U.S.-Philippines Cold Chain Standards and Innovation Virtual Workshop

Operating Procedures for Ammonia Refrigeration Systems

October 19th, 2022

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SAFE AND SUSTAINABLE USE OF NATURAL REFRIGERANTS

IIAR Suite of Standards

Closed-Circuit Ammonia Refrigeration Systems

IIAR 1 – Definitions and Terminology Used in IIAR Standards
IIAR 2 – Safe Design (of…)
IIAR 3 – Ammonia Refrigeration Valves
IIAR 4 – Installation (of…)
IIAR 5 – Startup (of…)
IIAR 6 – Inspection, Testing, and Maintenance (of…)
IIAR 7 – Developing Operating Procedures (for…)
IIAR 8 – Decommissioning (of…)
IIAR 9 – Minimum System Safety Requirements (for Existing…)

ANSI/IIAR CO2-2021

Safety Standard for Closed-Circuit Carbon Dioxide Refrigeration Systems

Specify minimum requirements:

- Design
- Installation
- Start-up
- Inspection, Testing, & Maintenance

IIAR HC – Standard Presently in Development

Safety Standard for Closed-Circuit Refrigeration Systems Utilizing Hydrocarbon Refrigerants

Using “natural” Hydrocarbon Refrigerants

Agenda

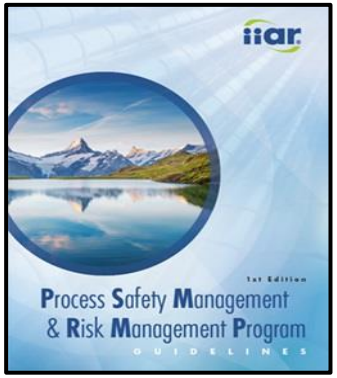
Operating Procedures

for Ammonia Refrigeration Systems:

- Purpose, Importance, and Requirements
  - ✓Operating Phases
  - ✓Operating Limits
  - ✓Safety & Health Considerations
  - ✓Precautions & Control Measures
  - ✓Safe Work Practice Considerations

Process Safety Management (PSM)

Operating Procedures



SAFE AND SUSTAINABLE USE OF NATURAL REFRIGERANTS

Operating Procedures

iiar®

SAFE AND SUSTAINABLE USE OF NATURAL REFRIGERANTS

Operating Procedures - Purpose

The employer must develop and implement written operating procedures

Describes:

- Tasks to Be Performed
- Data to Be Recorded
- Operating Conditions to Be Maintained
- Samples to Be Collected
- Safety and Health Precautions to Be Taken
- Safety Implications Information

Operating Procedures - Purpose

The employer must develop and implement written operating procedures

Provides:

- Benchmark for Quality
  - Operations
  - Maintenance
- Standardization/Uniformity
- Instructions
- Protection
- Confidence

Operating Procedures

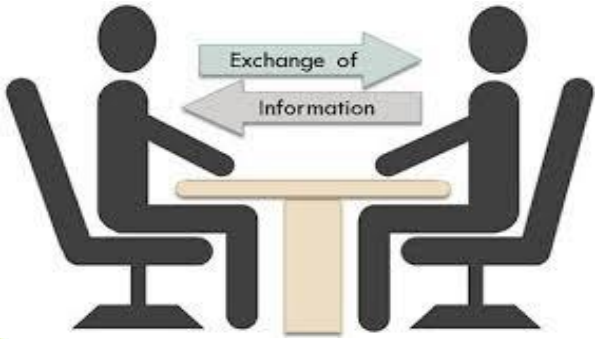
General Requirements:

- Technically Accurate
- Understandable to Employees
- Reviewed Periodically:
  - Reflect Current Operations

Operating Procedures

General Requirements:

- Consistent with Process Safety Information
- Provide Clear Instructions for Safely Conducting Activities and Carrying Out Duties
- Well Communicated to Employees



Operating Procedures

Must Address:

1) Steps for Each Operating Phase
2) Operating Limits
3) Safety and Health Considerations

Operating Procedures

1) Steps for Each Operating Phase:

- Initial Startup
- Normal Operations
- Temporary Operations
- Emergency Shutdown:
  - Includes conditions under which emergency shutdown is required
  - Assignment of shutdown responsibility to qualified operators

Operating Procedures

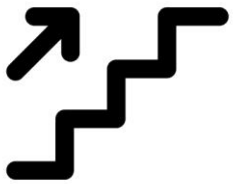
1) Steps for Each Operating Phase - Continued:

- Emergency Operations
- Normal Shutdown
- Startup:
  - Following a Turnaround
  - After an Emergency Shutdown

Operating Procedures

1. Steps for Each Operating Phase – Continued

Other Steps to Consider:



- Lockout/Tagout
- Pull-out/Pumpout/Pump Down
- Oil Draining
- Other Safe Work Practices
  - Line Opening
  - Hot Work Permit
  - Working at Height (Fall Protection)
  - Confined Space Entry
  - Electrical Safety & Arc Flash Prevention
  - Ground Disturbance

Sample - Steps for Each Operating Phase

Normal Start-Up

Company Name
City, State

Standard Operating Procedures **#1234**

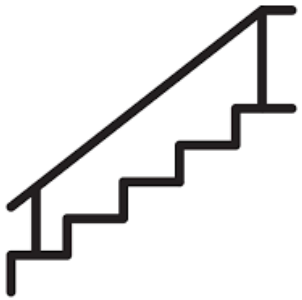
Equipment: Ammonia to Glycol Chiller

Task	Step	Awareness
2. Normal Start-Up	1. Check for flow through chiller. The glycol pump discharge pressure should be between 60 to 65 psig. 2. Check to make sure the ammonia liquid stop hand valves (HV14, HV20, HV21, HV27) are open. 3. At start-up, the refrigerant is below the level of the operating level, therefore the refrigerant liquid solenoid valves (LSV18, LSV25) will energize to feed liquid into the side of the surge drum or chiller barrel through the hand expansion valve (HXV26). OR (HXV19) The solenoid valve will remain open until the liquid level reaches the operating level of the electronic float switch and then closes. 4. As the liquid level in the chiller barrel drops below the differential (approximately 2") of the operating level, the liquid solenoids (LSV18, LSV25) will open and feed refrigerant to the chiller barrel until the reaches its operating level and shuts the liquid solenoid OFF. 5. If the refrigerant level does not reach the operating level, the hand expansion valve (HSV26) should be *slowly* opened to allow additional refrigerant flow. Adjust the hand expansion valve until there is a constant OPEN operation of the refrigerant solenoid valve by the electronic float switch at least 50% of the time. 6. Turn on power to back pressure regulator (BPRV03) using (MCP-1482) located south of the Normandy training room.	See troubleshooting to correct/avoid pressure deviations

Operating Procedures

2) Operating Limits:

- Consequences of Deviation
- Steps Required:
  - Correct Deviation
  - Avoid Deviation



Operating Procedures

2) Operating Limits (Continued)

Others Functions to Consider:

- Controls & Instrumentation
- Safety Systems & Their Functions

Sample-Operating Limit

Operating Limits, Consequence of Deviations, Steps Required to Correct And/Or Avoid Deviation Troubleshooting

Company Name
City, State

Standard Operating Procedures **# 1234**

Equipment: Ammonia to Glycol Chiller

OPERATING LIMITS

OPERATING LIMITS	CONSEQUENCES OF DEVIATIONS	STEPS REQUIRED TO CORRECT AND/OR AVOID DEVIATION TROUBLESHOOTING
Glycol Return Temperature: Target: 41°F Range: 34°F to 42°F Glycol Feed Temperature: Target: 26°F Range: 25°F to 28°F	Higher or lower temperatures could shutdown the Normandy line because the product fill temperatures may not be within range.	1. Check the cooling water system upstream of the glycol chiller. 2. Check the glycol temperature control system. For example, ensure that the pressure regulator control system is in high side vs. low side mode. 3. Check the ammonia level control system for the surge drum.
Refrigerant Operating Level: Target: 20% Range: 10%(low) to 80%(high)	Lower operating levels could cause higher glycol temperatures (see above for consequences of higher glycol temperatures). Higher operating levels could flood the surge drum and send liquid ammonia to a transfer system. The resulting machine room floodback which could damage compressors if left unchecked. In addition, there could be higher glycol temperatures (see above for consequences of higher glycol temperatures).	1. Check the sight glass to confirm level in the surge drum. 2. Check the level transmitter, make-up solenoid valves and manual valves to make sure they are functioning and set up correctly.
Refrigerant Operating Pressure: Low Side Range: 40 to 45 psig High Side Range: 60 to 65 psig	Higher or lower temperatures could cause higher or lower glycol temperatures (see above for consequences of higher or lower glycol temperatures).	1. Check the pressure gauges on the regulators to confirm the pressure. 2. Ensure that the pressure regulator control system is in high side vs. low side mode and is functioning properly.
Glycol Pump Discharge Pressure: Range: 60 to 65 psig	Lower pressures, which could be caused by low glycol floe rates, could cause higher glycol temperatures (see above for consequences of higher glycol temperatures). Lower pressures/flows could also cause freezing in	1. Check pressure gauge on the discharge side of the pump to confirm the pressures. 2. Check to make sure that the glycol circulation system (pump, valve, etc.) is set up correctly. 3. Check the glycol make-up (jockey) pump and the glycol Make-up tank.

Sample-Operating Limit

Controls & Instrumentation

Company Name
City, State

Standard Operating Procedures **# 1234**

Equipment: Ammonia to Glycol Chiller

CONTROLS & INSTRUMENTATION

CONTROLS & INSTRUMENTATION	FUNCTIONS	SETPOINT
Surge drum level control system	The electronic level control system (LE34) is designed to open/close the operating feed solenoid (LSV25) as necessary to control the level in the surge drums.	20% (setpoint is adjustable on the level control system)
Glycol temperature control system (low side mode)	I/P control system is designed to control the operating back pressure regulator (BPRV03) in the surge drum suction line as necessary to control glycol supply temperature (TE478059) at the setpoint when the control system is set up in the low side mode. Note that the back-up (secondary) pressure regulator (BPR10) can be used as the operating regulator if necessary.	Glycol supply temperature: 26°F to 28°F
High side pressure control system (high side mode)	The operating back pressure regulator (BPRV03) goes to the higher pressure setpoint when the control system is set up in the high side mode. Note that the system is typically put in high side mode during shutdown or clean-up conditions.	Suction pressure setpoint: 60 to 65 psig

Sample- Operating Limit

Safety Systems and Their Functions

Company Name
City, State

Standard Operating Procedures **# 1234**

Equipment: Ammonia to Glycol Chiller

SAFETY SYSTEMS AND THEIR FUNCTIONS

SAFETY SYSTEMS	FUNCTIONS	SETPOINT
Glycol supply high temperature alarm (82912)	The high temperature alarm will give a visual alarm (flashing light) in the Normandy area when the setpoint is reached.	26°F glycol supply temperature. 26°F to 28°F
Back-up (secondary) back pressure regulator (BPRV10)	The back-pressure regulator will open to the suction header if pressures in the surge drum increase above the setpoint.	60 to 65 psig
Surge drum rupture disc and pressure relief valves (PSV30/32)	The rupture disc and pressure relief valves will open and vent ammonia to the atmosphere when the setpoints are reached.	Rupture disc: 200 psig Relief valve: 250 psig
Plate heat exchanger rupture disc and pressure relief valves (PSV 47/48)	The rupture disc and pressure relief valves will open and vent ammonia to the atmosphere when the setpoints are reached.	Rupture disc: 200 psig Relief valve: 250 psig
Oil pot rupture disc and pressure relief valves (PSV55/54)	The rupture disc and pressure relief valves will open and vent ammonia to the atmosphere when the setpoints are reached.	Rupture disc: 200 psig Relief valve: 250 psig
High and low level alarms (LE34)	The electronic level controller will provide audible and visual alarms on the PC in the control room if the setpoints are reached.	High level alarm: 18" Low level alarm: 4:
High level float cutout (LCH37)	The high-level float will close the high-level feed solenoid (LSV24) when the setpoint is reached.	22"
Excess flow system on main liquid feed header to the glass filling area	A PC will automatically stop the supply of liquid to the entire glass filling area (including this chiller) if the setpoint is reach. The system can also be manually activated.	Flow exceeds 10% of normal flow volume
Ammonia detector in glycol chiller room	If ammonia concentrations reach the warning setpoint, there will be audible and visual alarms on the PC in the control room.	Warning setpoint: 20 ppm ammonia Alarm setpoint: 50 ppm ammonia Evacuation setpoint: 75 ppm

Operating Procedures

3) Safety and Health Considerations:

- Properties of Chemical Used
- Hazards Presented by Chemical Used
- Precautions Necessary to Prevent Exposure:
  - Engineering Controls
  - Administrative Controls
  - Personal Protective Equipment (PPE)

Operating Procedures

3) Safety and Health Considerations - Continued:

- Control Measures:
  - Physical Contact
  - Airborne Exposure
- Quality Control:
  - Raw Materials
  - Chemical Inventory Levels

Operating Procedures

3) Safety and Health Considerations - Continued:

- Special or Unique Hazards
- Safety Systems and Their Functions:
  - Interlocks
  - Detection Systems
  - Suppression Systems

Sample - Safety and Health Considerations

Compan
City, State

Date of Field Review:	
Date of Mgmt. Review:	
Initials:	

Standard Operating Procedures **# 1234**

Equipment: Ammonia to Glycol Chiller **Model:** N/A **Drawing No:** 441345-L 1044-26

Department: Refrigeration **Equip. No:** 12345 **Ref. #** #1GC-Name

Location: Facility Location Name

Operator: Refrigeration Operator

Refrigerant: R 717 (Ammonia, NH_3)

SAFETY AND HEALTH CONSIDERATIONS

Hazards & Properties of Ammonia:

Ammonia is a colorless gas or liquid with an extremely pungent odor. It is a gas at room temperature and has a boiling point of -33°C (-28°F) and a freezing point of -78°C (-108°F). When ammonia is in it's vapor phase, it is lighter than air and has a vapor density of 0.60 (Air = 1). When ammonia exists as an aerosol, it is heavier than air (vapor density >1.0).

Ammonia is considered a high health hazard. If inhaled, it is pungent and can be suffocating. It is extremely irritating to the mucous membranes and to lung tissue. Repeated or prolonged contact to concentrations greater than 400 ppm can cause permanent injury or death. However, because of ammonia's low odor threshold (approximately 20 ppm) and pungent odor, people will seek relief from its effects at much lower concentrations. Contact of vapors or liquid can cause skin burns and eye irritation. When heated, toxic nitrogen oxides are produced. Ammonia has fire and explosion limits of 16% to 25% if a source of ignition is present.

Sample - Safety and Health Considerations

Compan, ...
City, State

Standard Operating Procedures **# 1234**

Equipment: Ammonia to Glycol Chiller

Ammonia Safety Precautions

Wear **RUBBER GLOVES, SPLASH GOGGLES AND A FACE SHIELD** when performing work where there is the potential that ammonia could be released, for example, when pumping out oil or charging ammonia to the system. Have **RESPIRATORY PROTECTIVE EQUIPMENT** available as a back-up when working in an area with a noticeable ammonia smell. Always follow line opening procedures when performing maintenance or other procedures that require opening of any part of the system. Use the buddy system on all procedures where it applies.

Ammonia First Aid: "Control Measures to be taken if physical contact or airborne exposure occurs:"

In case of **EYE** contact:	Flush eyes with water for at least 15 minutes. Exposed person should be evaluated at the medical department.
In case of **SKIN** contact:	Wash affected skin areas thoroughly with soap and water. Exposed person should be evaluated at the medical department.
In case of **INHALATION**:	Remove subject to uncontaminated area. If breathing has stopped or is labored, call emergency number 3333/3003. Request medical assistance.

Sample - Safety and Health Considerations

Company Name
City, State

Standard Operating Procedures **# 1234**

Equipment: Ammonia to Glycol Chiller

Quality Control for Raw Materials:

Ammonia Manufacturer/Provider name here - Sole Source Vendor.
Closed Loop Systems.

Control of Hazardous Chemical Inventory levels.

Continuous monitoring of ammonia receiver levels.
Ammonia purchasing history.
Closed loop system.

Related Documents:

Material Safety Data Sheets Manuals (MSDS)
Lockout/Tagout Procedures (LOTO)
Routine Equipment Inspections (MTS Sheets)
Hazmat Integrated Contingency Plan (ICP)

Operating Procedures

Another Item to Consider:

- Piping & Instrumentation Diagrams

(P&IDs)

Sample - Safety and Health Considerations

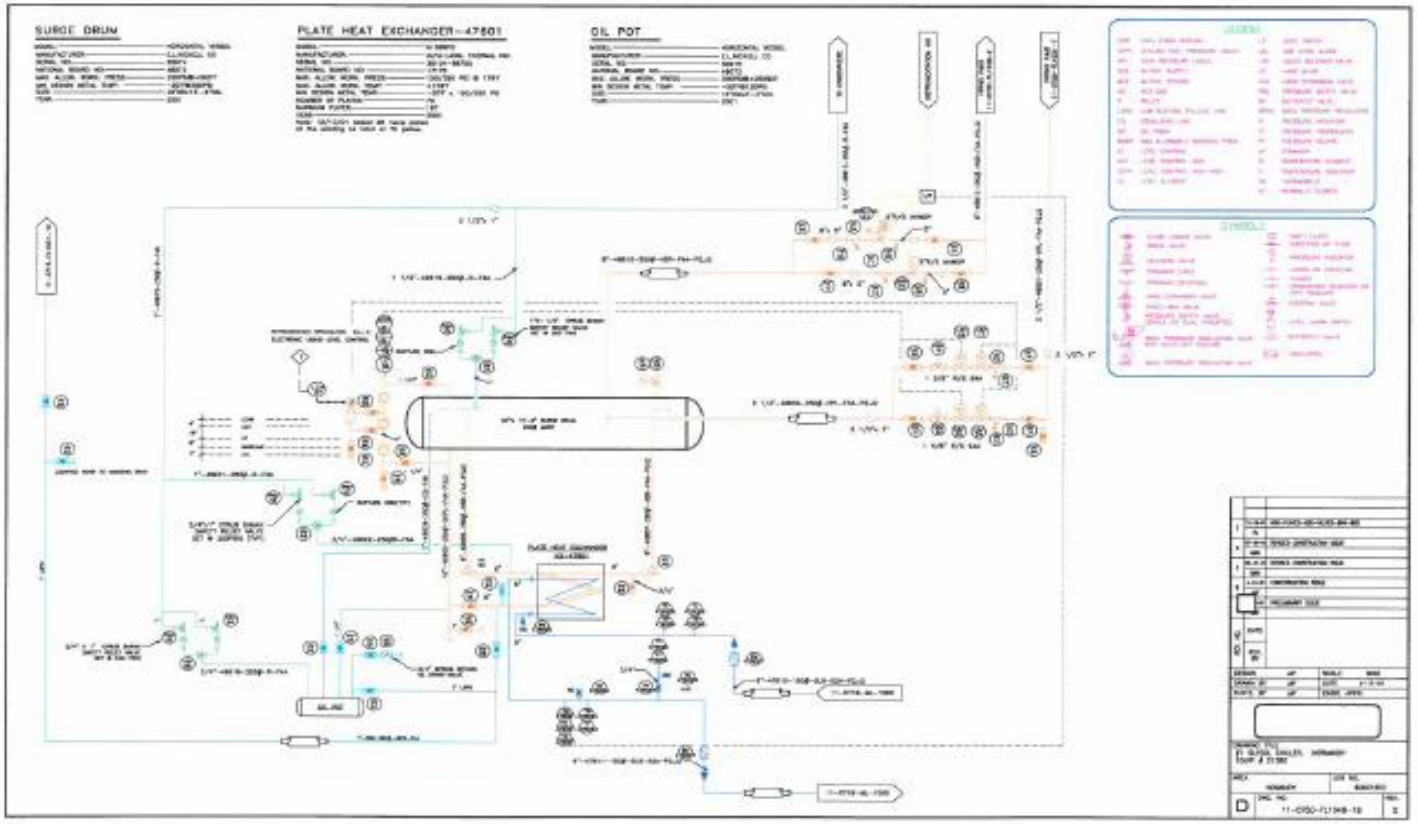
Company Name
City, State

Piping & Instrumentation Diagram (P&ID)

Standard Operating Procedures **#1234**

Equipment: Ammonia to Glycol Chiller

Task	Step	Awareness
12. Procedures to	1. Use the following procedures to turn the back-up (secondary) pressure	



Operating Procedures

Must Be:

- Readily Accessible to Employees
  - Operate Process
  - Maintain Process – Mechanical Integrity
    - ✓ PSM 1910.119 (j)

✓ Forms Foundation for Needed Training

✓ Ensures Status of Procedures:

- Ready
- Up-to-Date

Operating Procedures

Maintain Process – Mechanical Integrity

- OSHA believes it is important to maintain the mechanical integrity of critical process equipment to ensure it is designed and installed correctly and operates properly.
- The employer must establish and implement written procedures to maintain the ongoing integrity of process equipment.

Operating Procedures

Maintain Process – Mechanical Integrity

- Employees involved in maintaining the ongoing integrity of process equipment must be trained in an overview of the process and its hazards and trained in the procedures applicable to the employee's job tasks.

Operating Procedures

Maintain Process – Mechanical Integrity

- Inspection and Testing must be performed on process equipment, using procedures that follow:

"Recognized And Generally Accepted Good Engineering Practices"

RAGAGEP

Operating Procedures

Must Be:

- Reviewed Periodically:
  - Reflect current operating practices
  - Reflect current changes
- Guard Against:
  - Outdated
  - Inaccurate

Operating Procedures

The employer
must certify annually
that their operating procedures are
current and accurate.

Operating Procedures

The employer
must develop and implement
"Safe Work Practices"
to provide for the control of hazards
during work activities.

Operating Procedures

Standard Operating Procedures (SOP's)

for Operations

Consider Language Capabilities:

- Where Not Fluent in English
- Develop Procedures in Required Language(s)
- Procedures Must be Understood by Workers

Operating Procedures

"Safe Work Practices"

Such As:

- Lockout/Tagout
- Confined Space Entry
- Hot Work Permit (PSM Element)
- Work at Height (Fall Protection)
- Electrical Safety & Arc Flash Prevention
- Line Opening
- Ground Disturbance

Thank you!

Questions and Answers (Q & A)

ACADEMY OF NATURAL REFRIGERANTS

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