



Cold Storage automation for Safety & Energy Efficiency

by

Anand Joshi

President AAR

BOG Member RATA

Past President ISHRAE Pune

Member IIAR (USA), ASHRAE (USA), IDA, IETE, IGCC

Made In India since 1978



Why Automation ?

Observation

- ▶ Practically impossible to load unload, start stop compressor manually depending on load variation.
- ▶ Operator frequently throttle valves installed at liquid Header (going to cold room) from plant room to avoid liquid stroke to compressor.
- ▶ Manually Difficult, every hour to measure and log each room temperature.
- ▶ Manually Difficult to close / open each cold room liquid header isolation valve when room temperature is achieved and to reduce load on compressor.
- ▶ Measuring and recording energy

Why Automation ?

Human errors and inefficiency

- a. Operating plant at designed conditions
- b. Safety
- c. Energy efficiency
- d. Parameters recording



Which Parameters ? Why ?

Level : Safety & Efficiency

Temperature : Product storage life

Carbon Dioxide CO₂ : Product storage life

Relative Humidity : Weight Loss

Pressure : Efficiency



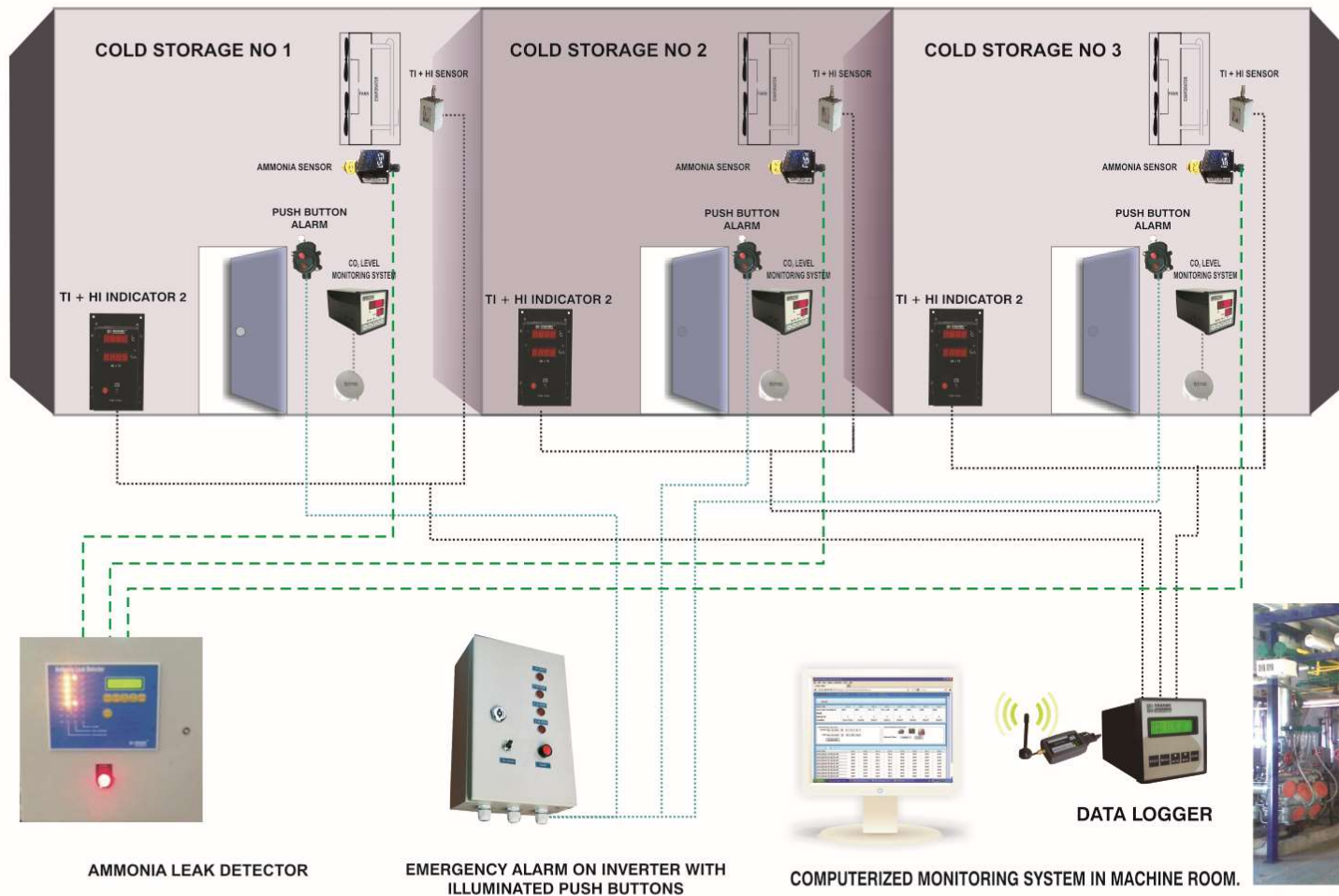
Various Controls for Refrigeration

- ▶ Liquid Level Controllers, Level Transmitters & Float Switches
- ▶ Solenoid Valves, Gas Operated Solenoid Valves Single and Two Stage
- ▶ Safety Controls Safety valves, Dual Manifold for Safety Valves, Dead Man's Valve
- ▶ Automatic Air Purger, Ammonia Purifier
- ▶ In Line components Non Return valves, Strainers,
- ▶ Controls Valves Flow Regulating Valves, Over Flow Valves, Pressure & Temperature Regulating Valves, Crank case Pressure Regulators

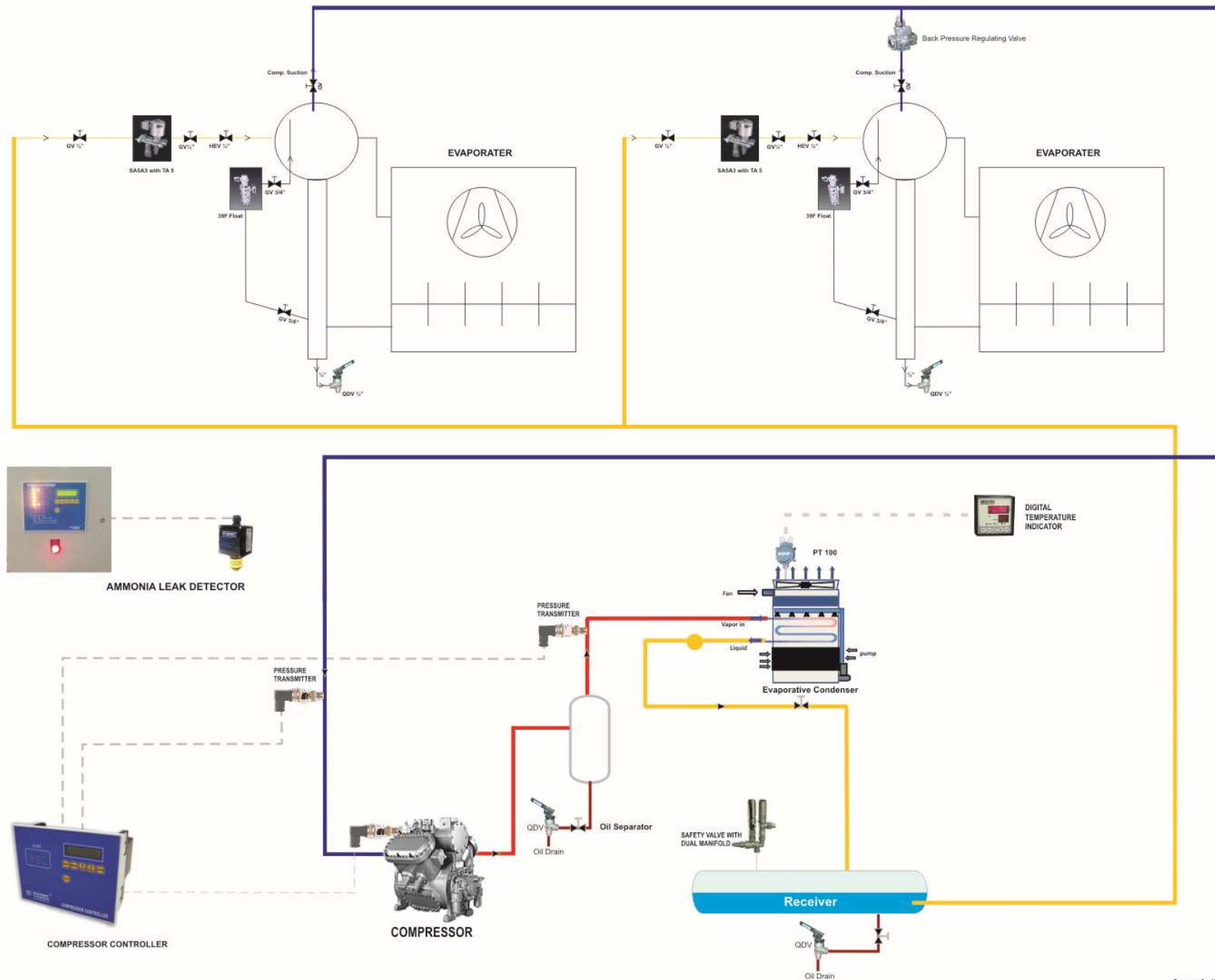
Various Controls for Refrigeration

- ▶ Compressor Capacity Controllers, PLCs for Piston and Screw Compressors
- ▶ Data Loggers, Temperature, Pressure, Humidity and Gas Indicators / Indicating controllers
- ▶ Alarm Annunciators, Defrost Controllers, Ice thickness Controllers
- ▶ Ammonia Leak Detectors
- ▶ Sensors & Transmitter for temperature, pressure, humidity, CO₂, ethylene, Oxygen etc.
- ▶ Web-base Monitoring & Control Systems
- ▶ Mobile Applications to Monitor plant

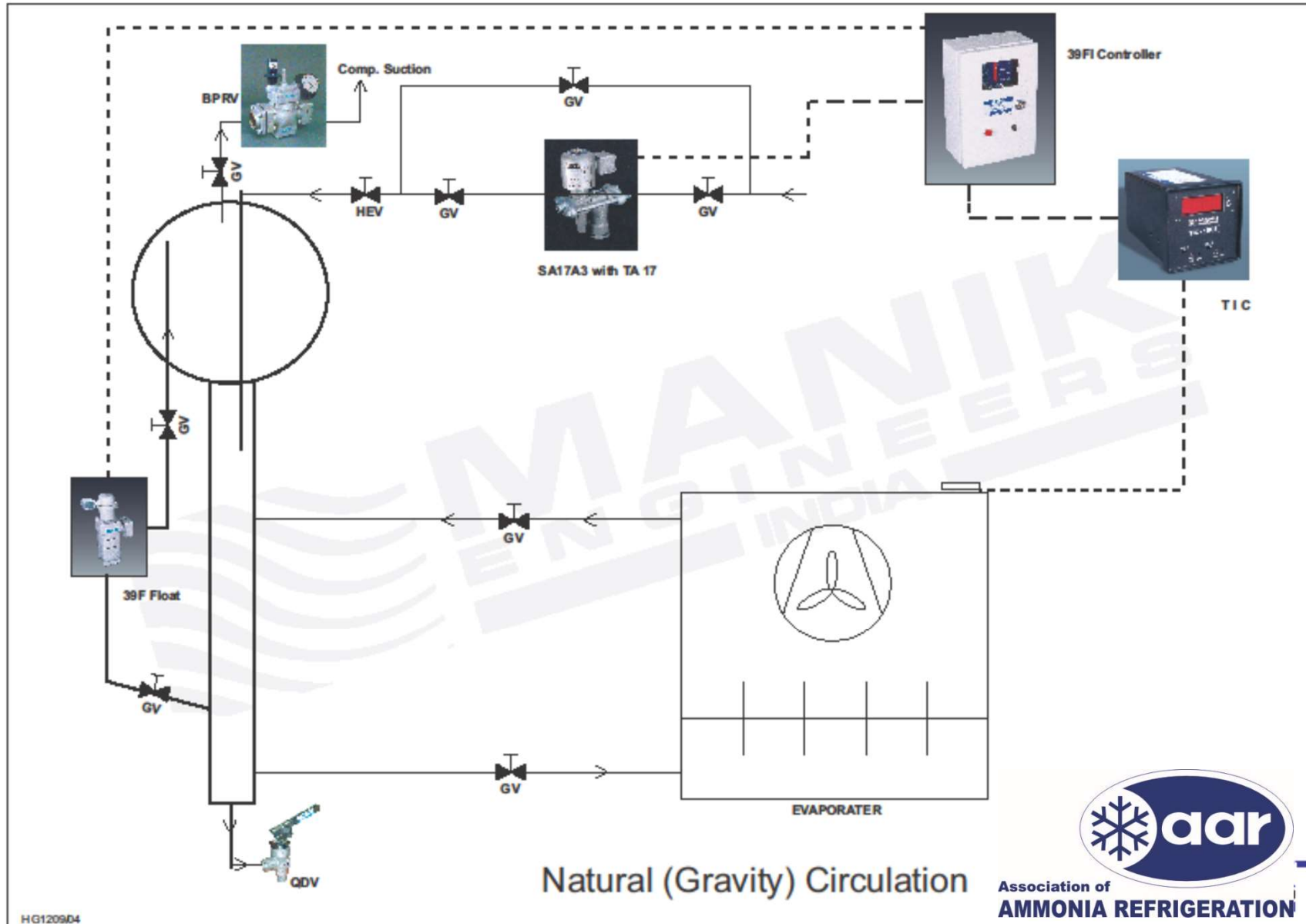
COLD STORAGE AUTOMATION



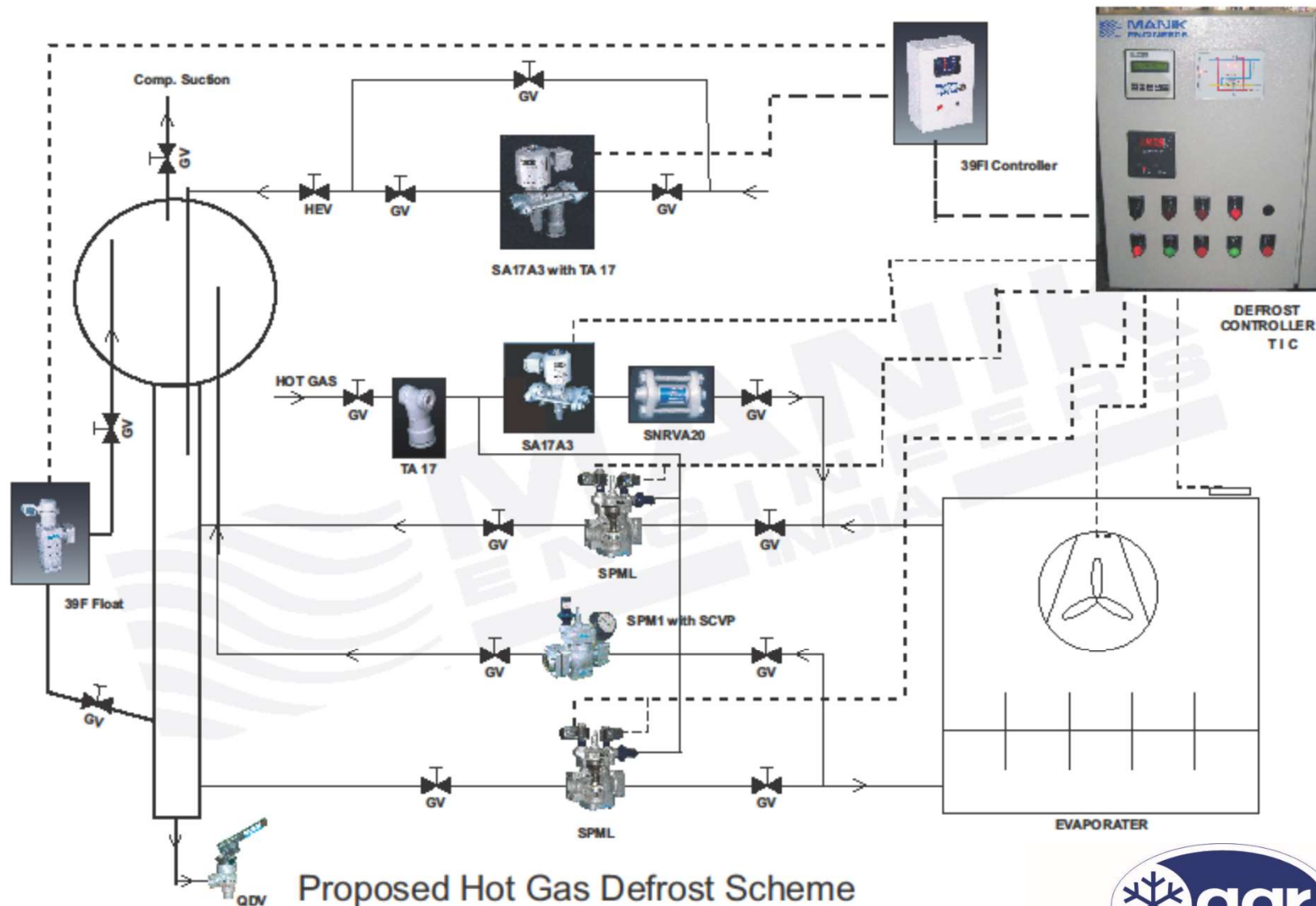
AMMONIA GRAVITY FIELD SYSTEM



TYPICAL INSTALLATION FLOODED AIR COIL UNIT



Flooded System with Hot Gas Defrost



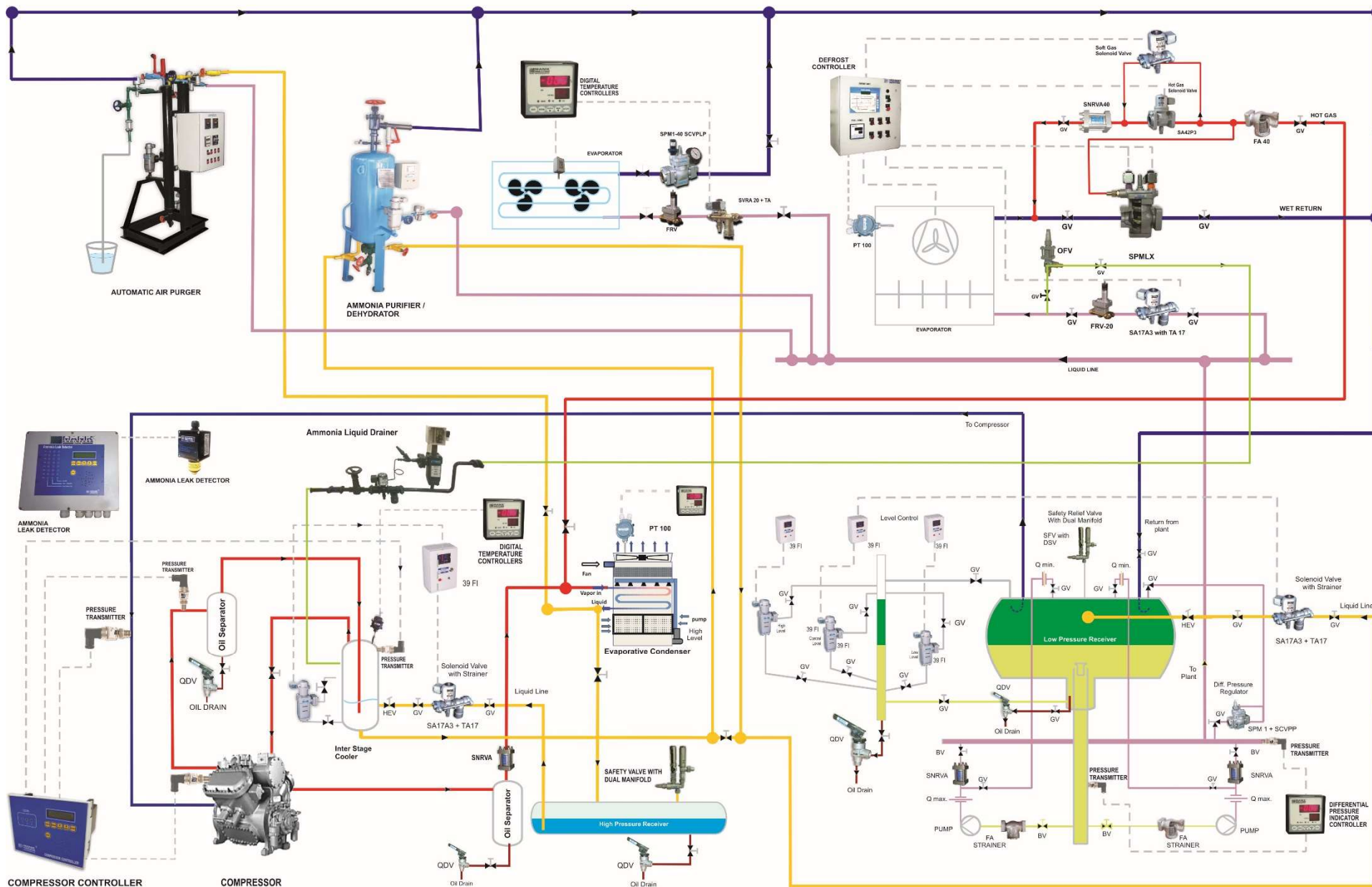
Proposed Hot Gas Defrost Scheme For Natural (Gravity) Circulation

Flooded System with Hot Gas Defrost

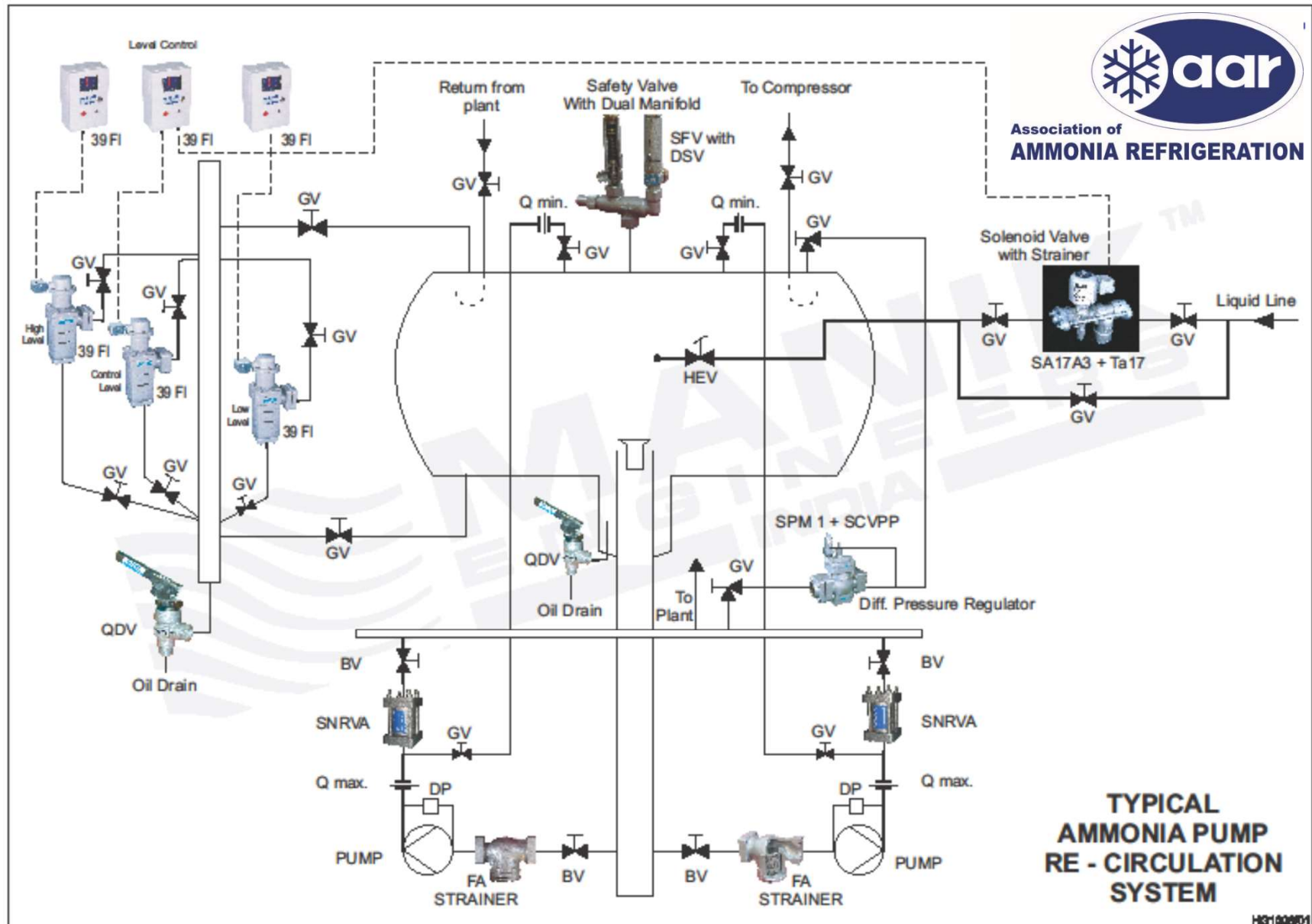




Ammonia Liquid Overfeed Industrial Refrigeration System Association of AMMONIA REFRIGERATION

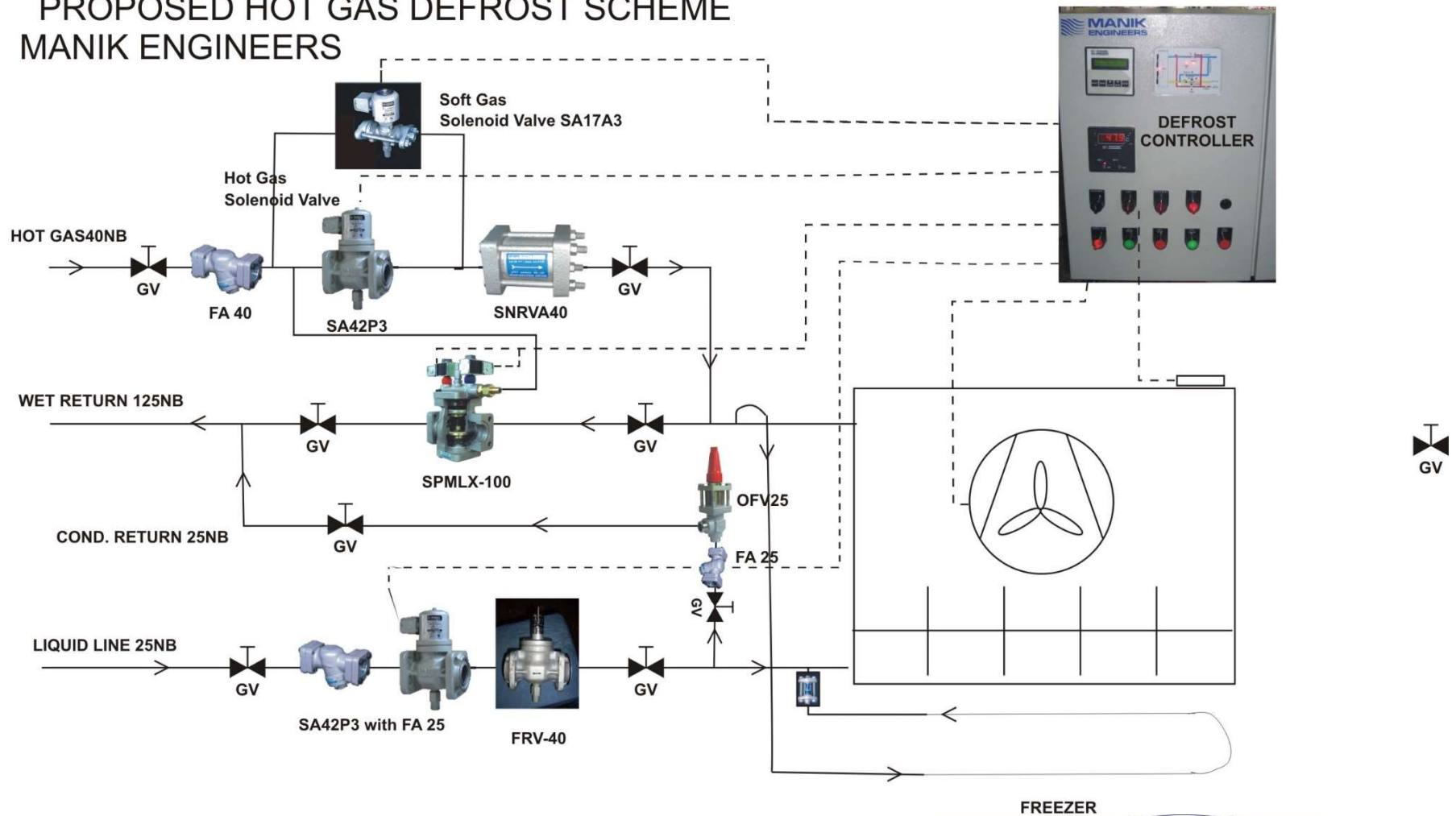


TYPICAL OVER FEED SYSTEM VESSEL



Hot Gas Defrost for Over feed System

PROPOSED HOT GAS DEFROST SCHEME
MANIK ENGINEERS



HG1209/04

PROPOSED HOT GAS

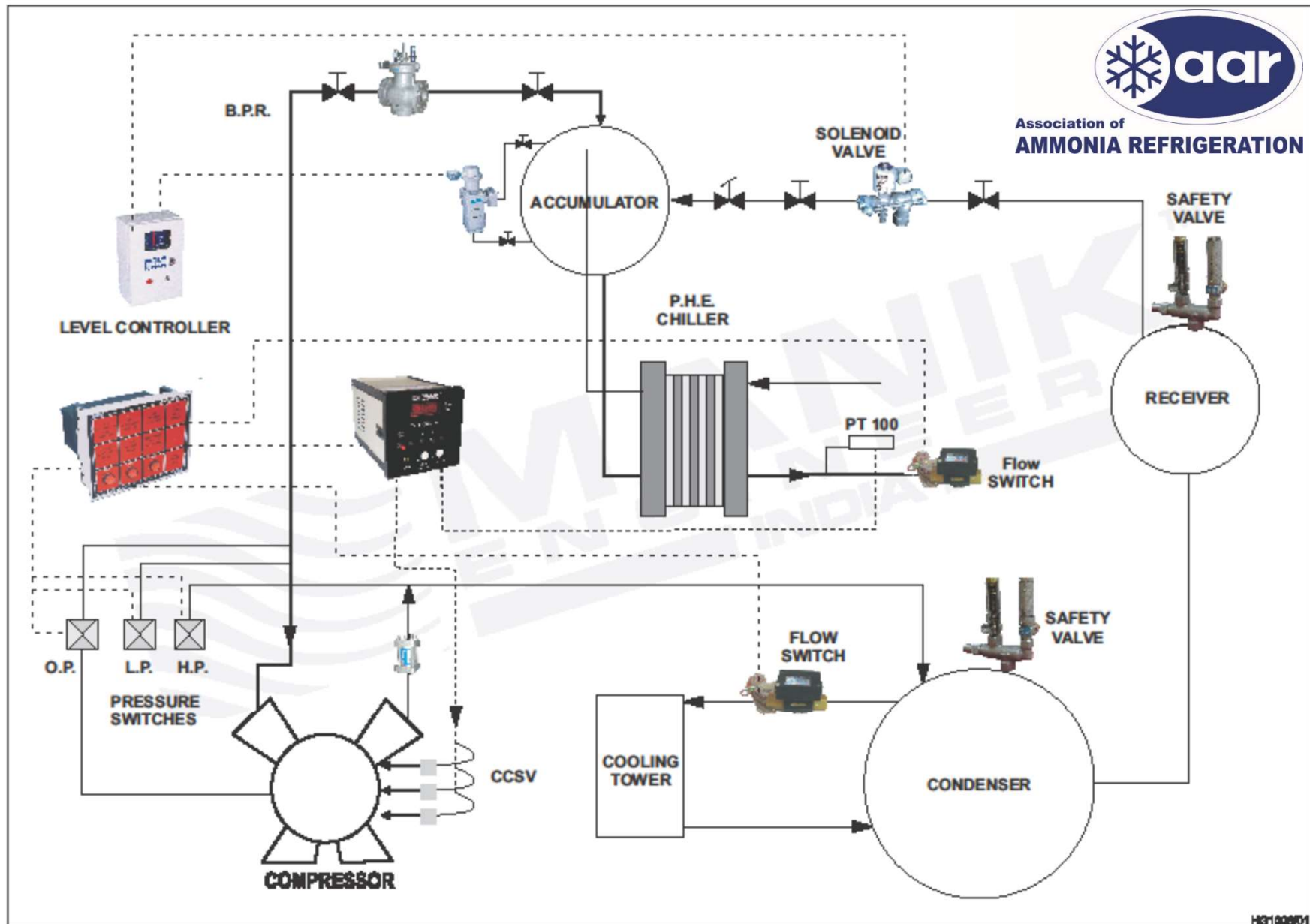


Association of
AMMONIA REFRIGERATION

Hot Gas Defrost for Over feed System



Typical Controls for Flooded PHE System



Level Control

Liquid Level Controllers

Float Switches

Level Transmitters

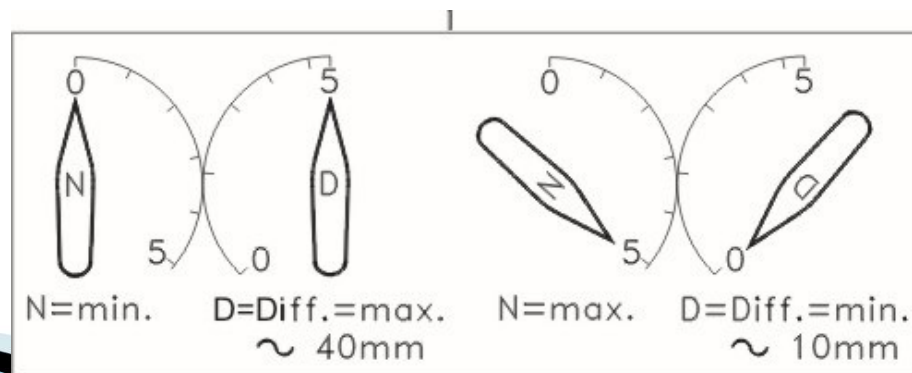
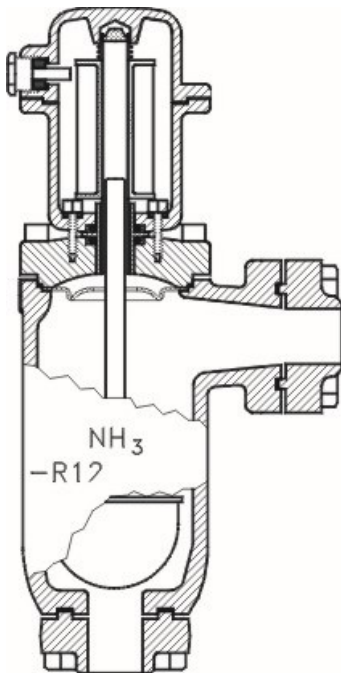


Why to Control Level in flooded system ?

- ▶ Liquid Level Controllers along with Solenoid Valve maintains evaporator flooded
- ▶ Prevents Liquid Stroke to the compressor
- ▶ Appropriate flooding of evaporator
- ▶ Better heat transfer efficiency of the evaporator
- ▶ Less wear & tear of compressor
- ▶ Running hours of compressor are reduced
- ▶ This all generates energy saving
- ▶ Bar graph display continuously display the rising & falling of liquid level inside the float chamber



Liquid Level Controller



Float Switch



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FUNCTION:-

- 1 Internal float assembly
- 2 Switch box
- 3 M4x8pinol tail stock screw
- 4 Top cover
- 5 4 pcs.M12x35 stainless steel bolt
- 6 FKS 39 housing
- 7 Pressure tube
- 8 Top cover gasket
- 9 'O'- ring for pressure tube
- 10 DIN plug for electrical connection
- 11 Aluminum gasket
- 12 Locking ring for internal float
- 13 Stainless steel bolts
- 14 Flanges
- 15 Flanges gaskets

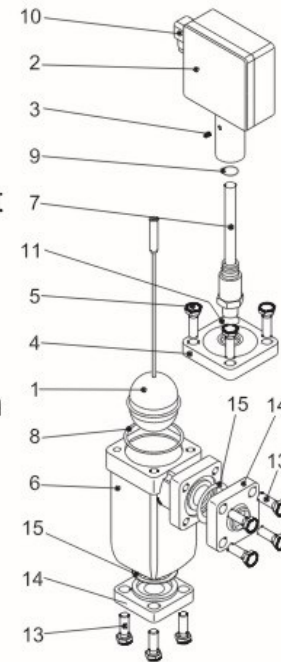


fig. 1

- An electro -mechanical float switch
- Adjustable liquid level differential switch point
- The complete switch box can easily be replaced without any interference with the refrigeration system.

Solenoid Valves



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Type Solenoid Valves

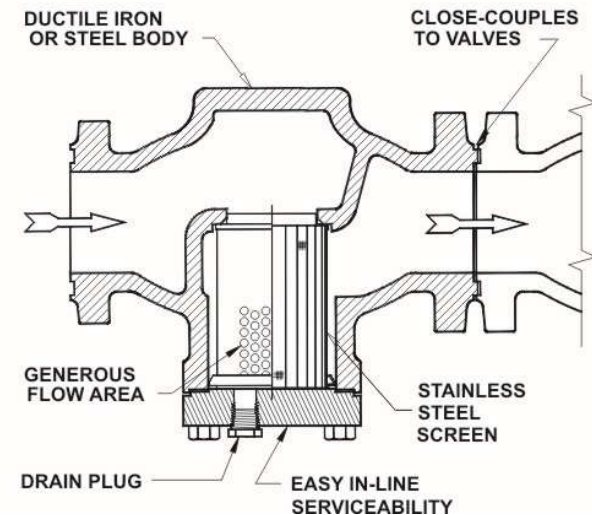
- Direct Acting
- Pilot Operating
- Piston Type
- Diaphragm Type



STRAINERS



KEY FEATURES



- Strainer are with interchangeable filter insert
- Suitable for all common nonflammable refrigerants, including R 717
- Pleated filter net of stainless steel with a very large net surface ensures long intervals between cleaning and low-pressure loss.
- Retains contaminants, e.g. slag, and weld beads and swart.
- Pressure drop insignificant.
- Filter insert Stainless steel weave, mesh size

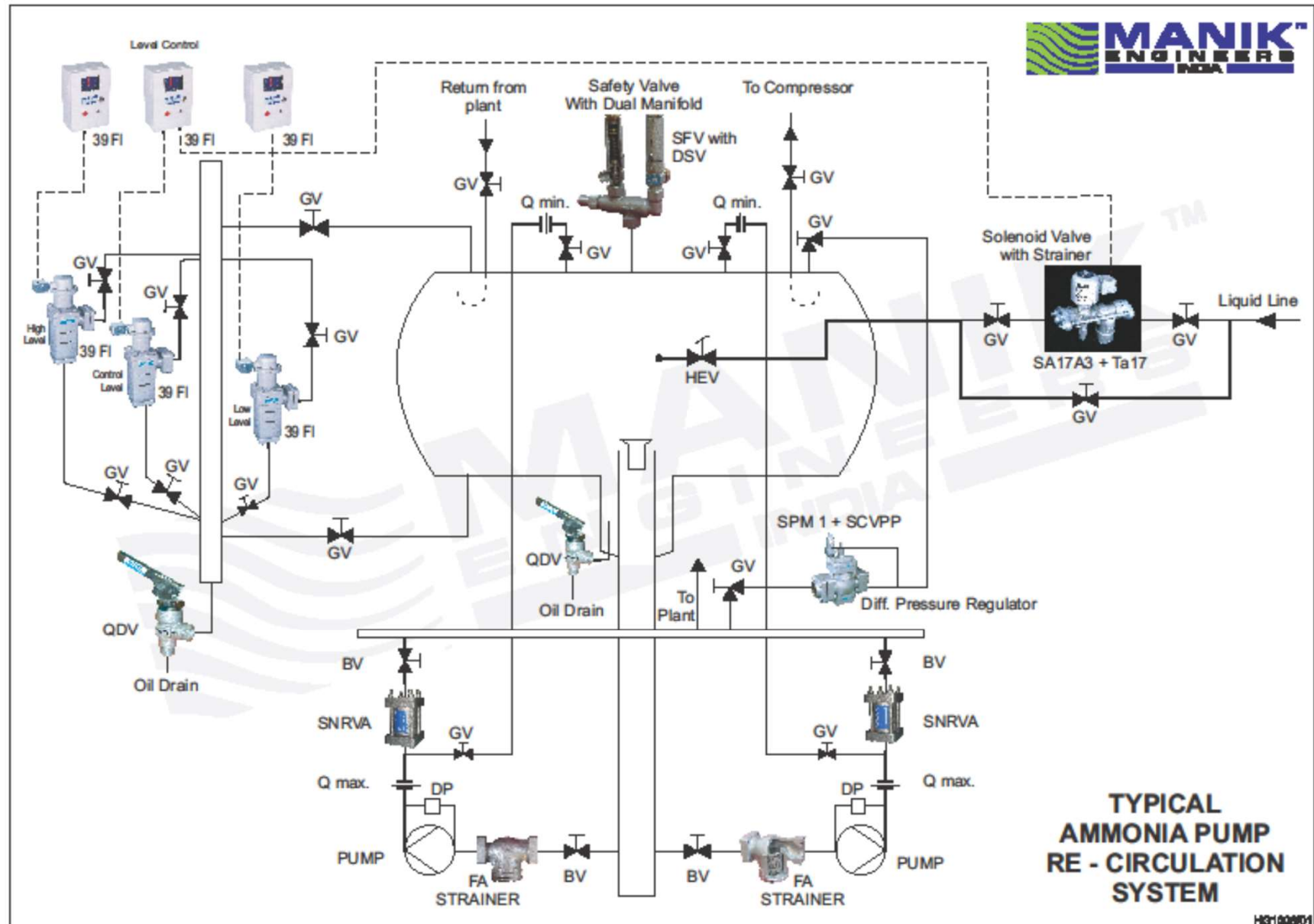
TYPICAL INSTALLATION FLOODED AIR COIL UNIT



TYPICAL INSTALLATION FLOODED AIR COIL UNIT



TYPICAL OVER FEED SYSTEM VESSEL



PUMP OVERFEED SYSTEM VESSEL



MULTI FUNCTION PRESSURE & TEMPERATURE REGULATORS



- Pilot operated main valve
- Screwed-in pilot valves or pilot valves mounted in an external pilot line.
- Two Variants
 - One screwed-in pilot valve
 - Three screwed-in pilot valves
- Used in refrigeration plant with
 - Dry evaporation
 - Pump circulation
 - Natural circulation

PILOT CONTROL MODULES

PILOT VALVES



- Pressure controlled pilot valve low pressure from vacuum (-0.6 bar) up to 7 bar
- High pressure from 4 to 28 bar
- Differential pressure control
- Solenoid pilot valve normally closed and normally open
- Out Let Pressure Regulator
- Crank case Pressure regulation

The pilot valves can perform the following functions:

- Constant pressure regulation
- Capacity regulation
- Crank case pressure regulation
- Refrigerant pressure regulation
- Normally Open / Normally Close Solenoid

Evaporator Pressure Regulation



Differential Pressure Regulation



Solenoid Valves: External Pressure Operated

TWO STAGE OPERATION



- 2-step servo-controlled main valves with screwed-on pilot solenoid valves.
- Uses an external pressure source
- No differential pressure across the valve is required
- Replaces SPML with bypass solenoid valve, 2 signals and one timer
- Screw thread pilot valve fitting

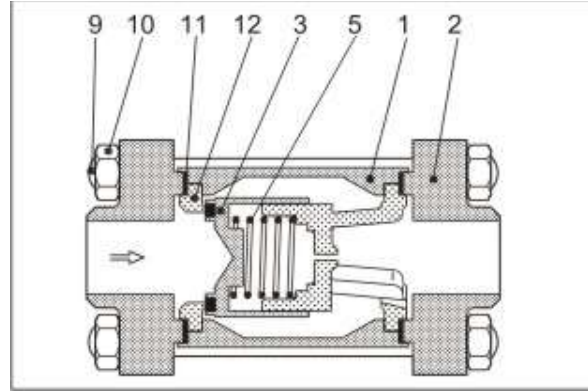
- Two steps Operation

Step one opens to 10% of the capacity,

Step two opens automatically after the pressure differential across the valve reaches approximately 1.5 bar.

- Only one signal required for both pilot solenoid valves
- Provides safety against pressure "shocks" as the valve can only open fully when $D p < 1.5 \text{ bar}$

IN LINE NON RETURN VALVES / CHECK VALVES



No.	Parts
1	Housing
2	Flanges
3	Valve Cone
5	Spring
9	Bolts
10	Nut
11	Gasket
12	Valve Seat

- Ensures correct direction of flow.
- Fitted with damping piston that makes the valves suitable for installation in lines where pulsation can occur, e.g. in the discharge line from the compressor.
- Teflon tightening ring on valve cone ensures perfect sealing
- Minimal Pressure Drop

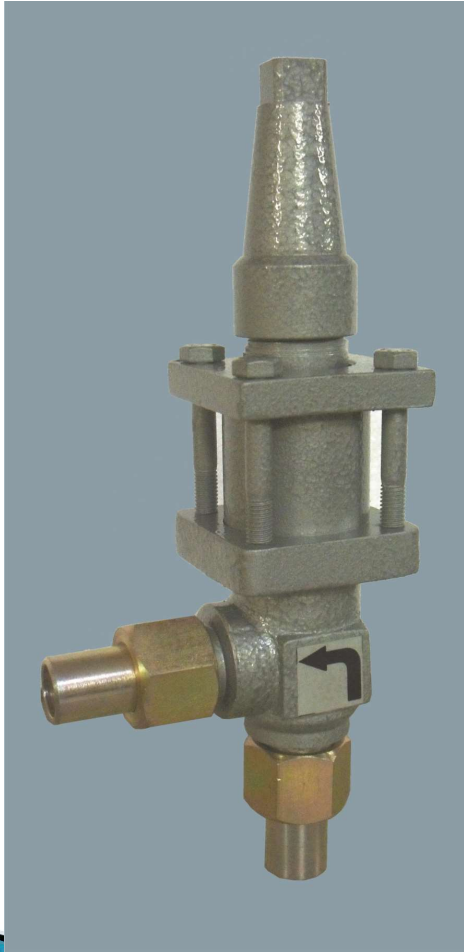
FLOW REGULATING / METERING VALVE



Automatic Flow Regulator, once set, maintains a constant flow rate of liquid to the evaporator.

It also serves as a check valve to prevent back flow into the liquid line from the evaporator during pressure reversals which occur during hot gas defrost.

OVER FLOW VALVE



- OFV is angle-way over flow valve, which have adjustable opening pressure
- Cover the differential pressure range (ΔP): 2 - 8 bar (29 - 116 psi).
- The valve can be closed manually, e.g. during plant service and have back seating, enabling the spindle seal to be replaced with the valve still under pressure.
- The OFV valve is back pressure dependent

SAFETY VALVES AND DUAL MANIFOLD



SAFETY VALVES AND DUAL MANIFOLD

- Single Safety Valve
 - Dual Manifold for Safety Valve
 - Various Sizes of Safety valves

Single Safety Valve or Dual Manifold ?

- Single Pressure Relief Valve for Vessel of internal gross volume more than 3 cu. ft or less than 10 cu. Ft
- Dual Manifold for all pressure vessels with internal gross volume more than 10 cu. Ft.

THREE WAY VALVE / DUAL MANIFOLD

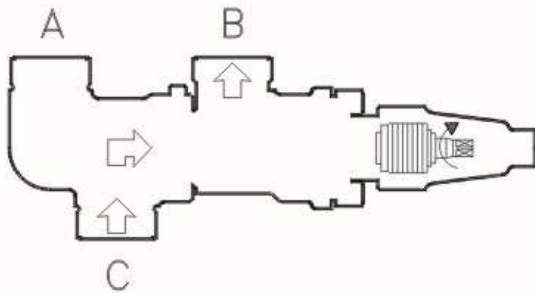


Fig. 1

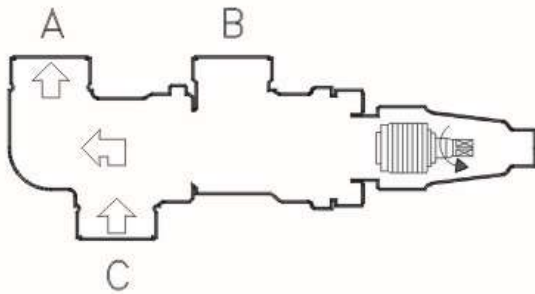
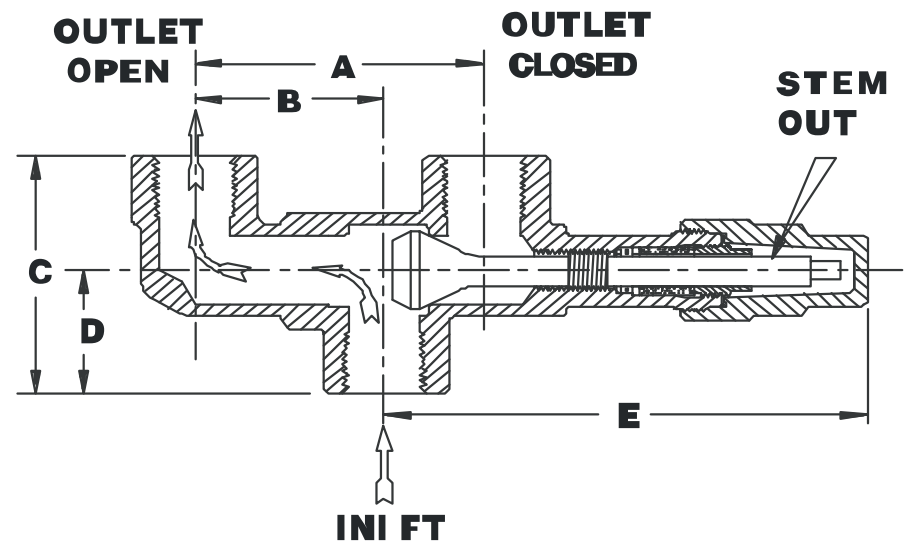
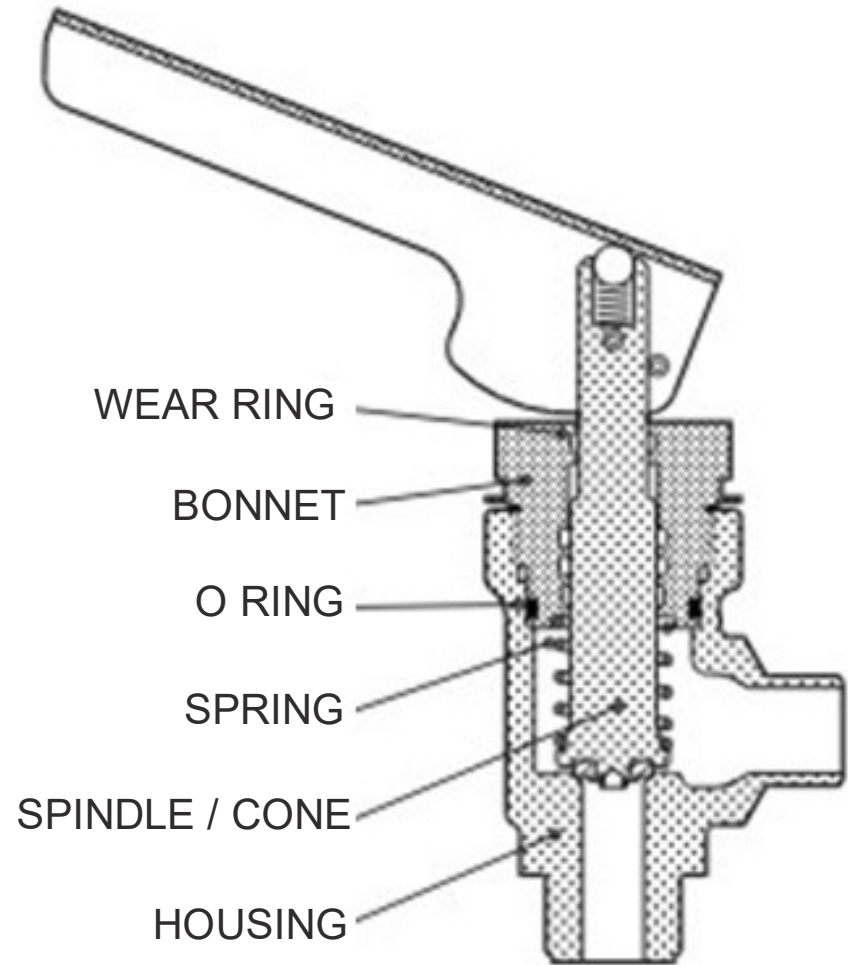


Fig. 2



DEAD MAN'S VALVE



DEAD MAN'S VALVE



AMMONIA LEAK DETECTOR & ALARM

Limits of Toxicity of Ammonia

Minimum Detectable Concentration	10 ppmv
TWA Value	30 ppmv
Serious Irritation Level	250 ppmv
Limit to Tolerable Breathing	500 ppmv



AMMONIA LEAK DETECTOR & ALARM

Ammonia Leak Detector Setting		
Alarm	Setting PPM	
	Manned Area	Unmanned Area
First	50	30
Second	150	70
Third	250	100

AMMONIA LEAK DETECTOR & ALARM



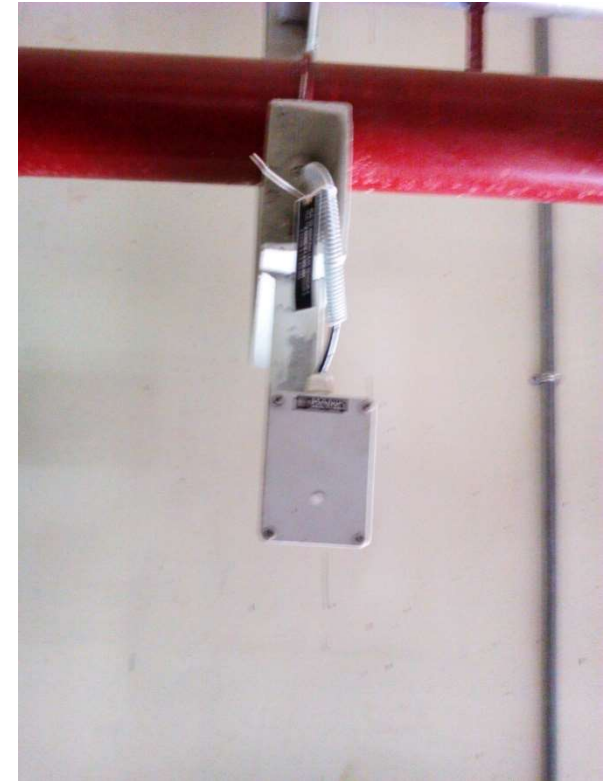
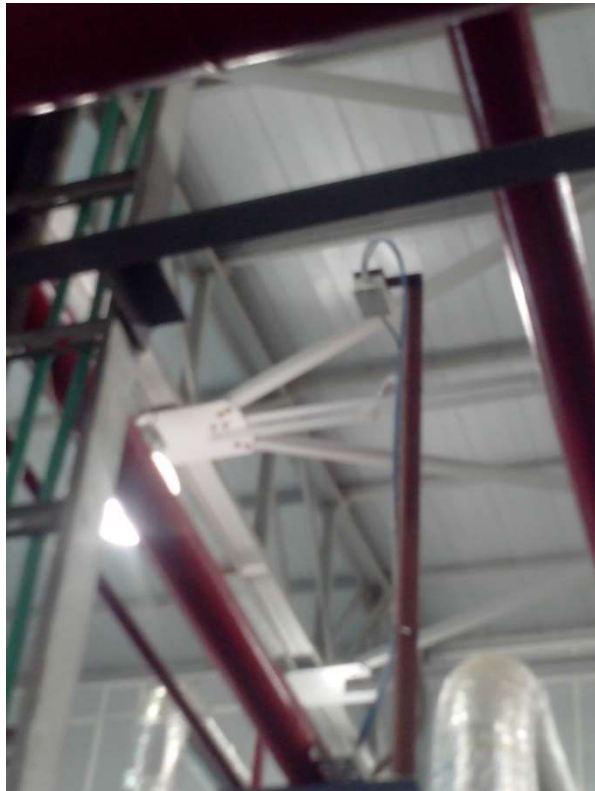
- Detects Leakage of Ammonia from 30 PPM
- Multi Level Alarm
- Single and Multi Channel Detection Unit
- 16 X 2 Line LCD display shows continuous ammonia level
- Inbuilt Hooter, And Relay to Operate Ventilation System
- Easy to Install
- Three Core Cable connection for Sensor
- Area Covered by one sensor is @ 2000 Sq. ft.

AMMONIA LEAK DETECTOR & ALARM

Location of Ammonia Sensors

- The Gas Detectors must be installed at High Level
- At least 1 detector at ceiling level on a grid of 10m to 20m intervals
- Above or to both sides of compressors
- Above Pressure vessels like H P / LP receivers
- Emergency power supply, e.g. battery or UPS for the detection system

AMMONIA LEAK DETECTOR & ALARM



Sensor & Transmitters for Temperature, Humidity, Pressure, Ethaline, CO₂ & O₂

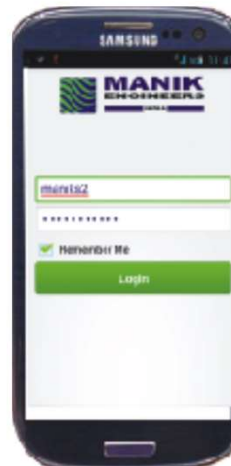


Association of
AMMONIA REFRIGERATION

TEMPERATURE INDICATORS & CONTROLLERS

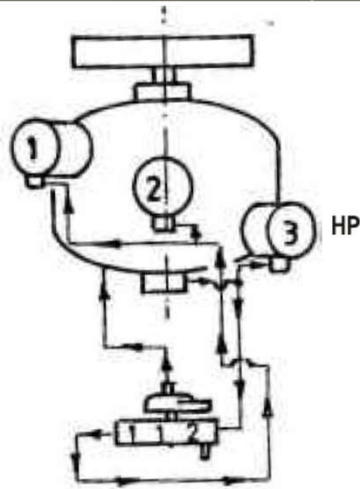


WEB-BASED MONITORING SYSTEMS



COMPRESSOR CONTROLLERS

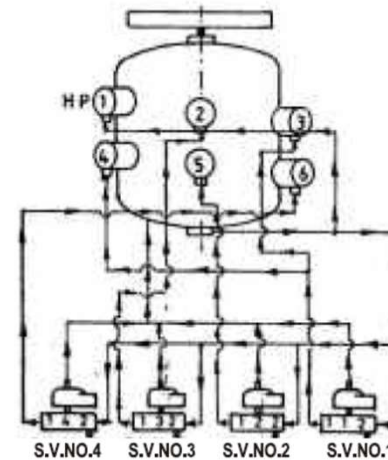
CAPACITY CONTROL DIAGRAM



Compressor KC-21

Figure 15

	Cyl. Block. No.			Capacity	Ø
	1	2	3	%	-
Direct Connection	-	-	✓	50	-
Solenoid Valve ON	✓	✓	✓	100	2

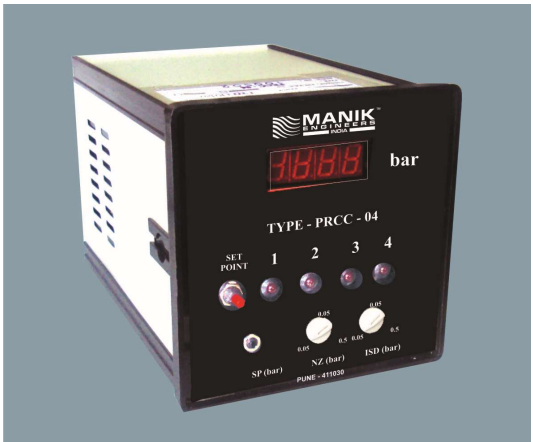


Compressor KC-51

Figure 18

	Cyl. Block. No.						Capacity	Ø
	1	2	3	4	5	6	%	-
Direct Connection	✓	-	-	-	-	-	-	-
Solenoid Valve 1 ON	✓	-	✓	✓	-	-	40	2
Solenoid Valve 2 ON	✓	-	✓	✓	✓	-	60	3
Solenoid Valve 3 ON	✓	✓	✓	✓	✓	-	80	4
Solenoid Valve 4 ON	✓	✓	✓	✓	✓	✓	100	5

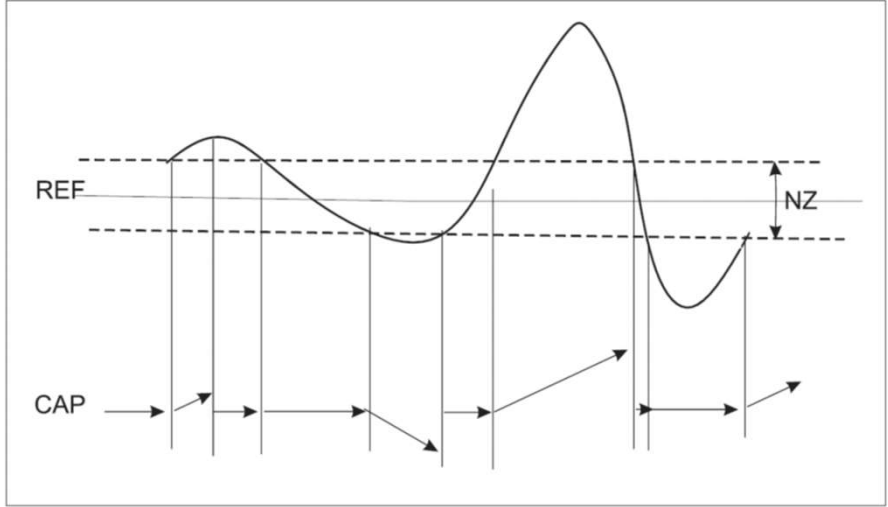
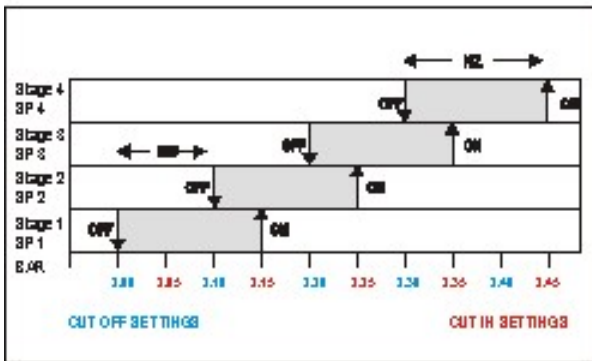
COMPRESSOR CONTROLLERS



Typical application

PRCC-04 unit stage control:

Set Point 2.00 bar
Neutral Zone 0.15 bar
Inter-Stage Differential 0.10 bar



COMPRESSOR CONTROLLERS



COLD ROOM ALARM



The COLD ROOM ALARM kit allows a person trapped in inside the cold room to activate an acoustic-luminous alarm installed outside the room and so call for help.

The system will work even in the event of a temporary power cut thanks to the buffer battery on the external unit.

The Cold Room Alarm Unit is available in 3 different models 4, 8 or 16 Input.

The 4 input unit can be used for 4 cold rooms.



KAMBOLIWALA DAIRY



Ref.

Date: 09-03-2016

TO WHOM IT MAY CONCERN

This is to certify that Plant automation system supplied and installed and commissioned in our plant is working satisfactorily. The total system is easy to operate and maintain to its satisfactory level to control all parameters in our refrigeration system.

Manik has installed following system for up gradation.

1. Automatic Air Purger
2. Compressor Automatic Control System
3. Cold room Level & Temperature Management System.

We have observed following effects of the system installed on our plant.

- 1.—our Compressor discharge pressure (KC-51) REDUCED TO 12 KG/SQ. CM,
- 2--- The average compressor motor power consumption has reduced .
- 3—The overall compressor running hours reduced.
- 4—We have achieved -30 degree centigrade cold room temp. which were not able to go below -25 degree centigrade.

We are to note that we are able to achieve desired temperature through this modification and up gradation system and also reduce the over all power consumption. This has improved our product freezing quality and reduced freezing time.

We are thankful to MANIK ENGINEERS FOR DEPUTING SERVICE TECHNICIAN Mr. S ANJAY. He has carried out entire job intelligently without disturbing our production.

We appreciate your company efforts for developing such technology , we are proud to be associated with MANIK as it is an exemplary "MAKE IN INDIA "company and also economic operation of plant .

We wish Manik for great success in future.

SHABBIR PATEL
FOR KAMBOLIWALA DAIRY , AMOD



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Tel: (O) 02641-245090, 246090
E-mail : kamboliwala@yahoo.com

TIN : 24210600074, Dt: 14-09-2005
C.S.T.: 24710600074, Dt: 14-09-2005



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Jagatpur Industrial Estate, Cuttack-754 021
Tel.: +91671-2491010, 2491465, Fax : 2490010
E-mail : frostee@frosteer.net, Web : www.frosteer.net



Ref. No.

Date: 28.11.2015

To
M/S Manik Engineers
Pune

Dear Mr. Anand Joshi

We are pleased to inform you that plant automation system supplied and installed in our plant is working satisfactorily. The total system is easy to operate and maintain.

We have installed following systems

1. Automatic Air Purger
2. Compressor Automatic Control System
3. Room Level & Temperature Management system

We have observed following effects on our plant

1. Our compressor discharge pressure **reduced to 12 kg/sq. cm from 16 kg / sq. cm**
2. The average compressor (KC21, KC51 & KC42) **motor power consumption reduced by 25%**
3. The overall **compressor running hours reduced by 25%**
4. We are able to **achieve -33°C** room temperature. Earlier we were not able to go below -16°C.

Thus we are able to achieve desired temperature and reduce the overall power consumption. This has improved our product freezing quality and reduced freezing time.

The overall payback period for all investment is less than six 180 days.

We thank you for deputing your service technician Mr. Sanjay. He carried out all work intelligently without disturbing our production.

We appreciate your company efforts to develop, make and install all products. We are proud to be associated with your company as it is an exemplary "MAKE IN INDIA" company.

For Health Food Product (P) Ltd.

Sanjayal
Managing Director/Executive Director

An ISO 9001:2000 & HACCP Certified Company

Customer testimonials



C. S. T. No. MT-5073648
U.P.T.T. No. MT-0123943

Subject to Hathras Jurisdiction

S. T. D. Code 05661
Cold : 80226 / 80301
Resi. : 80227 / 80327

AGRAWAL ICE & COLD STORAGE SADABAD (HATHRAS)

Ref. No.

To,
Manik engineers,
PUNE.

Dated

Kind attn: Managing Director.

Subject: Letter of appreciation for Refrigeration Controls like level control 39FI and Solenoid Valve.

Dear Sir,

We would like to extend our sincere appreciation and gratitude for the quality of controls delivered to us by your company. It gives us immense pleasure to inform you that we are successfully running COLD STORAGE since the year 1980..... We would also like to mention that your controls fitted in this system are giving us excellent performance through out their operation life without much trouble.

We have observed that besides smooth operation of Refrigeration plant, it also reduces the ELECTRICITY Consumption by about 10 % to 15 %.
Our total investment was recovered in 6 month.

No doubt, a well-planned and properly maintained refrigeration system at our place is also one of the reason in smooth functioning of these refrigeration Controls. The timely check ups and good of operator on this sophisticated controls and safety devices in refrigeration system also share the credits for this.

We want to share this joy with you, as you are the manufacturers of the well functioning controls of Refrigeration Systems.

Regards,
For Agrawal Ice & Cold Storage.

COLOUR XEROX

S.N. Agrawal ICE & COLD STORAGE



MAFCO LIMITED
(A Government of Maharashtra Enterprise)
MAFCO FACTORY, Gokhale Nagar Pune 411 016
Gram : "CORPOAGRAH"
Office : 339997, 339278
PHONE { Manager Resi. : 333181

February 15, 1993.

Ref : MFP/ENR/355 /33.

TO WHOMSOEVER IT MAY CONCERN

This is to certify that we have installed two sets of Electronic Liquid Level Controllers alongwith Liquid Line Solenoid Valves supplied by M/s Manor Enterprises for our two BLAST FREEZERS in December, 1992 and one for Block Ice Plant in January, 1993.

We have found that this system is very efficient and it has resulted in:

- substantial reduction in time required for attaining the temperature.
- better quality of freezing and
- remendous saving in power consumption as is evident from statistics given below indicating difference in performance by installation of floats :

	before	after install.
1) Average time required to attain temperature	16 to 16 hrs.	8 to 10 hrs.
2) % saving in time	-	50 to 56%
B) Before installation		After installation
		Saving of Units
Dec-1992	73,972 KWH	Dec-1993 57,248 KWH Compared with Dec 16,724 KWH
Jan-1992	99,306 KWH	Jan-1993 84,262 KWH Compared with Jan 15,044 KWH

Monthly power bill saving of Rs.36000/- to Rs.38,000/- observed for last two months compared with same months of previous years. The production quantities remaining almost equal for the months of comparison.

The liquid stroke to compressor is now totally avoided Due to remote on-off indication in plant room, vigilance and skill on the part of the operator is greatly reduced.

We recommend these controllers and solenoid valves for deriving multiple benefits of a) power saving, b) reduction in maintenance costs, c) better plant capacity-utilisation and d) reduction in no. of skilled operators.

For MAFCO LIMITED
(S. V. Phadnis)
Factory Manager (Pune)

COLOUR XEROX

Registered Office - MAFCO LTD.

Mistry Bhavan, 6th floor, Dinshaw Vachha Road, Bombay - 400 020.

Phone - 222244

Thank You