

RMIT TAFE Training

Building 57

NH3 / CO2 Refrigeration Unit

Design Safety Review

Reference: CA Group Drawings Q0804

Rev: 2

Date: 17-Dec-14

Brief Description of Refrigeration Plant

Ammonia / CO2 Cascade System in the form of a packaged rack to service two (2) Chiller Rooms (on glycol) and one (1) Freezer Room (CO2 DX).

Ammonia / CO2 Rack comprises: -

- Single reciprocating NH3 compressor with suction trap and oil separator
- Air cooled condenser
- Optional water cooled condenser for heat recovery with pump and associated pipework
- DX NH3 / glycol PHE chiller with glycol circulation pump and associated pipework
- Gravity flooded NH3 / CO2 PHE Cooler with horizontal surge drum
- Semi-hermetic CO2 compressor with suction trap and oil separator
- Air cooled desuperheater
- Insulated liquid receiver with R134A back-up cooling unit
- CO2 liquid subcooling PHE

The Chiller Rooms will each be serviced by a ceiling mounted induced draught unit cooler on glycol.

The Freezer Room will have a ceiling mounted induced draught evaporator on CO2 DX.

Performance Parameters: -		CO2	NH3
SST	°C	-30	-6
SCT	°C	-4	38
Design Capacity	kWR	5.44	13.2

Ammonia Side

AS/NZS 1677.2:1998 Refrigeration systems Part 2: Safety requirements for fixed applications

Clause 2

2.1	System Designation	Indirect closed system			
2.2	Occupancy Classification	Category II			
2.3	Refrigerant Group	B2			Complies Y/N
2.7.2	Maximum Charge	No restriction	Actual	12 kgs	Y
	Machinery installed at ground level or above				

Clause 3

3.1.2 (a) Low Pressure Side

Melbourne summer critical process 0800-1800	38.0	°C
System design saturated temperature	38.0	°C

Maximum operating pressure	13.71	barg
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3.1.2 (c) High Pressure Side - air cooled

Melbourne summer critical process 0800-1800	add	16.7	°C
System design saturated temperature		38.0	°C
		54.7	°C

Maximum operating pressure	22.1	barg
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3.2 Component Design Pressure

			Complies Y/N
- Manual isolating valve	Danvalve SVA type	40 bar	Y
- Stop check valves	Danvalve SCA type	40 bar	Y
- Gauge valves	Danfoss SNV 8	25 bar	Y
- Oil level control	HBSO type	150 bar	Y
- Solenoid valves	Danfoss EVRA type	28 bar	Y
- Strainers	Danfoss FA type	28 bar	Y
- Non-return valves	Danfoss NRVA or NRVS	28 bar	Y
- Manual regulating valves	Danfoss REG type	40 bar	Y
- Motorised regulating valves	Danfoss ICM type	52 bar	Y
- Pressure switches	Danfoss (models not specified)		Y
- Liquid level switches	HBSR type	100 bar	Y
- Oil drain valves	Danfoss ODV type	25 bar	Y

3.3 Pressure Vessels (AS/NZS 1200)

			Complies Y/N
- Cascade PHE Surge Drum	Heldon HHR-038	25 bar	Y
- Liquid Receiver	Heldon HVR-040	42 bar	Y
- Suction Trap	Heldon HVA-002	31 bar	Y
- Oil Separator	Temprite 922R	44.8 bar	Y

3.4 Heat Exchangers

			Complies Y/N
- Water cooled PHE Condenser	AlfaNova 27-24H	30 bar	Y
- Glycol Chiller PHE	AlfaNova 52-30H	30 bar	Y
- CO2 / NH3 Cascade PHE	AlfaNova HP52-50H	40 bar	Y
- Air cooled condenser	Guntner AGVH 090.4C/1-ND.1	32 bar	Y

3.6 Pipe & Fittings

Complies Y/N

3.7 Protection against excess pressure

			Complies Y/N
- Liquid Receiver PRV	Valco 15 x 20mm	27.5 bar	Y
- Suction Trap PRV	GBI 15 x 20mm	17.5 bar	Y
- Oil Separator PRV	Valco 15 x 20mm	27.5 bar	Y
- Cascade PHE Surge Drum PRV	Valco 15 x 20mm	17.5 bar	Y

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3.7.3.1	Trapped liquid / hydrostatic expansion - possible pressure build-up on liquid supply line to glycol chiller if plant is located outside (full sunlight)			N???
3.8	Arrangement of Pressure Gauges			Complies Y/N
	- Gauge valve connections available			Y
3.9	Liquid Level Indicators			Complies Y/N
	- Cascade PHE Surge Drum	HBSR type	100 bar	Y
Clause 4				
4.7	Machinery Room			Complies Y/N
	Ventilation			
4.8	Refrigerant Leak Detectors			Complies Y/N
	4.8.2 Machinery Rooms			
4.9	Electrical Installations			Complies Y/N
	4.9.2 Electrical supplies			

CO2 Side

Plant Room

ISO 5149-1:2014 Refrigerating systems and heat pumps - Safety and environmental requirements - Part 1: Definitions, classification and selection criteria

	Refrigerant	R744		
5.1	Occupancy category	b - Supervised occupancy		
5.2	Systems classification	Direct system		
5.3	Location class	III - Machinery room or open air		
Table B.1	Toxicity Class	A		
Table A.1	Charge Limit Requirement based on Toxicity	No charge restriction		
Table B.1	Flammability Class	1		
Table A.2	Charge Limit Requirement based on Flammability	Not applicable		Complies Y/N
	Refrigerant Charge Limit	No limit	Actual 8 kgs	Y

Freezer Room 2.4m L x 2.0m W x 2.5m H (= 12 m³ internal volume)

	Refrigerant	R744		
5.1	Occupancy category	b - Supervised occupancy		
5.2	Systems classification	Direct system		
5.3	Location class	I - Mechanical equipment within occupied space		
Table B.1	Toxicity Class	A		
Table A.1	Charge Limit Requirement based on Toxicity	Toxicity level x Room volume		
Table B.1	Flammability Class	1		
Table A.2	Charge Limit Requirement based on Flammability	Not applicable		Complies Y/N
	Refrigerant Charge Limit		0.1 kg/m ³ x 12 m ³ = 1.2 kg	
	Actual CO2 Charge (advised)		8.0 kg	N
			(= 0.67 kg/m ³)	

Alternative Provisions

Detector and alarm required	YES
Ventilation required	YES

ISO 5149-2:2014 Refrigerating systems and heat pumps - Safety and environmental requirements - Part 2: Design, construction, testing, marking and documentation

Clause 5 Requirements for assembly

5.2.2.1	For low temperature side of a cascade system, maximum allowable pressure is determined by the designer			Complies Y/N
	From CA drg, PRV LS = 30 bar, HS = 40 bar			Y
5.2.2.2	Component maximum allowable pressure			Complies Y/N
	- CO2 / NH3 Cascade PHE	AlfaNova HP52-50H	40 bar	Y
	- Liquid Receiver	Heldon HVR-040	42 bar	Y
	- CO2 Liquid Sucooling PHE	Alfa Laval CBH30-20H-F	50 bar / 50 bar	Y
	- Suction Trap	Heldon 3100-084010A	31 bar	Y
	- Compressor	Bitzer 2KSL-1K-40S	30 / 53 bar	Y
	- Oil level control	Trax TR3101	35 bar	Y
	- Oil Separator	Temprite 922R	44.8 bar	Y
	- Air cooled desuperheater	Buffalo Trident RC13-C-8C	50.77 bar	Y
	- CO2 Condenser Pressure Regulator	Danfoss ICMTS 20A	90 bar	Y
	- CO2 Gas Bypass Regulator	Danfoss CCM 10	50 bar	Y
	- Solenoid valves	Danfoss EVR6	45.2 bar	Y
	- Manual isolating valves	Heldon (models not specified)	42 bar	Y
	- Manual ball valves	Heldon (models not specified)	48 bar	Y
	- Non-return valves	Heldon F63	up to 52 bar	Y
	- Filter/driers	Heldon 3001	42 bar	Y

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- Pressure switches	- HP side	Danfoss KP6W	46.5 bar	Y
- Pressure switches	- LP side	Danfoss KP6B	46.5 bar	Y
- Pressure sensors		Emerson CPC 800-2X00	100 bar	Y
- Temperature sensors		Emerson 501-1122 & 201-1191	N/A	Y
- Evaporator		TBA	?? bar	
- TX Valve		TBA	?? bar	
5.2.3 Piping & fitting				Complies Y/N
5.2.3.3	Flared joints - annealed pipe under 20mm OD			
5.2.3.5	Compression joints - max DN32			
5.2.3.6	Requirements for piping installed at site (also on skid)			
5.2.3.8	Spacing for pipe support (max 2m for 3/8" & 1/2" Cu pipe)			
5.2.3.9	Protection of pipes			
5.2.3.11	Location (refer to spec)			
5.2.3.12	Accessibility of piping & joints - clearances			
5.2.3.13	Piping for accessories & measurements			
5.2.3.14	Drain and vent connections - capped valves			
5.2.4 Shut-off devices				Complies Y/N
5.2.4.1	Isolating valves			Y
5.2.4.2	Hand-operated valves			
5.2.5 Setting of protection devices				Complies Y/N
5.2.5.1	Set to 90% or lower of the setting of the pressure relief devices			
5.2.6	Safety switch devices for limiting the pressure			
5.2.6.1	Electro-mechanical safety switching devices			
5.2.6.2	Electronic safety switching for limiting the pressure			
5.2.6.3	Arrangement of safety switching devices - no intermediate shut-off valves			
5.2.7 Size calculations for pressure relief devices				
5.2.7.1 Calculations				
	- Liquid Receiver PRV			Complies Y/N
	- Suction Trap PRV			Y
	- Oil Separator PRV			Y
	- Cascade PHE Surge Drum PRV			Y
	- CO2 Liquid Sucooling PHE			Y
	- Liquid Receiver PRV	Heldon 5231AX	40 bar	Y
	- Suction Trap PRV	Heldon 5231A	31 bar	Y
	- Oil Separator PRV	Heldon 5231AX	40 bar	Y
	- Cascade PHE Surge Drum PRV	Heldon 5231AX	40 bar	Y
	- CO2 Liquid Sucooling PHE	Heldon 5231A	31 bar	Y
5.2.9 Application of the protection devices				Complies Y/N
5.2.9.2	Protection of the refrigerating system against excessive pressure			
5.2.9.4	Isolation and arrangement of protection devices for refrigerating systems			
5.2.10 Indicating and measuring instruments				Complies Y/N
5.2.10.2	Pressure indicator connections			
5.2.10.3	Liquid level indicators			
5.2.11 Electrical requirements				
5.2.12 Protection against hot surfaces				
5.2.13 Protection against moving parts				
5.2.14 Safe handling of equipment				
5.2.15 Standstill conditons during trasportation				
5.2.17 Requirements for ventilated enclosures				