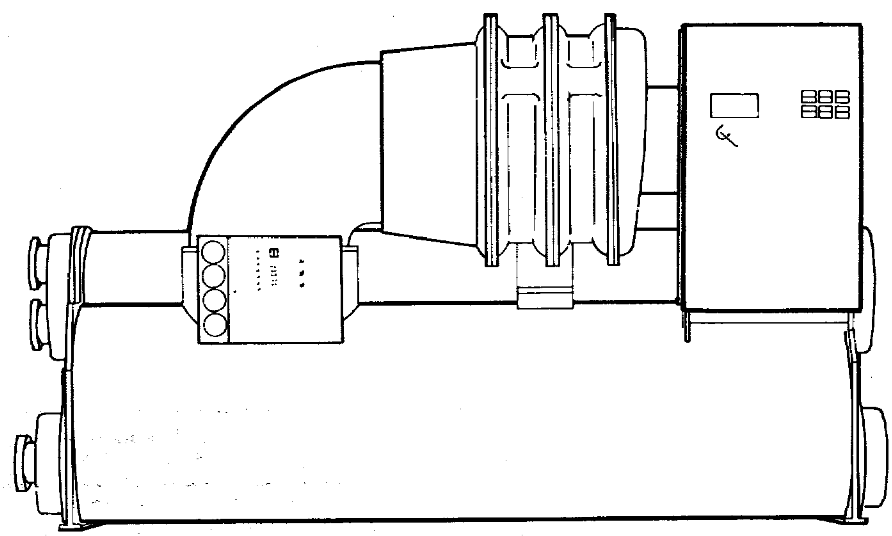
# Operation Maintenance

CVHE-M-4A

| | |
|---|---|
| Library | Service Literature |
| Product Section | Refrigeration |
| Product | Cent. Liquid Chillers/Water-Cooled |
| Model | CVHE, Cooling-Only and Heat-Recovery |
| Literature Type | Operation/Maintenance |
| Sequence | 4A |
| Date | September 1986 |
| File No. | SV-RF-CTV-CVHE-M-4A-986 |
| Supersedes | CVHE-M-4 386 |

## Models CVHE 013 thru 125 Centrifugal Liquid Chiller



**Cooling-Only and Heat-Recovery Direct-Drive CenTraVac w/Standard Control Panel**

*Since The Trane Company has a policy of continuous product improvement, it reserves the right to change specifications and design without notice. The installation and servicing of the equipment referred to in this booklet should be done by qualified, experienced technicians.*

Drwg. No. X39640289-02

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## Notice

The Trane Company urges that all HVAC servicers working on Trane equipment, or any manufacturer's products, make every effort to eliminate, if possible, or vigorously reduce the emission of CFC, HCFC and HFC refrigerants to the atmosphere resulting from installation, operation, routine maintenance, or major service on this equipment. Always act in a responsible manner to conserve refrigerants for continued use even when acceptable alternatives are available.

Conservation and emission-reduction can be accomplished by following recommended Trane service and safety procedures published in Trane General Service Bulletin CTV-SB-81. The information and procedures provided in CTV-SB-81 supersedes those published in this manual. Copies of this bulletin may be obtained by contacting your local Trane commercial product representative.

The Trane Company
La Crosse, Wisconsin 54601-7599
Printed in U.S.A.


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# Model Number Description

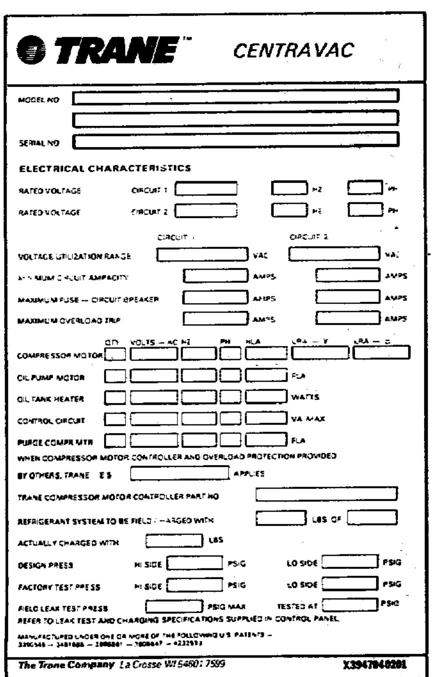
All standard Trane products are identified by a multiple-character model number that precisely identifies a particular type of unit. An explanation of the alphanumeric identification code used with CenTraVac units is provided on the next three pages. Its use will enable the owner/operator, installing contractor(s), and service engineer(s) to define the operation, components and options for a particular unit.

Be sure to refer to the model number stamped on the unit nameplate (shown below, and mounted on the left-hand side of the unit control panel enclosure) when ordering replacement parts or requesting service.

**Note:** Trane-built unit-mounted starters are identified by a separate number found on the starter.

**Model No.**
Digit

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Model No. | CV | H | E - | 014 | A - | A | K | 4 | A | B | 235 | 5 | C | E |
| Digit | 1,2 | 3 | 4 | 5,6,7 | 8 | 9 | 10 | 11 | 12 | 13 | 14,15,16 | 17 | 18 | 19 (cont.) |




Drwg. X39470402

## Digits 1,2
### CenTraVac

## Digit 3
### Direct-Drive

## Digit 4
### Development Sequence

## Digits 5, 6, 7
### Compressor Designators (Unit Capacity)

| | | | | |
|---|---|---|---|---|
| 013 | 023 | 040 | 071 | 112 |
| 014 | 025 | 045 | 080 | 125 |
| 016 | 028 | 050 | 089 | SSS |
| 018 | 032 | 056 | 090 | |
| 020 | 036 | 063 | 100 | |

## Digit 8
### Nominal Voltage

| | |
|---|---|
| A = 200/60/3 | H = 575/60/3 |
| B = 208/60/3 | J = 600/60/3 |
| C = 230/60/3 | K = 2300/60/3 |
| D = 380/60/3 | L = 2400/60/3 |
| E = 440/60/3 | M = 4000/60/3 |
| F = 460/60/3 | N = 4160/60/3 |
| G = 480/60/3 | S = Special |

## Digit 9
### Unit Type
A = Hermetic, Std.
B = Hermetic w/Heat-Recovery
C = Hermetic w/Aux. Condenser
D = Hermetic w/Free-Cooling
S = Special

## Digit 10
### Design Sequence

## Digit 11
### Economizer and Hot Gas Bypass
2 = Std. Economizer (Flanged Elbow)
4 = Std. Economizer w/HGBP
S = Special

## Digit 12
### Compressor Motor KW

| | | |
|---|---|---|
| A = 96 | J = 204 | V = 586 |
| B = 105 | K = 230 | W = 653 |
| C = 118 | L = 256 | X = 742 |
| D = 131 | N = 323 | Y = 853 |
| E = 142 | P = 361 | Z = 954 |
| F = 155 | R = 403 | S = Special |
| G = 172 | T = 453 | |
| H = 184 | U = 513 | |

## Digit 13
### Compressor Motor Vendor

## Digits 14, 15, 16
### Impeller Cutback Diameter

| | |
|---|---|
| 235 = 23.50 | 255 = 25/50 |
| 237 = 23.70 | 257 = 25.70 |
| 238 = 23.80 | 258 = 25.80 |
| 240 = 24.00 | 260 = 26.00 |
| 242 = 24.20 | 262 = 26.20 |
| 243 = 24.30 | 263 = 26.30 |
| 245 = 24.50 | 265 = 26.50 |
| 247 = 24.70 | 267 = 26.70 |
| 248 = 24.80 | 268 = 26.80 |
| 250 = 25.00 | 270 = 27.00 |
| 252 = 25.20 | 272 = 27.20 |
| 253 = 25.30 | 273 = 27.30 |
| | 275 = 27.50 |

## Digit 17
### Evaporator Bundle Size

## Digit 18
### Evaporator Length
C = Short
D = Long
S = Special

## Digit 19
### Evaporator Tube Specifications
A = 0.028 Cu
B = 0.035 Cu
*E = 0.028 Cu (IE)*

## Model Number

Digit Number

| A | A | 1 | 5 | C | A | 1 | A | 0 | 0 | 0 | 0 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | (continued) |

### Digit 20
### Evaporator Water Pass Arrangement

| DESIGNATOR | NUMBER OF PASSES | TYPE[1] | CONNECTION ARRANGEMENT[2] INLET: RIGHT OR LEFT HAND | INLET: END, FRONT, OR REAR | OUTLET: RIGHT OR LEFT HAND | OUTLET: END, FRONT, OR REAR |
|---|---|---|---|---|---|---|
| A | 1 | M | — | F | — | F |
| B | 1 | M | — | R | — | R |
| C | 1 | M | LH | F | RH | R |
| C | 1 | M | RH | R | LH | F |
| D | 1 | M | LH | R | RH | F |
| D | 1 | M | RH | F | LH | R |
| J | 2 | M | LH | F | LH | R |
| K | 2 | M | LH | R | LH | F |
| L | 2 | M | RH | F | RH | R |
| M | 2 | M | RH | R | RH | F |
| N | 3 | M | LH | F | RH | R |
| N | 3 | M | RH | R | LH | F |
| P | 3 | M | RH | F | LH | R |
| P | 3 | M | LH | R | RH | F |
| Y | 1 | NM | — | E | — | E |
| Z | 2 | NM | RH | E | RH | E |
| 1 | 2 | NM | LH | E | LH | E |
| 3 | 3 | NM | — | E | — | E |

[1]Type M = Marine Type NM = Non-Marine Type
[2]Connection arrangement determined when facing control panel side of unit

### Digit 21
### Evap. Working Pressure (Water Side)

A = Flanged; 150 psig
B = Flanged; 300 psig
C = Victaulic; 150 psig
D = Victaulic; 300 psig
E = Flanged; 150 psig (ASME)
F = Victaulic; 150 psig (ASME)
S = Special

### Digit 22
### Condenser Construction (Refrigerant Side)

1 = Standard
2 = ASME
S = Special

### Digit 23
### Condenser (Cooling) Bundle Size

### Digit 24
### Condenser (Cooling) Length

C = Short
D = Long
S = Special

### Digit 25
### Condenser (Cooling) Tube Specifications

A = 0.028 Cu
B = 0.035 Cu
M = 0.035 Cu/Ni; 90/10
E = 0.028 Cu (IE)
S = Special

### Digit 26
### Condenser (Cooling) Water Pass Arrangement

| DESIGNATOR | NUMBER OF PASSES | TYPE[1] | CONNECTION ARRANGEMENT[2] INLET: RIGHT OR LEFT HAND | INLET: END, FRONT, OR REAR | OUTLET: RIGHT OR LEFT HAND | OUTLET: END, FRONT, OR REAR |
|---|---|---|---|---|---|---|
| E | 2 | M | LH | F | LH | F |
| F | 2 | M | LH | R | LH | R |
| G | 2 | M | RH | F | RH | F |
| H | 2 | M | RH | R | RH | R |
| J | 2 | M | LH | F | LH | R |
| K | 2 | M | LH | R | LH | F |
| L | 2 | M | RH | F | RH | R |
| M | 2 | M | RH | R | RH | F |
| Z | 2 | NM | RH | E | RH | E |
| 1 | 2 | NM | LH | E | LH | E |
| S | Special | | | | | |

[1]Type M = Marine Type NM = Non-Marine Type
[2]Connection arrangement determined when facing control panel side of unit

### Digit 27
### Cond. (Cooling) Water Pass Arrangement

A = Flanged; 150 psig
B = Flanged; 300 psig
C = Victaulic; 150 psig
D = Victaulic; 300 psig
E = Flanged; 150 psig (ASME)
F = Victaulic; 150 psig (ASME)
S = Special

### Digit 28
### Condenser (Heating) Bundle Size

### Digit 29
### Condenser (Heating) Length

0 = None
C = Short
D = Long
S = Special

### Digit 30
### Condenser (Heating) Tube Specifications

0 = None
A = 0.028 Cu
B = 0.035 Cu
M = 0.035 Cu/Ni; 90/10
E = 0.0.28 Cu (IE)
S = Special

### Digit 31
### Condenser (Heating) Water Pass Arrangement

| DESIGNATOR | NUMBER OF PASSES | TYPE[1] | CONNECTION ARRANGEMENT[2] INLET: RIGHT OR LEFT HAND | INLET: END, FRONT, OR REAR | OUTLET: RIGHT OR LEFT HAND | OUTLET: END, FRONT, OR REAR |
|---|---|---|---|---|---|---|
| E | 2 | M | LH | F | LH | F |
| F | 2 | M | LH | R | LH | R |
| G | 2 | M | RH | F | RH | F |
| H | 2 | M | RH | R | RH | R |
| J | 2 | M | LH | F | LH | R |
| K | 2 | M | LH | R | LH | F |
| L | 2 | M | RH | F | RH | R |
| M | 2 | M | RH | R | RH | F |
| Z | 2 | NM | RH | E | RH | E |
| 1 | 2 | NM | LH | E | LH | E |
| 0 | No Heat Recovery Condenser | | | | | |

[1]Type M = Marine Type NM = Non-Marine Type
[2]Connection arrangement determined when facing control panel side of unit

## Model Number

Digit Number

| 0 | 0 | 0 | 0 | 5 | 1 | A | 0 | 0 |
|---|---|---|---|---|---|---|---|---|
| 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |

### Digit 32
### Condenser (Heating) Working Pressure

0 = None
A = Flanged; 150 psig
B = Flanged; 300 psig
C = Victaulic; 150 psig
D = Victaulic; 300 psig
E = Flanged; 150 psig (ASME)
F = Victaulic; 150 psig (ASME)
S = Special

### Digit 33
### Auxiliary Condenser Size (Tube and Bundle)

0 = None
A = 0.028 Cu; Small Bundle
B = 0.028 Cu; Large Bundle
S = Special

### Digit 34
### Auxiliary Condenser Water Pass Arrangement

| DESIGNATOR | NUMBER OF PASSES | TYPE* | CONNECTION ARRANGEMENT² INLET RIGHT OR LEFT HAND | CONNECTION ARRANGEMENT² INLET END FRONT OR REAR | CONNECTION ARRANGEMENT² OUTLET RIGHT OR LEFT HAND | CONNECTION ARRANGEMENT² OUTLET END FRONT OR REAR |
|---|---|---|---|---|---|---|
| E | 2 | M | LH | F | LH | F |
| F | 2 | M | LH | R | LH | R |
| G | 2 | M | RH | F | RH | F |
| H | 2 | M | RH | R | RH | R |
| J | 2 | M | LH | F | LH | R |
| K | 2 | M | LH | R | LH | F |
| L | 2 | M | RH | F | RH | R |
| M | 2 | M | RH | R | RH | F |
| Z | 2 | NM | RH | E | RH | E |
| 1 | 2 | NM | LH | E | LH | E |
| 0 | No Auxiliary Condenser | | | | | |

*Type M = Marine Type NM = Non-Marine Type
²Connection arrangement determined when facing control panel side of unit

### Digit 35
### Auxiliary Cond. Working Pressure (Water Side)

0 = None
A = Flanged; 150 psig
B = Flanged; 300 psig
C = Victaulic; 150 psig
D = Victaulic; 300 psig
S = Special

### Digit 36
### Orifice*

1 = 4 Sizes Under
2 = 3 Sizes Under
3 = 2 Sizes Under
4 = 1 Size Under
5 = Nom. Size Orifice
6 = 1 Size Over
7 = 2 Sizes Over
S = Special
*CVHE computer selection program includes proper orifice designator.

### Digit 37
### Insulation & Shipping

| DESIGNATOR | INSULATION | PACKAGING STD | PACKAGING STD EXPORT | PACKAGING FULL SHEATH EXPORT | ISOLATION NEOPRENE | ISOLATION SPRING |
|---|---|---|---|---|---|---|
| 1 | X | X | | | X | |
| 2 | | X | | | X | |
| 3 | X | | X | | X | |
| 4 | | | X | | X | |
| 5 | X | | | X | X | |
| 6 | | | | X | X | |
| A | X | X | | | | X |
| B | | X | | | | X |
| C | X | | X | | | X |
| D | | | X | | | X |
| E | X | | | X | | X |
| F | | | | X | | X |
| S | SPECIAL | | | | | |

### Digit 38
### Control Panel

| DESIGNATOR | OPTION* ELECTRIC CONTROL | PNEUMATIC CONTROL | NUMBER OF STARTS COUNTER | ELAPSED TIME METER | UL APPROVAL | CSA APPROVAL |
|---|---|---|---|---|---|---|
| A | X | | | | X | |
| B | X | | | | | X |
| C | X | | | | | |
| D | | X | | | X | |
| E | | X | | | | X |
| F | | X | | | | |
| G | X | | X | X | X | |
| H | X | | X | X | | X |
| J | X | | X | X | | |
| K | | X | X | X | X | |
| L | | X | X | X | | X |
| M | | X | X | X | | |

*"X" indicates the option(s) provided

### Digit 39
### Starter

0 = w/o Starter
1 = w/Unit-Mounted Starter
S = Special

### Digit 40
### Starter Options

| DESIGNATOR | STARTER OPTIONS* AMMETER | VOLTMETER | CKT. BRKR. | HI INTERRUPT CAPACITY CKT. BREAKER | GROUND FAULT PROTECTION |
|---|---|---|---|---|---|
| A | | | | | |
| B | X | | | | |
| C | | X | | | |
| D | X | X | | | |
| E | | | X | | |
| F | X | | X | | |
| G | | X | X | | |
| H | X | X | X | | |
| J | | | | X | |
| K | X | | | X | |
| L | | X | | X | |
| M | X | X | | X | |
| N | | | X | | X |
| P | X | | X | | X |
| R | | X | X | | X |
| T | X | X | X | | X |
| U | | | | X | X |
| V | X | | | X | X |
| W | | X | | X | X |
| Y | X | X | | X | X |
| 0 | NO UNIT-MOUNTED STARTER | | | | |

*"X" indicates the starter option(s) included.

# General Information

## Literature Change History

### CVHE-M-4 (February 1986)
Original issue of manual; provides operation, maintenance, and diagnostic information for CVHE units of "F" through "H" design. Also includes information on automatic condenser cleaning system.

### CVHE-M-4A (September 1986)
Corrections made to front cover; manual also covers "J" design; changes made to purge maintenance instructions.

## Introduction

This manual describes the operation and maintenance of Model CVHE Cooling-Only and Heat-Recovery CenTraVac liquid chillers. Its use will enable the owner/operator to understand the chiller systems, and to successfully operate and maintain the machine. Trouble analysis information is provided at the end of this manual to allow the operator to analyze and resolve a number of system malfunctions, if any should occur. (If mechanical problems do occur, however, Trane recommends that trained service personnel be contacted to ensure proper diagnosis and repair of the unit.)

### Warnings and Cautions

Notice that warnings and cautions appear at appropriate intervals throughout this manual. Warnings are provided to alert operating and service personnel to potential hazards that could result in personal injury or death; they do not replace the manufacturer's recommendations. Cautions are designed to alert personnel to conditions that could result in equipment damage.

Your personal safety and the proper operation of this machine depend upon the strict observance of these precautions.

# Mechanical Operation

## General

Each CVHE unit is comprised of five basic components: the evaporator, three-stage compressor, water-cooled condenser, two-stage economizer, and related interconnecting piping. A heat-recovery or auxiliary condenser can be factory-added to the basic unit assembly to provide a heat-recovery cycle. Refer to Figure 1 for an illustration of a typical unit.

Following are discussions of the unit's cooling-only and heat-recovery modes of operation. A pressure/enthalpy diagram (shown in Figure 2) is provided to further illustrate unit operation.

**Figure 1**
**Typical CVHE Chiller**
**(General Unit Assembly Shown)**

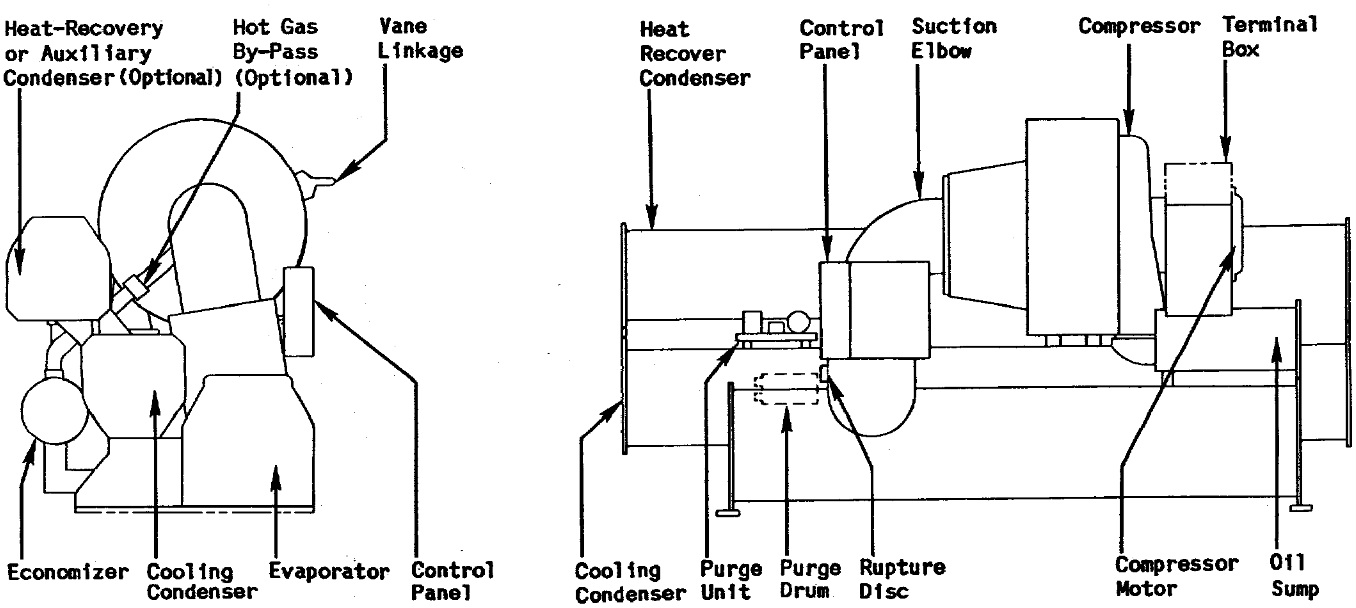
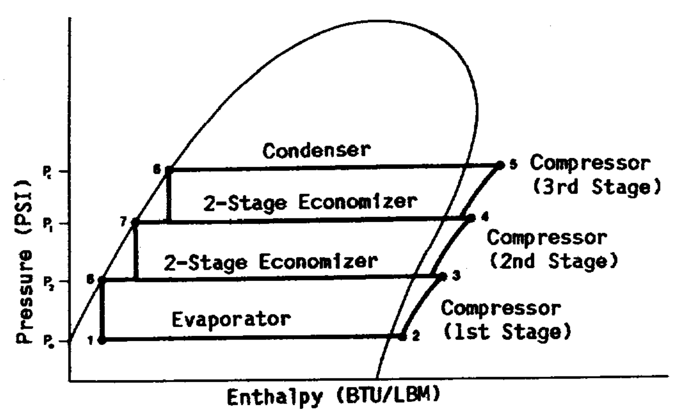



**Figure 2**
**CVHE Pressure/ Enthalpy Curve**



## Cooling-Only Cycle

When the CVHE is functioning in the cooling mode, liquid refrigerant is distributed along the length of the evaporator and sprayed through small holes in a distributor (which runs the entire length of the shell) to uniformly coat each evaporator tube. Here, the liquid refrigerant absorbs enough heat from the system water circulating through the evaporator tubes to vaporize. The gaseous refrigerant is then drawn through the eliminators (which remove droplets of liquid refrigerant from the gas) and first-stage variable inlet guide vanes, and into the first-stage impeller. (The inlet guide vanes are designed to modulate the flow of gaseous refrigerant to meet system capacity requirements; they also prerotate the gas, allowing it to enter the impeller at an optimal angle that maximizes efficiency at all load conditions.)

Compressed gas from the first-stage impeller flows through the fixed, second-stage inlet vanes and into the second-stage impeller. Here, the refrigerant gas is again compressed, and then discharged through the third-stage variable guide vanes and into the third-stage impeller. Once the gas is compressed a third time, it is discharged into the condenser.

Baffles within the condenser shell distribute the compressed refrigerant gas evenly across the condenser tube bundle. Cooling tower water--circulated through the condenser tubes--absorbs heat from the refrigerant, causing it to condense. The liquid refrigerant then passes through an orifice plate and into the two-stage economizer.

The economizer reduces the energy requirements of the refrigeration cycle by eliminating the need to pass all of the gaseous refrigerant through the three stages of compression. See Figure 3. Notice that some of the liquid refrigerant will "flash" to a gas because of the pressure drop created by the orifice plates, thus further cooling the liquid refrigerant. This flash gas is then drawn directly from the first (Chamber A) and second (Chamber B) stages of the economizer into the third- and second-stage impellers of the compressor, respectively. The remaining liquid refrigerant flows through another orifice plate (labelled "C" in Figure 3) to the evaporator.

**Note:** Some CVHE units are equipped with single-stage economizers. This type of economizer serves the same function as the two-stage economizer, but the flash gas is discharged only to the third stage of the compressor.

## Heat-Recovery Cycle

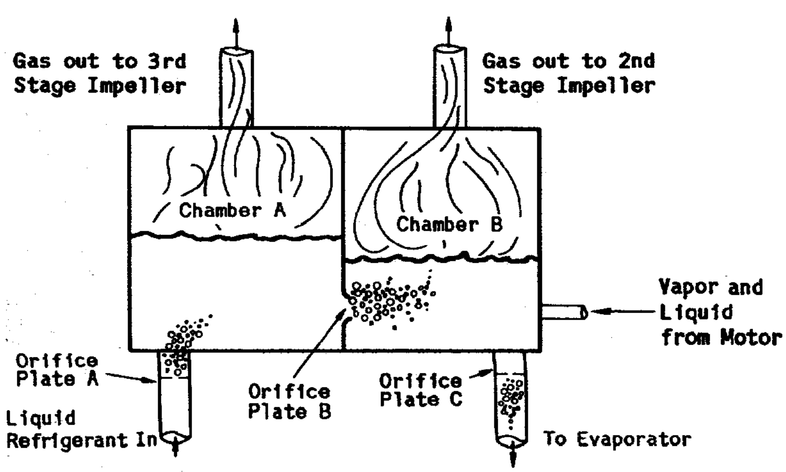
The purpose of the heat-recovery cycle is to salvage the heat that is normally rejected to the atmosphere through the cooling tower, and put it to beneficial use. For example, a high-rise office building may experience simultaneous heating and cooling requirements during the winter months. With the addition of a heat-recovery cycle, the heat removed from the building cooling load can be transferred to that area of the building which requires heat. (Remember that a cooling load must exist to act as a heat source if the heat-recovery cycle is to be used.)

To provide a heat-recovery cycle, a heat-recovery condenser is added to the unit; see Figure 1. Though physically identical to the standard condenser, the heat-recovery condenser is piped into a heating circuit rather than to the cooling tower.

During the heat-recovery cycle, the unit operates just as it does in the cooling-only mode except that the cooling load heat is rejected to the heating water circuit rather than to the cooling tower water circuit. When hot water is required, the heating water circuit pumps energize. The water circulated through the heat-recovery (or auxiliary) condenser tube bundle by the pumps absorbs the cooling load heat from the compressed refrigerant gas discharged by the compressor. The heated water is then used to satisfy building comfort heating requirements.

**Note:** Unlike the heat-recovery condenser (which is designed to satisfy comfort heating requirements), the auxiliary condenser serves a preheat function only, and is used in those applications where hot water is needed for use in kitchens, lavatories, etc. While the operation of the auxiliary condenser is physically identical to that of the heat-recovery condenser, it is comparatively smaller in size, and its heating capacity is not controlled. (Because of its small size, The Trane Company does not recommend operating the auxiliary condenser alone.)

**Figure 3**
**Two-Stage Economizer**



## Compressor Lubrication System

A schematic diagram of the compressor lubrication system is illustrated in Figure 4; this system supplies oil to the compressor motor bearings.

Oil is pumped from the oil tank (by a pump and motor located within the tank) through an oil pressure-regulating valve designed to maintain a net oil pressure of 18 to 20 psig. It is then filtered and sent to the compressor motor bearings. From here, the oil drains back to the oil tank through return lines. Notice that each oil return line is equipped with a sight glass. This enables the operator to check for oil flow when the oil pump is energized.

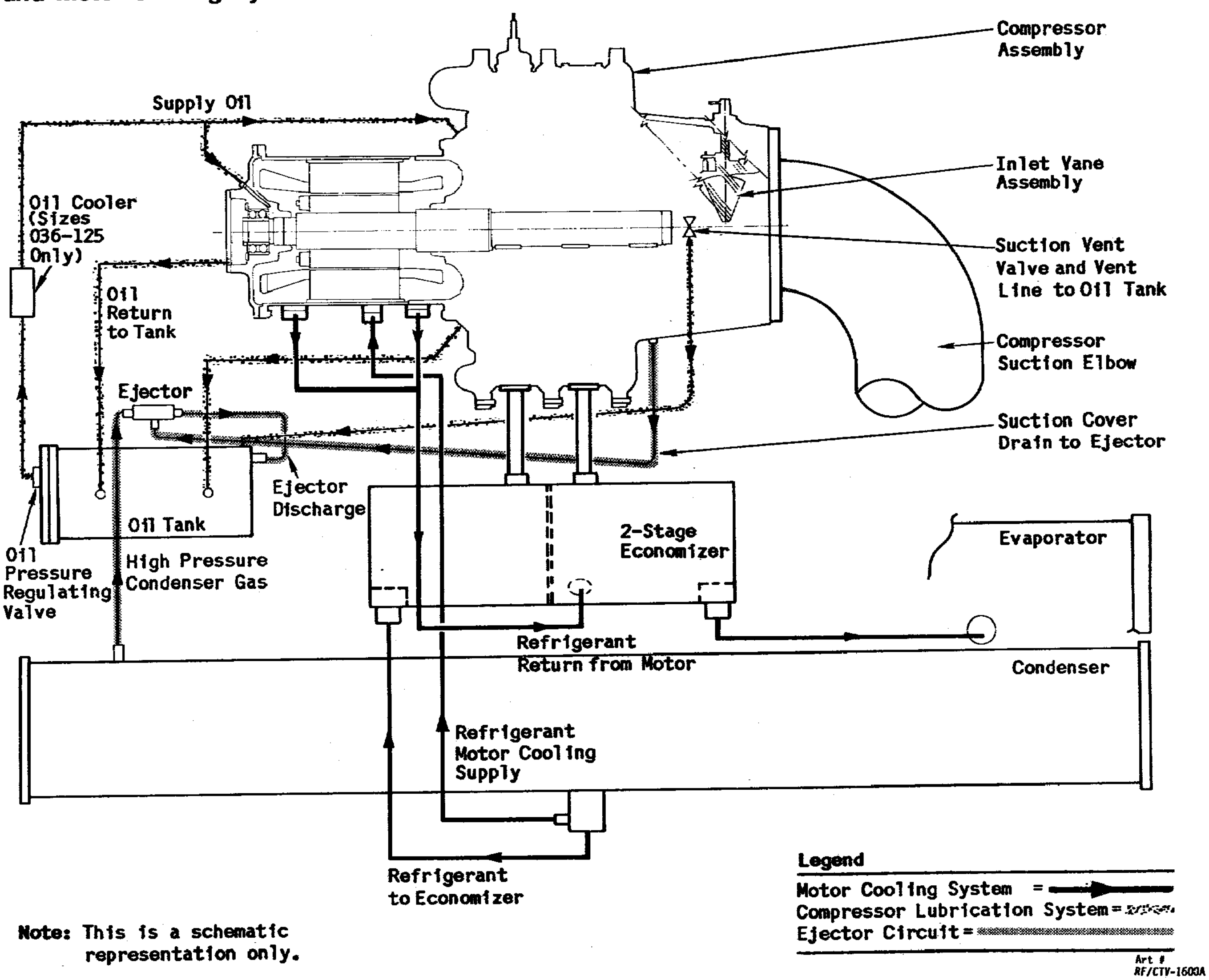
To ensure proper lubrication and prevent refrigerant from condensing in the oil tank, a 1000-watt heater is secured to the oil tank exterior. Operating in response to the oil temperature control (S10), this heater energizes as necessary to maintain an oil tank temperature of 140 to 145 F when the chiller is not operating. When the chiller is operating, the temperature of the oil tank is typically 115 to 150 F.

Notice that the oil tank is vented between the compressor inlet vanes and the first-stage impeller suction cover; refer to Figure 4. During normal system operation, motor barrel pressure is greater than that of the oil tank. Therefore, any gaseous refrigerant that enters the motor bearing cavities is drawn toward the oil tank where it is removed by the vent line.

Any oil that collects in the suction cover area is pulled back to the oil tank by an ejector pump. This pump uses high-pressure condenser gas to draw the oil from the suction cover area back to the ejector; from the ejector, the oil is discharged into the oil tank.

**Caution: The oil tank vent must remain completely open on those units equipped with ejectors; closure of the vent line may hamper the return of oil to the oil tank and result in damage to the chiller.**

**Figure 4**
**Compressor Lubrication and Motor-Cooling Systems**



## Oil Cooler (CVHE 036 thru 125 Only)

Oil coolers are installed as a standard feature on CVHE 036 through 125 chillers. See Figure 5 for an illustration of the oil cooler assembly.

Oil--at approximately 140 to 145 F and 18 to 20 psig--is pumped from the oil tank, through the oil pressure-regulating valve, and into the oil cooler. The oil cooler is designed to maintain a leaving oil temperature of 115 to 130 F; temperature control is accomplished with a water-regulating valve that responds to a sensor in the bearing oil supply line. When the sensor detects an increase in oil temperature, the valve opens to allow more cooling water through the oil cooler. Conversely, the valve will limit water flow through the cooler when the sensor detects a drop in oil temperature.

The water-regulating valve is field-adjustable; simply tighten the adjusting screw to decrease water flow, and loosen it to increase water flow.

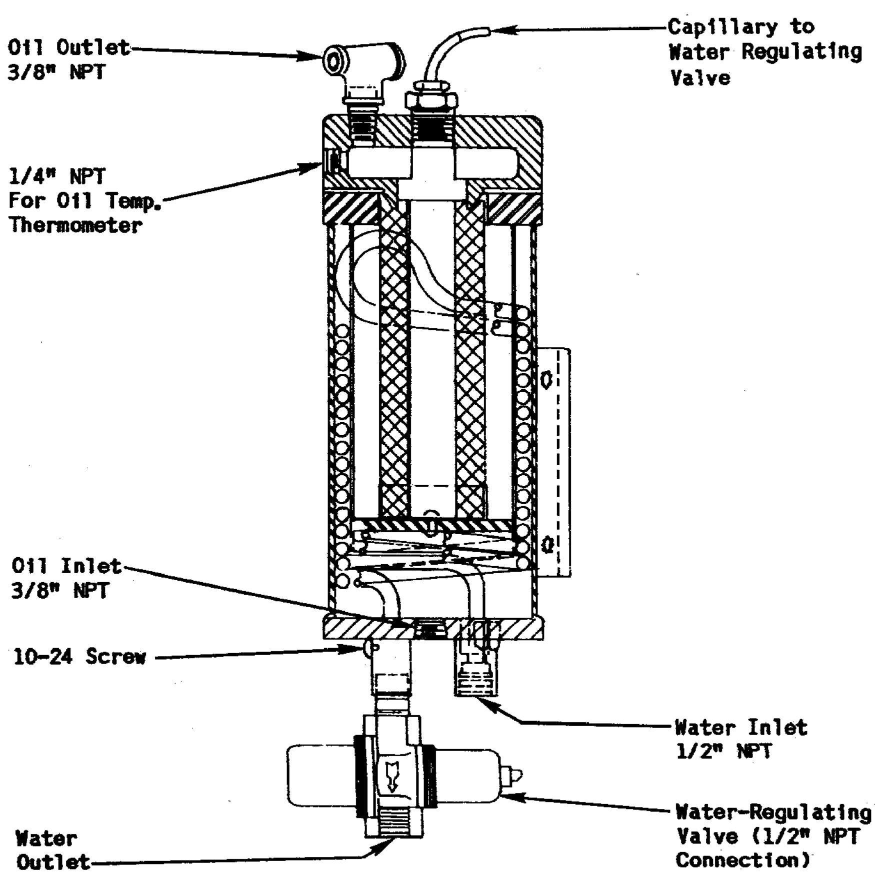
Notice that a drain hole is provided in the leaving water nipple of the oil cooler; see Figure 5. When open, this drain relieves all of the water in the circuit between the cooling coil and the normally-closed water-regulating valve. Drain the water from the oil cooler as necessary (i.e., by removing the small screw tapped into the outlet pipe) to perform maintenance procedures, and to prevent cooler freeze-up during winter shutdown.

## Motor Cooling System

The CVHE compressor motor is cooled with liquid refrigerant; a schematic illustration of this pressurized system is provided in Figure 4.

Liquid refrigerant flows from the condenser sump to the bottom of the compressor motor where it enters the motor chamber through a control orifice. As the liquid refrigerant touches the warmer motor components, a portion of it flashes to a gas and cools the motor. The flash gas and excess liquid refrigerant then drain to the second-stage of the economizer. Because of the positive pressure differential between the condenser and the economizer, proper refrigerant flow through the motor is maintained at all load conditions.

**Figure 5**
**Oil Cooler Assembly**
**(Chiller Sizes 036 thru 125 Only)**



## Purge System

The purge system removes noncondensible gases and water from the refrigeration system. Refer to purge system schematic shown in Figure 6. Notice that this system uses an oilless purge compressor specifically designed for CenTraVac application, thus eliminating the need for an oil separator tank. In addition, a check valve and solenoid valve (as well as an isolation valve at the condenser) are used to isolate the purge compressor from the rest of the system when it is off; this prevents refrigerant leakage.

**Caution: Before performing a standing vacuum test, be sure to close the manually-operated isolation valve at the condenser; this prevents air from entering the system.**

A mixture of refrigerant vapor, noncondensible gases and water is drawn from the condenser and compressed by the purge compressor. The compressed gas is then discharged directly into the purge drum; here, the condensible portion of the mixture condenses on the surfaces of the chilled water coil, while the noncondensibles rise to the top of the drum. (Refer to Figure 7 for an illustration of the CVHE's auxiliary chilled water piping.) When the pressure within the purge drum exceeds the setting of the purge drum relief valve (see Figure 6), the valve opens and exhausts the noncondensibles to the atmosphere. Any accumulated water floating on the surface of the refrigerant can be removed by opening the manual blow-off valve found on the water connection end of the purge drum.

**Note:** Check the purge drum for water accumulation on a weekly basis, and notice the amount of water removed. Any visible accumulation of water indicates that there is an air or water leak in the unit; if this condition occurs, be sure to contact a qualified service organization to correct this problem as soon as possible.

The remaining liquid refrigerant passes through a float valve within the purge drum and re-enters the refrigerant system through a valve at the evaporator.

The oilless ITT purge unit is controlled by the purge switch on the control panel as follows:

**OFF** - Purge will not operate.

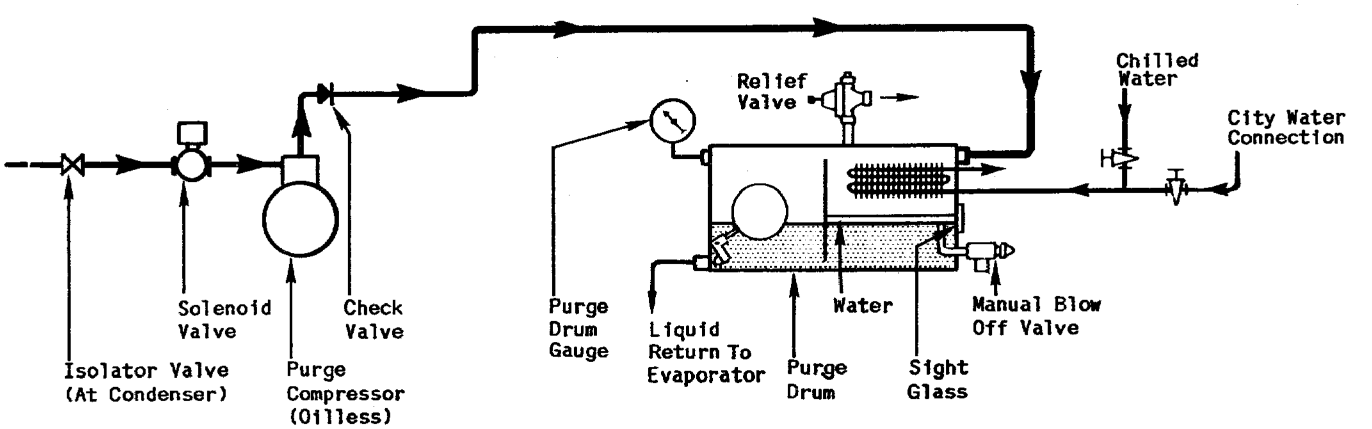
**MANUAL** - Purge will run continuously. This position is for service use only. The purge should not be left in this position during normal operation.

**Note:** When the unit is operating in the heating mode, close the manual shutoff valves on the cooling condenser. Reverse this procedure when the unit is operating in the heat-recovery mode. Purge only from the active condenser.

**AUTO** - In this position, the purge timer will run the compressor for five minutes out of every hour of machine operation. This is the normal switch position for machine purging.

Recommended operation of the new purge unit is in the "auto" mode or manually once per week for one hour.

**Figure 6**
**Purge System Schematic**

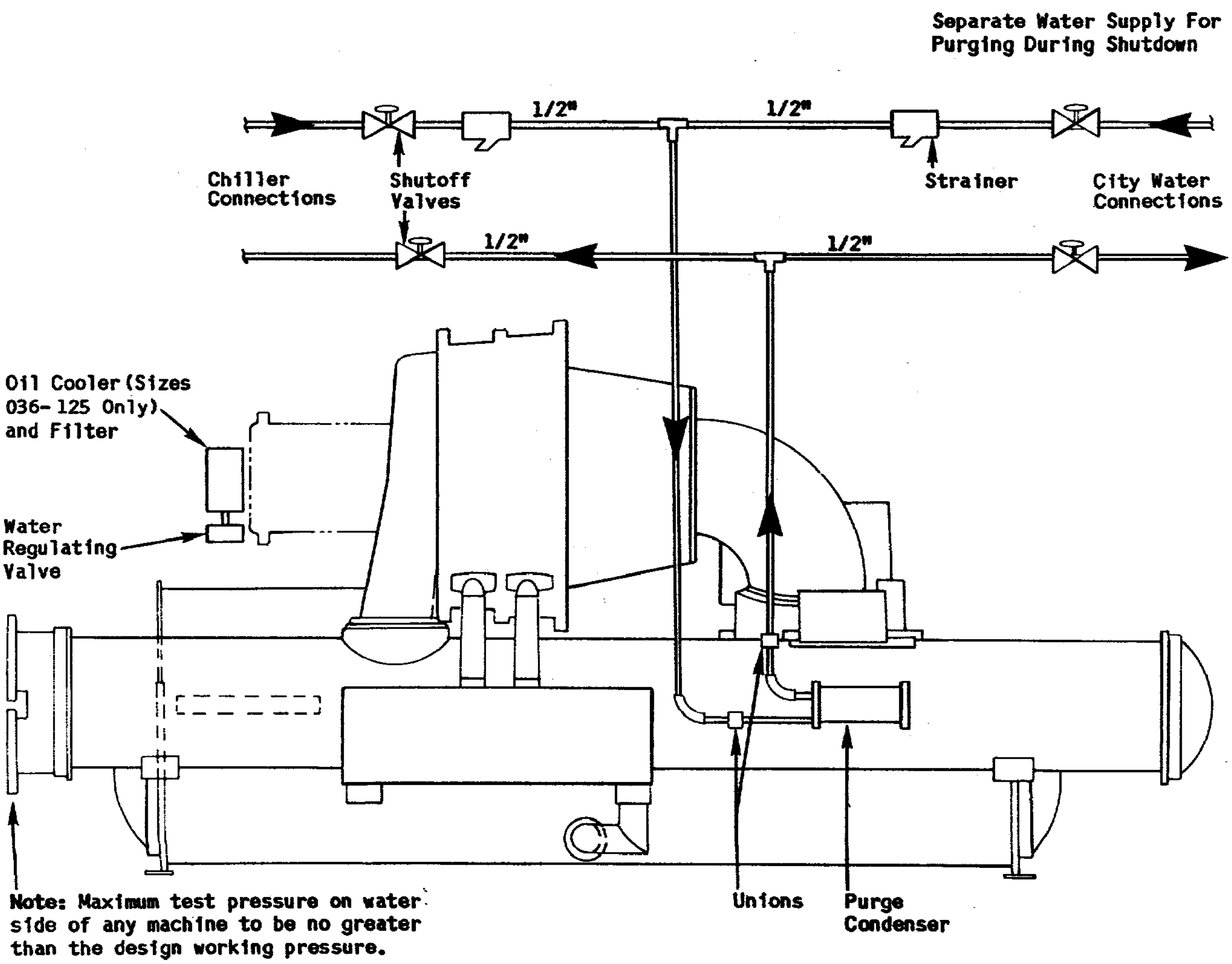


When the purge unit is operated in the "auto" mode, the purge compressor starts and stops under control of the timer. The timer should be set to operate for five minutes every hour. The timer can be adjusted to run the purge for less than five minutes per hour, if desired, to slow wear on the purge compressor rings.

**Note:** If five minutes per hour is not sufficient to keep the unit purged of air, the "on" time can be increased by adjusting the timer. However, operation in excess of five minutes per hour indicates an unacceptable leak rate that must be repaired to avoid machine damage and excessive wear on the purge compressor rings.

**Note:** Rotation of the time adjustment knob on the purge timer will not cycle the purge on and off. If the compressor is on, turning the knob will cycle the purge off. Further revolutions of the knob will not turn the compressor back on.

**Figure 7**
**CVHE Auxiliary Chilled Water Piping Connections**



## Automatic Condenser Cleaning System

The factory-installed automatic condenser cleaning system option is designed to maintain a "clean tube" fouling factor in the condenser. See Figure 8 for system components and assembly.

While the chiller is on-line, the 4-way flow diverter will activate upon a preset signal (normally every 4 to 6 hours) from the integral controller and reverse the water flow forcing the brushes through the tubes. Several seconds later, the diverter deactivates and water flow returns to normal flow causing the brushes to return to their original position.

At each tube end is a factory-installed basket and removeable end clip which retains the nylon-bristle brush.

A factory-installed and wired control panel (mounted on top of the flow diverter housing) controls all functions of the automatic condenser cleaning system. The control functions are described below.

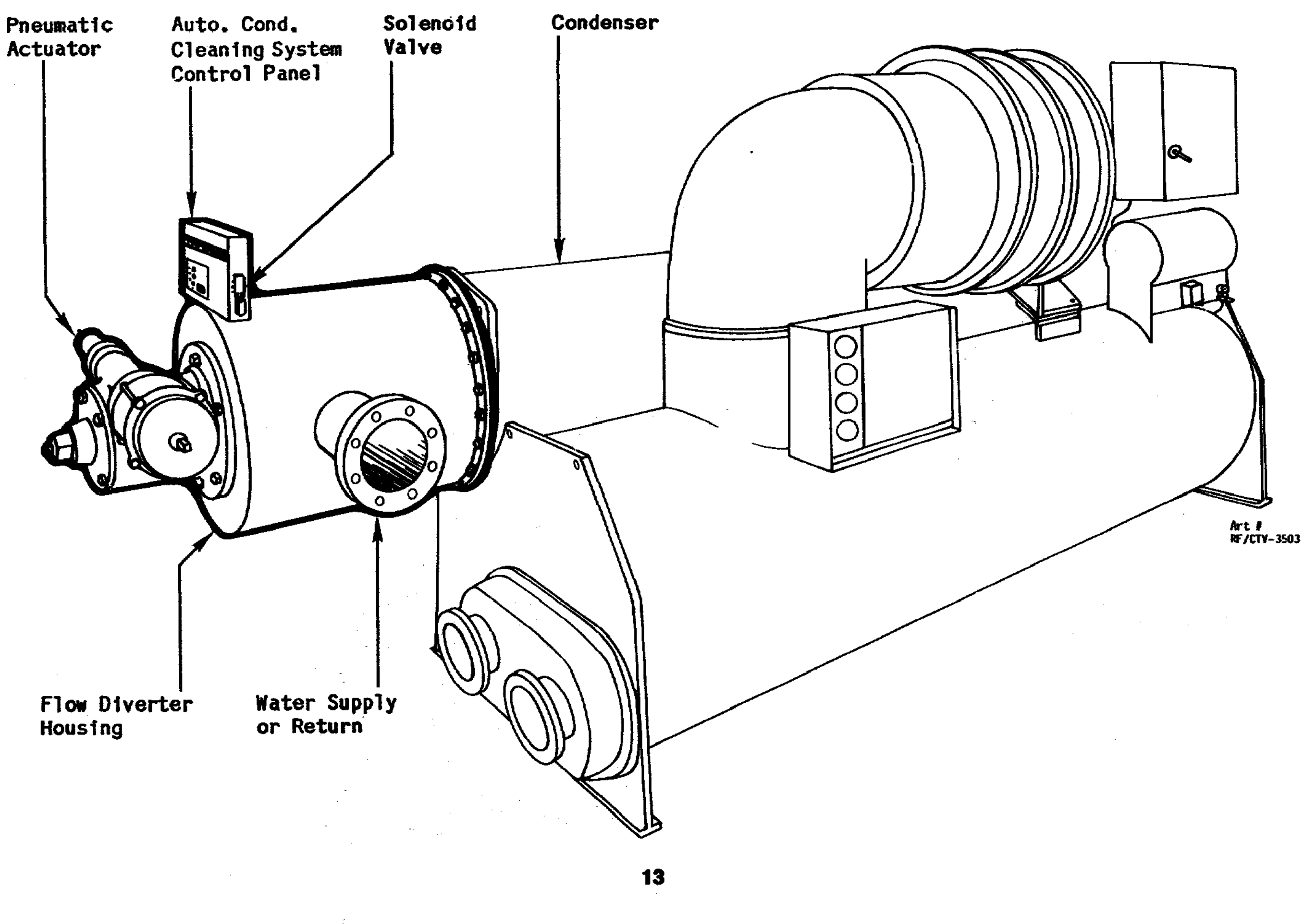
## Cycle Frequency

Cycle frequency is set at the 24-hour time clock at pre-determined time intervals. Appropriate pins should be pushed in to the desired actual time of the cleaning cycle operation. Recommened cycle intervals are every 6 hours of unit operation. With "IE" (internally enhanced) tubes, this time should be shortened to 4 hours. Cycle frequency should be increased if the water treatment program is inadequate or excessive fouling conditions exist.

**Caution: To ensure proper brush release and movement, treat cooling tower water as required and install strainers or screening (3/16" openings maximum) in the condenser water supply.**

In the event that a scheduled cycle would fall within a peak operating period, this cycle may be pushed ahead or back by 2 hours, provided all other scheduled times remain unchanged.

**Figure 8**
**Automatic Condenser Cleaning System Option**



## Timer Clock Programming

After determining desired frequency times, program the clock by depressing the tripper pins (found around the outer edge of the timer clock) corresponding with desired times (see Figure 9).

**Note:** Schedule cleaning cycle times only during the time of day the unit is in operation. During unit shutdown there is no water flow to move the brushes.

**Caution: If any extended shutdown occurs, make sure the flow diverter cycles at least once each day. This will prevent binding of the diverter and possible diverter damage.**

## Diverter Cycle Time

The cycle time period consists of the time the diverter transfers from the "normal" to "reverse" position, plus the time the diverter remains in the "reverse" position, plus the transfer time back to "normal" position. For normal cycle times, the diverter should remain in the "reverse" position for approximately 25 seconds.

**Note:** The 1TR timer in the control panel (see Figure 9) should be factory-set at 30 seconds. This is the time the solenoid valve remains energized. Insure that 1TR is set at 30 seconds.

Diverter transfer times are factory-set at the exhaust restrictor set-screws located on the 4-way solenoid valve (see Figure 10). By turning each set-screw counter-clockwise, the transfer time will decrease (speeding movement) or vice-versa. Use the test cycle push-button located on the control panel to cycle the diverter until the proper transfer time is established. The pointer on the end of the pneumatic actuator (see Figure 11) will allow you to monitor diverter movement. The "N" is the normal diverter position, while "R" is the reverse flow position.

As a guideline, the transfer time in each direction should be approximately 5-6 seconds, or fast enough to minimize condenser water stagnation, but slow enough to prevent water hammer or slamming action of the diverter under full flow conditions.

## Incomplete Sequence Alarm

If at any time the diverter should take longer to transfer than the alarm time time is set, the "Incomplete Sequence" alarm light will illuminate on the control panel indicating a diverter movement problem. The alarm time is set at the 2TR timer located inside the control panel (see Figure 9). The timer should be set at 3 seconds greater than the "set" transfer time. For example, if transfer time is 6 seconds, set the 2TR timer at 9 seconds. If the diverter takes longer than 9 seconds to transfer, the 2TR timer will time out, illuminating the "Incomplete Sequence Alarm" light.

**Figure 9**
**Automatic Condenser Cleaning System Control Panel**

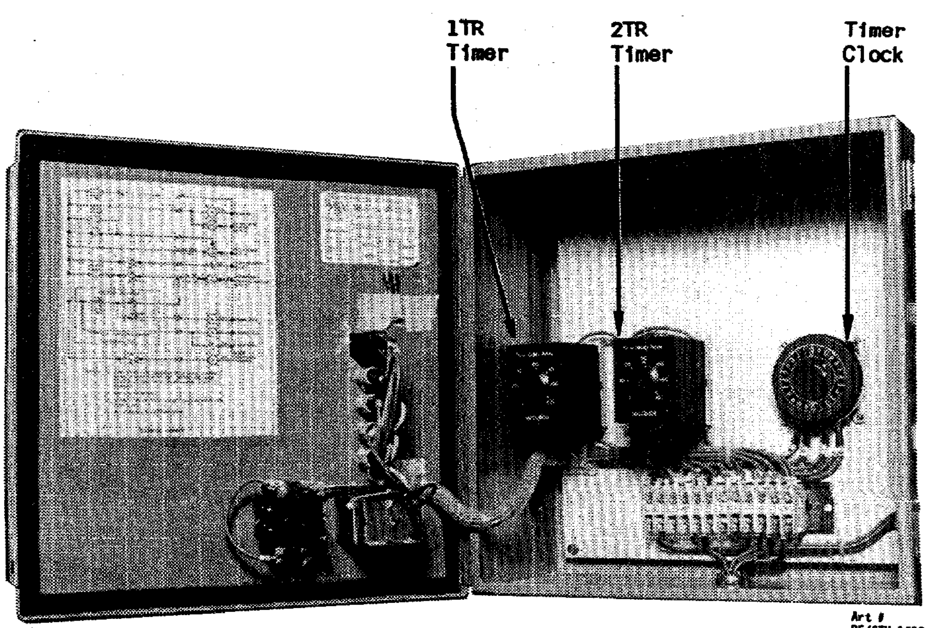


Figure 10
Automatic Condenser
Cleaning System Solenoid
Valve

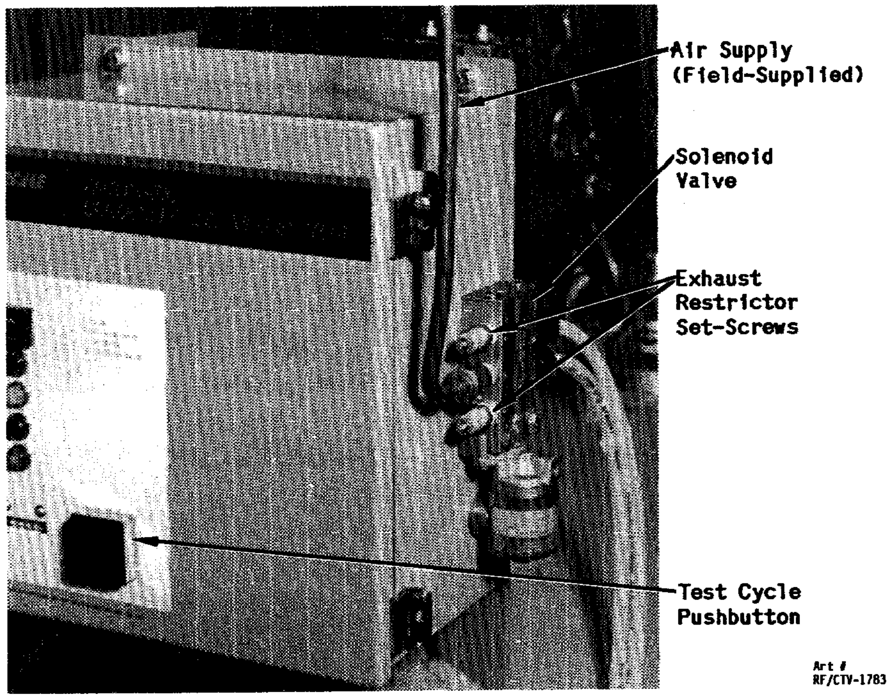
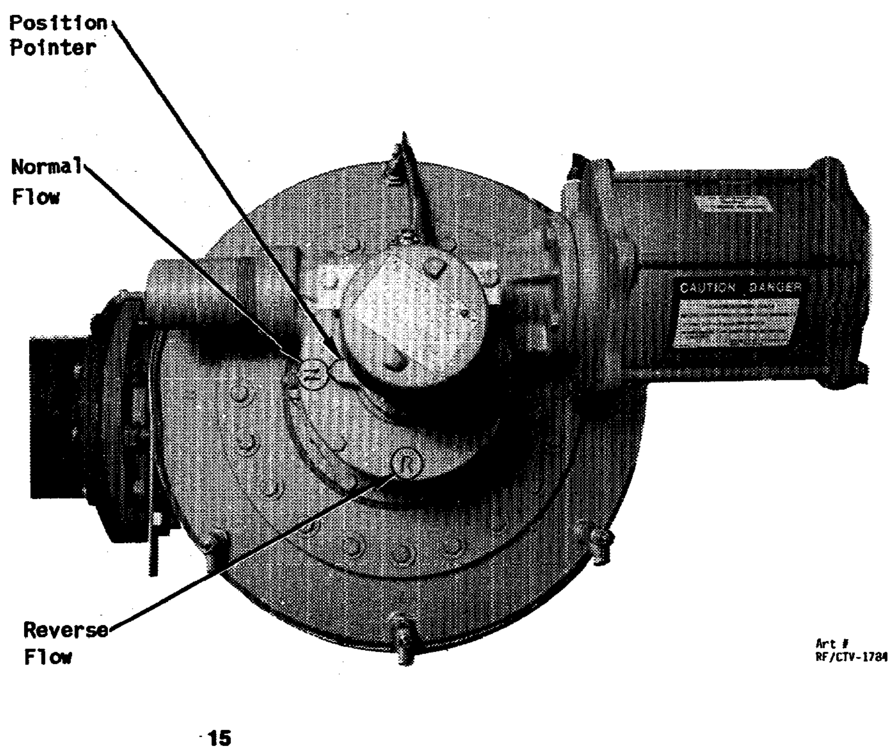



Figure 11
Pneumatic Actuator
(End View)



# System Control

## Control Panel

Safety and operating controls are housed in the CenTraVac unit control panel. Panel functions are divided into four categories, as indicated by the physical layout of the panel; see Figure 12.

1. Pressure gauges--located on the left-hand side of the panel--indicate condenser, evaporator, lubricating oil, and purge drum pressures.

2. Seven system sequence status lights (located to the immediate right of the pressure gauges) perform an important diagnostic function by monitoring the progress of the chiller start-up sequence. As each of the seven control circuit interlocks is verified, its control panel pilot light illuminates. If, for some reason, the start-up sequence is aborted, the operator can determine the point of the breach by checking these pilot lights.

3. Five safety indicators are provided in the center of the control panel, directly below the unit AUTO/OFF and purge MAN/OFF/AUTO switches; see Figure 12. These circuit interrupters are used to open the control circuit since they will hold their position in the event of a power interruption. This means that a power failure does NOT require manual resetting of all safeties.

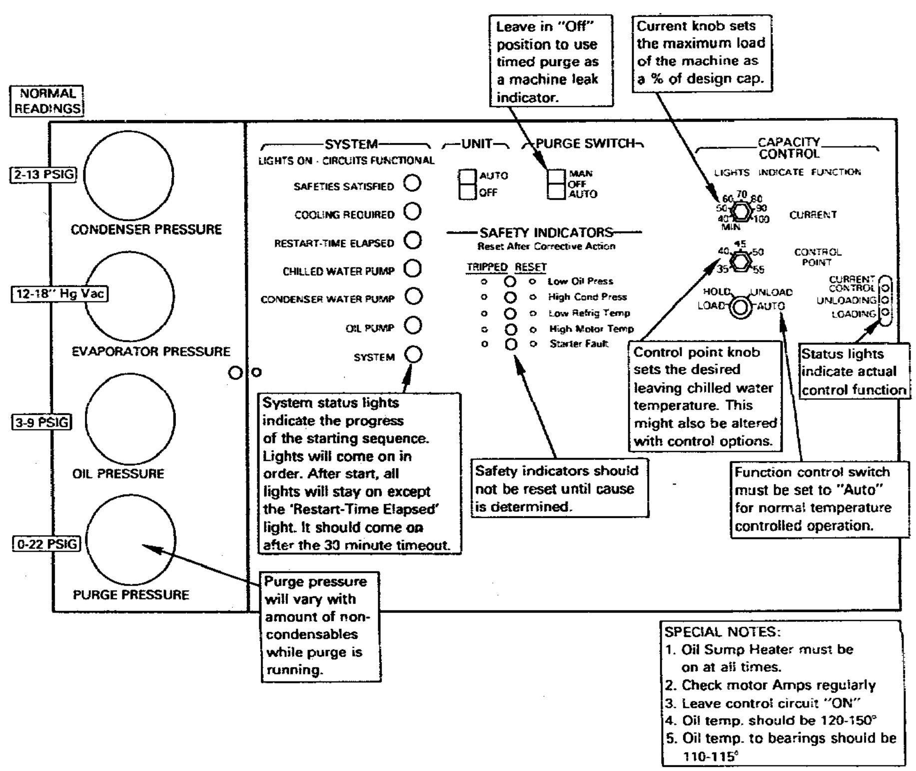
**Note:** Additional alarm contacts on each of the safety indicators are brought to a terminal strip for external field-installed connection.

4. The electronic capacity control system, located on the right-hand side of the control panel, operates an electric vane motor to load and unload the chiller. This system consists of three elements: a current limiter, a chilled water temperature control, and the function control switch (and indicator lights).

The current limit control (labelled % CURRENT) can be set to control at any value below 100 percent of the motor rated load current. Motor current is sensed by three current transformers, and processed into a proportional DC voltage signal by the CenTraVac motor overload (A1). This same DC voltage signal is monitored by the current limiter. When the set percentage of rated load current is reached, the current limiter prohibits the inlet vanes from opening further; if the setting is exceeded, the inlet vanes are modulated toward the closed position.

The chilled water temperature control module uses a solid-state temperature sensor to monitor leaving chilled water temperature. If this temperature varies

**Figure 12**
**CVHE Unit Control Panel**



from setpoint (which is set using the knob labelled CONTROL POINT, and is based on design conditions), an electronic controller sends a pulsing signal to the inlet vane actuator; this tells the actuator to adjust the guide vanes to compensate for the variance from setpoint. (The standard control point is adjustable between 35 and 55 F.)

The function control switch, labelled with LOAD/HOLD/UNLOAD/AUTO positions, governs the function of the capacity control module. It must be set at AUTO to provide normal unit operation, and is only readjusted to one of the other switch positions for service work. To the right of the function control switch are three pilot lights which indicate whether the chiller is loading, unloading, or limiting the chiller capacity based on current draw. If all three of these pilot lights are out, the three conditions they represent are presently satisfied and the unit is functioning normally (i.e., holding with no inlet vane movement).

**Note:** The unit safety controls can override the setting of the function control switch regardless of its position; this override capability ensures that the chiller is protected from most dangerous operating conditions; however, no safety device protects against surge!

In addition to the gauges, status lights, safety indicators, and electronic capacity control system, the unit AUTO/OFF and purge MAN/OFF/AUTO switches are also located on the unit control panel. The unit AUTO/OFF switch allows the chiller to be shut down manually; when positioned at AUTO, the chiller will operate in response to the unit controls and safeties. (Remember that the unit will not start automatically unless all of the start-up safety conditions have been satisfied and cooling is required.) This switch is usually left in the AUTO position when cooling is needed.

**Caution: Do NOT operate the purge compressor in the manual mode unless there is water flow through the purge drum! If the purge switch is positioned at MAN without water flow through the drum, refrigerant will be purged from the machine, resulting in excessive refrigerant loss.**

## Electrical Sequence of Operation

Be sure to refer to the typical wiring schematic provided in Figure 13 when reviewing the step-by-step electrical sequences of operation provided below

**Caution: The wiring diagram provided in Figure 13 is only typical and is provided ONLY for general reference; it may not reflect the actual wiring of your unit. For specific electrical connection and schematic information, refer to the wiring diagrams which shipped with the chiller.**

### Electronic Capacity Control System

The electronic capacity control system used to govern chiller operation consists of six control devices; their functions are reviewed below:

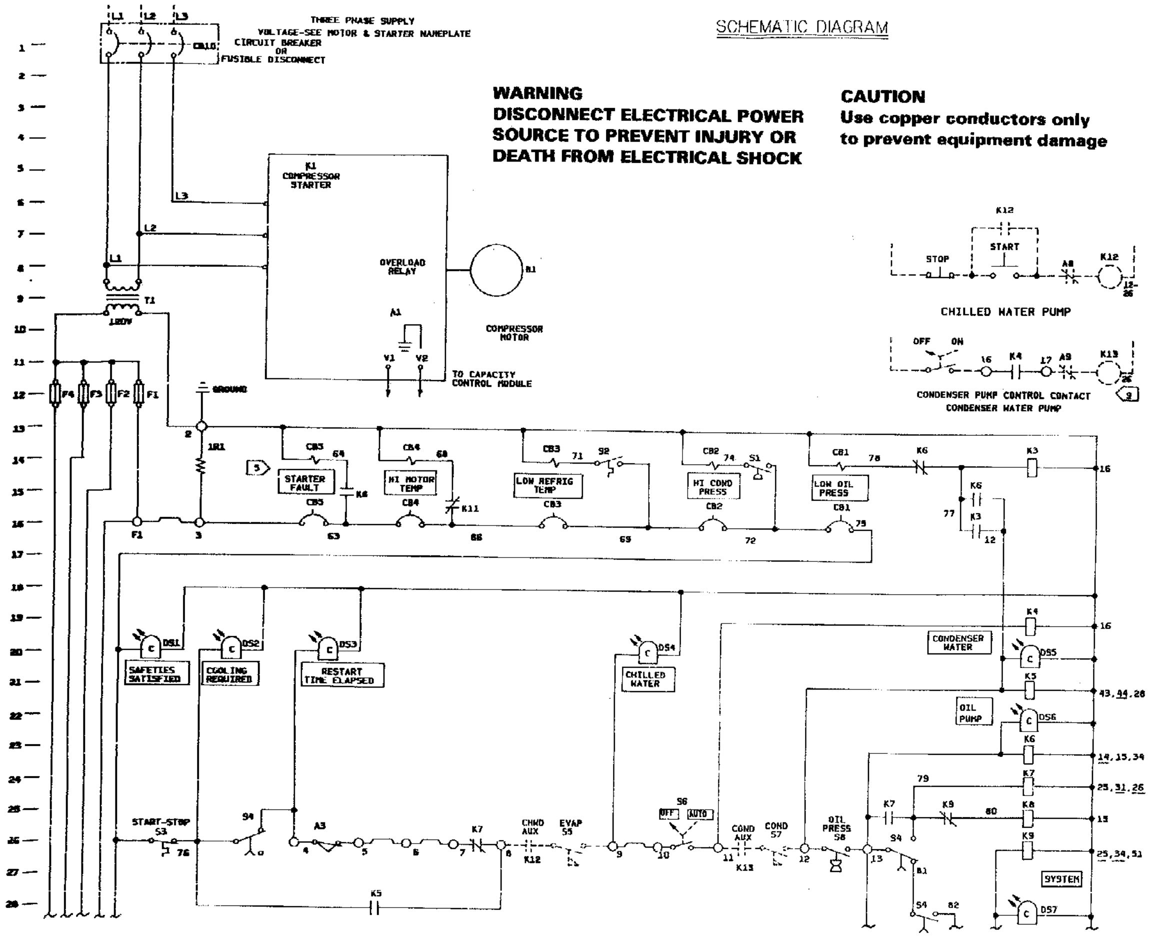
Electronic Starter Overload Relay (A1) - This device monitors the compressor motor starting current, and initiates transition to full voltage when the current draw falls to 85 percent of motor RLA. Once transition is complete, it compares the motor current against a calibrated value of 107 percent of RLA; if the current reaches this value, the overload will trip to disconnect the motor.

Compressor Inlet Vane Actuator (A3) - The actuator end switch (see Line 26, Figure 13) is closed when the compressor inlet vanes are at the full closed position. A3's limit switch (see Line 38) is open whenever the inlet vanes are fully open, while a second A3 limit switch (Line 40) is open when the vanes are fully closed.

Anti-Recycle Timer (S4) - This timer (found on Line 34) limits the compressor to one start every 30 minutes, and also provides the "start" signal to the compressor motor starter (K1).

Oil Pump Timer (S9) - With a total timing cycle of four minutes, this control device allows the oil pump to provide a pre-lube cycle of approximately one minute and twenty seconds; at the end of the pre-lube interval, the anti-recycle timer (S4) energizes and the oil pump timer stops timing until the unit shuts down. At that point, S9's timing cycle resumes and will continue until the four-minute cycle is complete, thereby providing a compressor post-lube period of approximately three and one-half minutes.

**Figure 13**
**Electrical Schematic for CVHE Units w/Electronic Capacity Control**

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## Legend

- A1 Electronic Starter Overload
- A3 Compressor Vane Actuator
- A8 Chilled Water Pump Overload (Field-Supplied)
- A9 Condenser Water Pump Overload (Field-Supplied)
- A12 Free-Cooling Liquid Line Valve Actuator (Optional)
- A13 Free-Cooling Gas Line Valve Actuator (Optional)
- A14 Hot Gas Bypass Valve Actuator (Optional)
- B1 Compressor Motor
- B2 Oil Pump Motor
- B3 Purge Compressor Motor
- B1R1 Motor Temp. Sensor
- B1R2 Motor Temp. Sensor
- B1R3 Motor Temp. Sensor
- C1 Oil Pump Start Capacitor
- CB1 Low Oil Pressure Fault
- CB2 Hi Condenser Pressure Fault Indicator
- CB3 Low Refrig. Temp. Fault Indicator
- CB4 Hi Motor Temp. Fault Indicator
- CB5 Starter Fault Indicator
- CB10 Starter Main Ckt. Breaker
- DS1 SAFETIES SATISFIED Indicator Light
- DS2 COOLING REQUIRED Indicator Light
- DS3 RESTART TIME ELAPSED Indicator Light
- DS4 CHILLED WATER Flow Indicator Light
- DS5 CONDENSER WATER Flow Indicator Light
- DS6 OIL PUMP Indicator Light
- DS7 SYSTEM Operating Indicator Light
- F1 Control Power Fuse
- F2 Oil Pump Fuse
- F3 Oil Heater Fuse
- F4 Purge Unit Fuse
- F8 Oil Pump Motor Fuse
- F9 Oil Pump Motor Fuse
- HR1 Oil Sump Heater
- K1 Compressor Motor Starter
- K3 Low Oil Pressure Arming Ckt.
- K4 Condenser Pump Control Relay
- K5 Start Oil Pump Timer/Jump-Out Start Inhibit Circuit
- K6 Oil Pressure Arming Ckt./Start S4 Timer Motor
- K7 Prevent Voltage Feedback/De-energize Start Counter/Starter Fault-Arming Ckt.

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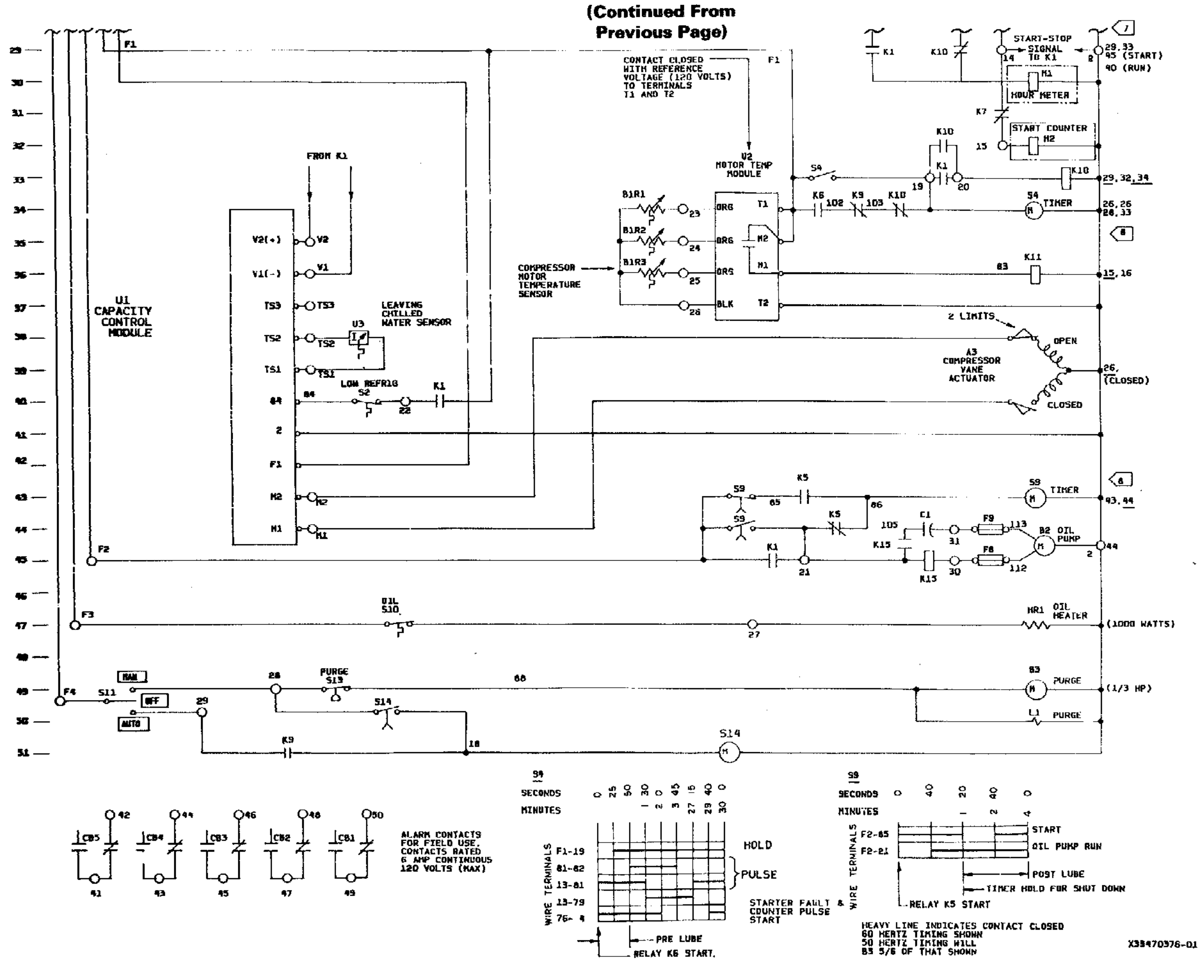



K8 Starter Fault-Trip Ckt.
K9 Starter Fault-Arming Ckt./S4 Timer De-energized Ckt./Automatic Purge Operation
K10 Start Pulse Signal/S4 Timer De-energized Ckt.
K11 Hi Motor Temp. Trip Ckt.
K12 Chilled Water Pump Starter
K13 Condenser Water Pump Starter
K14 Oil Pump (Manual Purge Ckt.)
K15 Oil Pump Starter Relay
K16 Electric Hot Gas Bypass Control Relay (Optional)
L1 Purge Solenoid
L3 Load Solenoid (Pneumatic Option)
L4 Unload Solenoid (Pneumatic Option)
M1 Hour Meter
M2 Start Counter
S HGBP Valve Actuator Limit Switch (Opt.)
S1 Hi Condenser Pressure Switch
S2 Low Refrig. Temp. Switch
S3 Start-Stop Chilled Water Demand Switch
S4 Anti-Recycle Timer
S5 Evaporator Flow Switch
S6 ON/OFF Switch
S7 Condenser Flow Switch
S8 Oil Pressure Switch
S9 Oil Pump Post-Lube Timer
S10 Oil Temp. (Heater) Switch
S11 Purge ON/OFF/AUTO Switch
S12 Guide Vane Linkage Limit Switch (HGBP Opt.)
S13 Purge Hi Pressure Switch
S14 Purge Timer
S15 Proof-of-Closure Switch (Pneumatic Opt.)
S22 Compressor Hi Discharge Temp. Switch (HGBP Opt.)
T1 Control Power Transformer
U1 Electronic Capacity Control Module
U3 Leaving Chilled Water Temp. Sensor
2U3 Return Chilled Water Temp. Sensor

NOTES:

1. UNLESS OTHERWISE NOTED ALL SWITCHES ARE SHOWN AT 25°C (77°F), AT ATMOSPHERIC PRESSURE, AT 50% RELATIVE HUMIDITY, WITH ALL UTILITIES TURNED OFF, AND AFTER A NORMAL SHUTDOWN HAS OCCURRED.
2. DASHED LINES INDICATE RECOMMENDED FIELD WIRING BY OTHERS. PHANTOM LINES INDICATE ALTERNATE CIRCUITRY OR AVAILABLE SALES OPTIONS.
3. NUMBERS ALONG THE RIGHT SIDE OF THE SCHEMATIC DESIGNATE THE LOCATION OF THE CONTACTS BY LINE NUMBERS. AN UNDERLINED NUMBER INDICATES A NORMALLY CLOSED CONTACT.
4. MAXIMUM AMBIENT TEMPERATURE 50°C (120°F) AVERAGE AIR TEMPERATURE IN THE IMMEDIATE NEIGHBORHOOD OF THE CONTROL PANEL.
5. CIRCUIT BREAKERS CB1-CB5 EMPLOYED AS FAULT INDICATORS IN THE CONTROL CIRCUIT ARE DESIGNED TO BE SHUNT TRIP VOLTAGE DEVICES (120 VAC AT ±15%) NOT CURRENT SENSITIVE DEVICES AS NORMALLY APPLIED. AUX CONTACT ARE LOCATED ON LINE 56
6. ALL FIELD WIRING MUST BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE (NEC), STATE AND LOCAL REQUIREMENTS, OTHER COUNTRIES APPLICABLE NATIONAL AND/OR LOCAL REQUIREMENTS SHALL APPLY. EXAMPLE: CANADA-SHALL COMPLY WITH CANADIAN STANDARDS ASSN. (CSA)
7. START-STOP SIGNAL TO K1 120 VOLTS, 1.0 AMP INRUSH .5 AMP CONTINUOUS (MAX)
8. FOR TIMING SEQUENCE OF TIMERS S4 & S9 SEE TABLES
9. K4 CONTACT RATED AT 30 AMP INRUSH 6 AMP CONTINUOUS 120 VOLTS (MAX)

Electronic Capacity Control Module (U1) - This device modulates the inlet vane actuator (A3; Line 39) by balancing the CONTROL POINT knob setting against the leaving chilled water temperature sensed by the leaving chilled water temperature sensor (U3; Line 38).

The U1 module also serves as a load limiting device as a result of an input signal received from the electronic overload relay (A1); the circuit between the control power fuse (F1) and Terminal 84 (on U1) must be complete before the module can open the compressor inlet vanes.

Compressor Motor Hi-Temperature Cutout (U2) - The M1-M2 contacts of this device (found on Line 35) close shortly after 115-volt control power is provided to Terminals T1 and T2, and will remain closed unless the temperature of the compressor motor windings exceeds 265 ± 5 F. If the motor winding temperature exceeds this level, the M1-M2 contacts will open to shut down the machine; when the winding temperature drops to 235 F, these contacts will automatically reclose.

The motor temperature sensors B1R1, B1R2, and B1R3 are located on the ends of the motor windings at 2, 6, and 10 o'clock positions. These sensors are not replaceable.

**Note:** Be sure to refer to the legend provided when reviewing the electrical sequence of operation outlined in the paragraphs which follow.

With the chilled water pump starter (K12; Line 13) energized, and the unit ON/OFF switch (S6; Line 26) set at AUTO, 115-volt control power flows through the string of safety controls and safety lockout contacts (Line 16). If all of the safeties are satisfied, the SAFETIES SATISFIED indicator light (DS1; Line 20) illuminates.

Current then flows to the chilled water demand switch (S3; Line 26), whose temperature-sensing element is located in the return water entering the chiller. When the return water temperature rises above the control point, S3 closes; this illuminates the COOLING REQUIRED indicator light (DS2; Line 20) and "feeds" current to the anti-recycle timer contacts (S4; Line 26). If a minimum of 30 minutes has elapsed since the last compressor start, S4's contacts allow the current to pass; this causes the RESTART TIME ELAPSED indicator light (DS3; Line 26) to illuminate, and current flows to the compressor inlet vane actuator (A3). If the inlet vanes are closed and the compressor is off, current flows through the compressor inlet vane end switch and the contacts of relay K7 to Terminal 8. The CHILLED WATER flow indicator light (DS4; Line 20) will then light, provided that the evaporator flow switch (S5; Line 26) verifies chilled water flow.

Notice that positioning switch S6 (Line 26) at AUTO also allows current to energize the condenser pump control relay (K4; Line 19); K4's contacts (Line 16) then close, energizing the condenser water pump starter (K13). If condenser water flow is proven, current flows through condenser flow switch S7 (Line 26), illuminates the CONDENSER WATER flow indicator light (DS5; Line 20), and energizes relay K5 (Line 21). One set of normally-open K5 contacts (Line 43) closes to energize the oil pump timer (S9). After the 40-second timing period has elapsed, S9's contacts (Line 44) close and oil pump motor B2 (Line 45) energizes.

The oil pump utilizes a capacitor-start/induction-run, single-phase motor; its current-sensitive starter relay (K15; Line 45) is wired in series with the pump motor's run winding, allowing it to switch from start to run. When the oil pump motor first starts, it draws locked rotor current; this high current draw causes relay K15 to close its contacts (Line 45). The start capacitor then energizes, and the motor start winding begins its rotation. Once the motor is fully accelerated, the current draw falls, causing K15's contacts (Line 45) to open and drop out of the start winding. The oil pump motor is now in its run configuration.

Once proper oil pressure is established, oil pressure switch S8 (Line 26) closes and the OIL PUMP indicator light (Line 22) illuminates. Relay K6 (Line 23) then energizes, and one set of its single-pole/double-throw contacts (Lines 14 and 15) switch to energize the low oil pressure arming circuit (K3; Line 14). (This occurs when K3's contacts--in Line 16--subsequently close to energize low oil pressure fault indicator CB1.)

A second set of normally-open K6 contacts (Line 34) closes to energize the anti-recycle timer (S4). Within 25 seconds, the S4 contacts in Line 33 close, while another set of S4 contacts in Line 28 closes 20 seconds later. With S4's contacts closed, the SYSTEM operating indicator light (DS7; Line 28) illuminates and relay K9 (Line 26) energizes. A compressor start is then initiated when compressor motor starter relay K1 energizes; one set of K1 "start" contacts (Line 29) closes to maintain power to the compressor starter, while a second set of "start" contacts (Line 34) closes to energize the start pulse signal relay (K10).

Notice that one set of single-pole/double-throw K10 contacts (Lines 32 and 34) switch immediately to ensure the the K10 relay remains energized for the duration of anti-recycle timer S4's timing period. Another normally-closed set of K10 contacts (Line 29) opens to interrupt the "start" signal to the compressor motor through the S4 contacts in Line 26. **Note:** The original "start" signal sent through the S4 contacts in Line 26 is maintained just long enough to energize the "start" contactor of compressor motor starter K1. If K1 drops out of the circuit for any reason, it will remain de-energized until the anti-recycle timer (S4) completes its timing cycle.)

An additional set of normally-open K1 "start" contacts (Line 45) closes to ensure that the oil pump is energized as long as K1's contacts are closed.

When compressor motor starter K1 "converts" the compressor to the run configuration, K1's normally-open "run" contacts (Line 40) close to supply power to Terminal 84 of the capacity control module (U1). (However, the low refrigerant temperature switch (S2) must be closed for this to occur.) Control module U1 then opens the compressor inlet vanes as needed.

Remember that the "starter fault" safety circuit was armed at the same time that compressor motor starter K1--along with relay K9--was initially energized; a set of normally-closed K9 contacts in Line 25 opened to ensure that relay K8 (i.e., starter fault tripping circuit) remained de-energized. At that point, S4 contacts in Line 26 switched from 13-81 to 13-79 to energize relay K7 (Line 24). Normally-closed K7 contacts in Line 25 then closed, allowing relay K7 to remain energized and completing the arming of the "starter fault" circuit. If compressor motor starter K1 drops out of the circuit for any reason, the K1 contacts in Line 29 will open and relay K9 will de-energize. K9's normally-closed contacts (Line 25) will then reclose to energize the starter fault tripping circuit relay (K8) and cause its normally-open contacts (K8; Line 15) to close. This action trips the starter fault indicator (CB5) and locks the unit off.

When there is no longer a call for cooling--or if a safety opens, compressor starter K1 and relay K5 (i.e., oil pump timer/jump-out start inhibit circuit) are de-energized. A set of S9 contacts (Line 44) ensures that the oil pump timer (S9) and oil pump motor (B2) remain energized for three minutes to provide lubrication during compressor coast-down.

If there is a loss of oil pressure while the compressor is running, oil pressure switch (S8; Line 26) opens; this stops the compressor and de-energizes relay K6 (oil pressure arming circuit/start S4 timer motor; Line 23). Current is then routed from Terminal 12 (Line 26), through the K3 contacts in Line 16 and the normally-closed K6 contacts in Line 14. This trips the low oil pressure fault indicator (CB1), and the compressor is locked out.

**Note:** Alarm contacts (Line 56) for field connection are factory-wired using a set of auxiliary, normally-closed contacts on each of the control safety lockouts.

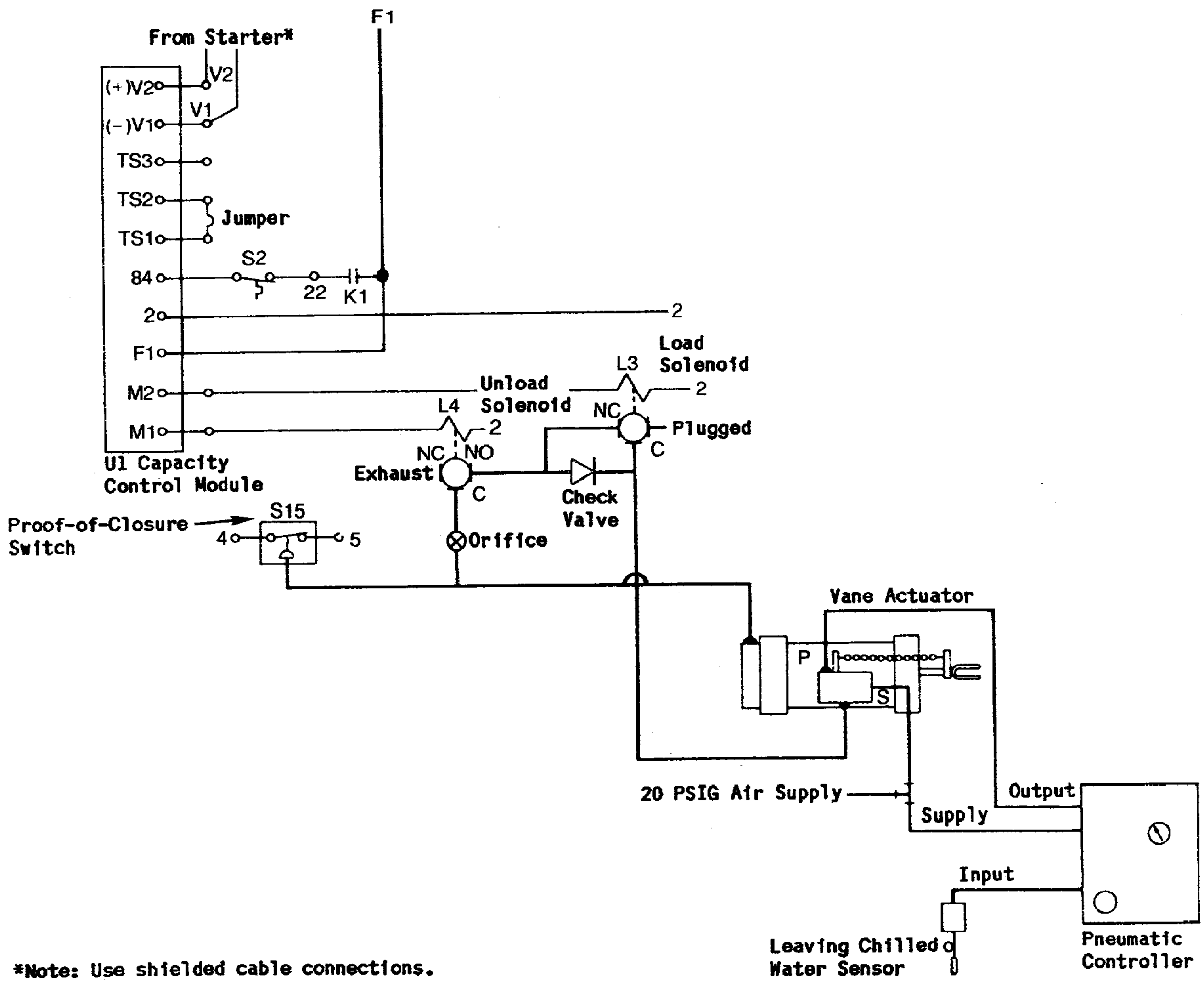
## Control Options: Pneumatic Capacity Control System

In this control scheme, an analog (proportional) signal from a conventional pneumatic temperature controller (also optional) is fed into the pilot port (labelled "P" in Figure 14) of the pneumatic inlet vane actuator's pilot positioner. Notice that a jumper between Terminals TS1 and TS2 on the capacity control module (U1) is substituted for the electronic leaving chilled water sensor (U3) used in the electronic control scheme described in the preceding section.

When the compressor motor starter assumes the "run" configuration, K1's interlocking contacts close; the continuous circuit between TS1 and TS2 causes the module to transmit a repeated, pulsed loading signal to solenoid valve L3. Unlike the electronic capacity control system, the duration of this pulse is solely the function of motor current in terms of its relationship to the % CURRENT setting of the current limiter. The preselected 10 to 310-second time lapse is observed between successive load pulses.

During the load pulse, the normally-closed (NC) port of solenoid valve L3 opens, permitting the output air pressure from the pilot positioner to be transmitted through the normally-open (NO) and common (C) ports of solenoid valve L4 to the vane actuator. Within the time interval of the load pulse, the pneumatic temperature controller has the authority to open, close or hold the vane position.

**Figure 14**
**CVHE Pneumatic Control Interface**




*Note: Use shielded cable connections.

When the system is shut down, opening the K1 contacts--or a low refrigerant temperature condition opens switch S2--control module U1 transmits a continuous unloading signal. This signal closes the normally-open (and opens the normally-closed) ports of valve L4 to exhaust the control air pressure from the actuator and close the vanes.

Load limiting within the pneumatic control system is handled in the same manner as the electronic control scheme: as motor current rises, the duration of the loading pulse decreases. At 100 percent of the % CURRENT setting, the pulse duration drops from 0.25 seconds to zero. At 103 percent, a 0.25-second unloading pulse is initiated, followed by a 10 to 310-second load-delay period; this represents an attempt to return the chiller to 100 percent of the demand limiter setting. Finally, at 105 percent, a continuous unloading pulse is established and is terminated only when the motor current is reduced to 95 percent of the demand limit setting. (Refer to Figure 14; a pressure-relief check valve is connected to the normally-open port of L4 to allow the unit to unload when motor current is between 100 and 103 percent of the % CURRENT setting and the chilled water set-point has been reached. This check valve also enables the pneumatic control to reduce the branch pressure on the actuator when the unit is under current limit and the chilled water setpoint has been reached.)

Notice that control air is supplied to--and exhausted from--the vane actuator through an orifice. This orifice is factory-adjusted to produce the same vane movement rate as that produced by the actuator used in the electronic capacity control system.

Finally, proof-of-closure switch S15, which closes on a drop in pressure, replaces and performs the same function as the end switch of the electric inlet vane actuator (A3; Figure 13 - Line 26).

The remaining circuitry of the pneumatic capacity control system is the same as that used in the electronic control scheme.

## Control Options: Sequence Panel

**Note:** When reviewing the following operational sequence, be sure to refer to the appropriate wiring diagram in the wiring booklet which shipped with the unit. For more comprehensive installation and application information, refer to the submittal information which shipped with the panel.

To ensure that the system operates properly when power is applied, several adjustments must be made to the sequence panel and to the unit controls.

1. On the sequence panel:

a. Select the desired unit operating sequence, and set the sequence switch accordingly.

b. Use the knobs located on the mounting plate within the panel to set the load and unload thresholds.

   Set the <u>load threshold</u> to the percentage of maximum load desired on the lead unit before the lag unit starts; a setting of 90 percent is recommended.

   Set the <u>unload threshold</u> to that percentage of minimum load required with both units operating before the lag unit shuts down. To prevent cycling at this transition point, the setting must be less than half of the load setting; a setting of 40 percent is recommended. As a part of set-up, determine what the minimum current threshold is before adjusting the minimum set-point to insure that the motor will go to 40%.

2. Adjust the controls of the lead (A) and lag (B) units. The power switches (labelled AUTO/OFF on the control panel of each unit) should be set at AUTO, and the temperature control adjustments should be set to the same desired control temperature.

Make sure that the knobs on the temperature controls are properly adjusted. The pointer of each should be aligned with the calibration mark on the dial when in the fully counterclockwise position.

In addition, adjust the current limit potentiometers to the fully clockwise position.

These are the only adjustments required for the successful operation of the system.

When control power is applied to a pair of chillers (<u>piped in parallel</u>) utilizing the sequence panel control option, the operational characteristics of the system are the same as those described in the previous sections. Start-up is controlled by the sequence panel OFF/ON switch; refer to Figure 15 for an illustration of the sequence panel and possible panel applications. When the system switch is positioned at ON, its contacts close to the lead unit, and pilot light No. 1 illuminates. If all of the start sequence circuit interlocks are verified, the lead unit will start.

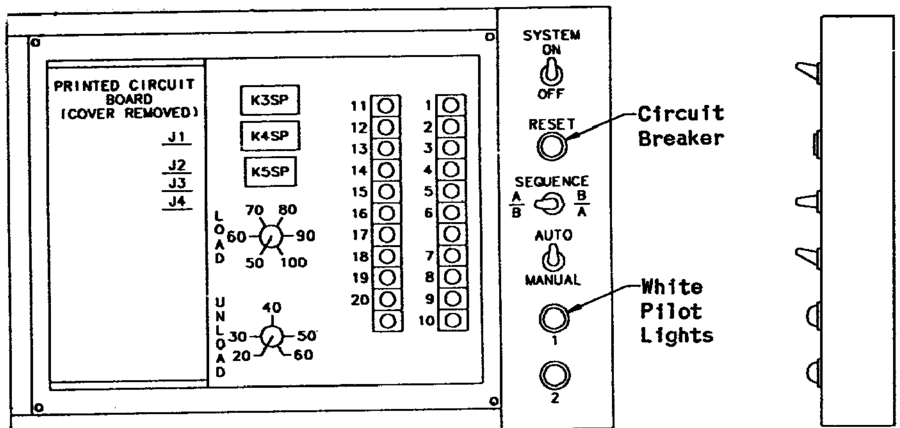
If the current draw of the lead unit exceeds the setting on the load selector, a 15-minute timer energizes. Once the timing cycle is complete, the second (or lag) unit starts and pilot light No. 2 illuminates. At this point, the lead unit begins to unload and the lag unit loads up. After a period of adjustment, the units stabilize, with each carrying half of the cooling load; any further change in cooling demand will be shared equally.

In some applications, the sequence panel is used in conjunction with a pair of chillers piped in series with one chilled water pump; this changes the master/slave control scheme. When both units are on, the "B" (or lag) unit always operates with its temperature control in its current limit mode (i.e., the yellow light is on); its loading, however, tracks that of the "A" (or lead) unit. If the load decreases, the lag unit will shut down 15 minutes after reaching the setting on the unload selector. The remaining unit adjusts to carry the load.

Should it become necessary to run either or both chillers independently from the sequence panel, adjust the OFF/ON system switch on the sequence panel to the OFF position. Then, when the sequence panel's AUTO/MANUAL switch is set at MANUAL, the units will operate in response to their individual control adjustments.

**Note:** The sequence panel pilot lights indicate a call for the units' operation; they do NOT confirm unit operation.

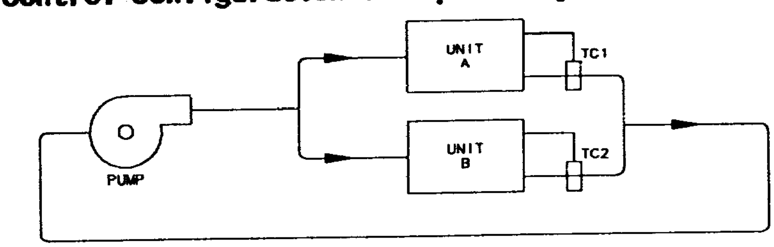
**Figure 15**
**Optional Sequence Panel**



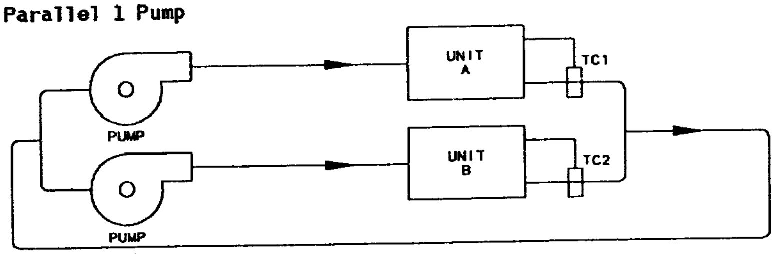

**Front View**
**(Shown w/Cover Removed)**

**Side View**

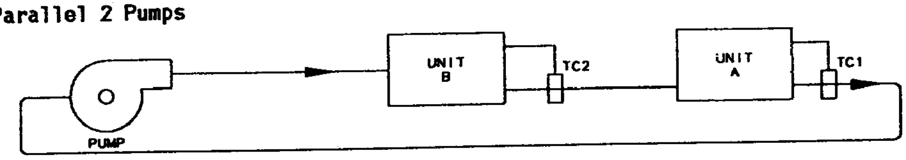
## Control Configurations: Sequence System w/Two Units




Parallel 1 Pump




Parallel 2 Pumps




Series

## Control Options: Free-Cooling

Free-Cooling, an accessory to CVHE CenTraVacs, adapts the basic chiller so it may function as a simple heat exchanger using refrigerant as the working fluid; however, it does not provide control of the leaving chilled water temperature. When condenser water is available at temperatures lower than the desired chilled liquid temperature, the free-cooling option can provide substantial nominal chiller capacity without operating the compressor, resulting in substantial energy cost savings.

The principle behind the free-cooling option is that refrigerant flows to the area of lowest temperature in the system. When condenser water is available at a temperature lower than the required leaving chilled water temperature, the operator manually stops the compressor and starts the free-cooling cycle by pressing a push button control located in the lower right-hand corner of the unit control panel. See Figure 16. Changeover from the free-cooling cycle to mechanical cooling is accomplished by pressing this same button.

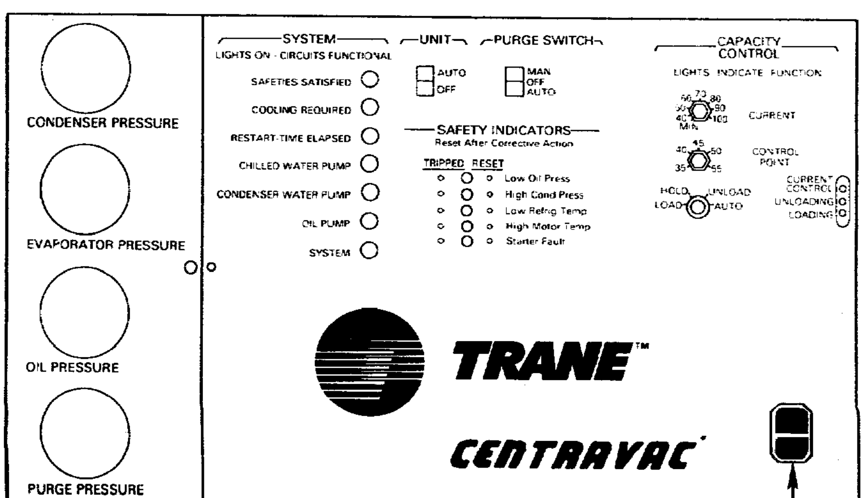
To equip the chiller with the free-cooling option, several components are factory-installed or -supplied: a refrigerant gas line (including an electrically-actuated shutoff valve) installed between the evaporator and condenser; a valved liquid return line (including an electrically-activated shutoff valve) between the condenser sump and the evaporator; a liquid refrigerant storage vessel; additional refrigerant charge; and, a free-cooling selector switch (located on the unit control panel).

When the chiller operator initiates the changeover to the free-cooling cycle, the shutoff valves in the liquid and gas lines open, and a lockout circuit prevents the compressor from energizing. Liquid refrigerant then drains--by gravity--from the storage tank into the evaporator and floods the tube bundle. Since the temperature and pressure of the refrigerant in the evaporator are higher than in the condenser because of the difference in water temperature, the refrigerant in the evaporator vaporizes and flows to the condenser. This gaseous refrigerant then condenses as a result of the effects of the cooling tower water, and flows--again, by gravity--back to the evaporator. Refer to Figure 17 for an illustration of the free-cooling cycle.

The automatic refrigeration cycle described above is sustained as long as a temperature differential exists between the condenser and evaporator liquids. The cooling capacity provided by the free-cooling cycle is determined by the difference in temperature between the evaporator water and the condenser water which, in turn, determines the rate of refrigerant flow between the two shells.

If the system load exceeds the available free-cooling capacity, the operator must manually initiate changeover to the mechanical cooling mode by pressing the free-cooling switch on the unit control panel. The gas and liquid line valves then close and compressor operation begins. Refrigerant gas is drawn out of the evaporator by the compressor, and is then compressed and discharged to the condenser. Most of the condensed refrigerant initially follows the path of least resistance by flowing into the

**Figure 16**
**CVHE Unit Control Panel w/Free-Cooling Option**



Free Cooling Switch

storage tank. The storage tank is vented to the economizer sump through a small bleed line; when the storage tank is full, liquid refrigerant must flow through the bleed line restriction.

Because the pressure drop through the bleed line is greater than that of the orifice flow control device, the liquid refrigerant flows normally from the condenser through the orifice system and into the economizer.

**Note:** During the changeover from free-cooling to mechanical cooling, the refrigerant transfer process is completed within three minutes. The loading ramp prevents carry-over by loading the machine slowly.

## Control Options: Hot Gas Bypass

The hot gas bypass (i.e., HGBP) control system is designed to minimize machine cycling by allowing the CVHE unit control system to operate stably under minimum load conditions. In these situations, the guide vanes are locked at a preset minimum point and the unit capacity control function is performed by the HGBP valve positioner. Circuits are also provided to allow both the guide vanes and the HGBP valve to close for unit shutdown.

There are four control components associated with the hot gas bypass option:

1. Relay K16: This control device is located in the unit control panel (or mounted in a separate box for retrofit applications), and enables the closure of the HGBP valve and guide vanes at unit shutdown.

2. Switch S12: This single-pole/double-throw limit switch is mounted on the guide vane linkage, and operates when the vanes pass through a particular minimum setting.

3. Switch S: Mounted in the HGBP valve actuator, this single-pole/double- throw limit switch operates when the valve just begins to open. Notice that the "close" limit switch mounted in the valve actuator must be set to operate just after (i.e., valve more closed) Switch S operates.

4. Switch S22: This device is designed to shut the unit down if the discharge temperature exceeds 210 F, thereby preventing the unit from running at extremely low loads for extended periods of time.

**Note:** When reviewing the sequence of operation provided below, be sure to refer to the hot gas bypass schematic and connection diagrams included in the wiring booklet which shipped with the chiller.

At unit start-up, the HGBP control relay (K16) energizes, and load signals from M2 flow to the "open" terminal of the vane actuator. When the vanes open past the preset minimum operating point, the contacts of limit switch S12 switch so that any unload signals from M1 are routed to the vane actuator. From this point, the unit will load and unload normally throughout the range of guide vane positions. (If the vanes do not open past the preset minimum operating point, however, the unit will remain on inlet guide vane control only.)

**Figure 17**
**Free-Cooling Operation**
**Vs. Compressor Operation**

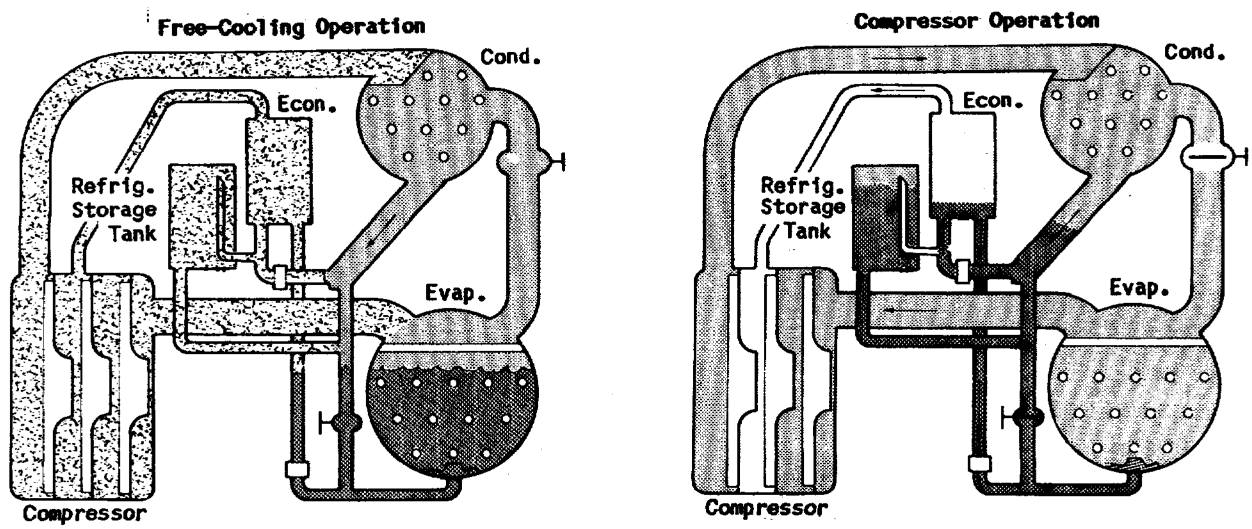


**Table 1**
**Demand-Limit Interface: Input vs. Current**

| Potentiometer Input | Maximum Current |
|---|---|
| 0 Ohms | 100% |
| 200 Ohms | 88% |
| 400 Ohms | 76% |
| 600 Ohms | 64% |
| 800 Ohms | 52% |
| 1000 Ohms | 40% |

When the unit unloads and the guide vanes reach a preset minimum point, Switch S12 energizes and passes unload signals from M1 to the "open" terminal of the HGBP valve actuator. When the HGBP valve opens, Switch S energizes and passes load signals from M2 to the "close" terminal of the HGBP valve actuator. Unit capacity is then controlled by the HGBP valve actuator with the guide vanes held at the minimum position. When the unit again loads, the HGBP valve closes; once it reaches the full-closed position, Switch S energizes and sends additional load signals to the vane actuator.

At unit shutdown, HGBP control relay K16 is de-energized and the unload signal from M1 passes through the normally-closed contacts of K16 to the "close" terminals of the vane and HGBP valve actuators. This operation prepares the unit for restart.

**Note:** Be sure to contact a qualified service organization for proper adjustment of the HGBP valve actuator limit switches.

## Control Options: Demand-Limit Interface

The demand-limit interface control option--whether factory- or field-installed on the unit control panel--is designed to enable the chiller to be demand-limited from an external source. Once the demand-limit module is installed, the CVHE control system can accept a 0 to 1000-ohm potentiometer input (or equivalent). This resistive input limits the maximum current that the compressor motor can draw. Refer to Table 1 to determine the relationship between the potentiometer inputs and the resulting maximum current values. Notice that as the maximum allowable current is decreased, the capacity controller decreases the inlet guide vane opening in an attempt to meet the maximum limit. Current draw with fully closed inlet guide vanes may range from 60 to 30 percent of the rated load amps (RLA), depending on the individual machine amd the operating conditions. Once the vanes are fully closed, any additional signals input to further limit the maximum current will have no effect.

To demonstrate chiller operation during demand-limiting, let's look at the example provided below:

A CVHE unit is drawing 60 percent current, and a 200-ohm potentiometer signal is inputted into the control system. This 200-ohm signal sets the maximum current draw at 88 percent; see Table 1. Since the actual current draw of 60 percent is less than the maximum allowable current draw of 88 percent, the unit will not respond with a capacity reduction at this time.

However, if the load current tries to rise above the maximum allowable current (i.e., 88 percent), demand-limiting will occur. The inlet guide vanes will modulate closed until the actual current draw equals the maximum current allowable.

If the maximum allowable current setting is raised, the inlet guide vanes open slowly, stopping at a position that corresponds to some current draw below the ceiling level.

**Note:** Make sure that the demand limiter dial on the front of the unit control panel is set at 100 percent. Any demand-limiting initiated with this dial is superimposed onto the external demand-limiting signal (e.g., a dial setting of 75 percent plus a 200-ohm potentiometer input yields a maximum allowable current of 62 percent).

**Note:** Demand-limiting a centrifugal chiller may cause the machine to temporarily operate in an unstable mode that produces refrigerant gas noise. Since job site conditions vary greatly, it is recommended that the rate of demand-limiting--as well as the maximum amount of demand-limiting--be determined on the job site at start-up.

## Control Options: Chilled Water Reset Interface

**Note:** This control option is not compatible with the unit pneumatic capacity control system.

The chilled water reset interface option consists of a control module which is factory- or field-installed on the outside of the unit control panel. When connected to a remote signal device (i.e., field-supplied and -installed), the interface control module will linearly reset the leaving chilled water control point to a maximum of 10 F above the unit control panel setting. (The reset interface control module is designed to accept signals of 0 to 10 VDC, 4 to 20 maDC, or 0 to 1000 ohms.)

## Control Options: Chilled Water Reset

**Note:** This control option is not compatible with the unit pneumatic capacity control system.

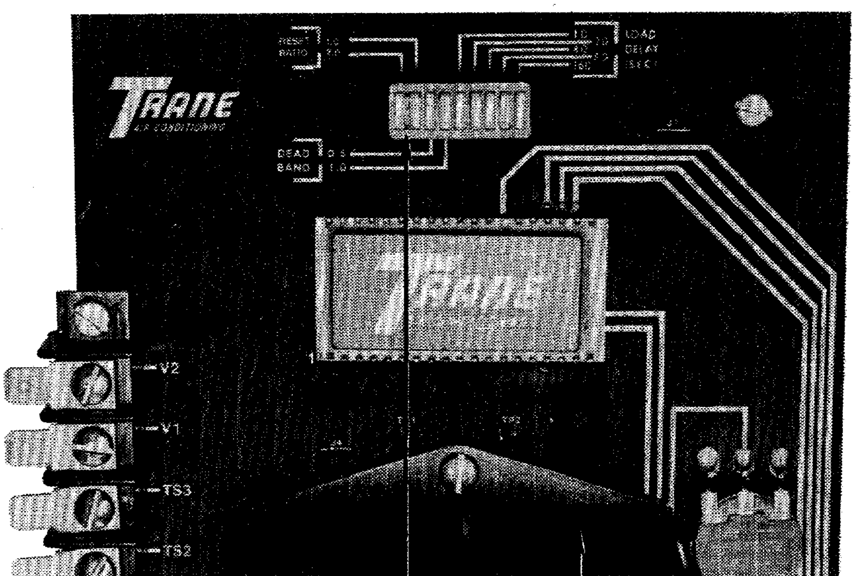
Chilled water reset is designed for those applications where the system operates at part load, and does not require design chilled water temperature at part load. In these cases, the leaving chilled water temperature setpoint can be reset upward using the chilled water reset option.

Using an additional temperature sensor field-installed in the return chilled water piping, the chilled water reset control option enables the capacity control module to sense the cooling load on the chiller. **Note:** Be sure to select the proper sensor, depending upon the full-load delta "T". As the unit unloads, the control module will raise the leaving water temperature according to one of three available ratios; refer to Figure 18. Each of the reset ratios is defined as the change in entering water temperature vs. the change in leaving water temperature. To select the desired reset ratio, adjust the "dip" switches located on the capacity control module found within the unit control panel. See Figure 18.

Once the proper reset ratio has been selected, the chilled water reset option operates automatically, raising the leaving water temperature as the cooling load decreases. No further adjustment or maintenance is required.

**Note:** The chilled water reset control can be enabled or disabled with the addition of a single, field-supplied, mercury-wetted relay. By short-circuiting the two wires that connect the sensor to the control panel, the capacity control module overrides the reset signal and returns to the control panel setpoint.

**Figure 18**
**Capacity Control Module**
**Dip Switch Adjustment**
**for Chilled Water Reset Option**




| Reset Ration | Dip Switch #1 | Dip Switch #2 |
|---|---|---|
| None | Off | Off |
| 1/2 : 1 | On | Off |
| 1 : 1 | Off | On |
| 2 : 1 | On | On |

**Notes:**
1. These ratios represent the change in entering water temperature vs. the change in leaving water temperature.
2. The actual amount of temperature reset is dependent on 4 parameters: sensor "range", design delta-T, reset ratio, and cooling load.

## Automatic Condenser Cleaning System Electrical Sequence of Operation

Before a cycle is initiated, the normal flow light is on as shown in the electrical schematic (Figure 19).

Contact MTR of the 24 HR time control closes at preset times during the day, energizing the single shot timer 1TR. The 1TR contact will close for approximately 30 seconds, energizing the 4-way solenoid valve SOL.

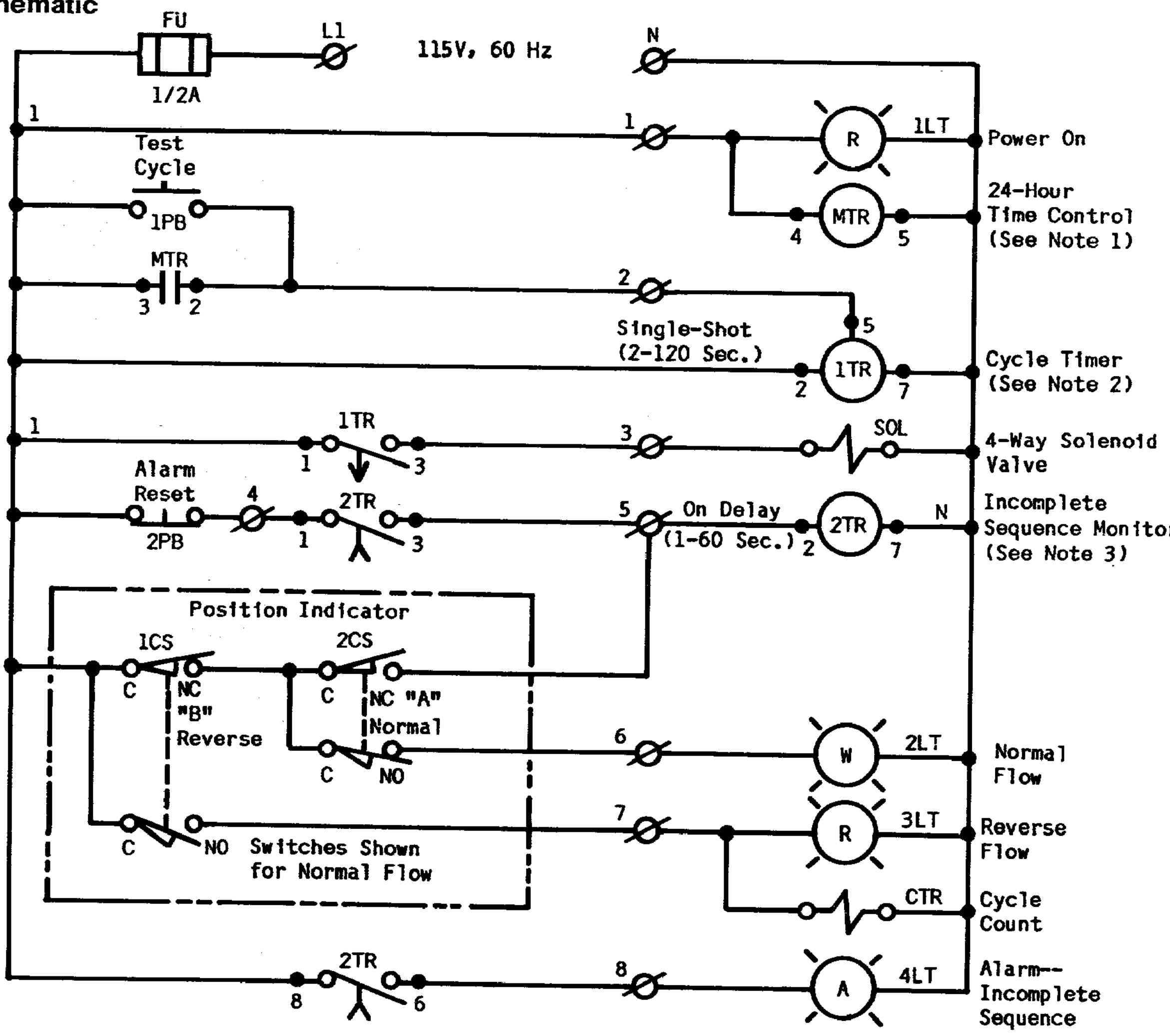
Energizing SOL will reverse the air to the flow diverter actuator (double acting cylinder) causing the flow diverter to move from normal to reverse position. Once the flow diverter plug moves from the normal position, the 2CS contacts (switch A) of the valve position indicator close, turning off the "Normal Flow" light and closing the circuit to the incomplete sequence on-delay relay 2TR, starting the timer.

When the plug reaches the reverse position, the 1CS contacts (switch B of the valve position indicator switch) close, turning the "Reverse Flow" light on and advancing the counter one half count. The circuit to 2TR is opened, resetting it to zero.

After 1TR times out (approximately 30 seconds), it will de-energize, opening the 1TR contact and de-energizing SOL. SOL de-energizing will cause the air to the flow diverter actuator to reverse, and the opposite action just described will occur. The "Reverse Flow" light will go out and the cycle counter will advance another one-half count making one full count. At this point the normal flow light will illuminate.

If diverter transfer time exceeds the time set at the 2TR timer, 2TR will time out and close contacts illuminating the "Incomplete Sequence Alarm". To reset 2TR and turn the "Incomplete Sequence Alarm" light off, push "Alarm Reset". The flow diverter must be in the "Normal" or "Reverse" position to reset.

**Figure 19**
**Automatic Condenser Cleaning System (Option) Electrical Schematic**




**Notes:**
1. Turn outer dial clockwise until white pointer lines up with time of day. Depress one tripper at the time of day each cleaning cycle is desired.
2. Set 1TR to 30 seconds.
3. Adjust time on 2TR to actual valve transfer time + 3 sec.
4. O = Terminal block connections.

**WARNING**
**DISCONNECT ELECTRICAL POWER SOURCE TO PREVENT INJURY OR DEATH FROM ELECTRICAL SHOCK**

**CAUTION**
**Use copper conductors only to prevent equipment damage**

## Daily Unit Start-Up

1. Check the oil tank oil level; the level must be visible in–or above–the lower sight glass. Also, be sure to check the oil tank temperature; normal oil tank temperature before start-up is 140 ± 5 F.

2. Adjust the unit AUTO/OFF switch to the OFF position.

3. Check for chilled water and condenser water flow.

4. If necessary, readjust the current limit control (labelled % CURRENT) to the desired position.

5. Check the position of the function control switch; it should be set at AUTO.

6. If necessary, readjust the chilled water temperature control (labelled CONTROL POINT) to the desired temperature.

7. Verify that the safety indicators are in the reset position. If any have tripped, be sure to diagnose and correct the cause of the trip-out.

8. Recheck the oil temperature; once it reaches 140 ± 5 F, start the unit by adjusting the unit switch to the ON position.

## Daily Unit Shutdown

1. Adjust the unit switch to the OFF position.

2. Shut down the chilled water pump if chilled water service is no longer required.

## Seasonal Unit Start-Up

1. Close all drain valves, and reinstall the drain plugs in the evaporator and condenser headers.

2. Service the auxiliary equipment according to the start-up/maintenance instructions provided by the respective equipment manufacturers.

3. Chiller Sizes 036 thru 125 Only: Open the manual valves in the oil cooler water circuit.

4. Vent and fill the cooling tower, if used, as well as the condenser and piping.

**Caution: If the chiller is equipped with the automatic condenser cleaning system, take care when filling the condenser to prevent any sudden surge of water which may damage the retainer baskets and brushes. Action of the flow diverter should also be disabled at this time.**

At this point, all air must be removed from the system (including each pass). Then install the vent plugs in the condenser water boxes.

5. Close the city water valves to the purge condenser.

6. Open all of the valves in the evaporator and purge condenser chilled water circuits.

7. If the evaporator was previously drained, vent and fill the evaporator and chilled water circuit. When all air is removed from the system (including each pass), install the vent plugs in the evaporator water boxes.

8. Lubricate the external vane control linkage.

9. Check the refrigerant in the unit; to do this, the refrigerant must be drawn off and weighed back into the chiller. (If the unit is low on charge, be sure to contact a qualified service organization.)

10. Check the adjustment and operation of each safety and operating control.

11. Close all disconnect switches.

**WARNING: Use care when measurements, adjustments, or other service-related operations must be made with the power on to prevent injury or death due to electrical shock or contact with moving parts.**

12. Start the purge system.

13. Verify that each of the safety indicators on the unit control panel is in the reset position.

14. Check the oil tank level; the level must be visible in the lower sight glass. Also, be sure to check the oil tank temperature; normal oil tank temperature before start-up is 140 ± 5 F.

15. Verify that the unit AUTO/OFF switch is positioned at OFF; then energize the water pumps. Check for chilled water and condenser water flow.

16. If necessary, set the current limit control (labelled % CURRENT) at its minimum setting.

17. Check the position of the function control switch; it should be set at AUTO.

18. If necessary, adjust the chilled water temperature control (labelled CONTROL POINT) to the desired temperature.

19. Recheck the oil temperature; once it reaches 140 ± 5 F, start the unit by adjusting the unit switch to the ON position.

The system should now operate automatically.

## Seasonal Unit Shutdown

1. Stop the system at the chilled water push button station, or stop the chilled water flow by the means devised for this particular application.

2. Open all disconnect switches except the control power disconnect switch.

**WARNING: Use care when measurements, adjustments or other service-related operations must be made with the power on to prevent injury or death due to electrical shock or contact with moving parts.**

**Caution: The control power disconnect MUST remain closed during the entire shutdown period to allow oil sump and separator (if applicable) heater operation. This will prevent refrigerant from condensing in the oil sump.**

**Caution: During a shutdown of more than 1 or 2 days, the optional automatic condenser cleaning system should be cycled at least once a day. This will prevent any diverter binding problems and possible unit damage.**

3. Drain the condenser piping and cooling tower, if used.

4. Remove the drain and vent plugs from the condenser headers to drain the condenser.

5. If the system will be subjected to freezing temperatures, vent and drain the evaporator, oil cooler, and all connecting piping.

6. Once the unit is secured for winter, perform the maintenance procedures described in the "Annual Maintenance" section of this manual.

**Note:** During shutdown, be sure to operate the purge unit for a 30-minute period every two weeks. This will prevent the accumulation of air and noncondensibles in the machine. To start the purge, position the water valves to circulate city water through the purge condenser; then adjust the purge switch *to the manual (MAN)* position.

# Periodic Maintenance

This section describes basic chiller preventive maintenance procedures, as well as the recommended intervals for the performance of these procedures. Remember that a periodic maintenance program is important to obtain the best possible performance and efficiency from the CenTraVac chiller. Proper maintenance also assures that minor problems are detected and resolved before they become major.

An important aspect of the chiller maintenance program is the regular completion of the CenTraVac Operating Log; refer to the last page of this manual for an example of this log. When filled out accurately by the operator, the completed logs can be reviewed to identify any developing trends in the chiller's operating conditions. If, for example, a gradual increase in condensing pressure is noted during a month's time, the operator can systematically check--then correct--the possible causes of this condition (e.g., fouled condenser tubes, noncondensibles in the system, etc.).

### Daily Maintenance and Checks

1. Check the chiller's evaporator, condenser and purge drum pressure, oil sump temperature, and net oil pressure. Compare the readings obtained with the values provided in Table 2.

2. Check the oil level in the chiller oil sump using the two sight glasses provided in the oil sump head. When the unit is operating, the oil level should be visible in the lower sight glass.

### Weekly Maintenance

Check the purge drum sight glass for evidence of condensate. (Water condensed in the purge drum floats on the surface of the liquid refrigerant, creating a visible line of separation in the sight glass.)

To remove water from the drum, operate the purge compressor until a positive pressure of 5 to 10 psig is indicated on the purge drum pressure gauge. Then, shut down the purge compressor and open the manual blow-off valve (located on the water connection end of the drum) to release the water and other noncondensibles.

**Caution: If frequent purging is required, identify and correct the source of the air or water leak as soon as possible. Moisture contamination caused by leakage can shorten the life expectancy of the machine.**

**Note:** If the unit is operating in the cooling mode, close the manual shutoff valves on the heating condenser and open the valves on the cooling condenser. Reverse this procedure when the unit is operating in the heat-recovery mode. Be sure to purge only from the active condenser.

**Table 2**
**Normal Chiller Operating Characteristics**

| Operating Characteristic | Normal Reading |
|---|---|
| Evaporator Pressure | 12 to 18" w.c. Hg (vacuum) |
| Condenser Pressure[1] | 2 to 12 psig |
| Purge Drum Pressure | 0 to 22 psig |
| Oil Sump Temperature: | |
| Unit Not Running | 140 to 145 F |
| Unit Running | 115 to 150 F |
| Net Oil Pressure[2] | 18 to 20 psid |

**Notes:**
**1.** Condenser pressure is dependent upon the temperature of the condensing water, and should equal the saturation pressure of R-11 at a temperature 5 to 10 F above that of the leaving condenser water at full load.
**2.** Net oil pressure (i.e., usable oil pressure) is determined by subtracting the oil sump pressure (i.e., evaporator pressure) from the oil pressure gauge reading.
**Example:** Oil Pressure Gauge = 10 psig, and the evaporator pressure = 18" Hg (vacuum). First, convert 18" Hg to psig (i.e., -18/2.03 = -8.87 psig).

Then, subtract -8.87 psig from 10 psig (i.e., 10 - (-8.87) = 10 + 8.87 = 18.87 psid). In this example, the net oil pressure of 18.87 psid is within the acceptable limits.

If your chiller is equipped with the factory-installed automatic condenser cleaning system, refer to the following weekly maintenance checks:

[ ] The movement of the diverter valve should be observed (the diverter pointer should rotate 90 degrees between "N" and "S"). Proper movement of the valve should insure that the control and air systems are functioning properly and that the correct transfer time is set.

[ ] Inspect the diverter packing during cycling to insure that no water leakage occurs.

[ ] Insure that the proper air pressure is maintained (70 - 100 psig).

[ ] Check cycle counter to insure that the proper number of cycles are registered.

## Every Three Months

**WARNING: Open and lock the unit disconnect to prevent injury or death due to electrical shock or contact with moving parts.**

1. Clean all water strainers in the CenTraVac water piping system.

2. Complete all recommended daily and weekly maintenance procedures. (Refer to the previous sections for details.)

If your chiller is equipped with the optional automatic condenser cleaning system lubricate the diverter journal bearings through the grease fittings provided at both the front (actuator end) and rear journal bearings. Use Keystone Nevastane medium grease or equivalent.

## Every Six Months

**WARNING: Open and lock the unit disconnect to prevent injury or death due to electrical shock or contact with moving parts.**

1. Lubricate the vane control linkage bearings, ball joints, and pivot points; a few drops of light machine oil (e.g., SAE-20) is sufficient. Also, apply one or two drops of oil on the vane operator shaft and spread it into a very light film; this will protect the shaft from moisture and rust.

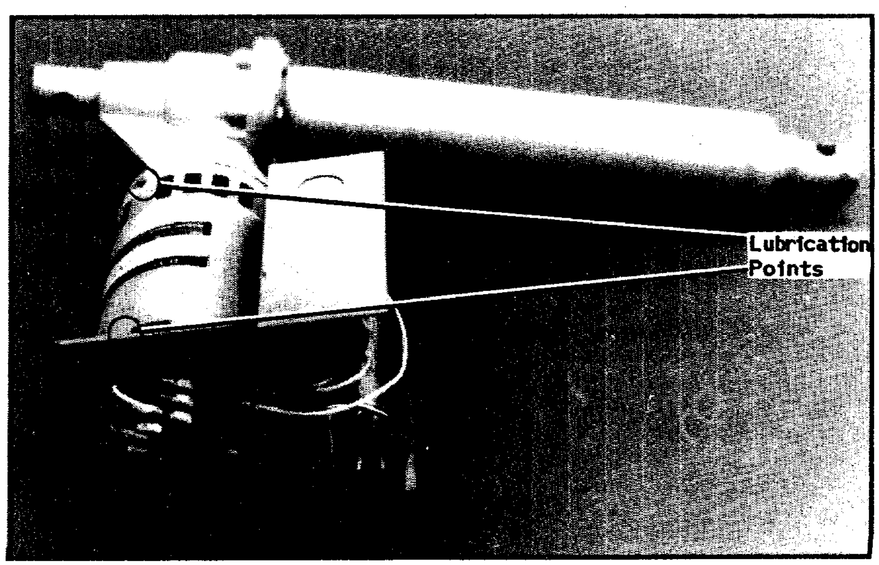
2. Lubricate the actuator motor bearings by inserting a long nozzle into the lubrication ports on the actuator. See Figure 20. Several drops of SAE-20 oil, or equivalent, is sufficient.

### Off-Season Maintenance

During those periods of time when the chiller is not being operated, be sure to operate the purge unit for a 30-minute period every two weeks. This will prevent the accumulation of air and noncondensibles in the machine. Since the machine is not providing chilled water, cool water (i.e., less than 80 F) must be supplied to the purge condenser drum by adjusting the water valves to provide alternate water flow through the purge condenser.

**Caution: If frequent purging is required, identify and correct the source of the air or water leak as soon as possible. Moisture contamination caused by leakage can shorten the life expectancy of the machine.**

**Figure 20**
**Compressor Inlet Vane Actuator**



## Annual Maintenance

**WARNING: Open and lock the unit disconnect to prevent injury or death due to electrical shock or contact with moving parts.**

The Trane Company recommends that the chiller be shut down for inspection once each year to check the items listed below; for a more detailed inspection checklist, refer to the "Model CVHE CenTraVac Annual Inspection Checklist and Report" illustrated in Figure 21.

1. Inspect and clean the inside of the purge drum; step-by-step instructions are provided in the "Maintenance Procedures" section of this manual.

2. Change the oil in the oil sump.

**Note:** If an oil analysis program is being implemented, use the set procedures established with the program. The time between changes can be extended based on the analysis results.

3. Replace the oil system filter. While other methods are commonly practiced in the field, the recommended procedure for removing the oil filter (or element filter in an oil cooler) from a unit under negative pressure requires the use of dry nitrogen to bring the unit up to atmospheric pressure. Once the old filter is replaced and reassembly completed, the unit must be purged.

**Note:** If the unit is under a positive pressure, the entering and leaving lines at the oil filter (or oil cooler) must be disconnected. Be sure to plug the open end of each line with a flare fitting plug to reduce refrigerant loss during the filter changeout procedure.

4. Inspect the condenser tubes for fouling; clean if necessary.

5. Measure the compressor motor winding resistance to ground; qualified service personnel should conduct this procedure to ensure that the findings are properly interpreted.

6. Contact a qualified service organization to leak-test the chiller; this procedure is especially important if the system requires frequent purging.

**Caution: If frequent purging is required, identify and correct the source of the air or water leak as soon as possible. Moisture contamination caused by leakage can shorten the life expectancy of the machine.**

Remember that if the system will be off for an extended period of time, the purge unit must be operated for approximately 30 minutes every two weeks to keep the chiller free of air and noncondensibles. Since the machine is not providing chilled water, cool water (i.e., less than 80 F) must be supplied to the purge condenser drum by adjusting the water valves to provide alternate water flow through the purge condenser.

## Other Maintenance Recommendations

1. Use a nondestructive tube test to inspect the condenser and evaporator tubes at three-year intervals.

**Note:** It may be desirable to perform tube tests on these components at more frequent intervals, depending upon chiller application. This is especially true of critical process equipment.

2. Depending upon chiller duty, contact a qualified service organization to determine when to conduct a complete examination of the unit to discern the condition of the compressor and internal components.

Conditions which may dictate shorter intervals between chiller inspections include:

a. chronic air leaks, which can cause acidic conditions in the compressor oil and result in premature bearing wear; and,

b. evaporator or condenser water tube leaks. Water mixed with the compressor oil can result in bearing pitting, corrosion, or excessive wear.

3. Submit a sample of the compressor oil to a qualified laboratory for comprehensive analysis on an annual basis; such an analysis will determine the system moisture content, acid level and wear metal content of the oil, and can be used as a diagnostic tool.

Figure 21
CVHE Annual Inspection Checklist and Report

# Model CVHE CenTraVac
# Annual Inspection Checklist and Report

1. **Review Unit with Operating Personnel.**

2. **Compressor Motor.**

   __Motor Continuity Check __Good __Open
   __Check and Tighten Motor Terminals
   __Meg Motor __Phase 1 __Phase 2 __Phase 3
   __Check Nameplate Amp Rating __Amps

3. **Starter.**

   __Check Overload Setting __Trip Point, Amps
   __Tighten all Terminals
   __Check Condition of Starter
   Contacts __Good __Fair __Replace

4. **Oil Sump.**

   __Change Oil __Gallons (7 Gallons Required)
   (If Oil Analysis, Refer to Program Procedures)
   __Check Oil Condition __Good __Fair __Poor
   __Check Oil Temperature Control Setting __°F
   __Oil Pump Motor Continuity Test __Good __Open
   __Oil Pump Motor Ground Check __Good __Bad
   __Check Motor Terminals, Tighten
   __Check Magnetic Starter
   __Clean all Strainers
   __Change Hi-Density Filter

5. **Control Circuits.**

   __Low Temperature Control Calibration
   __Setpoint __Trip-Point (Ice Water)
   __High Pressure Control Calibration
   __Setpoint __Trip-Point (Use Oil-Pumped Dry Nitrogen to Check)
   __Oil Pressure Control Calibration
   __Cut-Out __Cut In
   __Check Adjustment and Operation of Damper Motor

6. **Condenser.**

   __Visually Inspect for Scaling in Tubes, Note Findings and Make Recommendations

7. **Leak Test Chiller.**

8. **Refrigerant and Oil Analysis for Acid Content.**
   (Attach Copy of Analysis to Next Monthly Inspection Report)

   __Sample Refrigerant and Oil for Lab. Analysis

9. **Purge Unit.**

   __Check Condition and Level of Float Valve
   __Meg Purge Unit Motor __To Ground
   __Motor Condition __Clean __Dirty
   __Lubricate Motor
   __Make Leak Check at Connections
   __Check Relief Valve Action
   __Check Compressor Efficiency
   __Disassemble and Clean Purge Tank and Coil

10. **Cover Logs and Logging System with Operator**

    __Review Proper Logging Procedures with Operator

11. **Comments.**

    ______________________________
    ______________________________
    ______________________________

12. **Recommendations.**

    ______________________________
    ______________________________

## Purge Unit Maintenance

Before conducting the purge maintenance procedures described in the following paragraphs, shut down purge unit operation.

**WARNING: Before attempting to perform any maintenance on the purge unit, disconnect the electrical power supply to the purge unit heater and purge compressor drive motor. To prevent injury or death due to electrical shock or contact with moving parts, verify that all power switches are locked or safetied in the "OFF" position.**

The compressor in the purge unit has been tested and found to have an acceptable leak rate during the first 1500 hours of normal purge operation. This performance has been obtained through the use of rings specifically designed for this application.

**Note:** Replacement of the compressor or rings with standard parts will result in refrigerant loss at a rate approximately eight times greater than the Trane version.

The rings will have to be replaced at 1500 hour intervals or excessive refrigerant will be lost. Contact a local Trane service technician for ring replacement.

## Purge Drum Cleanup

The purge drum should be disassembled annually for cleaning and maintenance. Use the procedure outlined below to remove the purge drum from the chiller.

**WARNING: Open and lock unit disconnect to prevent injury or death due to electrical shock or contact with moving parts.**

1. Isolate the purge suction line by closing the isolator valve at the condenser.

2. Isolate the refrigerant return line by closing the isolator valve at the evaporator.

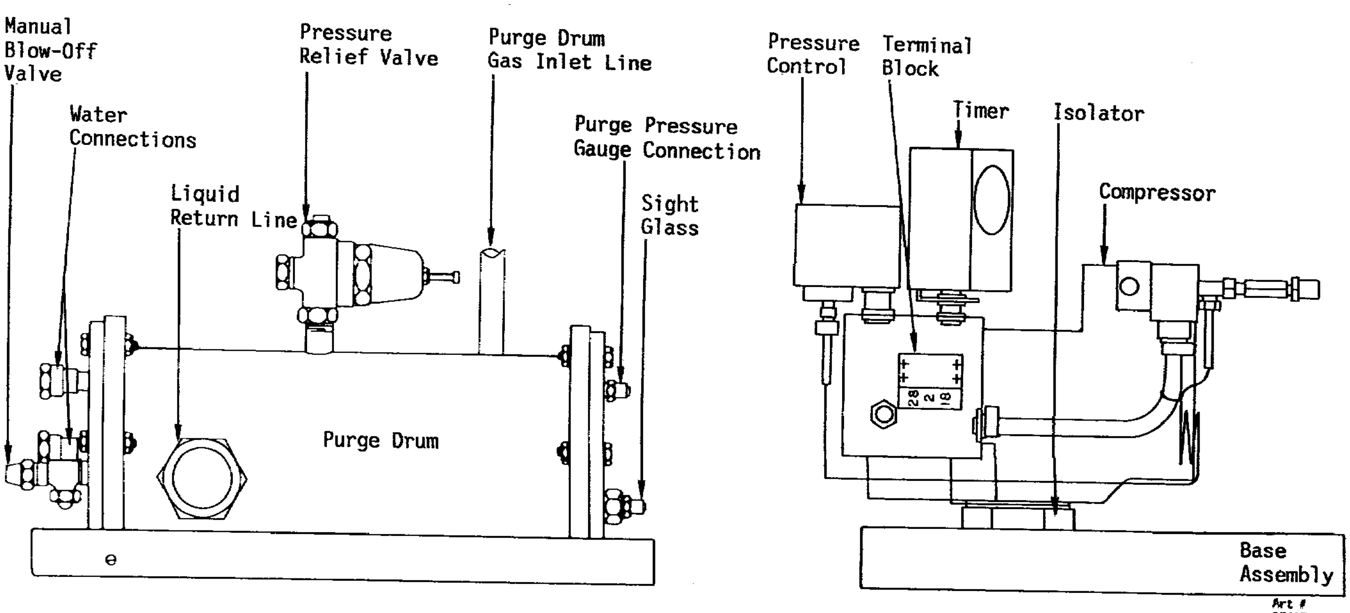
3. Close all of the water supply and return valves to the purge drum; then, disconnect the water connections at the drum. Refer to Figure 22 for an illustration of the purge drum.

4. Disconnect the evaporator liquid return line connection at the purge drum.

5. Detach the purge drum gas inlet line.

6. Remove the four purge drum base plate retaining screws.

**Figure 22**
**Purge Unit Components**



7. Clean the purge drum water coil using the step-by-step instructions provided below:

a. Remove the six end plate retaining screws from the water connection end of the purge drum; see Figure 23.

b. Remove the end plate with attached coil and gasket. Refer to Figure 24.

c. Clean the outside of the water coil with a brush or solvent.

**Caution: To prevent damage to the water coil, do NOT use a wire brush to clean the coil surface.**

d. Clean the inside of the purge drum with a solvent. (Again, do not use a wire brush or the interior surface of the drum may be damaged.)

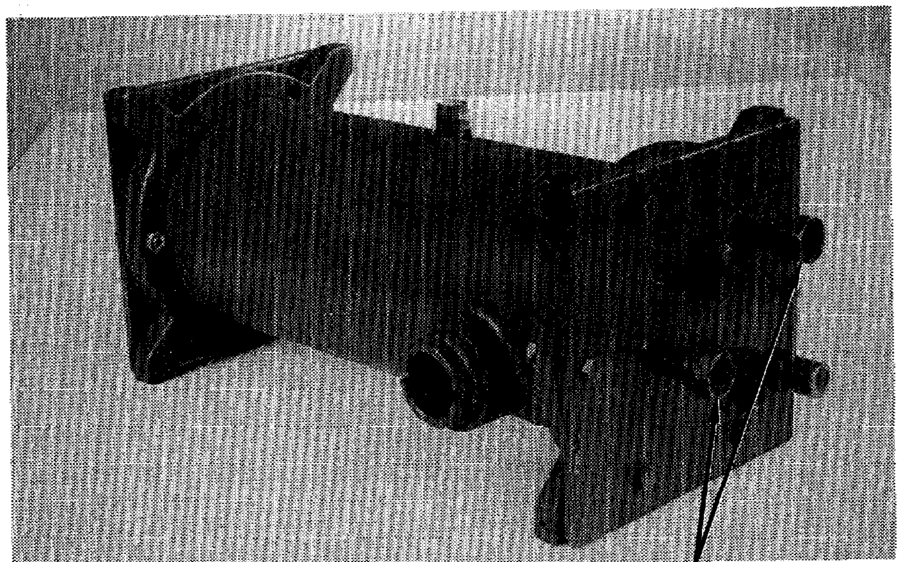
e. Clean the small vent hole at the top of the divider plate; this hole must be open. Refer to Figure 25 for vent hole location.

f. Circulate a chemical cleaning solution through the water coil to remove scale from the interior surfaces.

8. Use the procedure outlined below to remove and clean the float valve assembly:

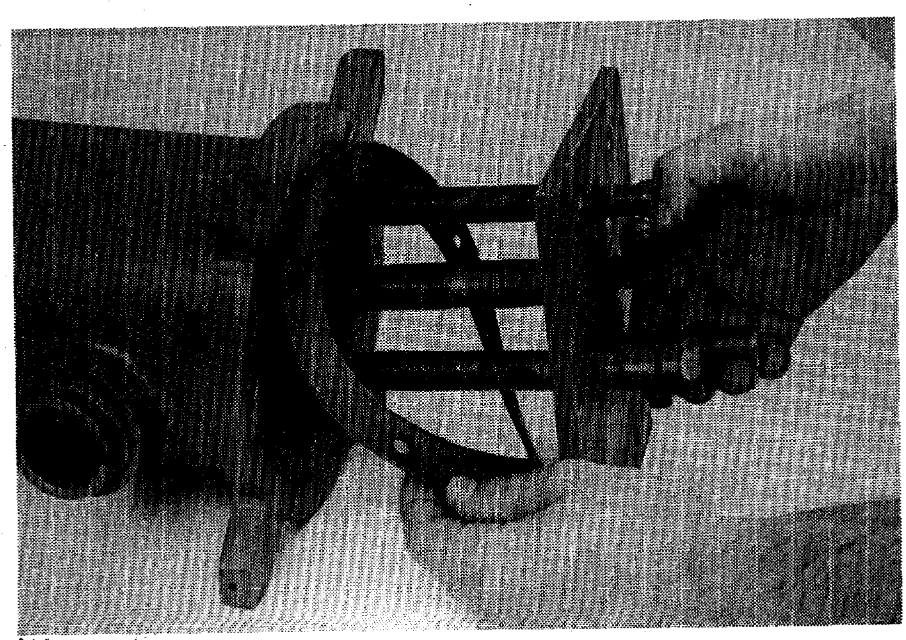
a. Remove the six end plate retaining bolts from the refrigerant connection end of the purge drum.

**Figure 23**
**Purge Unit Assembly**




Art #
RF/CTV-1725

**Figure 24**
**Removing Drum End Plate, Including Water Coil and Gasket**



Art #
RF/CTV-1726

b. Remove the end plate and gasket shown in Figure 26.

c. Clean the inside of the purge drum with a solvent; do not use a wire brush or the interior surface of the drum may be damaged.

Be sure to check the small hole at the top of the drum divider plate and the slot at the bottom - both should be open.

d. Remove the cotter pin from the float valve assembly; see Figure 26.

e. Clean or replace the float valve seat shown in Figure 27. (To remove the seat, remove the 1/4-inch angle fitting and the float seat retaining nut.)

f. Examine the viton washer identified in Figure 28; if it is cracked or hardened, replace it.

g. Check the condition of the float; if necessary, it can be detached for replacement by removing the retaining screw.

9. Reassemble the purge drum by reversing the order of disassembly. Be sure to use new gaskets on the end plates, but do not use oil or grease on the gaskets and flanges. Tighten the end plate bolts evently until the gaskets just begin to protrude between the flanges.

10. Pressure test all joints at 30 psig using dry nitrogen and R-12 as a tracer.

## Purge Drum Water Elimination

Water condensed in the purge drum floats on the surface of the liquid refrigerant. Normally, a line of separation can be seen through the purge drum sight glass.

To remove water from the drum, operate the purge compressor until a positive pressure of 5 to 10 psig is indicated on purge drum pressure gauge. Then turn off the purge compressor and open the blow-off valve (Figure 22) until all of the water has drained away.

**Caution: If frequent purging is required, identify and correct the source of the air or water leak as soon as possible. Moisture contamination caused by leakage can shorten the life expectancy of the machine.**

## Lubrication

The only components of the CVHE CenTraVac that require periodic lubrication are the bearing surfaces of the external vane linkage assembly, and the flow diverter on the optional automatic condenser cleaning system.

Lubricate the vane shaft bearings and the rod end bearings on the vane linkage with a few drops of light machine oil. For flow diverter lubrication, refer to "Periodic Maintenance".

**Figure 25**
**Interior of Purge Drum (Viewed from Either End)**

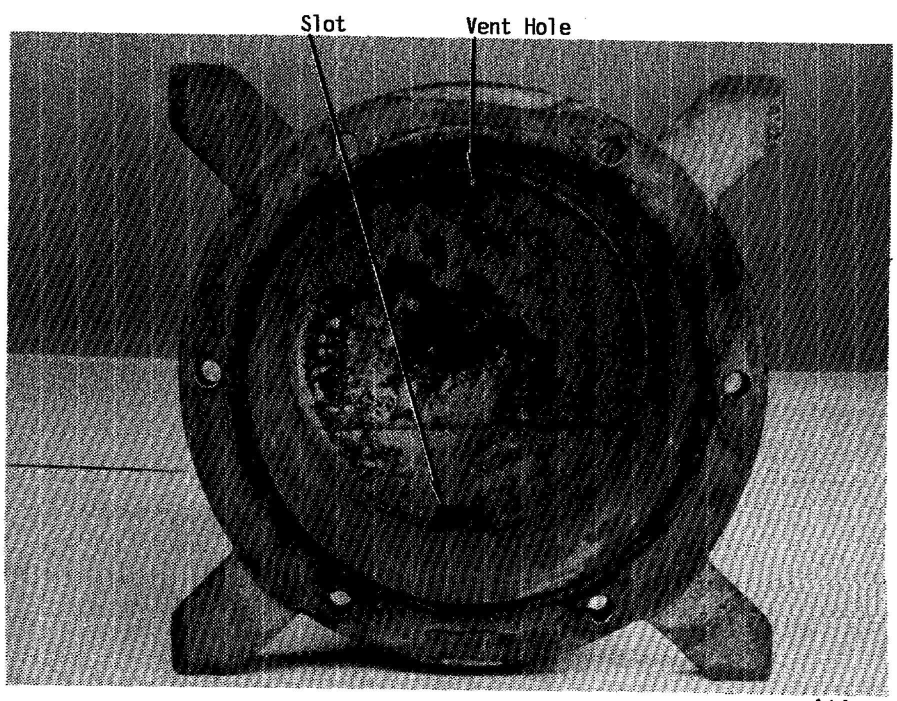


Figure 26
Purge Drum Float Assembly

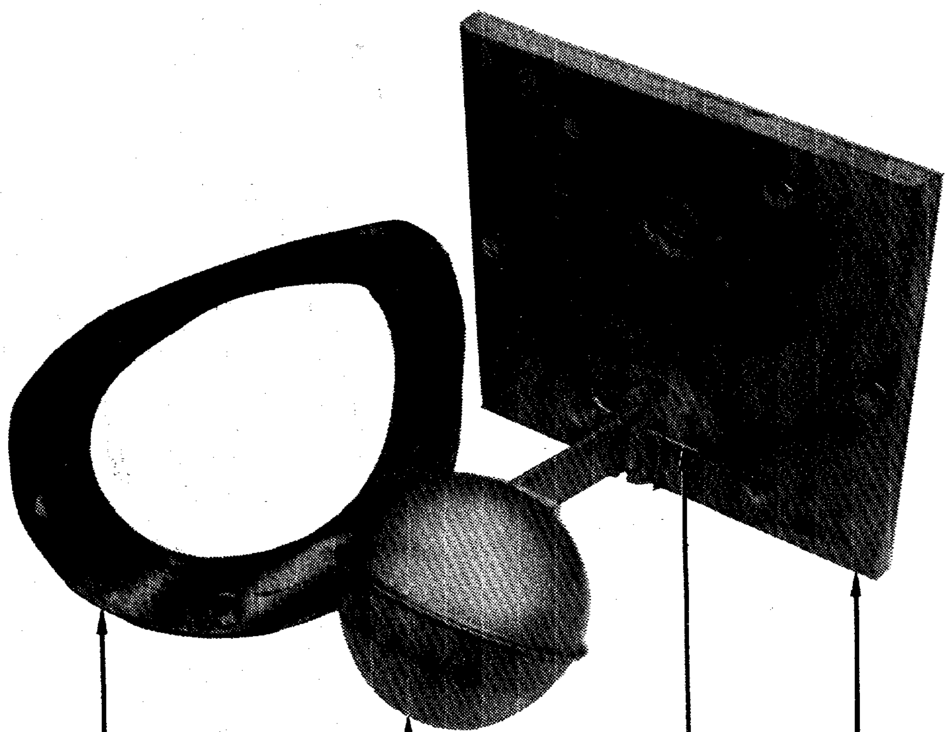



Figure 27
Valve Seat Location

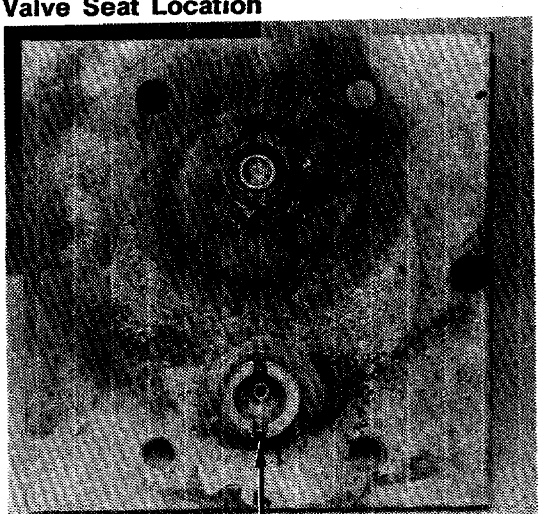
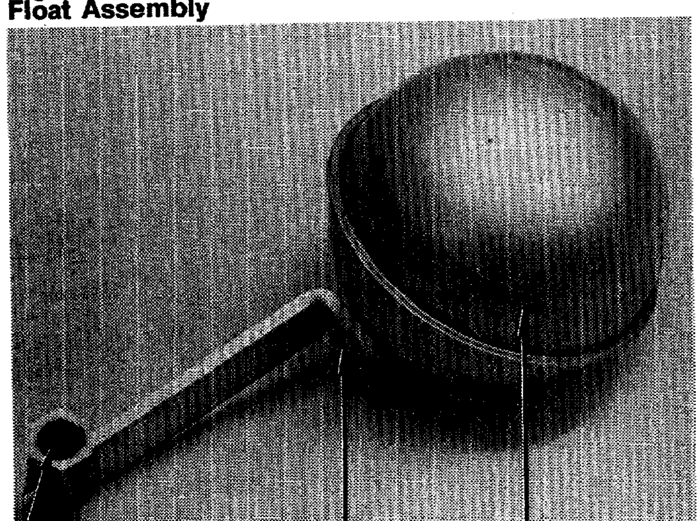



Figure 28
Float Assembly



## Refrigerant Charge

To determine the refrigerant charge in the chiller, it is necessary to draw off the refrigerant and weigh it back into the machine. If the unit is low on refrigerant, contact a qualified service organization to ensure that the proper amount of refrigerant is added.

## Cleaning the Condenser

**Caution: Do not use untreated or improperly treated water, or equipment damage may occur.**

Condenser tube fouling is indicated when the approach temperature (i.e., the difference between the refrigerant condensing temperature and the leaving water temperature) is higher than predicted. If the annual condenser tube inspection indicates that the tubes are fouled, two cleaning methods--mechanical and chemical--can be used to rid the tubes of this foreign matter.

Use the mechanical cleaning method to remove sludge and loose material from the condenser tubes:

1. Remove the retaining nuts and bolts from the water box covers at each end of the condenser. Use a hoist to lift the covers off the water box. (A threaded connection is provided on each water box cover to allow the insertion of an eyebolt.)

2. Work a round nylon or bristle brush (attached to a rod) in and out of each of the condenser water tubes to loosen the sludge.

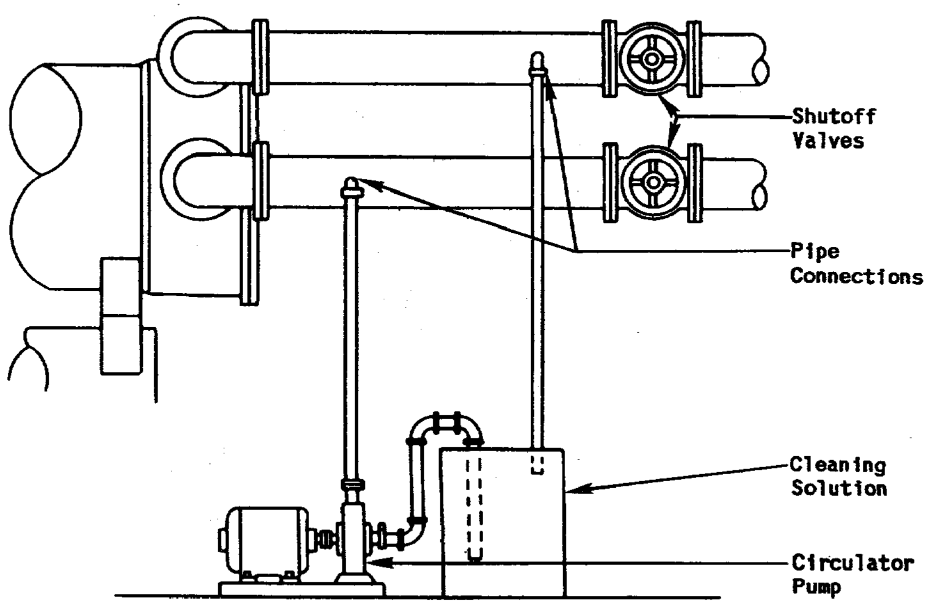
3. Thoroughly flush the condenser water tubes with clean water.

Scale deposits are best removed by chemical means. Be sure to consult any large chemical house in the area (i.e., since they will know the chemistry of the water) for a recommended cleaning solution suitable for the job. (Remember that the standard condenser water circuit is composed solely of copper, cast iron and steel.) Refer to Figure 29 for an illustration of a typical chemical cleaning setup.

All of the materials used in the external circulation system, the quantity of the solution, the duration of the cleaning period, and any required safety precautions should be approved by the company furnishing the materials or performing the cleaning. Remember, however, that whenever the chemical tube cleaning method is used, it must be followed up with mechanical tube cleaning. The Trane Company assumes no liability for equipment damage caused by improper cleaning procedures.

**Note:** Since the evaporator is typically part of the closed circuit, it does not accumulate appreciable amounts of scale or sludge. However, if cleaning is deemed necessary, use the same cleaning methods described above for the condenser tube bundle.

**Figure 29**
**Typical Chemical Cleaning Setup**



## Cleaning the Auxiliaries

If the coils of the purge unit are supplied with water from the same source as that used by the evaporator, they will be subjected to the same type of scaling. When cleaning is required, use the same chemical cleaning method described for the condenser; be sure to thoroughly flush the chemically-cleaned parts with clear water before connecting them to the remainder of the water circuit.

**Note:** If the auxiliaries are piped into the chilled water circuit only, cleaning is usually not necessary.

**Caution: Do not use untreated or improperly treated water, or equipment damage may result.**

## Compressor Oil

**Caution: To prevent the possible burnout of the oil sump heater, be sure to open the control panel disconnect switch before draining the sump.**

Approved oils for CVHE CenTraVac chillers are Mobil Whiterex No. 425 and Texaco WF-68; the design oil charge for all units is seven gallons. If these oils cannot be obtained, contact your local Trane representative for recommendations.

**Note:** An oil transfer pump can be used to change the compressor motor oil incidentally of machine pressure.

## Draining the Oil Sump

The saturation pressure of R-11 is less than atmospheric pressure at temperatures below 75 F, and greater than atmospheric pressure at temperatures above 75 F. If the ambient temperature is 75 F or above and the evaporator pressure gauge indicates a positive pressure, open the oil sump charging valve located at the rear of the oil sump and drain the oil into a suitable container.

If the ambient temperature is less than 75 F and the evaporator pressure gauge indicates a negative pressure, the oil must be pumped and drawn from the sump. To do this:

1. Connect a line from an auxiliary oil pump to the oil charging valve located at the rear of the oil sump.

2. Operate the auxiliary oil pump and open the charging valve.

3. After the oil is removed from the sump, close the charging valve.

**Note:** In lieu of an auxiliary pump, the oil can also be forced from the sump by using dry nitrogen to build a slight positive pressure in the unit.

## Filling the Oil Sump

**Note:** The procedure described below is only applicable if the system is under a vacuum. If the ambient temperature conditions and evaporator pressure gauge reading indicate a positive pressure, pump the oil into the system.

Use the procedure outlined below to fill the oil sump. Be sure to charge the oil directly from the container in which it was shipped to prevent dirt and other foreign matter from entering the sump.

1. Connect a clean piece of clear Tygon vacuum tubing to the oil charging valve.

2. Submerge the open end of the tubing in the container of oil.

3. Open the oil charging valve; if the system is under a vacuum, the oil will be drawn readily from the container.

**Caution: To prevent the entry of air into the oil sump make certain that the open end of the tube remains submerged in the oil during the entire charging process. Close the charging valve before raising the tube above the surface of the oil.**

4. After the sump is full, close the control panel disconnect switch to energize the oil sump heater.

## Control Settings and Adjustments

For your reference, a list of the CVHE controls and their settings is provided in Table 3. For control calibration and checkout procedures, contact a qualified service organization.

**Table 3**
**CVHE Control Settings**

| Control | Setting |
|---|---|
| High Pressure Control (S1)[1] | 15 psig cutout, 5 psi differential |
| Low Refrigerant Temp. Control (S2) | Opens as necessary on a fall in refrigerant temperature; adjustable |
| Chilled Water Demand Control (S3) | As Required |
| Oil Pressure Control (S8) | Cut-in = 15 psid, Cut-out = 8 psid |
| Oil Temperature Control (S10) | 150 F setpoint, 5 F differential |
| Purge High Pressure Control (S13) | 30 psig cutout, 10 psi differential |

**Note:** If the ASME construction stamp appears on the condenser shell, the *HPC cutout point is 25 ± 5 psig.*

# Trouble Analysis

To use the troubleshooting charts provided on the following pages, use the instructions outlined below:

1. Locate the chart that pertains to the general category of the problem experienced (i.e., Chart A = Unit Start-Up, Chart B = Unit Operation, Chart C = Lubrication System, Chart D = System Temperatures and Pressures, and Chart E = Automatic Condenser Cleaning System Option).

2. After locating the proper chart, determine which of the problem types listed horizontally across the top of the chart is applicable. Notice that the trouble analysis chart for the automatic condenser cleaning system is divided into three columns: "Symptom", "Probable Cause", and "Recommended Action".

3. Use the symptoms listed on the slanted lines to pinpoint the specific problem being experienced. (Legends identifying the control panel lights and circuit breakers are provided on Chart A for your reference.)

4. Trace down the vertical column directly beneath the problem identified in Step 3 to the numbered boxes. The horizontal lines on which the numbered boxes occur indicate the possible causes (left-hand side) and the recommended actions (right-hand side).

The numbers in the boxes indicate the order of probability in which these causes are likely to occur, and the sequence in which the recommended actions should be checked.

**Note:** These troubleshooting charts are provided solely as a guide for determining the cause of mechanical failure or equipment malfunction. When operational problems do occur, be sure to contact a qualified service organization to ensure proper diagnosis and repair of the unit.

## Chart A: Trouble Analysis - Unit Start-Up

Panel Light Legend
DS1 Safeties Satisfied
DS2 Cooling Required
DS3 Restart Time Elapsed
DS4 Chilled Water
DS5 Condenser Water
DS6 Oil Pump
DS7 System

Circuit Breaker Legend
CB-1 Low Oil Pressure
CB-2 Hi Cond. Pressure
CB-3 Low Refrig. Temp.
CB-4 Hi Motor Temp.
CB-5 Starter Fault
CB-6 Hi Oil Temp.

| | Unit Will Not Start | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Compressor Motor Starter Will Not Pull In | | | | | | | | | |
| | Oil Pump Will Not Run | | | | | Oil Pump Runs | | | | |
| Panel Light On | None | DS1 ON | DS2 | DS3 | DS4 | DS4 | DS6 | DS7 | DS7 | |
| Symptom | No Voltage To F1 Side of DS1 Light | No Voltage to F1 Side of DS2 Light | No Voltage to F1 Side of DS3 | No Voltage to F1 Side of DS4 | No Voltage to F1 Side of DS6 | No Voltage to F1 Side of DS6 | No Voltage to F1 Side of DS7 | No Voltage to K23-24 Relays in Comp. Motor Starter | Comp. Motor Starter Pulls In, To Transition or Immediate CB-5 Trip | |
| POSSIBLE CAUSE | | | | | | | | | | RECOMMENDED ACTION |
| Main Disconnect Open | 2 | | | | | | | | | Close Main Disconnect |
| No Control Voltage | 3 | | | | | | | | | Check Control Circuit Fuse |
| Safety Tripped | 4 | | | | | | | | | Reset Safety Control Circuit Breakers (See Charts C & D For Causes) |
| Loose Wiring or Connectors | 5 | 2 | 2 | 6 | | 2 | 3 | 1 | | Check Wiring |
| S3 - Start-Stop Thermostat Open | | 1 | | | | | | | | No Call For Cooling |
| S4 Program Timer Open | | | 1 | | | | | | | Restart Time Not Elapsed |
| A3 Vane Actuator end Switch Open | | | | 1 | | | | | | Check Vane Position |
| S10 Low Oil Sump Temp. Thermostat Open | | | | 5 | | | | | | Check Oil Sump Temperature |
| S1 High Cond. Press. Switch Contacts Not Closed | | | | 4 | | | | | | Check S1 Switch Contacts |
| K9 Normally Closed Contacts Open | | | | 2 | | | | | | Check Relay Contacts |
| S5 Evap. Chilled Water Flow Switch Open | | | | 3 | | | | | | Check Evap. Water Flow |
| S6 Switch (S-6) In Off Position | | | | | 1 | | | | | Check Switch Position |
| S8 Oil Pressure Switch Not Closed | | | | | | 1 | | | | Check Oil Pressure (Oil Filter, Pressure, Regulator, Oil Pump Defective). |
| S4 Program Timer Holding Unit Off | | | | | | | 1 | | | Check S4 Contacts 13-81 and 81-82 |
| K10 Normally Closed Contact Open. | | | | | | | 2 | | | Check S4 Timer. Check For Defective K10 Contacts |
| Not Energizing | | | | | 3 | | | | | Check For Defective K1 Contacts. S9 Contacts, F2-21 Open, or Defective K-5 Contacts |
| Oil Pump Motor Defective | | | | | 2 | | | | | Meg Oil Pump Motor |
| Compressor Motor Starter Defective | | | | | | | | | 1 | Contact a Qualified Service Organization |
| Compressor Motor Defective | | | | | | | | | 2 | Contact a Qualified Service Organization |
| Main Electrical Power Distribution | 1 | | | | | | | | 3 | CONTACT POWER COMPANY |

## Chart B: Trouble Analysis - Unit Operation

| POSSIBLE CAUSE | COMPLAINT: Unit Runs For A While Then Stops — SYMPTOM: Safety CKT Breakers Open | Unit Runs For A While Then Stops — Demand Switch S-3 Closes and Opens | Unit Runs For A While Then Stops — Starter Overloads Trip Out | Unit Runs For A While Then Stops — No Apparent Symptoms | Unit Runs Without Stopping — Does Not Lower Water Temperature | Unit Runs Without Stopping — Lower Water Temp. Slightly | Unit Surges (Squealing or Buffeting Sound From Compressor) — High Condenser Pressure | Unit Surges (Squealing or Buffeting Sound From Compressor) — Low Evaporator Pressure | Unit Hunts — Loads and Unloads Continuously | Unit Carries Over — Disch. and Suction Temp. Low | Fluctuating Amps — Ammeter Reading Not Steady | RECOMMENDED ACTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit Shutdown On Safety Controls | 1 | | | | | | | | | | | Refer to "Unit Starting" Chart A |
| Low Load On System | | 1 | | | | | | | | | 4 | Normal Operation, Lower Cut-Out Point and Widen Differential to Reduce Cycling |
| Chilled Water Demand Switch Faulty or Improperly Set | | 2 | | | | | | 3 | | | | **Contact a Qualified Service Organization** |
| Temp. Controller Faulty or Improperly Set | | 3 | | | 1 | 2 | | 2 | 6 | | 1 | **Contact a Qualified Service Organization** |
| Low Water Flow Through Evap. Air In Water Circuit | | 4 | | | | | | | 4 | | | Check Water Pumps, Strainers, Valves |
| Motor Overload Out of Adj. | | | 1 | | | | | | | | | **Contact a Qualified Service Organization** |
| Low Voltage To Unit | | | 2 | | | | | | | | | Contact Power Company |
| Current Control Faulty or Improperly Adjusted | | | 3 | | | | | | | | | **Contact a Qualified Service Organization** |
| Vane Operator Faulty or Out of Adjustment | | | 4 | | | | | | | | | **Contact a Qualified Service Organization** |
| Compressor Motor Faulty | | | 5 | | | | | | | | | **Contact a Qualified Service Organization** |
| Interlocks Faulty | | | | 1 | | | | | | | | Check Opr. of Water Pumps, Flow Switches, etc. |
| Fluttering Flow Switches | | | | 3 | | | | | | | | Check Location of Switches. Bleed Air From Water Circuit |
| Auxiliary Run Contacts On Starter Faulty | | | | | 2 | 4 | | | | | | Clean or Replace |
| Low Refrigerant Charge | | | | | 3 | 5 | | 6 | 2 | | | **Contact a Qualified Service Organization** |
| Air In Water Circuit | | | | 2 | 4 | 6 | 2 | 4 | 5 | | | Vent Air From Water Circuit |
| Loose Wiring or Connections | | | | 4 | 5 | 7 | | | | | | Check Continuity of Circuit to Locate - Repair |
| Oil In Evaporator | | | | | 6 | 9 | | | | 2 | | Run Unit at Part Load to Bring Oil Back to Sump. Check For Blocked or Loose Oil Lines. Check Distill System |
| Load Too Great For Unit | | | | | | 1 | | | | | | Check Building for Excessive Heat Load |
| Current Control Switch Set Too Low | | | | | 7 | 3 | | | | | | Raise Setting |
| Evaporator Tubes Fouled | | | | | | 8 | | | | | | Clean Tubes - Check Water Treatment |
| High Condenser Pressure | | | | | | | 1 | | | | | See Chart D |
| Low Evaporator Pressure | | | | | | | | 1 | | | | See Chart D |
| Overcharge of Refrigerant | | | | | | | | | | 1 | | **Contact a Qualified Service Organization** |
| Blocked Orifice Plates | | | | | | | | 5 | | | | **Contact a Qualified Service Organization** |
| System Water Returning to Unit Too Warm | | | | | | | | | | 3 | | Reduce Current Control Setting if Just Starting Unit. Check Bldg. for Excessive Heat Load |
| Unit Carrying Over | | | | | | | | | 3 | | 2 | See Column On "Unit Carries Over" |
| Unit Surging | | | | | | | | | | | 3 | See Column On "Unit Surges" |
| Low Press. Override Faulty or Improperly Set | | | | | | | | | 1 | | | **Contact a Qualified Service Organization** |

## Chart C: Trouble Analysis - Lubrication

| POSSIBLE CAUSE | COMPLAINT: Unit Trips on Low Oil Pressure / SYMPTOM: CB1 Trips | COMPLAINT: Oil Pressure Too High / SYMPTOM: Net Oil Pressure Above 35 PSIG | COMPLAINT: Oil Sump Too Cold / SYMPTOM: Sump Temp. Below 125 F | COMPLAINT: Oil Sump Too Hot / SYMPTOM: Sump Temp. Above 160 F | COMPLAINT: Unit Loses Oil / SYMPTOM: Oil Level Below Sight Glass | COMPLAINT: Excess Refrig. In Oil / SYMPTOM: Oil Sump Foams Excessively | RECOMMENDED ACTION |
|---|---|---|---|---|---|---|---|
| Oil Filter Dirty | 1 | | | | | | Change Filter Element |
| Oil Cold - Refrig. In Oil | 2 | | | | | | Check "Oil Sump Too Cold" Column |
| Oil Press. Control Faulty Or Out of Adjustment | 3 | | | | | | **Contact a Qualified Service Organization** |
| Oil Press. Regulator Faulty or Out of Adjustment | 4 | | | | | | **Contact a Qualified Service Organization** |
| Low Oil Level In Sump | 5 | | | | | | See Column on "Unit Loses Oil" |
| Faulty Oil Pump | 6 | | | | | | Replace |
| Improper Oil | 7 | 1 | | | | | Change Oil and Use Recommended Oil Only |
| Faulty Gauge | 8 | 2 | 5 | | | | **Contact a Qualified Service Organization** |
| Temp. Control Faulty or Out of Adjustment | | | 1 | | | | **Contact a Qualified Service Organization** |
| Faulty Oil Heater | | | 2 | | | | Check Operation of Heater |
| Excessive Refrig. In Oil | | | 3 | | | | See Column on "Excess Refrig. In Oil" |
| Oil Pump Continues to Run When Unit Stops | | | 4 | | 2 | 3 | If Pump Runs More Than 3 Min., Check for Defective K5 Contacts, S-9 Timer, K-1 Contacts |
| Oil Sump Too Cold | | | | | 3 | 2 | See "Oil Sump Too Cold" Column |
| Loose or Blocked Oil Lines | | | | | 1 | | Check External Line For Leaks - Contact **a Qualified Service Organization** To Inspect Internal Lines |
| Oil Sump Vent Open Too Far | 10 | | 7 | | | | **Contact a Qualified Service Organization** |
| Oil Sump Vent Not Open Far Enough | | | | 2 | 5 | 5 | **Contact a Qualified Service Organization** |

## Chart D: Trouble Analysis - System Temperatures and Pressures

| POSSIBLE CAUSE | COMPLAINT: High Cond. Pressure / SYMPTOM: CB2 TRIPS | Low Cond. Pressure / Condenser Excessively Cool | Low Evap. Pressure / CB3 Trips | High Evap. Pressure / Evaporator Excessively Warm | Low Oil Pressure or Temperature / See Chart C | High Oil Pressure or Temperature / See Chart C | Motor Temp. High / CB4 Trips | RECOMMENDED ACTION |
|---|---|---|---|---|---|---|---|---|
| Condenser Dirty | 1 | | | | | | | See "Cleaning Condenser" |
| Air In Water Circuit | 2 | | 7 | | | | | Vent Air From Circuit |
| High Press. Control Faulty or Out of Adjustment | 3 | | | | | | | **Contact a Qualified Service Organization** |
| Safety Control Relay Faulty | 4 | | | | | | | Replace |
| Loose Wiring or Connections | 5 | | | | | | | Check Continuity of Circuits - Repair |
| Temp. Control Faulty or Improperly Set | | | 1 | | | | | **Contact a Qualified Service Organization** |
| Vane Operator Faulty or Out of Adjustment | | | 2 | | | | | **Contact a Qualified Service Organization** |
| Low Water Flow Through Evaporator | | | 3 | | | | | Check Water Pumps, Strainers and Valves |
| Chilled Water Demand Switch Faulty or Improperly Set | | | 4 | | | | | **Contact a Qualified Service Organization** |
| Low Refrigerant Charge | | | 5 | | | | | **Contact a Qualified Service Organization** |
| Low Press. Control Faulty or Improperly Set | | | 6 | | | | | **Contact a Qualified Service Organization** |
| Blocked Orifice Plates | | | 8 | | | | | **Contact a Qualified Service Organization** |
| Light Load on Unit | | 1 | | 1 | | | | Normal Operation |
| Unit Not Lowering Water Temperature | | | | 2 | | | | See Chart B "Unit Runs Without Stopping" |
| Blocked Motor Cooling Line | | | | | | | 1 | Check Motor Cooling Sight Glass For Flow - Clean Strainer Make Sure Service Valves are Open |
| Motor Temp. Control Faulty | | | | | | | 2 | Replace |
| Voltage Imbalance In Power Circuit | | | | | | | 3 | Contact Power Company to Correct |
| Compressor Motor Faulty | | | | | | | 4 | **Contact a Qualified Service Organization** |

## Chart E: Trouble Analysis: Automatic Condenser Cleaning System (Optional)

| Symptom | Probable Cause | Recommended Action |
|---|---|---|
| Incomplete Sequence Alarm light on. Normal and reverse lights illuminate properly. | Inadequate air pressure. | Check supply pressure. |
| | Choppy movement of diverter plug. | Contact your service company to readjust plug. |
| | Solenoid valve sticking or exhaust restrictor(s) partially plugged. | Clean solenoid valve/ exhaust restrictor(s); check condition of air. |
| | Exhaust restrictor screw(s) not set properly. | Reset screws for proper transfer time. Be sure to tighten lock nuts. |
| | Setting of 2TR timer less than actual transfer time. | Re-adjust setting of 2TR timer to reflect actual transfer time. |
| | Air leak in:<br>a. Air lines/connections<br>b. Actuator cylinder seals. | <br>Isolate and repair leak.<br>Contact service company to install repair kit. |
| Incomplete Sequence Alarm light on but normal and reverse lights not lit. Diverter in correct position. | Position indicator switch not being depresssed. | Contact service company for adjustments or repair. |
| | Faulty position indicator switch. | Replace switch. |
| | Faulty 2TR timer. | Replace timer. |
| Normal or Reverse lights not on. Diverter in correct position. Incomplete Sequence Alarm light not on. | Lamp(s) faulty. | Check indicator lights; replace bulb(s) if needed. |
| No panel lights on. | Fuse blown. | Replace fuse; check incoming power. |
| | No power at panel. | Check power source. |
| Diverter won't cycle. Cycle count lower than expected. | 24 hour time clock malfunctioning. | Check time clock operation; contact service company for repair or replacement. |
| | 1TR timer malfunctioning. | Check timer operation; contact service company for repair or replacement. |
| | No/low air pressure. | Check supply pressures. |
| | Diverter plug stuck. | Contact service company to readjust plug. |
| | Solenoid valve stuck, or exhaust restrictors plugged. | Clean solenoid valve/ exhaust restrictors; check condition of air. |
| Water leaking from packing area. | Packing gland loose. | Tighten packing gland. |
| | Packing needs replacement. | Contact service company to replace packing. |
| Water hammer occurs during diverter cycling. | Transfer time too fast. | Throttle exhaust restrictors to slow diverter transfer time. |

## CENTRAVAC OPERATING LOG

TRANE AIR CONDITIONING

Unit Designation ______________ Unit Serial No. ______________ Date ______________

Operator ______________ Time Started ______________ AM _ PM _

| STATION | READING | HOUR OR LOGGING TIME | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| | Voltage | | | | | | | | |
| | Amperage | | | | | | | | |
| | Oil Temp-Sump °F | | | | | | | | |
| | Oil Level | | | | | | | | |
| | Oil Gauge Pressure psig | | | | | | | | |
| | Evap. Gauge Pressure psig | | | | | | | | |
| | Cond. Gauge Pressure psig | | | | | | | | |
| | Purge Drum Pressure (if operating) psig | | | | | | | | |
| | Condenser Water Pressure Difference - psig | | | | | | | | |
| | Condenser Water - In °F | | | | | | | | |
| | Condenser Water - Out °F | | | | | | | | |
| | Refrigerant Liquid Temp. Condenser - °F | | | | | | | | |
| | Chilled Water Pressure Difference - psig | | | | | | | | |
| | Chilled Water In - °F | | | | | | | | |
| | Chilled Water Out - °F | | | | | | | | |
| | Refrigerant Liquid Temperature Evaporator °F | | | | | | | | |
| | % current | | | | | | | | |

### OPERATORS REPORT

ENTER ALL STARTS-STOPS-PERIODIC MAINTENANCE CHECKS, MALFUNCTIONS, ETC.

### PERIODIC MAINTENANCE CHECKS

WEEKLY

_____ Operate Purge as needed

_____ Check Purge drum for water

QUARTERLY

_____ Check oil in Purge Comp.

_____ Oil Purge comp. motor

_____ Check Purge belt tension

_____ Clean all water strainers

FOR ANNUAL SERVICE INSPECTION

Contact a Qualified Service Organization

Refer to your Trane Operation & Maintenance Manual for Complete Recommendations and Procedures.