

Handout Book

Additional information with exercises charts forms, etc.

TM-70010 10/02

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System Descriptions

Deluxe Systems: 6-30 ton Dual Compressor or 6-50 ton Chilled Water units. Floor mounted with either downflow or upflow discharge air patterns.

1965 - 1973: System/1 Johnson Controls, Sequencer Type.

1973 - 1983: System/2 Solid State Controls (Plug in Modules “Black Box” w/ Motherboard).

1983 - 1986: System/3 Microprocessor Controls (Level’s 01, 02 and 03).

1986 - 1994: Microprocessor Controls (Level’s 00 and 10).

1994 - 9/2000: Microprocessor Controls (Level’s SM, AM and AG).

Sept. 2000 - Present: Microprocessor Controls (Level’s AM and AG).

Challengers: 3 and 5 ton Single Compressor or 3 and 5 ton Chilled Water units. Floor mounted with either downflow or upflow discharge air patterns.

1975 - 1978: Challenger/1 Johnson Controls, Sequencer Type.

1978 - 1986: Challenger/2 Solid State Control (Plug in Modules w/ Motherboard).

1986 - 1994: Challenger/3 Microprocessor Control (Level 00).

1994 - 9/2000: Challenger 3000 Microprocessor Controls (Level’s SM, AM and AG).

Sept. 2000 - Present: Challenger 3000 Microprocessor Controls (Level’s AM and AG).

Himod: 8,10,12 ton Single Compressor units. Floor mounted with either downflow or upflow discharge air patterns

Dec. 2001 - Present: Himod Microprocessor Controls (Level’s AM and AG).

Small Systems: Available in Self Contained or Split System configurations.

mini-Mate: 1 1/2 ton Single Compressor or Chilled Water unit. Installed in space above the
drop ceiling.

mini-Mate Plus: 2, 3 and 5 ton Single compressor or Chilled Water. Installed in the
space
above the drop ceiling with remote wall mounted controller.

Mini-Mate2: 1 1/2, 2, 3 and 5 ton Single compressor or Chilled Water and 8 ton dual
compressor systems. Installed in the space above the drop ceiling with
remote
wall mounted controller.

DataMate: 1 1/2, 2 and 3 ton Single compressor or Chilled Water. Floor or wall mounted

1978 - 1990: Solid State Controls, unit mounted.

1990 - Sept. 2000: Microprocessor Controls, unit mounted.

Sept. 2000 - Present: Microprocessor Controls with remote wall mounted controller.

Industrial Cooling Series: 10-60 ton Dual Compressor or Chilled Water units. Floor mounted

with upflow discharge air patterns.

1990 - 1994: Microprocessor Controls (Level's 00 and 10)

1994 - 9/2000: Microprocessor Controls (Level's SM, AM and AG)

Sept. 2000 - Present: Microprocessor Controls (Level's AM and AG)

Intelecool 2: 2, 3, 4 and 5 ton Single Compressor Air Cooled upflow with Economizer. Built

for the Telecommunications industry.

1994 - Present: Electro-Mechanical Control

CSU3000 Chillers: 5 - 37 ton, 1 to 3 module Compressorized or Chilled Water units to fluid

cool a main frame computer.

1979 - Present: Solid State Controls (Plug in Modules with Motherboard)

Process Fluid Chillers: 1 1/2 - 8 ton , Single Compressor Air Cooled units to fluid cool both

medical equipment and industrial equipment.

1995 - Present: Make/ break stat type control

Deluxe Systems Model Number Designation

Designations since February 1999

FH	245	A	—	A	A	E	I
DH = Downflow DE = Downflow w/ Econ-o-coil VH = Upflow DX VE = Upflow w/ Econ-o-coil FH = Downflow UH = Upflow CW FE = Downflow w/ Econ-o-coil	Nominal Capacity in Thousand BTU/H see chart below	A = Air Cooled W = Water Cooled G = Glycol Cooled C = Chilled Water	- = 2 Step DX or Std. CW U = 4 step DX V = VSD CW (Variable Speed Drive) H = DX w/ Hot Gas Bypass	A = 460/3/60 B = 575/3/60 C = 208/3/60 D = 230/3/60 F = 380/3/50 G = 415/3/50 H = 230/3/50 J = 200/3/50 U = 400/3/50	S = Standard Micro-processor A = Advanced Micro-processor G = Advanced Graphics Micro-processor	0 = No Reheat E = Electric Reheat H = Hot Water Reheat G = Hot Gas Reheat T = Steam Reheat	0 = No Humidifier I = Infrared Humidifier G = Steam Grid Humidifier S = Steam Generating Humidifier

Designations 1983 - January 1999

FH	245	A	—	A	00
FH = Downflow UH = Upflow FE = Downflow w/ Econ-o-coil UE = Upflow w/ Econ-o-coil	Nominal Capacity in Thousand BTU/H See chart below	A = Air Cooled W = Water Cooled G = Glycol Cooled C = Chilled Water	- = 2 Step DX or Std. CW U = 4 Step DX V = VSD CW	A = 460/3/60 B = 575/3/60 C = 208/3/60 D = 230/3/60	00 = Level 00 Microprocessor 10 = Level 10 Microprocessor 01 = Level 01 Microprocessor 02 = Level 02 Micro processor 03 = Level 03 Microprocessor

Tonnage	6	8	10	15	20	22	30	40	50
Air Cooled	075	114	125	199	245	290	380		
Water Cooled	086	127	138	219	267	315	412		
Glycol Cooled	072	110	116	192	240	265	363		
Chilled Water	147	200	248	302	376	422	529	600	740

Challenger Systems Model Number Designation

Challenger 3000 Designations, 1994 – Present

BF	042	A	—	A	A	E	I
BF = Downflow BE = Downflow w/ Econ-o- coil BU = Upflow BK = Upflow w/ Econ- o- coil	Nominal Capacity in Thousand BTU/H	A = Air Cooled W/G = Water/Glycol Cooled C = Chilled Water E = vaporator	Std DX or Std. CW	A = 460/3/60 B = 575/3/60 C = 208/3/60 D = 230/3/60	S = Standard Micro- processor A = Advanced Micro- processor G = Advanced Graphics Micro- processor	0 = No Reheat E = Electric Reheat H = Hot Water Reheat G = Hot Gas Reheat S = SCR Reheat	0 = No Humidifier I = Infrared Humidifier S = Steam Generating Humidifier

Challenger 3 Designations, 1986 - 1994

CF	045	A	—	A	00
CF = Challenger Downflow CU = Challenger Upflow CE = Downflow w/ Econ- o- coil CK = Upflow w/ Econ-o- coil	Nominal Capacity in Thousand BTU/H	A = Air Cooled W = Water Cooled G = Glycol Cooled C = Chilled Water	- Std. DX or Std. CW	A = 460/3/60 B = 575/3/60 C = 208/3/60 D = 230/3/60	00 = Level 00 Microprocessor

Himod Designations, 2001-Present

HM	U	28	A	1	A	A	E	S
Himod	Air Discharge U=Upfow F=Downflow	Capacity KW 28 34 40	Cooling Type A=Air cooled G=Glycol K=Glycool D=Dual cool w Air H=Dual cool w Glycol	Refrigerant 1=407C 0=R22	Voltage A=460/3/60 C=208/3/60 D=230/3/60	Controls A=Advanced G=Advanced w\Graphics	Reheat E=Electric 0=None	Humidifer S=Steam Generator 0=None

Small Systems Model Number Designation

Mini-Mate2 Model Designation

MM	D	60	E	-	C	H	E	L	A
Mini-Mate 2 Microprocessor Control	D = Disconnect O = No Disconnect	Nominal BTU/h's (in Thousands)	E = Split Evaporator K = Evaporator w/Free Cooling	DX Evaporator	Voltage See Chart	H = Canister O = No Humidifier	E = Electric S = SCR H = Hot Water O = No Reheat	Fan Speed L = Low H = High	Options See Chart

Voltages

A = 460/3/60

B = 575/3/60

Firestat

C = 208/3/60

Detector

D = 230/3/60

M = 380/400/3/50

Options

O = None

A = Filter Clog

B = Smoke Detector

C = Firestat

D = Filter Clog & Smoke Detector

E = Filter Clog & Firestat

F = Smoke Detector &

G = Filter Clog & Smoke

&Firestat

Mini-Mate Model Designation

MME	018	E-	P	H	0
MME = mini-Mate Ceiling Unit DMC = Outdoor Condensing Unit	Nominal Capacity in Thousand BTU/H	E = Evaporator Only A = Air Cooled W/G = Water/Glycol Cooled Condenser C = Chilled Water Water/ Glycol Cooled Condensers WG = 2-way 150 psi WH = 2-way 300 psi W3 = 3-way 150 psi WT = 3-way 300 psi	P = 208/230/1/60 X = 277/1/60	H = With Humidifier and Reheat O = Cooling Only L = Lee-Temp (Condensing Unit)	0 = Revision Level

Mini-Mate Plus Model Designation

MME	024	E-	P	H	1
MME = mini-Mate Plus Evaporator Section MMC = mini-Mate Plus Condensing Section DMD = Outdoor Condensing Unit	Nominal Capacity in Thousand BTU/H	E = Evaporator Only A = Air Cooled WG = Water/Glycol Cooled Condenser C = Chilled Water W = Water Cooled G = Glycol Cooled AC = DMC with Coated Coil	A = 460/3/60 B = 575/3/60 P = 208/230/1/60 X = 277/1/60 Y = 208/230/3/60	H = With Humidifier O = No Humidifier C = Cooling Only L = Lee-Temp Water or Glycol Condensing Unit O = 2-way 150 psi H = 2-way 300 psi 3 = 3-way 150 psi T = 3-way 300 psi	1 = Revision Level

Data-Mate Model Designation

BME	020	E-	P	H	3
DME = DataMate Evaporator Section MCD = Mini-Mate2 Condensing Section DMC = DataMate W/G Condensing Section	Nominal Capacity in Thousand BTU/H	E = Evaporator Only A = Air Cooled W/G = Water/Glycol Cooled Condenser C = Chilled Water W = Water Cooled G = Glycol Cooled	P = 208/230/1/60 X = 277/1/60 A = 460/3/60 Y = 208/230/3/60	H = Humidifier and Reheat O = Reheat C = Cooling Only Water or Glycol Condensing Unit O = 2-way 150 psi H = 2-way 300 psi 3 = 3-way 150 psi T = 3-way 300 psi	2 = Revision Level

IntelCool 2 Model Designation

ET	036	H	R	P	F	B	T
External Communication	Nominal Btuhs in 1000	H = Hermetic Compressor S = Scroll Compressor	R = Right Compressor L = Left Compressor	P = 208/230/1/60 S = 220/240/1/50 A = 460/3/60 Y = 208/230/3/60 N = 208/230/3/60 M = 380/415/3/50	O = Standard F = Fixed Outside Air Damper E = Economizer Cooling	0 = No Heat A = 5 kW B = 10 kW C = 15 kW	T = Tan Painted Steel Panels C = Custom Color Painted Steel Panels A = Aluminum Panels

CSU3000 Chiller Model Designation

DS	065	A-	A
DS = Single Module, 2 ½ or 5 Ton DD = Dual Module, 2 ½ or 5 Ton CS = Single Module, 7 ½, 10, 12, or 15 Ton CD = Dual Module, 7 ½, 10, 12, or 15 Ton CT = Triple Module, 20 30, or 37 ½ Ton	Nominal Capacity in Thousand BTU/H	A = Air Cooled W = Water Cooled G = Glycol Cooled L = Glycol Cooled	A = 460/3/60 B = 575/3/60 C = 208/360 D = 230/3/60

Process Fluid Chiller Model Designation

PS	036	A	P	B	3	0
PS = Process Chiller	Nominal Capacity in Thousand BTU/H	A = Air Cooled	A = 460/3/60 Y = 208/230/3/60 P = 208/230/1/60	S = Stainless Steel Pump B = Gauges/ Heater/ SS Pump M = Multi-Stage Pump (8/10 Ton Models) R = Gauges/ Heater/ Multi-Stage Pump (8/10 Ton Models)	3 = Rev. Level	0 = No Tank T = 100 Gal Tank

Industrial Cooling Series Designations - Present

UP	245	A	—	A	AM
UP = Upflow	Nominal Capacity in Thousand BTU/H	A = Air Cooled W = Water Cooled	- = 2 Step DX U = 4 Step DX	A = 460/3/60 B = 575/3/60	AM = Advanced Microprocessor AG = Graphics Microprocessor

Essential Environmental Control for Sensitive Electronics

Sensitive electronic devices require more than “People Comfort” air conditioning systems. Systems designed for people simply cannot provide the kind of environment required for high performance electronic equipment. Network and web site servers, data center mainframes, mini-computers and workstations in engineering and R&D, industrial process control instrumentation, sophisticated telephone and telecommunications systems, and medical instrumentation are just a few examples of the high-tech systems that require specialized protection from temperature and humidity fluctuations and the damaging effects of air-borne dirt, dust, and other contaminants. The high cost of equipment shutdown and/or replacement makes it imperative that the air conditioning system chosen for these critical areas be designed to maintain the exacting environmental requirements of the electronics manufacturers.

The areas which house sensitive electronics, computers and associated equipment, and the operating personnel requires proper environmental conditions and controls. These conditions must be satisfactory for both the equipment and the personnel, with consideration toward equipment comfort. While people can generally tolerate moderate fluctuations in temperature electronics equipment cannot. If the temperature of a critical area is too high or too low, data integrity and operating reliability can be compromised. Additionally, electronic equipment generates heat which is not uniform in its distribution because of the equipment’s size and operation, which compounds the difficulty of controlling temperature precisely.

Controlling the relative humidity of critical spaces is just as important as controlling the temperature. Too much humidity in the air allows moisture to condense on the electronic circuitry. This condensation combined with the trace contaminants found in the air produces corrosion of contacts and components on circuit boards. This type of high humidity corrosion accounts for 30 - 40% of all equipment failures. High humidity can also cause paper to swell, creating serious problems in the operation of any paper-handling device such as printers, plotters, fax machines, word processor and copiers. Paper jams and form miss-feeds are common occurrences in these situations.

Excessively low humidity is just as much of a problem as high humidity. In an environment where the air is very dry, a touch from a finger can produce a shock of static electricity. This static voltage can cause equipment malfunctions, damage components and scramble or erase data. Magnetic media such as disks and tapes can suffer oxide shed which increases the possibility of altered or lost data. Static charges on paper can create jams and miss-feeds in paper handling devices similar to the problems cause by high humidity conditions.

The total cooling load within a critical space is a combination of the equipment heat load in the room, number of people in the room, migration of heat into/out of the room through the walls and windows and the load resulting from bringing in outside air. The introduction of outside air typically increases both the sensible heat load and the latent (moisture) load of the cooling system. This impact of outside air changes from day to day and season to season, requiring the engineer to carefully consider the effects in room load calculations and environmental equipment control operational. To meet these environmental control requirements the critical space needs to be a separate sealed area within the main building structure. Critical space air conditioning is not so much the regulation of the space environment as it is the maintaining of the space conditions within certain established limits. So important is system operation to maintain these environmental concerns that the cost of back-up systems is often justified.

In many instances the importance of providing precision air conditioning for sensitive electronics equipment is not given the consideration it deserves. In many facilities, management assumes the same “comfort” cooling system designed for people will be sufficient for computers, workstations, and industrial controllers. However as the chart demonstrates, there are major differences in performance between precision air conditioning systems and comfort air conditioning systems.

Design Considerations	Precision A/C Systems	Comfort Cooling Systems
Temperature	72-75°F (± 2°F)	78-80°F (± 5°F)
Relative humidity	45-50% (± 5%)	50% (± 15%)
Cold weather operation	Good to -30°F	Usually not available.
Sensible heat ratio	Typically 0.90 - 0.98	Typically 0.60 - 0.70
Load density (sq ft/ton)	50 - 100	200 - 400
Hours of operation	8760 per year.	≈ 1200 hours per year.
Humidification & dehumidification control	Standard.	Not available. Add-on system needed.
Cooling control stages	Multiple stages of control.	Single stage of control.
Flexibility	Mandatory.	Not necessary.
Redundancy	Mandatory.	Not necessary.
Air movement	550 - 600+ cubic ft./minute	Typically 350 - 400 cubic ft./minute
Filter	High efficiency up to 85% ASHRAE	Standard throw-away furnace filter

Critical spaces that house sensitive electronics can be conditioned using a variety of systems. The most prevalent are air cooled, water cooled, glycol cooled, and chilled water. These systems can be used singularly or in combination with one another. The self-contained system is designed specifically for critical space applications and should be installed within the space for both efficient operation and security. These units are built to high reliability standards because of the performance required during year round operation. The completely packaged system is self-descriptive, each unit contains all necessary components needed to obtain and then maintain the precise environment of the critical space. These units supply conditioned either upward to plenums and ceiling ducts or downward under false floors.

The central air system has its components located outside the critical space. This allows for larger capacity units than the self-contained systems, permitting greater flexibility in system design and arrangement. The major consideration when using a central air system is the proper design and installation of the ductwork to the space. Security of the system from tampering is also an important item of concern. The decentralized air handling system is another type in use today. These systems are similar to the self contained units which are serviced by remote refrigeration units. These are normally chilled water systems that use cold water supplied by the building chiller plant.

Regardless of the system type used, it must be able to achieve several objectives. It must maintain room environmental conditions through continuous operation, and be capable of expansion. The equipment should be manufactured to allow servicing without interfering with the critical spaces normal operation. It must be able to operate on non-utility emergency power. It must be reliable and energy efficient.

Once the system to be used is determined the type of refrigeration cycle to be used must be considered. As previously stated, there are four systems mainly in use today, when selecting the refrigeration cycle to be used several items should be considered. The condensing method desired, its ease of installation and serviceability, if a refrigeration system is already installed, and the availability of cooling medium selected, both present and future. Also to be considered is the cost, both the initial equipment installation and that of future expansion.

The last concern in designing the environmental system is air distribution, this covers both the supply and return air arrangements. Because the heat load of an electronic device is concentrated at the equipment itself, supply air distribution should be introduced at the points of highest heat intensity. To accomplish this, there are several types of air distribution arrangements used. These include the ceiling plenum, zoning and under floor discharge.

Ceiling plenums supply air by using duct runs with diffusers. The advantage of this system is its ability to introduce large amounts of conditioned air into the space where required. The major disadvantage with this type of system is its inflexibility when the space is either expanded or equipment is re-located. The repositioning of ductwork and diffusers is both expensive and difficult in a active space. Another concern deals with the air stratification, turbulence and accompanying hot spots located in an area six to eight feet above the floor.

Zoning is another type of distribution system, all spaces require some form of zoning whether it be individual or with other distribution systems. Zoning is accomplished by varying the air volume, the air temperature or by a combination of both methods. This type of air distribution system should not be confused with the normal self-zoning of the critical space by the air conditioning equipment.

Under floor air discharge systems require the use of false (raised) floors which become pressurized by forcing the air under it. Air is distributed to the room through various types of registers located in the floor panels. This system reduces air requirements by supplying conditioned air directly into the electronic equipment or in the area of its air intake. Another advantage of the under floor discharge system is its flexibility when the space is expanded or equipment re-located, by moving floor panels the discharge air patterns are easily change. For proper operation of this type of system all floor openings not used for air discharge should be sealed. When designing this type of discharge air system care should be given in determining both the raised floor height and the location and placement of obstructions.

Return air systems are basically self descriptive. Their purpose is to return the heated air to the cooling equipment. This is accomplished by either a return air duct system or open return to the air conditioning equipment.

Once the mechanical system has been selected, the engineer must now investigate the various types of controls available. The system controls are critical to both system performance and the maintaining of the required environmental conditions. These controls should have an adjustable setpoint and sensitivity range, have visual and audible alarm capability, visual display of room conditions and equipment operating status, and be capable of communicating with remote control and monitoring systems.

The microprocessor control system is far superior to solid state devices due to precise control programmability, speed of response for maintaining the critical environment, and the ability to communicate with remote control and monitoring systems. Besides the superior performance aspect of microprocessor control, the reliability factor also increases over the solid state device. Microprocessor control is the present generation in system controls, be it residential, commercial or sensitive electronics space application. To service, maintain and operate these systems requires properly trained individuals. This training incorporates not only mechanical operation but also requires a basic understanding of computer systems.

When selecting critical space environmental conditioning equipment, care and consideration must be taken. There are many manufacturers and types of equipment on the market today. The major considerations should always include; initial cost versus operating cost, equipment flexibility and reliability, system design and system serviceability. Remember, don't short change the critical space by choosing equipment based on lower initial cost, system failure is too expensive. Always consider all options, then choose your system with care.

Room Requirements

Efficient operation of electronic equipment requires precise control of both the power and environmental conditions within the space. To accomplish this requires the engineer to investigate thoroughly not only the design of the system, but also the physical construction of the space itself. Location along with proper installation of the environmental systems and electronics equipment within the space determines the overall efficiency of the operation. Our concern deals with the requirements for proper environmental control and operation.

Electronic equipment are generators of large amounts of sensible heat and require continuous control of room conditions. The environmental equipment must be able to control simultaneously both temperature and humidity while moving and filtering large amounts of air. To achieve optimum efficiency requires installation of these systems within a properly constructed room.

Space requirements

Location of the space within the building structure is as important as its construction. Ideally, location of the space is within the core of the building which provides isolation from seasonal environmental load influences. The space should not be adjacent to any mechanical room or unconditioned area as these locations can have a thermal impact on the environmental conditions of the room. Once space location is determined the walls, sub-floor and ceiling must be constructed and insulated to prevent both thermal and moisture migration.

Thermal and moisture loads must be accounted for in the overall load calculations and equipment operations for the critical space. Failure to include these loads, affects space performance and efficiency. Seasonal thermal load gain and loss is determined by calculations using accepted design values for various geographic locations. Using these calculated values the proper R-value insulation is selected. Also outside air supplied to the room should be treated to match the conditions being maintained within the controlled space. This air should also be restricted to the minimum requirements per local codes. These air influences are detrimental to efficient space control.

Moisture migration is deterred by the addition of a polyethylene barrier within the exterior walls of the space. This barrier is often missing when the critical space is located within the building core because normal construction only includes the barrier in the exterior building walls. The belief that building structure performs the vapor barrier function is incorrect. Typical wall coverings of foil backed or painted gypsum board are not vapor barriers. A vapor barrier is also an air barrier. Deletion of this barrier results in nuisance alarm activation's, increased humidification and dehumidification run time, and problems with devices that use paper products. The end results are substantially higher operating, service and replacement costs.

Spaces constructed without the required vapor barrier can be sealed through a variety of means, the most common are painting the wall surfaces or the installation of plastic backed wall panels. The sub-floor should be sealed with a good epoxy based material. All openings in the perimeter of the space should be sealed using a caulking material with a high permeability factor. Permeability is defined as 'the ability of one substance to allow another substance to pass through it'. Items such as doorways should have a method of automatic closure with no gap between the bottom edge and floor. Windows should be excluded whenever possible, if not they should be double paned on internal walls. Exterior windows should be triple paned and tinted with some type of blinds installed to help decrease the solar gain impact on the space.

Another area of concern is the space above the dropped ceiling, based on the designed use of this area it must also be insulated and sealed for the same reasons as the space exterior walls. When using the area above the drop ceiling as part of the building comfort system additional requirements exist. These include but are not limited to isolation of area between the drop ceiling and building structure from the building system, and the use of insulated duct work between building system and outside air inlet opening. Total isolation of the data center space from the building and outside environmental conditions is a requirement for system operating efficiency and to help control operating costs.

Raised Floors

Most data centers are built with raised floor structures, this structure is a sealed false floor installed above the slab floor on metal support legs creating an air space between the two structures. This false floor serves two purposes, it is used by the contractor for routing of electrical and piping components, and as the discharge air plenum for the environmental equipment.

Unfortunately the first objective usually creates problems for the environmental equipment, as these components become obstructions to air movement. Care must be taken to assure the routing of these components along the outside perimeter of the space. When installed in this manner they will not interfere with the required airflow. If this is not possible then the following points should be considered, route the obstructions parallel to discharge airflow patterns to reduce their impact on air movement, keep the obstructions flat on the sub-floor surface out of the airflow, when

crossing the airflow keep obstructions as far from unit as possible, and do not use the raised floor as a storage area.

To increase air movement while reducing the impact of under floor obstructions, raised floors should fall within recommended heights. Typical range is from 12 inches to 30 inches. Raised floor heights of less than 12 inches should have a turning vane apparatus installed on the discharge air section of the environmental unit. This directs a higher percentage of air to the required areas while decreasing losses at the slab floor. If raised floor heights exceed 30 inches the engineer should consider the under floor space volume and the affect it has on pressurization for air movement. Prior to installing the raised floor panels thoroughly clean the sub-floor of all debris.

Equipment Location

The environmental conditioning equipment is designed to be located within and positioned around the perimeter of the space. This causes the zoning of space based on discharge air patterns and load locations. The conditioning equipment should never be located in the vicinity of the building supply air outlets. Location of the environmental equipment return air, with control sensors near the building system outlets will create false return air conditions. Since the equipment operates on return air conditions, these false values will lead to improper equipment operation, higher operating costs and decrease in room control efficiency.

Some systems are designed requiring the conditioning equipment be installed outside the space to be controlled. This type of installation requires that all duct runs between the conditioning equipment and critical space be tight and properly insulated, sized for proper pressure drops and airflow requirements. Additionally the supply air outlets should be located in the areas of highest heat loads, and the environmental equipment control sensors should be located within the area being conditioned for proper response to environmental changes. Regardless of where the environmental equipment is installed, the customer should leave enough space around the equipment to allow access for service. Recommendations of the equipment manufacturer should be always be followed.

Air Distribution

The distribution of air throughout the space is accomplished by using under floor air distribution or overhead ducted distribution (also free discharge). In under floor air distribution systems the raised floor is used as the discharge air duct. Air is introduced into the space through perforated floor tiles placed around the room. Location of these tiles is determined by the spacing of the various loads. Another method is to supply air directly to the load device through an opening in its bottom plate. Air movement in a raised floor system is affected not only by the under floor obstructions but the floor height as well. Refer to the section on raised floors for additional information.

Some data centers rooms are designed with overhead ducted or free discharge systems. This type of system delivers air using overhead duct runs with discharge outlets, or directly discharges air into the space. Always locate the discharge air outlets in the areas that have the highest load concentrations. Installed individual dampers on each branch run to allow for proper airflow balancing. Free discharge systems require plenum arrangement to direct the airflow to the required locations. Ducted systems should be insulated to deter thermal contamination, be properly supported and should be leak free. The installer should pressure test all duct runs.

When modifying existing systems the engineer should never mix equipment with different airflow patterns. If the existing space has an overhead ducted system then the new equipment should be the same. To mix overhead and under floor airflow patterns leads to environmental control problems, additional operation time and increased costs. Regardless of the air distribution system selected the installer and the customer must leave enough clearance around the equipment. This spacing is not only for servicing, but also for unobstructed air discharge and return patterns. Restriction of airflow patterns create environmental control problems that could potentially shutdown the electronic equipment due to increased space temperatures.

Installation

Installation of the equipment should be performed by a qualified technician. All equipment should be installed in accordance with state and local codes. Factory recommended components supplied by the installer is based on the type of piping system installed. They include isolation valves in all piping, air vents, flow regulating valves, pressure ports, strainers with cleanable filters, check valves, drain lines with hose bibs, and traps in all refrigerant hot gas lines.

Start-up

Once the equipment is installed according to the manufacturers instructions and prior to start-up, the installer should conduct a thorough inspection of the complete system. This inspect should include but not be limited to indoor environmental equipment, outdoor heat rejection equipment, all piping and wiring routed between the indoor and outdoor equipment, all customer connected components to the equipment.

Start-up instructions should be supplied by the equipment manufacture and followed carefully by the installer. Record all detailed information as required and return the proper forms to the manufacturer for warranty purposes. The installer and the owner should also keep a copy for their files. Start-up like installation should only be performed by a qualified technician.

Balancing

Balancing the environmental conditioning system is important for both proper control and cost efficiency. Based on the type of system selected balancing can range from an elementary to very complex procedure. The key to properly balancing any system is to have it operating in the mode of highest load, this normally is full cooling. Regardless of system type selected the installer should follow several basic points.

Airflow

1. Set all dampers and grilles to their full open position.
2. Check unit controls and set for full cooling.
3. Verify CFM requirements at all ducted outlets or floor grilles use site design drawings.
4. Operate only the primary units during balancing. If redundant units are supplied do not operate during balancing.
5. Adjust dampers and grilles to their required position.

Fluid Flow

1. Set all flow control devices to their full open position.
2. Verify GPM requirements at each unit, use site design drawings and manufacturers data for required values.
3. Verify supply fluid temperature, use manufacturers data for required values.
4. Adjust flow control devices to their required position.

Maintenance

A complete maintenance program should be developed using the equipment manufacturer suggestions. This type of program, performed properly increases system performance and extends equipment life.

Liebert Tech Note

Possible Pitting of Copper Tubes in Water Piping

Summary

Pitting and subsequent leaks are caused by dirt and contaminants in the water loop. Problems can be prevented through system design (closed towers and open towers that offer filtration and/or heat exchangers) and product selection (coil materials that are more corrosion resistant than copper) and frequent flushing of coils.

The presence of dirt and contaminants in any water loop over a long period of time will ultimately result in the corrosion and pitting of the copper tube within the systems connected to it. This is a potential problem for any copper coil, regardless of who the manufacturer is.

Mechanism of Corrosion

In addition to excellent heat transfer characteristics, copper tubes offer good corrosion resistance when used in coils and condensers. Copper forms an oxide film on the inner surface which, during normal operation (2-6 feet per second water velocities), acts as a protective coating. Unfortunately, if this film is damaged or disturbed by dirt, scale, or chemical treatment, the copper is exposed to corrosive action. If this happens frequently or if the film is prevented from forming, the corrosion becomes significant. It will continue until the contaminants in the water are removed or until the pitting penetrates the wall of the tube and a leak occurs. Systems with coils that have very low water velocities or coils that have water laying in them for extended periods of time (such as econ-o-coils) are especially susceptible.

Preventing Corrosion

Several things can be done to reduce corrosion and avoid corrosion-caused leaks. Remedies can be applied individually to a system or in conjunction with the building water delivery loop. They include:

- * Design a closed tower system. A closed loop system eliminates the continual introduction of dirt and airborne bacteria into the water circulation system.
- * Provide a filtration system or plate heat exchanger on open tower systems. These methods keep contaminants from reaching the coils in units by either filtering them out or isolating the dirty water side of the loop from the clean side via a heat exchanger.
- * Flush the coils in a system periodically to remove potential corrosion causing contaminants before they settle on tube walls and destroy the natural corrosive resistance of the oxide film.
- * Use a more corrosion resistant material for the coil, e.g. stainless steel. This extends the life of the coil, but will affect the heat transfer characteristics and possibly the system capacities.

The choices between a closed tower, open tower, and a heat exchanger should be addressed by a design engineer. The choice of coil material and the need for coil flushing can be addressed when recommending/selecting Liebert products. Special coil materials can be provided via SFA's, assuming the performance criteria can still be met. Coil flushing is a standard feature of the advanced microprocessor control on Liebert environmental units. For a more detailed discussion of corrosion control, see ASHRAE Handbook (HVAC Applications edition) and its chapter on corrosion control and water treatment. Responsible engineering practices should always be encouraged.

Application Guideline: Dual Source or Freecooling Deluxe Units (FE Models)

Summary

The Deluxe units are available in various configurations of DX systems and econ-o-coil to provide the most appropriate configurations to meet our customers' application and economic needs. Care must be taken to choose the correct system and match it with the appropriate technical data. This article clarifies many of the variations and requirements.

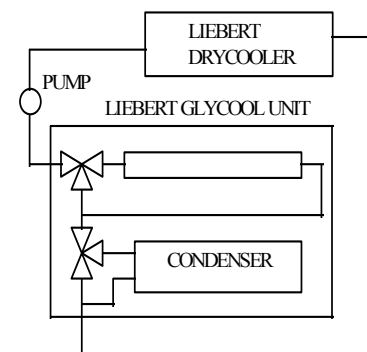
Glycool Models

The standard downflow Glycool unit includes an econ-o-coil **Cooling** (3-row on 6, 8, and 10 ton units, 4 row on 15, 20, 22, and 30 ton units), a 3-way econ-o-coil valve and two 3-way water regulating valves (one on each condenser). There is one supply and one return for the entire system, and all the valves must be 3-way because the components are designed to operate in series (Fig. 1). The glycol flow rate cataloged for each model is the flow rate that produces the econ-o-coil capacity at an entering fluid temperature of 45°F and the DX capacity at an outside ambient temperature of 95°F (assuming the standard 95°F ambient drycooler is used). Unit pressure drops are based on the highest value from the three different operating modes (total free cooling, partial free cooling with DX, and total DX).

An optional 6-row econ-o-coil is available in all models except the 30-ton unit (due to fan motor restrictions). The catalog capacity of the 6-row coils are based on the same glycol flow as the standard coils, but with an entering fluid temperature of 50°F. Rating the coils in this manner shows the additional free cooling obtained at warmer ambient conditions. Units with 6-row coils are only available with 2" thick filters due to space requirements in the cabinets. In the field, 4" filters can replace the 2" filters with the understanding that the 4" filters will protrude above the top of the unit by 2". Also, air flow will be reduced due to the increased pressure drop.

Upflow Glycool units are available in 6 through 20 tons and have 3-row econ-o-coils built as an integral part of the A-frame DX coil. The upflow ratings are slightly different than the

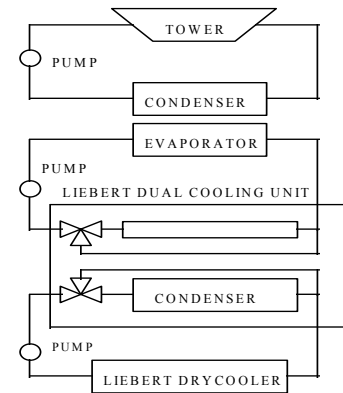
Glycool Unit: "Free



Glycool Unit: Dual Cooling Source

downflow ratings due to physical construction, but the above description still applied to those units. There is, however, no 6-row econ-o-coil available on the upflow units. Liebert equipment can be modified to meet the specific needs of the customer. This program is called Special Features Authorization or SFA, and is used to modify standard equipment to meet the specific needs of the job. The following refers to several different modifications by SFA number and description.

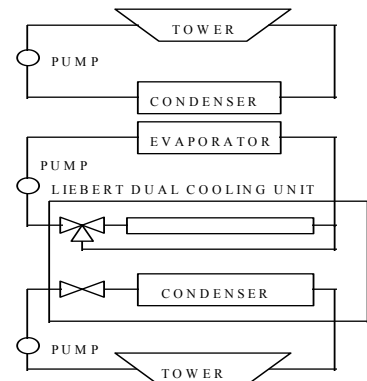
A Glycol unit can be ordered as a dual cooling source unit (Fig. 2) by including SFA #E9032 and specifying a separate supply and return for the econ-o-coil and a separate supply and return for the condensers (DX system). This system requires the Glycol unit flow rate to each piping system to obtain the catalog capacities. (Econ-o-coil capacities will be slightly higher than the catalog values if 0% glycol solution is used.) The DX system fluid pressure drop will be the same as the standard glycol unit. The econ-o-coil system fluid pressure drop can be obtained from the local Liebert sales office.



Water Cooled Models

Water cooled models with econ-o-coil are available in several different configurations depending on the specific application. The standard downflow unit configuration (dual cooling source) includes the following components: 6 row econ-o-coil with 3-way chilled water valve, DX system with two 2-way water regulating valves, and separate connections for the econ-o-coil and DX sections (Fig. 3). Water requirements for each section are shown in the catalog, with the econ-o-coil capacities based on 45°F chilled water and the DX capacities based on 65°F, 75°F, or 85°F condenser water. Standard catalog variations of this configuration include the 2-way with bypass or 3-way water regulating valves in lieu of the standard 2-way valves. A 2-way chilled water valve can be substituted for the 3-way valve by using SFA #E3974, but there is one field change that must be done with this configuration. The thermistor on the chilled water supply line in the unit must be relocated to a main chilled water supply line in the building. This allows the control to continually monitor the available chilled water temperature.

Water Cooled Unit: Dual Source Cooling



High pressure econ-o-coil circuits are available with standard options or various SFAs (E4739, E4364, and E5449) depending on the pressure and type of valve required. A common variation of

Water Cooled Unit: "Free Cooling"

water cooled unit with econ-o-coil is a “free-cooling” version (not dual source) which uses cooling tower water to provide econ-o-coil cooling in the winter time and DX cooling in the summer time (Fig. 4). The function of this unit is identical to a Glycool unit except it carries a water cooled unit model number (i.e. FExxxW). See “Techniques Possible Pitting of Copper Tubes in Water Piping Systems”, included in this booklet, for special considerations relative to corrosion protection in these systems.

When providing rating for these units, the GPM valve shown in the catalog for the econ-o-coil should be used as the unit flow rate. This ensures econ-o-coil capacity and DX capacity under any operating conditions. The pressure drop for this “free cooling” unit should be confirmed by your Liebert sales office.

Additional SFAs are available to supply 4-row econ-o-coils, high pressure components, and upflow units. All of these should be discussed in detail with your local Liebert sales office to verify that you have the right configuration.

Air Cooled Models

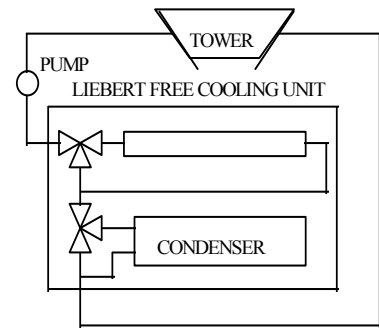
Air cooled models with econ-o-coils are the simplest version to deal with because they do not involve two water circuits (Fig. 5). The price book options includes a 6-row econ-o-coil and 3-way chilled water valve. SFA #E3974 replaces the 3-way valve with a

2-way valve, but it also necessitates the relocation of the thermistor in the field (as explained previously). High pressure options as well as upflow versions are also available with SFAs.

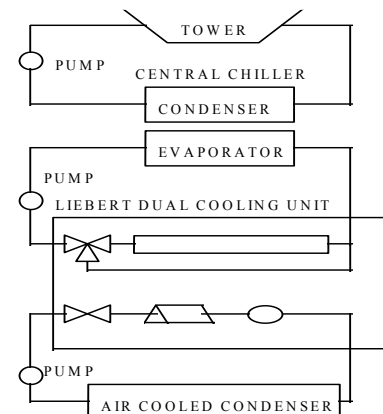
When using upflow units, the econ-o-coil capacities should be verified by your local Liebert sales office. In most cases, these will be slightly less than the DX capacities because the upflow econ-o-coil has less heat transfer surface than the downflow 6-row econ-o-coil.

General Comment

The “free cooling” and dual source cooling controls function with the econ-o-coil as the first step of cooling and the DX as the second and third (and fourth and fifth with 4-step). On the dual source units, this means that the chilled water system is the primary cooling source and the DX system is the backup. SFA #E5056 provides a modified control which makes the DX system the primary mode and the chilled water system the backup.



Air Cooled Unit: Dual Cooling Source



WHO TO CALL AT LIEBERT

MAIN PHONE: Environmental Service (800) 543-2778
Environmental Parts (800) 543-4349

Environmental Service & Parts fax: (614) 841-6781

TRAINING CENTER PHONE: (614) 841-6120

TRAINING CENTER FAX: (614) 841-6107

World Wide Web

Additional Liebert product information is available on the Internet. Simply locate Liebert at:

Home Page at <http://www.liebert.com>

Contact webmaster@liebert.com

Training Information www.liebert.com (See Quick link on home page)

All equipment Installation, Operation and Maintenance, and Technical Data manuals can be found on the Product page and the are in the PDF format for download or printing.

ELECTRICAL CHECKS/ ADJUSTMENT INFORMATION

DELUXE SYSTEM/3 and INDUSTRIAL COOLING SERIES UNITS WITH MICROPROCESSOR CONTROLS

For proper equipment operation verify that the indoor unit, heat rejection device, and all interconnecting piping and wiring has been installed according to the instructions given in the installation manual.

Step 1: Disconnect ALL power to the Liebert indoor unit, heat rejection device and verify that the unit disconnect switch is in the OFF position.

Step 2: Tighten all High and Low voltage electrical connections which may have loosened during shipment or during equipment operation.

Step 3: At the indoor unit remove all line voltage fuses except for the Main Fan and Control Transformers.

Step 4: Verify that the Temperature and Humidity sensors are in their proper sockets. Socket call outs are silk-screened on the printed circuit board.

Step 5: Turn on main breaker and check supply line voltage at the unit disconnect switch. Line voltage must be within 10% of nameplate voltage. If not, re-tap primary connection on all transformers.

Step 6: Place the indoor unit disconnect switch in the ON position and check the secondary voltage as follows;

Levels 00, 01, 02, 03 and 10: Transformer T5 secondary must be 24 VAC \pm 10% and transformer T115 secondary must be 115 VAC \pm 10%.

SM, AM/AG control transformer T1 secondary must be 24 VAC \pm 10%.

Step 7: Check the indoor unit DC power supply output voltage. Place meter leads on V+ and V-. Voltage should be as follows:

Levels 01, 02 and 03 = 5.2 VDC min. and 5.25 VDC max.
Levels 00 and 10 = 5.0 VDC min. and 5.1 VDC max.

NOTE: When adjusting the DC power supply output, ALWAYS unplug P23 from the microprocessor controls.

SM/ AM/ AG Microprocessor controls have a power supply that is part of the Control Board, use the LED's to verify voltage is present.

Step 8: Depress the indoor unit ON button. Main Fan will start and the ON lamp will light.

Step 9: Air movement in the indoor unit will cause the fan safety switch to close, energizing

Control Voltage Relay R1. On Microprocessor controls Levels 00, 01, 02, 03 and SM energization of the R1 relay allows line voltage to the primary connections of Control Transformers T2, T3, and T4. Check the secondary voltage, of each transformer, use plugs P4 and P6 as check points.

NOTE: Level 10 and AM/AG controls do not use the Control Voltage Relay R1.

Step 10: Set temperature and humidity set points and sensitivity, humidifier flush rate if available, alarm trip points, and other control functions as required.

Step 11: Push the ON button to the off position and place the unit disconnect switch in the OFF position.

Step 12: Replace all line voltage fuses.

Step 13: Return the indoor unit and heat rejection device disconnect switches to the ON position and push the ON button to activate the indoor unit.

Step 14: On new installations, complete and process the unit Startup form.

NOTE: OPEN ALL REFRIGERANT ISOLATION VALVES and WATER/GLYCOL SUPPLY AND RETURN ISOLATION VALVES.

ELECTRICAL CHECKS/ ADJUSTMENT INFORMATION

Challenger 2 and 3 with LEVEL 00 MICROPROCESSOR CONTROL and Challenger3000 with SM/AM/AG MICROPROCESSOR CONTROLS

For proper equipment operation verify that the indoor unit, heat rejection device and all interconnecting piping and wiring has been installed according to the instructions given in the installation manual.

Step 1: Disconnect ALL power to the Liebert indoor unit, heat rejection device and verify that

the unit disconnect switch is in the OFF position.

Step 2: Tighten all High and Low voltage electrical connections which may have loosened

during shipment or equipment operation.

Step 3: At the indoor unit remove all line voltage fuses except for the Main Fan and Control Transformers.

Step 4: Verify that the Temperature and Humidity sensors are in their proper sockets. Socket

Call outs are silk-screened on the printed circuit board.

Step 5: Turn on main breaker and check supply line voltage at the unit disconnect switch. Line voltage must be within 10% of nameplate voltage. If not, re-tap primary connection on all transformers.

Step 6: Place the indoor unit disconnect switch in the ON position and check the secondary voltage of transformers as follows:

Challenger/2: T5 secondary must be $24 \text{ VAC} \pm 10\%$; T115 secondary must be $115 \text{ VAC} \pm 10\%$.

Challenger/3: T5 secondary must be $24 \text{ VAC} \pm 10\%$. T1 is a dual secondary device, the 24 VAC connections must $24 \text{ VAC} \pm 10\%$, the 115 VAC connections must be $\pm 10\%$.

Step 7: Check the indoor unit DC power supply output voltage. Place meter leads on V+ and V-. Voltage should be 5.0 VDC min. and 5.1 VDC max.

NOTE: When adjusting the DC power supply output, ALWAYS unplug P23 from the microprocessor controls.

SM/ AM/ AG Microprocessor controls have a power supply that is part of the Control Board, use the LED's to verify voltage is present.

Step 8: Depress the indoor unit ON button. Main Fan will start and the ON lamp will light.

Step 9: Air movement in the indoor unit will cause the fan safety switch to close energizing Control Voltage Relay R1. Energizing the R1 relay allows line voltage to the primary connections of Control Transformers T2 and T4. Check the secondary voltage of each transformer, use plugs P4 and P6 as check points.

Step 10: Set temperature and humidity set points and sensitivity, humidifier flush rate if available, alarm trip points and other control functions as required.

Step 11: Push the ON button to the off position and place the unit disconnect switch in the OFF position.

Step 12: Replace all line voltage fuses.

Step 13: Return the indoor unit and heat rejection device disconnect switches to the ON position and push the ON button to activate unit.

Step 14: On new installations complete and process the unit Startup form.

NOTE: OPEN ALL REFRIGERANT ISOLATION VALVES and WATER/GLYCOL SUPPLY AND RETURN ISOLATION VALVES.

GLYCOL SYSTEMS

Liebert Corporation is continually being questioned on glycol types and reasons for failure of heat transfer in shell and tube condensers and drycoolers. The following quoted information is from various materials supplied to Liebert from Union Carbide Corporation, Danbury, Connecticut.

Product Profile

UCARTHERM* Heat Transfer Fluids (HTFs) are ethylene glycol (EG) based fluids that provide outstanding freeze and burst protection. They are formulated with an extensive and synergistic inhibitor package, they also provide maximum corrosion protection, meeting or surpassing all ASTM requirements for glycol based coolants. UCARTHERM* HTFs are shipped in concentrated form or in water dilutions from 25 to 65% ethylene glycol, in 5% increments.

UCARTHERM* Industrial Cleaners and Degreasers clean rust, scale, and hydrocarbon foulants from dirty cooling system pipes, manifolds, and passages. Clean heat transfer surfaces are important in maintaining the integrity of the cooling system.

Fluid Selection and Use

Proper specification of the heat transfer fluid is important so that ineffective alternatives are not substituted during any stage of system construction or installation. Such substitutions can jeopardize the performance of the cooling system and result in major equipment damage. The maximum system operating temperature for using an ethylene glycol based coolant is 275°F (135°C).

System Preparation

System cleanliness is critical to prevent corrosion and to obtain optimum performance from industrial coolants. When industrial coolant is being added to a system for the first time, the system should be inspected for cleanliness and cleaned as follows.

Older systems need to be inspected for rust, scale, oil, hydrocarbons, and other contaminants. Systems that have been using water based fluids as the heat transfer fluid are prone to the formation of mineral and corrosion scales. These deposits can build up on the interior walls of the system, acting like an insulator thereby reducing the heat transfer performance, and increasing the corrosion rate. Scale buildup may crack cylinder heads due to lack of cooling capacity. A buildup of 1/4-inch of scale insulates like a one-inch asbestos board.

A sample of the coolant or water previously used in an older system should be sent to a qualified testing laboratory to help identify the chemical composition of any system scales or contaminants. If the heat transfer fluid to be used has been stored, it may require filtering before usage. A clean older system can be flushed with a high quality dilution of water.

NORKOOL* and UCARTHERM* Industrial Heat Transfer Cleaners are highly effective in cleaning scales and deposits from dirty older systems and restoring heat transfer performance. NORKOOL* and UCARTHERM* Degreasers are water based liquids containing surfactants that effectively remove hydrocarbon based foulants such as oils, greases, waxes, gums, tars, and coke. The combined use of these cleaning products offers the advantage of cleaning and degreasing in a single step.

New systems may contain dirt. Debris, metal filings, minor grease, oil, and pipe dope. They may also have flash rusting due to atmospheric corrosion. A preliminary chemical cleaning is

recommended using a single application of NORKOOL* and UCARTHERM* Industrial Heat Transfer Cleaner. A water flush using high quality dilution water may be adequate.

Maintaining Maximum Performance

Selecting the proper coolant concentration is determined by first deciding what freeze and/or burst protection is appropriate for your application, based on the operating temperatures or the ambient temperatures. The perfect time to consider freeze protection for your HVAC system is in the fall before cold weather sets in. Establishing the right concentration of heat transfer fluid is the key to proper

The first step is to determine what type and level of protection is desired. Too low of a concentration and pipes could freeze and burst, too high and there may be a feeling of wasted dollars. Because the cost and consequences of damage are high, it is always best to error on the side of protection with an added in margin of safety. Burst protection is generally considered a requirement for systems that are inactive in the winter. Freeze protection is adequate for systems that operate in the winter and where there is space available to accommodate the expansion of an ice/slush mixture.

Ethylene glycol gives added protection against system damage due to bursting. On freezing, water expands by about 9% in volume: this volume change may rupture piping and cause system failure. The addition of ethylene glycol significantly reduces the expansion the solution undergoes on freezing, thus reducing the likelihood of the system pipes bursting. The higher the ethylene glycol concentration, less is the fluid volume expansion: pure ethylene glycol does not expand at all upon freezing. The table below provides guidelines for determining freeze and burst protection percentages when using ethylene glycol concentrations.

Concentration (Volume %) Needed For		
Temperature, °F (°C)	Freeze Protection	Burst Protection
20 (-7)	16	11
10 (-12)	25	16
0 (-18)	32	21
-10 (-23)	39	26
-20 (-28)	44	31
-30 (-34)	48	36
-40 (-40)	52	37
-50 (-46)	55	38
-60 (-51)	58	40

Adequate protection requires that the glycol solution must maintain a freezing point at least 5 °F below the lowest anticipated ambient temperature. The freeze protection should be tested annually.

Dilution Water Quality

To ensure superior corrosion protection, the water used to dilute the glycol concentration must be of high quality. Poor quality water contains ions that make the fluid "hard" and corrosive. Calcium and magnesium hardness ions build up as scale on the interior walls of the system and reduce the heat transfer rate of the system. These ions may also react with the corrosion inhibitors in the heat transfer fluid, causing them to precipitate (separate) out of the solution rendering them ineffective in protecting against corrosion. In addition, high concentrations of corrosive ions, such

as chloride and sulfate, will eat through any protective layer that the corrosion inhibitors have formed on the walls of the system.

Ideally, de-ionized water should be used for dilution, since de-ionizing removes both the corrosive and hardening ions. Distilled water and zeolite-softened water are often times also acceptable. Softened water, although free of hardness ions, may actually have increased concentrations of corrosive ions and its quality must be monitored. For systems where high quality dilution water is not available, Union Carbide offers pre-diluted mixtures.

Materials Compatibility

When installing heat transfer fluids, it is important to check the system to ensure that all components are compatible. Union Carbide industrial coolants are compatible with many plastics, rubbers, elastomers, and other non-metallic materials used in heat transfer equipment, including polyethylene, polypropylene, polyvinyl chloride (PVC), and many types of fiberglass-reinforced plastic. However, as with any material, it is important to adhere to the manufacturer's guidelines for safe temperature operating ranges. Union Carbide industrial coolants are also compatible with most metals including cast iron, carbon steel, stainless steel, aluminum, copper, brass, and solder. However like all glycol solutions UCARTHERM* Industrial Heat Transfer coolants should not be used with galvanized steel or other zinc containing materials..

In general NORKOOL* and UCARTHERM* Industrial Heat Transfer coolants are compatible with most elastomers and seals used for water service. Nevertheless, although both water and glycol may be compatible with a seal material, switching a system from water to glycol sometimes requires replacement of seals. During service the elastomer will swell a characteristic amount, depending on the fluid used in the system: if the fluid is replaced with another, the elastomer may fail. Therefore to prevent a possible failure, it is recommended that if the fluid is changed so should the seal be changed.

Optimal System Maintenance

Laboratory analytical service is critical to help monitor the condition of your coolant. Union Carbide has developed a state of the art analytical service program. The laboratory integrates these test results into a customer database containing analytical from previous samples and other information about the mechanical system. This program provides both analysis and interpretation of the chemistry of the coolants and inhibitors in use in the system being tested. The resulting recommendations are designed to maximize the useful life of both the equipment and the heat transfer fluid, and to maintain optimum heat transfer efficiency.

A pre-fill analysis includes an analysis of the previous fill and an analysis of the dilution water. It is also recommended that the customer inspect the interior of the system to check for scale buildup and the need for cleaning. Follow up fluid samples should be submitted by the customer every six months for NORKOOL* Coolants and every year for UCARTHERM* Fluids for testing.

The analysis includes, but is not limited to the following information:

- Glycol content/ freezing point: makes a recommendation of concentration range
- pH/ reserve alkalinity: suggests the buffering capacity of the fluid
- Inhibitor levels: tells if levels are high enough to optimize corrosion protection
- Solids: reports the presence of corrosion products or contaminants that could cause erosion of surface metals

- Corrosion products: indicated past or ongoing problems
- Contaminants: identifies substances that shorten the life of the fluid and may undermine the benefits of the inhibitors
- Corrosive ion contamination

Specifications for Ethylene Glycol Based Heat Transfer Fluids:

The elements included in the typical specifications for UCARTHERM Fluids and NORKOOL Coolants are listed below. Automotive antifreeze, uninhibited glycol, and field-inhibited glycol do not meet these specifications. NOTE, the values shown are only representative for a typical fluid. Each product has its own set of specifications.

Base Fluid: The industrial grade ethylene glycol fluid base contains less than 0.5% by weight of diethylene glycol or other glycols.

Corrosion Inhibitors: Glycol compatible corrosion inhibitors protect ferrous and copper based metals and work synergistically to prevent corrosion of metal surfaces.

Buffers: Buffers extend the life of the ethylene glycol component by resisting fluid oxidation. The buffering capacity as measured by the reserve alkalinity has a minimum value of 22 for the concentrated HTF. The reserve alkalinity of pre-diluted blends of the fluid concentrate is 22 times the HTF concentration (for example, for a 40% solution, the reserve alkalinity is $22 \times 0.4 = 8.8$).

pH: The pH of the HTF fluid concentrate is 8.5 to 9.2 and is 8.0 to 9.2 for pre-diluted blends.

Antifoams: Antifoaming agents minimize foaming and air entrainment in the system.

Dyes: Dyes are incorporated to distinguish the heat transfer fluid from other fluids, a fluorescing agent is added to facilitate leak detection.

Corrosion Rates: Corrosion rates are less than 0.02 mils per year for steel and iron, and less than 0.2 mils per year for copper and brass, as measured by ASTM D1384.

Specific Gravity: The specific gravity of the concentrate at 68/68°F (20/20°C) is 1.133.

Flash Point: There is no flash point when diluted for use.

Chloride Content: The industrial heat transfer fluid concentrate and its factory supplied dilutions have a chloride content of less than 5 ppm.

Automotive Antifreeze

Automotive antifreeze can cause extensive damage to an HVAC cooling system. The silicate/silicone inhibitors in automotive antifreeze provide corrosion protection by coating the engine's aluminum surfaces to protect them when the system is not in operation. Industrial HVAC systems normally operate continuously and contain little or no aluminum, therefore the silicate/silicone inhibitor system merely reduces the heat transfer and cooling capacity of the system.

The silicate/silicone can also gel and foul the industrial system resulting in further loss of heat transfer, and may even plug the piping completely. The formation of gritty particles when used

with hard water ions can cause erosion and corrosion of the metal walls of the piping used in the system. Automotive antifreeze also requires frequent fluid replacement as the inhibitors lose their strength, an expensive undertaking in industrial systems where downtime and the quantity of replacement fluid needed are both major expenses.

Environmental Considerations

UCTHERM* Heat Transfer Fluid is readily biodegradable and is relatively nontoxic to aquatic life. UCTHERM* HTF concentrate will almost completely biodegrade in an aquatic environment or in a biological wastewater treatment plant. UCTHERM* HTF concentrate has a 5-day bio-oxidation of 38% and a 20-day bio-oxidation of nearly 100%.

The total Biochemical Oxygen Demand is 1.22 lb O₂/lb HTF, and the 5-day Biochemical Oxygen Demand will be approximately 0.46 lb BOD 5/lb HTF.

Consult with local authorities before discharging UCTHERM* HTF to a wastewater treatment plant. Local requirements may vary.

Remember for specific information contact your local Union Carbide representative or Union Carbide Corporation at 1-800-568-4000. Product information can also be found on Union Carbides web page on the Internet World Wide Web (<http://www.unioncarbide.com>).

* Registered Trademark of the Union Carbide Company

TEMPERATURE/HUMIDITY SENSOR FREQUENCY CHECK

Purpose:

To show the student a practical method for testing the accuracy of the temp./ humid. sensors and their signal input to the microprocessor control.

Preparation:

Step 1 - Locate the Fluke meter.

Procedure:

All power must be applied for this exercise.

Step 1 - Validate that the temperature/humidity test sensors in their proper sockets.

Step 2 - Set the Fluke 87 Meter at VAC and depress the HZ button to set the meter for frequency measurement, HZ will be displayed in the upper left hand corner of the meter.

Step 3 - Temperature, measure at Plug P16 as follows:

Levels 01, 02, 03, 00 and 10: between pins #1 (temperature) and #4 (V- ref).

Levels SM, AM and AG: between pins #4 (temperature) and #1 (V- ref). This reading in Hz is for unit the displayed temperature, record both values.

Frequency _____ unit display _____

Step 4 - Humidity, measure at Plug P16 as follows:

Levels 01, 02, 03, 00 and 10: between pins #2 (humidity) and #4 (V- ref).

Levels SM, AM and AG: between pins #3 (humidity) and #1 (V- ref). This reading in Hz is for the unit displayed humidity, record both values.

Frequency _____ unit display _____

Step 5 - Compare the recorded values with the information located in the appropriate Environmental Training & Service manual.

Moisture Content Exercise

Comparison of Level 00 and SM Controls to Level 10 and AM/AG Controls

Activities:

Calculate RH control band for Level 00 and SM

Calculate Moisture content control band for Level 10 and AM/AG

Determine Systems Operation

Programmable Input Values:

Temperature Set point 70° F

Relative Humidity Set point 50% RH

Relative Humidity Sensitivity 3% RH

ROOM CONDITIONS SYSTEM OPERATIONS

Time of Day	Return Air Conditions	Levels 00 or SM	Levels 10 or AM/AG
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6:00 am	70° F - 47% RH		
10:00 am	68° F - 53% RH		
2:00 pm	72° F - 52% RH		
6:00 pm	74° F - 47% RH		

Steps to determine the systems operations:

Level 00 or SM using RH Control:

Use the Humidity Set point value and add the Humidity Sensitivity value to give the top of the RH control band. Subtract the Humidity Sensitivity value from the Humidity Set point to give the bottom of the RH Control band. Then use the return air RH value to determine if the system operation is to HUMIDIFY or DEHUMIDIFY or no operation (satisfied).

Level 10 or AM/AG using Absolute Control:

Use the programmed Temperature Set point value, Humidity Set point value with the Humidity Sensitivity value added to determine the top of the control band for the content level. Now use the Temperature Set point value, Humidity Set point with the Humidity Sensitivity value subtracted to determine the bottom of the control band for content level. Next use the return air Temperature value and return Relative Humidity value to determine the present content level. Now compare the present content level with the previously determined content control band and determine if the system operation is to HUMIDIFY or DEHUMIDIFY or no operation (satisfied)*.

* Use the Moisture Content Charts locate in the Level 10 or AM/AG Training and Service Manual,.

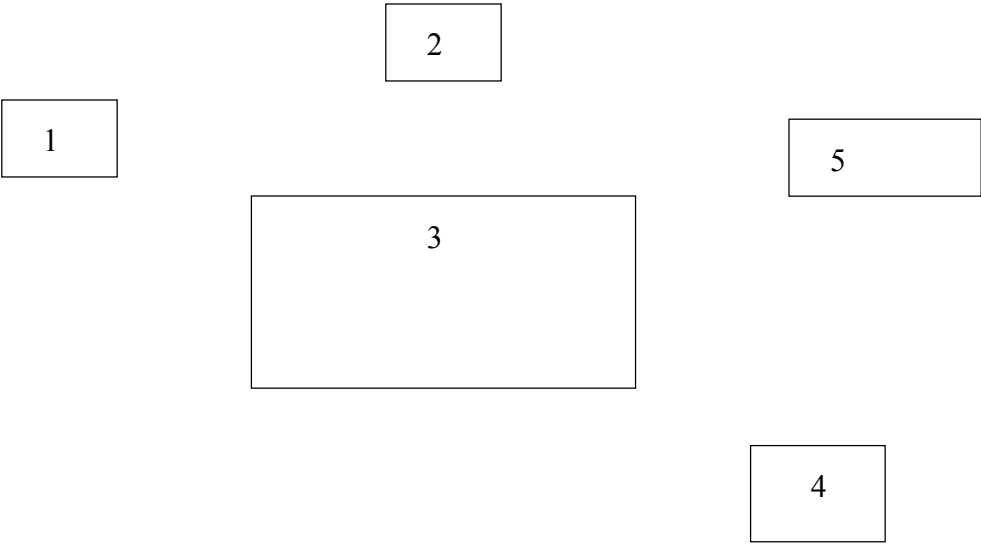
LEVEL 00 CONTROL - Identify the printed circuit boards indicated in the Control Section Layout below:

- 1. _____
- 2. _____
- 3. _____
- 4. _____
- 5. _____

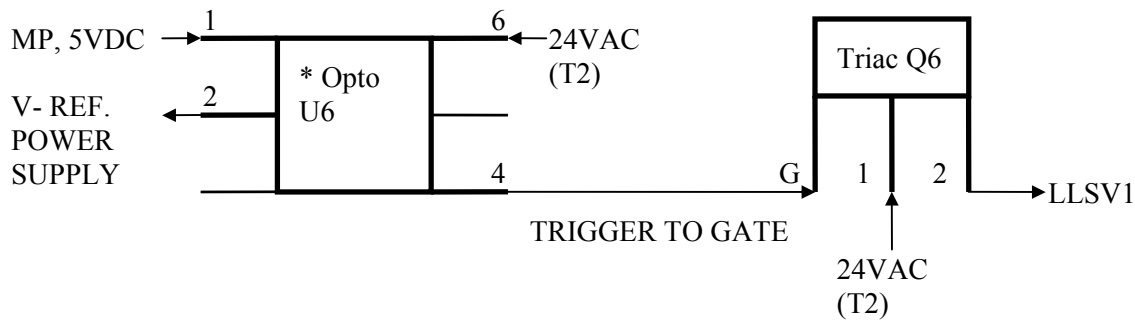
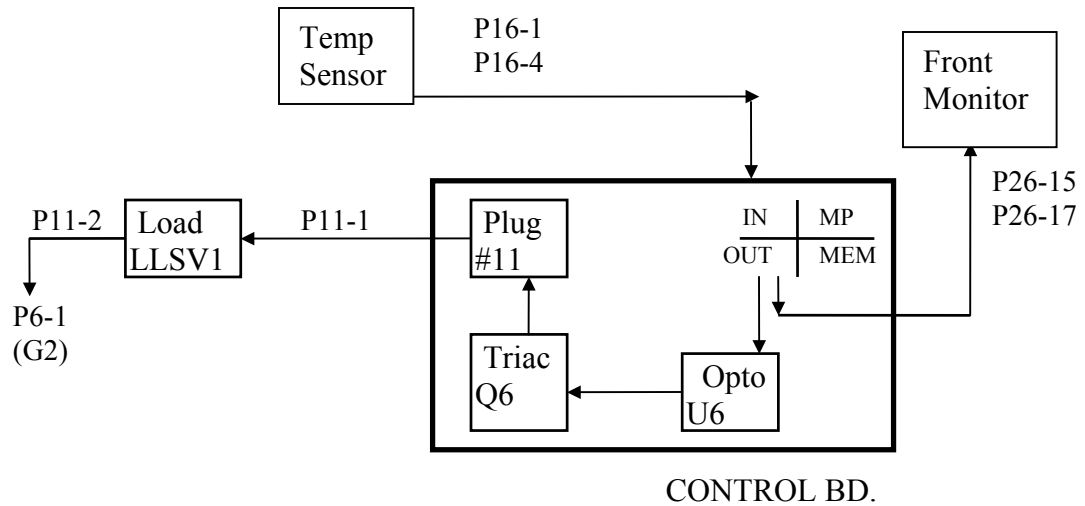
Identify the cables/wires connecting the Control Board to the other boards supplied on a Level 00 Glycool System/3 unit.

PC Board	Cables/wires	PC Board

Control Section Layout

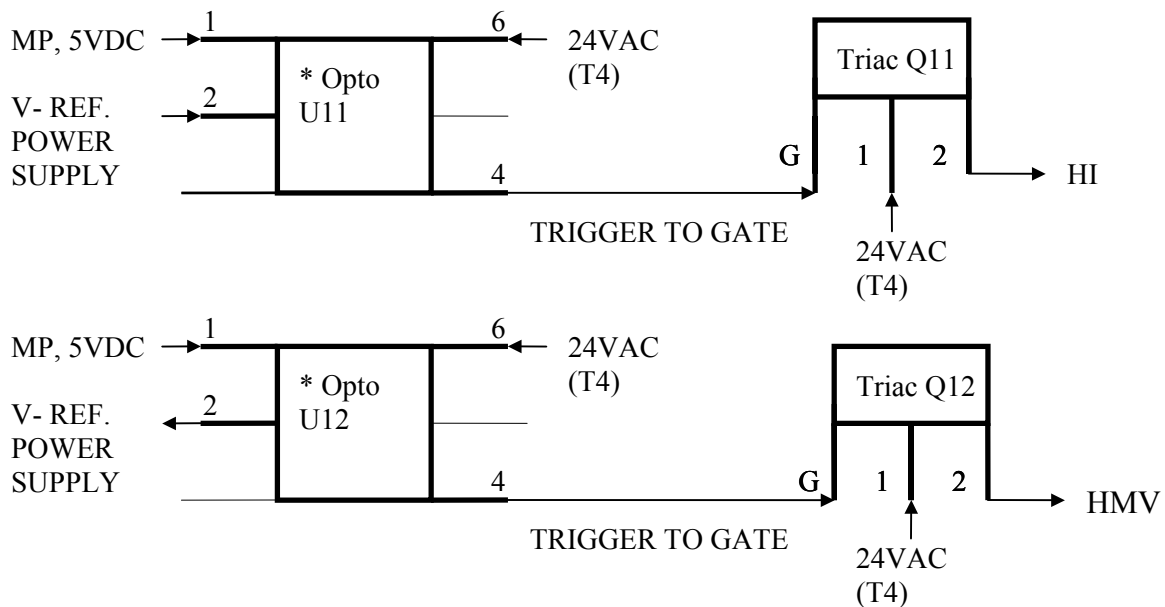
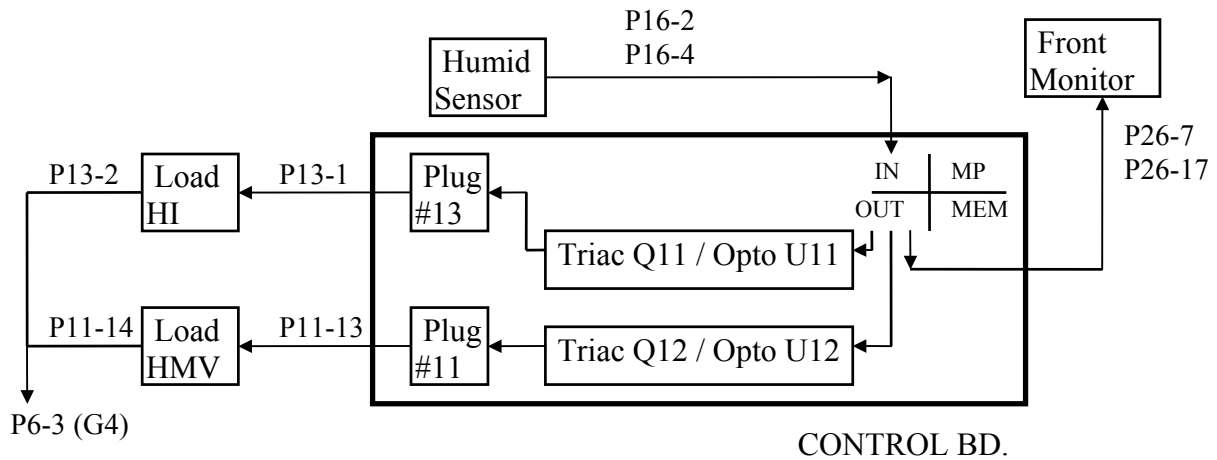


LEVEL 00 - Signal flow for Cooling Stage #1, assume a System/3 DX type unit, disregard other options.



Briefly describe a call for Cooling Stage #1, define program and parameters.
TEMP SENSOR MONITORS ROOM CONDITIONS AND INPUTS TO MP AS A FREQ. MP CHECKS MEMORY FOR SET POINT AND SENSITIVITY, DECIDES TO COOL.
MP OUTPUTS ARE AS FOLLOWS:
TO FRONT MONITOR ENERGIZING COOLING LED
TO OUTPUT OPTO U6 TRIGGERING TRIAC Q6 ENERGIZING LLSV1 WHICH OPENS SUPPLYING REFRIGERANT TO THE EVAPORATOR. LOW PRESSURE SWITCH LPI CLOSES ENERGIZING COMPR #1 CONTACTOR, STARTING COMPR #1, SENSIBLE COOLING NOW TAKES PLACE.
WHEN CONDITIONS ARE WITHIN PROGRAMMED VALUES THE MP REMOVES THE OUTPUTS. COMPR #1 WILL CONTINUE TO RUN UNTIL LOW PRESSURE SWITCH LPI OPENS BREAKING THE CONTACTOR CONTROL CIRCUIT, THIS IS CALLED PUMPDOWN.

LEVEL 00 - Signal flow for Infrared Humidification, last operation was 3 hours earlier.



Briefly describe a call for Humidification, define program and parameters.

HUMIDITY SENSOR MONITORS ROOM CONDITIONS AND INPUTS TO MP AS A FREQ. MP CHECKS MEMORY FOR SET POINT AND SENSITIVITY AND DECIDES TO HUMIDIFY.

THE MP OUTPUTS ARE AS FOLLOWS:

TO FRONT MONITOR TO ENERGIZE THE HUMIDIFICATION LED

TO OUTPUT OPTO U11 WHICH TRIGGERS Q11 WHICH ENERGIZES CONTACTOR HI WHICH ENERGIZES THE HUMIDIFIER BULBS

TO OUTPUT OPTO U12 WHICH TRIGGERS Q12 WHICH ENERGIZES THE HMV

WHICH OPENS SUPPLYING WATER TO THE PAN, TIMING PROGRAM STARTS HUMIDIFICATION NOW TAKES PLACE UNTIL THE ROOM CONDITIONS ARE WITHIN THE PROGRAMMED VALUES

LEVEL 10 CONTROL - Identify the printed circuit boards indicated in the Control Section Layout Below:

1. _____

2. _____

3. _____

4. _____
5. _____

6. _____

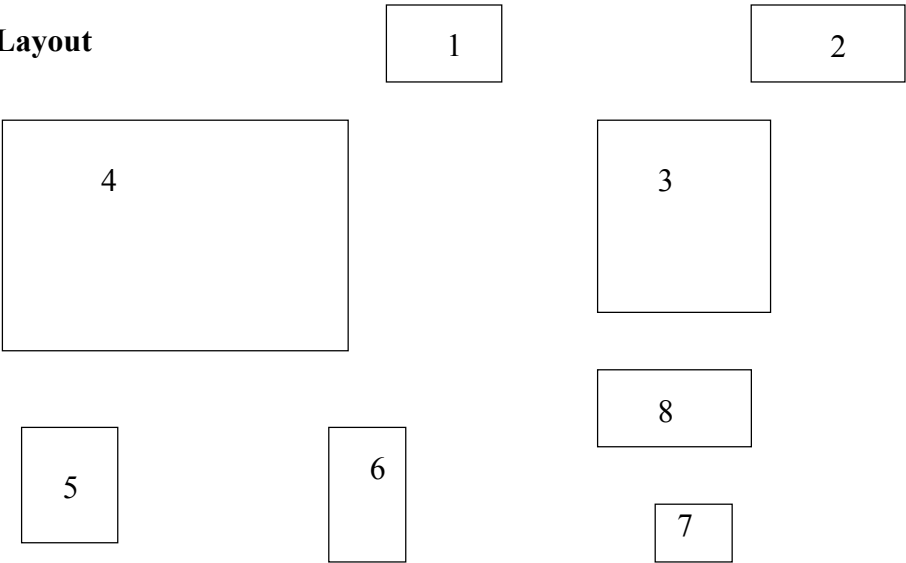
7. _____

8. _____

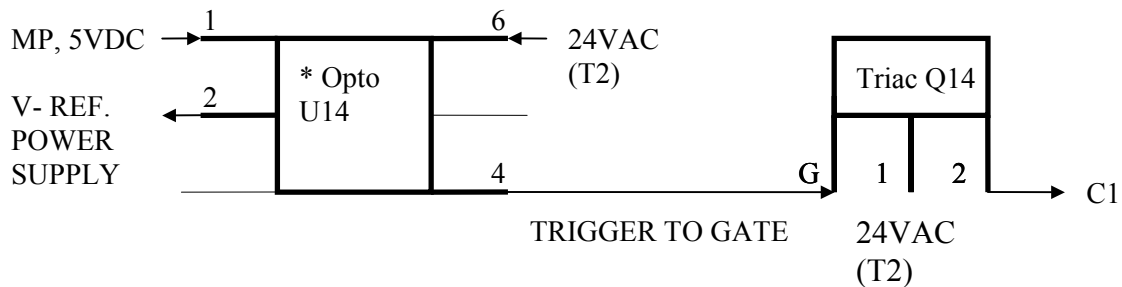
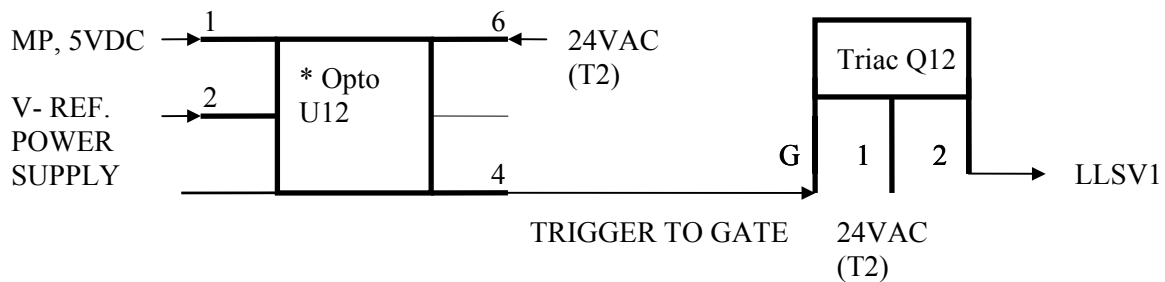
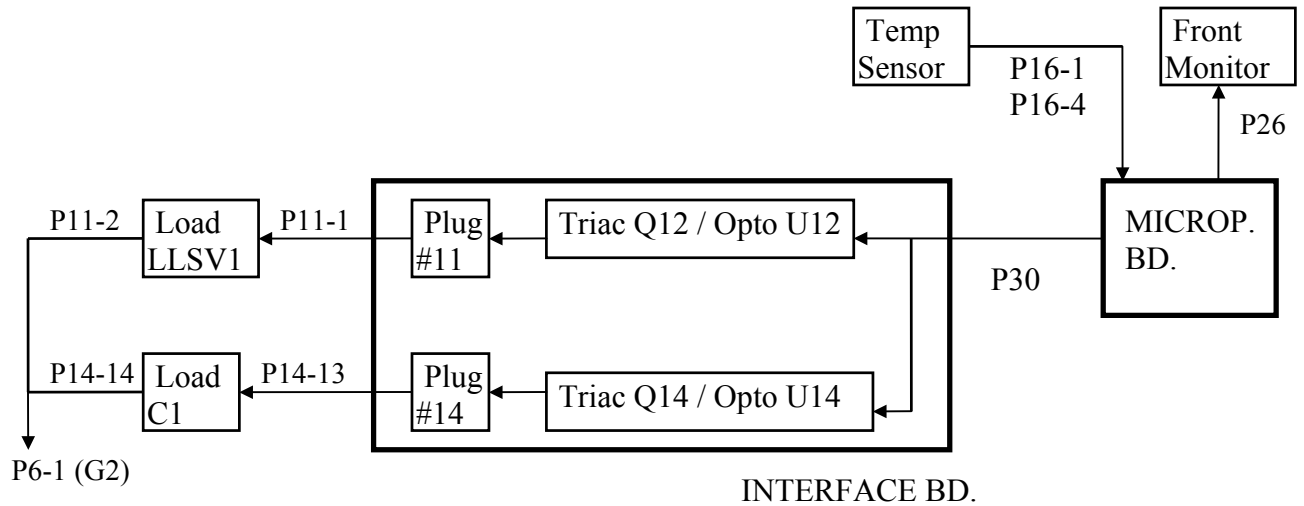
Identify the inter-connecting cables/wires supplied on Level 10 Glycool System/3 unit.

PC Board	Cables/wires	PC Board

Control Section Layout



LEVEL 10 - Signal flow for Cooling Stage #1, assume a System/3 DX type unit, disregard other options.



Briefly describe a call for Cooling, define program and parameters.

TEMP SENSOR MONITORS ROOM CONDITIONS AND INPUTS TO MP AS A FREQ. MP CHECKS MEMORY FOR SET POINT AND SENSITIVITY, DECIDES TO COOL.

MP OUTPUTS ARE AS FOLLOWS:

TO FRONT PANEL ENERGIZING COOLING LED

TO OUTPUT OPTO U12 TRIGGERING TRIAC Q12 ENERGIZING LLSV1 WHICH OPENS SUPPLYING REFRIGERANT TO THE EVAPORATOR

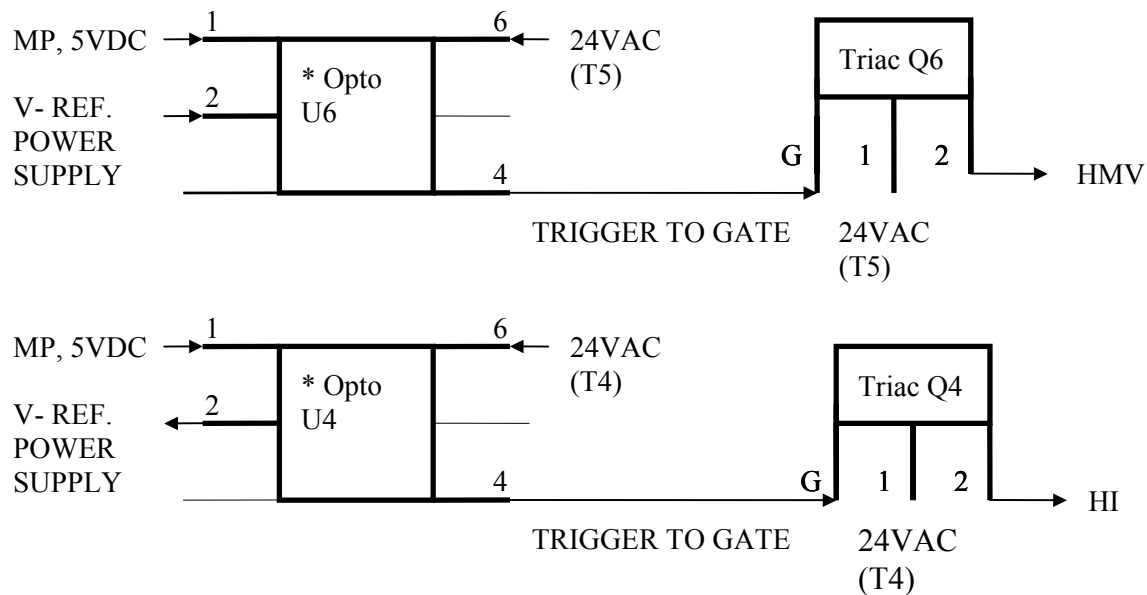
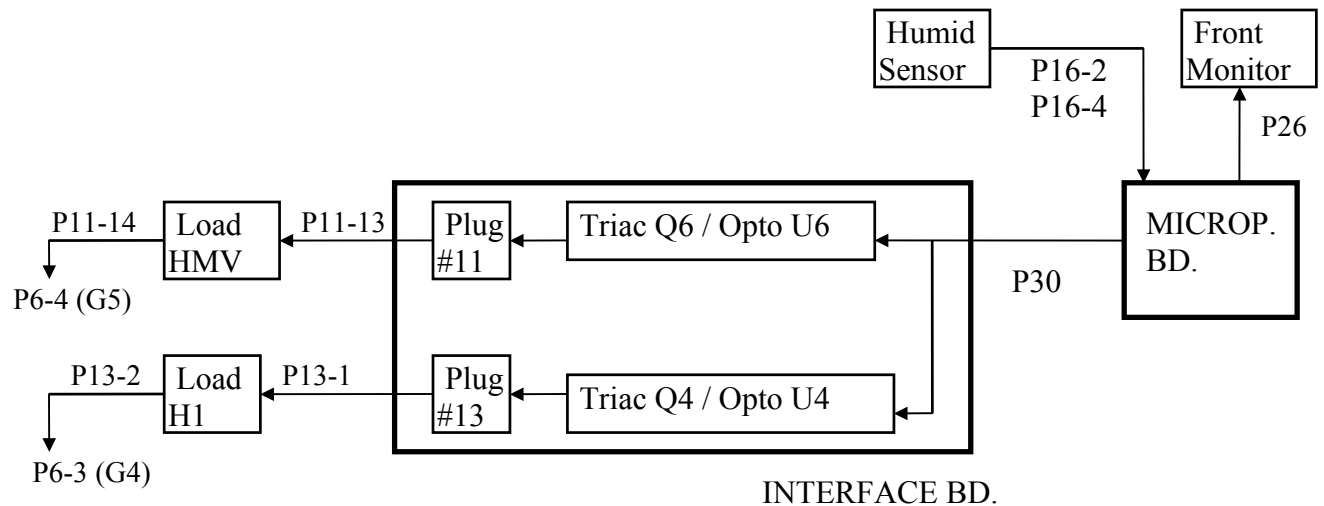
TO OUTPUT OPTO U14 TRIGGERING TRIAC Q14 ENERGIZING COMPR #1

CONTACTOR STARTING COMPR #1, SENSIBLE COOLING NOW TAKES PLACE

WHEN ROOM CONDITIONS ARE WITHIN PROGRAMMED VALUES THE MP REMOVES THE

OUTPUTS. COMPR #1 WILL CONTINUE TO RUN UNTIL LOW PRESSURE SWITCH LP1 OPENS BREAKING THE CONTACTOR CONTROL CIRCUIT, THIS IS CALLED PUMPDOWN

LEVEL 10 - Signal flow for Humidification, assume last call 33 hours earlier, disregard other options.



*Briefly describe a call for Humidification, define program and parameters.
HUMIDITY SENSOR MONITORS ROOM CONDITIONS AND INPUTS TO MP AS A FREQ. MP
CHECKS MEMORY FOR SET POINT AND SENSITIVITY, DECIDES TO HUMID.
MP OUTPUTS ARE AS FOLLOWS:*

*TO FRONT MONITOR ENERGIZING THE HUMIDIFICATION LED
TO OUTPUT OPTO U6 TRIGGERING TRIAC Q6 ENERGIZING HMV WHICH OPENS
SUPPLYING WATER TO THE HUMID PAN FOR PRE-FILL TIME PERIOD
AFTER PRE-FILL TIME DELAY TO OUTPUT OPTO U4 TRIGGERING TRIAC Q4
ENERGIZING HUMID BULB CONTACTOR WHICH TURNS ON THE BULBS
HMV TIMING PROGRAM NOW STARTS WITH BULBS LOCKED ON HUMID OPERATION
CONTINUES UNTIL ROOM CONDITIONS ARE WITHIN PROGRAMMED VALUES.*

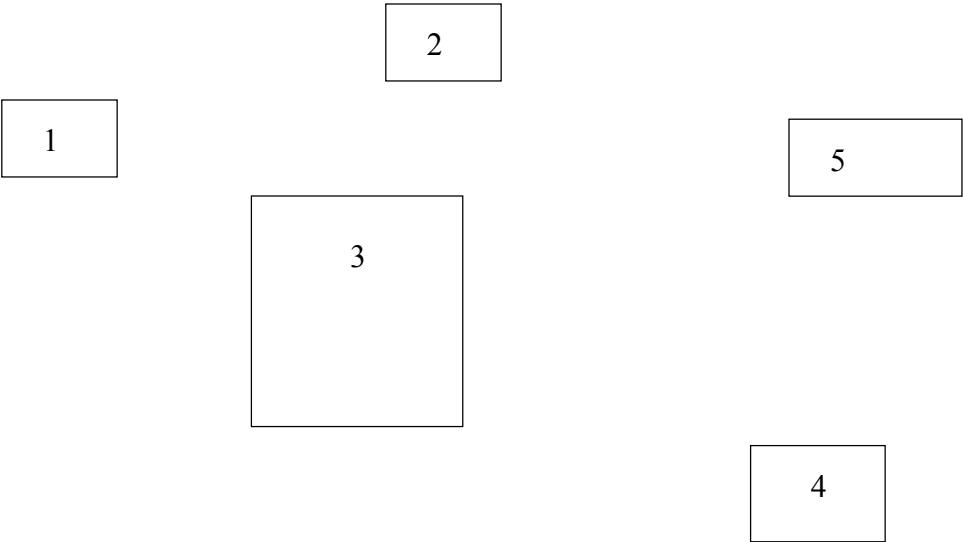
STANDARD MICROPROCESSOR (SM) CONTROL - Identify the printed circuit boards indicated in the Control Section Layout below:

- 1. _____
- 2. _____
- 3. _____
- 4. _____
- 5. _____

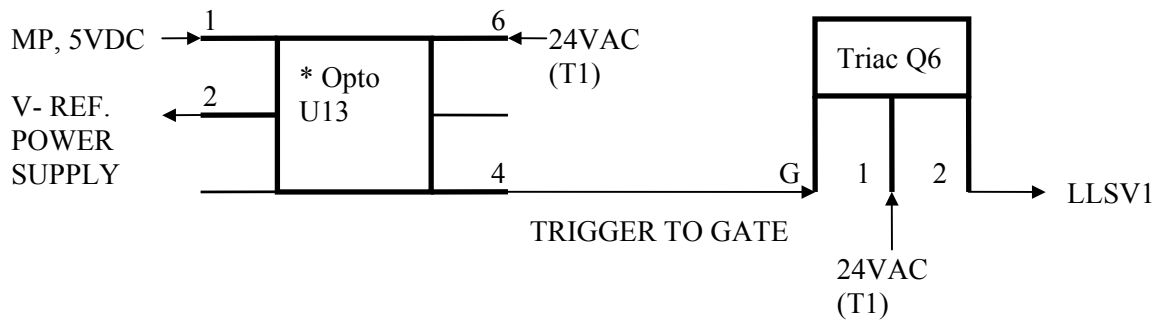
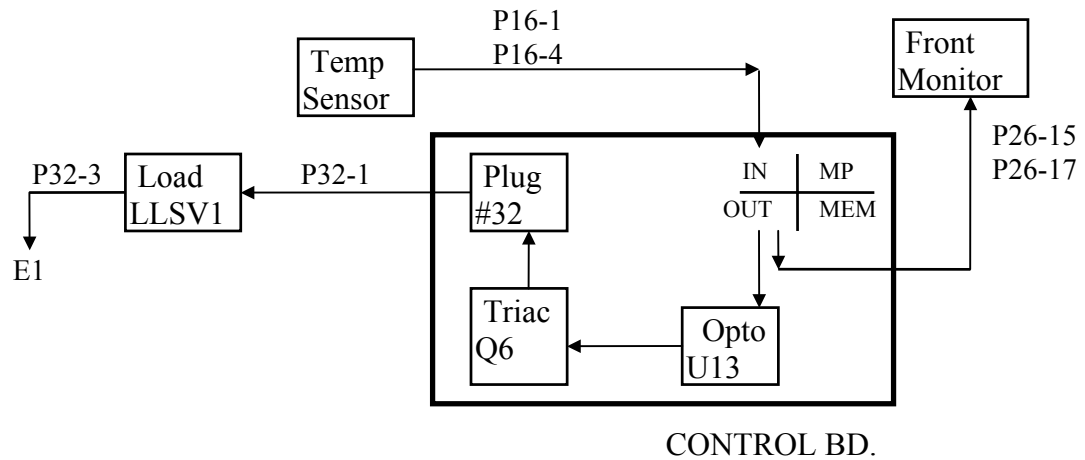
Identify the cables/wires connecting the Control Board to the other boards supplied on a Level SM Glycool System/3 unit.

PC Board	Cables/wires	PC Board

Control Section Layout



Level SM - Signal flow for Cooling Stage #1, assume a System/3 DX type unit, disregard other options.



Briefly describe a call for Cooling Stage #1, define program and parameters.

TEMP SENSOR MONITORS ROOM CONDITIONS AND INPUTS TO MP AS A FREQ. MP CHECKS MEMORY FOR SET POINT AND SENSITIVITY, DECIDES TO COOL.

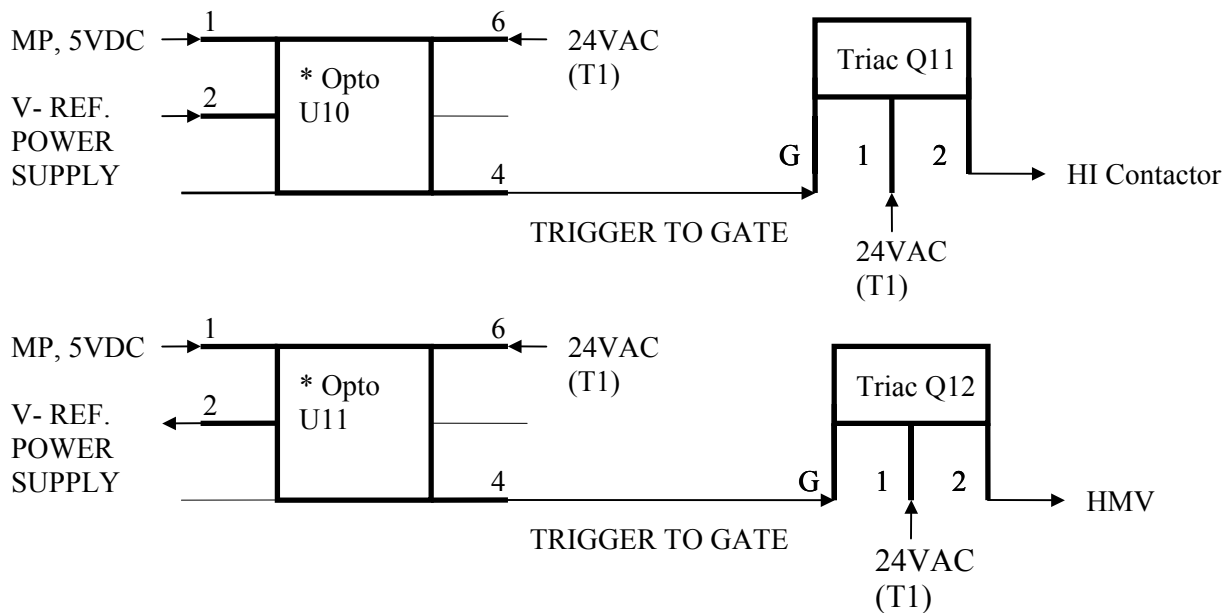
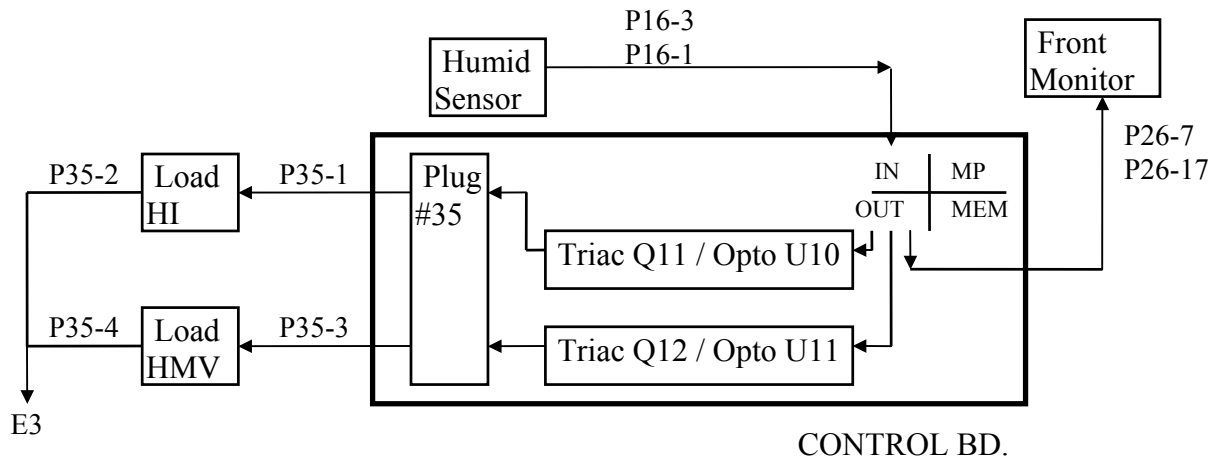
MP OUTPUTS ARE AS FOLLOWS:

TO FRONT MONITOR ENERGIZING COOLING LED

TO OUTPUT OPTO U13 TRIGGERING TRIAC Q6 ENERGIZING LLSV1 WHICH OPENS SUPPLYING REFRIGERANT TO THE EVAPORATOR. LOW PRESSURE SWITCH LPI CLOSES ENERGIZING COMPR #1 CONTACTOR, STARTING COMPR #1, SENSIBLE COOLING NOW TAKES PLACE.

WHEN CONDITIONS ARE WITHIN PROGRAMMED VALUES THE MP REMOVES THE OUTPUTS. COMPR #1 WILL CONTINUE TO RUN UNTIL LOW PRESSURE SWITCH LPI OPENS BREAKING THE CONTACTOR CONTROL CIRCUIT, THIS IS CALLED PUMPDOWN.

Level SM - Signal flow for Infrared Humidification, last operation was 3 hours earlier.



Briefly describe a call for Humidification, define program and parameters.

HUMIDITY SENSOR MONITORS ROOM CONDITIONS AND INPUTS TO MP AS A FREQ. MP CHECKS MEMORY FOR SET POINT AND SENSITIVITY AND DECIDES TO HUMIDIFY. THE MP OUTPUTS ARE AS FOLLOWS:

FRONT MONITOR TO ENERGIZE THE HUMIDIFICATION LED

OUTPUT OPTO U10 WHICH TRIGGERS Q11 WHICH ENERGIZES CONTACTOR HI WHICH ENERGIZES THE HUMIDIFIER BULBS

OUTPUT OPTO U11 WHICH TRIGGERS Q12 WHICH ENERGIZES THE HMV

WHICH OPENS SUPPLYING WATER TO THE PAN, TIMING PROGRAM STARTS

HUMIDIFICATION NOW TAKES PLACE UNTIL THE CONDITIONS ARE WITHIN

*PROGRAMMED VALUES. **ADVANCED and ADVANCED W/ GRAPHICS***

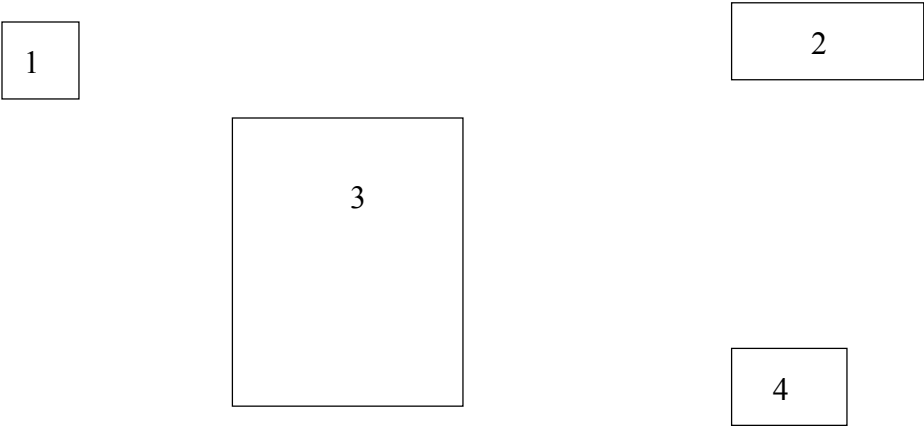
(AM and AG) CONTROL - Identify the printed circuit boards indicated in the Control Section Layout below:

1. _____
2. _____
3. _____
4. _____

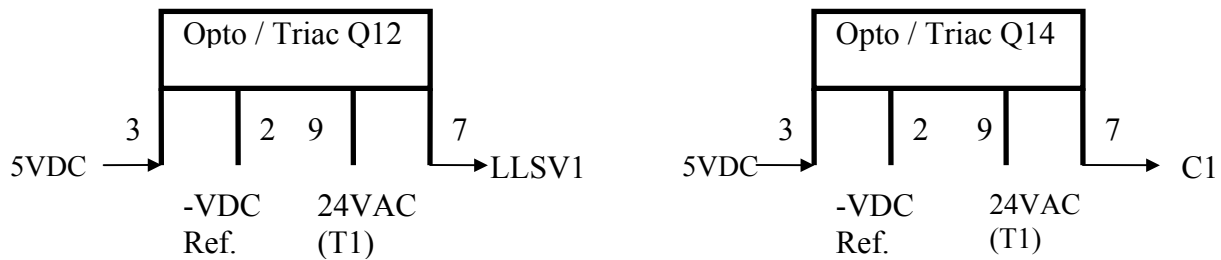
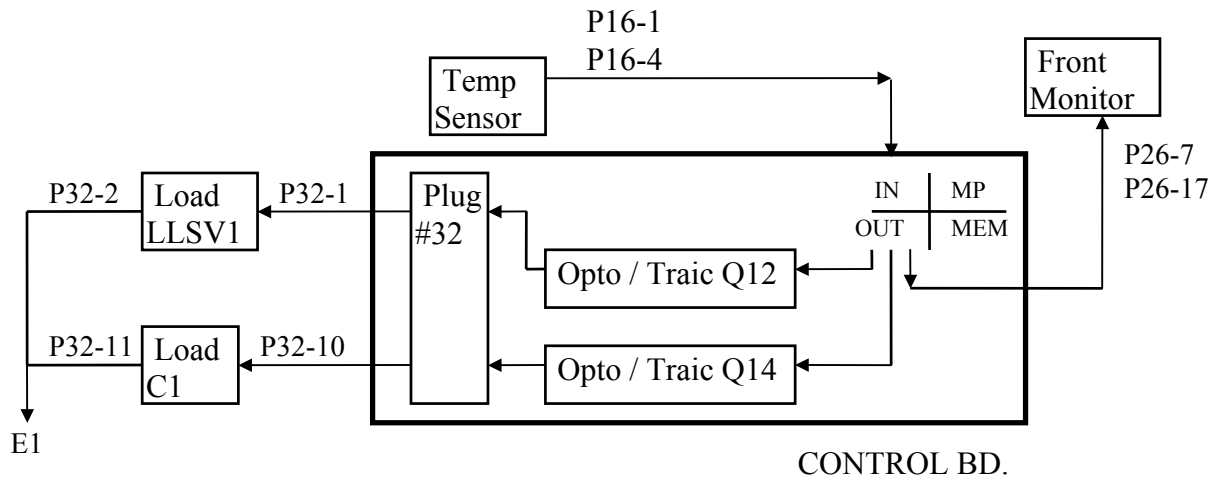
Identify the cables/wires connecting the Control Board to the other boards supplied on an AM/AG System/3 unit.

PC Board	Cables/wires	PC Board

Control Section Layout



AM/AG - Signal flow for Cooling Stage #1, assume a System/3 DX type unit, disregard other options.



Briefly describe a call for Cooling, define program and parameters.

TEMP SENSOR MONITORS ROOM CONDITIONS AND INPUTS TO MP AS A FREQ. MP CHECKS MEMORY FOR SET POINT AND SENSITIVITY, DECIDES TO COOL.

MP OUTPUTS ARE AS FOLLOWS:

TO FRONT MONITOR DISPLAY FOR COOLING READOUT

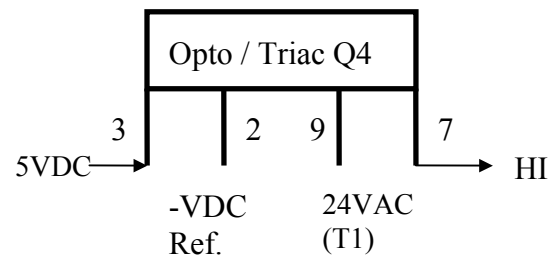
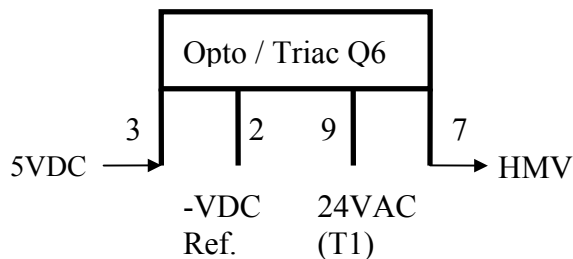
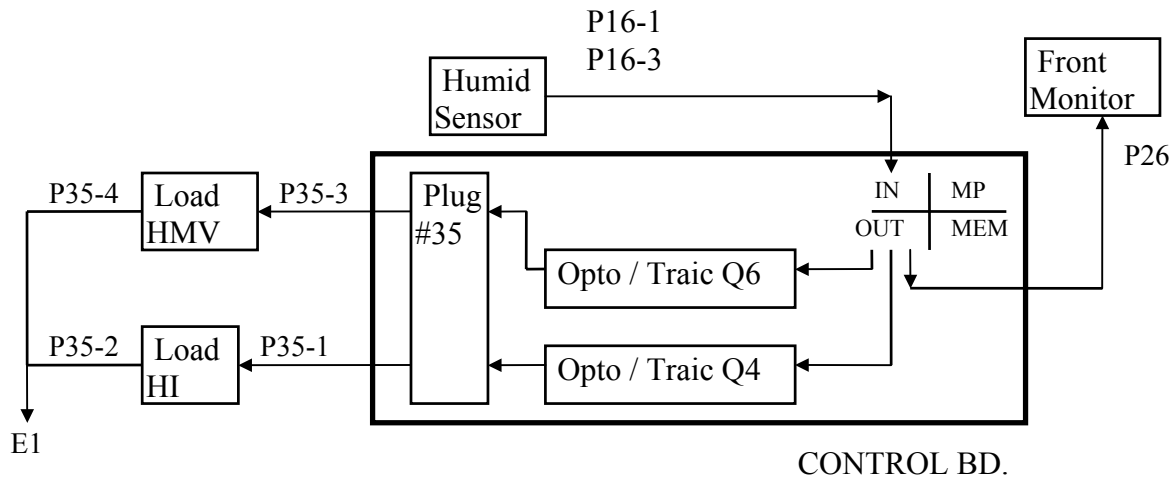
TO OUTPUT OPTO/TRIAC Q12 ENERGIZING LLSV1 WHICH OPENS SUPPLYING REFRIGERANT TO THE EVAPORATOR

TO OUTPUT OPTO/TRIAC Q14 ENERGIZING COMPR #1 CONTACTOR

WHICH STARTS COMPR #1, SENSIBLE COOLING NOW TAKES PLACE

WHEN ROOM CONDITIONS ARE WITHIN PROGRAMMED VALUES THE MP REMOVES THE OUTPUTS. COMPR #1 WILL CONTINUE TO RUN UNTIL LOW PRESSURE SWITCH LP1 OPENS, THIS IS PUMPDOWN.

AM/AG - Signal flow Humidification, assume last call 33 hours earlier, disregard other options.



Briefly describe a call for Humidification, define program and parameters.

HUMIDITY SENSOR MONITORS ROOM CONDITIONS AND INPUTS TO MP AS A FREQ.

MP CHECKS MEMORY FOR SET POINT AND SENSITIVITY, DECIDES TO HUMID.

MP OUTPUTS ARE AS FOLLOWS:

TO FRONT MONITOR DISPLAY FOR HUMIDIFICATION READOUT

TO OUTPUT OPTO U6 TRIGGERING TRIAC Q6 ENERGIZING HMV WHICH OPENS SUPPLYING WATER TO THE HUMID PAN FOR PRE-FILL TIME PERIOD

AFTER PRE-FILL TIME DELAY TO OUTPUT OPTO U4 TRIGGERING TRIAC Q4

ENERGIZING HUMID BULB CONTACTOR WHICH TURNS ON THE BULBS HMV

TIMING PROGRAM NOW STARTS WITH BULBS LOCKED ON

HUMID OPERATION CONTINUES UNTIL ROOM CONDITIONS ARE WITHIN

PROGRAMMED VALUES

Procedure For Troubleshooting Signal Flow On Any Individual Output Circuit of A Liebert Microprocessor Controlled Environmental Unit

Example: Unit load is not energizing. Troubleshooting Steps:

Programming

1. Read and record all program set points (Set Modes 1 & 2).
2. Read and record all DIP (control) switch positions. Check programming in appropriate manuals to verify selected options.
3. Reboot system (disconnect switch off - on) to reconfigure system. If programming error is detected, recheck unit for proper operation.

If problem is not resolved in programming section, begin the signal flow check.

Signal Flow Check - Assumption is the unit is calling for a mechanical operation but the load is not activated. Using chapter 5 of the appropriate control training and service manual, identify the output opto-isolator to be checked, locate the opto-isolator on the PCB and perform the following.

DC Voltage check:

1. Using a digital volt meter check for the correct VDC signal at the output opto-isolator. Pin 1 referenced to - VDC on the power supply will show low VDC (approximately 1.2 VDC) if the microprocessor control side of the device is functioning. A high VDC (approximately 5 VDC) indicates a microprocessor control problem. A meter reading of 0 VDC indicates a loss of microprocessor voltage, check VDC at the power supply referenced +VDC to -VDC should be approximately 5 VDC.
2. This check involves the microprocessor. To bypass the microprocessor completely, jumper from Pin 2 on the output opto-isolator to -VDC on the power supply. As soon as the jumper is applied the load device should activate. If the load device activates the problem is in the microprocessor itself or the programming. If the load device does not activate continue the signal flow check.

AC Voltage check:

Place the digital VOM meter on AC voltage, minimum 30 VAC scale and verify that 24 VAC is being applied to the output opto-isolator by placing the VOM between Pin 6 and the proper transformer ground connection. To verify that the switch leg of the output opto-isolator is working properly place the VOM between Pin 4 and the proper transformer ground connection. A high VAC (approximately 24 VAC) display indicates a closed switch leg, a low VAC indicates an open switch leg.

If the programming is correct and the output opto-isolator is functioning properly but the load device is not activated the next step is to check the triac and hard wiring to the load device. Verify that 24 VAC is being applied to Pin 1 of the triac, place the VOM leads between Pin 1 and the proper transformer ground connection. If 24 VAC is not present at Pin 1 of the triac backtrack the circuit to the proper secondary hot of the control transformer.

If 24 VAC is present perform the following:

Level's 00 and SM - Place the factory supplied jumper on the double post beside the triac to sent 24 VAC to the load device. If load activates the triac is bad, if the load does not activate check circuit wiring and the load device itself.

Level 10 - Use the service terminal following the instruction in the training and service manual. The service technician can also place a jumper between the proper pins on the white plugs located on the interface board, use the unit schematic to locate the proper jumper points. If load activates the triac is bad, if the load does not activate check circuit wiring and load device.

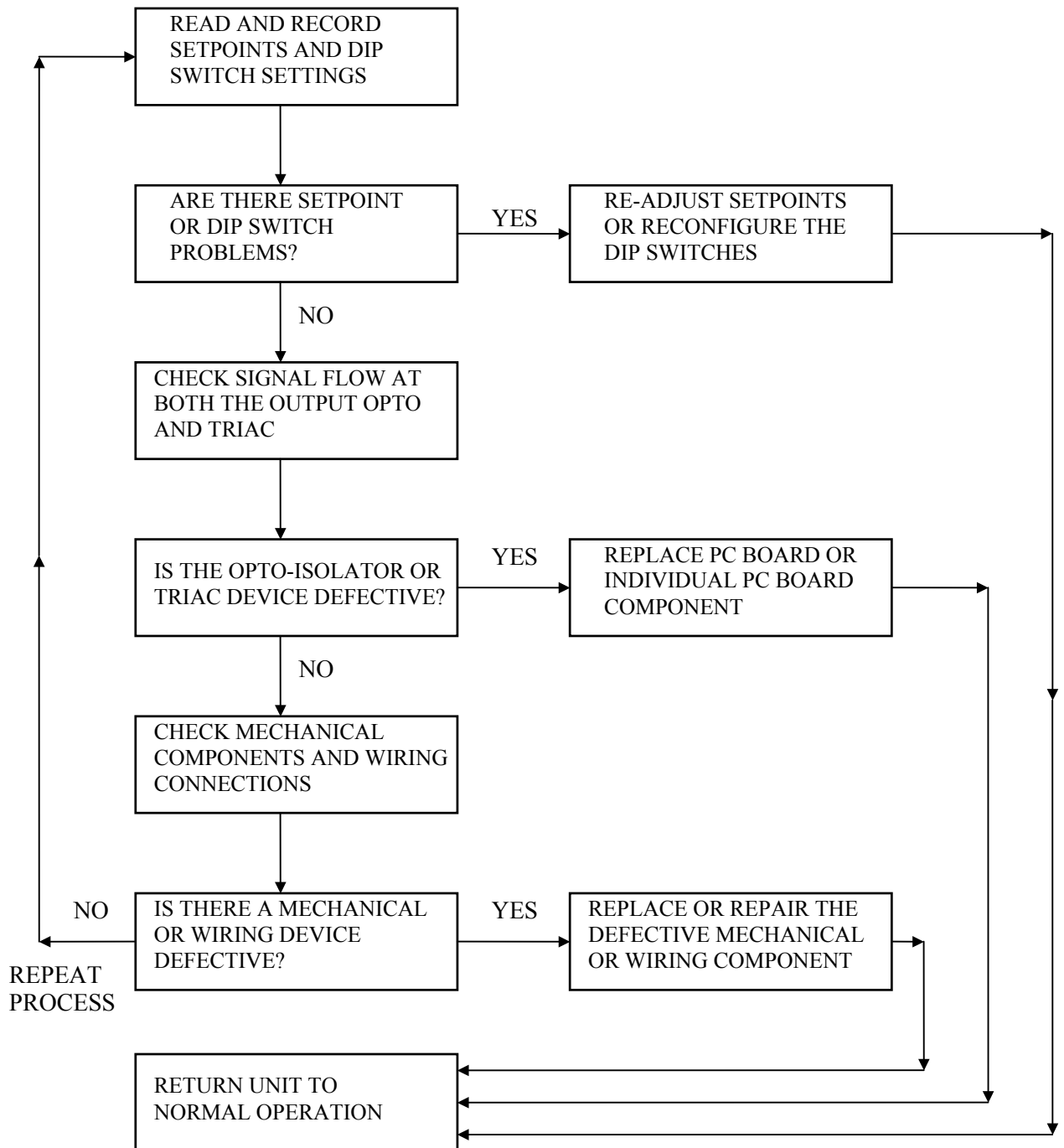
Level's 01/02/03 - Use a small alligator clip to jumper Pins 1 and 2 on the triac itself, to sent 24 VAC to the load device. If load activates the triac is bad, if the load does not activate check circuit wiring and the load device itself. The triacs are located on the interface board, use the proper training and service manual to identify and locate the triac. The service terminal should be used to troubleshoot the Level 02/03 controls following the instructions in the proper training and service manual.

Level's AM/AG - Select the appropriate diagnostics function from the control menu, use the training and service manual for reference. During the TEST OUTPUTS function the green LED on the microprocessor should light. If the LED lights check the hardware from the plug to the load device. If the LED does not light run the TEST CONTROL BOARD diagnostics function, if board failure is displayed contact your local sales office.

Note: Triacs are current limiting devices, therefore the load device must be connected to obtain valid voltage readings when doing VOM checks and circuit troubleshooting. Repair or replace any missing or defective components in the circuit.

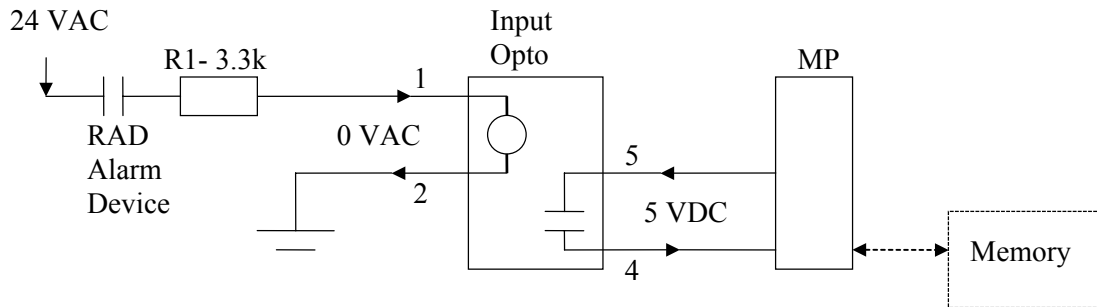
Mechanical Problems - If the failure of the load device to activate is determined to be mechanical in nature consult the appropriate Liebert system operation and maintenance, reference the individual component manufacturers literature or contact your local Liebert representative.

TROUBLESHOOTING FLOWCHART

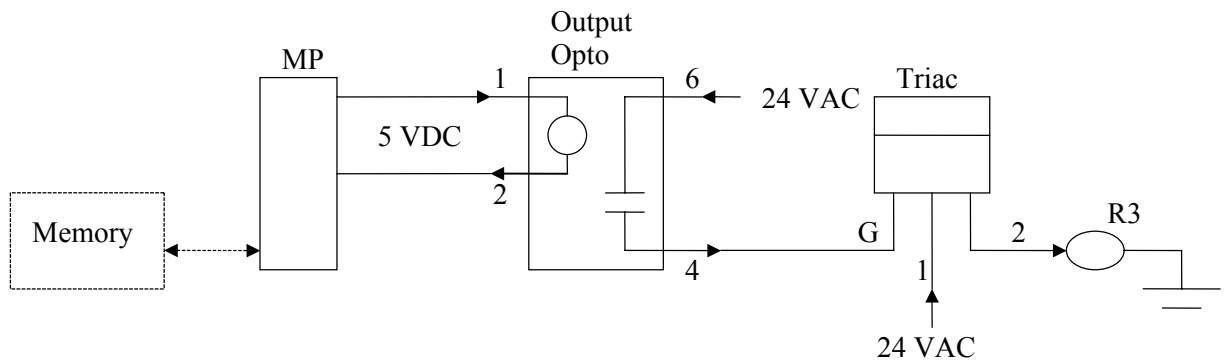


Signal Flow - Input and Output Alarm Circuit

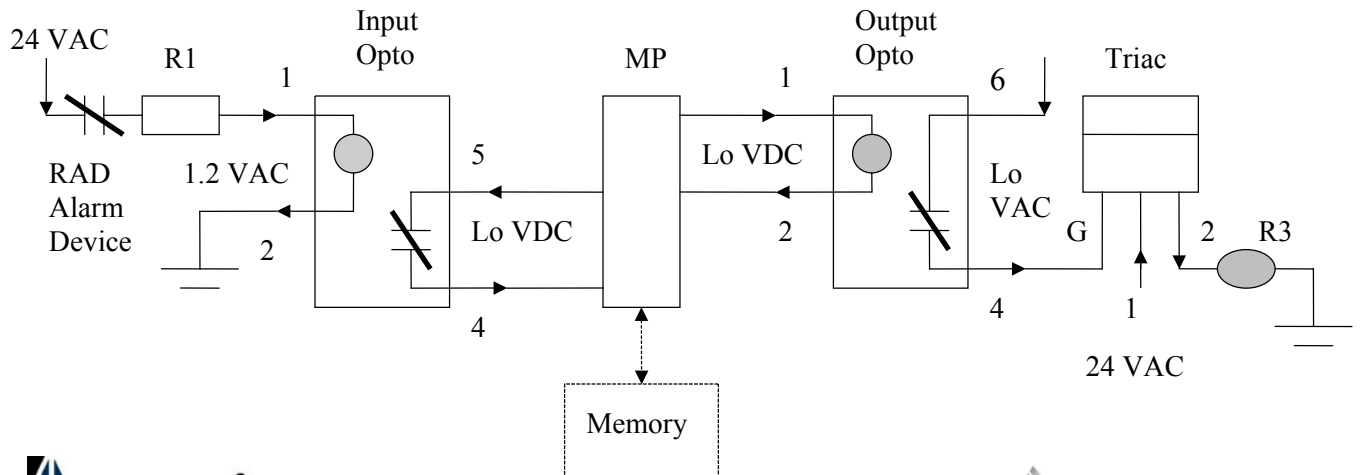
Alarm Device to Input Opto to Microprocessor, alarm device open



Microprocessor to Output Opto to Triac to Load Device, no alarm



Alarm Device Closed to Input Opto to Microprocessor to Output Opto to Load Device



LEVEL 00 READ AND RECORD

Using the advance, increase, and decrease push buttons, record the following data: To access Set Mode 2, advance the LED to temperature and depress the increase/decrease push buttons simultaneously for approximately 15 seconds. The flashing LED indicates Set Mode 2 operation.

SET MODE 1

Temperature _____

Temperature Set Point _____

Temperature Sensitivity _____

Humidity (Pan Size) _____ (____)

Humidity Set Point _____

Humidity Sensitivity _____

Humidifier Water Rate _____

SET MODE 2

Compressor Sequence _____

High Temp Alarm Trip _____

Low Temp Alarm Trip _____

High Humid Alarm Trip _____

Low Humid Alarm Trip _____

Now record the positions of the DIP switches:

	#1	#2	#3	#4	#5	#6	#7	#8
ON (up)								
OFF (down)								

LEVEL 10 READ AND RECORD

Access Set Mode 1 by depressing the white SET button once. The SET LED located on the Front Display will light and stay on. Now read and record the following Set Mode 1.

SET MODE 1

Temperature Set Point _____ High Temp Alarm Trip _____
Temperature Sensitivity _____ Low Temp Alarm Trip _____
Humidity Set Point _____ High Humid Alarm Trip _____
Humidity Sensitivity _____ Low Humid Alarm Trip _____
Humidifier Flush Rate _____

Access Set Mode 2 by depressing the white SET button twice. The Front Monitor LED will blink to acknowledge Set Mode 2. Now read and record the following information.

SET MODE 2

Temperature Calibration _____ Front Monitor LED Test (All ON) _____
Humidity Calibration _____ Font Monitor LED Test (All Off) _____
Audible Alarm Tone Adjustment _____

ON/OFF - COMMON ALARMS (R3 CONTACT CLOSURE)

Humidifier Problem _____ Local Alarm 3 _____
High Head Pressure 1 _____ Local Alarm 4 _____
High Head Pressure 2 _____ High Temp Alarm _____
Change Air Filters _____ Low Temp Alarm _____
Loss of Air Flow _____ High Humid Alarm _____
Local Alarm 1 _____ Low Humid Alarm _____
Local Alarm 2 _____

ENABLE/DISABLE - FRONT MONITOR LED's

Humidifier Problem _____ Local Alarm 3 _____
High Head Pressure 1 _____ Local Alarm 4 _____
High Head Pressure 2 _____ High Temp Alarm _____
Change Air Filters _____ Low Temp Alarm _____
Loss of Air Flow _____ High Humid Alarm _____
Local Alarm 1 _____ Low Humid Alarm _____
Local Alarm 2 _____

LOCAL ALARM TIME DELAY PERIODS

Local Alarm 1 _____
Local Alarm 2 _____
Local Alarm 3 _____
Local Alarm 4 _____

Now record the positions of the DIP switches:

LEFT-HAND GROUPING - SW2

	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8
ON (up)								
OFF (down)								
	Unlock	A	B	C	D	E	F	G

RIGHT-HAND GROUPING - SW1

	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
ON (up)								
OFF (down)								
	No Beep	H	J	K	L	M	N	P

STANDARD MICROPROCESSOR (SM) READ AND RECORD

Using the advance, increase, and decrease push buttons, record the following data. To access Set Mode 2, advance the LED to temperature and depress the increase/decrease push buttons simultaneously for approximately 15 seconds. The flashing LED indicates Set Mode 2.

SET MODE 1

Temperature _____

Temperature Set Point _____

Temperature Sensitivity _____

Humidity (Pan Size) _____ (____)

Humidity Set Point _____

Humidity Sensitivity _____

Humidifier Water Rate _____

SET MODE 2

Temp Sensor Calibration _____

High Temp Alarm Trip _____

Low Temp Alarm Trip _____

Humid Sensor Calibration _____

High Humid Alarm Trip _____

Low Humid Alarm Trip _____

Compressor Sequence _____

Now record the positions of the DIP switches:

	#1	#2	#3	#4	#5	#6	#7	#8
ON (up)								
OFF (down)								

ADVANCED MICROPROCESSOR (AM) READ AND RECORD

Depress the MAIN/ESC key to view the available menu. Using the down arrow key select STATUS/ALARM DATA, depress the enter key to view the alarm data. Depress the MENU/ESC key select SETPOINTS/ SETUP, depress the enter key. Select VIEW SETPOINTS, depress the enter key and record displayed data. Based on the system type and control setup not all information on the following pages is displayed.

VIEW SETPOINTS

Temperature Set Point _____	High Temp Alarm Trip _____
Temperature Sensitivity _____	Low Temp Alarm Trip _____
Humidity Set Point _____	High Humid Alarm Trip _____
Humidity Sensitivity _____	Low Humid Alarm Trip _____

Exit VIEW SETPOINTS, enter SETUP SYSTEM, record displayed data.

SETUP OPERATION

Cold Start TD _____	CW/HW Coil Flush TD _____
Restart TD _____	Celsius/Fahrenheit _____
Infrared Fill Rate _____	

Exit SETUP OPERATION, enter SELECT OPTIONS, record displayed data.

SELECT OPTIONS

Heating _____	Hot Gas Reheat _____
Humidifier _____	Heat Stages _____
Dehumidifier _____	Dehumidification Stages _____
Humidifier Pan Size _____	

Exit SELECT OPTIONS, enter CALIBRATE SENSORS, record displayed data.

Temp Sensor _____	Humid Sensor _____
Calibrated Value _____	Calibrated Value _____

Exit CALIBRATE SENSORS, enter SHOW DIP SWITCHES, record displayed data.

Dip Switch	position/operation	Dip Switch	position/operation
#1	_____	#5	_____
#2	_____	#6	_____
#3	_____	#7	_____
#4	_____		

Exit SHOW DIP SWITCHES, enter SELECT CONTROL TYPE, record displayed data.

Control Type selected _____

Exit SELECT CONTROL TYPE, enter SETUP ALARMS, select SET TIME DELAYS, record displayed data.

Humidifier Problem TD _____	High Humid TD _____
High Head #1 TD _____	Low Humid TD _____
High Head #2 TD _____	Low Suction Press #1 TD _____
Change Filters TD _____	Low Suction Press #2 TD _____
Loss of Air TD _____	Short Cycle #1 TD _____
Customer #1 TD _____	Short Cycle #2 TD _____
Customer #2 TD _____	Comp #1 OL TD _____
Customer #3 TD _____	Comp #2 OL TD _____
Customer #4 TD _____	Main Fan OL TD _____
High Temp TD _____	Loss of Power _____
Low Temp TD _____	

Exit SET TIME DELAYS, enter ENABLE ALARMS, record displayed data.

Humidifier Problem _____	High Humid _____
High Head #1 _____	Low Humid _____
High Head #2 _____	Low Suction Press #1 _____
Change Filters _____	Low Suction Press #2 _____
Loss of Air _____	Short Cycle #1 _____
Customer #1 _____	Short Cycle #2 _____
Customer #2 _____	Comp #1 OL _____
Customer #3 _____	Comp #2 OL _____
Customer #4 _____	Main Fan OL _____
High Temp _____	Loss of Power _____
Low Temp _____	

Exit ENABLE ALARMS, enter ENABLE COMMON ALARM, record displayed data.

Humidifier Problem _____	High Humid _____
High Head #1 _____	Low Humid _____
High Head #2 _____	Low Suction Press #1 _____
Change Filters _____	Low Suction Press #2 _____
Loss of Air _____	Short Cycle #1 _____
Customer #1 _____	Short Cycle #2 _____
Customer #2 _____	Comp #1 OL _____
Customer #3 _____	Comp #2 OL _____
Customer #4 _____	Main Fan OL _____
High Temp _____	Loss of Power _____
Low Temp _____	

Exit ENABLE COMMON ALARM, enter SET CUSTOM ALARMS, record data.

Custom Alarm 1 Text _____

Custom Alarm 2 Text _____

Custom Alarm 3 Text _____

Custom Alarm 4 Text _____

Change Custom Text 1 _____

Change Custom Text 2 _____

Exit CHANGE CUSTOM TEXT 2, enter HUM CONTROL METHOD, record data.

Humidity Control type selected: _____

Exit HUM CONTROL METHOD, enter ANALOG SETUP, record data.

A/D INPUT 1 - ENTER KEY - SLOPE(#1) _____

TEXT(#1) _____

INTERCEPT(#1) _____

A/D INPUT 2 - ENTER KEY - SLOPE(#2) _____

TEXT(#2) _____

INTERCEPT(#2) _____

A/D INPUT 3 - ENTER KEY - SLOPE(#3) _____

TEXT(#3) _____

INTERCEPT(#3) _____

A/D INPUT 4 - ENTER KEY - SLOPE(#4) _____

TEXT(#4) _____

INTERCEPT(#4) _____

Exit ANALOG SETUP, enter CALIBRATE ACTUATOR, record data.

ADVANCED GRAPHICS (AG) READ AND RECORD

Depress the MAIN/ESC key to view the available menus for programming. Using the down arrow key select SETUP ALARMS, depress enter key, record the displayed data. Based on the system type and control setup not all information on the following pages is displayed.

ALARM	TRIP POINT	TIME DELAY	ALARM TYPE
High Temperature	_____	_____	_____
Low Temperature	_____	_____	_____
High Humidity	_____	_____	_____
Low Humidity	_____	_____	_____
Main Fan Overload		_____	_____
Loss of Power		_____	_____
Humidifier Problem		_____	_____
Change Filters		_____	_____
Loss of Air Flow		_____	_____
Custom Alarm #1		_____	_____
Custom Alarm #2		_____	_____
Custom Alarm #3		_____	_____
Custom Alarm #4		_____	_____
Hi Head #1		_____	_____
Hi Head #2		_____	_____

Exit SETUP ALARMS select SETUP CUSTOM ALARMS, enter SETUP CUSTOM ALARM TEXT, record displayed data.

SETUP CUSTOM ALARM

Custom Alarm 1 Text _____

Custom Alarm 2 Text _____

Custom Alarm 3 Text _____

Custom Alarm 4 Text _____

Exit SETUP CUSTOM ALARM TEXT, enter VIEW WATER DETECT FLOOR PLAN to view previously entered floor plan data. Exit VIEW WATER DETECT, enter OPERATING STATUS, record the displayed data.

Exit OPERATING STATUS, enter VIEW/SET CONTROL SETPOINTS, record displayed data.

VIEW SETPOINTS

Temperature Setpoint _____	Humidity Setpoint _____
Temperature Sensitivity _____	Humidity Sensitivity _____
High Temperature Alarm _____	High Humidity Alarm _____
Low Temperature Alarm _____	Low Humidity Alarm _____

Exit VIEW/SET CONTROL SETPOINTS and select SETUP SYSTEM enter SETUP OPERATION, record the displayed data.

SETUP OPERATION

Cold Start Delay _____	CW/HW Coil Flush TD _____
Auto Restart Delay _____	Celsius/Fahrenheit _____
Infrared Flush Overfill _____	

Exit SETUP OPERATION and enter SELECT OPTIONS, record the displayed data.

SELECT OPTIONS

Reheat _____	Hot Gas Reheat _____
Humidify _____	Stages of Reheat _____
Dehumidify _____	
Humidifier Pan Size _____	

Exit SELECT OPTIONS, enter CALIBRATE SENSORS, record displayed data.

Temp Sensor _____

Calibrated Value _____

Humid Sensor _____

Calibrated Value _____

Exit CALIBRATE SENSORS, enter CALIBRATE ACTUATOR, record displayed data.

Exit CALIBRATE ACTUATOR, enter SELECT CONTROL ALGORITHM, record displayed data.

Exit SELECT CONTROL ALGORITHM, enter SELECT HUMIDITY SENSING MODE, record displayed data.

Exit SELECT HUMIDITY SENSING MODE, enter SHOW DIP SWITCHES, record displayed data.

Dip Switch	position/operation
#1	_____
#2	_____
#3	_____
#4	_____
#5	_____
#6	_____
#7	_____

SMALL SYSTEMS READ AND RECORD

Mini-MATE, mini-MATE Plus and DataMate

Depress the **SET POINTS** key to access the following parameters, read and record the displayed values. To advance to the next, depress the **SET POINT** key.

High Temp Set Point _____ High Temp Alarm Pt. _____

Low Temp Set Point _____ Low Temp Alarm Pt. _____

High Humid Set Point _____ High Humid Alarm Pt. _____

Low Humid Set Point _____ Low Humid Alarm Pt. _____

By depressing the **CLOCK** key while in the High Temperature set point mode the following items can be selected by pressing the **SET POINTS** key. Read and record the displayed values.

Set Cal Temp _____

Set Cal Humid _____

Set DE _____

Set F/ C _____

Now record the positions of the DIP switches:

	#1	#2	#3	#4
ON (up)				
OFF (down)				

MINI-MATE2: 1 to 8 Ton and DATAMATE: 1 to 3Ton MICROPROCESSOR READ AND RECORD

Press the **MENU** key to view the available menu. Using the down arrow key select **SETPOINTS**, press the enter key then the down arrow key to view/scroll through the various sub-menus. Read and record displayed data. Based on the system type and control setup not all information on the following pages is displayed.

SETPOINTS

Temperature Set Point _____	High Temp Alarm Trip _____
Temperature Sensitivity _____	Low Temp Alarm Trip _____
Humidity Set Point _____	High Humid Alarm Trip _____
Humidity Sensitivity _____	Low Humid Alarm Trip _____

Exit SETPOINTS/SETUP, enter STATUS, record displayed data.

DX Cooling % _____	CW Cooling % _____
Econ Cooling % _____	Heat % _____
Dehumidifying % _____	Humidifying % _____

Exit STATUS, scroll past Active Alarms, Time and Date Screens. Enter SETBACK, record displayed data.

Event	Weekend 1	Weekend 2	Weekday 1	Weekday 2
ON/OFF				
Time 1				
Temp 1				
Temp Sensitivity 1				
Humid 1				
Humid Sensitivity 1				
Time 2				
Temp 2				
Temp Sensitivity 2				
Humid 2				
Humid Sensitivity 2				

Exit SETBACK, enter SETUP OPERATION, record displayed data.

Restart TD _____ Celsius/Fahrenheit _____

Humidity Control Method _____ Lead Compressor _____

Now record the positions of the DIP switches (DIP switches located in the ceiling unit):

	#1	#2	#3	#4	#5	#6	#7	#8
ON (up)								
OFF (down)								

Valve Time _____ CW Flush _____

Exit SETUP OPERATION, enter SETPOINT PASSWORD, program and record the password.

Exit SETPOINT PASSWORD, enter SETUP PASSWORD, program and record the password.

Exit SETUP PASSWORD, enter CALIBRATE SENSORS, record displayed data.

Temp Calibration _____ Humid Calibration _____

Temp Time Delay _____ Humidity Time Delay _____

Exit CALIBRATE SENSORS, enter ALARM ENABLE, record displayed data.

Humid Prob _____ Low Temp _____

Change Filter _____ High Humid _____

Loss Air _____ Low Humid _____

Custom #1 _____ Short Cycle 1 _____

Custom #2 _____ Short Cycle 2 _____

Custom #3 _____ Fan Overload _____

High Temp _____ Loss Pwr _____

Exit ALARM ENABLE, enter ALARM TIME DELAY, record displayed data.

Humid Prob _____	Low Temp _____
Change Filter _____	High Humid _____
Loss Air _____	Low Humid _____
Custom #1 _____	Short Cycle 1 _____
Custom #2 _____	Short Cycle 2 _____
Custom #3 _____	Fan Overload _____
High Temp _____	Loss Pwr _____

Exit ALARM TIME DELAY, enter COMMON ALARM ENABLE, record displayed data.

Humid Prob _____	High Temp _____
Hi Head #1 _____	Low Temp _____
Hi Head #2 _____	High Humid _____
Change Filter _____	Low Humid _____
Loss Air _____	Short Cycle 1 _____
Custom #1 _____	Short Cycle 2 _____
Custom #2 _____	Fan Overload _____
Custom #3 _____	Loss Pwr _____
High Water _____	

Exit COMMON ALARM ENABLE, enter CUSTOM ALARMS, record displayed data.

Custom Alarm #1 _____

Custom Alarm #2 _____

Custom Alarm #3 _____

Exit CUSTOM ALARMS, enter CUSTOM TEXT, record displayed data.

Custom Text #1 _____

Custom Text #2 _____

Custom Text #3 _____

Large Systems Monthly Maintenance Inspection Checklist

Date: _____

Prepared By: _____

Model #: _____

Serial #: _____

Filters

- o Restricted air flow
- o Check filter section
- o Wipe section clean leaks

Blower Section

- o Impellers free of debris and move freely
- o Check belt tension
- o Bearings in good condition
- o Check fan safety switch operation leaks
- o Check pulleys and motor mounts

Compressor

- o Check oil levels
- o Check for leaks

Air Cooled Condenser (if applicable)

- o Condenser coil clean
- o Motor mounts tight valve
- o Bearings in good condition
- o Refrigerant lines properly supported

Refrigerant Charge

- o Check refrigerant level

Notes:

Signature:

Steam Generating Humidifier

- o Check canister for deposits
- o Check condition of steam hoses
- o Check water make-up valve for

Infrared Humidifier

- o Check pan drain for clogs
- o Check humidifier lamps
- o Check pan for mineral deposits
- o Check water make-up valve for

Refrigeration Cycle/Section

- o Check refrigerant lines
- o Check sight glass for moisture
- o Check suction pressure
- o Check head pressure
- o Check discharge pressure
- o Check hot gas bypass valve
- o Check thermostatic expansion

Air Distribution Section

- o Restrictions in free grille area

Large Systems Semi-Annual Maintenance Inspection Checklist

Date: _____

Prepared By: _____

Model #: _____

Serial #: _____

Filters

- o Restricted air flow
- o Check filter section
- o Wipe section clean

Blower Section

- o Impellers free of debris and move freely
- o Check belt tension
- o Bearings in good condition
- o Check fan safety switch operation
- o Check pulleys and motor mounts

Compressor

- o Check oil levels
- o Check for leaks

Air Cooled Condenser (if applicable)

- o Condenser coil clean
- o Motor mounts tight
- o Bearings in good condition
- o Refrigerant lines properly supported

Water/Glycol Condenser (if applicable)

- o Copper tubes clean
- o Water regulating valves function
- o Check glycol solution
- o Check for water/glycol leaks

Glycol Pump

- o Check for glycol leaks
- o Pump operation

Steam Generating Humidifier

- o Check canister for deposits
- o Check condition of steam hoses
- o Check water make-up valve for leaks

Infrared Humidifier

- o Check pan drain for clogs
- o Check humidifier lamps
- o Check pan for mineral deposits
- o Check water make-up valve for leaks

Refrigeration Cycle/Section

- o Check refrigerant lines
- o Check sight glass for moisture
- o Check suction pressure
- o Check head pressure
- o Check discharge pressure
- o Check hot gas bypass valve
- o Check thermostatic expansion valve

Air Distribution Section

- o Restrictions in free grille area

Refrigerant Charge

- o Check refrigerant level

Electric Panel

- o Check fuses
- o Check electrical connections
- o Check operation sequences

Air Distribution Section

- o Restriction in grille area

Notes:

Signature:

Small Systems Maintenance Inspection Checklist

Date: _____

Prepared By: _____

Model #: _____

Serial #: _____

MONTHLY

Filters

- o Restricted air flow
- o Check filter section
- o Wipe section clean

Steam Generating Humidifier

- o Check canister for deposits
- o Check condition of steam hoses/fittings
- o Check water make-up valve for leaks
- o Check condition of electrodes

Fan Section

- o Impellers free of debris and move freely
- o Bearings in good condition

SEMI-ANNUALLY

Compressor Section

- o Check for signs of oil leaks
- o Check liquid indicator
- o Check vibration isolation

Refrigeration Cycle/Section

- o Check suction pressure
- o Check head pressure
- o Check Superheat
- o Evaporator Coil Clean
- o Insulation intact

Air Cooled Condenser (if applicable)

- o Condenser coil clean
- o Motor mounts tight
- o Bearings in good condition
- o Refrigerant lines properly supported

Flood Back Head Pressure Control (if applicable)

- o Check refrigerant level

Water/Glycol Condenser (if applicable)

- o Check for leaks
- o Regulating valve adjustment

Glycol Pump

- o Check for glycol leaks
- o Check pump operation
- o Check pH level

Electric Panel

- o Check electrical connections
- o Check operation sequences

Notes:

Signature:

IntelCool2 Maintenance Inspection Checklist

Date: _____

Prepared By: _____

Model #: _____

Serial #: _____

MONTHLY

Filters

- o Restricted air flow
- o Check filter section
- o Wipe section clean

Fan Section

- o Impellers free of debris and move freely
- o Bearings in good condition

Economizer

- o Check damper for tightness & wear

SEMI-ANNUALLY

Compressor Section

- o Check for signs of oil leaks
- o Check vibration isolation

Air Cooled Condenser

- o Condenser coil clean
- o Motor mount tight
- o Bearings in good condition
- o Refrigerant lines properly supported

Refrigeration Cycle/Section

- o Check suction pressure
- o Check head pressure
- o Check Superheat
- o Evaporator Coil Clean
- o Insulation intact

Electric Panel

- o Check electrical connections
- o Check operational sequences

Notes:

Signature:

CSU3000 Chillers Maintenance Inspection Checklist

Date: _____

Prepared By: _____

Model #: _____

Serial #: _____

MONTHLY

Compressor

- o Check for signs of leaks
- o Check oil level

Air Cooled Condenser (if applicable)

- o Condenser coil clean
- o Motor mounts tight
- o Bearings in good condition
- o Refrigerant lines properly supported valve

Refrigeration Cycle/Section

- o Check suction pressure
- o Check head pressure
- o Check Superheat
- o Check refrigerant lines
- o Check sight glass for moisture
- o Check discharge pressure
- o Check hot gas bypass valve
- o Check thermostatic expansion

SEMI-ANNUALLY

Compressor

- o Check for signs of leaks
- o Check oil level

Air Cooled Condenser (if applicable)

- o Condenser coil clean
- o Motor mounts tight
- o Bearings in good condition
- o Refrigerant lines properly supported valve

Refrigeration Cycle/Section

- o Check suction pressure
- o Check head pressure
- o Check Superheat
- o Check refrigerant lines
- o Check sight glass for moisture
- o Check discharge pressure
- o Check hot gas bypass valve
- o Check thermostatic expansion

Water/Glycol Condenser (if applicable)

- o Copper tubes cleans
- o Water regulating valves function
- o Check glycol solution
- o Check for water/glycol leaks

Glycol Pump (if applicable)

- o Check for glycol leaks
- o Check pump operation
- o Check glycol solution
- o Check pH level

Chilled Water Pump

- o Check for leaks
- o Check pump operation

Electric Panel

- o Check electrical connections
- o Check operation sequences
- o Check fuses

Notes:

Signature:

Customer Course Critique

Name: _____ Date: _____

Rating System: Using a scale of 1 = (Poor or Low) to 5 = (Excellent or High)

1. How do you rate the hands-on training? _____
2. How do you rate the technical training session for the amount of time? _____
3. How do you rate the difficulty level of the class? _____
4. How do you rate the instructor? _____
5. How do you rate the written tests (if applicable)? _____
6. Do the training manuals, user manuals, literature meet your needs? Yes ___ No ___
7. How can the training and/or materials be improved?

8. Does the training facility meet your needs? Yes _____ No _____
9. How can the technical training be improved?

10. Additional comments?

Use the back of the page if necessary