



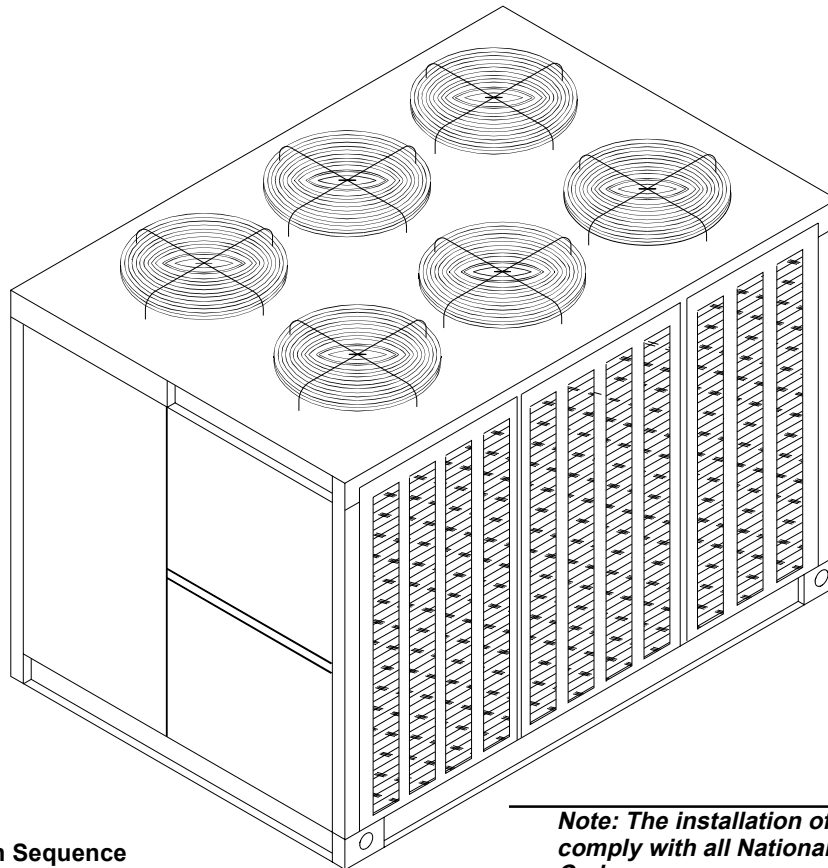
TRANE™

**Installation
Operation
Maintenance**

CAUC-IOM-7

Library	Service Literature
Product Section	Refrigeration
Product	Air Cooled Condenser
Model	CAUC
Literature Type	Installation/Operation/Maintenance
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Remote Air Cooled Condensers



Models

"J" and Later Design Sequence

- CAUC-C20 CAUC-C40
- CAUC-C25 CAUC-C50
- CAUC-C30 CAUC-C60

Note: The installation of this equipment must comply with all National, State, and Local Codes.

About The Manual

Literature Change History

CAUC-IOM-7 (December 2001)

First issue of manual; provides Installation, Operation, and Maintenance instructions for “J” and later design sequence on CAUC 20 through 60 Ton air cooled condensing units.

Overview of Manual

Note: One copy of this document ships inside the control panel of each unit and is customer property. It must be retained by the unit's maintenance personnel.

This booklet describes proper installation, operation, and maintenance procedures for air cooled systems. By carefully reviewing the information within this manual and following the instructions, the risk of improper operation and/or component damage will be minimized.

It is important that periodic maintenance be performed to help assure trouble free operation. A maintenance schedule is provided at the end of this manual. Should equipment failure occur, contact a qualified service organization with qualified, experienced HVAC technicians to properly diagnose and repair this equipment.

Note: The procedures discussed in this manual should only be performed by qualified, experienced HVAC technicians. Do Not release refrigerant to the atmosphere! If adding or removing refrigerant is required, the service technician must comply with all federal, state, and local laws.

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General Information

Model Number Description

All 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 is provided below. Its use will enable the owner/operator, installing contractors, and service engineers to define the operation, specific components, and other options for any specific unit.

When ordering replacement parts or requesting service, be sure to refer to the specific model number, serial number, and DL number (if applicable) stamped on the unit nameplate.

Sample Model No.: CAUC - C60 4 - 2 A 1 0 H, etc.

Digit No.: 1 2 3 4 5,6,7 8 9 10 11 12 13 +

Digit 1 - Unit Type

C=Condenser

Digit 2 - Condenser

A= Air Cooled

Digit 3 - Air Flow

U = Up Flow

Digit 4 - Development Sequence

C = Third

Digits 5, 6, 7 - Nominal Capacity

C20 = 20 Tons

C25 = 25 Tons

C30 = 30 Tons

C40 = 40 Tons

C50 = 50 Tons

C60 = 60 Tons

Digit 8 - Power Supply

G = 200/230/60/3 XL

4 = 460/60/3 XL

5 = 575/60/3 XL

Digit 9 - Condenser Circuit

1 = Single

2 = Dual

Digit 10 - Design Sequence

J = Disconnect Redesign

Digit 11 - Ambient Control

0 = Standard

1 = 0° F

Digit 12 - Agency Approval

0 = None

3 = UL / CSA

Digit 13 - Miscellaneous Options, etc.

H = Copper Fins

1 = Spring Isolators

2 = Rubber Isolators

9 = Packed Stock

Unit Nameplate

One Mylar unit nameplate is located on the outside upper right corner of the control panel door. It includes the unit model number, serial number, electrical characteristics, weight, refrigerant charge, as well as other pertinent unit data. A small metal nameplate with the Model Number, Serial Number, and Unit Weight is located just above the Mylar nameplate, and a third nameplate is located on the inside of the control panel door.

When ordering replacement parts or requesting service, be sure to refer to the specific model number, serial number, and DL number (if applicable) stamped on the unit nameplate.

Hazard Identification

▲ WARNING: Warnings are provided throughout this manual to indicate to installing contractors, operators, and service personnel of potentially hazardous situations which, if not avoided, COULD result in death or serious injury.

▲ CAUTION: Cautions are provided throughout this manual to indicate to installing contractors, operators, and service personnel of potentially hazardous situations which, if not avoided, MAY result in minor or moderate injury.

Unit Description

All air cooled condensing units are designed for outdoor installations with vertical air discharge. These units may be installed on a flat roof or placed on a concrete slab at ground level.

Before shipment, each unit is leak-tested, evacuated, a **Nitrogen** holding charge is added, and the controls are tested for proper operation.

The condenser coils are aluminum fin, bonded to copper tubing. Copper-fin coils are optional. Louvered condenser grilles for coil protection are standard.

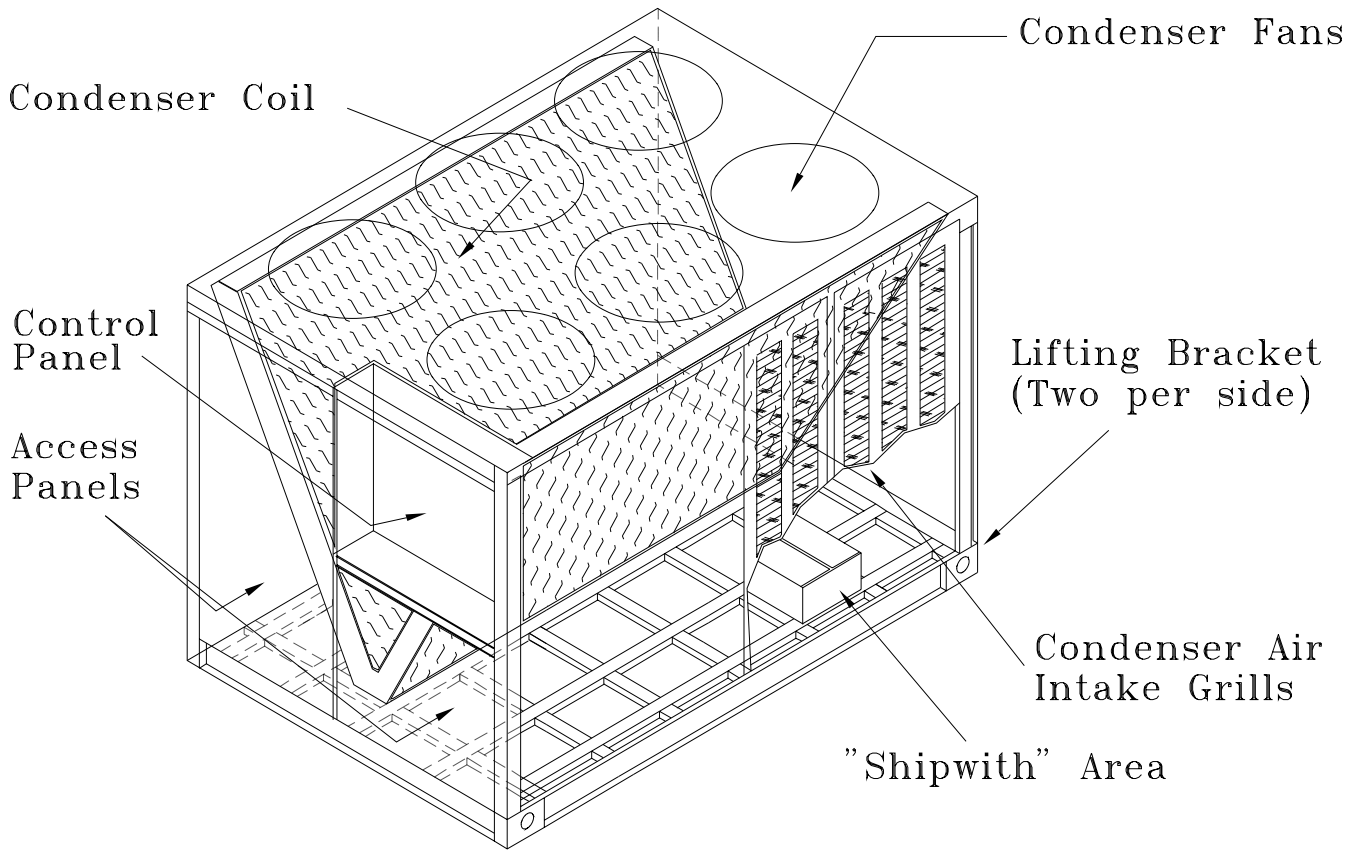
Direct-drive, vertical discharge condenser fans are provided with built-in current and overload protection.

For "Shipwith" items, refer to the Unit Component "Layout" and "Shipwith" Locations illustration.

If low ambient operation is required, low ambient dampers are available as a field or factory installed option.

The unit control panel contains all required fan cycling controls, compressor interlocks, and a 115 volt control power transformer. Field wiring, electrical schematics and panel connection diagrams are located inside the control panel access door.

Unit Component "Layout" and "Shipwith" Locations
(60 Ton Unit Illustrated)



Unit Inspection

As soon as the unit arrives at the job site

- [] Verify that the nameplate data matches the data on the sales order and bill of lading (including electrical data).
- [] Verify that the power supply complies with the unit nameplate specifications.
- [] Visually inspect the exterior of the unit, including the roof, for signs of shipping damage.
- [] Check for material shortages. Refer to the Component Layout and Shipwith Location illustration.

If the job site inspection of the unit reveals damage or material shortages, file a claim with the carrier immediately. Specify the type and extent of the damage on the "bill of lading" before signing.

- [] Visually inspect the internal components for shipping damage as soon as possible after delivery and before it is stored. Do not walk on the sheet metal base pans.

WARNING:

NO STEP SURFACE!

FOR ACCESS TO COMPONENTS, THE BASE SHEET METAL SURFACE MUST BE REINFORCED.

Bridging between the unit's main supports may consist of multiple 2 by 12 boards or sheet metal grating.

Failure to comply can cause severe personal injury or death from falling.

- [] If concealed damage is discovered, notify the carrier's terminal of damage immediately by phone and by mail. Concealed damage must be reported within 15 days.

Request an immediate joint inspection of the damage by the carrier and the consignee. Do not remove damaged material from the receiving location. Take photos of the damage, if possible. The owner must provide reasonable evidence that the damage did not occur after delivery.

- [] Notify the appropriate Trane office before installing or repairing a damaged unit.

Installation

Unit Clearances

Figure 3-1 illustrates the minimum operating and service clearances for either a single, multiple, or pit application. These clearances are the minimum distances necessary to assure adequate serviceability, cataloged unit capacity, and peak operating efficiency.

Providing less than the recommended clearances may result in condenser coil starvation or recirculation of hot condenser air.

Locate the unit as close to the applicable system support equipment as possible, to minimize refrigerant piping lengths.

Unit Dimensions & Weight Information

Overall unit dimensional data for each unit is illustrated in Figure 3-2.

A Center-of-Gravity illustration and the dimensional data is shown in Figure 3-3.

Table 3-1 lists the typical unit operating and point loading weights.

Foundation

If the unit is installed at ground level, elevate it above the snow line. Provide concrete footings at each support location or a slab foundation for support. Refer to Table 3-1 for the unit operating and point loading weights when constructing the footing foundation.

Anchor the unit to the footings or slab using hold down bolts or isolators. Isolators should be installed to minimize the transmission of vibrations into the building. Refer to the "Unit Isolation" section for spring or rubber isolator installation instructions.

For rooftop applications, ensure the roof is strong enough to support the unit. Refer to Table 3-1 for the unit operating weights.

Anchor the unit to the roof with hold-down bolts or isolators. Follow the instructions under "Unit Isolation" for proper isolator placement and installation.

Check with a roofing contractor for proper waterproofing procedures.

Figure 3-1
Typical Installation Clearances for Single, Multiple or Pit Applications

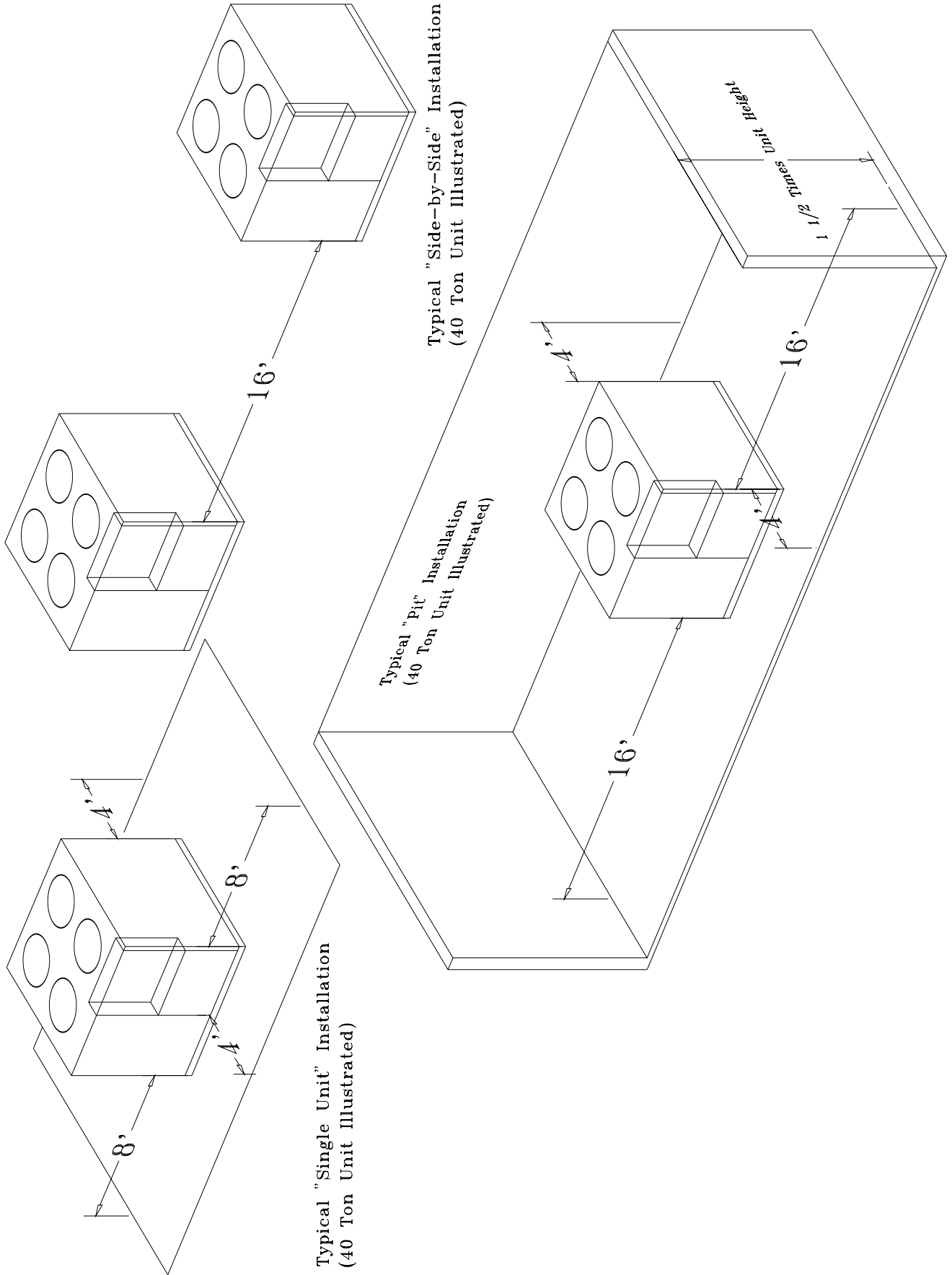


Figure 3-2
CAUC-C20 Unit Dimensional Data & Recommended Clearances

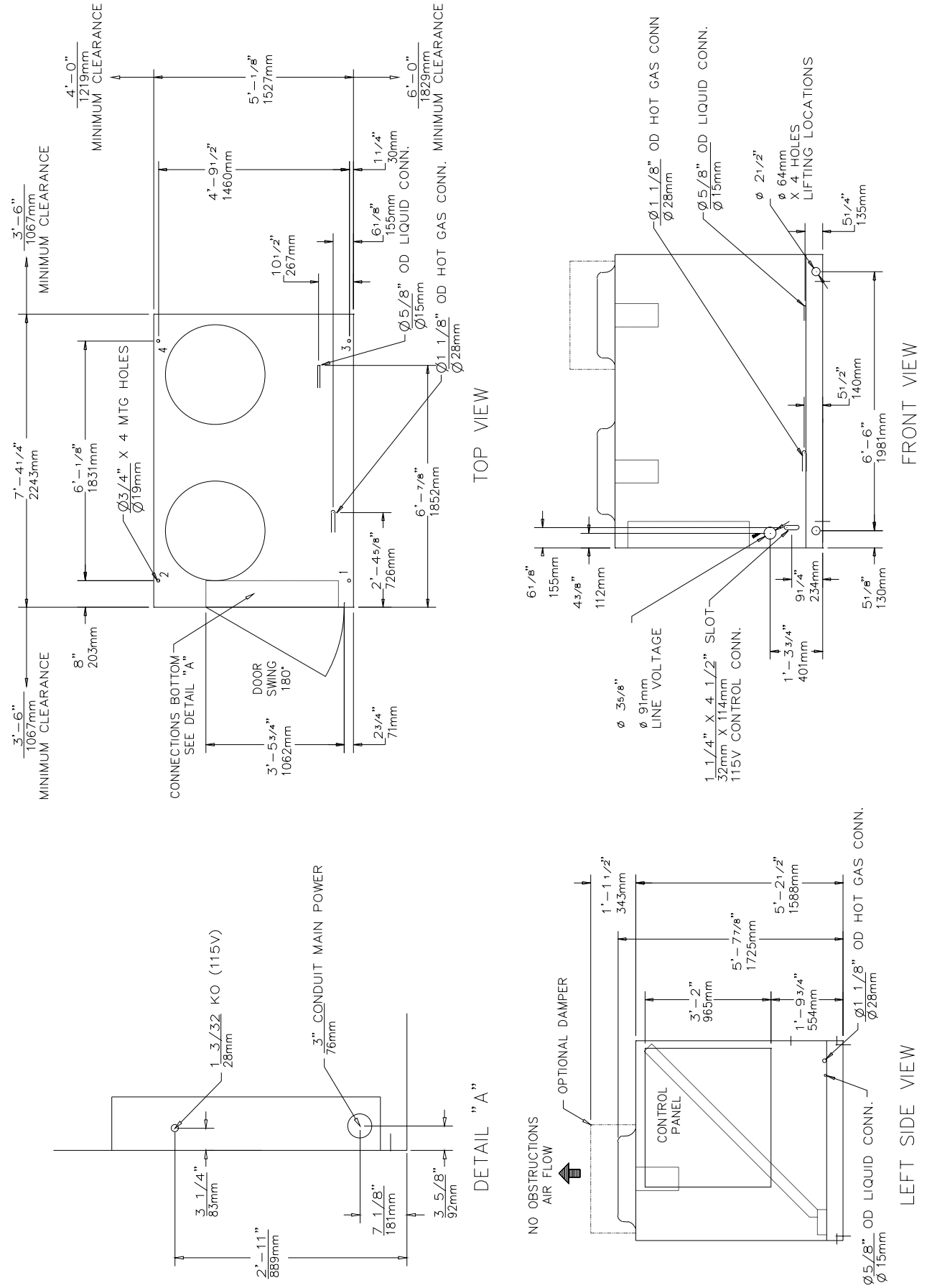


Figure 3-2 (Continued)
CAUC-C50 Unit Dimensional Data & Recommended Clearances

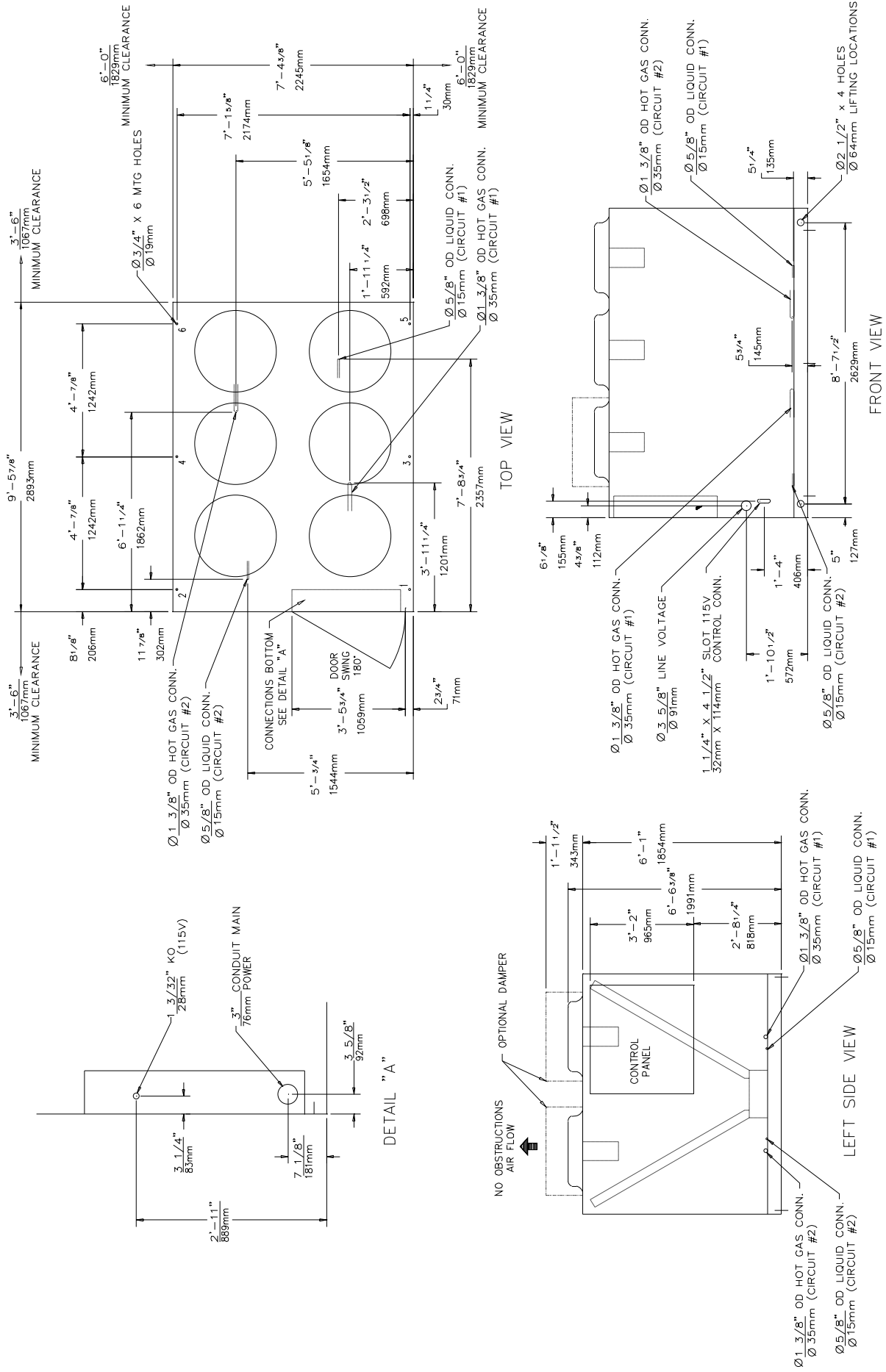


Figure 3-2 (Continued)
CAUC-C60 Unit Dimensional Data & Recommended Clearances

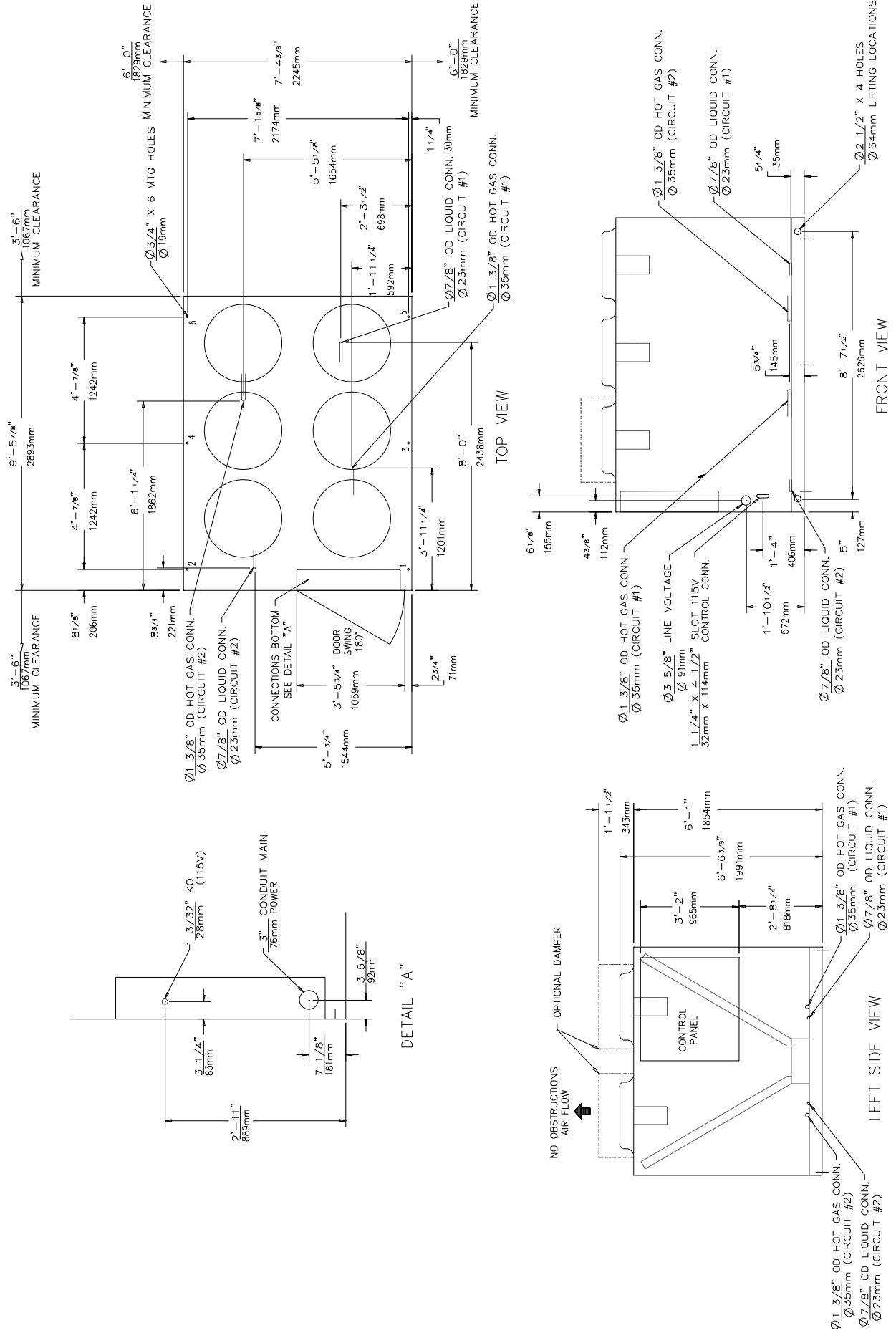


Table 3-1
Typical Unit Weights & Point Loading Data

Unit Size	Operating Weight		Unit Weight on Isolator @ Mounting Location											
			1		2		3		4		5		6	
	AL	CU	AL	CU	AL	CU	AL	CU	AL	CU	AL	CU	AL	CU
C20	1146	1343	320	371	326	365	248	306	252	301				
C25	1190	1393	329	378	337	381	259	315	265	319				
C30	1302	1594	353	414	371	444	282	355	296	381				
C40	2048	2379	363	406	347	392	349	404	334	389	335	401	320	387
C50	2280	2672	407	464	392	449	387	453	373	438	367	441	354	427
C60	2465	3036	433	515	420	505	417	511	405	501	401	507	389	497

Notes:

1. Mounting locations correlate with those shown in point loading illustration.

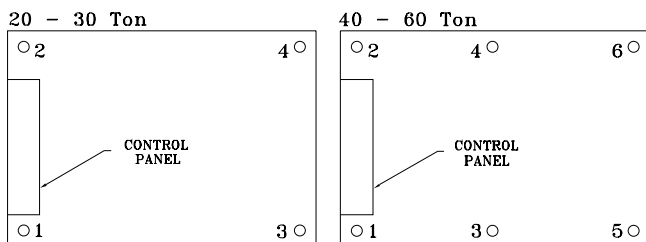
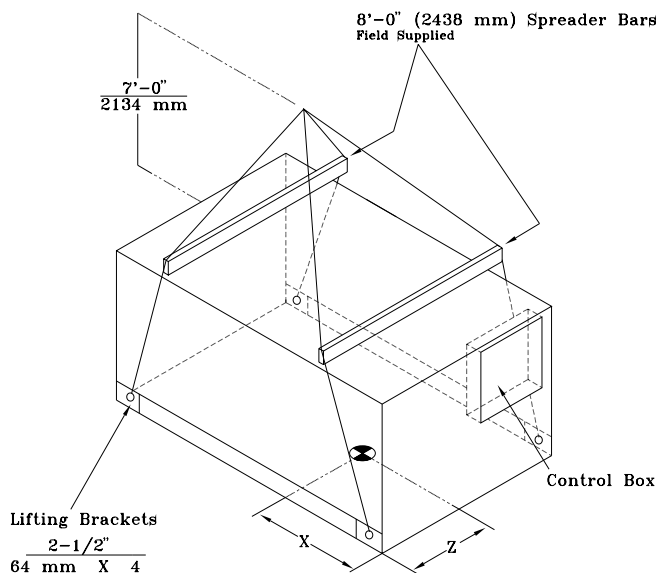


Figure 3-3
Rigging and Center-of-Gravity Data



Unit Size	Shipping Weight (Max. Lbs)	Location of Center of Gravity =			
		X		Z	
		In	mm	In	mm
C20	1348	41	1026	30	754
C25	1394	41	1031	30	762
C30	1585	41	1046	31	790
C40	2366	44	1115	43	1097
C50	2664	56	1428	43	1100
C60	3010	57	1440	44	1107

▲ WARNING:

LIFTING AND MOVING INSTRUCTIONS!

DO NOT USE CABLES (CHAINS OR SLINGS) EXCEPT AS SHOWN. OTHER LIFTING ARRANGEMENTS MAY CAUSE EQUIPMENT DAMAGE OR SERIOUS PERSONAL INJURY.

EACH OF THE CABLES (CHAINS OR SLINGS) USED TO LIFT UNIT MUST BE CAPABLE OF SUPPORTING THE ENTIRE WEIGHT OF THE UNIT.

LIFTING CHAINS (CABLES OR SLINGS) MAY NOT BE THE SAME LENGTH. ADJUST AS NECESSARY FOR EVEN LEVEL LIFT.

USE SPREADER BARS AS SHOWN IN DIAGRAM. REFER TO INSTALLATION MANUAL OR NAMEPLATE FOR UNIT WEIGHT. REFER TO INSTALLATION INSTRUCTIONS LOCATED INSIDE CONTROL PANEL FOR FURTHER RIGGING INFORMATION.

Installation (Continued)

Rigging

A Rigging illustration and Center-of-Gravity dimensional data table is shown in Figure 3-3. Refer to the typical unit operating weights table before proceeding.

1. Rig the condensing unit as shown in Figure 3-3. Attach adequate strength lifting slings to all four lifting brackets in the unit base rail. Do not use cables, chains, or slings except as shown.
2. Install spreader bars, as shown in Figure 3-3, to protect the unit and to facilitate a uniform lift. The minimum distance between the lifting hook and the top of the unit should be 7 feet.
3. Test-lift the unit to ensure it is properly rigged and balanced, make any necessary rigging adjustments.
4. Lift the unit and position it into place.

Unit Isolation

To minimize unit sound and vibration transmission, one of the following installation methods should be used:

1. Install the unit directly on an isolated (detached) concrete pad or on isolated concrete footings located at each unit load point.
2. Install the optional neoprene or spring isolators at each mounting location. Refer to the following "Neoprene isolators" or "Spring Isolator" section.

Neoprene Isolators

Install the neoprene isolators at each unit mounting (load) point, using the following procedure:

1. Elevate the unit (one side at a time) to allow access to the base rail mounting holes.

Note: Use solid type blocks, i.e. 4" X 4" wood blocks or similar material to prevent collapsing. Keep hands and other body limbs clear of elevated base rail while installing isolators to prevent personal injury.

2. Align the mounting holes in the base rail of the unit with the holes in the top of the appropriate isolator. Refer to Figure 3-4 for the appropriate isolator for each load point.
3. Install a 1/2" NC bolt (field supplied) through the base rail of the unit into the threaded bolt hole of the isolator. Position the isolator to allow access to the mounting holes in the base of the isolator, then tighten securely.
4. Lower the unit and isolator onto the mounting surface. The maximum isolator deflection should be approximately 1/4 inch.
5. Secure the isolator to the mounting surface using the base holes in the isolator.
6. Level the unit carefully. Refer to the "Leveling the Unit" section.
7. After the unit is level, tighten the isolator base mounting bolts to secure them to the mounting surface.

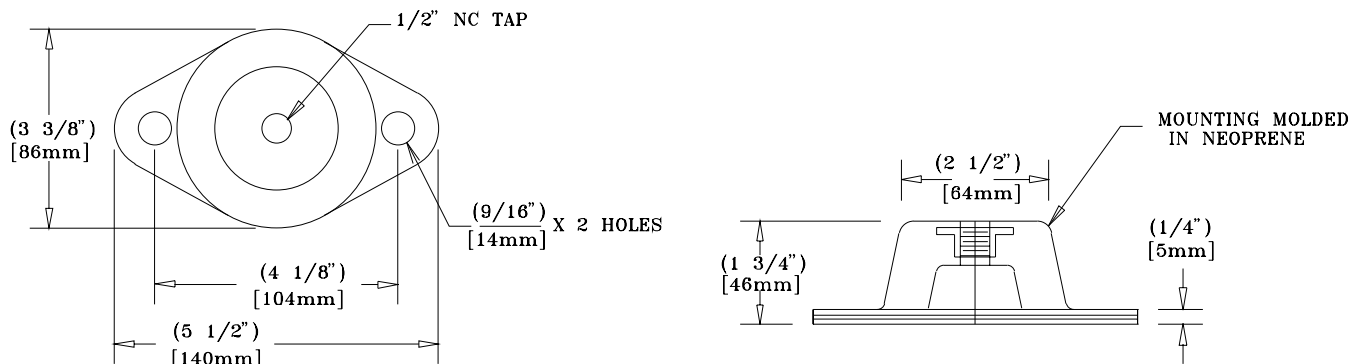
Figure 3-4

Typical Neoprene Isolator Selection & Location

Unit Size	Fin Material	Neoprene Isolator Part Number @ Mounting Location					
		Location 1	Location 2	Location 3	Location 4	Location 5	Location 6
C20	Al	RDP-3-RED	RDP-3-RED	RDP-3-RED	RDP-3-RED		
	Cu	RDP-3-GRN	RDP-3-RED	RDP-3-RED	RDP-3-RED		
C25	Al	RDP-3-RED	RDP-3-RED	RDP-3-RED	RDP-3-RED		
	Cu	RDP-3-GRN	RDP-3-GRN	RDP-3-RED	RDP-3-RED		
C30	Al	RDP-3-RED	RDP-3-GRN	RDP-3-RED	RDP-3-RED		
	Cu	RDP-3-GRN	RDP-3-GRN	RDP-3-RED	RDP-3-GRN		
C40	Al	RDP-3-RED	RDP-3-RED	RDP-3-RED	RDP-3-RED	RDP-3-RED	RDP-3-RED
	Cu	RDP-3-GRN	RDP-3-GRN	RDP-3-GRN	RDP-3-GRN	RDP-3-GRN	RDP-3-GRN
C50	Al	RDP-3-GRN	RDP-3-GRN	RDP-3-GRN	RDP-3-GRN	RDP-3-RED	RDP-3-RED
	Cu	RDP-3-GRN	RDP-3-GRN	RDP-3-GRN	RDP-3-GRN	RDP-3-GRN	RDP-3-GRN
C60	Al	RDP-3-GRN	RDP-3-GRN	RDP-3-GRN	RDP-3-GRN	RDP-3-GRN	RDP-3-GRN
	Cu	RDP-3-GRN	RDP-3-GRN	RDP-3-GRN	RDP-3-GRN	RDP-3-GRN	RDP-3-GRN

Notes:

1. Mounting locations correlate with those shown in point loading illustration.



Installation (Continued)

Spring Isolators

Install the spring isolators at each unit mounting (load) point using the following procedure:

1. Elevate the unit (one side at a time) to allow access to the base rail mounting holes.

Note: Use solid type blocks, i.e. 4" X 4" wood blocks or similar material to prevent collapsing. Keep hands and other body limbs clear of elevated base rail while installing isolators to prevent personal injury.

2. Align the mounting holes in the base rail of the unit with the positioning pin in the top of the appropriate isolator. Refer to Figure 3-5 for the appropriate isolator for each load point.
3. Position the isolator to allow access to the mounting holes in the base of the isolator.
4. Lower the unit onto the isolator. The positioning pin on the isolator must engage into the hole of the base rail. The clearance between the upper and lower isolator housings should be approximately 1/4 to 1/2 inch. Refer to Figure 3-5. A clearance greater than 1/2 inch indicates that shims are required to level the unit. Refer to the "Leveling the Unit" section.

5. Make minor clearance adjustments by turning the isolator leveling bolt (Figure 3-5) clockwise to increase the clearance and counterclockwise to decrease the clearance. If proper isolator clearance cannot be obtained by turning the leveling bolt, level the isolators themselves. A 1/4 inch variance in elevation is acceptable.

6. Secure the isolator to the mounting surface using the base holes in the isolator.

7. After the unit is level, tighten the isolator base mounting bolts to secure them to the mounting surface.

Leveling the Unit

Before tightening the mounting bolts, level the unit carefully. Use the unit base rail as a reference. Level the unit to within 1/4 inch over its entire length. Use shims if adjustable isolators (neoprene) are not used.

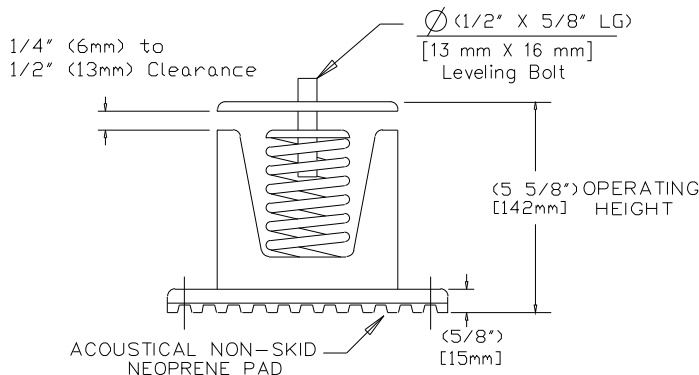
If adjustable isolators (spring) are used, ensure that the proper isolator housing clearance is maintained while leveling the unit. Isolators are identified by color and/or an isolator part number. Shims under the isolators may be required if the unit can not be leveled using the isolator leveling bolt.

Figure 3-5
Typical Spring Isolator Selection & Location

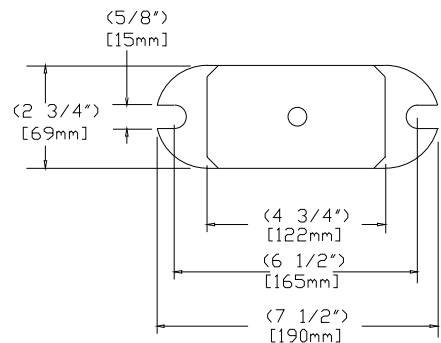
Spring Isolator Part Number @ Mounting Location												
Unit Tons	Location 1		Location 2		Location 3		Location 4		Location 5		Location 6	
	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu
C20	CP-1D-675	CP-1D-675	CP-1D-675	CP-1D-675	CP-1D-510	CP-1D-510	CP-1D-510	CP-1D-510				
C25	CP-1D-675	CP-1D-675	CP-1D-675	CP-1D-675	CP-1D-510	CP-1D-510	CP-1D-510	CP-1D-675				
C30	CP-1D-675	CP-1D-900	CP-1D-675	CP-1D-900	CP-1D-510	CP-1D-675	CP-1D-510	CP-1D-675				
C40	CP-1D-675	CP-1D-900	CP-1D-675	CP-1D-675	CP-1D-675	CP-1D-675	CP-1D-675	CP-1D-675	CP-1D-675	CP-1D-675	CP-1D-510	CP-1D-675
C50	CP-1D-900	CP-1D-900	CP-1D-675	CP-1D-900	CP-1D-675	CP-1D-900	CP-1D-675	CP-1D-900	CP-1D-675	CP-1D-900	CP-1D-675	CP-1D-675
C60	CP-1D-900	CP-1D-900	CP-1D-900	CP-1D-900	CP-1D-900	CP-1D-900	CP-1D-900	CP-1D-675	CP-1D-900	CP-1D-900	CP-1D-900	CP-1D-675

Notes

1. Mounting locations correlate with those shown in point loading illustration.
2. The spring is marked with the full spring ID part # (ie CP-1D-900)
The isolator spring is color coded as follows;
CP-1D-510=Black, CP-1D-675=Dark Purple, CP-1D-900=Dark Green
3. Refer to the "Spring Isolator" section, step 4, for proper clearance.



CP-1



Installation (Continued)

General Unit Requirements

The checklist listed below is a summary of the steps required to successfully install a commercial air cooled condenser. This checklist is intended to assist the installing personnel with what is required in the installation process. It does not replace the detailed instruction called out in the applicable sections of this manual.

- Verify that the power supply complies with the unit nameplate specifications.
- Check the unit for shipping damage and material shortage; file a freight claim and notify Trane office.
- Verify that the installation location of the unit will provide the required clearance for proper operation.
- Install appropriate isolators, if required.

Refrigerant Piping

- Install properly sized liquid line(s) between the liquid line connections on the unit and the evaporator. (i.e., DX evaporator or an EVP Chiller Barrel). Refer to the "Refrigerant Piping" section for recommended liquid line components and guidelines.
- Install properly sized discharge (hot gas) line(s) between the discharge line connections on the unit and the compressor unit. Refer to the "Refrigerant Piping" section for recommended discharge line components and guidelines.
- Install shutoff valves in the liquid line(s) to isolate the filter drier(s) for service.
- Install proper filter driers in each liquid line.
- Leak test the system. Refer to the "Refrigerant Piping" section for recommended procedures.

Main Electrical Power Requirements

- Verify the power supply meets the required power requirements of the system.
- Install power wiring in accordance with all applicable codes.
- Install and connect properly sized power supply wiring, with over current protection, to the main power terminal block (1TB1) in the unit control panel.
- Install proper grounding wires to an earth ground.

Field Installed Control Wiring

- Verify that the Control transformer (1T1) is wired for the proper operating voltage.
- Install the interlock circuitry wiring between the unit and the appropriate compressor unit to permit condenser fan operation when the compressor starter auxiliary contacts closes. Refer to the Field Connection Diagram that shipped with the unit for interlocking information.
- Verify the appropriate jumpers have been installed on the unit to allow proper condenser fan operation (If applicable). Refer to the control wiring diagram that shipped with the unit for jumper details.

Refrigerant Piping

Refrigerant piping must be properly sized and applied. These two factors have a very significant effect on both system performance and reliability.

Note: Use Type "L" refrigerant grade copper tubing only.

Refrigerant Piping should be sized and laid out according to the job plans and specifications. This should be done when the system components are selected. The primary objective when sizing refrigerant piping for this unit is to make refrigerant line sizes as small as possible while avoiding excessive refrigerant pressure drops.

Sizing refrigerant lines as small as possible minimizes the required refrigerant charge and maximizes compressor life.

Trane recommends that the Refrigerant Line Sizing program in the "Trane C.D.S. Application Toolbox" be used to size the refrigerant lines. This program supersedes the line sizing tables in both the Trane Reciprocating Refrigeration publication and the Trane Air Conditioning Manual. If you do not have access to this program, contact your local Trane Commercial Sales office for assistance.

Liquid Lines

Basic sizing parameters with the system operating at full load for liquid lines are:

Maximum Liquid velocity 600 fpm

Maximum allowable pressure drop 7 psig (1°F)

As the pressure drop in the liquid line increases, the potential for liquid flashing, due to reduced refrigerant pressure corresponding to a reduced liquid temperature (subcooling), increases. Under these conditions, liquid lines exposed to high surrounding ambient temperatures must be insulated.

Note: Adding refrigerant to a system with improperly sized refrigerant lines will only decrease system performance and reliability and accentuate poor operating condition.

Isolate all refrigerant lines from the building. This prevents transferring line vibration to the structure. Do not secure the lines rigidly to the building at any point since this will defeat the isolation system of the unit.

Refer to the appropriate unit illustration in Figure 3-2 for refrigerant line size connections and locations. Connect the liquid line piping to the stubs provided at the liquid line shut-off valves.

Note: The installer must cut an appropriately-sized opening in the unit sheet metal for the refrigerant piping entrance into the unit.

Installation (Continued)

Liquid Line Components

Filter driers and valves (expansion valves, charging valves, etc.) should be provided in the liquid lines just before the evaporator. Minimize the use of valves, reducers and tube bends as much as possible to avoid excessive pressure drop before the expansion valve.

Liquid Line Filter Drier

Install the filter driers (provided by the installer) in the liquid lines as close as possible to the expansion valves. Locate them upstream of the moisture indicator and solenoid valves (Solenoid valves may not be applicable).

Liquid Line Moisture Indicators

To aid in troubleshooting, charging and servicing the system, install moisture indicators in the liquid lines near the evaporator, down stream of the liquid line drier between the solenoid valve (if applicable) and the expansion valve.

Liquid Line Solenoid Valves

Liquid line solenoid valves are not recommended on units when they are connected to DX coils. Liquid line solenoid valves are recommended for refrigerant migration control when they are connected to an EVP chiller and should be connected as described in the "Electrical Wiring" section.

Note: Do not use any solenoid valve as a pumpdown device. Equipment damage will occur.

Thermostatic Expansion Valve (TEV)

Trane recommends a balance-ported externally equalized valve in order to maintain satisfactory superheat control down to lower valve loading conditions and to compensate for pressure drops between the expansion valve and superheat control point (evaporator refrigerant outlet). The power head should be a "VGA" charge with Sporlan valves or a "W" charge with Alco valves. These charges provide smooth control at air conditioning conditions and are less susceptible to power head "charge migration" than the conventional gas charged types.

Discharge (Hot Gas) Lines

Discharge lines should be pitched downward 1/2 inch for each 10 feet of horizontal run in the direction of hot gas flow and away from the compressor. Insulate any portion of the discharge piping that is exposed to outdoor ambient temperature.

Discharge line sizing is based on the minimum velocity required to provide good oil movement through the system.

Basic discharge line parameters are:

Maximum allowable pressure drop 6 psig

Maximum velocity 3500 fpm

Minimum velocities at Minimum Load:

Horizontal Lines 500 fpm

Vertical Lines Refer to the Table 3-2

A double riser system may be necessary to meet the discharge line velocity requirements.

When either a single or double discharge riser is used, the line should drop well below the discharge outlet of the compressor before starting the vertical rise to prevent the possibility of refrigerant draining back to the compressor during the "Off" cycle.

Table 3-2
Minimum Vertical Line Velocities

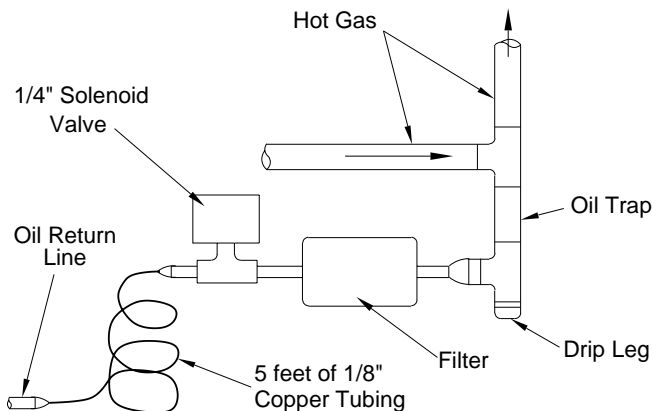
Line Dia.	Minimum Velocity (fpm)
7/8"	470
1-1/8"	540
1-3/8"	600
1-5/8"	650
2-1/8"	750
2-5/8"	825
3-1/8"	915
3-5/8"	975

Discharge (Hot Gas) Line Components

Field supplied hot gas mufflers, pipe anchors, single or double risers, oil traps, etc. as applicable, should be provided to prevent excessive line vibration and assure proper oil return to the compressor for proper system operation.

A field supplied discharge "shutoff" valve in each hot gas line near the condenser is recommended to facilitate refrigerant storage in the condenser during service procedures.

A "constant drain" oil trap is illustrated below and can be used as an alternative to a double riser application. The constant drain oil trap assures adequate oil return to the suction line even at part load conditions. Refer to "Reciprocating Direct Expansion Piping Systems" (AM-REF 1/82) for suggested piping arrangement details.



Final Refrigerant Pipe Connections

To access the refrigerant pipe connections, remove the louvered side grills. Refer to Figure 3-2.

These condensing units are shipped with a **Nitrogen** holding charge. Install pressure gauges to the appropriate access valve(s) and take a reading. If no pressure is present, refer to the "Leak Testing Procedure" section. If pressure is

Installation (Continued)

present, relieve the pressure before attempting to unsweat the "seal" caps. If refrigerant connections are not capped, but are "spun-end" tubes, use a tubing cutter to remove the end from the pipe.

Note: To prevent damage to the system, do not drill a hole in the seal caps or saw the ends off pipe stubs. This may introduce copper chips into the system piping.

Brazing Procedures

Proper brazing techniques are essential when installing refrigerant piping. The following factors should be kept in mind when forming sweat connections.

1. When copper is heated in the presence of air, Copper oxide forms. To prevent copper oxide from forming inside the tubing during brazing, sweep an inert gas, such as dry nitrogen, through the tubing. Nitrogen displaces air in the tubing and prevents oxidation of the interior surfaces. A nitrogen flow of one to three cubic feet per minute is sufficient to displace the air. Use a pressure regulating valve or flow meter to control the flow.

WARNING:

USE NITROGEN ONLY TO PURGE THE SYSTEM WHILE SWEATING CONNECTIONS.

Failure to follow proper procedures can result in personal injury or death due to a possible formation of an explosive mixture of R-22 and air and/or inhalation of phosgene gas.

2. Ensure that the tubing surfaces to be brazed are clean, and that the ends of the tubes have been carefully reamed to remove any burrs.
3. Make sure the inner and outer tubes of the joint are symmetrical and have a close clearance, providing an easy slip fit. If the joint is too loose, the tensile strength of the connection will be significantly reduced. The overlap distance should be equal to the diameter of the inner tube.
4. Wrap the body of each refrigerant line component with a wet cloth to keep it cool during brazing. Move any tube entrance grommets away for the brazing area.

Note: Use 40 to 45% silver brazing alloy (BAg-7 or BAg-28) on dissimilar metals. Use BCup-6 brazing alloy on copper to copper joints.

5. If flux is used, apply it sparingly to the joint. Excessive flux can enter the system which will contaminate the refrigerant system.
6. Apply heat evenly over the length and circumference of the joint to draw the brazing material into the joint by capillary action. Remove the brazing rod and flame from the joint as soon as a complete fillet is formed to avoid possible restriction in the line.
7. Visually inspect the connection after brazing to locate any pin holes or crevices in the joint. The use of a mirror may be required, depending on the joint location.

Leak Testing Procedure

When Leak-testing a refrigerant system, observe all safety precautions.

Note: Never use oxygen, acetylene or compressed air for leak testing. Always install a pressure regulator, shutoff valves and gauges to control pressure during leak testing.

Trane condensing units are shipped with a **Nitrogen** holding charge. If there is no pressure, the unit must be leak tested to determine the location of leak as follows:

Note: These service procedures require working with refrigerant, Do NOT release refrigerant to the atmosphere! The service technician must comply with all federal, state, and local laws. Refer to general service bulletin MSCU-SB-1 (latest edition).

Use refrigerant gas as a tracer for leak detection and use oil-pumped dry nitrogen to develop the required test pressure. Test the high and low side of the system at pressures dictated by local codes.

1. Close the field supplied liquid line service valve(s) installed near the evaporator and the compressor discharge service valve to isolate the system's high side from the low side. Pressure test the liquid line, discharge line, and condenser coils at pressures dictated by local codes. Do not exceed 10# above the pressure control settings.
2. Connect a refrigerant cylinder to the charging port of the liquid line service valve. Use the refrigerant to raise the high side pressure to 12 to 15 psig.
3. Disconnect the refrigerant cylinder. Connect a dry nitrogen cylinder to the charging port and increase the high side pressure. Do not exceed the condenser maximum working pressure listed on the unit nameplate.
4. Use a halide torch, halogen leak detector or soap bubbles to check for leaks. Check all piping joints, valves, etc...
5. If a leak is located, use proper procedures to remove the refrigerant/nitrogen mixture, break the connection and re-make as a new joint. Retest for leaks after making repairs.
6. Repeat the test procedure for the low side of the system, charging through the suction pressure gauge port or through an access provided on the suction line by the installer. Increase the system pressure to 100 psig.
7. If a leak is located, use proper procedures to remove the refrigerant/nitrogen mixture, break the connection and re-make as a new joint. Retest for leaks after making repairs.
8. Open the liquid line service valve and the compressor discharge service valve.

Installation (Continued)

Field Installed Power Wiring

An overall dimensional layout for the field installed wiring entrance into the unit is illustrated in Figure 3-2. To insure that the unit's supply power wiring is properly sized and installed, follow the guidelines outlined below.

Note: All field installed wiring must conform to NEC guidelines as well as State and Local codes.

Verify that the power supply available is compatible with the unit's nameplate ratings. The available supply power must be within 10% of the rated voltage stamped on the nameplate. Use only copper conductors to connect the 3-phase power supply to the unit.

CAUTION:

**USE COPPER CONDUCTORS ONLY!
UNIT TERMINALS ARE NOT DESIGNED TO ACCEPT
OTHER TYPES OF CONDUCTORS.**

Failure to do so may cause damage to the equipment.

Main Unit Power Wiring

Table 3-3 list the field connection wire ranges for the main power terminal block 1TB1. Table 3-4 lists the condensing unit electrical data. The electrical service must be protected from over current and short circuit conditions in accordance with NEC requirements. Protection devices must be sized according to the electrical data on the nameplate. Refer to the "Electrical Service Sizing Equations", for determining;

- a. the appropriate electrical service wire size based on "Minimum Circuit Ampacity" (MCA).
 - b. the "Maximum Over Current Protection" (MOP) device.
 - c. the "Recommended Dual Element fuse size" (RDE).
1. A field supplied disconnect switch must be installed at or near the unit in accordance with the National Electrical Code (NEC latest addition). Refer to the "Electrical Service Sizing Equations" (DSS calculation), for determining the correct size.
 2. Complete the unit's power wiring connections onto the main terminal block 1TB1 inside the unit control panel. Refer to the customer connection diagram that shipped with the unit for specific termination points.
 3. Provide proper supply power (with over current protection) to the Compressor unit and Air Handling unit ("No Control", "VAV", and "Constant Volume") applications. For chilled water systems, provide a properly sized power supply to the circulating pump motor (EVP control applications). Be certain that these components are properly grounded.
 4. Provide proper grounding for the unit in accordance with local and national codes.

Installation (Continued)

Table 3-3
Customer Connection Wire Range

CUSTOMER WIRE SELECTION AND FUSE REPLACEMENT TABLE		
POWER WIRE SELECTION TO MAIN TERMINAL BLOCK (1TB1)		
UNIT VOLTAGE	TERMINAL BLOCK SIZE	CONNECTOR WIRE RANGE
ALL	175A	(1) #14 -- 2/0
CONTROL WIRE SELECTION TO CONTROL TERMINAL BLOCK (1TB2) "SEE NOTE 6"		
WIRE GAUGE	OHMS PER 1000 FEET	
18	8	
16	5	
14	3	
12	2	

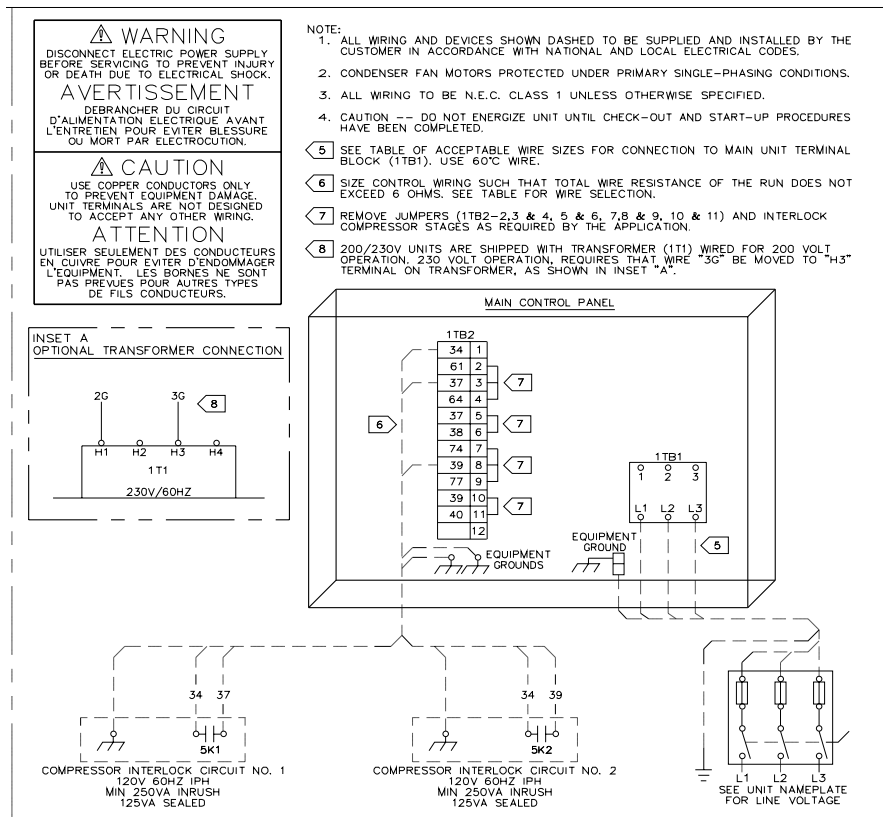
Table 3-4
Unit Electrical Data

Unit Size	Rated Voltage	Allowable Voltage Range	Minimum Circuit Ampacity	Maximum Fuse Size	Dual Element Fuse	Qty.	Condenser Fan Motors			
							HP (Each)	FLA (Each)	LRA (Each)	KW (Each)
C20	200/230/60/3	180-220/208-254	9.2	15	15	2	1.0	4.1	20.7	0.9
	460/60/3	416-508	4.1	15	15	2	1.0	1.8	9.0	0.9
	575/60/3	520-635	3.2	15	15	2	1.0	1.4	7.2	0.9
C25	200/230/60/3	180-220/208-254	13.3	20	15	3	1.0	4.1	20.7	0.9
	460/60/3	416-508	5.9	15	15	3	1.0	1.8	9.0	0.9
	575/60/3	520-635	4.6	15	15	3	1.0	1.4	7.2	0.9
C30	200/230/60/3	180-220/208-254	13.3	20	15	3	1.0	4.1	20.7	0.9
	460/60/3	416-508	5.9	15	15	3	1.0	1.8	9.0	0.9
	575/60/3	520-635	4.6	15	15	3	1.0	1.4	7.2	0.9
C40	200/230/60/3	180-220/208-254	17.4	20	20	4	1.0	4.1	20.7	0.9
	460/60/3	416-508	7.7	15	15	4	1.0	1.8	9.0	0.9
	575/60/3	520-635	6	15	15	4	1.0	1.4	7.2	0.9
C50	200/230/60/3	180-220/208-254	25.6	30	30	6	1.0	4.1	20.7	0.9
	460/60/3	416-508	11.3	15	15	6	1.0	1.8	9.0	0.9
	575/60/3	520-635	8.8	15	15	6	1.0	1.4	7.2	0.9
C60	200/230/60/3	180-220/208-254	25.6	30	30	6	1.0	4.1	20.7	0.9
	460/60/3	416-508	11.3	15	15	6	1.0	1.8	9.0	0.9
	575/60/3	520-635	8.8	15	15	6	1.0	1.4	7.2	0.9

Notes:

1. Electric information is for each individual motor.
2. Minimum Circuit Ampacity is 125% of the RLA of one motor plus the RLA of the remaining motors.
3. Maximum Fuse Size is 300% of the RLA of one motor plus the RLA of the remaining motors.
4. Recommended Dual Element Fuse Size is 225% of the RLA of one motor plus the RLA of the remaining motors.
5. RLA is rated in accordance with UL Standard 465.
6. Local codes may take precedence.

Figure 3-6
Typical CAUC C20 through C60 Ton Field Wiring Diagram



Power Wire Sizing and Protection Device Equations

To correctly size the main power wiring for the unit, use the appropriate calculation(s) listed below. Read the load definitions that follow and use Calculation #1 for determining the MCA (Minimum Circuit Ampacity), MOP (Maximum Over current Protection), and RDE (Recommended Dual Element fuse size) for each unit. Use Calculation #2 to determine the DSS (Disconnect Switch Size) for each unit.

- Load Definitions:**
- LOAD 1** = CURRENT OF THE LARGEST MOTOR (COMPRESSOR OR FAN MOTOR)
 - LOAD 2** = SUM OF THE CURRENTS OF ALL REMAINING MOTORS
 - LOAD 4** = CONTROL POWER TRANSFORMER
 = AND ANY OTHER LOAD RATED AT 1 AMP OR MORE

Calculation #1 (MCA, MOP, and RDE)

$$MCA = (1.25 \times \text{LOAD 1}) + \text{LOAD 2} + \text{LOAD 4}$$

$$MOP = (2.25 \times \text{LOAD 1}) + \text{LOAD 2} + \text{LOAD 4}$$

Select a fuse rating equal to the MOP value. If the MOP value does not equal a standard fuse size as listed in NEC 240 - 6, select the next lower standard fuse rating.

Note: If selected MOP is less than the MCA, then select the lowest standard maximum fuse size which is equal to or larger than the MCA, provided the selected fuse size does not exceed 800 amps.

$$RDE = (1.5 \times \text{LOAD 1}) + \text{LOAD 2} + \text{LOAD 4}$$

Select a fuse rating equal to the RDE value. If the RDE value does not equal a standard fuse size as listed in NEC 240 - 6 select the next higher standard fuse rating.

Note: If the selected RDE is greater than the selected MOP value, then select the RDE value to equal the MOP value.

Calculation #2 Disconnect Switch Sizing (DSS)

$$DSS = 1.15 \times (\text{LOAD 1} + \text{LOAD 2} + \text{LOAD 4})$$

Field Installed Control Wiring

Before installing any connecting wiring, refer to Figure 3-2 for the electrical access locations provided on the unit. Install appropriately sized control wiring for the 115 volt electrical components as required by the application.

⚠ WARNING:
HAZARDOUS VOLTAGE!

**DISCONNECT ALL ELECTRIC POWER INCLUDING
REMOTE DISCONNECTS BEFORE SERVICING.**

**Failure to disconnect power before servicing can
cause severe personal injury or death.**

Since the unit-mounted 115V control power transformer (1T1) is provided on all units, it is not necessary to run a separate 115 volt control power source to the unit.

Note: 200/230 Volt units are shipped with transformer 1T1 wired for 200 volt operation. If the unit is to be operated on a 230 volt power supply, rewire the transformer as shown on the unit schematic.

When the 115 volt control circuit is properly connected to the field provided interlock contacts 5K1 for circuit #1 and 5K2 for circuit #2 (if applicable), proper condenser fan cycling and ambient control for the remaining fans is achieved with corresponding compressor operation.

Note: All field wiring must conform to NEC guidelines as well as state and local codes.

CCAD Package Chiller Interface

The Unit Control Module (UCM) within the Trane Model CCAD package chiller is designed to control the CAUC condenser fan operation. To obtain proper condenser fan sequencing for the CCAD package chiller, several control wiring modifications must be made to the CAUC units.

Refer to Figure 3-7 and the field wiring diagram in the CCAD package chiller installation literature. Follow the appropriate procedure below for the operating ambient application when installing the 115 volt electrical wiring for the CAUC unit.

Installation (Continued)

Standard Ambient Operation (Circuit #1 - 20 through 60 Ton Units)

1. Remove the jumper wire from between terminals 1TB2-3 and 1TB2-4 in the CAUC unit control panel.
2. Install a jumper between terminals 1TB3-3 and 1TB3-4 in the CAUC control panel.
3. Install interconnecting wiring between the following terminals:

CAUC Unit		CCAD Unit
1TB2-1	to	TB1-3 of 1U1A7
1TB2-4	to	TB1-2 of 1U1A7
1TB2-5	to	TB1-1 of 1U1A7

(Circuit #2 - 40 through 60 Ton Units)

4. Remove the jumper wire from between terminals 1TB2-8 and 1TB2-9 in the CAUC unit control panel.
5. Install a jumper between terminals 1TB3-8 and 1TB3-9 in the CAUC control panel.
6. Install interconnecting wiring between the following terminals:

CAUC Unit		CCAD Unit
1TB2-1	to	TB1-3 of 1U1A8
1TB2-9	to	TB1-2 of 1U1A8
1TB2-10	to	TB1-1 of 1U1A8

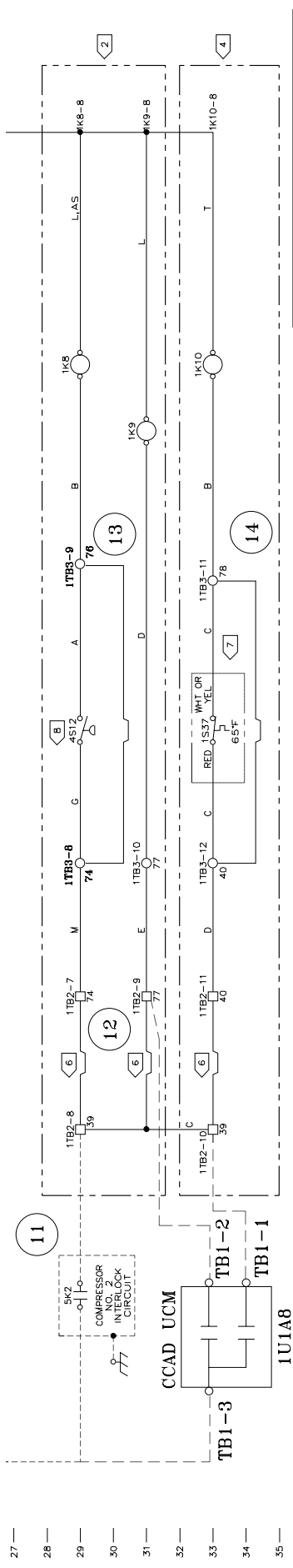
Low Ambient Operation

(Circuit #1 - 20 through 60 Ton Units)

1. Complete steps 1 through 3 of the previous standard ambient procedure for Circuit # 1.
2. Install an additional jumper between terminals 1TB3-6 and 1TB3-7 in the CAUC control panel.

(Circuit #2 - 40 through 60 Ton Units)

3. Complete steps 4 through 6 of the previous standard ambient procedure for Circuit #2.
4. Install an additional jumper between terminals 1TB3-11 and 1TB3-12 in the CAUC control panel.
5. Follow the low ambient damper adjustment procedure listed in the "Low Ambient Damper" section before starting the unit.



LEGEND

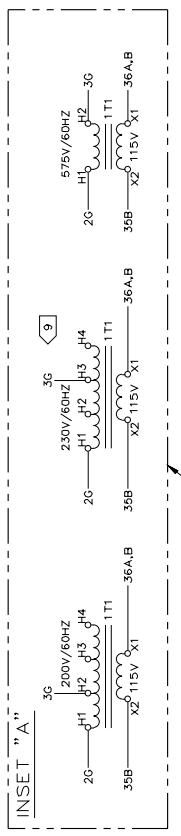
DEVICE DESIGNATION	DESCRIPTION	LINE NUMBER
IF7	CONTROL CIRCUIT FUSE	17
1K5, 1K6, 1K7	CONDENSER FAN CONTACTOR	19, 21, 23
1K8, 1K9, 1K10	CONDENSER FAN CONTACTOR	29, 31, 33
1S36, 1S37	FAN TEMPERATURE CONTROL	23, 33
1T1	CONTROL POWER TRANSFORMER	16
1TB1	POWER TERMINAL BLOCK	8
1TB2, 1TB3	CONTROL TERMINAL BLOCK	16
2B1 - 2B6	CONDENSER FAN MOTOR	4
4S11, 4S12	FAN PRESSURE CONTROL	19, 29
5K1, 5K2	CUSTOMER INTERLOCK	19, 29

AREA	LOCATION
1	UNIT CONTROL PANEL
2	FAN SECTION
4	EXTERNAL MOUNTED COMPONENTS
5	CUSTOMER OR FIELD PROVIDED

⚠ WARNING
 HAZARDOUS VOLTAGE!
 DISCONNECT ALL ELECTRIC POWER INCLUDING REMOVING FUSE BEFORE SERVICING. FAILURE TO DISCONNECT POWER BEFORE SERVICING CAN CAUSE SEVERE PERSONAL INJURY OR DEATH.

⚠ AVERTISSEMENT
 VOLTAGE HASARDEUX!
 DECONNECTEZ TOUTES LES SOURCES ELECTRIQUES INCLUANT LES DISJONCTEURS SITUÉS A DISTANCE AVANT D'EFFECTUER L'ENTRETIEN. L'EGOUTTEMENT D'UNE SOURCE ELECTRIQUE PEUT ENTRAINER DES BLESSURES CORPORELLES SEVERES OU LA MORT.

⚠ CAUTION
 USE COPPER CONDUCTORS ONLY!
 UNIT TERMINALS ARE NOT DESIGNED TO ACCEPT OTHER TYPES OF CONDUCTORS.
 FAILURE TO DO SO MAY CAUSE DAMAGE TO THE EQUIPMENT.



NOTE:

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. DASHED LINES INDICATE RECOMMENDED FIELD WIRING BY OTHERS, PHANTOM LINES INDICATE ALTERNATE CIRCUITRY OR AVAILABLE SALES OPTIONS. NUMBERS ALONG THE RIGHT SIDE OF THE SCHEMATIC DESIGNATE THE LOCATION OF THE CONTACTS BY LINE NUMBER, AN UNDERLINED NUMBER INDICATES A NORMALLY CLOSED CONTACT.

- 2 USED ON 40, 50 AND 60 TON UNITS ONLY.
- 3 USED ON 25, 30, 50 AND 60 TON UNITS ONLY.
- 4 USED ON 50 AND 60 TON UNITS ONLY.
- 5 460 VOLT 60HZ TRANSFORMER (1T1) SHOWN. SEE INSET "A" FOR OTHER VOLTAGE CONNECTIONS.
- 6 REMOVE JUMPERS AND INTERLOCK COMPRESSOR STAGES AS REQUIRED BY THE APPLICATION.
- 7 1S36, 1S37 AND ASSOCIATED WIRING ARE USED WITH LOW AMBIENT OPTION ONLY. REMOVE METAL JUMPER BETWEEN NODES 65 AND 38 & 78 AND 40 (1TB3-6 AND 1TB3-7 & 1TB3-11 AND 1TB3-12) ON UNITS WITH LOW AMBIENT OPTION.
- 8 4S11 AND 4S12 ARE SET TO OPEN AT 155 PSI AND CLOSE AT 300 PSI.
- 9 200/230 VOLT UNITS ARE CONNECTED AS 200 VOLT UNITS. 230 VOLT UNITS REQUIRE THAT WIRE "3G" BE MOVED TO "H3" TERMINAL OF TRANSFORMER (1T1), AS SHOWN IN INSET "A".
- 10 WIRES "W40" & "W41" REQUIRED ONLY WITH LOW AMBIENT DAMPER OPTION.
- 11 NOT REQUIRED WHEN CAUC IS USED WITH TRANE CCAD CHILLER
- 12 WHEN CAUC IS USED WITH TRANE CCAD CHILLER, REMOVE JUMPER BETWEEN 1TB2-3 & 1TB2-4 FOR 20 - 30 TON UNITS AND CIRCUIT #1 ON 40 - 60 TON UNITS. FOR CIRCUIT #2 ON 40 - 60 TON UNITS, ALSO REMOVE JUMPER BETWEEN 1TB2-8 & 1TB2-9.
- 13 WHEN CAUC IS USED WITH TRANE CCAD CHILLER, INSTALL JUMPER BETWEEN TERMINALS 1TB3-3 & 1TB3-4 FOR 20 - 30 TON UNITS AND 1TB3-8 & 1TB3-9 FOR 40 - 60 TON UNITS.
- 14 WHEN CAUC IS USED WITH CCAD CHILLER & CAUC IS EQUIPPED WITH LOW AMBIENT OPTION, INSTALL JUMPER BETWEEN TERMINALS 1TB3-7 & 1TB3-8 FOR 20 - 30 TON UNITS ALSO FOR 40 - 60 TON UNITS, INSTALL JUMPER BETWEEN TERMINALS 1TB3-11 & 1TB3-12.

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Use the checklist provided below in conjunction with the "General Unit Requirement" checklist" to ensure that the unit is properly installed and ready for operation. Be sure to complete all of the procedures described in this section before starting the unit for the first time.

- [] Turn the field supplied disconnect switch, located upstream of the unit, to the "Off" position.

▲ WARNING:

HAZARDOUS VOLTAGE!

DISCONNECT ALL ELECTRIC POWER INCLUDING REMOTE DISCONNECTS BEFORE SERVICING.

Failure to disconnect power before servicing can cause severe personal injury or death.

- [] Turn the "System" selection switch (at the Remote Panel) to the "Off" position and the "Fan" selection switch (if Applicable) to the "Auto" or "Off" position.
- [] Check all electrical connections for tightness and "point of termination" accuracy.
- [] Verify that the condenser airflow will be unobstructed.
- [] Check the condenser fan blades. Ensure they rotate freely within the fan orifices and are securely fastened to the fan motor shaft.
- [] Verify that all compressor service valves, discharge service valves, and liquid line service valves are back seated on each circuit.

▲ CAUTION:

COMPRESSOR SERVICE VALVES!

COMPRESSOR SERVICE VALVES MUST BE FULLY OPENED BEFORE START-UP (SUCTION, DISCHARGE, LIQUID LINE, AND OIL LINE).

Failure to fully open valves prior to start-up may cause compressor failure due to lack of refrigerant and/or oil flow.

- [] Inspect the interior of the unit for tools and debris.

System Evacuation Procedures

Each refrigeration circuit for split system applications must be evacuated before the unit can be started. Use a rotary type vacuum pump capable of pulling a vacuum of 100 microns or less. Verify that the unit disconnect switch and the system control circuit switches are "OFF".

The oil in the vacuum pump should be changed each time the pump is used with a high quality vacuum pump oil. Before using any oil, check the oil container for discoloration which usually indicates moisture in the oil and/or water droplets. Moisture in the oil adds to what the pump has to remove from the system, making the pump inefficient.

When connecting the vacuum pump to a refrigeration system, it is important to manifold the vacuum pump to both the high and low side of the system (liquid line access valve

System Pre-Start Procedures

and suction line access valve). Follow the pump manufacturer's directions for the proper methods of using the vacuum pump.

Note: Do not, under any circumstances, use a megohm meter or apply power to the windings of a compressor while it is under a vacuum. Electrical shorting between motor windings and/or housing can occur while in a vacuum, causing motor burnout.

The lines used to connect the pump to the system should be copper and of the largest diameter that can practically be used. Using larger line sizes with minimum flow resistance can significantly reduce evacuation time. Rubber or synthetic hoses are not recommended for system evacuation because they have moisture absorbing characteristics which result in excessive rates of evaporation, causing pressure rise during the standing vacuum test. This makes it impossible to determine if the system has a leak, excessive residual moisture, or a continual or high rate of pressure increase due to the hoses.

An electronic micron vacuum gauge should be installed in the common line ahead of the vacuum pump shutoff valve, as shown in Figure 4-1. Close Valves B and C, and open Valve A. Start the vacuum pump, after several minutes, the gauge reading will indicate the maximum vacuum the pump is capable of pulling. Rotary pumps should produce vacuums of less than 100 microns.

Open Valves B and C. Evacuate the system to a pressure of 300 microns or less. As the vacuum is being pulled on the system, there could be a time when it would appear that no further vacuum is being obtained, yet, the pressure is high. It is recommended that during the evacuation process, the vacuum be "Broken", to facilitate the evacuation process.

To break the vacuum;
Shutoff valves A, B, & C and connect a refrigerant cylinder to the charging port on the manifold. Purge the air from the hose. Raise the standing vacuum pressure in the system to "zero" (0 psig) gauge pressure. Repeat this process two or three times during evacuation.

Note: It is unlawful to release refrigerant into the atmosphere. When service procedures require working with refrigerants, the service technician must comply with all Federal, State, and local laws. Refer to the General Service Bulletin MSCU-SB-1 (latest edition).

Standing Vacuum Test

Once 300 microns or less is obtained, close Valve A and leave valves B and C open. This will allow the vacuum gauge to read the actual system pressure. Let the system equalize for approximately 15 minutes. This is referred to as a "standing vacuum test" where, time versus pressure rise. The maximum allowable rise over a 15 minute period is 200 microns. If the pressure rise is greater than 200 microns but levels off to a constant value, excessive moisture is present. If the pressure steadily continues to rise, a leak is indicated. Figure 4-2 illustrates three possible results of the "standing vacuum test".

System Pre-Start Procedures (Continued)

If a leak is encountered, repair the system and repeat the evacuation process until the recommended vacuum is obtained.

Once the system has been evacuated, break the vacuum with refrigerant, and complete the remaining "Pre-Start Procedures" before starting the unit.

Figure 4-1
Typical Vacuum Pump Hookup

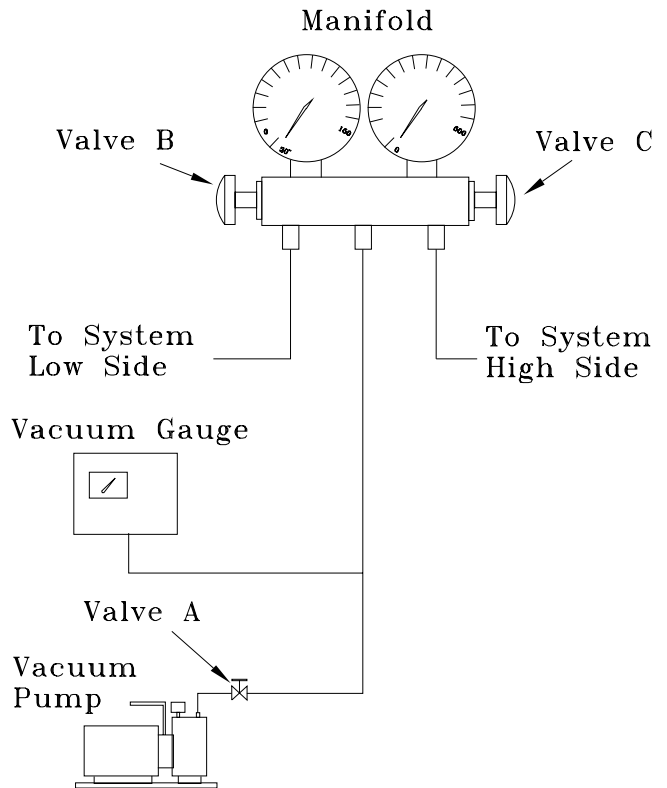
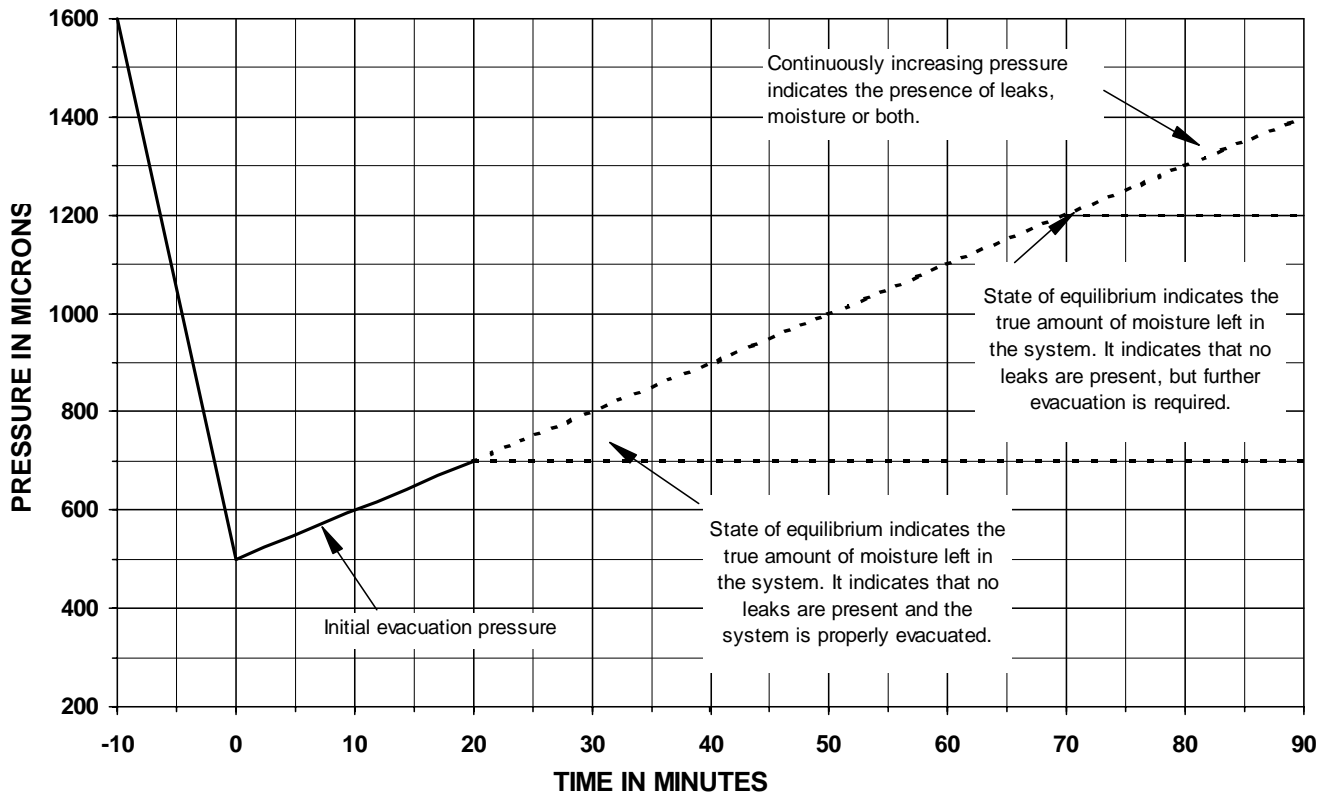


Figure 4-2
Evacuation Time-vs-Pressure Rise



System Pre-Start Procedures (Continued)

Voltage Imbalance

Excessive three phase voltage imbalance between phases will cause motors to overheat and eventually fail. The maximum allowable voltage imbalance is 2%. Measure and record the voltage between phases 1, 2, and 3 and calculate the amount of imbalance as follows:

$$\% \text{ Voltage Imbalance} = 100 \times \frac{AV - VD}{AV} \text{ where;}$$

$$AV \text{ (Average Voltage)} = \frac{\text{Volt 1} + \text{Volt 2} + \text{Volt 3}}{3}$$

V1, V2, V3 = Line Voltage Readings

VD = Line Voltage reading that deviates the farthest from the average voltage.

Example: If the voltage readings of the supply power measured 221, 230, and 227, the average volts would be:

$$\frac{221 + 230 + 227}{3} = 226 \text{ Avg.}$$

VD (reading farthest from average) = 221

The percentage of Imbalance equals:

$$100 \times \frac{226 - 221}{226} = 2.2\%$$

The 2.2% imbalance in this example exceeds the maximum allowable imbalance of 2.0%. This much imbalance between phases can equal as much as a 20% current imbalance with a resulting increase in motor winding temperatures that will decrease motor life. If the voltage imbalance is over 2%, notify the proper agencies to correct the voltage problem before operating this equipment.

Electrical Phasing

Proper electrical phasing can be quickly determined and corrected before starting the unit by using an instrument such as an Associated Research Model 45 Phase Sequence Indicator and following the steps below:

- [] Turn the field supplied disconnect switch that provides power to terminal block 1TB1 to the "Off" position.

WARNING:

HAZARDOUS VOLTAGE!

DISCONNECT ALL ELECTRIC POWER INCLUDING REMOTE DISCONNECTS BEFORE SERVICING.

Failure to disconnect power before servicing can cause severe personal injury or death.

- [] Connect the phase sequence indicator leads to the terminal block or to the "Line" side of the optional factory mounted disconnect switch as follows;

Phase Sequence Leads	Unit Power Terminal
Black (phase A)	L1
Red (phase B)	L2
Yellow (Phase C)	L3

- [] Close the disconnect switch or circuit protector switch that provides the supply power to the condensing unit.
- [] Observe the ABC and CBA phase indicator lights on the face of the sequencer. The ABC indicator light will glow if the phase is ABC. If the CBA indicator light glows, open the disconnect switch or circuit protection switch and reverse any two power wires.
- [] Restore the main electrical power and recheck the phasing. If the phasing is correct, open the disconnect switch or circuit protection switch and remove the phase sequence indicator.

System Start-Up

Sequence of Operation

Standard Model 20 through 60 Ton air cooled condensers function as the outdoor condensing units for appropriately sized split refrigeration systems. These units, operating in conjunction with a matched indoor compressor/evaporator configuration, provide refrigerant condensing for these systems down to a normal ambient temperature of 40 F. Operation to 0°F ambient is possible with the addition of externally mounted low ambient dampers.

All condenser fans are direct drive, 26 inch propeller type. They are driven by 1 HP thermally protected motors.

Condenser fan cycling is accomplished through interlocking the fan operation with compressor operation (5K1 & 5K2), liquid line pressure switches (4S11 & 4S12). When the low ambient option is applied, ambient temperature thermostats (1S36 & 1S37) are used to provide additional fan cycling control. Table 5-1 lists the condenser fan sequencing data and Figure 5-1 illustrates the condenser fan locations with their respective fan and relay designators.

When wired properly, the unit will start and operate satisfactorily as long as the operating temperature is above the minimum operating temperature listed in Table 5-2.

The condensing unit operation starts and stops automatically when the cooling demand is initiated and terminated by the cooling circuit interlock relays illustrated in Figure 5-2.

The control components are mounted in the various areas of the unit as illustrated in Figure 5-3.

Table 5-1
Condenser Fan Sequencing Data

Controlling Device (3)	Fan "ON"	Fan "OFF"	Fan Identification
Customer Interlock Circuit 1	5K1 Closed	5K1 Open	2B1, 2B2, 2B3 (1)
Customer Interlock Circuit 2	5K2 Closed	5K2 Open	2B4, 2B5, 2B6 (1)
Fan Temperature Switch	67.5°F	65 F	1S36 (2) 2B3 (1)
Fan Pressure Switch	275 psig	155 psig	4S11 2B1 (1)
	275 psig	155 psig	4S12 2B6

Notes:

1. Bold fan identifies fans used on 25, 30, 50 & 60 Ton units only.
2. 1S36 and 1S37 normally-closed contacts open on ambient temperature drop to 65°F. Contacts reclose on ambient temperature rise to 67.5°F.
3. Above data does not apply when units are interfaced with Trane Model CCAD package chillers. UCM for the CCAD unit commands fan control.

Low Ambient Damper Operation

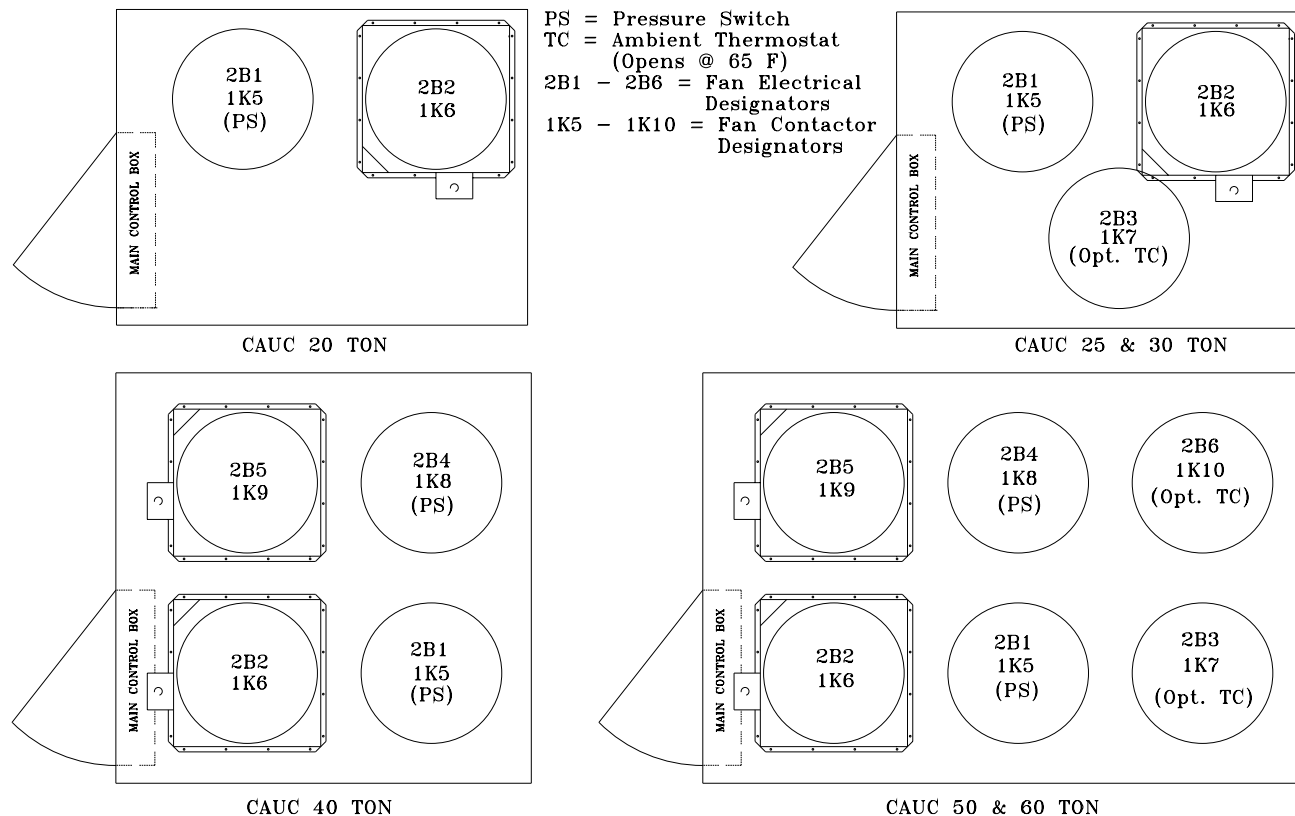
Low Ambient Dampers are available as a factory installed option or can be field-installed. Dampers are used to extend the operation of these units from the standard operational temperatures to a minimum of 0°F without hot gas bypass or 10°F with hot gas bypass. (These values apply when wind speed across the condenser coil is less than 5 m.p.h.). If typical wind speeds are higher than 5 m.p.h., a wind screen around the unit may be required. By restricting the airflow across the condenser coils, saturated condensing temperatures can be maintained as the ambient temperatures change.

The low ambient damper actuator controls damper modulation for each refrigerant circuit in response to saturated condensing temperature.

Low Ambient Thermostat Operation

In addition to the low ambient dampers on 25, 30, 50 & 60 Ton units, a low ambient thermostat is installed to further restrict the airflow across the condenser by cycling the 2B3 condenser fan on 25 & 30 Ton units plus 2B6 on 50 & 60 Ton units. The thermostat opens when the ambient temperature approaches 65°F and closes at approximately 67.5°F.

Figure 5-1
Condenser Fan Locations



Verifying Proper Condenser Fan Rotation

1. "Open" the field supplied disconnect switch or circuit protector switch that provides power to the compressor unit and lock it in the "Off" position.
2. Open the disconnect switch or circuit protector switch that provides power to the condensing unit.
3. Install temporary jumpers across terminals 1TB2-1 to 1TB2-3, 1TB2-1 to 1TB2-8, and the applicable cycling controls, i.e., pressure switches and ambient thermostats, to start the condenser fans, as illustrated in Figure 5-2. For CCAD applications, refer to the illustration in Figure 3-8 for proper jumper connections.

▲ WARNING:
ROTATING PARTS!

UNIT STARTS AUTOMATICALLY

Make sure all personnel are standing clear of the unit before proceeding. The programmed components will start when the TEST START time designated in the previous step has elapsed.

4. "Close" the disconnect switch or circuit protector switch that provides power to the condensing unit. The fans will start when the power is applied.
5. Check the condenser fans for proper rotation. The direction of rotation is clockwise when viewed from the top of the unit.

All Fans are Rotating Backwards;

1. Turn the field supplied disconnect switch or circuit protector switch that provides power to the condensing unit to the "Off" position. Lock the disconnect switch in the open position while working at the unit.
2. Interchange any two of the field connected main power wires at the unit terminal block 1TB1 in the unit control panel.
3. Remove all temporary jumpers previously installed in step 3 of "Verifying Proper Condenser Fan Rotation".

Note: Interchanging "Load" side power wires at the fan contactors will only affect the individual fan rotation. Ensure that the voltage phase sequence at the main terminal block 1TB1 is ABC as outlined in the "Electrical Phasing" section.

Some Fans are Rotating Backwards;

1. "Open" the field supplied disconnect switch upstream of the unit. Lock the disconnect switch in the "Open" position while working at the unit.
2. Interchange any two of the fan motor leads at the fan contactor for each fan that is rotating backwards.
3. Remove all temporary jumpers previously installed in step 3 of "Verifying Proper Condenser Fan Rotation".

Low Ambient Damper Adjustment (Factory or Field Installed)

When a unit is ordered with the low ambient option (i.e., Digit 11 is a "1" in the model number), a damper is factory installed over the lead condenser fan for each refrigeration circuit. Refer to the appropriate unit illustrated in Figure 5-1 for the damper locations.

For field installation, mount the dampers over the condenser fans at the locations shown in Figure 5-1 and connect the actuator, controller, and sensor for each circuit. (Refer to the Installation Instructions provided with each low ambient damper kit.)

The controller has a factory default setpoint of 105 F. This setpoint can be adjusted by installing a field supplied resistor on 2TB34 in the low ambient control panel located in the back of the main control panel. (See the low ambient wiring diagram, that shipped with the unit or with the field kit, for resistance values and installation location.)

Inspect the damper blades for proper alignment and operation. Dampers should be in the closed position during the "Off" cycle. If adjustment is required;

1. Remove the sensor leads from the input terminals 6 and 7 for circuit #1 and/or 11 and 12 for circuit #2. (Controller output signal will go to 0.0 VDC and the damper will drive to the closed position.)
2. Loosen the damper shaft "Locking" set screws on the actuator
3. Firmly hold the damper blades in the closed position
4. Retighten the "Locking" set screws.

To check damper operation, jumper between the sensor input terminals 6 and 7 and/or 11 and 12 (if applicable). Controller output signal will go to 10 VDC and the damper will drive to the full open position.

Charging the System

1. Verify that all discharge service valves and liquid line service valves for each circuit is back seated.
2. Attach a set of service gauges onto the liquid line and discharge line gauge ports for each circuit.
3. Charge liquid refrigerant into the liquid line of each refrigerant circuit with the required amount of R-22. Refrigerant should be charged into the system by weight.

Use an accurate scale or a charging cylinder to monitor the amount of refrigerant entering the system. Refer to Table 5-3 for the recommended refrigerant capacities for the condensing unit. The weight of refrigerant required for the liquid line and liquid line driers are listed in Table 5-4.

If the pressure within the system equalizes with the pressure in the charging cylinder before charging is completed, complete the process by vapor charging into the suction (low) side of the system after the system has been started.

System Start-Up (Continued)

Table 5-2 gives the minimum starting temperatures for both "Standard" & "Low" Ambient units.

Do not attempt to charge the system with the low ambient dampers and/or hot gas bypass operating (if applicable). Disable the low ambient dampers in the "Open" position (refer to the "Low Ambient Damper Adjustment" section) and de-energize the hot gas bypass solenoid valves before proceeding.

4. On units with dual circuits, start only one circuit at a time. To disable the second circuit compressors, refer to the compressor sequencing information that shipped with the compressor unit.
5. With the compressors operating, slowly open the "Low Side" valve on the manifold gauge set. The remainder of the refrigerant will be drawn into the system.
6. Once the charging for the operating circuit has been completed, check and record the:

ambient temperature;
compressor oil level (each circuit);
compressor suction and discharge pressures (each circuit);
superheat and subcooling (each circuit);

Record this data on an "operator's maintenance log" like the one shown in Table 5-5. If the operating pressures indicate a refrigerant shortage, measure the system superheat and system subcooling. Repeat steps 1 through 6 for the second refrigeration circuit, if applicable.

Table 5-2
Minimum Starting Ambient Temperature

Unit Size	Standard		Low Ambient	
	With HGBP	No HGBP	With HGBP	No HGBP
20 Ton through 60 Ton	40	30	10	0

Note:

Minimum starting ambients in degrees F, based on unit at minimum step of unloading and 5 mph wind across the condenser.

Table 5-3
Recommended Refrigerant Capacities

Unit Size	Operating Charge per Circuit (1)	Condenser Storage Capacity (2)
C20	25	67
C25	28	76
C30	37	96
C40	26	68
C50	28	71
C60	37	92

Notes:

1. CAUC-C20 - C30 are single-circuit units
CAUC-40 - C60 are dual-circuit units
2. Pounds R-22 per circuit @ 95°F ambient, 95% full.

System Start-Up (Continued)

Table 5-4
Liquid Line & Drier Refrigerant Requirements

Liquid Line O.D.	Liquid Line Charge	Sporlan Part No.	Drier Refrigerant Charge
5/8"	1.827	C-305-S	1 lb. - 1 oz.
3/4"	2.728	C-307-S	1 lb. - 1 oz.
		C-417-S	1 lb. - 8 oz.
7/8"	3.790	C-307-S	1 lb. - 1 oz.
		C-417-S	1 lb. - 8 oz.
1-1/8"	6.461	C-419-S	1 lb. - 8 oz.

Note: Refrigerant charge given in ounces per foot.

Table 5-5
Sample Operator's Maintenance Log

Date	Current Ambient Temp. (F)	Refrigerant Circuit #1						Refrigerant Circuit #2					
		Compr. Oil Level	Suct. Press. (Psig)	Disch. Press. (Psig)	Liquid Press. (Psig)	Super-heat (F)	Sub-cool. (F)	Compr. Oil Level	Suct. Press. (Psig)	Disch. Press. (Psig)	Liquid Press. (Psig)	Super-heat (F)	Sub-cool. (F)
		- ok - low						- ok - low					
		- ok - low					- ok - low						
		- ok - low					- ok - low						
		- ok - low					- ok - low						
		- ok - low					- ok - low						
		- ok - low					- ok - low						
		- ok - low					- ok - low						
		- ok - low					- ok - low						
		- ok - low					- ok - low						

Note: Check and record the data requested above each month during the cooling season with the unit running.

Blank

Figure 5-2
Typical Wiring Schematic for 20 through 60 Ton Units

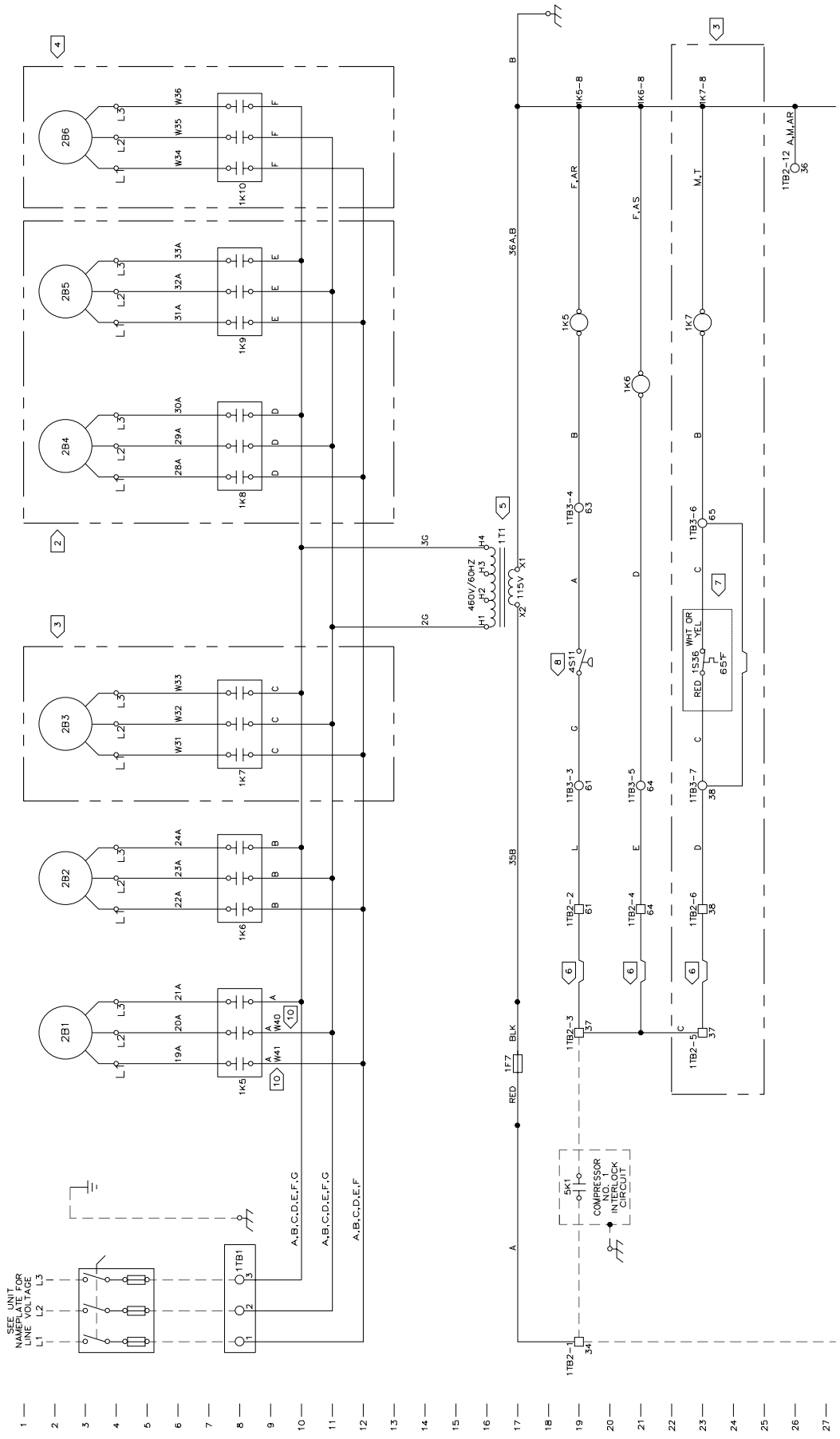
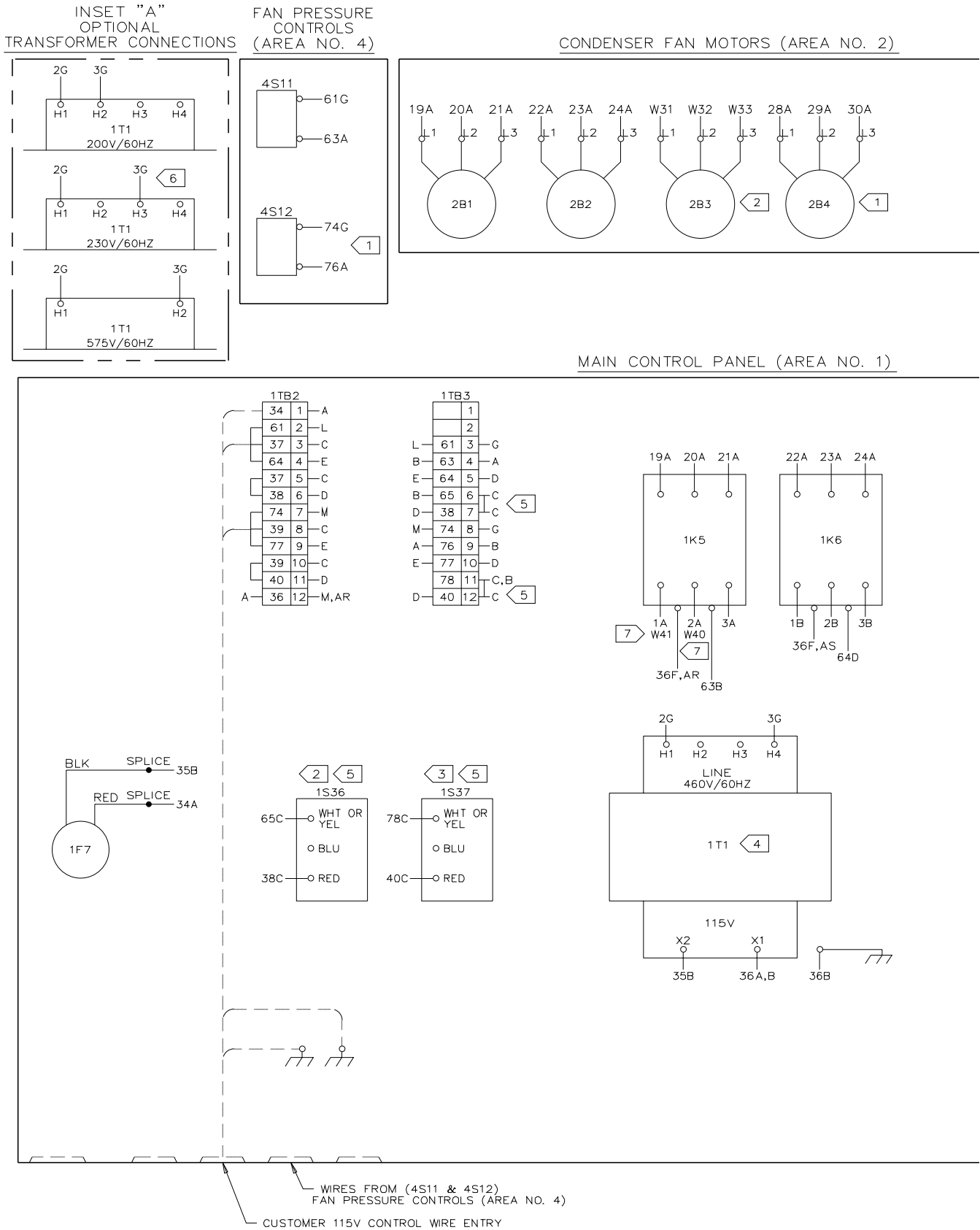
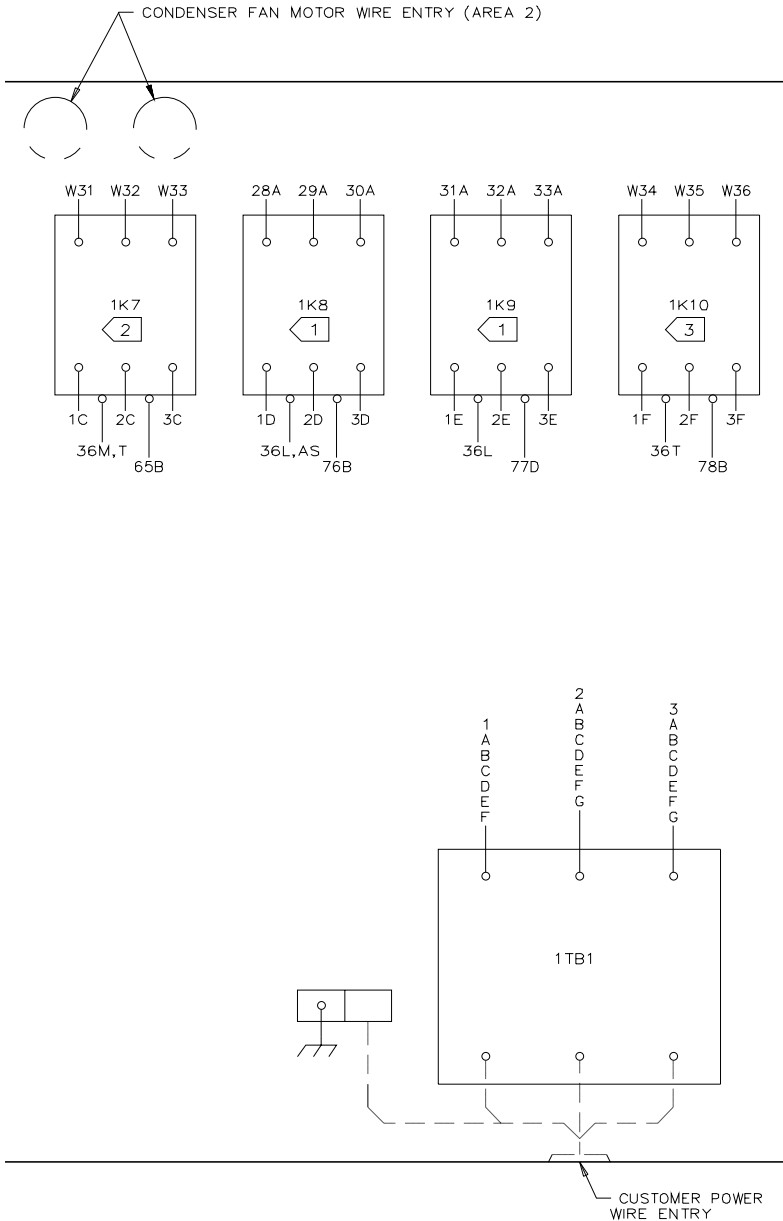
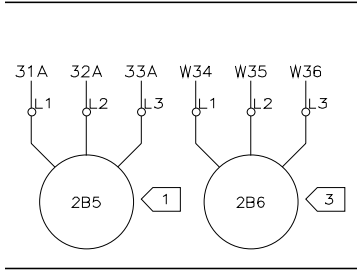


Figure 5-3
Typical Control Panel Connections Diagram for 20 through 60 Ton Units





⚠ WARNING

HAZARDOUS VOLTAGE!
DISCONNECT ALL ELECTRIC POWER INCLUDING REMOTE DISCONNECTS BEFORE SERVICING.

FAILURE TO DISCONNECT POWER BEFORE SERVICING CAN CAUSE SEVERE PERSONAL INJURY OR DEATH.

⚠ AVERTISSEMENT

VOLTAGE HASARDEUX!
DECONNECTEZ TOUTES LES SOURCES ELECTRIQUES INCLUANT LES DISJONCTEURS SITUES A DISTANCE AVANT D'EFFECTUER L'ENTRETIEN.

FAUTE DE DECONNECTER LA SOURCE ELECTRIQUE AVANT D'EFFECTUER L'ENTRETIEN PEUT ENTRAINER DES BLESSURES CORPORELLES SEVERES OU LA MORT.

⚠ CAUTION

USE COPPER CONDUCTORS ONLY!
UNIT TERMINALS ARE NOT DESIGNED TO ACCEPT OTHER TYPES OF CONDUCTORS.
FAILURE TO DO SO MAY CAUSE DAMAGE TO THE EQUIPMENT.

NOTES:

- 1 1K8,1K9,2B4,2B5,4S12 AND ASSOCIATED WIRING ARE USED ON 40 THRU 60 TON UNITS ONLY.
- 2 1K7,1S36,2B3 AND ASSOCIATED WIRING ARE USED ON 25,30,50 AND 60 TON UNITS ONLY.
- 3 1K10,1S37,2B6 AND ASSOCIATED WIRING ARE USED ON 50 AND 60 TON UNITS ONLY.
- 4 TRANSFORMER (1T1) PRIMARY (LINE) CONNECTION AS SHOWN IS FOR 460V/60HZ. SEE INSET "A" FOR OTHER VOLTAGE CONNECTIONS.
- 5 1S36,1S37 AND ASSOCIATED WIRING ARE USED WITH LOW AMBIENT OPTION ONLY. REMOVE JUMPER (1TB3-6 & 1TB3-7 AND 1TB3-11 & 1TB3-12) WHEN REQUIRED.
- 6 200/230 VOLT UNITS ARE CONNECTED AS 200 VOLT UNITS. 230 VOLT UNITS REQUIRE THAT WIRE "3G" BE MOVED TO "H3" TERMINAL OF TRANSFORMER (1T1), AS SHOWN IN INSET "A".
- 7 WIRES "W40" & "W41" REQUIRED ONLY WITH LOW AMBIENT DAMPER OPTION.

Service and Maintenance

Fuse Replacement Data

Table 6-1 lists the replacement fuses for the control circuit and Transformers.

Table 6-1
Fuse Replacement Data

FUSE REPLACEMENT SELECTION				
FUSE DESCRIPTION	UNIT SIZE	UNIT VOLTAGE	FUSE TYPE	FUSE SIZE
CONDENSER FAN FUSE {1F1-1F3 ON 20 - 30 TON} {1F1-1F6 ON 40 - 60 TON}	ALL	200/230 VOLT	CLASS K5	25 AMP
		460/575 VOLT 380/415 VOLT		15 AMP
CONTROL CKT FUSE (1F7)	20-30 TON	ALL	BUSSMANN S - 3.20	3.20 AMP
	40-60 TON	ALL	BUSSMANN S - 6.25	6.25 AMP
COMPR PROTECTOR FUSE {1F8 ON 20 - 60 TON} {1F9 ON 40 - 60 TON}	ALL	ALL	BUSSMANN MTH - 6	6 AMP

Monthly Maintenance

Before completing the following checks, turn all system control circuit switches to the "Off" position. "Open" the main power disconnect switches for the Condensing Unit and all system support equipment. "lock" the disconnect switches in the "Off" position before removing any access panels.



WARNING: **HAZARDOUS VOLTAGE!**

**DISCONNECT ALL ELECTRIC POWER INCLUDING
REMOTE DISCONNECTS BEFORE SERVICING.**

**Failure to disconnect power before servicing can
cause severe personal injury or death.**

Air Handling Equipment

- [] Inspect the return air filters. Clean or replace them if necessary.
- [] Check the evaporator drain pan and condensate piping to ensure that there are no blockages.
- [] Inspect the evaporator coils for dirt. If the coils appear dirty, clean them according to the instructions described in the "Coil Cleaning" section.
- [] Inspect the economizer damper hinges and pins (if applicable) to ensure that all moving parts are securely mounted. Clean the blades as necessary.
- [] Verify that all damper linkages move freely; lubricate with white grease, if necessary.
- [] Check Supply Fan motor bearings; repair or replace the motor as necessary.
- [] Check the fan shaft bearings for wear. Replace the bearings as necessary.
- [] Lubricate the supply fan bearings. Refer to the equipment manufacturer for their recommended greases.

Note: Over lubrication can be just as harmful as not enough grease.

Use a hand grease gun to lubricate these bearings; add grease until a light bead appears all around the seal. Do not over lubricate!

After greasing the bearings, check the setscrews to ensure that the shaft is held securely to the bearings and Fan wheels. Make sure that all bearing supports are tight.

- [] Check the supply fan belt(s). If the belts are frayed or worn, replace them.
- [] Verify that all wire terminal connections are tight.
- [] Generally inspect the unit for unusual conditions (e.g., loose access panels, leaking piping connections, etc.)
- [] Make sure that all retaining screws are reinstalled in the unit access panels once these checks are complete.

Condensing Unit

- [] Manually rotate the condenser fans to ensure free movement and check motor bearings for wear. Verify that all of the fan mounting hardware is tight.
- [] Verify that all wire terminal connections are tight.
- [] Inspect the condenser coils for dirt and foreign debris. If the coils appear dirty, clean them according to the instructions described in the "Coil Cleaning" section.
- [] Inspect the compressor and condenser fan motor contactors. If the contacts appear severely burned or pitted, replace the contactor. Do not clean the contacts.
- [] Check the compressor oil level. (Compressors "Off")

System operation

- [] Close the main power disconnect switch for the Condensing Unit and all system support equipment. Turn all system control circuit switches to the "On" position.

▲ WARNING:
HAZARDOUS VOLTAGE
ROTATING PARTS!

UNIT STARTS AUTOMATICALLY

Make sure all personnel are standing clear of the unit before proceeding. The system components will start when the power is applied.

- [] With the unit running, check and record the:

ambient temperature;
compressor oil level (each circuit);
compressor suction and discharge pressures (each circuit);
superheat and Subcooling (each circuit);

Record this data on an "operator's maintenance log" similar to the one illustrated in the "Final Setup" section of this manual. If the operating pressures indicate a refrigerant shortage, measure the system Superheat and system Subcooling. For guidelines, refer to the "system Start-Up" section.

Note: Do Not release refrigerant to the atmosphere! If adding or removing refrigerant is required, the service technician must comply with all federal, state and local laws. Refer to general service bulletin MSCU-SB-1 (latest edition).

Coil Cleaning

Regular coil maintenance, including annual cleaning, enhances the unit's operating efficiency by minimizing:

compressor head pressure and amperage draw;
evaporator water carryover;
fan brake horsepower, due to increase static pressure losses;
airflow reduction.

At least once each year, or more often if the unit is located in a "dirty" environment, clean the evaporator and condenser coils using the instructions outlined below. Be sure to follow these instructions as closely as possible to avoid damaging the coils.

To clean refrigerant coils, use a soft brush and a sprayer (either a garden pump-up type or a high-pressure sprayer). A high-quality detergent is also required; suggested brands include "SPREX A.C.", "OAKITE 161", "OAKITE 166" and "COILOX". If the detergent selected is strongly alkaline (ph value exceeds 8.5), add an inhibitor.

1. Remove enough panels from the unit to gain access to the coil.
2. Protect all electrical devices such as motors and controllers from any overspray.

Service and Maintenance (Continued)

3. Straighten any bent coil fins with a fin comb.
4. Mix the detergent with water according to the manufacturer's instructions. If desired, heat the solution to 150°F maximum to improve its cleansing capability.

▲ CAUTION:
CONTAINS REFRIGERANT!

SYSTEM CONTAINS OIL AND REFRIGERANT

Do not heat the detergent-and-water solution above 150° F. Hot liquids sprayed on the exterior of the coil will raise the coil's internal pressure and may cause it to burst.

Failure to follow proper procedures can result in personal illness or injury or severe equipment damage.

Note: Refrigerant oil is detrimental to some roofing materials. Care must be taken to protect the roof from oil leaks or spills.

5. Pour the cleaning solution into the sprayer. If a high-pressure sprayer is used:
 - a. do not allow sprayer pressure to exceed 600 psi.
 - b. the minimum nozzle spray angle is 15 degrees.
 - c. maintain a minimum clearance of 6" between the sprayer nozzle and the coil.
 - d. spray the solution perpendicular (at 90 degrees) to the coil face.
6. Spray the leaving-airflow side of the coil first; then spray the opposite side of the coil. Allow the cleaning solution to stand on the coil for five minutes.
7. Rinse both sides of the coil with cool, clean water.
8. Inspect both sides of the coil; if it still appears to be dirty, repeat Steps 6 and 7.
9. Reinstall all of the components and panels removed in Step 1 and any protective covers installed in step 2.
10. Restore the unit to its operational status and check system operation.

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WARRANTY AND LIABILITY CLAUSE

COMMERCIAL EQUIPMENT RATED 20 TONS AND LARGER AND RELATED ACCESSORIES

PRODUCTS COVERED - This warranty* is extended by American Standard Inc. and applies only to commercial equipment rated 20 Tons and larger and related accessories.

Warrantor warrants for a period of 12 months from initial start-up or 18 months from date of shipment, whichever is less, that the products covered by this warranty (1) are free from defects in material and manufacture and (2) have the capacities and ratings set forth in catalog and bulletins; provided, that no warranty is made against corrosion, erosion or deterioration. In addition, if the stainless steel, Fully modulating, gas heat exchanger fails because of a manufacturing defect within the first 10 years from date of initial start-up, warrantor will furnish a replacement heat exchanger. Warrantor's obligation and liabilities under this warranty are limited to furnishing replacement parts. Warrantor shall not be obligated to pay for the cost of lost refrigerant. No liability whatever shall attach to warrantor until said products have been paid for and then said liability shall be limited to the purchase price of the equipment shown to be defective.

THE WARRANTY AND LIABILITY SET FORTH HEREIN ARE IN LIEU OF ALL OTHER WARRANTIES AND LIABILITIES, WHETHER IN CONTRACT OR IN NEGLIGENCE, EXPRESS OR IMPLIED, IN LAW OR IN FACT, INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR USE, IN NO EVENT SHALL WARRANTOR BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

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PW-215-2688

*Optional Extended Warranties are available for compressors and heat exchangers of Combination Gas-Electric Air Conditioning Units.

