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Bulk Low Pressure Carbon Dioxide Storage Tank Unit

Operation and Maintenance Manual

Issued August 2014
Revision AA
Manual S/N 70000398

FOREWORD

Note: Thi [redacted] Low Pressure Carbon Dioxide Storage Tank Unit Owner's manual, stock number 70000398, is for use only by qualified and factory-trained personnel with working knowledge of applicable standards such as NFPA, as well as a working knowledge of Chemetron CARDOX Low Pressure Carbon Dioxide (CO2) Fire Protection Systems. Chemetron does not authorize or recommend use of this manual by others.

The data contained herein is provided by Chemetron as a guide only. It is not intended to be all inclusive and should not be substituted for professional judgment. Chemetron believes the data to be accurate, but this data is provided without guarantee or warranty to its accuracy or completeness.

Any questions concerning the information presented in this manual should be addressed to:

[redacted]

ABBREVIATIONS

ABS:	Absolute	N.C.:	Normally Closed
ADA:	Americans with Disabilities Act	NFPA:	National Fire Protection Association
AH:	Ampere Hour	N.O.:	Normally Open
AWG:	American Wire Gauge	$N_{2:}$	Nitrogen
BIL:	Basic Installation Level	PED:	Pressure Equipment Directive
C:	Common	S/N:	Stock Number
CFM:	Cubic Feet per Minute	TC:	Transport Canada
CO_2:	Carbon Dioxide	TCF:	Temperature Correction Factor
DC:	Direct Current	TPED:	Transportable Pressure Equipment Directive
DOT:	Department of Transportation	UL/ULI:	Underwriters Laboratories, Inc.
FM:	Factory Mutual	ULC:	Underwriters Laboratories of Canada
H_20:	Water	V:	Volts
HVAC:	Heating, Venting and Air Conditioning	Vac:	Volts AC
Hz:	Hertz (Frequency)	Vdc:	Volts DC
mA:	Milliamperes		

TERMS

Carbon Dioxide	The chemical compound formed by combining one atom of carbon with two atoms of oxygen
CO2	The molecular formula for carbon dioxide
Critical Point	The temperature and pressure above which a chemical compound can only exist as a supercritical fluid - for Carbon Dioxide: 87.9 ºF (31.1 ºC) and 1070.6 psig (73.8 bar)
Design Pressure	MAWP + pressure from liquid level + dynamic movement of liquid (if applicable)
Dry Ice	Solid carbon dioxide
MAWP	Maximum Allowable Working Pressure - Maximum gauge pressure permissible at the top of a completed vessel in its normal operating position
MDMT	Minimum Design Metal Temperature - Minimum temperature at which a pressure vessel may be operated as indicated on the vessel name plate
Safety Relief Valve	Vessel pressure relieving device with a maximum set pressure of the MAWP of the vessel
Supercritical Fluid	A chemical compound at temperature and pressure greater than its critical point
Triple Point	The conditions at which all three states (solid, liquid and vapor) of some chemical compounds can exist - for Carbon Dioxide: -69.9 ºF (-56.6 ºC) and 60.4 psig (4.2 bar)

COMPRESSED GAS ASSOCIATION CONTACT INFORMATION

Compressed Gas Association
1725 Jefferson Davis Hwy.
Suite 1004
Arlington, VA 22202-4102 USA
Phone: (703) 412-0900

SAFETY SUMMARY

Th [redacted]ow Pressure Carbon Dioxide Systems uses pressurized equipment, and therefore you MUST notify personnel responsible or who may come into contact with the fire suppression system, of the dangers associated with the improper handling, installation, maintenance, or use of this equipment.

Fire suppression service personnel must be trained in the proper installation, service and use of the equipment in compliance with applicable regulations and codes and following the instructions in this manual, any Safety Bulletins, and on the cylinder nameplate.

[redacted] has provided warnings and cautions at a number of locations throughout this manual. These warnings and cautions are not comprehensive, but provide a good guide as to where caution is required. These warnings and cautions are to be adhered to at all times. Failure to do so may result in serious injury.

DEFINITIONS

WARNING — **Indicates an imminently hazardous situation which, if not avoided, could result in death, serious bodily injury and/or property damage.**

CAUTION — **Indicates a potentially hazardous situation which, if not avoided, could result in property or equipment damage.**

SUBJECT: SPECIFIC HAZARD

WARNING — **Because carbon dioxide reduces the available oxygen in the atmosphere, it will not support life. Care must be taken, and appropriate alarms shall be used, to ensure that all personnel are evacuated from the protected space prior to discharging the system. Suitable warning signs must be prominently displayed in clear view at the point of entry into the protected area to alert people to the asphyxiation properties of carbon dioxide.**

Before handling [redacted]X products, all personnel must be thoroughly trained in the safe handling of the containers as well as in the proper procedures for installation, removal, filling, and connection and other interconnected devices/components that are under pressure or may be exposed to pressure.

READ, UNDERSTAND and ALWAYS FOLLOW the operation and maintenance manuals, owners manuals, service manuals, etc., that are provided with the individual systems.

MATERIAL SAFETY DATA SHEETS

Hard copies of the Material Safety Data Sheets (MSDS) are not included with this manual. The latest version of the MSDS you are searching for can be found online at th[redacted]. Use the built-in navigation links to view the desired sheet.

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CHAPTER 1
GENERAL INFORMATION

1-1 INTRODUCTION

[redacted] Fire Systems Bulk Low Pressure Carbon Dioxide Storage Units are available in models capable of storing from 2.75 U.S. tons to 60 U.S. tons of liquid carbon dioxide. These units are made of the highest quality materials and workmanship.

1-2 UNDERSTANDING CARBON DIOXIDE

Carbon dioxide is a chemical compound formed by combining one atom of carbon with two atoms of oxygen, and is expressed by the molecular formula CO2. Carbon dioxide can exist in any one or all three states of matter: solid, liquid, and/or vapor; depending on conditions of temperature and pressure.

Under normal atmospheric conditions, carbon dioxide exists as a colorless, odorless gas which is about 1.5 times heavier than air. Carbon dioxide will not burn or support combustion and will not sustain life.

When confined within a suitable pressure vessel, carbon dioxide can exist in any of three states of matter depending on conditions of temperature and pressure. The point at which all three states may exist is -69.9 °F (-56.6 °C) and 60.4 psig (4.2 bar). This is called the triple point. At temperatures and pressures lower than the triple point, carbon dioxide may be either a solid or a vapor, again depending on conditions. Dry ice (solid carbon dioxide), at a temperature of -109.3 °F (-78.5 °C) at atmospheric pressure, sublimes (transforms directly from solid into vapor without the formation of a liquid).

The critical point of carbon dioxide is 87.9 °F (31.1 °C) and 1070.6 psig (73.8 bar). At temperatures and pressures greater than 87.9 °F (31.1 °C) and 1070.6 psig (73.8 bar), carbon dioxide liquid cannot exist. At pressures and temperatures greater than the critical point, carbon dioxide exists only as a supercritical fluid.

At temperatures and pressures above the triple point and below the critical point, carbon dioxide liquid with overlying vapor may exist in equilibrium within a closed vessel. Within this range, there is a definite relationship between temperature, pressure, and density.

By following the vapor pressure curve in Figure 1.1 on page 1.2, it becomes obvious that if you desire to store liquid carbon dioxide at 70 °F (21.1 °C), the pressure vessel would have to be built to withstand pressures of around 840 psig (57.9 bar). By following the liquid density curve, one finds that the liquid becomes less dense as the temperature increases and at 70 °F (21.1 °C), the liquid density is around 47 pounds per cubic foot (762 kg/m3).

By comparing the pressure and liquid density at 70 °F (21.1 °C) [837.8 psig (57.8 bar) and 47.6 pounds per cubic foot (762 kg/m3)] with the pressure and density at 0 °F (-17.8 °C) [291.1 psig (20.1 bar) and 63.65 pounds per cubic foot (1020 kg/m3)],it is obvious that relatively large quantities of carbon dioxide liquid can be stored in relatively small, thin walled pressure vessels; hence low-pressure bulk storage of CO2.

The term "low-pressure" is used in the industry to describe the storage of carbon dioxide at low temperatures below ambient, usually around 0 °F (-17.8 °C). It is a relative term and should not be taken literally, as the pressures involved range up to around 350 psig (24.1 bar).

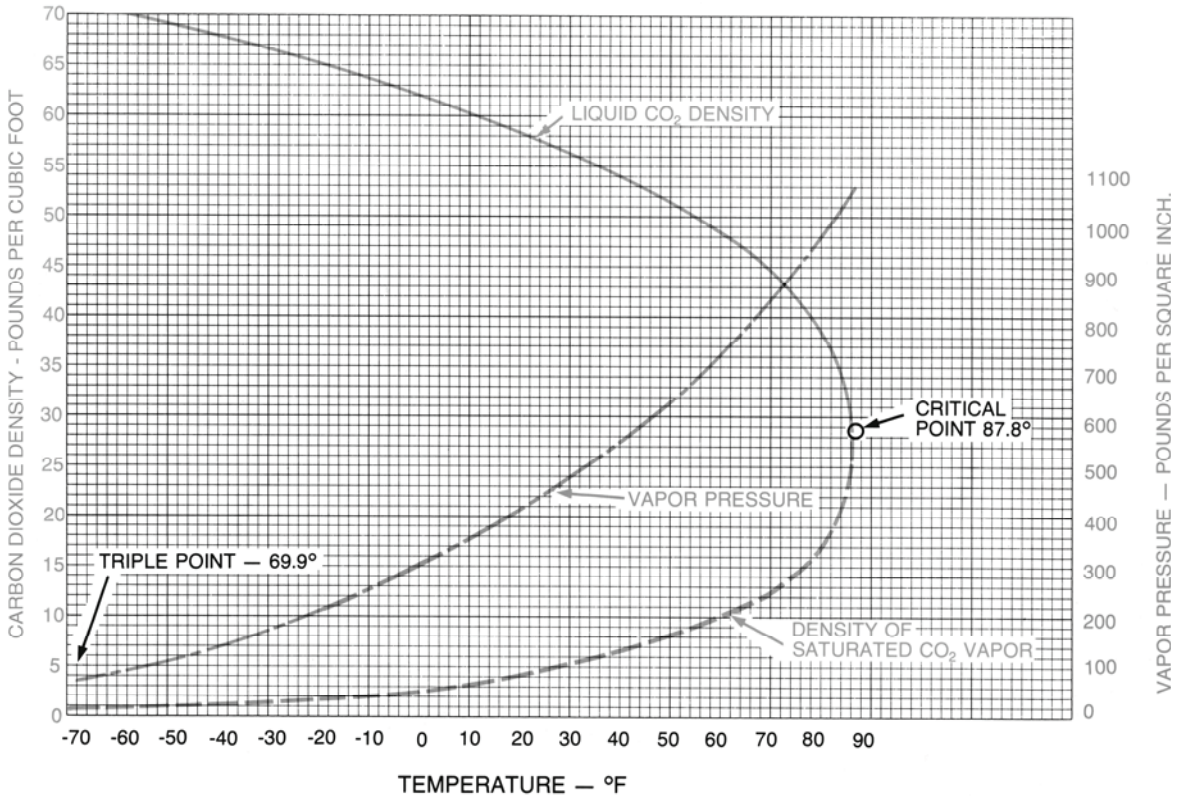

Figure 1-1. Carbon Dioxide Density and Vapor Pressure

Table 1-1. Physical Constants of Carbon Dioxide

Physical Constants of Carbon Dioxide		
Description	**Measurements (English)**	**Measurements (Metric)**
Molecular Weight		
	44.01 lb/lb-mol	44.01 kg/kg-mol
Vapor Pressure		
at 70 °F (21.1 °C)	838 psig	57.79 bar
at 32 °F (0 °C)	491 psig	33.86 bar
at 2 °F (-16.7 °C)	302 psig	20.83 bar
at -20 °F (-28.9 °C)	200 psig	13.79 bar
at -69.9 °F (-56.6 °C)	60.4 psig	4.17 bar
at -109.3 °F (-78.5 °C)	0 psig	0 kPa
Density of the gas		
at 70 °F (21.1 °C)	0.1144 lb/ft3	1.833 kg/m3
at 32 °F (0 °C)	0.1234 lb/ft3	1.977 kg/m3
Specific gravity of the gas		
at 70 °F (21.1 °C)	1.522	1.522
at 32 °F (0 °C)	1.524	1.524
Specific volume of the gas		
at 70 °F (21.1 °C)	8.741 ft3/lb	0.5457 m3/kg
at 32 °F (0 °C)	8.104 ft3/lb	0.5059 m3/kg
Density of liquid, saturated		
at 70 °F (21.1 °C)	47.6 lb/ft3	764 kg/m3
at 32 °F (0 °C)	58.0 lb/ft3	931 kg/m3
at 2 °F (-16.7 °C)	63.3 lb/ft3	1016 kg/m3
at -20 °F (-28.9 °C)	66.8 lb/ft3	1072 kg/m3
at -69.9 °F (-56.6 °C)	73.5 lb/ft3	1179 kg/m3
Sublimation temperature (1 atm)		
	-109.3 °F	-78.5 °C
Critical temperature		
	87.9 °F	31.1 °C
Critical pressure		
	1070.6 psig	73.81 bar, abs
Critical density		
	29.2 lb/ft3	468 kg/m3
Triple point		
	-69.9 °F at 60.4	-56.6 °C at 4.16

Physical Constants of Carbon Dioxide		
Description	**Measurements (English)**	**Measurements (Metric)**
Latent heat of vaporization		
at 32 °F (0 °C)	100.8 Btu/lb	234.5 kJ/kg
at 2 °F (-16.7 °C)	119.0 Btu/lb	276.8 kJ/kg
at -20 °F (-28.9 °C)	129.6 Btu/lb	301.4 kJ/kg
Latent heat of fusion		
at -69.9 °F (-56.6 °C)	85.6 Btu/lb	199 kJ/kg
Density of liquid		
at 2 °F (-16.7 °C)	63.3 lb/ft3	1015.9 kg/m3
Latent heat of sublimation		
at -109.3 °F (-78.5 °C)	245.5 Btu/lb	571.0 kJ/kg

1-3 LEARNING MORE ABOUT CARBON DIOXIDE

An important part of maintaining a carbon dioxide storage unit is understanding the properties of CO2. For example, both a lower than normal tank pressure and a higher than normal tank pressure are signs that the system may need maintenance or adjustment.

Maintenance and service of your CO2 storage unit should be performed only by a qualified carbon dioxide equipment technician, because CO2 knowledge is an important part of maintaining a CO2 storage unit.

To start or increase your knowledge of carbon dioxide, we recommend that you begin with the pamphlets and literature from the CGA (Compressed Gas Association). The CGA has a number of pamphlets and videos on CO2 and CO2 storage units.

We recommend:

- G-6 Carbon Dioxide
- G-6.1 Standard for Low Pressure Carbon Dioxide Systems at Consumer Sites (Please note: Chemetron units with a MAWP (Maximum Allowable Working Pressure) of 350 psig (24.1 bar) are considered low-pressure.)
- G-6.4 Safe Transfer of Low Pressure Liquified Carbon Dioxide in Cargo Tanks, Tank Cars and Portable Containers
- G-6.7 Safe Handling of Liquid Carbon Dioxide Containers That Have Lost Pressure (Please note: Failure to follow the recommendations in this pamphlet could result in a catastrophic brittle failure of the tank and/or may require the storage unit to be removed from service for an extended period of time.)
- S-1.3 Pressure Relief Device Standards – Part 3 – Stationary Storage Containers for Compressed Gases
- AV-7 Characteristics and Safe Handling of Carbon Dioxide

The CGA has other publications, videos, etc. that pertain to the storage unit. Contact the CGA for a list of available publications at:

Compressed Gas Association

1725 Jefferson Davis Hwy.

Suite 1004

Arlington, VA 22202-4102 USA

Phone: (703) 412-0900

1-4 SPECIFICATIONS

1-4.1 PRESSURE VESSEL

- See Table 1-2
- Designed, built and tested according to ASME (American Society of Mechanical Engineers) Boiler & Pressure Vessel Code, Section VIII, Division 1, Pressure Vessels
- Material: SA-612 normalized carbon steel
- MAWP (Maximum Allowable Working Pressure): 350 psig (24.1 bar)
- MDMT (Minimum Designed Metal Temperature): -40 ºF (-40 ºC)

1-4.2 INSULATION

- Horizontal models: 4” (101.6 mm) Polyurethane with 0.063” (1.6 mm) aluminum outer jacket
- Vertical models: 6” (152.4mm) Polyurethane with 0.063” (1.6mm) aluminum outer jacket

1-4.3 PIPING

- Schedule 80 seamless pipe, 2000 lb. forged steel fittings, ball type valves

1-4.4 SAFETIES

- Dual ASME approved direct spring loaded or pilot operated, sized for nonfire area installation

1-4.5 REFRIGERATION

- Low-Temp Air-Cooled Condensing Units
- Environmentally Safe R-404A refrigerant standard (See the Refrigeration Drawing in the Appendix of this manual for the actual refrigerant type.)
- Most electrical requirements available

1-4.6 INSTRUMENTATION

- Liquid Level Gauge: Differential pressure indicator type with 6” (152.4 mm) dial
- Pressure Gauge: 0 to 600 psig with 6” (152.4 mm) dial
- Audible High/Low Pressure Alarm

1-5 AVAILABLE OPTIONS UPON PURCHASE

- Dual contact switches for liquid level gauge
- 4-20MA output signal from liquid level gauge
- Cold weather provisions for instrumentation and compressor

Table 1-2. Storage Unit Data

Size (Tons)	Part Number	Length	Height	Width	Nominal Capacity	Weight Empty	Dip Tube Size	Weight Filled	Deliverable CO_2
Horizontal Tanks									
2 3/4	7048H021	14ft. 4 1/2in. (4381mm)	6ft. 10in. (2082mm)	4ft. 3in. (1295.4mm)	5,500lb. (2494kg)	4000lb. (1814kg)	4in.	9,500lb. (4309kg)	4,950lb. (2245kg)
3 3/4	7048H03X	11ft. 10 1/8in. (3611.5mm)	8ft. 9 3/8in. (2676mm)	5ft. 9in. (1754.1mm)	7,500lb. (3401kg)	7,500lb. (3,402kg)	6in.	15,000lb. (6803kg)	6,750lb. (3061kg)
6	7048H06X 7148H06X	15ft. 11 5/8in. (4868.8mm)	8ft. 9 3/8in. (2676mm)	5ft. 9in. (1754.1mm)	12,000lb. (5443kg)	9,000lb. (3359kg)	6in.	21,000lb. (9525kg)	10,800lb. (4898kg)
8	7048H08X 7148H08X	19ft. 6in. (5943.6mm)	8ft. 9 3/8in. (2676mm)	5ft. 9in. (1754.1mm)	16,000lb. (7257kg)	10,200lb. (4,627kg)	6in.	26,200lb. (11884kg)	14,400lb. (6531kg)
10	7048H10X	23ft. 4in. (7112mm)	8ft. 9 3/8in. (2676mm)	5ft. 9in. (1754.1mm)	20000lb. (9071kg)	11,500lb. (5216kg)	8in.	31,500lb. (14288kg)	18,000lb. (8164kg)
12	7048H12X	26ft. 2in. (7975.6mm)	8ft. 9 3/8in. (2676mm)	5ft. 9in. (1754.1mm)	24,000lb. (10886kg)	12,650lb. (5738kg)	8in.	36,650lb. (16624kg)	21,600lb. (9797kg)
14	7048H14X	19ft. 8in. (5994.4mm)	10ft. 6 3/8in. (3209mm)	7ft. 4in. (2235.2mm)	28,000lb. (12700kg)	14,000lb. (6350.2kg)	8in.	42,000lb. (19050kg)	25,200lb. (11430kg)
18	7048H18X	25ft. 0in. (7620.0mm)	10ft. 6 3/8in. (3209mm)	7ft. 4in. (2234.4mm)	36,000lb. (16329kg)	16,800lb. (7620kg)	8in.	52,800lb. (23949kg)	32,400lb. (14696kg)
22	7048H22X	29ft. 4in. (8940.8mm)	10ft. 6 3/8in. (3209mm)	7ft. 4in. (2234.4mm)	44,000lb. (19958kg)	19,000lb. (8618kg)	8in.	63,000lb. (28576kg)	39,600lb. (17962kg)
26	7048H26X	32ft. 7 7/8in. (9953.4mm)	10ft. 6 3/8in. (3209mm)	7ft.4in. (2234.4mm)	52,000lb. (23586kg)	23,500lb. (10,659kg)	8in.	75,500lb. (34246kg)	46,800lb. (21228kg)
30	7048H30X	36ft. 7 7/8in. (11172.6mm)	10ft. 8 7/8in. (3274mm)	7ft. 4in. (2234.4mm)	60,000lb. (27215kg)	26,500lb. (12,020kg)	8in.	86,500lb. (39235kg)	54,000lb. (24493kg)
34	7048H34X	40ft. 7 7/8in. (12391.8mm)	10ft. 8 7/8in. (3274mm)	7ft. 4in. (2234.4mm)	68,000lb. (30844kg)	29,000lb. (13154kg)	8in.	97,000lb. (43998kg)	61,200lb. (27759kg)
38	7048H38X	44ft. 7 7/8in. (13611.2mm)	10ft. 8 7/8in. (3274mm)	7ft. 4in. (2234.4mm)	76,000lb. (34473kg)	31,500lb. (14288kg)	8in.	107,500lb. (48761kg)	68,400lb. (31025kg)
42	7048H42X	48ft. 7 7/8in. (14830.4mm)	10ft. 8 7/8in. (3274mm)	7ft. 4in. (2234.4mm)	84,000lb. (38101kg)	34,000lb. (15422kg)	8in.	118,000lb. (53523kg)	75,600lb. (34921kg)
46	7048H46X	52ft. 7 7/8in. (16049.6mm)	10ft. 8 7/8in. (3274mm)	7ft. 4in. (2234.4mm)	92,000lb. (41730kg)	36,500lb. (16556kg)	8in.	128,500lb. (58286kg)	82,800lb. (37557kg)
50	7048H50X	56ft. 7 7/8in. (17268.8mm)	10ft. 8 7/8in. (3274mm)	7ft. 4in. (2234.4mm)	100,000lb. (45359kg)	40,000lb. (18143kg)	8in.	140,000lb. (63502kg)	90,000lb. (40823kg)
60	7048H60X	66ft. 7 7/8in. (20316.8mm)	10ft. 8 7/8in. (3274mm)	7ft. 4in. (2234.4mm)	120,000lb. (54431kg)	45,000lb. (20411kg)	8in.	165,000lb. (74842kg)	108,000lb. (48987kg)
Vertical Tanks									
6	7048V06X	7ft. 10 1/2in. (2400.3mm)	15ft. 3in. (4648.2mm)	6ft. 5in. (1955.8mm)	12,000lb. (5443kg)	10,000lb. (4535kg)	6in.	22,000lb. (9979kg)	10,800lb. (4898kg)
14	7048V14X	8ft. 9in. (2667mm)	22ft. 4in. (6807mm)	8ft. 6in. (2438mm)	28,000lb. (12700kg)	15,500lb. (7030kg)	6in.	43,500lb. (19731kg)	25,200lb. (11430kg)
26	7048V26X	8ft. 9in. (2667mm)	33ft. 8in. (10261mm)	8ft. 6in. (2438mm)	52,000lb. (23586kg)	25,000lb. (11339kg)	6in.	82,000lb. (37194kg)	46,800lb. (21228kg)
30	7048V30X	8ft. 9in. (2667mm)	37ft. 5in. (11404mm)	8ft. 6in. (2438mm)	60,000lb. (27215kg)	30,000lb. (13607kg)	6in.	95,000lb. (43091kg)	54,000lb. (24493kg)

1-6 LOW PRESSURE CARBON DIOXIDE STORAGE UNIT MODELS

The X as shown in the Table 1-2 stock numbers represents a place holder to specify the refrigeration compressor voltage. The valid range for the X placeholder is 1 through 7 as applicable to each storage unit voltage available. The full range of voltages may not be available for every storage unit capacity model. See [redacted] for available refrigeration voltages.

1-6.1 STOCK NUMBER "X" PLACEHOLDER AVAILABLE VOLTAGES

1 = 120V/60Hz/1-Phase

2 = 220V/60Hz/1-Phase

3 = 220V/50Hz/1-Phase

4 = 220V/60Hz/3-Phase

5 = 380V/50Hz/3-Phase

6 = 460V/60Hz/3-Phase

7 = 575V/60Hz/3-Phase

Additionally, each storage unit may be outfitted with standard or optional features. These are detailed in the table below. Each storage unit shall be assigned the stock number with the appropriate suffix number to identify standard/optional features included. These options are FM approved.

1-6.2 SUFFIX NUMBER FOR STANDARD/OPTIONAL FEATURES

Table 1-3. Suffix Numbers

Suffix Number	Description
L0	Standard Outfit-Liquid Level Gauge without contacts
L1	Outfit Option – Liquid Level Gauge with NO/NC Dual Contacts
L2	Outfit Option – Liquid Level Gauge with 4-20mA Output Signal
C0	Standard Outfit – No Cold Weather Package
C1	Outfit Option – Cold Weather Package (Heated Liquid Level Gauge Lines, Refrigeration Unit Crankcase Heater, etc.)
A0	Standard Outfit – Factory Mutual (FM) Approved
A1	Outfit Option – CSA Approved
A2	Outfit Option – PED Approved

An example of a 10 ton, 460v-3ph-60hz storage unit with contacts included on the liquid level gauge, no cold weather package, and approved to FM requirements would be represented by part number 7048H106-L1-C0-A0.

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CHAPTER 2
CARBON DIOXIDE SAFETY

The text in this section has been adapted from CGA (Compressed Gas Association) publication CGA G-6 – 1984: Carbon Dioxide

2-1 GENERAL SAFETY CONSIDERATIONS

Gaseous carbon dioxide is an asphyxiate. Concentrations of 10% or more can produce unconsciousness or death. Lower concentrations may cause headache, sweating, rapid breathing, increased heart rate, shortness of breath, dizziness, mental depression, visual disturbances, and shaking. The seriousness of the latter manifestations is dependent on the concentration of carbon dioxide and the length of time the individual is exposed.

Carbon dioxide is an odorless gas and should be treated as a material with poor warning properties. It is denser than air, and high concentrations can persist in open pits, tanks, or low depressions on the terrain. Before entering such an area, carbon dioxide monitoring should be carried out and the area cleared by forced ventilation, or a self-contained, supplied air respirator should be worn.

Appropriate warning signs should be affixed outside of those areas where high concentrations of carbon dioxide gas can accumulate. One such sign is shown below:

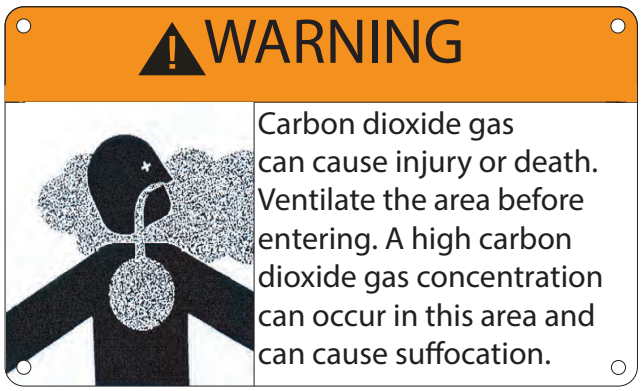

Figure 2-1. Warning sign

2-2 RESCUE

Do not attempt to remove the individual without utilizing proper rescue equipment or you may also become a casualty. If the exposed person is unconscious, obtain assistance and put into effect the established emergency procedures.

2-3 INHALATION FIRST AID

Inhalation of gaseous carbon dioxide can adversely affect body function. Skin, eye, or mouth contact with dry ice (solid carbon dioxide) or compressed carbon dioxide can cause adverse effects.

If a person has inhaled large amounts of carbon dioxide and is exhibiting adverse effects, move the exposed individual to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get professional medical attention immediately.

2-4 EXTERNAL EXPOSURE FIRST AID

Skin or mouth contact with dry ice or with vapor or liquid carbon dioxide discharged from a container may result in frostbite, causing skin lesions or more serious injury from deep freezing of the tissues.

If dry ice or compressed CO2 vapor comes in contact with the skin or mouth, stop the exposure immediately. If frostbite has occurred, obtain professional medical attention immediately. Do not rub the area. Do not apply heat warmer than 107 °F (41.7 °C).

Eye contact with dry ice or compressed CO2 should be considered as a corneal burn. Frostbite of the eye structure may also occur.

If dry ice or CO2 vapor or liquid comes in contact with the eyes, stop the exposure and obtain professional medical attention immediately.

CHAPTER 3
INSTALLATION

3-1 SELECTING A LOCATION

Carbon dioxide storage units are generally filled from large cargo tank trailers. Therefore, the location selected should provide easy access for these delivery units. The storage unit should also be as close to the point of use as possible.

Do not locate the storage unit in an area where it will be subjected to high temperatures (above 110 °F (43.3 °C)) for prolonged periods of time.

The hazardous effects from potential flooding and fire conditions must also be considered when choosing a location. A dry, well ventilated location is preferable.

Do not locate the storage unit in an area where it might be struck by heavy moving or falling objects. Damage to the outer vessel jacket can cause a loss of vapor barrier, resulting in a loss of insulation efficiency.

If a small, enclosed location is used, the outlet from the safety relief valves and bleeder valves must be piped to the outside or to a point where discharge will not result in a high concentration of CO2. Such piping must be provided with drain holes at low points and **must not** be equipped with valves or any other means of restricting or stopping the flow of vapor. The size of the discharge line should be such that any pressure that may exist or develop will not reduce the relieving capacity of the safety relief valve below that required. The safety relief valves on standard units are sized for non-fire, outdoor locations. For locations in areas other than this, consult Chemetron Fire Systems for proper sizing.

WARNING

Restricting or blocking safety relief valve outlet can have disastrous results including a catastrophic failure of the pressure vessel and death.

The installation of a carbon dioxide storage unit in or on a building, platform or any existing surface, should only be made after it is determined that the surface can support the system. When so installed, flexibility should be provided in piping and electrical conduit runs. See Foundation Details for horizontal and vertical storage units.

3-2 FOUNDATION DESIGN

To ensure a proper foundation for the vessel, the owner should obtain an independent foundation design from a registered civil/structural engineer familiar with regulatory requirements at the installation site. See Appendix B for foundation drawings. The following must be among the information considered in the foundation design:

- Controlling building code(s)
- Soil bearing pressure
- Controlling seismic or wind criteria
- Extreme frost penetration
- Any other specific design requirements which may apply

3-3 INSTALLATION

On arrival, inspect the storage unit for transit damage. Report any such damage to the carrier at once and note it on the freight bill.

Unload the storage unit with a crane using cables. Lifting lugs are located on top of the vessel.

The storage units are designed for Seismic Zone 4 (per Uniform Building Code) loads and are designed to be bolted to a concrete foundation.

WARNING

Never lift or relocate a storage unit that contains liquid carbon dioxide. Always empty the unit and allow the inner steel vessel to warm to ambient temperature prior to lifting or relocating

Install and level the storage unit with a 1" (25.4 mm) minimum grout allowance between the top of the concrete foundation (see “FOUNDATION DESIGN” on page 3-1) and bottom of vessel base plate. After leveling and final positioning of anchor bolts, fill the voids in the anchor bolt sleeves with solid non-shrink grout. Proper tension should be provided, using the turn-of -nut tightening, calibrated wrench tightening, or by use of a direct tension indicator as prescribed by the AISC (American Institute of Steel Construction) for the anchor bolt material and size.

CAUTION

To insure safe & proper operation and prevent possible overfilling, it is imperative that the storage unit be installed level.

3-4 PRECAUTIONS FOR INTERCONNECTED LIQUID CO2 TANKS

To allow the proper operation of the safety relief valve(s), all liquid CO2 tanks must have a vapor space at the top of the tank and not be allowed to go liquid full. Because liquid seeks its own level, the maintenance of the proper vapor space can be compromised when two or more liquid CO2 tanks are interconnected by piping. When there are interconnected liquid CO2 tanks, an evaluation must be performed and when necessary proper valves and controls must be put in place to prevent this dangerous condition from occurring.

WARNING

Incorrectly interconnecting liquid co2 tanks can cause improper operation of the safety relief valve(s) and catastrophic failure of the tank.

In all the cases shown below (Figure 3-1), additional valves and controls would be needed if any of these tanks were interconnected. Contact Chemetron Fire Systems Technical Support for acceptable details and parts.

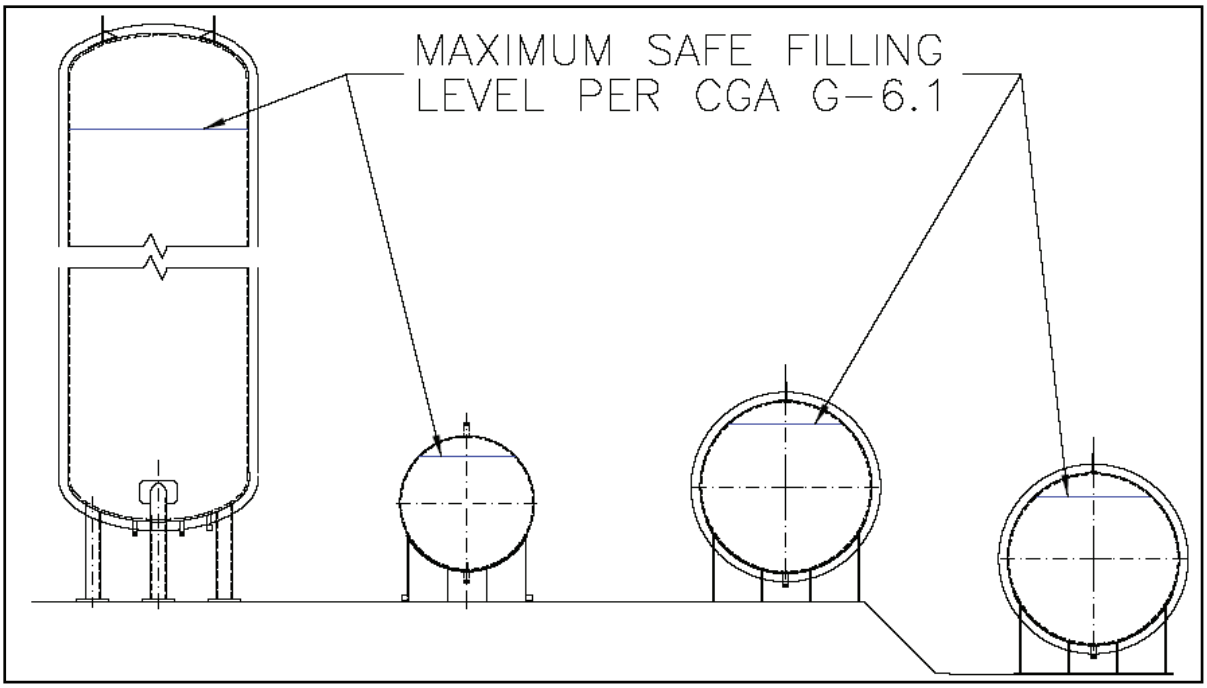

Figure 3-1. Maximum Safe Filling

3-5 STORAGE TANK POWER REQUIREMENTS

Refer to Table 3-1 for recommended wire sizes, circuit ratings and fuse sizes to supply the AC power to the storage tank.

3-5.1 POWER SUPPLY DEPENDABILITY

Careful consideration shall be given in each case to the dependability of the electrical supply and wiring system. This shall include the possible effect of fire that may threaten the service to the storage unit. Electrical service shall be installed in accordance with NFPA 70 (National Electric Code) and all state and local codes. Refer to Electric Schematic Wiring Diagrams in Appendix A.

CHAPTER 4
OPERATION AND MAINTENANCE

4-1 INITIAL START UP INSTRUCTIONS

Following is the standard initial start-up procedure for [redacted] carbon dioxide storage unit.

Note: THIS SHOULD BE PERFORMED BY A QUALIFIED CARBON DIOXIDE/REFRIGERATION EQUIPMENT TECHNICIAN ONLY. Refer to the General Arrangement Drawing and the Process and Instrumentation Diagram Drawing in the Appendix of this manual for valve identification

1. Perform a visual inspection of the storage unit including the refrigeration unit and tubing to determine if any shipping, rigging or installation damage has occurred.
2. If the Safety Relief Valve Assembly was shipped loose, seal the connecting threads and install it before proceeding.
3. Make the proper electrical service connection at the refrigeration panel and ground the unit base. Leave the electrical disconnect switches in the OFF position at this time.
4. Check the refrigeration system sight glass for a dry system indication.
5. Connect refrigeration gauges to receiver valve and compressor suction valve.
6. Open receiver valve to pressurize high pressure side to 50 psi.
7. Open refrigeration gauge and compressor suction valve to pressurize low pressure side.
8. Close receiver valve. Check for leaks and repair if required.
9. Remove refrigeration compressor blocking if applicable.
10. Open all refrigeration service valves to the full open position.
11. Refer to Figure 4-1 on page 4.5 for hose configurations & valve numbers.
12. Prepare to fill the storage unit by following steps 1 - 8 under Section 4-3, TYPICAL TWO HOSE FILLING PROCEDURE.

Note: This should fill tank with vapor only. That vapor will be at the equalization pressure. The equalization pressure will be the same as the pressure in the cargo tank, pressures in the 200-300 psi (13.8-26.7 bar) range are not uncommon.

13. Before shipment, the storage unit was purged of air; however, no warranty is expressed or implied that the vapor contents, when shipped, were free of air or other non-condensable. Therefore, it is strongly suggested that the storage unit be purged before filling. Your CO2 supplier should follow his standard procedure for purging a new system. If your supplier has no set procedure, purge the storage unit as follows:
    a. Blow storage unit pressure down to 0 psig through vapor balance valve (V-3).
    b. Pressurize to 10 psig (0.7 bar), allow to stand 2 minutes.
    c. Blow down to 2 psig (0.1 bar) through vapor process valve.
    d. Repeat steps B and C at least 3 times.

Note: Depending on the valve configuration of the hoses used to connect the cargo tank to the storage unit, it may be necessary to connect and disconnect the hose connected to the vapor balance valve (V-3) multiple times when using steps a-d in the above procedure.

14. After purging, pressurize with carbon dioxide vapor to 100 psig (6.9 bar) and check for leaks using a solution suitable for detecting leaks in pressurized piping.
15. Allow tank trailer pressure and storage unit pressure to equalize, making sure that the pressure is a minimum of 200 psig (13.8 bar).

16. Check again for carbon dioxide leaks.
17. Open instrumentation equalizer valve (V-15).
18. Check instrumentation low-pressure isolation valve (V-16) (should be completely open).
19. Check instrumentation high-pressure isolation valve (V-14) (should be completely open).
20. Check liquid level gauge calibration (should be near zero).
21. Purge instrumentation lines by opening the instrumentation purge valve (V-13) for 5 to 10 seconds, then closing.
22. Close instrumentation equalizer valve (V-15).
23. Refer to steps 9 - 16 under "TYPICAL TWO HOSE FILLING PROCEDURE" on page 4-3 and pump approximately 1000 pounds (453.6 kg) of liquid carbon dioxide into the storage unit. Note: Storage unit pressure must be a minimum 200 psig (13.8 bar) to ensure that the pressure vessel temperature and pressure are within the safe range for liquid filling.

WARNING

Filling a carbon dioxide storage unit outside of the normal operating temperature and pressure range can have disastrous results including a catastrophic failure of the pressure vessel and death.

24. Check all liquid piping and valves for leaks.
25. Allow the storage unit pressure to build to above 305 psig (21.0 bar).
26. Move the refrigeration disconnect switch to the ON position. The refrigeration unit should start.
27. Check rotation of fan motor to be sure it is rotating in the direction of the arrow.

CAUTION

If the storage unit is equipped with an scroll refrigeration compressor correct operation is dependent on its internal direction of rotation. If the compressor appears "noisy" or if the suction and discharge pressures do not change while running, the compressor rotation is incorrect. If needed, reverse the rotation of the compressor by swapping any two power leads to the unit.

28. Monitor the suction and discharge pressures for 15 minutes. The suction pressure should settle between 15 and 22 psig (1.0 - 1.5 bar) at ambient temperatures of 60 ºF (15.6 ºC) or above. However, it is not uncommon for the suction pressure to fluctuate slightly as the thermostatic expansion valve throttles.
29. Check the refrigerant level at the refrigeration system sight glass. If the refrigerant level is low (indicated by bubbles in the sight glass window), add refrigerant until the sight glass is clear of bubbles. See the Refrigeration Drawing in the Appendix of this manual for the refrigerant type.
30. Refer to steps 15 - 28 under"TYPICAL TWO HOSE FILLING PROCEDURE" on page 4-3 and complete the filling procedure.
31. While the refrigeration system runs, continue to monitor the suction and discharge pressures.
32. After the refrigeration system has operated for approximately two hours, check the oil level in the refrigeration compressor. The system should be running to get a proper level indication. A proper level is indicated when the level of the refrigeration oil is near the top of the sight glass on the side of the compressor. If the level is low, move the refrigeration disconnect switch to OFF and add refrigeration oil using a polyester type refrigeration oil such as Mobil EAL Arctic 22CC™ (or equal) and then move the refrigeration disconnect switch back to the ON position.
33. Slowly open the Instrumentation Purge Valve (V-13) until the storage unit pressure drops below 295 psig (20.3 bar) and then close the valve. This will force the refrigeration unit to cycle off. At 295 psig (20.3 bar) the refrigeration liquid line solenoid valve will close. The refrigeration system will continue to run until all of the refrigerant in the system is pumped into the reservoir. Once this is completed, the refrigeration dual pressure control will shut the system off (refrigerant pressure at 6 psig (0.4 bar)). The

refrigeration system will cycle on again if the refrigerant pressure goes above 18 psig (1.2 bar). This is commonly referred to as a pump down cycle.

34. If the storage unit will be connected to a pressure build vaporizer, put it into operation according to the instructions in the Vaporizer Operation and Maintenance Manual. The vaporizer will operate automatically, and the set pressures can be found on the Wiring Schematic Drawing in the Appendix of the Vaporizer Operation and Maintenance manual.
35. Perform the steps under "TESTS FOR PROPER FILLING" on page 4-4.

4-2 DAILY OPERATION

Once the storage unit has been installed and the Initial Start-Up Instructions have been accomplished, it is ready for normal service. Make all necessary process connections according to industry standards for pressurized piping, and follow your company's established procedure for daily product use. The refrigeration system and pressure build vaporizer system (if applicable) should be left on at all times except for service and maintenance.

4-3 TYPICAL TWO HOSE FILLING PROCEDURE

Following is a typical two hose procedure for filling a carbon dioxide storage unit from a carbon dioxide cargo tank (transport trailer) as adapted from the CGA (Compressed Gas Association) publication CGA G-6.4: Safe Transfer of Low Pressure Liquefied Carbon Dioxide in Cargo Tanks, Tank Cars and Portable Containers. Refer to Figure 4-1. Refer to the General Arrangement Drawing and the Process and Instrumentation Diagram Drawing in the Appendix of this manual for valve identification.

1. Park cargo tank so that unloading can be performed safely. Place chocks under cargo tank wheels.
2. Check markings on cargo and storage tank to verify that both are liquefied carbon dioxide tanks.
3. Pressure may exist between liquid and/or vapor shut-off valves and the dust caps. Relieve pressure on cargo tank piping by opening blow-down valves. After purging, close blow-down valves.
4. Remove dust caps from all liquid and vapor connections and inspect connections for cleanliness. Use rags to clean as necessary.

Note: Do not use glycol or other lubricants to the connections.

5. Connect vapor hose from cargo tank vapor discharge line to the storage unit vapor balance valve (V-3). Attach hose safety restraints.
6. Connect liquid hose from the cargo tank liquid line to the storage unit liquid fill valve (V-2). Attach hose safety restraints.
7. Pressurize the vapor line by opening the cargo tank vapor discharge line valve. Purge line by opening the cargo tank vapor blow-down valve. After purging, close vapor blow-down valve.
8. Equalize pressure between the storage unit and the cargo tank by opening the storage unit vapor balance valve (V-3).

Note: If this is the initial fill of the tank, follow the step under "Initial Start Up Instructions" before proceeding.

9. Open the vapor by-pass valve on the cargo tank and pressurize the liquid discharge line.
10. Purge liquid line by opening cargo tank liquid blow-down valve. After purging, close liquid blow-down and vapor by-pass valves.
11. Check all connections for leaks and proper connections.
12. Open storage unit liquid fill valve (V-2).
13. Open cargo tank liquid valve.
14. Crack open the blow-down valve on the cargo tank vapor line
15. Be sure liquid loading pump is cooled down and flooded before starting.

Note: Storage unit pressure must be a minimum 200 psig (13.8 bar) to ensure that the pressure vessel temperature and pressure are within the safe range for liquid filling

WARNING

Filling a carbon dioxide storage unit outside of the normal operating temperature and pressure range can have disastrous results including a catastrophic failure of the pressure vessel and death.

16. Start pump.
17. Monitor the liquid level gauge. Once the storage unit is full (as indicated by the liquid level gauge) or when liquid begins to exit the blow-down valve on the cargo tank vapor line, stop the pump immediately to prevent overfilling.
18. Close the storage unit liquid fill (V-2) and vapor balance valves (V-3).
19. Close the cargo tank liquid valve.
20. Open cargo tank vapor by-pass valve.
21. Open both cargo tank blow-down valves to purge liquid carbon dioxide from pipe and hoses.
22. Close cargo tank vapor valve.
23. Close cargo tank vapor by-pass valve.
24. When liquid and vapor hoses are at atmospheric pressure, disconnect hoses and detach safety restraints.

Note: Note: check to insure hoses are vacant of liquid by weight , flexibility and the lack of pressure in the hose

25. Close both cargo tank blow-down valves.
26. Replace all dust plugs and/or caps, and store hoses in cargo tank hose tubes.
27. Close and latch cargo tank doors.
28. Remove wheel chocks from cargo tank wheels.
29. Perform “Tests for Proper Filling” on page 4.8

4-4 TESTS FOR PROPER FILLING

It is very important that the level of the liquid carbon dioxide in the storage unit be kept no higher than the bottom of the vapor balance line. After the storage unit is filled, and the hoses to the vapor balance and liquid fill valves have been disconnected, the vapor balance valve should be opened slightly to observe the discharge of carbon dioxide into the atmosphere. If the discharge is clear or only slightly foggy, the tank has been properly filled. If the discharge is a dense, white cloud containing particles of dry ice, the liquid level in the tank is too high. In the event of an overfill, the slow discharge should be continued until the dense, white fog discharge changes to a clear or blue fog discharge.

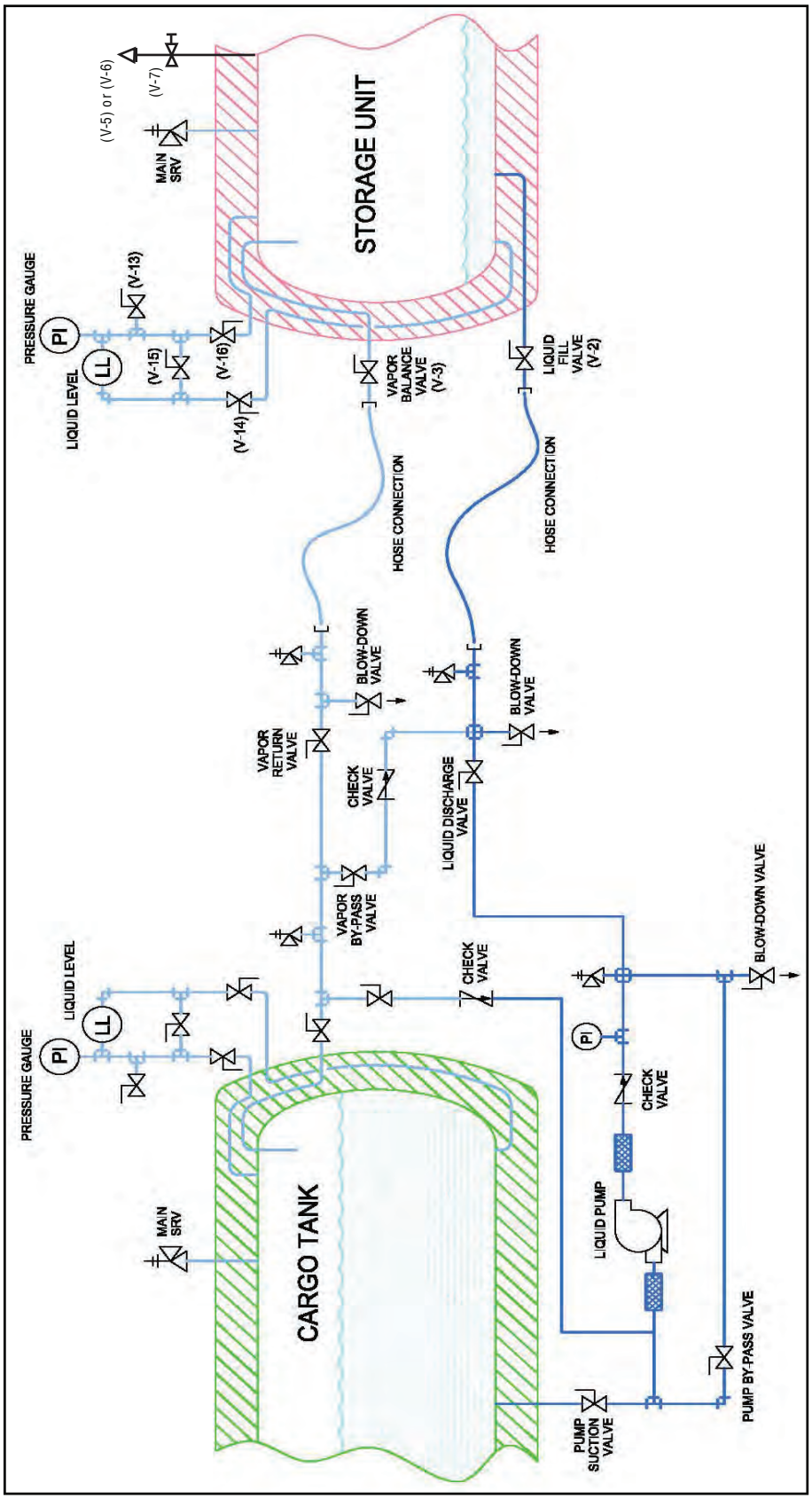

Figure 4-1. Typical Carbon Dioxide Transfer from Cargo Tank to Storage Unit

4-5 MAINTENANCE

4-5.1 DAILY

- Inspect the pressure vessel safety relief valve (SRV-1) for signs of malfunction. Be certain that the safety relief valve discharge piping is not plugged or obstructed in any manner.

WARNING

Restricting or blocking safety relief valve outlet can have disastrous results including a catastrophic failure of the pressure vessel and death.

- Monitor the storage unit pressure to ensure that it remains within the normal operating range. The refrigeration on/off pressure settings can be found on the Wiring Schematic Drawing in the Appendix of this manual. If the refrigeration unit is not turning on or off at the proper pressure settings, adjust the refrigeration pressure switch according to the procedure on"REFRIGERATION PRESSURE SWITCH ADJUSTMENT" on page 6-2
- Monitor the carbon dioxide liquid level and reorder carbon dioxide as needed.
- Inspect the area surrounding the storage unit and promptly remove any fire hazards.
- Remove any obstructions to the ventilation openings on the control cabinet.

4-5.2 EVERY SIX MONTHS

- Inspect all metal surfaces for rust or damage to paint. Repair as needed.
- Inspect the vessel outer jacket for damage. Repair as needed.
- Check the refrigeration compressor oil level. The system should be running to get a proper level indication. A proper level is indicated when the level of the refrigeration oil is near the top of the sight glass on the side of the compressor. If the level is low, move the refrigeration disconnect switch to OFF and add refrigeration oil using a polyester type refrigeration oil such as Mobil EAL Arctic 22CC™ (or equal) and then move the refrigeration disconnect switch back to the ON position.
- Check the refrigerant level at the refrigeration system sight glass. If the refrigerant level is low (indicated by bubbles in the sight glass window), add refrigerant until the sight glass is clear of bubbles.
- Clean the fins on the condensing unit coil to ensure adequate air flow.
- Inspect piping for signs of a leak. Have leaks repaired by a qualified CO2 equipment service technician.
- Inspect instrumentation for leaks or malfunction. If needed, perform repairs according to the procedure in Section 6-1, LIQUID LEVEL GAUGE CALIBRATION.

4-5.3 YEARLY

- It is recommended that the safety relief valve be tested by a qualified CO2 equipment service technician at least once per year. More frequent testing may be required in certain applications such as a corrosive environment

CHAPTER 5
TROUBLESHOOTING

All troubleshooting should only be performed by a qualified carbon dioxide service technician.

5-1 TROUBLESHOOTING CHART

PROBLEM	POSSIBLE CAUSE	REMEDY
Unit pressure high - refrigeration system not running	1. Blown fuse 2. Electric power off 3. Controls out of adjustment 4. Low refrigerant level	1. Replace fuse 2. Check power off 3. Adjust controls. Appropriate settings can be found on page 6-2 4. Check and add as needed
Unit pressure high - refrigeration system running	1. Insufficient air across condenser coils 2. Condenser coils dirty 3. Low on refrigerant 4. Suction pressure too high or too low 5. Bad compressor valves 6. Internal mechanical trouble in compressor	1. Determine reason and correct 2. Clean coils 3. Find & stop leak, add refrigerant 4. Replace expansion valve, **DO NOT ADJUST** 5. Replace valves 6. Replace compressor
Refrigeration system does not start, hums, but trips on overload protector	1. Low voltage 2. Single phasing 3. Compressor motor has a winding open or shorted 4. Internal mechanical trouble in compressor	1. Check power source 2. Check power source 3. Replace compressor 4. Replace compressor
Refrigeration system operates long or continuously	1. Low on refrigerant 2. Carbon dioxide pressure control differential too wide 3. Carbon dioxide control contacts stuck closed 4. Condenser coils dirty 5. Insufficient air across condenser coils	1. Fix leak, add refrigerant 2. Adjust differential to 10 psi 3. Replace control 4. Clean coils 5. Determine reason and correct
Refrigeration system starts, but short cycles on overload protector	1. Low or unbalanced voltage to unit 2. Excessive discharge pressure 3. Suction pressure too high 4. Compressor too hot 5. Overload protector defective	1. Determine reason and correct 2. Check ventilation. Check fans for proper operation. Check for air or other non-condensable in system 3. Bad expansion valve, replace - **DO NOT ADJUST** 4. Check refrigerant charge, repair leak, add refrigerant 5. Check current, replace overload protector
Refrigeration system runs, but short cycles on carbon dioxide switch	1. Differential set too close 2. Defective switch	1. Widen differential to 10 psi 2. Replace switch

PROBLEM	POSSIBLE CAUSE	REMEDY
Refrigeration system short cycles on dual refrigerant pressure control A. High side B. Low side	A. 1. Insufficient air across condenser coils 2. System overcharged 3. Air in system B. 1. Under charged 2. Suction Pressure too low 3. Liquid line crimped 4. Restriction in expansion valve	A. 1. Determine reason and correct 2. Reduce charge 3. Purge B. 1. Fix leak, add refrigerant 2. Adjust expansion valve 3. Replace crimped section 4. Clean expansion valve - replace if necessary
Refrigeration system operating, but suction line (and compressor) are frosted	1. Expansion valve passing excess refrigerant 2. Expansion valve stuck open 3. Over charge of refrigerant	1. Replace expansion valve, **DO NOT ADJUST** 2. Clean valve of foreign particles - replace if necessary 3. Reduce charge
Refrigeration system noisy	1. Loose parts or mountings 2. Tubing rattle	1. Locate and tighten 2. Re-form to be free of contact
Pressure bleeder valve venting when unit pressure is not too high	1. Defective valve	1. Replacement valve
Liquid level gauge shows 0 - unit known to contain liquid	1. Equalizer valve open 2. Liquid supply valve to instruments closed 3. Liquid supply frozen/ restricted. 4. Leak in instrument piping 5. Out of calibration. 6. Defective gauge.	1. Close equalizer valve 2. Open valve 3. Open equalizer valve, close liquid supply & vapor supply then open blow down valve, Loosen flare nut on liquid supply, wait about 5 minutes. Close blow down valve, then crack vapor valve to make sure pressure comes thru the line. Close vapor valve, hook- up liquid supply line, then open vapor supply & liquid supply, close equalizer valve. 4. Find & mark leak, proceed according to procedure for isolating instrument piping, then repair leak 5. Calibrate gauge 6. Replace gauge
Liquid level gauge shows over-full or reads high.	1. Vapor supply valve to instruments closed 2. Gauge out of calibration 3. Leak in instrument piping 4. Defective gauge	1. Open valve 2. Calibrate gauge according to instructions given in manual 3. Find & mark leak, proceed according to procedure for isolating instrument piping, then repair leak 4. Replace gauge

Liquid level gauge shows below zero	1. Liquid supply to instruments valve closed 2. Gauge out of calibration 3. Liquid supply frozen/restricted 4. Leak in instrument piping 5. Defective gauge	1. Open valve 2. Calibrate gauge 3. Open equalizer valve, close liquid supply & vapor supply then open blow down valve, loosen flare nut on liquid supply, wait about 5 minutes. Close blow down valve, then crack vapor valve to make sure pressure comes thru the line. Close vapor valve, hook-up liquid supply line, then open vapor supply & liquid supply, close equalizer valve. 4. Find & mark leak, proceed according to procedure for isolating instrument piping, then repair leak 5. Replace gauge
Liquid level gauge reading erratic	1. Equalizer valve not completely closed 2. Instrument bleed-off valve not completely closed 3. Leak in instrument piping 4. Liquid supply frozen/restricted 5. Defective gauge.	1. Close equalizer valve 2. Close valve 3. Find & mark leak, proceed according to procedure for isolating instrument piping, then repair leak 4. Open equalizer valve, close liquid supply & vapor supply then open blow down valve, loosen flare nut on liquid supply, wait about 5 minutes. Close blow down valve, then crack vapor valve to make sure pressure comes thru the line. Close vapor valve, hook- up liquid supply line, then open vapor supply & liquid supply, close equalizer valve. 5. Replace gauge.

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CHAPTER 6
REPAIR AND ADJUSTMENTS

All repairs and adjustments should be performed by a qualified carbon dioxide equipment service technician. Refer to the General Arrangement Drawing and the Process and Instrumentation Diagram Drawing in the Appendix of this manual for valve identification.

6-1 LIQUID LEVEL GAUGE CALIBRATION

The liquid level gauge supplied with your [redacted] Systems storage unit was calibrated at the factory. If you suspect that it requires re-calibration, contact th[redacted] Technical Support department.

6-2 INSTRUMENTATION COMPONENT AND PIPING REPLACEMENT OR REPAIR

Never attempt to replace any instrumentation component or repair leaks in the instrumentation piping while there is pressure in the instrumentation lines. The instrumentation system must be isolated from the pressure vessel and the pressure relieved from the instrumentation lines.

You should become familiar with the instrumentation system before replacing any instrumentation component or repairing leaks in the instrumentation piping. Identify all instrumentation components before proceeding. It is especially important that you identify the instrumentation low- and high-pressure isolation valves (V-16 and V-14).

Follow this procedure in the exact order given and do not skip any steps.

1. Move the disconnect switch on the refrigeration control panel and on the vaporizer control panel if applicable to the OFF position.
2. Open the instrumentation equalizer valve (V-15).
3. Close the instrumentation high-pressure isolation valve (V-14).
4. Close the instrumentation low-pressure isolation valve (V-16).
5. Slowly open the instrumentation purge valve (V-13) to relieve all pressure from the instrumentation system.

CAUTION

Never attempt to replace any instrumentation component or repair leaks in the instrumentation piping while there is pressure in the instrumentation lines.

6. Perform the component replacement or piping leak repair as required.
7. Close the instrumentation purge valve (V-13).
8. Slowly open the instrumentation low-pressure isolation valve (V-16).
9. Open the instrumentation high-pressure isolation valve (V-14).
10. Close the instrumentation equalizer valve (V-15).
11. Check instrumentation piping and component connections for leaks using a solution suitable for detecting leaks in pressurized piping.
12. Move the disconnect switch on the refrigeration control panel and on the vaporizer control panel if applicable back to the ON position.

6-3 ISOLATION VALVE REPLACEMENT

Contact th[redacted] Technical Support department before replacing isolation valves.

6-4 SAFETY RELIEF VALVE REPLACEMENT

Contact the[redacted] Technical Support department before replacing the safety relief valve.

6-5 PRESSURE BLEEDER VALVE REPLACEMENT

1. Close the pressure bleeder isolation or diverter valve so that the pressure bleeder valve to be replaced is isolated from the vessel pressure.
2. Remove the pressure bleeder valve.
3. Seal the threads of a new pressure bleeder valve and screw it in tightly.
4. Very slowly open the pressure bleeder relief isolation or diverter valve so that the new pressure bleeder valve is no longer isolated from the vessel pressure.
5. Check the joint for leaks using a water/soap solution

6-6 REFRIGERATION PRESSURE SWITCH ADJUSTMENT

The refrigeration pressure switch supplied with your storage unit was preset at the factory. The standard pressure settings are refrigeration on at 305 psig (21.0 bar) and refrigeration off at 295 psig (20.3 bar). However, some specifications call for special on/off pressure settings. The actual on/off settings can be found on the Wiring Schematic Drawing in the Appendix of this manual.

If the refrigeration turns on or off at settings other than those shown on the Wiring Schematic Drawing, the pressure settings can be adjusted as follows Figure 6-1:

6-6.1 RERFIGERATION ON

1. If the refrigeration turns on at a pressure other than the on setting specified on the Wiring Schematic Drawing, adjust the Operating Range Adjustment Screw. Turn the screw clockwise to increase the refrigeration on pressure setting. Turn the screw counterclockwise to decrease the refrigeration on pressure setting.
2. Monitor the refrigeration on pressure and repeat as needed.

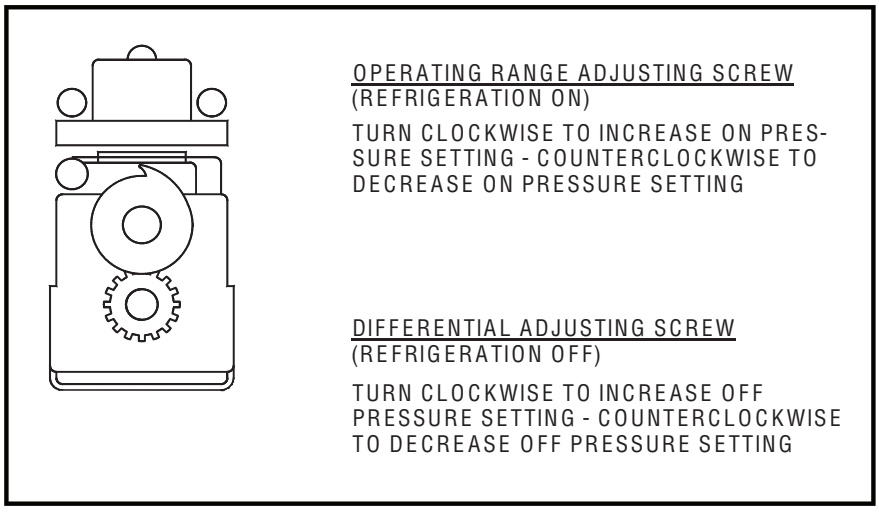


Figure 6-1. Refrigeration On/Off Pressure Setting Adjustment

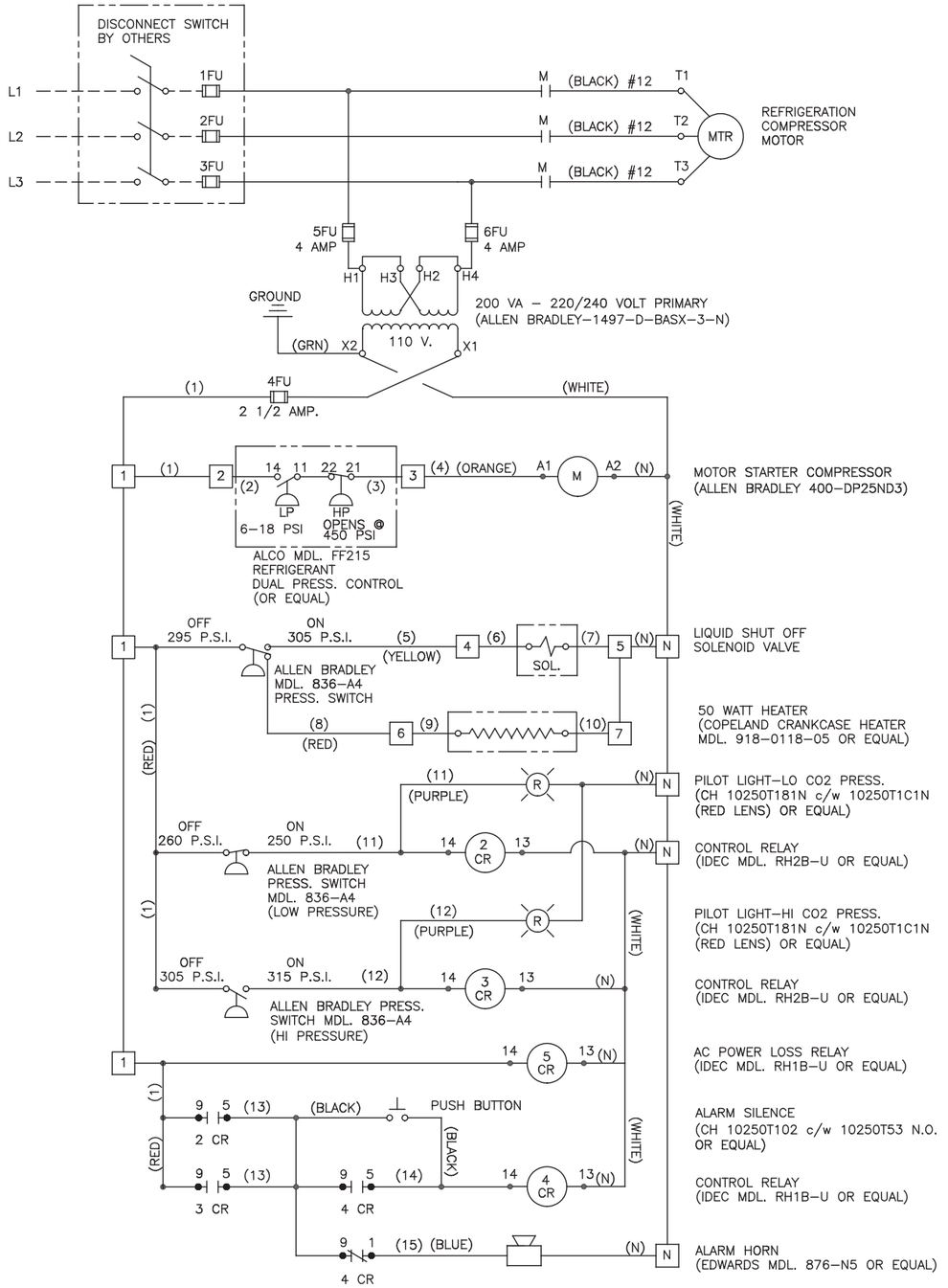
APPENDIX A
ELECTRICAL REFERENCE

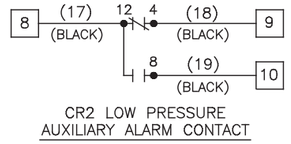
Table A-1. Storage Tank Electrical Requirements

Position	Capacity	3rd Item Number	Voltage	Hz	Phase	Schematic
Horizontal	2.75	7048H021	120	60	1	Figure A-4
Horizontal	2.75	7048H022	220	60	1	Figure A-2
Horizontal	2.75	7048H023	220	50	1	Figure A-2
Horizontal	2.75	7048H024	220	60	3	Figure A-1
Horizontal	2.75	7048H025	380	50	3	Figure A-5
Horizontal	2.75	7048H026	460	60	3	Figure A-3
Horizontal	2.75	7048H027	575	60	3	Figure A-6
Horizontal	3.75	7048H032	220	60	1	Figure A-2
Horizontal	3.75	7048H033	220	50	1	Figure A-2
Horizontal	3.75	7048H034	220	60	3	Figure A-1
Horizontal	3.75	7048H035	380	50	3	Figure A-5
Horizontal	3.75	7048H036	460	60	3	Figure A-3
Horizontal	3.75	7048H037	575	60	3	Figure A-6
Horizontal	6	7048H062	220	60	1	Figure A-2
Horizontal	6	7048H063	220	50	1	Figure A-2
Horizontal	6	7048H064	220	60	3	Figure A-1
Horizontal	6	7048H065	380	50	3	Figure A-5
Horizontal	6	7048H066	460	60	3	Figure A-3
Horizontal	6	7048H067	575	60	3	Figure A-6
Horizontal	8	7048H082	220	60	1	Figure A-2
Horizontal	8	7048H083	220	50	1	Figure A-2
Horizontal	8	7048H084	220	60	3	Figure A-1
Horizontal	8	7048H085	380	50	3	Figure A-5
Horizontal	8	7048H086	460	60	3	Figure A-3
Horizontal	8	7048H087	575	60	3	Figure A-6
Horizontal	10	7048H102	220	60	1	Figure A-2
Horizontal	10	7048H103	220	50	1	Figure A-2
Horizontal	10	7048H104	220	60	3	Figure A-1
Horizontal	10	7048H105	380	50	3	Figure A-5
Horizontal	10	7048H106	460	60	3	Figure A-3
Horizontal	10	7048H107	575	60	3	Figure A-6
Horizontal	12	7048H122	220	60	1	Figure A-2

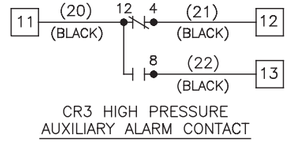
Position	Capacity	3rd Item Number	Voltage	Hz	Phase	Schematic
Horizontal	12	7048H124	220	60	3	Figure A-1
Horizontal	12	7048H125	380	50	3	Figure A-9
Horizontal	12	7048H126	460	60	3	Figure A-3
Horizontal	12	7048H127	575	60	3	Figure A-6
Horizontal	14	7048H142	220	60	1	Figure A-2
Horizontal	14	7048H144	220	60	3	Figure A-1
Horizontal	14	7048H145	380	50	3	Figure A-9
Horizontal	14	7048H146	460	60	3	Figure A-3
Horizontal	14	7048H147	575	60	3	Figure A-6
Horizontal	18	7048H182	220	60	1	Figure A-11
Horizontal	18	7048H184	220	60	3	Figure A-7
Horizontal	18	7048H185	380	50	3	Figure A-9
Horizontal	18	7048H186	460	60	3	Figure A-10
Horizontal	18	7048H187	575	60	3	Figure A-8
Horizontal	22	7048H222	220	60	1	Figure A-11
Horizontal	22	7048H224	220	60	3	Figure A-7
Horizontal	22	7048H225	380	50	3	Figure A-9
Horizontal	22	7048H226	460	60	3	Figure A-10
Horizontal	22	7048H227	575	60	3	Figure A-8
Horizontal	26	7048H262	220	60	1	Figure A-11
Horizontal	26	7048H264	220	60	3	Figure A-7
Horizontal	26	7048H265	380	50	3	Figure A-9
Horizontal	26	7048H266	460	60	3	Figure A-10
Horizontal	26	7048H267	575	60	3	Figure A-8
Horizontal	30	7048H302	220	60	1	Figure A-11
Horizontal	30	7048H304	220	60	3	Figure A-7
Horizontal	30	7048H305	380	50	3	Figure A-9
Horizontal	30	7048H306	460	60	3	Figure A-10
Horizontal	30	7048H307	575	60	3	Figure A-8
Horizontal	34	7048H342	220	60	1	Figure A-11
Horizontal	34	7048H344	220	60	3	Figure A-7
Horizontal	34	7048H345	380	50	3	Figure A-9
Horizontal	34	7048H346	460	60	3	Figure A-10
Horizontal	34	7048H347	575	60	3	Figure A-8
Horizontal	38	7048H384	220	60	3	Figure A-7
Horizontal	38	7048H385	380	50	3	Figure A-9
Horizontal	38	7048H386	460	60	3	Figure A-10

Position	Capacity	3rd Item Number	Voltage	Hz	Phase	Schematic
Horizontal	38	7048H387	575	60	3	Figure A-8
Horizontal	42	7048H424	220	60	3	Figure A-7
Horizontal	42	7048H425	380	50	3	Figure A-9
Horizontal	42	7048H426	460	60	3	Figure A-10
Horizontal	42	7048H427	575	60	3	Figure A-8
Horizontal	46	7048H464	220	60	3	Figure A-7
Horizontal	46	7048H465	380	50	3	Figure A-9
Horizontal	46	7048H466	460	60	3	Figure A-10
Horizontal	46	7048H467	575	60	3	Figure A-8
Horizontal	50	7048H504	220	60	3	Figure A-7
Horizontal	50	7048H505	380	50	3	Figure A-9
Horizontal	50	7048H506	460	60	3	Figure A-10
Horizontal	50	7048H507	575	60	3	Figure A-8
Horizontal	60	7048H604	220	60	3	Figure A-7
Horizontal	60	7048H606	460	60	3	Figure A-10
Horizontal	60	7048H607	575	60	3	Figure A-8
Vertical	6	7048V062	220	60	1	Figure A-2
Vertical	6	7048V063	220	50	1	Figure A-2
Vertical	6	7048V064	220	60	3	Figure A-1
Vertical	6	7048V065	380	50	3	Figure A-5
Vertical	6	7048V066	460	60	3	Figure A-3
Vertical	6	7048V067	575	60	3	Figure A-6
Vertical	14	7048V142	220	60	1	Figure A-2
Vertical	14	7048V144	220	60	3	Figure A-1
Vertical	14	7048V145	380	50	3	Figure A-5
Vertical	14	7048V146	460	60	3	Figure A-3
Vertical	14	7048V147	575	60	3	Figure A-6
Vertical	26	7048V262	220	60	1	Figure A-11
Vertical	26	7048V264	220	60	3	Figure A-7
Vertical	26	7048V265	380	50	3	Figure A-9
Vertical	26	7048V266	460	60	3	Figure A-10
Vertical	26	7048V267	575	60	3	Figure A-8
Vertical	30	7048V302	220	60	1	Figure A-11
Vertical	30	7048V304	220	60	3	Figure A-7
Vertical	30	7048V305	380	50	3	Figure A-9
Vertical	30	7048V306	460	60	3	Figure A-10
Vertical	30	7048V307	575	60	3	Figure A-8



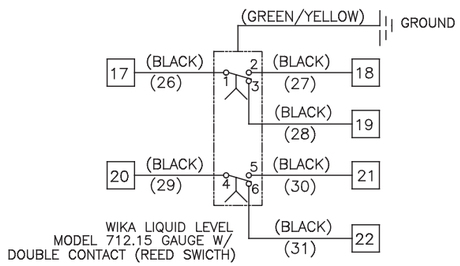


CR2 LOW PRESSURE
AUXILIARY ALARM CONTACT



CR3 HIGH PRESSURE
AUXILIARY ALARM CONTACT

CR5 AC POWER LOSS
RELAY CONTACTS



OPTIONAL LL GAUGE CONTACTS

SIZE	VOLTS	/PH	AMPS + 25%	T/D FUSE	WIRE
1 HP	220	3	8.7	15 AMP	#12
2 HP	220	3	11.1	15 AMP	#12

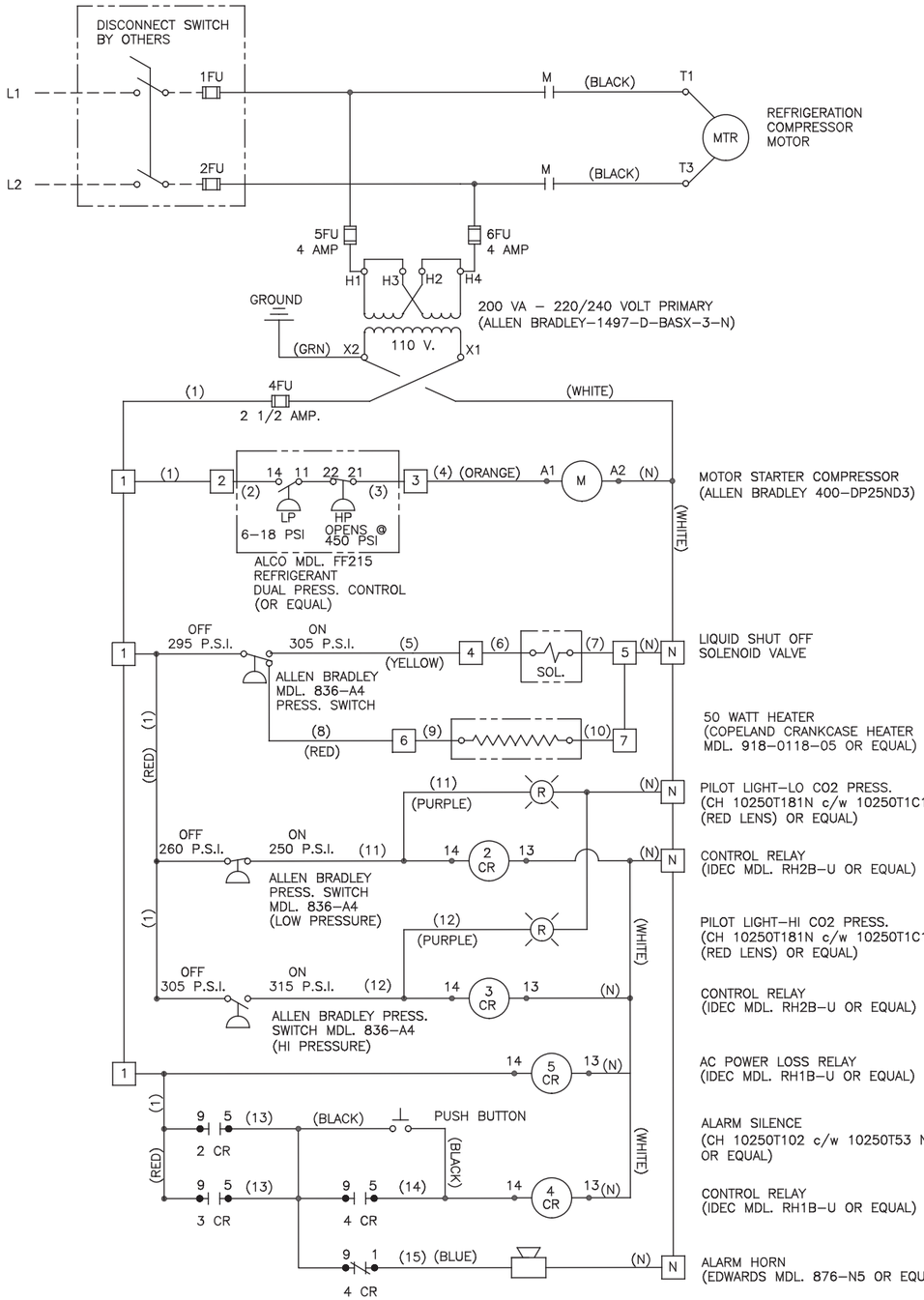
REPLACEMENT PRIMARY FUSES (5FU,6FU)

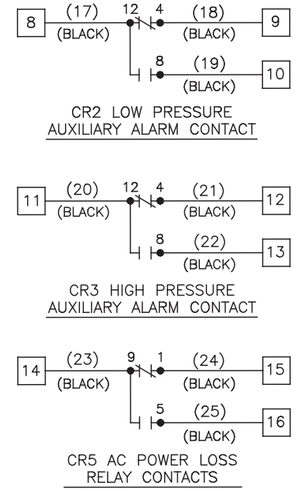
TRANSFORMER	VOLTAGE	FUSE
.200 VA	220	KLDR–4

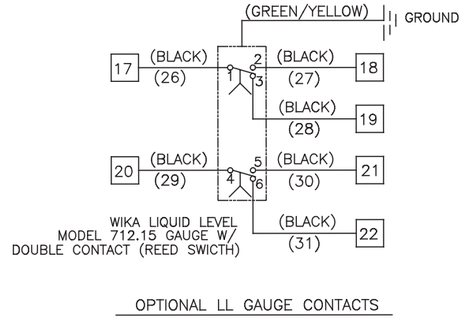
REPLACEMENT SECONDARY FUSES (4FU)

TRANSFORMER	VOLTAGE	FUSE
.200 VA	120	FLM–2 1/2

Figure A-1. 1-2 Horsepower, 220 VAC Wiring Schematic







SIZE	VOLTS /PH	AMPS + 25%	T/D FUSE	WIRE
1 HP	220 1	11.5	15 AMP	#12
2 HP	220 1	20.2	30 AMP	#10

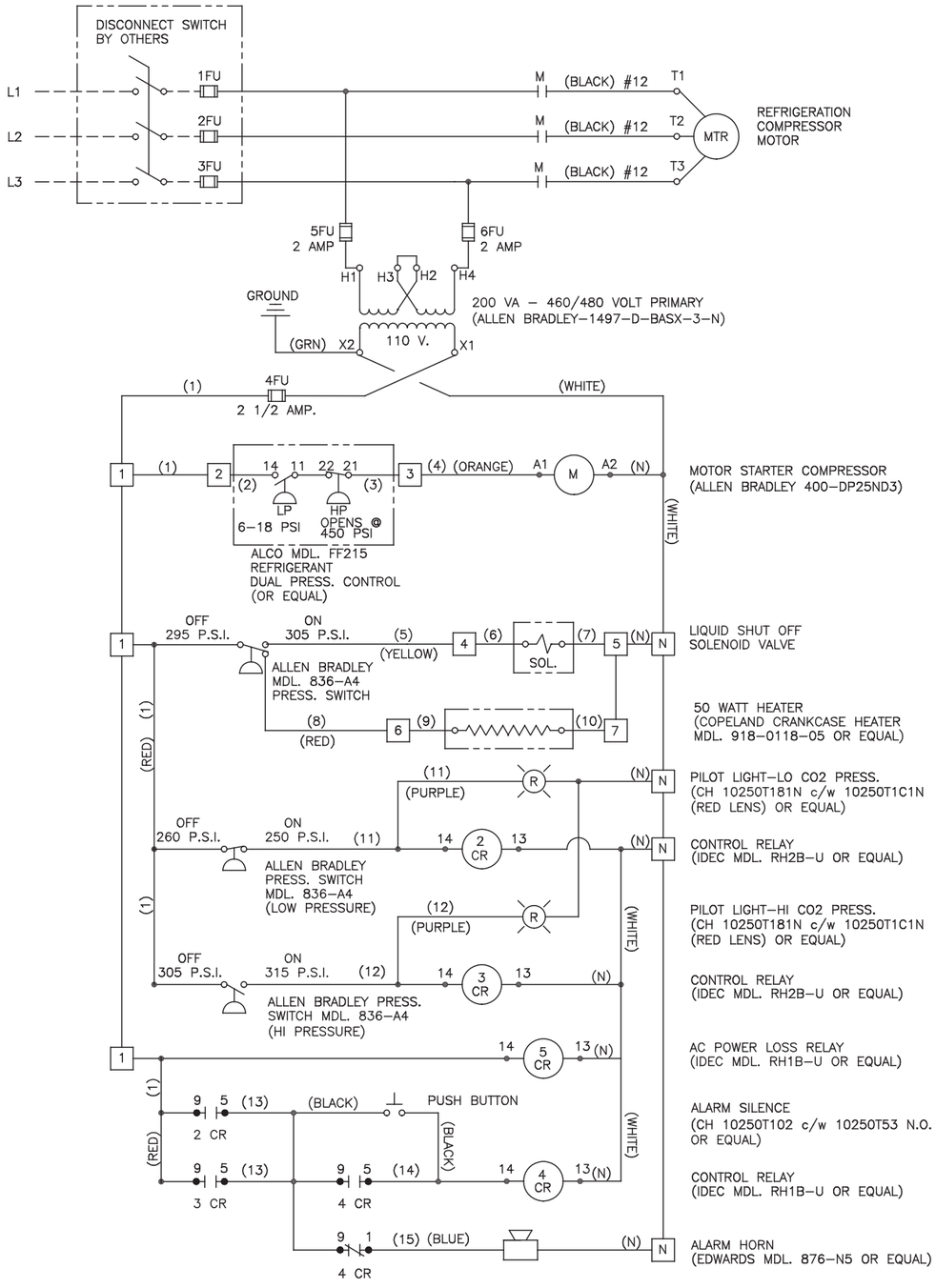
REPLACEMENT PRIMARY FUSES (5FU,6FU)

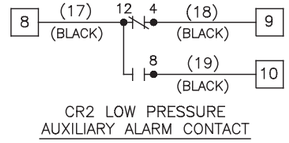
TRANSFORMER	VOLTAGE	FUSE
.200 VA	220	KLDR–4

REPLACEMENT SECONDARY FUSES (4FU)

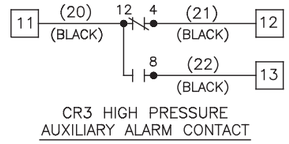
TRANSFORMER	VOLTAGE	FUSE
.200 VA	120	FLM–2 1/2

Figure A-2. 1-2 Horsepower, 220 VAC, 1 Phase Wiring Schematic

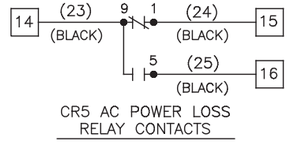




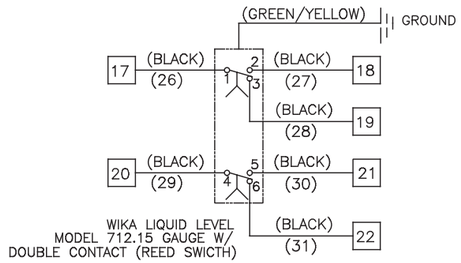
CR2 LOW PRESSURE
AUXILIARY ALARM CONTACT



CR3 HIGH PRESSURE
AUXILIARY ALARM CONTACT



CR5 AC POWER LOSS
RELAY CONTACTS



OPTIONAL LL GAUGE CONTACTS

SIZE	VOLTS /PH	AMPS + 25%	T/D FUSE	WIRE
1 HP	460 3	4.2	15 AMP	#12
2 HP	460 3	6.1	15 AMP	#12

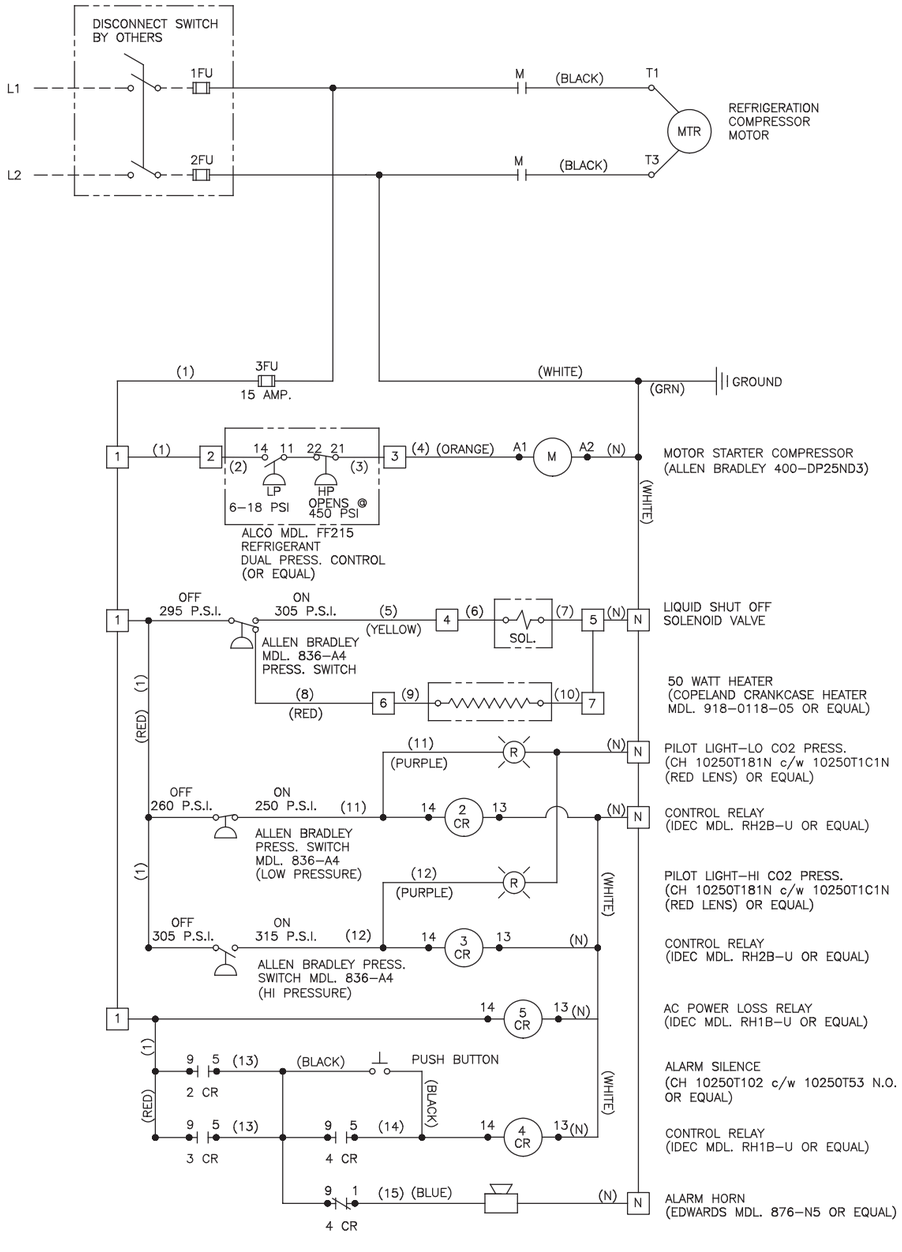
REPLACEMENT PRIMARY FUSES (5FU,6FU)

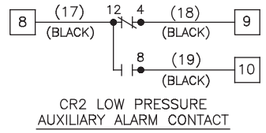
TRANSFORMER	VOLTAGE	FUSE
.200 VA	460	KLDR–2

REPLACEMENT SECONDARY FUSES (4FU)

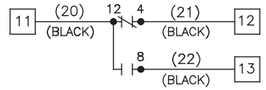
TRANSFORMER	VOLTAGE	FUSE
.200 VA	120	FLM–2 1/2

Figure A-3. 1-2 Horsepower, 460 VAC Wiring Schematic

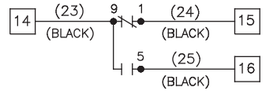




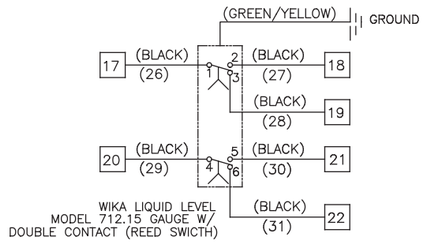
CR2 LOW PRESSURE
AUXILIARY ALARM CONTACT



CR3 HIGH PRESSURE
AUXILIARY ALARM CONTACT



CR5 AC POWER LOSS
RELAY CONTACTS



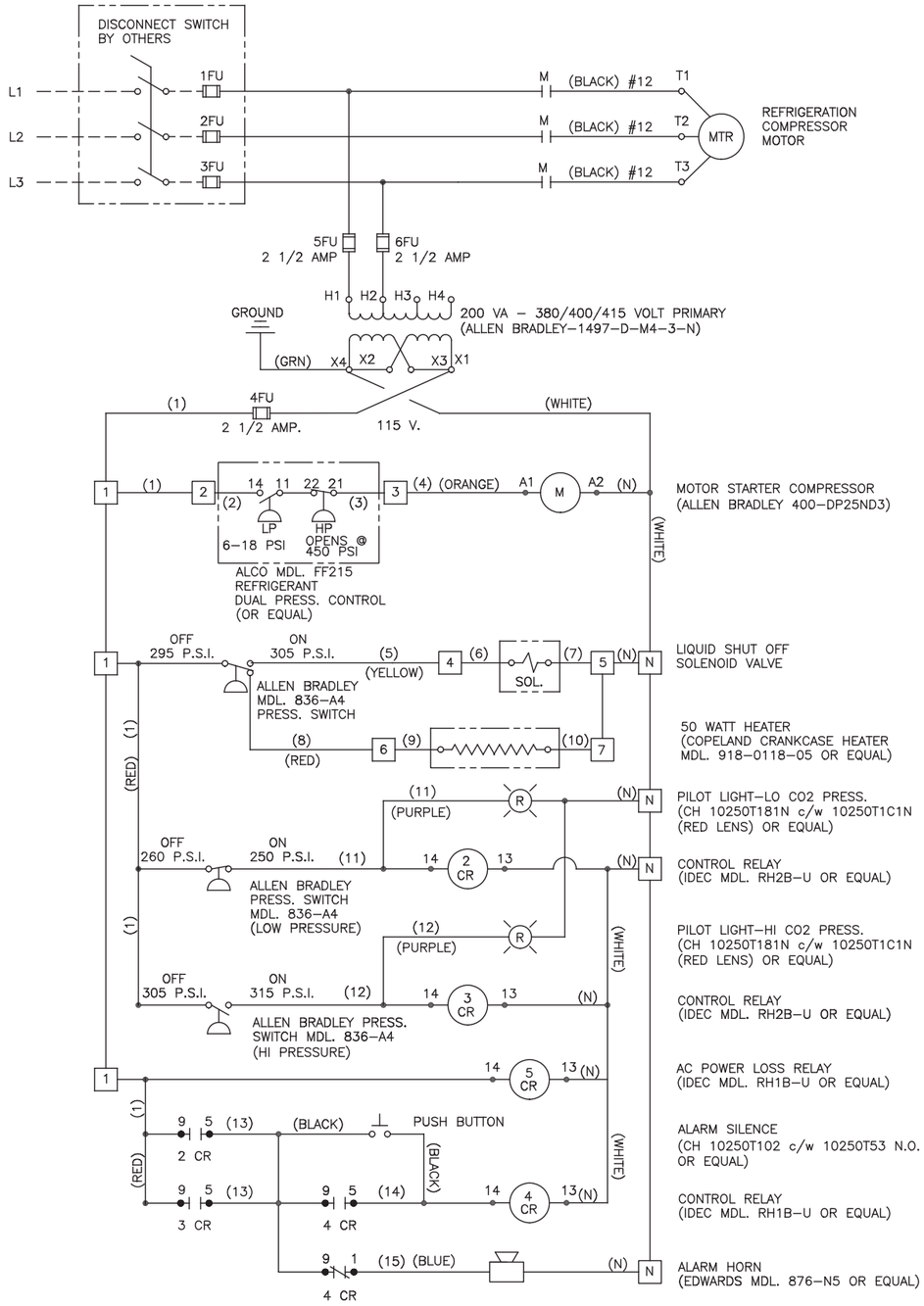
OPTIONAL LL GAUGE CONTACTS

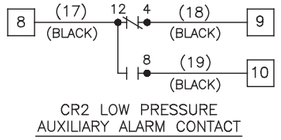
SIZE	VOLTS /PH	AMPS + 25%	T/D FUSE	WIRE
1 HP	120 1	21.1	25 AMP	#10

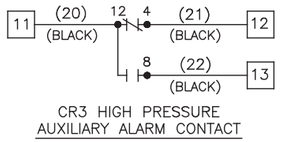
REPLACEMENT FUSES (3FU)

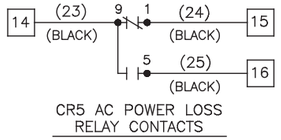
VOLTAGE	FUSE
120	FLM–15

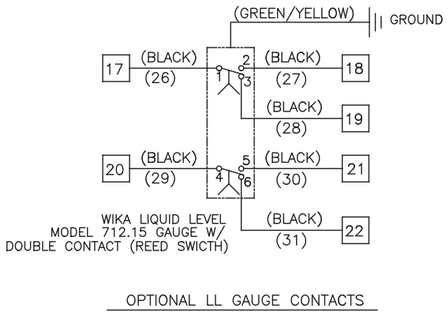
Figure A-4. 1-2 Horsepower, 120 VAC, 1 Phase Wiring Schematic











SIZE	VOLTS /PH	AMPS + 25%	T/D FUSE	WIRE
2 HP	380 3	6.1	15 AMP	#12

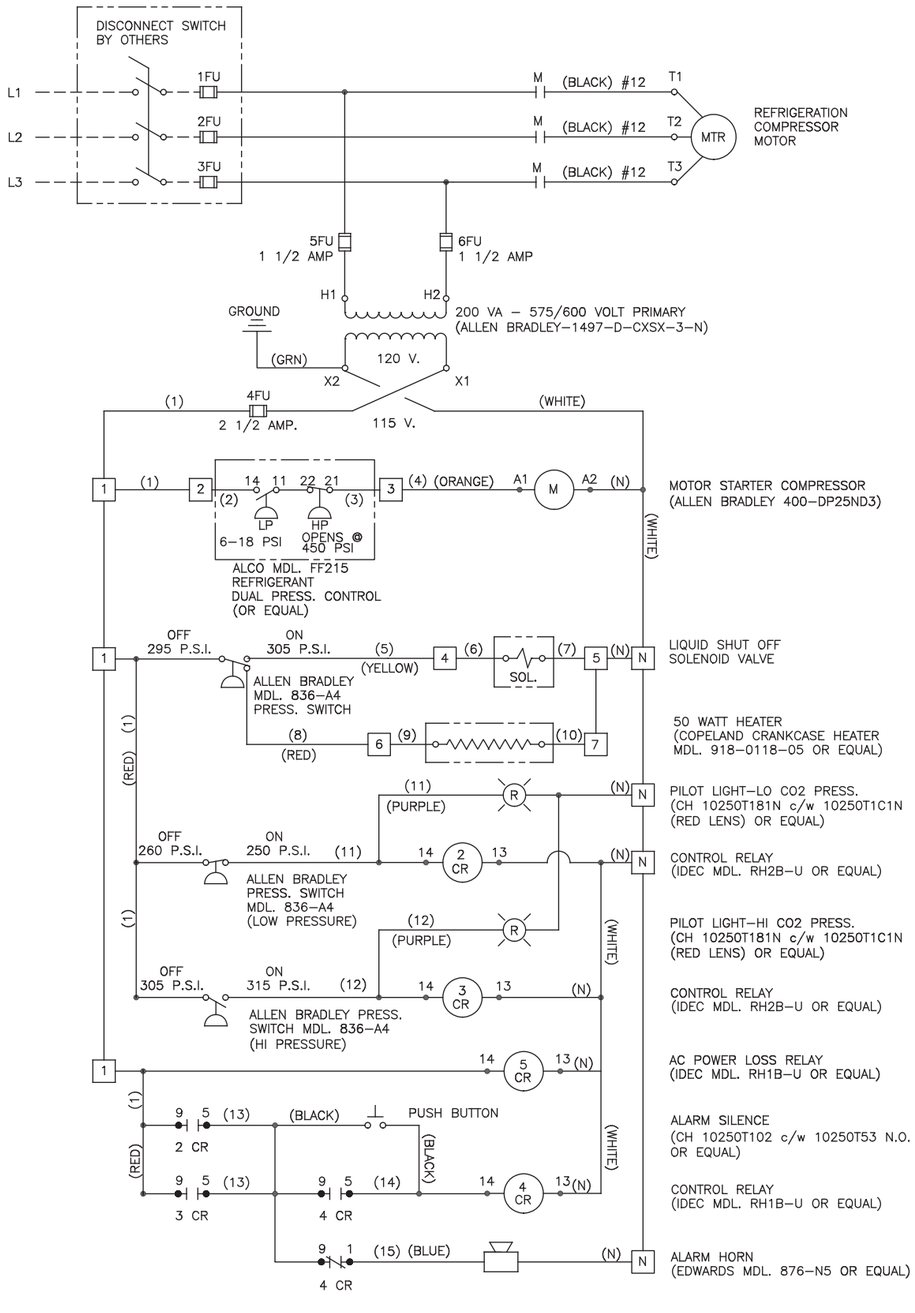
REPLACEMENT PRIMARY FUSES (5FU,6FU)

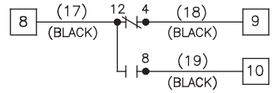
TRANSFORMER	VOLTAGE	FUSE
.200 VA	380	KLDR–2 1/2

REPLACEMENT SECONDARY FUSES (4FU)

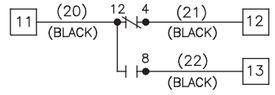
TRANSFORMER	VOLTAGE	FUSE
.200 VA	120	FLM–2 1/2

Figure A-5. 2 Horsepower, 380 VAC Wiring Schematic

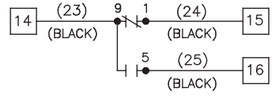




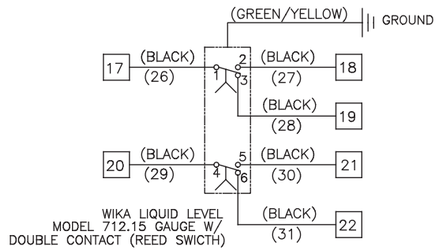
CR2 LOW PRESSURE
AUXILIARY ALARM CONTACT



CR3 HIGH PRESSURE
AUXILIARY ALARM CONTACT



CR5 AC POWER LOSS
RELAY CONTACTS



OPTIONAL LL GAUGE CONTACTS

SIZE	VOLTS /PH	AMPS + 25%	T/D FUSE	WIRE
2 HP	575 3	4.9	15 AMP	#12

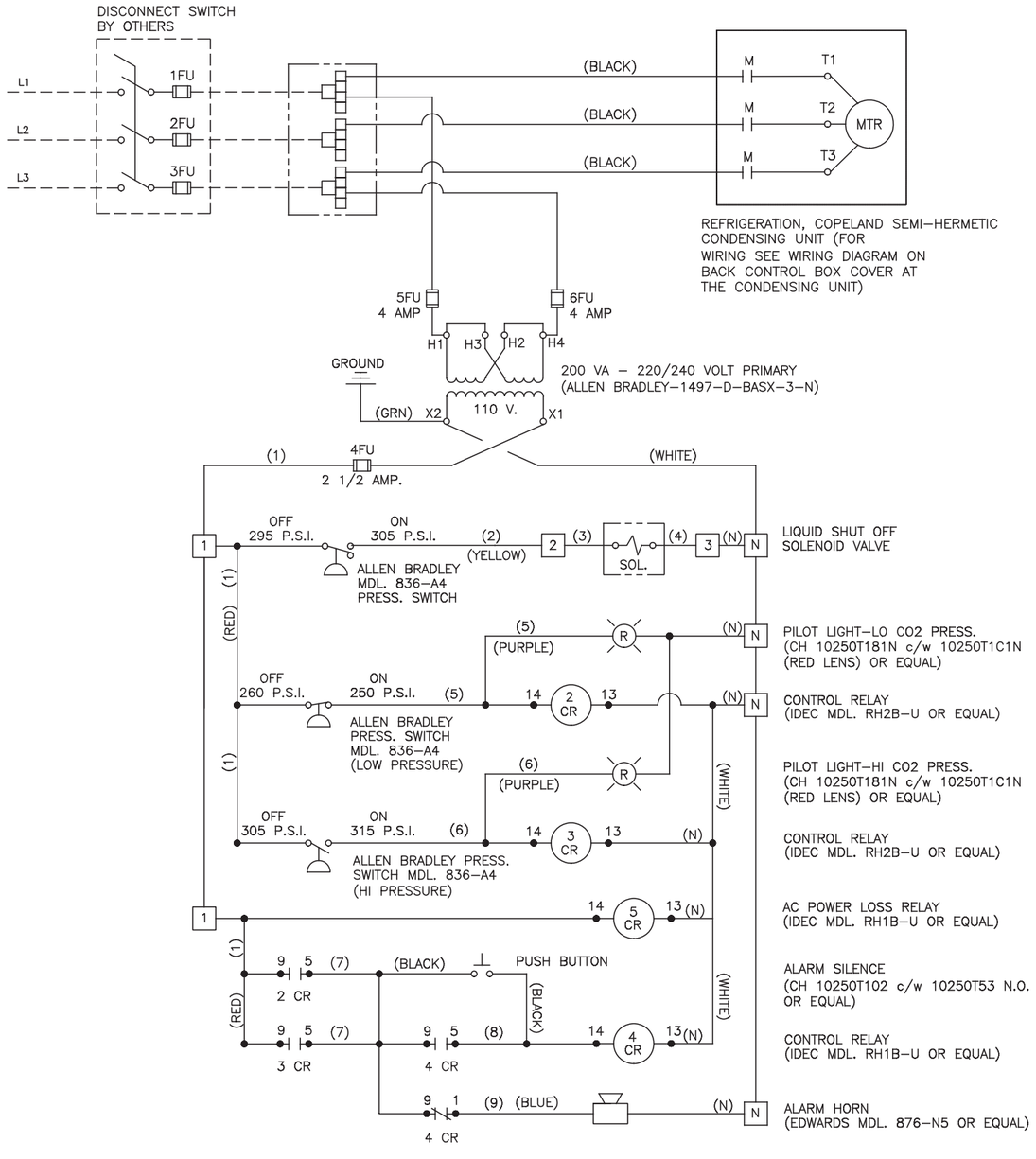
REPLACEMENT PRIMARY FUSES (5FU,6FU)

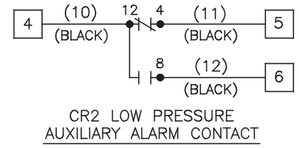
TRANSFORMER	VOLTAGE	FUSE
.200 VA	575	KLDR–1 1/2

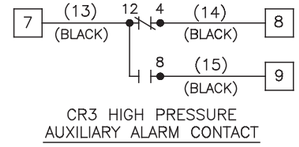
REPLACEMENT SECONDARY FUSES (4FU)

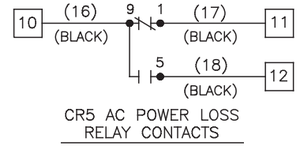
TRANSFORMER	VOLTAGE	FUSE
.200 VA	120	FLM–2 1/2

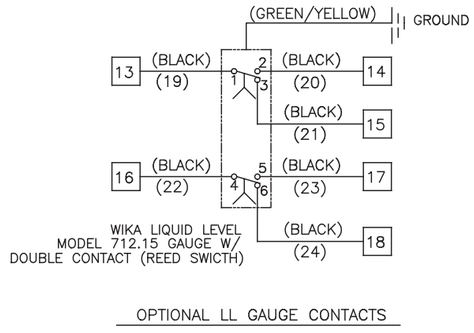
Figure A-6. 2 Horsepower, 575 VAC Wiring Schematic











SIZE	VOLTS	/PH	AMPS + 25%	T/D FUSE	WIRE
3 HP	220	3	25.4	30 AMP	#10
4 HP	220	3	40.4	50 AMP	#6

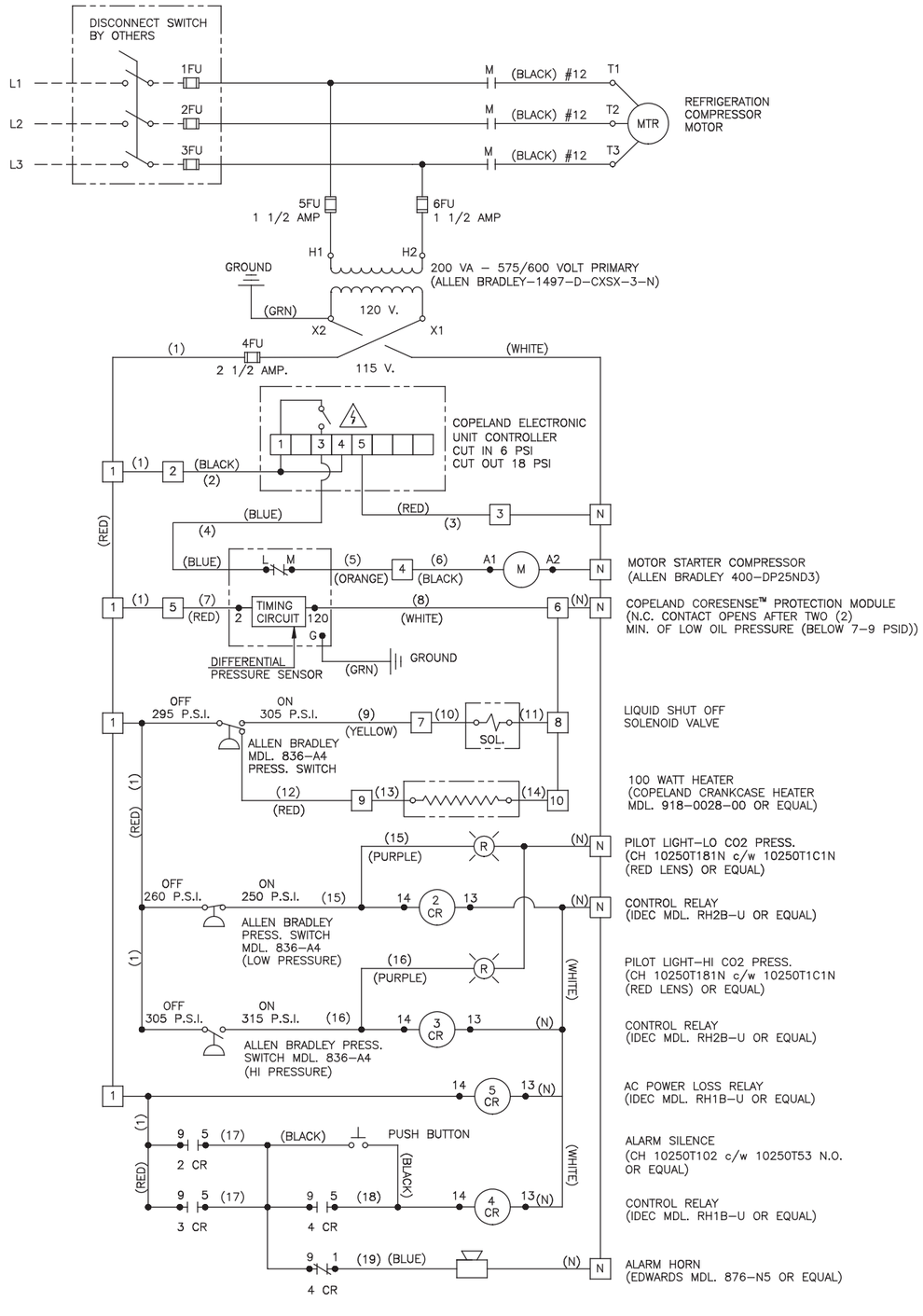
REPLACEMENT PRIMARY FUSES (5FU,6FU)

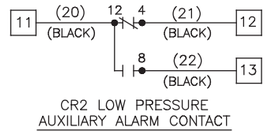
TRANSFORMER	VOLTAGE	FUSE
.200 VA	220	KLDR-4

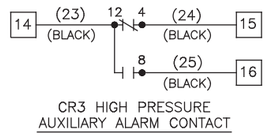
REPLACEMENT SECONDARY FUSES (4FU)

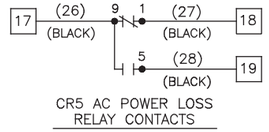
TRANSFORMER	VOLTAGE	FUSE
.200 VA	120	FLM-2 1/2

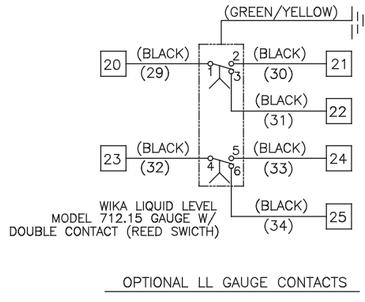
Figure A-7. 3-4 Horsepower, 220 VAC Wiring Schematic











SIZE	VOLTS /PH	AMPS + 25%	T/D FUSE	WIRE
3 HP	575 3	10.3	15 AMP	#12
4 HP	575 3	13.3	20 AMP	#12

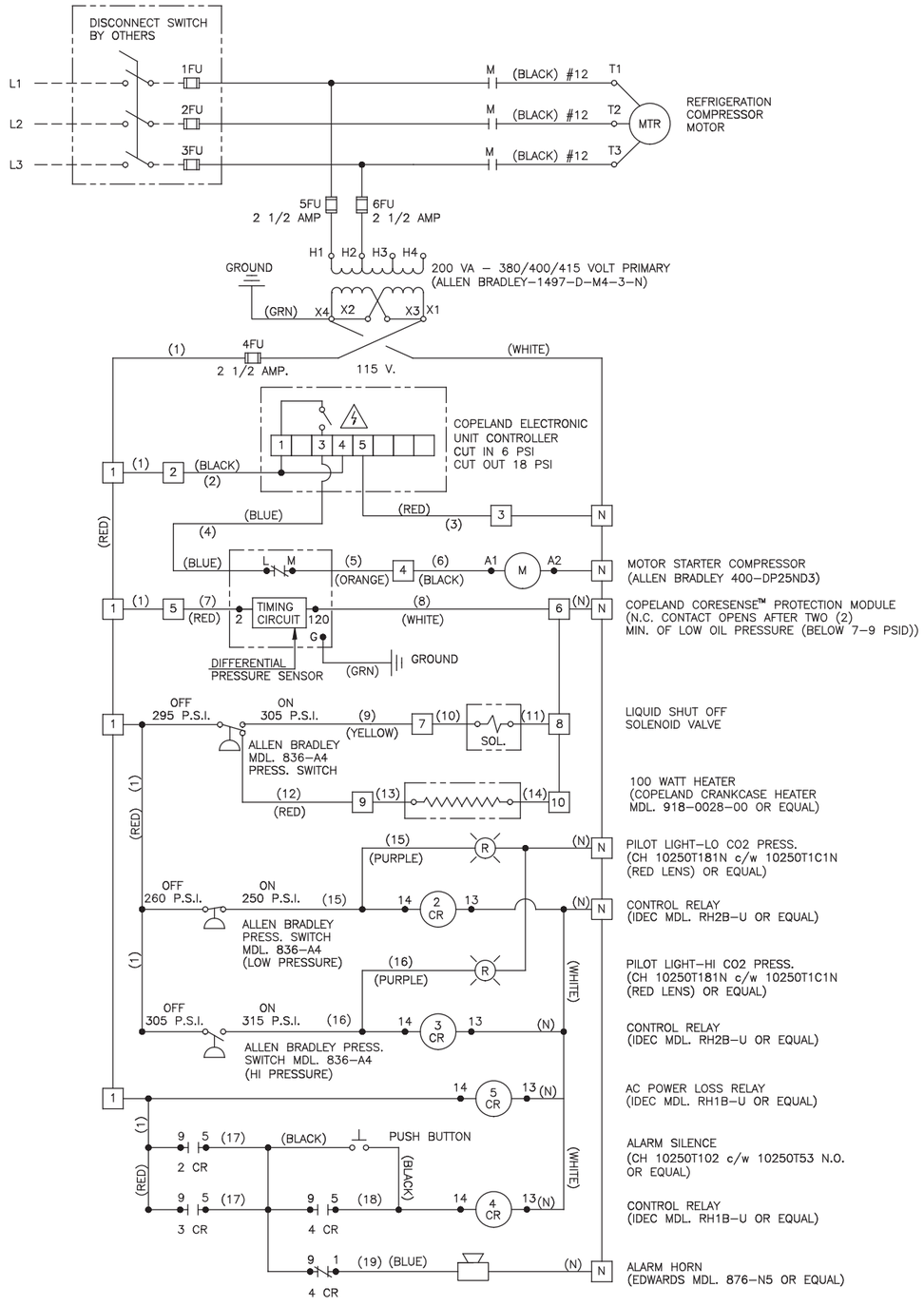
REPLACEMENT PRIMARY FUSES (5FU,6FU)

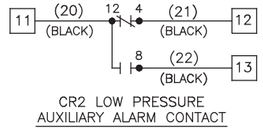
TRANSFORMER	VOLTAGE	FUSE
.200 VA	575	KLDR–1 1/2

REPLACEMENT SECONDARY FUSES (4FU)

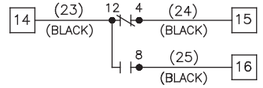
TRANSFORMER	VOLTAGE	FUSE
.200 VA	120	FLM–2 1/2

Figure A-8. 3-4 Horsepower, 575 VAC Wiring Schematic

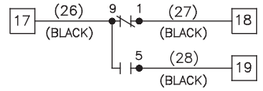




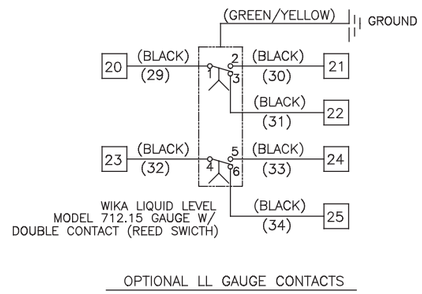
CR2 LOW PRESSURE AUXILIARY ALARM CONTACT



CR3 HIGH PRESSURE AUXILIARY ALARM CONTACT



CR5 AC POWER LOSS RELAY CONTACTS



OPTIONAL LL GAUGE CONTACTS

SIZE	VOLTS /PH	AMPS + 25%	T/D FUSE	WIRE
3 HP	380 3	12.5	15 AMP	#12
6 HP	380 3	15.2	20 AMP	#12

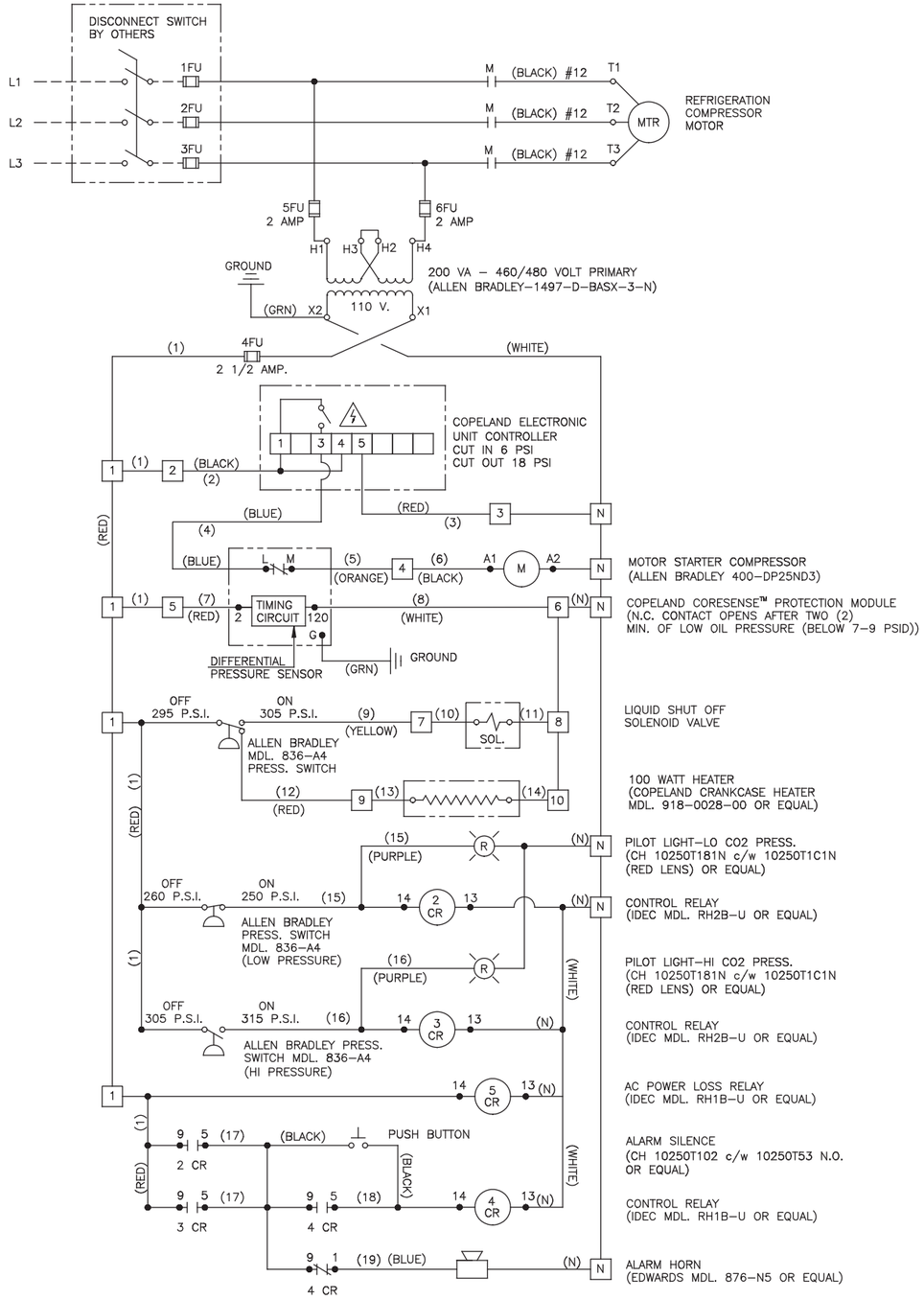
REPLACEMENT PRIMARY FUSES (5FU,6FU)

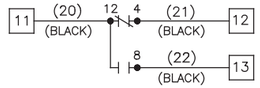
TRANSFORMER	VOLTAGE	FUSE
.200 VA	380	KLDR–2 1/2

REPLACEMENT SECONDARY FUSES (4FU)

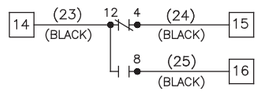
TRANSFORMER	VOLTAGE	FUSE
.200 VA	120	FLM–2 1/2

Figure A-9. 3-6 Horsepower, 380 VAC Wiring Schematic

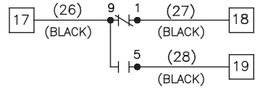




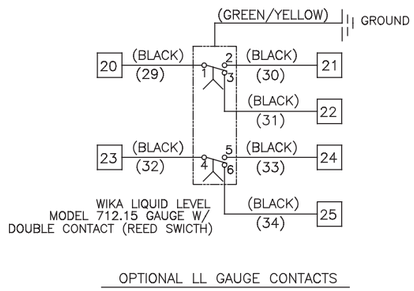
CR2 LOW PRESSURE
AUXILIARY ALARM CONTACT



CR3 HIGH PRESSURE
AUXILIARY ALARM CONTACT



CR5 AC POWER LOSS
RELAY CONTACTS



OPTIONAL LL GAUGE CONTACTS

SIZE	VOLTS /PH	AMPS + 25%	T/D FUSE	WIRE
3 HP	460 3	12.5	15 AMP	#12
6 HP	460 3	15.2	20 AMP	#12

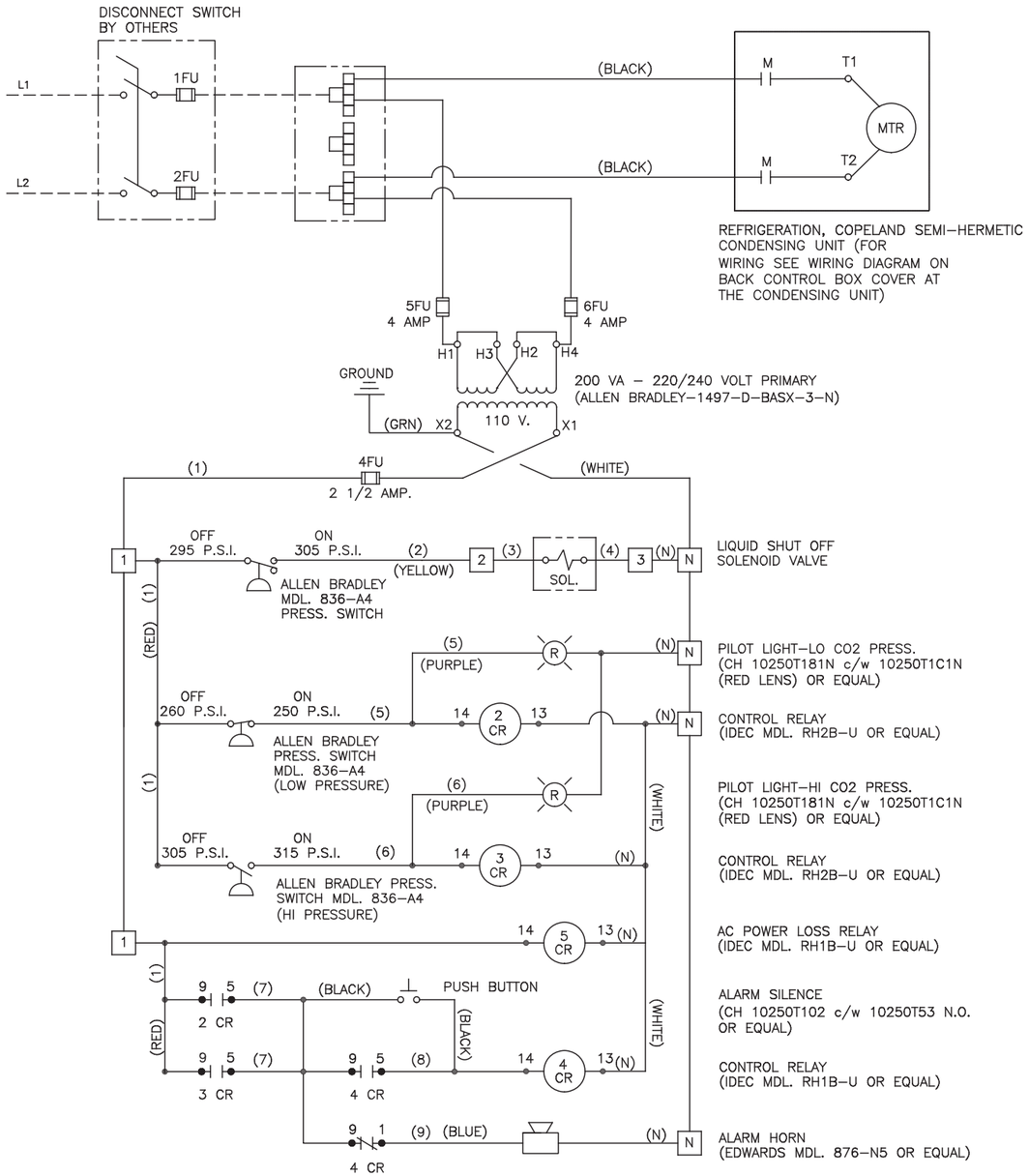
REPLACEMENT PRIMARY FUSES (5FU,6FU)

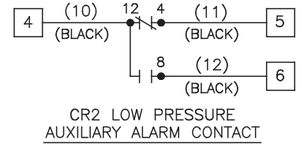
TRANSFORMER	VOLTAGE	FUSE
.200 VA	460	KLDR–2

REPLACEMENT SECONDARY FUSES (4FU)

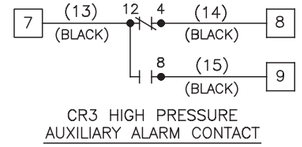
TRANSFORMER	VOLTAGE	FUSE
.200 VA	120	FLM–2 1/2

Figure A-10. 3-6 Horsepower, 460 VAC Wiring Schematic

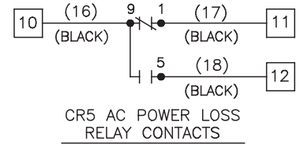




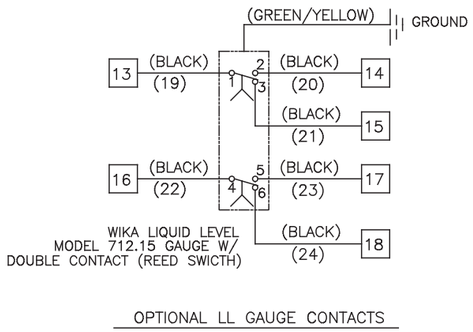
CR2 LOW PRESSURE
AUXILIARY ALARM CONTACT



CR3 HIGH PRESSURE
AUXILIARY ALARM CONTACT



CR5 AC POWER LOSS
RELAY CONTACTS



OPTIONAL LL GAUGE CONTACTS

SIZE	VOLTS /PH	AMPS + 25%	T/D FUSE	WIRE
3 HP	220 1	36.7	50 AMP	#6

REPLACEMENT PRIMARY FUSES (5FU,6FU)

TRANSFORMER	VOLTAGE	FUSE
.200 VA	220	KLDR–4

REPLACEMENT SECONDARY FUSES (4FU)

TRANSFORMER	VOLTAGE	FUSE
.200 VA	120	FLM–2 1/2

Figure A-11. 3 Horsepower, 220 VAC, 1 Phase Wiring Schematic

APPENDIX B
FOUNDATION PLANS

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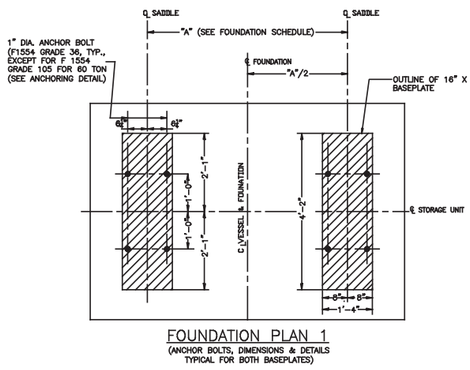
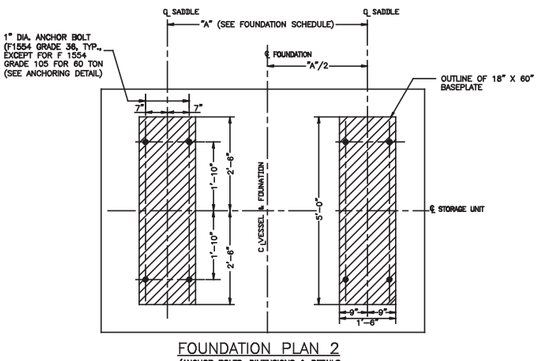
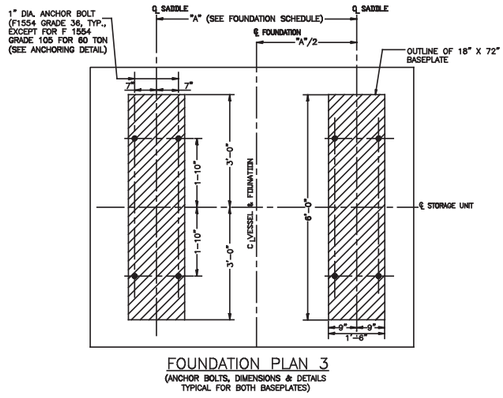


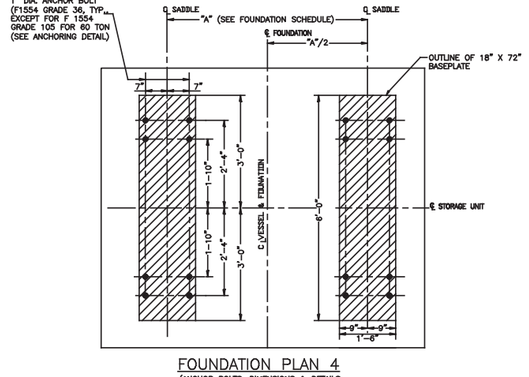
FOUNDATION PLAN 1
(ANCHOR BOLTS, DIMENSIONS & DETAILS TYPICAL FOR BOTH BASEPLATES)



FOUNDATION PLAN 2
(ANCHOR BOLTS, DIMENSIONS & DETAILS TYPICAL FOR BOTH BASEPLATES)



FOUNDATION PLAN 3
(ANCHOR BOLTS, DIMENSIONS & DETAILS TYPICAL FOR BOTH BASEPLATES)



FOUNDATION PLAN 4
(ANCHOR BOLTS, DIMENSIONS & DETAILS TYPICAL FOR BOTH BASEPLATES)

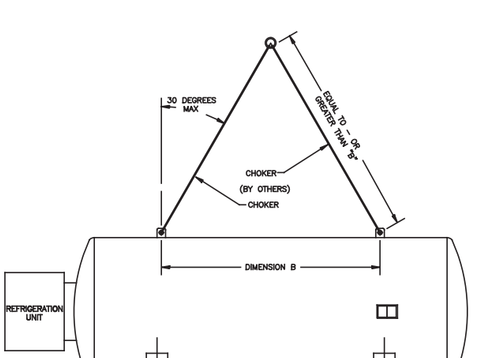
NOTES:

1. THE STORAGE UNIT SHALL BE MOUNTED UPON A C PIERS. ALL CIVIL WORK SHALL BE PROVIDED BY T ACCEPTANCE ATTAINED.
2. STORAGE TANK LIFTING LUGS ARE TO BE USED ONL
3. PRIOR TO STORAGE TANK INSTALLATION AND OPERA INSTALLATION AND SERVICE MANUAL.
4. THE SAFETY RELIEF VALVE ASSEMBLY IS REMOVED INITIAL FILLING AND OPERATION OF THE TANK.
5. A SITE SPECIFIC FOUNDATION DESIGN SHALL BE PR REQUIREMENTS ADDRESSED, INCLUDING REQUIREMEN ENGINEERING SEAL, SITE SOIL CONDITIONS, ETC.
6. THE BOTTOM OF THE FOUNDATION SHOULD BE LOC TO THE SITE. THE FOUNDATION SHALL BE APPROP FROST FREE STRUCTURAL FILL OR LEAN CONCRETE THE REQUIRED FROST DEPTH. (IF THE FOUNDATION WITH RESPECT TO CHANGED EFFECTS OF LOADING PREPARED WITH RESPECT TO COMPACTION AND DR
7. CONCRETE SHALL HAVE A 28-DAY COMPRESSIVE ST PROPORTIONED, MIXED, TESTED, INSTALLED AND CU
8. ANCHOR BOLTS SHALL CONFORM TO ASTM INFORMA HEAVY HEX NUTS (ANSI B18.2.2), AND WASHER (A PIPE SLEEVES OF ASTM A53, GRADE B, SCH.40.
9. INFORMATION GIVEN ON THIS DRAWING APPLIES TO INSTALLATION, SADDLE SPACING, BOLT HOLE SIZE, A FOR STORAGE UNIT TO BE INSTALLED.
10. THE OWNER/INSTALLATION CONTRACTOR IS TO OBTA PROVIDE A FOUNDATION DESIGN. THE REGISTERED THE INSTALLATION SITE, INCLUDING CONTROLLING B WIND CRITERIA, EXTREME FROST PENETRATION, FL
11. THE FOUNDATION SHOULD BE PROPORTIONED, TEST CONTROLLING BUILDING CODES AND ACCEPTED CON
12. ANCHOR BOLT SIZING AND INSTALLATION TO BE DE LENGTH ABOVE THE FOUNDATION SHOULD BE SUCH (S) THREADS PROTRUDING ABOVE THE HEXT NUT A
13. RECOMMENDATION: INSTALL THREADED ANCHOR BO

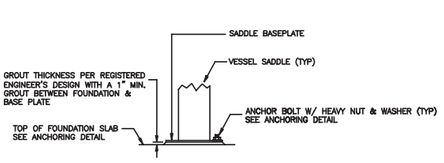
HORIZON

LOW PRESSURE CO2 STORAGE UNIT

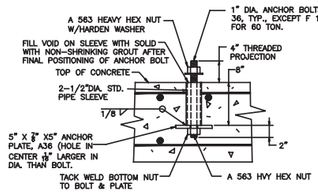
CAPACITY SIZE	LENGTH	WIDTH	HEIGHT	EMPTY WEIGHT
TONS	FEET, INCHES			IN
2.75	14'-6"	4'-3"	6'-10"	4,000
3.75	11'-11"	5'-9"	8'-10"	7,500
6	16'-0"	5'-9"	8'-10"	9,000
8	19'-6"	5'-9"	8'-10"	10,200
10	23'-4"	5'-9"	8'-10"	11,500
12	26'-2"	5'-9"	8'-10"	12,650
14	19'-8"	7'-4"	10'-7"	14,000
18	25'-0"	7'-4"	10'-7"	16,800
22	29'-4"	7'-4"	10'-7"	19,000
26	32'-8"	7'-4"	10'-9"	23,500
30	36'-8"	7'-4"	10'-9"	26,500
34	40'-8"	7'-4"	10'-9"	29,000
38	44'-8"	7'-4"	10'-9"	31,500
42	48'-8"	7'-4"	10'-9"	34,000
46	52'-8"	7'-4"	10'-9"	36,500
50	56'-8"	7'-4"	10'-9"	40,000
60	66'-8"	7'-4"	10'-9"	45,000



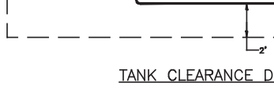
TANK ELEVATION DETAIL



BASEPLATE GROUTING DETAIL



ANCHORING DETAIL



TANK CLEARANCE D

Figure B-1. LP CO_2 Horizontal Storage Unit

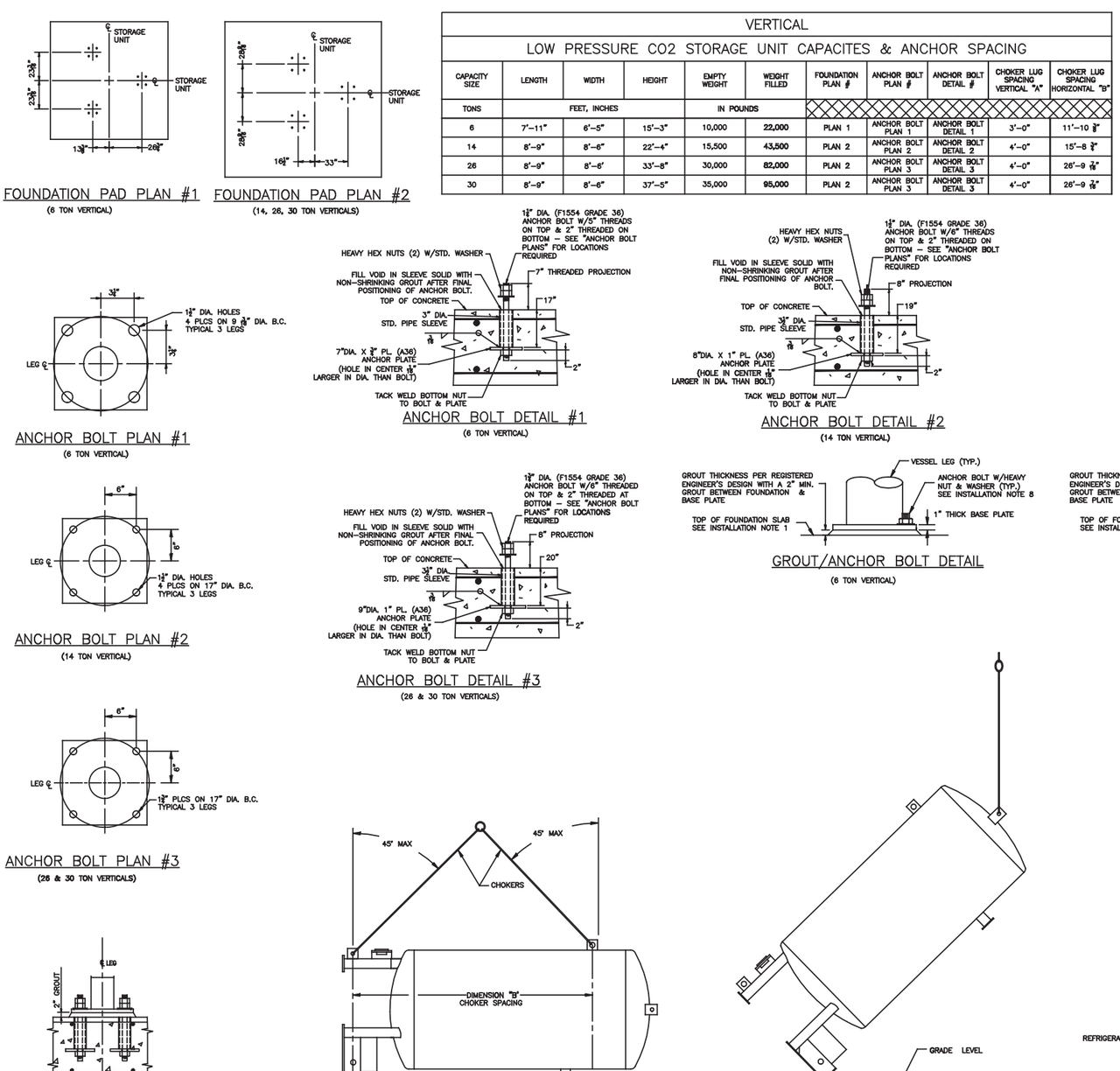


Figure B-2. LP CO_2 Vertical Storage Unit

[redacted]

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[redacted]

These instructions do not purport to cover all the details or variations in the equipment described, nor do they provide for every possible contingency to be met in connection with installation, operation and maintenance. All specifications are subject to change without notice. Should further information be desired or should particular questions arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred t

[redacted]