	@20 °C, 60 psig	3 gpm (11.36 lpm)
Process temperature range		-40 °C to +80 °C
Setpoint resolution		± 0.1 °C
Temperature regulation		± 1.0 °C typical
Facility water requirements	+10 °C (-0° +2°) to +26 °C (+0° -2°)	3 to 6 gpm (11.36 to 22.71 lpm)
Power requirements	3-phase delta (balanced load) , 4 wire (3 phases & earth gnd), 200 to 208 VAC, 50/60 Hz	30 amp outlet
Ambient operating temperature		+10 °C to +50 °C
Weight		450 pounds (204 kg)
Dimensions		22" wide x 30" deep x 35" high (56 cm x 76 cm x 89 cm)
Altitude		Up to 2000 meters (6562 ft.)
Max. relative humidity	Up to 31 °C	80%
	Above 31 °C	Derate linearly to 50% @ 50 °C,
Transient overvoltage	IEC 664, Installation Category II	2.5 kV
Pollution Degree	IEC 664	2 Π
Sound pressure level	At a distance of 1 meter.	65dB(A)

4.8 Dimensions



inches
(millimeters)

Figure 6 - TCU dimensions

5 INSTALLATION

5.1 Receiving and unpacking

Do a complete visual inspection of the TCU 40/80 for any damage. Do not use the TCU 40/80 if physical damage is evident. If there is any damage, notify your supplier and the carrier in writing within three days; state the item number of the TCU 40/80 together with your order number and supplier's invoice number. Retain all packing materials for inspection.

Caution



When using a forklift to move or position the TCU 40/80, do not install the secondary containment receptacle until the TCU 40/80 is in position.

Failure to follow these instructions may lead to damage of the secondary containment receptacle caused by the forks of the forklift.

5.2 Location

Allow a space 46" wide x 54" deep for the TCU 40/80 cable and coolant connections. The TCU 40/80 should have at least two feet of clearance at the rear and one foot along the sides of the unit. Be sure that the mounting surface can safely support the weight of the TCU 40/80 (450 pounds evenly distributed). The center of gravity is approximately the center of the refrigeration compartment.

When using a fork-lift to move the TCU 40/80, position the forks from the side of the unit.

Warning



The TCU 40/80 weighs 450 pounds (204 kg).

Failure to take proper care in moving or lifting these units can result in serious bodily injury.

A 3 foot (1m) service length of the power cable is required to fully open the electrical drawer. Therefore, do not install the TCU 40/80 further than 7 feet (2.1m) from the power source.

5.2.1 Securing the unit

The four lockable casters of the TCU 40/80 swivel to provide maximum maneuverability. Make sure that all four casters are turned inward and locked in position once the TCU 40/80 is situated.

5.2.2 Installing the secondary containment receptacle

The secondary containment receptacle slides into the base from the rear of the unit.

5.2.3 Floor levelers

An optional floor leveler kit is available to compensate for uneven surfaces. See Table 15 on page 52 for ordering information.

5.3 Stacking

The TCU 40/80 may be stacked two high. Be sure that the mounting surface can safely support the weight of the two units (900 pounds, 408 kg).

Be sure that the casters of the top unit are turned inwards, but are not locked, until the top unit is fully seated.

5.3.1 Tie-bolts

An optional tie-bolt kit is available for attaching stacked units. See Table 15 on page 52 for ordering information.

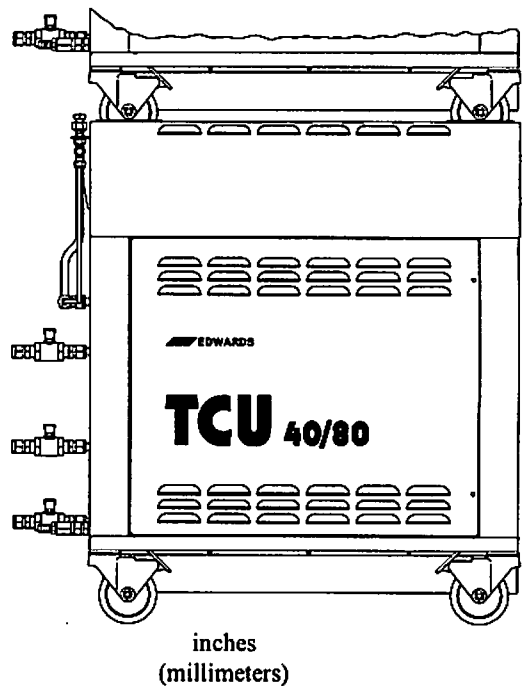


Figure 7- Stacked TCU 40/80 systems

5.4 Facilities

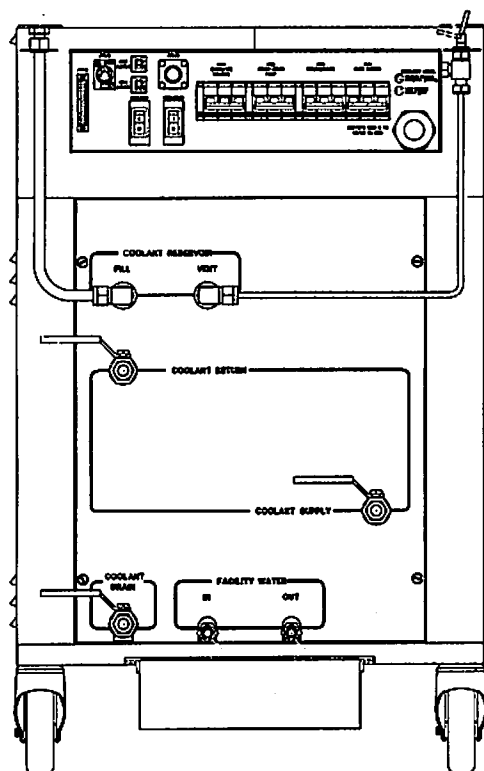
The TCU 40/80 requires a water supply flow rate between 3 to 6 gallons per minute at a maximum pressure of 100 psig, and an inlet temperature range of 10 °C to 26 °C

Power input is by a fused, suitable isolating electrical outlet, 208 VAC, 50/60 Hz, 30 amp, 3-phase delta (balanced load) , 3-wire and earth.

The required receptacle type is Hubbell P/N L21-30R2810-A, or equivalent.

5.4.1 Water and coolant connections

Figure 8 shows a rear view of the TCU 40/80 with its water and coolant connections.



inches
(millimeters)

Figure 8- System rear view

5.4.2 Water

Connections to the water supply and return are made to either 1/2" brass barb fittings or 1/2" compression fittings.

For bare hose connections (1/2" nominal I.D.):

1. Slip the hose over the barb fitting and tighten the hose clamp.
2. Turn on the water supply and check for leaks.

For connections using hose with tube adapters or tubing (1/2" nominal O.D.):

1. Remove the adapter coupled to the hose barb.
2. Insert the tube adapter or tubing with the appropriate ferrule and compression nut.
3. Tighten the compression nut, turn on the water supply, and check for leaks.

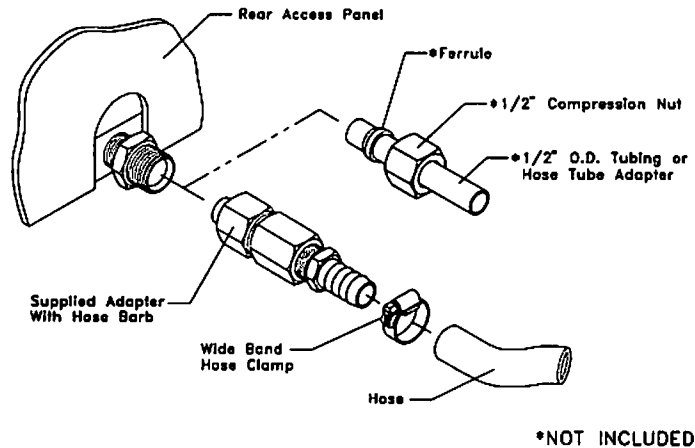


Figure 9 Water connections

5.4.3 Coolant

Note: If this TCU 40/80 is being installed on process equipment that has been used with a coolant other than Fluorinert, contact process equipment supplier for retrofit instructions.

Connections to the coolant supply and return are made on the rear panel (see Figure 8 on page 18). The maximum distance between the process equipment and the TCU 40/80 is 50 feet (100 feet total hose length).

1. Attach the hoses to the supply and return compression fittings. Follow the hose manufacturers recommendations for appropriate adapters.
2. Insulate the hoses with closed cell insulation in order to minimize heat loss.
3. Tape and glue the insulated joints to avoid condensation and icing.

5.4.4 Remote connections

Wiring details for remote connections are shown in Figure 15 on page 56. Remote connections should not be run near or parallel to a.c. power lines or in the vicinity of equipment that generates large electric fields.

6 OPERATION

6.1 Preparation

Verify that water and coolant connections are made at both ends, that the drain valve is closed and the coolant supply and return valves are open. Connect the remote interfaces if required.

1. To use an external RTD probe, attach it to connector J72J3. Refer to Figure 15 on page 56. Verify that the plug J72J2 is installed.
2. Press the EMERGENCY OFF button on the front panel.
3. Plug the TCU 40/80 power cord into a fused, switchable, 30 amp, 3-phase, 208 VAC outlet.
4. Ensure that all circuit breakers on the rear panel are in the ON position. CB7 and CB8 are non-switchable circuit breakers and will trip when there is a problem. They cannot be turned on or off, but they are re-settable.

6.2 Powering up the TCU 40/80

1. Verify that the POWER ON lamp on the front panel is illuminated.
2. Release the EMERGENCY OFF button.

Caution



If the Facility Power LED illuminates, the line voltage is low, or the phase of the main power supply is reversed.

Adjust the line voltage, if it is low.

Correct the phases by swapping two phases in the electrical outlet.

3. Press the RESET button and verify the front panel indicators are as in the Reset Condition column of Table 8.

Table 8 - Front panel power up indicator conditions

Indicator	Reset condition	Start condition
POWER ON	Green	Green
RESET	Off	White
FACILITY POWER	Green	Green
FACILITY WATER	Green	Green
CIRCUIT BREAKERS	Green	Green
COMPRESSOR	Off	Green
TEMPERATURE	Green	Green
FLOW	Off	Green
NORMAL LEVEL	Off	Green
LOW LEVEL	Red	Off
REMOTE RTD (if used)	Green	Green

4. Press MUTE to silence the alarm.

The TCU 40/80 is shipped without coolant. The coolant level alarm will sound and the front panel Reservoir Coolant Low Level LED will be red indicating that the reservoir must be filled.

5. Fill the coolant reservoir using the procedure Filling the Reservoir on page 26.
6. Press the START button and verify the front panel indicators are as in the Start Condition column of Table 8.
7. Use a halogen leak detector to check all supply and return line connections at both the TCU and process equipment, around the pump head assembly, drain valve, heater, flow switch, vent line, fill line, and reservoir pressure relief valve.

6.3 Changing the setpoint value (SV1)

The following instructions are for local temperature control only.

Caution



Do not exceed the temperature range of -40 °C to +80 °C.

This is the normal operating range of the TCU 40/80.

To change the temperature settings press page up or page down to either increase or decrease the temperature. The red display "PV" indicates the process value. The green display "SP" indicates the current setpoint.

Note: The temperature controller has been programmed to prevent the setpoint from exceeding the normal operating range of the TCU 40/80. The controller is also protected from unauthorized changes to the Pid and other settings. Contact the process equipment supplier for access to these settings and other information.

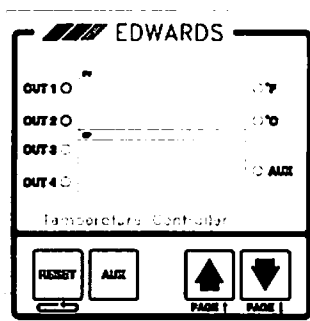


Figure 10 - Temperature controller

6.4 Temperature controller Pid settings

Edwards default settings are:

PID1 - heating	value	PID2 - cooling	value	parameter
Pb1	8.0	Pb2	12.5	proportional band
Ar1	0.43	Ar2	0.7	automatic reset
rAt1	7.0	rAt2	9.0	rate
db1	1.0	db2	1.0	deadband

6.5 Remote set-point

To use the remote set-point, wire the J72J2 mating connector as illustrated on page 56.

24vac must be applied to pins 3 and 4.

The AUX LED on the temperature controller will illuminate indicating remote setpoint enable mode as soon as the mating connector is installed.

6.6 Flow rate adjustment

Caution



Do not exceed coolant pressure of 100 psi.

Exceeding the coolant pressure may result in damage to the pump.

The Fluorinert flow rate of the TCU 40/80 is factory set to provide approximately 3 gpm at 60 psig/20°C for a unit operating at 208vac/3-ph/60Hz. If the flow rate requires adjustment to accommodate the process equipment suppliers recommendations, follow the steps below. The flow rate may be measured using a flow meter external to the TCU 40/80.

1. Open the left side access door.
2. Peel back the insulation covering the by-pass valve. Refer to Figure 1 on page 6.
3. The valve handle can be found in the plastic bag secured to the pump. Reduce the flow by turning the valve stem clockwise. To increase the flow, turn the stem counter clockwise. The valve is a 1/4 turn valve.
4. Once the required flow rate has been achieved, return the valve handle to the bag for future use, glue the insulation back in place, and secure the access door.

7 MAINTENANCE

This section contains information that will allow you to safely keep your TCU 40/80 in working order. It contains important Hazard Warnings, a Preventive Maintenance Schedule on page 27, and a Troubleshooting Guide on page 41.

Warning



Maintenance to the electrical system of the TCU40/80 should be performed by qualified personnel only.

Warning



The refrigeration units are sealed and are not user serviceable. Only trained and licensed refrigeration personnel should perform repairs on this equipment.

All applicable EPA regulations apply.

7.1 Hazard warnings

High Pressure



Water and the coolant are pressurized within this equipment. Water pressure will depend upon utility supply, but usually is up to 60 psig. The coolant can be at pressures up to 100 psig. Refrigerant pressures can be up to 300 psig.

Do not open lines with pressure present.

Toxic Gases



The coolant breaks down above 215 °C. If the coolant is allowed to reach these temperatures, toxic gasses may be discharged from the unit.

Refer to the Appendix for Material Safety Data Sheets for the coolant and refrigerant used in this system.

High Pressure



The reservoir may become pressurized due to changes in temperature.

Under no circumstances should the reservoir pressure relief valve be removed or capped off.

High Pressure



The refrigerant lines are at high pressure.

Under no circumstances should the refrigerant pressure relief valve be removed or capped off.

Eye Protection



Leakage or failure of high pressure circuits may cause injury or irritation of the eyes.

Eye protection should be worn when working with fluid systems.

Hand Protection



Hot or cold fluids and surfaces can cause injury or irritation of the hands.

Hand protection should be worn when working with these fluid systems.

Electric Shock



Ensure that all electrical power has been removed and the main circuit breaker has been turned off prior to opening the electrical drawer. The EMERGENCY OFF circuit (EMO) does not disconnect all power from the electrical drawer.

Extreme caution must be observed if performing maintenance operations with the drawer open.

Hot Surface



Refrigeration and circulating fluid lines can attain temperatures as high as 110 °C.

Caution must be observed.

7.2 Hazards

Table 9 gives the classifications of electrical hazards. This number indicates the severity of the hazard as defined by SEMI S2-93.

Table 9 - Electrical hazards classifications

Classification	Description	Comment
Type 1	Equipment is fully de-energized.	None called out.
Type 2	Equipment is energized. Live circuits are covered or insulated. Work is performed at a remote location to preclude accidental shock.	None called out.
Type 3	Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, 20 Joules. (See NFPA 79-14.3, IEC 204, UL 1950 & 1262, IEC 950.)	Called out as Type 3.
Type 4	Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are greater than 30 volts RMS, 42.2 volts peak, 240 volt-amps, 20 Joules or radio frequency (rf) is present.	Called out as Type 4.
Type 5	Equipment is energized and measurements and adjustments require physical entry into the equipment, or equipment configuration will not allow the use of clamp-on probes.	None called out.

7.3 Filling the reservoir

Warning



When retrofitting a TCU 40/80 in place of a water/glycol unit, the coolant lines must be flushed with nitrogen to remove moisture prior to installation.

1. Open the vent port valve (see Figure 8 on page 18) to avoid air locks that may slow filling.
2. Remove the plug and fasten the funnel accessory to the 1/2" fill port located at the rear of the unit (see Figure 8 on page 18).
3. Fill the reservoir with Fluorinert heat transfer fluid. The amount needed for a new installation is approximately 44 pounds for the TCU and an additional amount for process lines (approx. .15 lbs/ft.; 1/2" tube) and other external volumes. Fill the reservoir until the Coolant Normal Level LED on the rear electrical panel turns green.
4. In the event of over-filling, the Coolant Normal LED will change from green to amber. Drain excess fluid until the Coolant Normal Level LED turns green. Refer to Draining/Bleeding the Coolant Reservoir, below.

7.4 Draining/bleeding the coolant reservoir

It may be necessary to drain the coolant reservoir for storage of the TCU 40/80 or due to moisture contamination of the coolant.

It may be necessary to bleed the coolant reservoir to correct an overfill condition.

Note: The unit may continue running during this procedure.

Follow the procedure below whenever it becomes necessary to drain or bleed the system.

Extreme Temperature



Hot or cold coolant may reach -40 °C to +80 °C during operation. Hot or cold fluid can cause burns.

Coolant should be at ambient temperature before handling.

1. Open the vent valve located at the top of the unit.
2. Place an appropriate container beneath the drain valve. The capacity of the container used needs to be 10 liters plus the volume of the hoses and the volume of the process equipment.
3. Remove the cap fitting from the end of the drain valve.
4. Open the reservoir drain valve.
- 5a. To correct an overfill condition, drain the reservoir until the Coolant Level Normal LED on the rear electrical panel turns green. Close the reservoir drain and vent valves when the LED turns green.
- 5b. To empty the reservoir, remove power to the TCU and allow the unit to drain until all coolant has been removed.
6. Close the reservoir drain and vent valves.
7. For proper disposal of the coolant, follow the manufacturers recommendations.

Note: Uncontaminated Fluorinert may be reused. The Fluorinert should be stored in a compatible and sealed container.

7.5 Temperature probe calibration

The Edwards Temperature Controller comes equipped with a factory calibrated internal $\pm 10V$ remote input/output option making calibration unnecessary.

7.6 Preventive maintenance schedule

Table 10 shows the maintenance required to keep the TCU 40/80 in good working order. Failure to follow this schedule may result in degradation of system performance.

Table 10 - Preventive maintenance schedule

Frequency	Operation	Hazard
Semi-annually	Verify system status	
	Check coolant level	
	Check lamps	(Type 3)
	Coolant leak check	(Type 3)
	Refrigeration leak check	(Type 3)
	Insulation repair	(Type 3)
	Water leak check	(Type 3)
Annually	Replace solenoid coils SV1 and SV2	(Type 3)
	System check	(Type 3)
	Lamp replacement	(Type 3)

Note: All maintenance should be recorded on the Preventative Maintenance Record label located on the inside of the left-hand side access panel.

7.7 Semi-annual preventative maintenance

Refer to the Troubleshooting section on page 42 when results for any of the following check points are not as expected.

7.7.1 Required equipment

- 12" slotted screwdriver
- 4" slotted screwdriver
- Two 10" adjustable wrenches
- Halogen leak detector
- Spare lamps (24 vac / 60 mA)
- Fluorinert
- Insulation Tape

7.7.2 Preparation

- Locate the two screws securing each of the side access panels and loosen to open doors.
- Listen for excessive or questionable noise or sounds coming from the pump assembly, motor, compressor, or solenoid valves (SV1 and SV2).

7.7.3 Verify system status

- Verify system status led indicators on the front electrical panel. (See - Front panel power up indicator conditions table on page 20.)

7.7.4 Refrigeration leak check

- Visually check for signs of compressor oil on the base, insulation, and on all refrigeration pipework.
- Using a halogen leak detector check around the discharge and suction service valves of the compressor, and all accessible refrigeration pipework.

7.7.5 Fluorinert leak check

- Use a halogen leak detector to check all supply and return line connections at both the TCU and process equipment, around the pump head assembly, drain valve, heater, flow switch, vent line, fill line, and reservoir pressure relief valve.

7.7.6 Water leak check

- Visually check for signs of water leaks at all water line connections external to the TCU and at the condenser connections inside the unit.

7.7.7 Insulation repair

Note: If ice formation is excessive, it may be necessary to correct this condition before insulation can be repaired.

- Visually inspect refrigeration and process fluid lines both inside the TCU cabinet and at the supply and return line connections for signs of ice formation. Correct insulation as necessary.

7.7.8 Lamp check/replacement

Electric Shock



Ensure all electrical power has been removed and the main circuit breaker has been turned off due to the presence of high voltage or current.

Caution



Should a lamp require replacement, notify the appropriate personnel that an EMO condition will occur.

Failure to follow these instructions may result in the shut-down of the process tool and associated equipment.

Visually verify that the POWER ON and RESET lamps are working. If either lamp needs replacement and the proper authorization has been obtained:

1. Press STOP.
2. Turn off the main circuit breaker (CB1).
3. Disconnect power cord from mains power supply.
4. Locate the two securing screws on the front electrical panel and loosen. Open the electrical drawer.
5. If replacing the POWER ON lamp, locate contactor block (LP1) on the back side of the front electrical panel. If replacing the RESET lamp, locate contactor block (PB1) on the back side of the front electrical panel.
6. Pry up the metal retaining ring attached to the coupling plate. Remove the contact block assembly.
7. Replace the defective lamp.
8. Reinstall the contact block assembly by snapping it back onto the front element.
9. Close the electrical drawer and tighten securing screws.
10. Reconnect mains power and turn on the main circuit breaker (CB1).. The POWER ON lamp should be illuminated.
11. Press RESET. The lamp should illuminate. Press START to reactivate the TCU.

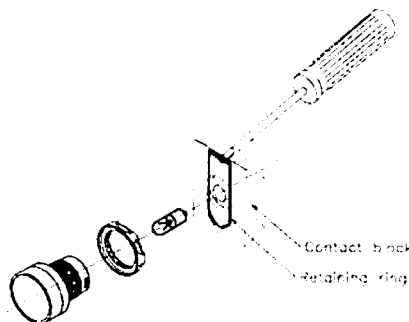


Figure 11 - Lamp replacement

7.8 Annual preventative maintenance

Refer to the Troubleshooting section on page 42 when results for any of the following check points are not as expected.

7.8.1 Required equipment

- 12" slotted screwdriver
- 4" slotted screwdriver
- 7" slotted screwdriver
- 8" phillips screwdriver
- Two 10" adjustable wrenches
- Wire strippers (14 AWG)
- Two test clips w/12" leads
- Miniature diagonal cutters
- Halogen leak detector
- 3/8" open-ended wrench
- 1/4" open-ended wrench
- Wire crimpers - Insulated terminal
- Digital multimeter (DMM)
- Remote RTD connector plug (J72J3)

7.8.2 Required supplies

- Preventative Maintenance Kit (P60153005)
- Fluorinert
- Insulation Tape

7.8.3 Solenoid valve coil replacement

Electric Shock



Ensure all electrical power has been removed and the main circuit breaker has been turned off due to the presence of high voltage or current.

Caution



Should a solenoid valve coil require replacement, notify the appropriate personnel that an EMO condition will occur.

Failure to follow these instructions may result in the shut-down of the process tool and associated equipment.

-
1. Press STOP.. Turn off the main circuit breaker (CB1).
 2. Disconnect the power cord from the mains power supply.
 3. Locate the main cooling solenoid valve (SV1) from the left side access door.
 4. Remove the junction box attachment screw. Slide off the junction box cover.
 5. Back off the strain relief retaining nut.
 6. Unfasten the ground screw. Cut off the wire butt splices (ensuring that the wire labels remain attached to the base assembly) and pull the wires through the junction box.
 7. Remove the solenoid valve coil lock nut. Lift off the spacer cup. Separate the coil from the solenoid valve body by gently pulling up on the coil.
 8. Remove replacement solenoid valve coil from packaging.
 9. Remove the junction box.
 10. Note the location of the conduit hole on the coil removed and remove the appropriate "knock-out" on the replacement coil.
-

11. Gently slip the replacement coil onto enclosing tube of solenoid valve body.
12. Pull the base assembly wiring through conduit hole and slip on the strain relief retaining nut.
13. Attach the ground wire to coil.
14. Strip the ends of all wires on base assembly and solenoid valve coils.
15. Crimp on the butt wire splices.
16. Tighten the strain relief retaining nut.
17. Install the original junction box cover and fasten attachment screw.
18. Install the spacer cup.
19. Install and tighten the lock nut.
20. Verify the coil junction box is labeled SV1.
21. Repeat the procedure for Hot Gas Bypass solenoid valve coil (SV2).
22. Discard the old solenoid coils.
23. Perform the System Check procedure.

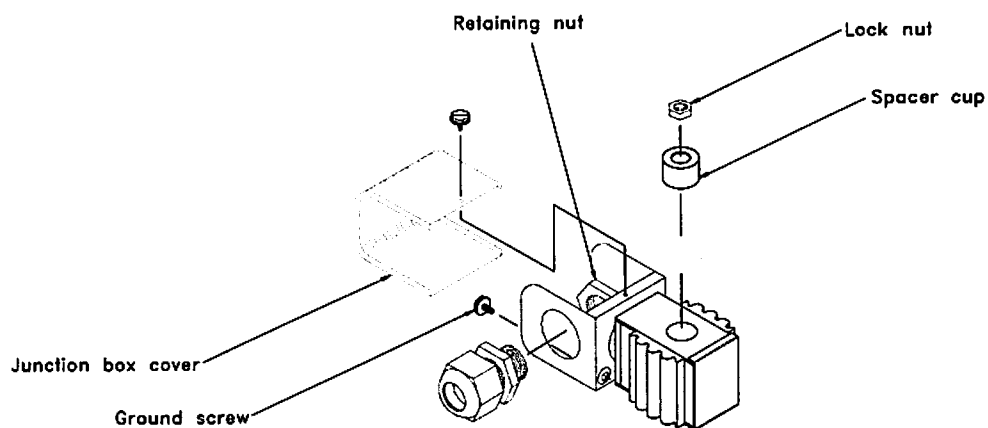


Figure 12 - Solenoid coil replacement

7.8.4 System check

Component settings

Motor overload setting (K3)	3.5 amps
Current sensing relay setting (CSR)	25 amps
Thermostat setting (TS1)	210°F (Differential set at 10°F)
High pressure switch setting (PS1)	300 psig. (Differential set at 40 psig)

Power-up conditions

- Power cord connected to mains power supply.
- All circuit breakers on.
- EMO released.
- Drawer interlock switch in maintenance position.
- Host connector J72J2 installed (pins 5 & 6 shorted).
- READY lamp on.

Indicator	Condition
Relays	All off
LEDs	All off
Power	On
Reset	Off
PMR	Green
Current sensing relay	Off

Note: REMOTE RTD is optional. LED will be green if used.

Reset button

1. Press RESET.
2. Verify contactor K1 engages.
3. Verify LED indicator on PMR is green.

Indicator	Condition
Relays	CR4 on all others off
LEDs	FACILITY POWER, FACILITY WATER, CIRCUIT BREAKERS, COOLANT TEMPERATURE, COOLANT NORMAL LEVEL, green COMPRESSOR, COOLANT FLOW,, COOLANT LOW LEVEL, REMOTE RTD off
Power	On
Reset	On
PMR	Green
Current sensing relay	Off

Note: REMOTE RTD is optional. LED will be green if used.

Temperature controller

1. All control parameters and selections procedures for the temperature controller are accomplished through simple MENU selections. These MENU selections are organized into PAGES. On each page you will find a specific set of related functions. The PAGES setup structure is as follows : diSP PAGE, Ctrl PAGE, inPt PAGE, ScAL PAGE, Out1 PAGE and Out2 PAGE.

To select a PAGE :

Press and hold the RESET key, while pressing the ▲ or ▼ keys. The upper display of the temperature controller will increment or decrement through the PAGEs, and PAGE will be displayed in the lower display.

To select a MENU :

After reaching the correct page, press reset to move through MENUs. The alpha cue for the MENU will appear on the upper display and the current value will appear in the lower display.

To change a MENU value :

After the MENU is selected and displayed, use the ▲ and ▼ keys to change the value.

2. To enter the SetUp Mode, press the controller RESET key and hold it for about 3 seconds. The controller will display LocH XXX where XXX is the security code. The security code number should be 458. If not, press either the ▲ or ▼ keys until the display reads 458. This is the first menu in the Ctrl PAGE.

3. Verify that the menu settings for the Ctrl PAGE are as follows :

PID1 - heating	value	PID2 - cooling	value	parameter
Pb1	8.0	Pb2	12.5	proportional band
Ar1	0.43	Ar2	0.7	automatic reset
rAt1	7.0	rAt2	9.0	rate
db1	1.0	db2	1.0	deadband

OFst = 0.0 FL = On	Orng = 0.0	Loop = OFF	Auto = 4	rrAt = OFF	Cont = HtCl
Cool = PID2	rSP = On	Enti = rSP	Au = none	Aout = Proc	rSEn = OFF

4. Select the next page which is the InPt PAGE. Verify that the menu settings for the InPt PAGE are as follows :

SEnS = rtdt unit = °C	CoFF = .0	SPLL = -40.0	SPUL = 80.0
-----------------------	-----------	--------------	-------------

5. Select the next page which is the ScAL PAGE. Verify that the menu settings for the ScAL PAGE are as follows :

DP = 1 AinL = -50.0	AinH = 100.0	AotL = -100.0	AotH = 100.0	rSPL = -100.0
rSPH = 100.0				

6. Select the next page which is the Out1 PAGE. Verify that the menu settings for the Out1 PAGE are as follows :

Cyc1 = 16 OL1 = 100.0 HoFF = .0

7. Select the next page which is the Out2 PAGE. Verify that the menu settings for the Out2 PAGE are as follows :

Cyc2 = 16 OL2 = 100.0 CoFF = .0

8. Press START.

To return to Operating Mode, press and hold the RESET key for more than 3 seconds. The controller will automatically return to operating mode after 10 minutes of no pushbutton activity.

9. Press START.

EMO circuit

Warning



Do not perform the EMO circuit check while the TCU is on-line with the process tool.

Failure to follow these instructions will lead to the shut-down of the process tool and other associated equipment.

1. Press the EMO button and check that the following occur.
 - READY lamp goes out.
 - All front panel LED indicators go out.
 - Temperature controller shuts off.
 - K1 contactor opens.
2. Release the EMO button and press RESET. Perform the following:
 - Remove rear panel connector J72J2. The READY lamp should go out. Contactor K1 should open, the temperature controller and the front panel LED indicators should go out. Replace J72J2 connector and press RESET.
3. Press in the interlock switch then release it. The READY lamp should go out. Contactor K1 should open, the temperature controller and the front panel LED indicators should go out. Place the drawer interlock switch in the maintenance position.
 - Press RESET
 - Press START

PMR

1. On the PMR rotate the adjustment knob completely clockwise.
2. Verify the unit shuts down, LED 1 (Facility Power) illuminates red, and that the alarm sounds.
3. Press MUTE.

Indicator	Condition
Relays	CR4, CR11, CR13 on all others off
LEDs	FACILITY WATER, CIRCUIT BREAKERS, COOLANT TEMPERATURE, COOLANT NORMAL LEVEL green COMPRESSOR, COOLANT FLOW, COOLANT LOW LEVEL, REMOTE RTD, off FACILITY POWER red
Power	On
Reset	Off
PMR	Red
Current sensing relay	Off

Note: REMOTE RTD is optional. LED will be green if used.

4. Return the PMR adjustment control to the original position.
5. Press RESET then START

Current sensing relay

1. Set CSR1 to 50 amps. The indicator LED on CSR1 should go from green to red.
2. After a 5 second time delay, verify that the unit shuts down, COMPRESSOR illuminates red and the alarm sounds.
3. Press MUTE.

Indicator	Condition
Relays	CR4, CR8, CR11, CR13 on all others off
LEDs	FACILITY POWER, FACILITY WATER, CIRCUIT BREAKERS, COOLANT TEMPERATURE, COOLANT NORMAL LEVEL green COOLANT FLOW, COOLANT LOW LEVEL, REMOTE RTD off COMPRESSOR red
Power	On
Reset	Off
PMR	Green
Current sensing relay	Off

Note: REMOTE RTD is optional. LED will be green if used.

4. Reset CSR1 to 25 amps.
5. Press RESET.
6. Press START.

Circuit breaker

1. Power off CB4. The TCU will shut down, alarm will sound and CIRCUIT BREAKER LED should be red.
2. Press MUTE.
3. Power on CB4, press START.
4. Repeat steps 1 thru 3 for CB3 and CB2.

Indicator	Condition
Relays	CR1, CR4, CR11, CR13 on all others off
LEDs	FACILITY POWER, FACILITY WATER, COOLANT TEMPERATURE, COOLANT NORMAL LEVEL green COMPRESSOR, COOLANT FLOW, COOLANT LOW LEVEL, REMOTE RTD, off CIRCUIT BREAKERS RED
Power	On
Reset	Off
PMR	Green
Current sensing relay	Off

Note: REMOTE RTD is optional. LED will be green if used.

Water supply

1. Short wire #23 (TB1) to wire #54 (relay board J3-13). The TCU will shut down, alarm will sound, and FACILITY WATER LED should illuminate red.
2. Press MUTE.

Indicator	Condition
Relays	CR2, CR4, CR11, CR13 on all others off
LEDs	FACILITY POWER, CIRCUIT BREAKERS, COOLANT TEMPERATURE, COOLANT NORMAL LEVEL green COMPRESSOR, COOLANT FLOW, COOLANT LOW LEVEL, REMOTE RTD off FACILITY WATER red
Power	On
Reset	Off
PMR	Green
Current sensing relay	Off

Note: REMOTE RTD is optional. LED will be green if used.

3. Remove short.
4. Press RESET.
5. Press START.

Reservoir over-temperature

1. Short wire #23 (TB1) to wire #56 (relay board J3-3)). The TCU will shut down, alarm will sound and COOLANT TEMPERATURE LED should be red.
2. Press MUTE.

Indicator	Condition
Relays	CR4, CR6, CR11, CR13 on all others off
LEDs	FACILITY POWER, FACILITY WATER, CIRCUIT BREAKERS, COOLANT NORMAL LEVEL green COMPRESSOR, COOLANT FLOW, COOLANT LOW LEVEL, REMOTE RTD off COOLANT TEMPERATURE red
Power	On
Reset	Off
PMR	Green
Current sensing relay	Off

Note: REMOTE RTD is optional. LED will be green if used.

3. Remove short.
4. Press RESET.
5. Press START.

Coolant flow

1. Short wire #57 (Relay board J2-5) to wire #58 (Relay board J3-9). After 5 second delay, the TCU will shut down, alarm will sound and COOLANT FLOW LED should be red.
2. Press MUTE.

Indicator	Condition
Relays	CR4, CR7, CR11, CR13 on all others off
LEDs	FACILITY POWER, FACILITY WATER, CIRCUIT BREAKERS, COOLANT TEMPERATURE, COOLANT NORMAL LEVEL green COMPRESSOR, COOLANT LOW LEVEL, REMOTE RTD off COOLANT FLOW red
Power	On
Reset	Off
PMR	Green
Current sensing relay	Off

Note: REMOTE RTD is optional. LED will be green if used.

3. Remove short.
4. Press RESET
5. Press START.

Compressor

1. Short wire #57 (Relay board J2-5) to wire #60 (Relay board J3-1). After 5 second delay, the TCU will shut down, alarm will sound and COMPRESSOR LED will be red.
2. Press MUTE.

Indicator	Condition
Relays	CR4, CR8, CR11, CR13 on all others off
LEDs	FACILITY POWER, FACILITY WATER, CIRCUIT BREAKERS, COOLANT TEMPERATURE, COOLANT NORMAL LEVEL green COOLANT FLOW, COOLANT LOW LEVEL, REMOTE RTD off COMPRESSOR red
Power	On
Reset	Off
PMR	Green
Current sensing relay	Off

Note: REMOTE RTD is optional. LED will be green if used.

3. Remove short.
4. Press RESET.
5. Press START.

Circulation pump

1. Adjust overload trip on K3 to the minimum setting. Within three minutes the overload will trip. After a five second time delay, the TCU will shut down, the alarm will sound and the COOLANT FLOW LED should illuminate red.
2. Press MUTE.

Indicator	Condition
Relays	CR4, CR7, CR11, CR13 on all others off
LEDs	FACILITY POWER, FACILITY WATER, CIRCUIT BREAKERS, COOLANT TEMPERATURE, COOLANT NORMAL LEVEL green COMPRESSOR, COOLANT LOW LEVEL, REMOTE RTD off COOLANT FLOW red
Power	On
Reset	Off
PMR	Green
Current sensing relay	Off

Note: REMOTE RTD is optional. LED will be green if used.

3. Reset overload trip to 3.5 amps.
4. Press RESET.
5. Press START.

Reservoir overfill

1. Short wire #23 (TB1) to wire #63 (Relay board J3-4). COOLANT NORMAL LEVEL LED will go from green to amber.

Indicator	Condition
Relays	CR4, CR5, CR10, CR12 on all others off
LEDs	FACILITY POWER, FACILITY WATER, CIRCUIT BREAKERS, COMPRESSOR, COOLANT TEMPERATURE, COOLANT FLOW COOLANT NORMAL LEVEL green COOLANT LOW LEVEL, REMOTE RTD off COOLANT NORMAL LEVEL amber
Power	On
Reset	On
PMR	Green
Current sensing relay	Green

Note: REMOTE RTD is optional. LED will be green if used.

Remote start/stop

1. Remove jumper from terminal strip (TB1).The TCU will shut down.
2. Press RESET.
3. Press START.

Remote temperature probe

1. Install connector J72J3 and verify REMOTE RTD illuminates green.

Indicator	Condition
Relays	CR4, CR9, CR10 on all others off
LEDs	FACILITY POWER, FACILITY WATER, CIRCUIT BREAKERS, COMPRESSOR, COOLANT TEMPERATURE, COOLANT FLOW, COOLANT NORMAL LEVEL, REMOTE RTD green COOLANT LOW LEVEL, off
Power	On
Reset	On
PMR	Green
Current sensing relay	Green

2. Remove connector J72J3.

Cooling

1. Change the temperature controller set point to -40°C.
2. Verify CR15 on the relay board illuminates.
3. Verify main solenoid valve (SV1) has opened by confirming that the sight glass has filled with refrigerant.
4. Verify OUT 2 LED on the temperature controller is on.

Indicator	Condition
Relays	CR4, CR10, CR15 on all others off
LEDs	FACILITY POWER, FACILITY WATER, CIRCUIT BREAKERS, COMPRESSOR, COOLANT TEMPERATURE, COOLANT FLOW, COOLANT NORMAL LEVEL, REMOTE RTD green COOLANT LOW LEVEL, REMOTE RTD off
Power	On
Reset	On
PMR	Green
Current sensing relay	Green

Note: REMOTE RTD is optional. LED will be green if used.

Heating

1. Change the temperature controller set point to 80°C.
2. Verify contactor K4 pulls in.
3. Verify CR15 goes out. Verify OUT 1 on the temperature controller is on and OUT 2 is off.
4. Verify hot gas bypass solenoid (SV2) is energized.

Indicator	Condition
Relays	CR4, CR10 on all others off
LEDs	FACILITY POWER, FACILITY WATER, CIRCUIT BREAKERS, COMPRESSOR, COOLANT TEMPERATURE, COOLANT FLOW, COOLANT NORMAL LEVEL, REMOTE RTD <i>green</i> COOLANT LOW LEVEL, REMOTE RTD <i>off</i>
Power	On
Reset	On
PMR	Green
Current sensing relay	Green

Note: REMOTE RTD is optional. LED will be green if used.

Process value setting

1. Set the temperature controller to the proper process set value.
2. Verify all the host interface connections are mated properly.

7.9 Preventive maintenance checklist

Record date:		Serial no:	
Customer name:		Line / area:	
Checked by:		Tool name:	

System status

Timer hours:	Hours		
Coolant pressure:	psig		
Process temperature:	°C		
Fluorinert type:	FC8270	FC77	Other:
Quantity of Fluorinert added:	lbs.	liters	
Operation mode:	Remote	Local	
Utilities water temperature:	°C		
Leak check results:	Pass	Fail	Remarks:

Parts replaced	Quantity	Cause / reason

Actions / concerns

8 TROUBLESHOOTING

Table 11, Table 12, Table 13 and Table 14 identify fault conditions that you may encounter with the TCU 40/80. For additional assistance contact the Edwards Service Department.

Table 11- Faults identified by front panel lamps

Indicator	Possible causes	Action	Hazard
POWER ON lamp is <u>not</u> illuminated.	No power to the TCU 40/80.	Verify that the power cord is plugged in. Verify that outlet's circuit breaker is on. Verify that the outlet's EMO is not activated.	Type 4
	The main power circuit breaker (CB1) is off.	Verify that the main power circuit breaker (CB1) is on.	
	POWER ON lamp requires replacement.	Verify that the POWER ON lamp assembly is receiving 24 VAC. To do this, opening of the electrical drawer is necessary. This will activate the drawer interlock switch and shut the TCU 40/80 down. <i>Notify the tool operator prior to opening the electrical drawer.</i> Check to see that 24 VAC is present across the lamp assembly terminal block (LP1), terminals X1 and X2. If 24 VAC is present, then replace the POWER ON lamp. (EHVI part no. P23247900). <i>Refer to the "Lamp Check/Replacement Procedure" on page 29.</i>	Type 4
	The transformer isolating circuit breaker CB5 may be off.	Verify that the transformer isolating circuit breaker CB5 is on.	
	The transformer isolating circuit breaker CB7 may be tripped.	Verify that the transformer isolating circuit breaker CB7 is not tripped. Reset if necessary.	
	One of the following circuit breakers may not be functional: <ul style="list-style-type: none"> main power circuit breaker (CB1) transformer isolating circuit breaker CB5 transformer isolating circuit breaker CB7 	Verify that the main power circuit breaker CB1 is functional. Replace if necessary. (EHVI part no. P43126700). Verify that the transformer circuit breaker CB5 is functional. Replace if necessary. (EHVI part no. P43129500). Verify that the transformer circuit breaker CB7 is functional. Replace if necessary. (EHVI part no. P43129100).	Type 4

Table 11- Faults identified by front panel lamps (continued)

Indicator	Possible causes	Action	Hazard
<p>POWER ON lamp is illuminated, but when RESET is pressed, it does not illuminate. The front panel LEDs are not illuminated, and the temperature controller is off.</p>	Local EMERGENCY OFF circuit (EMO) is engaged.	<p>Verify the front panel EMERGENCY OFF (EMO) is engaged.</p> <p>Ensure that the interface connector J72J2 is installed with pins 5 and 6 linked.</p> <p><i>Refer to the "Remote Interface wiring schematic" on page 56.</i></p>	Type 3
	Electrical drawer safety interlock switch is not engaged.	Ensure the electrical drawer is fully closed and that the securing screws are tightened.	
	Remote EMERGENCY OFF circuit (EMO) is engaged.	Verify that the remote EMERGENCY OFF (EMO) is not engaged.	
	Remote EMERGENCY OFF circuit (EMO) is not wired properly to interface connector J72J2.	<p>Verify the correct wiring to the interface connector J72J2.</p> <p><i>Refer to the "Remote Interface wiring schematic" on page 56.</i></p>	Type 3
<p>POWER ON lamp is illuminated. When RESET is pressed it does not illuminate. The audible alarm is sounding, the front panel LEDs are illuminated, and the temperature controller is on.</p>	A failure condition exists that must be satisfied.	<p>Review the front panel status indicators to identify the failure mode.</p> <p><i>Refer to the "Faults indicated by front panel lamps" on page 42.</i></p>	
<p>POWER ON lamp is illuminated. When RESET is pressed, it does not illuminate. There is no audible alarm sounding. The front panel LEDs are illuminated and do not indicate the presence of a failure mode. The temperature controller is on.</p>	RESET lamp requires replacement.	<p>Verify that the RESET lamp assembly is receiving 24 VAC. To do this, opening of the electrical drawer is necessary. This will activate the drawer interlock switch and shut the TCU 40/80 down.</p> <p><i>Notify the tool operator prior to opening the electrical drawer.</i></p> <p>Check to see that 24 VAC is present across the lamp assembly terminal block (LP2), terminals X1 and X2. If 24 VAC is present, then replace the RESET lamp. (EHVI part no. P23247900).</p> <p><i>Refer to the "Lamp Check/Replacement Procedure" on page 29.</i></p>	Type 4

Table 12 - Faults indicated by the front panel LED indicators

Indicator	Possible causes	Action	Hazard
FACILITY POWER LED is red; audible alarm is sounding; TCU will not start or has stopped operation.	Phasing of the incoming power is reversed.	Swap any two of the three power line supply phases in the outlet box.	Type 4
	Line voltage is low (below 177 VAC).	Correct low line voltage condition. <i>Refer to the "Specifications Table" on page 14.</i>	
	The phase monitor relay (PMR) is not set properly to 177 VAC.	The adjustment knob of the PMR should be positioned such that the arrow is pointing towards the calibration mark (a black ink marking) on the PMR. The PMR is calibrated to trip at 177 VAC. If necessary replace the PMR with a known calibrated PMR. (EHVI part no. P60056100).	Type 4
FACILITY WATER LED is red; audible alarm is sounding; TCU has stopped operation.	Water supply is off or not connected.	Verify that the water supply lines are connected properly to the unit. Verify water is turned on. <i>Refer to the "Water and coolant connections" instructions on page 18.</i>	
	Water supply is below 3 gpm.	Verify that water supply valves are open and that the water flow is between 3 - 6 gpm. <i>Refer to the "Specifications Table" on page 14.</i>	
	Water is too warm.	Verify facilities water supply meets the temperature specification of 10 - 26°C. <i>Refer to the "Specifications Table" on page 14.</i>	
	Pressure switch (PS1) has tripped.	Verify that the pressure switch (PS1) is set to 300 psig.	Type 2
CIRCUIT BREAKER LED is red; audible alarm is sounding; TCU has stopped operation.	One of the following circuit breakers as tripped: <ul style="list-style-type: none"> Compressor circuit breaker (CB2) Circulation pump circuit breaker (CB3) Heater circuit breaker (CB4) 	Examine the rear electrical panel of the unit to determine which circuit breaker has tripped. <i>Refer to the description of the "Rear panel" on page 13.</i> Reset the tripped circuit breaker. To restart the unit press the RESET button to clear the alarm condition, then press START . If the circuit breaker trips again, monitor the current draw from the proper corresponding component. The maximum current draw is as follows: <ul style="list-style-type: none"> Compressor: 7 amps per leg Circulation Pump: 3.5 amps per leg Heater: 3 amps per leg If the current draw is in excess of the values noted above, remove power to the unit and contact an Edwards service representative.	Type 4

Table 12 - Faults indicated by the front panel LED indicators (continued)

Indicator	Possible causes	Action	Hazard
	The circuit breaker may not be functioning properly.	Verify that the circuit breaker which is tripping is functioning properly. Replace if necessary. Compressor circuit breaker: EHVI part no. P43129400 Circulation pump circuit breaker: EHVI part no. P43129300 Heater circuit breaker: EHVI part no. P43129200	Type 4
COMPRESSOR LED is red; audible alarm is sounding; TCU has stopped operation.	Current sensing relay (CSR1) has tripped.	Verify that the current sensing relay (CSR1) is set to 25 amps. To do this, opening of the electrical drawer is necessary. This will activate the drawer interlock switch and shut the TCU 40/80 down. <i>Notify the tool operator prior to opening the electrical drawer.</i>	Type 4
	Refrigerant leak.	Visually check for signs of compressor oil on the base, insulation, around the compressor service valves, and on all refrigeration pipework. Use a halogen leak detector to leak check all accessible refrigeration pipework and the compressor service valves. If compressor oil is noted or a leak is located remove all power to the unit and contact an Edwards service representative.	Type 2
	Hot gas bypass solenoid valve (SV2) fail.	Verify 24 VAC is present between wire #15 (J4-5) on the relay board and wire #4 (TB1). To do this opening of the electrical drawer is necessary. This will activate the drawer interlock switch and shut the TCU 40/80 down. <i>Notify the tool operator prior to opening the electrical drawer.</i> Verify current draw of the solenoid is not above 1 amp. Verify that the resistance of the coil is about 8 Ω . If necessary, replace the coil (EHVI part no. P33030300).	Type 4
	Main cooling solenoid valve (SV1) fail.	Verify 24 VAC is present between wire #16 (J4-5) on the relay board and wire #4 (TB1). To do this, opening of the electrical drawer is necessary. This will activate the drawer interlock switch and shut the TCU 40/80 down. <i>Notify the tool operator prior to opening the electrical drawer.</i> Verify current draw of the solenoid is not above 1 amp. Verify that the resistance of the coil is about 8 Ω . If necessary, replace the coil (EHVI part no. P33030300).	Type 4

Table 12 - Faults indicated by the front panel LED indicators (continued)

Indicator	Possible causes	Action	Hazard
	Compressor tripped on thermal over-load.	<p>Verify that the temperature of the discharge line of the compressor has not exceeded 195°F. If the temperature is above 195°F, remove power to the unit and contact an Edwards service representative.</p> <p><i>Warning: Ensure all electrical power has been removed and the main circuit breaker has been turned off prior to checking the compressor motor winding resistance.</i></p> <p>Verify compressor motor winding resistance.</p> <p>The resistance between any two terminals of the compressor motor should be 1.4 Ω (\pm 0.3 Ω). Verify all three phases are within specification.</p> <p>If the motor winding resistance are out of tolerance contact an Edwards service representative.</p>	Type 4
	Incorrect line voltage to the compressor.	Verify that the compressor is receiving all three phases (208 VAC) at the compressor terminals.	Type 4
Coolant TEMPERATURE LED is red; audible alarm; system shut down.	An excessive heat load is causing the coolant temperature to exceed 90 °C.	<p>Ensure the heat load power does not exceed 2000 watts.</p> <p><i>Refer to the "Specifications Table" on page 14.</i></p>	
	The temperature switch (TS1) is not set correctly.	Verify that the temperature switch (TS1) is set at 210 °F.	Type 2
Coolant FLOW LED is red; audible alarm; system shut down.	Coolant supply shut-off valves at the rear of TCU are closed.	Verify coolant line valves are open.	
	Supply flow is inadequate.	<p>Verify adequate supply flow. Eliminate possible coolant line restrictions.</p> <p><i>Refer to the "Specifications Table" on page 14.</i></p>	
	Circulation pump thermal over-load protector (K3) is set improperly.	<p>Verify that the circulation pump thermal over-load protector (K3) is set to 3.5A. To do this, opening of the electrical drawer is necessary. This will activate the drawer interlock switch and shut the TCU 40/80 down.</p> <p><i>Notify the tool operator prior to opening the electrical drawer.</i></p>	Type 4
	Circulation pump thermal over-load protector (K3) is tripped.	<p>Press the "reset" button on the circulation pump thermal over-load protector (K3) to ensure that it is not tripped. To do this, opening of the electrical drawer is necessary. This will activate the drawer interlock switch and shut the TCU 40/80 down.</p> <p><i>Notify the tool operator prior to opening the electrical drawer.</i></p>	Type 4

Table 12 - Faults indicated by the front panel LED indicators (continued)

Indicator	Possible causes	Action	Hazard
	Flow switch may not be set properly.	<p>Monitor the voltage between wire #57 (J2-5) and wire #58 (J3-9) located on the relay board. To do this, opening of the electrical drawer is necessary. This will activate the drawer interlock switch and shut the TCU 40/80 down.</p> <p><i>Notify the tool operator prior to opening the electrical drawer.</i></p> <p>Place the drawer interlock switch in the maintenance position. Press the RESET button to clear the alarm condition, then press START. There should be 24 VDC present. If not, a minor adjustment of the reed contact of the flow switch is required.</p> <p>Remove the insulation from the enclosing tube of the flow switch. Loosen, but do not remove, the two locking plate securing screws on the top of the flow switch. This will allow movement of the reed contact.</p> <p>Make minor adjustments to the reed contact until 0 VDC is seen at "no flow" and 24 VDC is present when the unit is running.</p> <p>After the proper adjustment to the reed contact is complete, tighten the locking plate securing screws and re-attach the insulation.</p>	Type 4
	Excessive current draw from the circulation pump motor.	Verify current draw from each phase of the circulation pump motor does not exceed 3.5 Amps.	Type 4
Coolant NORMAL LED is amber.	Reservoir is over-filled.	<p>Drain the reservoir until the LED turns green.</p> <p><i>Refer to "Draining/bleeding the coolant reservoir" on page 26..</i></p>	
Coolant LOW LED is amber.	Fluid volume is low (less than 8 liters).	<p>Add fluid to reservoir until LED turns green.</p> <p><i>Refer to "Filling the reservoir" on page 26.</i></p>	
	There may be a leak.	<p>Visually check for signs of leaks inside the unit and at all connections between the TCU 40/80 and the process tool. Check all process line connections for leaks.</p> <p><i>Refer to the "Fluorinert leak check" on page 28.</i></p>	Type 2

Table 12 - Faults indicated by the front panel LED indicators (continued)

Indicator	Possible causes	Action	Hazard
Coolant LOW LEVEL LED is red.	Coolant level is very low; less than 3.5 liters.	Reservoir needs to be filled. <i>Refer to "Filling the reservoir" on page 26.</i>	
	Reservoir drain valve is open.	Close the drain valve.	
	There may be a leak.	Visually check for signs of leaks inside the unit and at all connections between the TCU 40/80 and the process tool. Check all process line connections for leaks. <i>Refer to "Fluorinert leak check" on page 28.</i>	Type 2
REMOTE RTD is in use but LED is off.	Terminals 4 and 5 on the interface connector J72J3 are not linked.	Verify that terminals 4 and 5 on interface connector J72J3 are linked. <i>Refer to the "Remote Interface wiring schematic" on page 56.</i>	Type 3

Table 13 - Faults identified by rear panel indicators

Indicator	Possible causes	Action	Hazard
Coolant NORMAL LEVEL LED is amber.	Reservoir is over-filled.	Drain the reservoir until the LED turns green. <i>Refer to "Draining/bleeding the coolant reservoir" on page 26.</i>	
Coolant LOW LEVEL LED is amber.	Fluid volume is low; less than 8 liters.	Add fluid to reservoir until LED turns green. <i>Refer to "Filling the reservoir" on page 26.</i>	
	There may be a leak.	Visually check for signs of leaks inside the unit and at all connections between the TCU 40/80 and the process tool. Check all process line connections for leaks. <i>Refer to "Fluorinert leak check" on page 28.</i>	Type 2
Coolant LOW LEVEL LED is red.	Coolant level is very low; less than 3.5 liters.	Reservoir needs to be filled? <i>Refer to "Filling the reservoir" on page 26.</i>	
	Reservoir drain valve is open.	Close the drain valve.	
	There may be a leak.	Visually check for signs of leaks inside the unit and at all connections between the TCU 40/80 and the process tool. Check all process line connections for leaks. <i>Refer to "Fluorinert leak check" on page 28.</i>	Type 2

Table 14 - Miscellaneous fault conditions

Indicator	Possible causes	Action	Hazard
Host fail signal. Supplies fail signal to the host interface when any of the following occur:	Unit in STOP mode FACILITY POWER Fail FACILITY WATER Fail CIRCUIT BREAKER Fail COMPRESSOR Fail TEMPERATURE Fail FLOW Fail Coolant LOW LEVEL FAULT	<i>Refer to the "Faults indicated by the front panel LED indicators" on page 44.</i>	
Host warn signal. Supplies warn signal to the process tool when any of the following occur:	Coolant NORMAL LEVEL OVER-FILL Coolant LOW LEVEL	<i>Refer to the "Faults indicated by the front panel LED indicators" on page 44</i>	
Temperature controller process value blinks.	RTD wired incorrectly to the interface connector J72J3.	Verify that the remote RTD is wired correctly. <i>Refer to the "Remote Interface wiring schematic" on page 56.</i>	Type 3
	Terminals 4 and 5 are not linked on the interface connector J72J3.	Verify that terminals 4 and 5 on connector J72J3 are linked. <i>Refer to the "Remote Interface wiring schematic" on page 56.</i>	Type 3
	Incorrect RTD type being utilized.	Verify that the RTD is 100 ohm European.	
	Temperature controller parameters are not set to factory defaults.	Verify temperature controller PID settings. <i>Refer to the "Temperature controller" portion of the System Check on page 21.</i>	Type 2
Failure to cool.	Main cooling solenoid valve (SV1) fail.	Verify 24 VAC is present between wire #16 (J4-5) on the relay board and wire #4 (TB1). To do this, opening of the electrical drawer is necessary. This will activate the drawer interlock switch and shut the TCU 40/80 down. <i>Notify the tool operator prior to opening the electrical drawer.</i> Verify current draw of the solenoid is not above 1 amp. Verify that the resistance of the coil is about 8 Ω . If necessary, replace the coil (EHVI part no. P33030300).	Type 4
	Relay board failure.	Verify that the main cooling relay (CR15) comes on when the unit is in cooling mode.	Type 3
	Moisture is in the system.	Verify that the moisture indicator in the sight glass is green. If it appears yellow in color remove power from the unit and notify an Edwards service representative.	Type 2

Table 14 - Miscellaneous fault conditions (continued)

Indicator	Possible causes	Action	Hazard
	Refrigerant leak.	Visually check for signs of compressor oil on the base, insulation, around the compressor service valves, and on all refrigeration pipework. Use a halogen leak detector to leak check all accessible refrigeration pipework and the compressor service valves. If compressor oil is noted or a leak is located remove all power to the unit and contact an Edwards service representative.	Type 2
	Temperature controller parameters are not set to factory defaults.	Verify temperature controller PID settings. <i>Refer to the "Temperature controller" portion of the System Check on page 21.</i>	Type 2
	Temperature controller is not functioning properly.	Verify that the OUT 2 lamp on the front of the temperature controller is ON when the unit is in cooling mode. Replace the temperature controller if necessary (EHVI part no. P43008000).	Type 4
Remote START/STOP fail.	J72J2 interface connector is wired incorrectly.	Verify proper wiring of connector J72J2. <i>Refer to the "Remote Interface wiring schematic" on page 56..</i>	Type 3
	Remote START/STOP jumper not removed	Verify that the remote START/STOP jumper located across terminal TB1-1 on terminal block TB1 is removed. To do this, opening of the electrical drawer is necessary. This will activate the drawer interlock switch and shut the TCU 40/80 down. <i>Notify the tool operator prior to opening the electrical drawer.</i>	Type 4
Hour counter fail.	Hour counter not recording operating time.	Verify 24 VDC across the wires connected to the hour counter (wire #28 and wire #29). To do this, removal of the front access panel is necessary. Replace the hour counter if necessary (EHVI part no. P43144900).	Type 4
Remote setpoint enable fail.	Absence of 24 VAC supply to interface connector J72J2 or interface connector is wired incorrectly.	Verify the host 24 VAC supply to pin 3 and pin 4 on connector J72J2. <i>Refer to the "Remote Interface wiring schematic" on page 56..</i>	Type 3
	Relay board failure (CR14).	Verify that the remote setpoint enable relay (CR14) is on.	Type 4
	Temperature controller parameters are not set to factory defaults.	Verify temperature controller PID settings. <i>Refer to the "Temperature controller" portion of the System Check on page 21..</i>	Type 2
	Temperature controller not functioning properly.	Verify temperature controller is in remote mode. The AUX lamp on the front of the controller should be ON. Replace the temperature controller if necessary (EHVI part no. P43008000).	Type 4

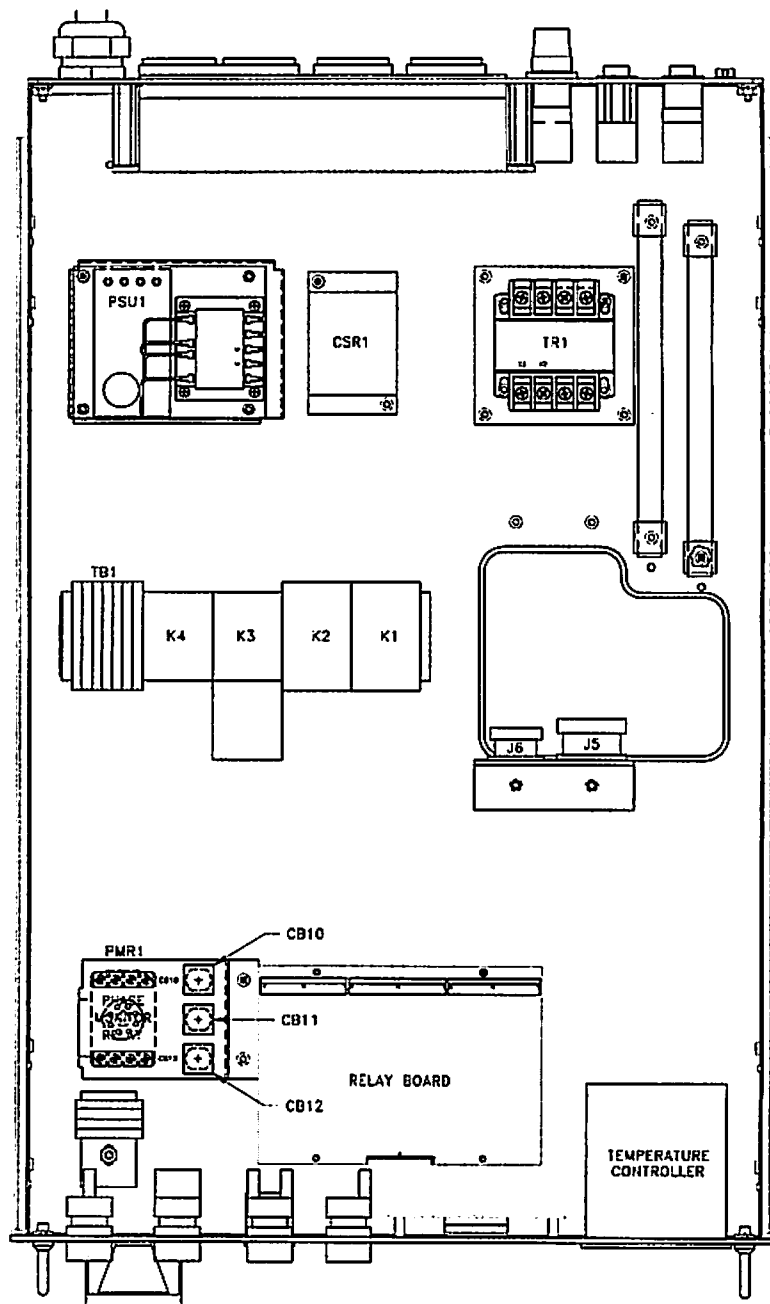


Figure 13 - Electrical drawer

9 ACCESSORIES AND SPARE PARTS

Accessories and spare parts are available from service centers at Edwards companies in Brazil, Canada, Germany, Great Britain, Italy, Japan, USA, and a worldwide network of distributors. The majority of these centers employ service engineers who have undergone comprehensive Edwards training courses.

When ordering please state for each part required:

- Model and code number of your equipment
- Description of part
- Serial number (if any)

Table 15 - Accessories

Part number	Description	Contents	Qty
P60150400	Coolant connection kit	Ball valve 1/2" female NPT	2
		1/2" male connector	4
P60152200	Tie-bolt kit (Anchors top to bottom unit when stacking)	Rod 3/8"-16 x 7"	4
		Hex nut 3/8"-16	4
		Flat washer 3/8"	4
P60154600	Stabilization kit (Anchors bottom or single unit to floor.)	Unistrut® channel	2
		Studs 3/8"-16 x 5"	4
		Hex nut 3/8"-16	4
		Flat washer 3/8"	4
		Lock washer 3/8"	4
P60153100	Remote RTD assembly (auxilliary)	100Ω RTD; 3 wire, 15' leads	1
		5 pin circular connector (J72J3)	1
P60188300	Coolant RTD assembly (external)	100Ω RTD; 3 wire, 15' leads	1
		5 pin circular connector (J72J3)	1
		1/2" X 1/2" pipe connector	1
P60152100	Leveler kit	Leveler pad	4
		Rod 3/8"-16 x 7"	4
		Hex nut 3/8"-16	4
		Flat washer 3/8"	4
		Lock washer 3/8"	4
P30152700	Secondary containment receptacle	Removable spill containment system	1
P60141100	Funnel	Off-set funnel with Swagelok connector	1
P60153200	Host interface connector kit	9 pin plug (J72J2)	1
		Sockets (J72J2)	9
		37 pin male "D" connector (J72J1)	1
		Backshell w/hardware (J72J1)	1
		5 pin circular connector (J72J3)	1
P53289800	Fluorinert	11 pound container	1
P53289900	Fluorinert	44 pound container	1

Table 16 Spare parts

Part number	Description	Contents	Qty
P60153005	Preventative maintenance kit	Lamps, 28vac, 60 mA	4
		Solenoid valve coils	2
P60140600	Electrical drawer assembly	Electrical drawer	1
P60153001	Refrigeration refurbishment kit	Filter/dryer	1
		Discharge service valve	1
		Suction service valve	1
P60153003	Electrical refurbishment kit	Heater contactor	1
		Pump contactor	1
		Solenoid valves	2
		Lamps	2
P60153004	Coolant pump rebuild kit	Gear shafts	2
		Gears (idler & drive)	2
		Seals	3
		Wear plates	4
		Bearings	4
P60140301	Coolant pump/motor assembly	Coolant pump/motor	1

APPENDIX

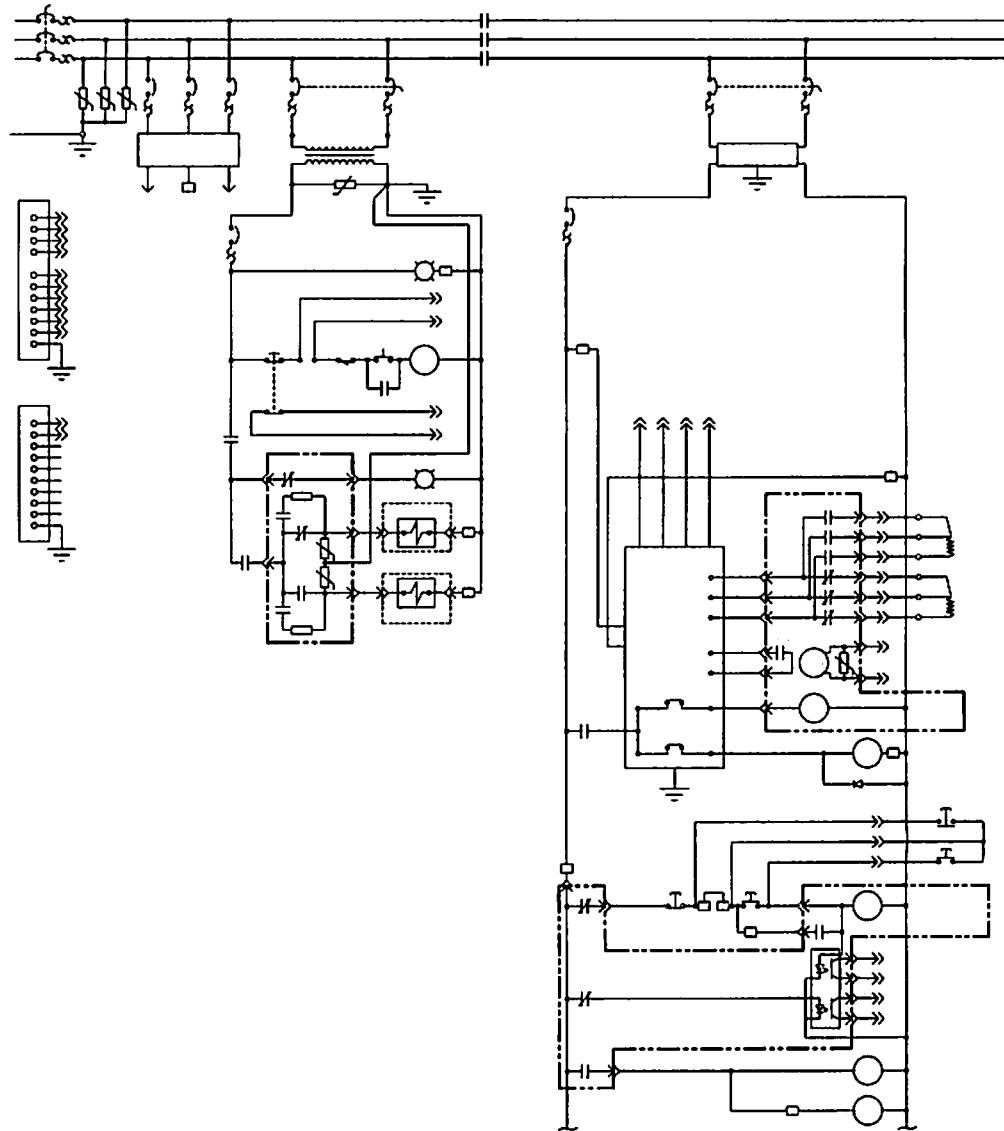
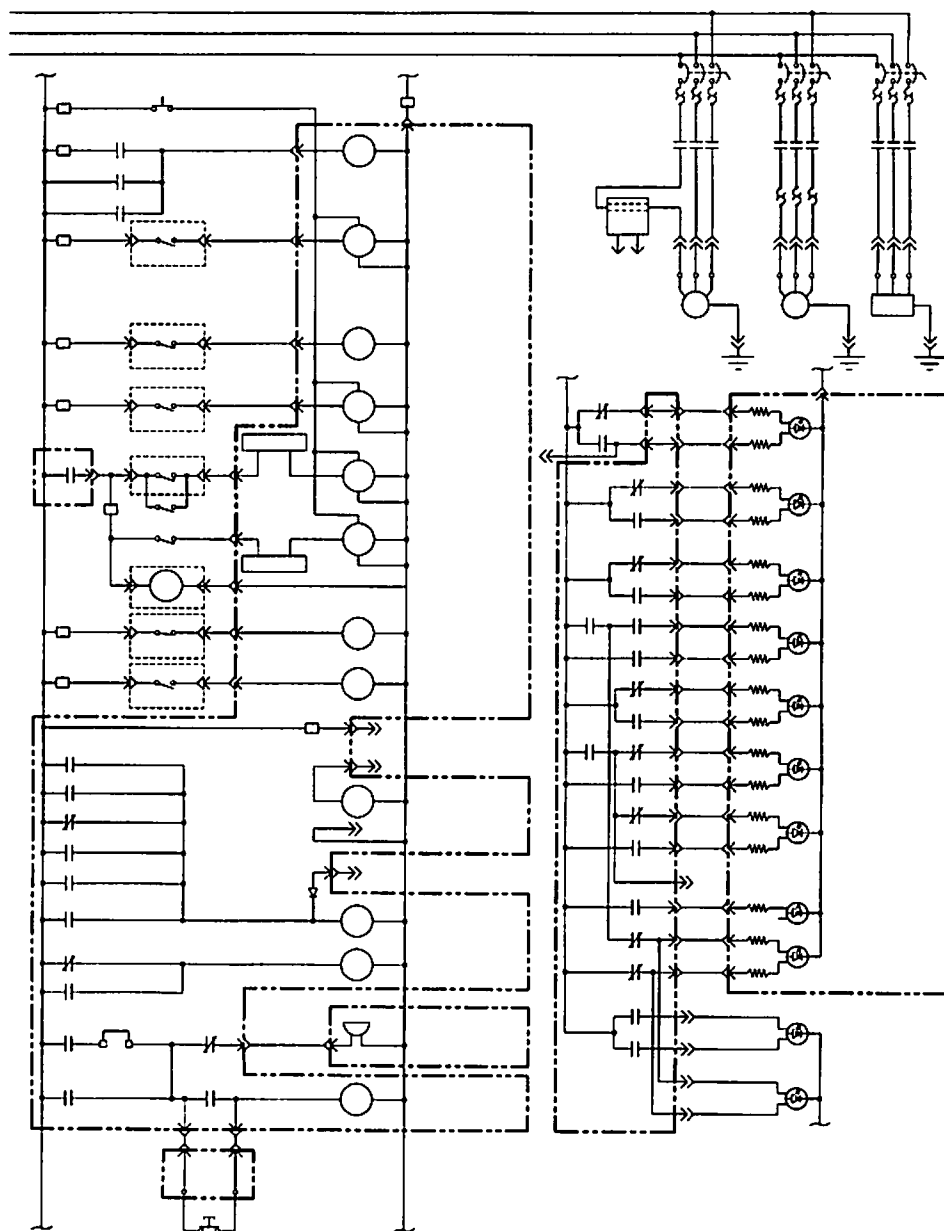


Figure 14- Electrical drawer schematic



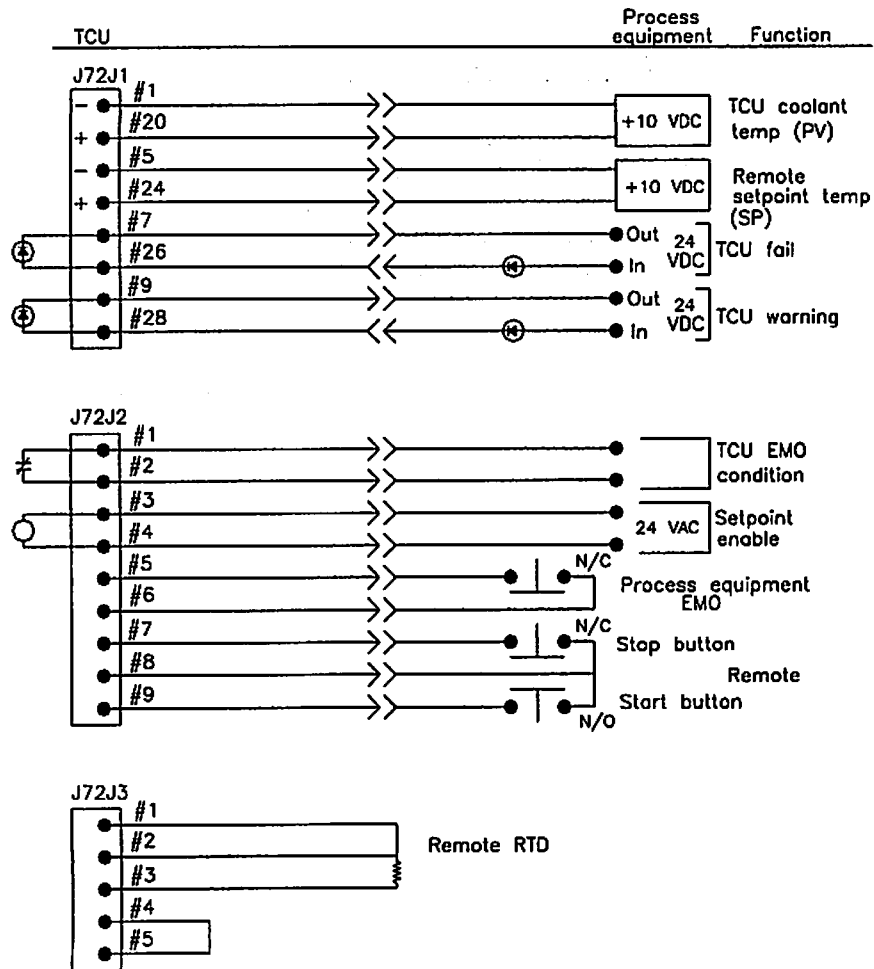


Figure 15 - Remote interface

Return of Edwards Equipment - Procedure

(Form HS1)

Introduction

Before you return your equipment you must warn your supplier if the substances you used (and produced) in the equipment can be dangerous. You must do this to comply with health and safety at work laws.

You must complete the Declaration (HS2) on the next page and sent it to your supplier before you dispatch the equipment. If you do not, your supplier will assume that the equipment is dangerous and he will refuse to accept it. If the Declaration is not completed correctly, there may be a delay in processing your equipment.

Guidelines

Take note of the following guidelines:

- Your equipment is '**uncontaminated**' if it has not been used or if it has only been used with substances that are not dangerous. Your equipment is '**contaminated**' if it has been used with any dangerous substances.
- If your equipment has been used with radioactive substances, you must decontaminate it before you return it to your supplier. You must send independent proof of decontamination (for example a certificate of analysis) to your supplier with the Declaration (HS2). Phone your supplier for advice.
- We recommend that contaminated equipment is transported in vehicles where the driver does not share the same air space as the equipment.

PROCEDURE

Use the following procedure:

1. Contact your supplier and obtain a Return Authorization Number for your equipment.
2. Turn to the next page(s), photocopy and then complete the Declaration (HS2).
3. Drain all fluids from the equipment and its accessories.
4. Disconnect all accessories, such as levelers and host connectors, from the equipment.
5. Close the drain, supply and return valves.
6. Ensure that the electrical drawer and all access doors are fastened securely.
7. Coil the main power cord and secure.
8. Wrap the TCU in bubble, polythene, or shrink wrap and enclose in the original or replacement shipping crate (Edwards part number P90150100).
9. If the equipment is contaminated, label the pallet (or box) in accordance with laws covering the transport of dangerous substances.
10. Fax or post a copy of the Declaration (HS2) to your supplier. The Declaration must arrive before the equipment.
11. Give a copy of the Declaration to the carrier. You must tell the carrier if the equipment is contaminated.
12. Seal the original Declaration in a suitable envelopes attach the envelope securely to the outside of the equipment package. **WRITE YOUR RETURN AUTHORISATION NUMBER CLEARLY ON THE OUTSIDE OF THE ENVELOPE OR ON THE OUTSIDE OF THE EQUIPMENT PACKAGE.**

Return of Edwards Equipment- Declaration

(FormHS2)

Return Authorization Number: _____

You must:

- Know about all of the substances which have been used and produced in the equipment before you complete this Declaration
- Read the Procedure (HS1) on the previous page before you attempt to complete this Declaration
- Contact your supplier to obtain a Return Authorization Number and to obtain advice if you have any questions
- Send this form to your supplier before you return your equipment

SECTION 1 : EQUIPMENT

Equipment model _____
Serial Number _____ Hours _____
Has the equipment been used, tested, or operated?
yes ☐ Go to Section 2 no ☐ Go to Section 4

FOR SEMICONDUCTOR APPLICATIONS ONLY:

Tool Reference Number _____
Process _____
Failure Date _____
Serial Number of Replacement TCU _____

SECTION 2 : SUBSTANCES IN CONTACT WITH THE EQUIPMENT

Are any of the substances used or produced in the equipment

- Radioactive yes ☐ no ☐
- Biologically active yes ☐ no ☐
- Dangerous to human health and safety? yes ☐ no ☐

If you have answered 'no' to all of these questions, go to Section 4.

Your supplier will not accept delivery of any equipment that is contaminated with radioactive substances, unless you:

- Decontaminate the equipment
- Provide proof of decontamination

YOU MUST CONTACT YOUR SUPPLIER FOR ADVICE BEFORE YOU RETURN SUCH EQUIPMENT

SECTION 3 : LIST OF SUBSTANCES IN CONTACT WITH THE EQUIPMENT

Substance name	Chemical symbol	Precautions required (for example, use protective gloves, etc.)	Action required after spillage or human contact.
1			
2			
3			
4			
5			
6			

SECTION 4 : RETURN INFORMATION

Reason for return and symptoms of malfunction: _____

If you have a warranty claim:

- who did you buy the equipment from ? _____
- give the supplier's invoice number _____

SECTION 5 : DECLARATION

Print your name: _____ Print your job title: _____

Print your organization: _____

Print your address: _____

Telephone number: _____ Date of equipment delivery: _____

I have made reasonable inquiry and I have supplied accurate information in this Declaration. I have not withheld any information. I have followed the Return of Edwards Equipment Procedure (HS1) on the previous page.

Signed: _____ Date: _____

Legal notices, limitations and disclaimers

For a period of twelve (12) months from the date of original shipment to Purchaser, the apparatus and each part of component manufactured by Edward's High Vacuum International (Edwards) is warranted to be free from functional defects in materials and workmanship. The foregoing warranty is subject to the condition that regular periodic maintenance and service be performed or replacements made in accordance with instructions provided by Edwards. The foregoing warranty shall not apply to any apparatus, part, or component that has been repaired other than by Edwards or an authorized Edwards representative or in accordance with written instructions provided by Edwards, that has been altered by anyone other than Edwards or that has been subject to improper installation or abuse, misuse, negligence, accident, or corrosion.

Purchaser's sole and exclusive remedy under the above warranty is limited to, at Edward's option, repair or replacement of defective parts of components or return to Purchaser of the price of the apparatus. The defect must be promptly reported to Edwards or Purchaser must return the part or component with a statement of the observed deficiency no later than seven (7) days after the expiration date of the warranty to the address designated by Edwards, transportation charges prepaid. In the event that Edwards elects to refund the purchase price, the apparatus shall be the property of Edwards and shall be shipped to Edwards at Edward's expense. This Mechanical Warranty shall be void and the apparatus shall be deemed to be purchased AS IS in the event that the entire purchase price has not been paid within thirty (30) days of original shipment of apparatus.

THERE ARE NO EXPRESS OR IMPLIED WARRANTIES THAT EXTEND BEYOND THE WARRANTY HEREIN ABOVE SET FORTH. THERE IS NO PARTICULAR WARRANTY OF MERCHANT ABILITY OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE APPARATUS OR ANY PART OR COMPONENT THEREOF AND NO WARRANTY SHALL BE IMPLIED BY LAW.

Items not of Edwards's manufacture but resold by Edwards are the products of other manufacturers and their warranty, if any, shall apply. THERE ARE NO WARRANTIES OF ANY KIND ON PRODUCTS OF OTHER MANUFACTURERS RESOLD BY EDWARDS EXCEPT THE WARRANTY OF TITLE. AND NO WARRANTIES SHALL BE IMPLIED BY LAW. THERE IS NOT EXPRESS OR IMPLIED WARRANTY OF MERCHANT ABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO PRODUCTS OF OTHER MANUFACTURERS.

In no event shall the Purchaser be entitled to any special, indirect, or consequential damages.

MSDS (material safety data sheet) - "SUVA" HP62

RECIPIENT
MATERIAL SAFETY DATA SHEETS
RECIPIENT

Du Pont Chemicals

6002FR

Revised 15-JUL- 1993

Printed 16-DEC-1993

"SUVA" HP62"

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

"SUVA" is a registered trademark of DuPont.

Corporate MSDS Number DUO05612

Company identification

MANUFACTURER/DISTRIBUTOR

DuPont
1007 Market Street
Wilmington, DE 19898

PHONE NUMBERS

Product Information	1-800-441-9442
Transport CHEMTREC:	1-800-424-9300
Medical Emergency	1-800-441-3637

COMPOSITION/INFORMATION ON INGREDIENTS

Components

Material	CAS Number	%
PENTAFLUOROETHANE (HFC-125)	354-33-6	44
ETHNE, 1,1,1 - TRIFLUORO- (HFC-143a)	420-46-2	52
		811-97-2
ETHANE, 1,1,1,2 - TETRAFLUORO. (HFO-134a)		4

HAZARDS IDENTIFICATION

Potential Health Effects

Inhalation of high concentrations of vapor is harmful and may cause heart irregularities, unconsciousness, or death. Intentional misuse or deliberate inhalation may cause death without warning. Vapor reduces oxygen available for breathing and is heavier than air. Liquid contact can cause frostbite.

(Continued)

HAZARDS IDENTIFICATION (Continued)

HUMAN HEALTH EFFECTS:

Overexposure to the vapors by inhalation may include temporary nervous system depression with anesthetic effects such as dizziness, headaches, confusion, incoordination, and loss of consciousness. Higher exposures to the vapors may cause temporary alteration of the heart's electrical activity with irregular pulse, palpitations, or inadequate circulation; or fatality from gross overexposure. Contact with the liquid may cause frostbite.

Individuals with preexisting diseases of the central nervous or cardiovascular system may have increased susceptibility to the toxicity of increase exposures.

Carcinogenicity Information

None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH as a carcinogen.

FIRST AID MEASURES

First Aid

INHALATION

If high concentrations are inhaled, immediately remove to fresh air. Keep person calm. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

SKIN CONTACT

Flush skin with water for at least 15 minutes after excessive contact. Treat for frostbite if necessary by gently warming affected area. Call a physician if irritation is present.

EYE CONTACT

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

INGESTION

Ingestion is not considered a potential route of exposure.

Notes to Physicians

Because of possible disturbances of cardiac rhythm, catecholamine drugs, such as epinephrine, should only be used with special caution in situations of emergency life support.

(Continued)

FIRE FIGHTING MEASURES

Flammable Properties

Flash Point	will not burn
Method	TOC
Flammable limits in Air	% by Volume
LEL	Not applicable
UEL	Not applicable
Autoignition	Not determined

Fire and Explosion Hazards:

Cylinders may rupture under fire conditions. Decomposition may occur.

Potential Combustibility:

"SUVA" HP62 is not *flammable* at temperatures up to 80 deg C (176 deg F) and at atmospheric pressure. Data are not available at higher temperatures and pressures. However, one of the components, HFC-143a is flammable. Another, HFC-134a, has been shown in tests to be combustible at pressures as low as 60 psig at ambient temperature when mixed with air at concentrations of 65 volume % air. Therefore, "SUVA" HP82 should not be mixed with air for leak testing. In general, it should not be used or allowed to be present with high concentrations of air above atmospheric pressures. Experimental data have also been reported which indicate combustibility of HFC-134a in the presence of certain concentrations of chlorine.

Extinguishing Media

As appropriate for combustible in area.

Fire Fighting Instructions

Cool cylinder with water spray or fog. Self-contained breathing apparatus (SCBA) is required if cylinders rupture and contents are released under fire conditions.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up.

Accidental Release Measures

Ventilate area, especially low or enclosed places where heavy vapors might collect. Remove open flames. Use self-contained breathing apparatus (SCBA) for large spills or releases.

(Continued)

HANDLING AND STORAGE

Handling (Personnel)

Avoid-breathing vapor. Avoid liquid contact with eyes and skin. Use with sufficient ventilation to keep employees exposure below recommended limits. Contact with chlorine or other strong oxidizing agents should also be avoided. See Fire and Explosion Data section.

Storage

Clean, dry area. Do not heat above 52 deg C (125 deg F).

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

Avoid breathing vapors. Avoid contact with skin or eyes. Use with sufficient ventilation to keep employee exposure below the recommended exposure limit. Local exhaust should be used if large amounts are released. Mechanical ventilation should be used in low or enclosed places..

Personal Protective Equipment

Impervious gloves should be used to avoid prolonged or repeated exposure. Chemical Splash goggles should be available for use as needed to prevent eye contact. Under normal manufacturing conditions, no respiratory protection is required when using this product. Self-contained breathing apparatus (SCBA) is required if a large release occurs.

Exposure Guidelines

Applicable Exposure Limits

PENTAFLUOROETHANE (HFC-125)

PEL	(OSHA)	None Established
TLV	(ACGIH)	None Established
AEL *	(Du Pont)	1000 ppm, 8 & 12 Hr. TWA

ETHANE, 1, 1, 1-TRIFLUORO- (HFC-143a)

PEL	(OSHA)	None Established
TLV	(ACGIH)	None Established.
AEL *	(Du Pont)	1000 ppm, 8 & 12 Hr. TWA

ETHANE, 1, 1, 1, 2-TETRAFLUORO- (HFC-134a)

PEL	(OSHA)	None Established
TLV	(ACGIH)	None Established
AEL *	(Du Pont)	1000 ppm, 8 & 12 Hr. TWA
WEEL	(AIHA)	1000 ppm, 8 Hr. TWA

* AEL is DuPont's Acceptable Exposure Limit. Where governmental imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.

(Continued)

PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Boiling Point	-46.7 C (-52, 1 F) Average
Vapor Pressure	182.1 psia at 25 deg C (77 deg F)
% Volatiles	100 WT%
Evaporation Rate	(CL4 = 1)
	Greater than 1
Solubility in Water	Not determined
Odor	slight ethereal
Form	Liquefied gas
Color	Clear, colorless
Specific Gravity	1.05 @ 25C (77F)

STABILITY AND REACTIVITY

Chemical Stability

Material is stable. However, avoid open flames and high temperatures.

Incompatibility with Other Materials

Incompatible with active metals, alkali or alkaline earth metals - powdered Al, Zn, Be, etc.

Polymerization

Polymerization will not occur.

Other Hazards

Decomposition Decomposition products are hazardous. "SUVA" HP62 can be decomposed by high temperatures (open flames glowing metal surfaces, etc) forming hydrochloric and hydrofluoric acids, and possibly carbonyl halides.

TOXICOLOGICAL INFORMATION

Animal Data

The blend is untested.

HFC-125

Inhalation 4-hour ALC: >709,000 ppm in rats

Single high inhalation exposures caused decreased activity, labored breathing and weight loss. Cardiac sensitization occurred in dogs exposed to concentrations of 10-30% in air and given an intravenous epinephrine challenge; no cardiac sensitization occurred at a concentration of 7.5%.

No animal data are available to define carcinogenic hazards. HFC-125 did not cause embryotoxicity or developmental toxicity in rats or rabbits at inhalation concentrations up

(continued)

TOXICOLOGICAL INFORMATION (Continued)

to 50,000 ppm. HFC-126 does not produce genetic damage in bacterial or mammalian cell cultures or when tested in animals.

HFC-134a

Inhalation 4-hour LC50: 567,000 ppm in rats

A 5 or 10 second spray of vapor produced very slight eye irritation and a 24-hour occlusive application produced slight skin irritation in rabbits. The compound is not a skin sensitizer in animals. No toxic effects were seen in animals from exposures by inhalation to concentrations up to 81,000 ppm. Lethargy and rapid respiration were observed at a vapor concentration of 305,000 ppm and pulmonary congestion, edema, and central nervous system effects occurred at a vapor concentration of 750,000 ppm. Cardiac sensitization occurred in dogs at 75,000 ppm following an epinephrine challenge. No effects in animals occurred from repeated inhalation-exposures to 99,000 ppm for two weeks or higher concentrations to 50,000 ppm for three months. Repeated exposures to higher concentrations caused transient tremors, incoordination and some organ weight changes. Long-term exposures produced increased testes weights and increased urinary fluoride levels. No adverse effects were observed in male and female rats fed diets containing 300 mg/kg/day of HFC-134a for 52 weeks. Animal testing indicates that this compound does not have carcinogenic or mutagenic effects. Inhalation of 50 000 ppm for two years caused an increase in benign testicular tumors in male rats. No effects were observed at lower concentrations. The tumors were late-occurring and were judged not to be life-threatening. Embryotoxic activity has been observed in some animal tests but only at high concentrations that were also maternally toxic.

HFC-143a

Inhalation 4-hour LC50: >540,000 ppm in rats

Single exposures by inhalation to 500,000 ppm caused anesthesia but no mortality at 540,000 ppm. Cardiac sensitization occurred in dogs at 600,000 ppm following an intravenous challenge with epinephrine. Two, 4-week inhalation have been conducted. In the first study, pathological changes in the testes were observed at all exposure concentrations; no effects were observed in females. The testicular effect was considered related to the method used to expose the rats to HFC-143a. In the second study using the same exposure concentrations, no effects were noted in males at any concentration. Data from a 90-day study revealed no effects in male or female rats at exposures up to 40,000 ppm. Long-term exposure caused significantly decreased body weights in male rats fed 300

(continued)

TOXICOLOGICAL INFORMATION (Continued)

mg/kg for 52 weeks, but there was no effect on mortality. Tests in rats demonstrated no carcinogenic activity when administered orally 300 mg/kg/day for 52 weeks and observed for an additional 73 weeks. Tests in bacterial cell cultures demonstrated mutagenic activity, but the compound did not induce transformation of mammalian cells in culture or in the whole animal. Tests in animals demonstrate no developmental toxicity.

ECOLOGICAL INFORMATION

Ecotoxicological Information Aquatic Toxicity

HFC 143a

96-hour LC50, rainbow trout: >40 mg/L

DISPOSAL CONSIDERATIONS

Waste Disposal

Comply with Federal, State, and local regulations. Reclaim by distillation or remove to a permitted waste disposal facility.

TRANSPORTATION INFORMATION

Shipping Information

D /IMO

Proper Shipping Name

LIQUEFIED GAS, N.O.S.
(CONTAINS PENTAFLUORDETHANE AND
TETRAFLUOROETHANE)

Hazard Class 2.2

UN No. 1956

DOT/IMO Label NON-FLAMMABLE GAS

Shipping Containers

Tank Cars,

Cylinders

Ton Tanks

REGULATORY INFORMATION

US Federal Regulations

TSCA Inventory Status Reported/Included.

TITLE III HAZARD CLASSIFICATIONS SECTIONS 311, 312

(Continued)

REGULATORY INFORMATION(Continued)

Acute: No
Chronic: No
Fire: No
Reactivity: No
Pressure: yes

LISTS:

SARA Extremely Hazardous Substance	No
CERCLA Hazardous Material	No
SARA Toxic Chemicals	No

OTHER INFORMATION

NFPA, NPCA-HMIS

NPCA-HMIS Rating
Health 1
Flammability 0
Reactivity 1

Personal Protection rating to be supplied by user depending on use conditions.

Additional Information

HFC-125 and HFC 143a are TSCA listed, and are controlled by a TSCA Section 5 Consent Order.

The date in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

Responsibility for MSDS DuPont Chemicals .
Address Engineering & Product Safety
P. O. Box S0709, Chestnut Run
Wilmington, DE 19880-0709

Telephone 302-999-4946

Indicates updated section.

End of MSDS

NOTES:

Edwards International

EUROPE

UNITED KINGDOM

Edwards High Vacuum International
Manor Royal
Crawley
West Sussex RH10 2LW
Tel: (01293)528844
Fax: (01 293) 533453

BELGIUM

Edwards
Bergensesteenweg 709
B1600 Sint-Pieters-Leeuw
Tel: 2 360 3671
Fax: 2 360 3591

FRANCE

Edwards SA
125 Avenue Louis Roche
92238 Gennevilliers, Cedex
Tel: (1) 4798 2401
Fax: (1)4798 4454

GERMANY

Edwards Hochvakuum GmbH
Postfach 1 409
D35004 Marburg
Tel: 6420 82410
Fax: 6420 82411

ITALY

Edwards Alto Vuoto SpA
Via Carpaccio 35
20090 Trezzano Sul Naviglio
Milano
Tel: 2 4840 2258
Fax: 2 4840 1638

SWITZERLAND

Edwards (ECH)
Postfach
CH-4104 Obrwil-Basel
Tel: 61 401 4344
Fax: 61 401 4352

AMERICAS

USA

Edwards High Vacuum International
One Edwards Park
301 Ballardvale St.
Wilmington, MA 01887
Tel: 508 658 5410
Fax: 508 658 7969

Edwards High Vacuum International
Sierra Technology Center
Building A Suite 120
3100 Alvin Devane Boulevard
Austin, TX 78741
Tel: 512 389 3883
Fax: 512 389 3890

Edwards High Vacuum International
550 Sycamore Drive
Milpitas, CA 95035
Tel: 408 946 4707
Fax: 408 946 8510

CANADA

Edwards High Vacuum
3375 North Service Road
Units B2/B3
Burlington
Ontario, L7N 3G2
Tel: 905 336 9119
Fax: 905 845 4924

BRAZIL

Edwards Alto Vácuo
Rua Benardo Wrona, 222
Bairro do Limão
02710 - São Paulo - SP
Tel: 11 858 0377
Fax: 11 265 2766

PACIFIC

JAPAN

Nippon Edwards KK
Shuwa Shiba Park Building A-3F
2-4-1 Shibakoen
Minato-ku
Tokyo 105
Tel: 3 5470 6530
Fax: 3 5470 6521

Nippon Edwards KK
Esaka Yodo Building 5F
16-34 Enoki-cho
Suita-shii
Osaka 564
Tel: 6 384 7052
Fax: 6 384 7504

Nippon Edwards KK
508-1 Yomogi-machi
Kumamoto-shi
Kumamoto 861-55
Tel: 96 326 7300
Fax: 96 326 7302

HONG KONG

Edwards High Vacuum (Pacific)
1308 Tower II
World Trade Square
123 Hoi Bun Road
Kwun Tong, Kowloon
Hong Kong
Tel: 796 9111
Fax: 796 9095

REPUBLIC OF KOREA

Songwon Edwards Ltd
Sun In Building
738-41 Panpo-Dong
Sochu Gu, Seoul
Tel: 2515 1811
Fax: 2 515 1818

TAIWAN

Zimmerman Scientific Co Ltd
Golden Dragon Building
8FL No 127
Fu-Shin South Road
Section 1, Taipei
Tel: 2 752 7075
Fax: 2 771 9415



Edwards High Vacuum International is part of BOC Limited
The stripe symbol is a trade mark of The BOC Group