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CONDENSER

IIAR OPENS 2025 CONFERENCE REGISTRATION

Event Highlights Technical Advances, Thought Leadership

IIAR 2025 NATURAL REFRIGERATION CONFERENCE & HEAVY EQUIPMENT EXPO

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08 COVER story

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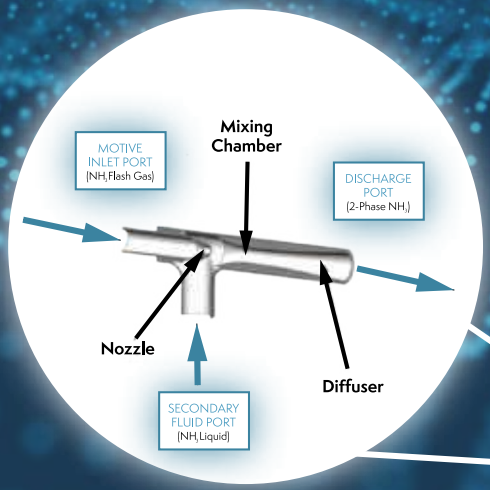

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Technical Papers Provide In-Depth Thought Leadership at the IIAR Conference

During the annual IIAR Industrial Refrigeration Conference & Exhibition, industry experts will present technical papers for the IIAR Technical Program, as well as a range of topics.

"Sustainability and decarbonization topics are of great interest and many topics are related to this," said Eric Smith, IIAR's vice president and technical director. "There are several papers about the use of heat pumps and heat recovery, which is directly related to sustainability."

While all the papers will provide valuable industry insights, Smith said there are several that are especially timely.

"EPA's New RMP Requirements and Suggestions for Compliance" by Bill Lape will cover a new compliance initiative EPA will be implementing. Smith said Lape has good ideas on how the industry can meet the new requirements.

Sustainability is a global concern, and the natural refrigerant industry can help companies meet regulatory requirements and their corporate goals.

"Livin' la Vida LOPA: A Case Study of the Application of HAZOP and LOPA for Ammonia Refrigeration Systems" by Michael Lacher will demonstrate a different way to accomplish hazard analysis. "The industry mostly uses what if/checklist for hazard analysis, but Layer of Protection Analysis could prove to be a more effective approach," Smith said. "This report on the author's experience could provide valuable insight."

Sustainability is a global concern, and the natural refrigerant industry can help companies meet regulatory requirements and their corporate goals. However, businesses must remain profitable when implementing sustainability goals. Travis Townsend covers this in his paper "Promoting Sustainability While Remaining Competitive and Profitable."

TECHNICAL PAPERS *at a glance*

Each technical paper presented at IIAR's annual conference is full of specific, actionable information about the refrigeration industry. Here is a full list of the available papers:

Refrigeration System Design Using Float Expansion Valves, Todd Jekel

Encontrando el balance entre consumo energético y de agua condensadores y torres de enfriamiento, Karel Israel Ortiz Rayas (presented in Spanish)

EPA's New RMP Requirements and Suggestions for Compliance, Bill Lape

Lessons Learned from a Collection of Ammonia Incident Investigations, C'Anna Wiens

Livin' la Vida LOPA: A Case Study of the Application of HAZOP and LOPA for Ammonia Refrigeration Systems, Michael Lacher

Using Scorecards to Manage and Improve Your RMP/PSM Program, Nikolaus Despain

Lubricant Selection and Oil Management Strategies for CO2 Systems, Giacomo Pisano

Applications of Ammonia and CO2 for Decarbonization and Markets Other Than the Food & Beverage Industry, Paul Danilewicz

How to Optimize your PSM Program, Eli Macha

CO2 Heat Pumps: System Solutions and Applications Mapping, Ivan Rangelov

Sustainable Solutions for Agricultural Cold Storage, Tania Herrera, Dan O'Brien

Connecting Cooling and Process Heating in Industrial Applications with Natural Refrigerants, Felix St-Germain

Decarbonizing with District Energy Systems – When an R744 (CO2) Heat Pump is the Obvious Choice, Parham Eslami-Nejad

Understanding Industry Needs in Water Treatment, James Booth

Cloud-Based Refrigeration Systems: Who's Really in Control?, James Majsak

Field Performance Assessment of Low Temperature Blast Freezing Systems, Eric Alar

Promoting Sustainability While Remaining Competitive and Profitable, Travis Townsend

Alternative Approach to Emergency Ventilation Calculations, Bill Greulich

IIAR OPENS 2025 CONFERENCE REGISTRATION

Event Highlights Technical Advances, Thought Leadership

IIAR's 2025 Natural Refrigeration Conference & Expo will take place in Phoenix, Arizona, from March 2-5, offering the natural refrigerant industry valuable technical knowledge, networking opportunities, and industry-sponsored events.

“We have the largest exhibit hall in the history of IIAR, including heavy equipment, with two full mornings and one evening of exhibit hall time. The conference will feature quality educational sessions and plenty of social networking times, and we are continuing our focus on attracting end users and students,” said Gary Schrift, president of IIAR.

EMPHASIZING EDUCATION

IIAR’s 2025 conference will feature numerous in-depth learning opportunities. “We have almost double the number of sessions as those of past conferences and have designed the educational program to appeal to many needs by creating six educational tracks, including system design, system safety, decarbonization, facility management, heat pumps, and an introduction to refrigeration/natural refrigerant basics," Schrift said.

With nearly 40 educational sessions this year—a record for IIAR—Eric Smith, IIAR vice president and technical director, said there will be something to learn for everyone. "Our refrigeration 101 track should prove to be valuable to those who are new or interested in the industry," he said, adding that the introductory track will be especially useful to students attending the conference and give them an overview of the industry.

Robert Billot, a U.S. environmental attorney, will offer a keynote address. “He will be discussing how PFAS, a forever chemical, polluted a town in West Virginia from Dupont’s Teflon plant and how chemical companies are currently dismissing the presence of PFAS chemicals in many of the new HFO refrigerants that they are promoting as replacements for their high GWP HFC synthetic refrigerants,” Schrift said.

The closing forum will provide a panel dedicated to lessons for end-users. “Our end users are the ones who directly use refrigeration, and all of the manufacturers, contractors, consultants and indeed other end users would be interested in hearing about end user concerns and solutions to their operational needs,” Smith said.

In addition to the panels, industry experts will present in-depth technical papers and workshop sessions that cover critical industry issues, including safety, efficiency, and new technology. The conference’s educational program offers professional development hours to all attendees. Plus, all technical sessions will be recorded, and recordings will be free for all members and attendees.

“You can watch the sessions you'd like to attend in person, and then you'll have access to the recordings throughout the year to watch what you didn't see,” said Yesenia Rector, IIAR’s annual conference and expo, meetings, and international program director.


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FORGING CONNECTIONS

The conference kicks off with the Natural Refrigeration Foundation's (NRF) Golf Tournament on Saturday, March 1, at the Arizona Grand Golf Course. Then, on Sunday, March 2, we will have the IIAR Committee meetings throughout the day. Also, on Sunday afternoon, participants can take part in NRF Bingo. The foundation deviated from pickleball and cornhole, which has featured in the past because the facilities weren't available. "We thought bingo would be a fun, inexpensive way for people to support the NRF," Rector said.

Attendees will have numerous opportunities to connect during various networking events, including the Chairman's Reception, an invitation-only VIP dinner for the IIAR and NRF Board, committees, NRF scholars, and other VIPs, and a fun-filled evening at Billiards and Bowling for all attendees. Attendees can also take advantage of the NRF Networking Lounge, which will be located near the technical program meeting spaces and will be open on Sunday, Monday, and Tuesday afternoons during the education program sessions. "The lounge is a space people can visit to take a break between the education program sessions, work, relax, or sit down and have an espresso," Rector said.

ENGAGING STUDENTS

The 2025 conference will continue to welcome students, encouraging university and technical college students to engage with industry leaders and learn more about career paths in natural refrigeration. NRF Scholarship recipients and any student attendees are invited to attend the full event, free of charge, where they can network with IIAR executives, board members, and exhibitors who will help them explore the showroom and introduce them to industry professionals.

ADVANCING CRITICAL INITIATIVES

Committee meetings will take place on Sunday, March 2. These meetings provide a forum for IIAR members to contribute to the organization's in-depth work. "We have shortened all of the committee meetings to one or two hours maximum so that most could be held on Sunday and so that members could attend more than one committee meeting," Schrift said. "The committee chairs use these meetings each year to mainly provide a committee initiatives update to all."

The 2025 IIAR Annual Conference in Phoenix promises a comprehensive experience for all attendees, blending technical learning with ample opportunities for networking and professional growth.

Students can attend the conference for free. First-time attendees and end users will receive IIAR membership pricing for conference registration, regardless of whether they are IIAR members or not. "Please help spread the word about these opportunities," Smith said.

View the IIAR 2025 Conference detailed schedule online.

The 2025 conference will continue to welcome students, encouraging university and technical college students to engage with industry leaders and learn more about career paths in natural refrigeration.

iiar® 2025 NATURAL REFRIGERATION CONFERENCE & HEAVY EQUIPMENT EXPO

IIAR Reaches End-Users and Contractors at Mexico Conference

IIAR had a successful three-day conference and expo in Guadalajara, Mexico, with 14 countries participating and a record number of attendees, including a large percentage of end-users and contractors.

“More than 30% of attendees were end users, and about 33% were contractors. That means about 65% of the people attending are those in the industry who will be installing, working on, and maintaining these systems," said Yesenia Rector, IIAR’s annual conference and expo, meetings and international program director. "Education is tied to safety, and we want to ensure the accepted, recognized engineering practices in the industry are communicated.”

While everyone in the refrigeration industry is essential, Rector said the end users are on the front lines, using the systems. “They are the ones who are going to implement our practices and ensure these systems are ultimately safe,” she explained.

IIAR's chapter in Mexico, with the support of IIAR USA, organized the event. “We had 125 companies participating and a total of almost 400 attendees,” Rector said, adding that more than 30 exhibitors took part in the conference, up from 26 at the last Mexico conference.

The education program consisted of over 12 technical presentations over two days. The third day featured a system maintenance presentation and a hands-on maintenance and equipment workshop. “That was very successful, and we had great reviews about it.”

IIAR also held a similar event in Costa Rica in in mid -November, in collaboration with their longstanding allied association, CIEMI. IIAR’s conference in Peru will be held the first week of June 2025, and the next conference in Mexico will take place in 2026.

"We have a new chair for the Mexico IIAR chapter, Robert Badillo from Danfoss. He will lead the 2026 event planning with the support of Frederico Alarcon, IIAR’s Latin American administrator. More information is to come,” Rector said.

Natural refrigerants, including CO2, are gaining traction in Latin America. IIAR has successfully supported standards in Latin America, but Rector said there is still a little way to go In Mexico.

“In Mexico, for reasons that I still cannot understand, it has been difficult,” she explained. “I think the regulatory agencies are rather scattered, making it challenging to establish a point of contact or determine where to start.”

IIAR has focused on training within the industry while continuing to reach out to key individuals and key agencies to support efforts to establish national standards in Mexico.

"Education is tied to safety, and we want to ensure the accepted, recognized engineering practices in the industry are communicated.”

EPA Launches Region 10 Initiative for Facilities Under 10,000 lbs of Ammonia

The Environmental Protection Agency has launched an initiative in the Pacific Northwest to improve the safety of smaller ammonia refrigeration facilities – focused on facilities with under 10,000 pounds of ammonia.

The initiative, which is being carried out by EPA Region 10, was developed with input from EPA Region 1 and the International Institute of All-Natural Refrigeration. It is aimed at improving compliance with the General Duty Clause of Section 112(r) of the Clean Air Act. Section 112(r) specifies that owners and operators of stationary sources producing, processing, handling, or storing extremely hazardous substances, including anhydrous ammonia, have the duty to reduce the risk of chemical accidents.

While there are three duties required by the General Duty Clause, EPA Region 10 said its initiative would focus on the first, which is to "identify hazards which may result from accidental releases using appropriate hazard assessment techniques."

FIND THE EPA FACT SHEET HERE

FIND THE IIAR ENFORCEMENT AWARENESS OVERVIEW HERE

Region 10 recently released a fact sheet on their planned initiative, which they said was based on previous Region 1 work. The fact sheet specifically references "trade association resources," which is a notable indication of the work IIAR has done in informing EPA enforcement actions by providing a body of tailored resources and information to IIAR members and non-members looking to interpret their obligations under the new action.

IIAR has also released an enforcement awareness overview of General Duty Clause requirements to help IIAR member and non-member facilities understand how to comply with the Region 10 initiative.

"EPA is providing advance notice of an upcoming enforcement initiative so that you can take steps now to avoid a penalty before the initiative begins," EPA Region 10 said in the fact sheet, adding that, "Trade associations may be able to help you find experienced consultants and hazard identification materials."

EPA Region 10 said its initiative will follow a three-phase (1) information request, (2) settlement, and (3) follow-up process.

In the (1) information request phase, EPA said it would send brief, targeted information requests to selected facilities that it had reason to believe may be out of compliance. Facilities will be required to respond to EPA answering four questions about their ammonia refrigeration systems, including whether a process hazard review (or an equivalent assessment using an appropriate hazard technique) has been performed. If a facility has not performed the required hazard review or equivalent assessment, the EPA will inform the facility that it has violated the first duty of the General Duty Clause.

The EPA said that it has already begun preliminary investigations into compliance with the General Duty Clause by facilities that it believes has fewer than 10,000 pounds of ammonia, with the primary focus of the initiative being facilities with more than 1,000 pounds of ammonia.

In the (2) settlement request phase, EPA said that it would offer to resolve a violation for a discounted penalty, provided the company agrees to perform a hazard review or equivalent assessment of its system with the help of an expert and provided that a significant release has not occurred at the facility. If a violation has been found, the company will also be required to meet with emergency responders and submit any missing Tier II forms.

In the (3) follow-up phase, EPA said it will inspect a small subset of facilities to determine if the initiative has improved compliance with the General Duty Clause.

EPA Region 10 cited a February 2015 enforcement alert as the origin of its recent initiative, saying that "Some of the most dangerous facilities that EPA

inspected were not aware of the hazards that their refrigeration systems posed to the public, emergency responders, and employees." EPA Region 10 added that "The Environmental Protection Agency (EPA) would like to work with facilities that have ammonia refrigeration systems to improve their safety, protect workers and the public from exposure to toxic gas, and avoid product losses."

The IIAR said it is working closely with EPA Region 1 and Region 10 to help the agency accomplish its goals – to communicate EPA's initiatives to members and non-members and deliver compliance resources and guidelines.

"The Environmental Protection Agency (EPA) would like to work with facilities that have ammonia refrigeration systems to improve their safety, protect workers and the public from exposure to toxic gas, and avoid product losses."

"IIAR's work with EPA Region 10 on this initiative is vital to IIAR's mission to uphold the industry's high safety standards and continually improve the safety of ammonia refrigeration systems both in the United States and around the world," said IIAR president Gary Schrift.

He added that IIAR is working closely with EPA Region 10 to communicate compliance resources that members and non-members may quickly reference as they determine how they will comply with the Region 10 initiative.

IIAR said it would help EPA Region 10 launch its initiative by sending email communication to all member and non-member contacts to outline the ways IIAR can help support ammonia refrigeration facilities that will be subject to the Region 10 initiative. These include:

1. IIAR PUBLICATIONS:

1. ARM (Ammonia Refrigeration Management) Program Guidelines and Templates ComplianceGuidelines_IIAR_Publications_Catalog_2024_Final-2.pdf
2. Critical Task Guidance for Ammonia System Emergency Planning. ComplianceGuidelines_IIAR_Publications_Catalog_2024_Final-2.pdf
3. Guide for Estimating NH3 Releases and the excel program ComplianceGuidelines_IIAR_Publications_Catalog_2024_Final-2.pdf
4. IIAR 1 thru IIAR 9 Ammonia Refrigeration Design and Operational Standards -all are **FREE to Members** Standards_IIAR_Publications_Catalog_2024_Final-3.pdf
5. Tech Papers – Various publications over the years on many Process Hazard/PHA issues. – **FREE to Members** Technical Papers (iiar.org)

2. ONLINE TRAINING:

1. ANR (Academy of Natural Refrigerants) – Planning and Performing an Effective PHA – **FREE to Members** Education ANR Certificate Courses (iiar.org)
2. ANR – ARM Ammonia Refrigerant Management Program – **FREE to Members** Education ANR Certificate Courses (iiar.org)
3. Series II – The IIAR Ammonia Refrigeration Safety Training Program – **FREE to Members** – Education Training Series (iiar.org)
4. Partner Programs – Fundamentals of Mechanical Integrity 2023 – Education Partner Training Programs (iiar.org)
5. Conference Technical Session Recordings – some Process Hazard related (for 2024 and moving forward – **FREE to Members**) hub & space (mosaic-apps.com)
6. Webinars (live and recorded) – **Free to Members** – IIAR Member Webinars – some recent webinars on the subject include" "General Duty Clause Requirements: Enforcement Awareness," and "General Duty Clause Requirements: Identifying Hazards Using Appropriate Hazard Assessment Techniques."

EPA Region 10 said any facility wishing to contact the agency with questions on the initiative should reach out directly to the initiative managers, Wren Ganey, or Mhara Coffman at: (ph) 206-553-0528.

IIAR encouraged any members looking for more information on the General Duty Clause or for further guidance on the EPA Region 10 initiative to reference the overview email outlining the EPA announcement and IIAR's resource guide or to call IIAR directly at 703-312-4200 with any questions.

"Net Zero GWP or extremely low GWP natural refrigerants are the best solution for a warming world, and this collaboration between EPA Region 10 and IIAR highlights one of the core reasons IIAR exists – to expand their use by informing regulatory actions and ensuring the safety of natural refrigerants both here in the US and around the world," said Schrift. "IIAR is excited to participate in this initiative and ready to help any facility looking for more information on compliance."

"IIAR's work with EPA Region 10 on this initiative is vital to IIAR's mission to uphold the industry's high safety standards and continually improve the safety of ammonia refrigeration systems both in the United States and around the world."

EPA fact sheet

Compliance Assurance and Enforcement Focus

The following fact sheet was published by the Environmental Protection Agency Region 10 to communicate details about the Region 10 compliance initiative for facilities under 10,000 pounds of ammonia. It is reproduced here for the benefit of IIAR members and non-members with facilities under 10,000 pounds of ammonia.

AMMONIA: AN EFFICIENT REFRIGERANT THAT MUST BE SAFELY MANAGED

While anhydrous ammonia has many environmental and operational benefits, it is also an extremely hazardous substance that, if accidentally released, presents a significant health hazard because it is corrosive to the skin, eyes, and lungs. Ammonia is also flammable at certain concentrations in air.

EPA inspection photo reveals dangerous ice buildup on ammonia piping and valves.

HOW SAFE IS YOUR REFRIGERATION SYSTEM?

Accidental releases of ammonia from refrigeration facilities have injured or killed people. See https://www.epa.gov/sites/production/files/2015-02/documents/112renforcementalert.pdf

Some of the most dangerous facilities that the EPA inspected were not aware of the hazards that their refrigeration systems posed to the public, emergency responders, and employees.

DOES YOUR FACILITY USE AMMONIA REFRIGERATION?

The Environmental Protection Agency (EPA) would like to work with facilities that have ammonia refrigeration systems to improve their safety, protect workers and the public from exposure to toxic gas, and avoid product losses.

NOTICE OF COMPLIANCE ASSURANCE AND ENFORCEMENT INITIATIVE

EPA is providing advance notice of an upcoming enforcement initiative so that you can take steps now to avoid a penalty before the initiative begins.

The initiative will focus on ammonia refrigeration facilities using fewer than 10,000 pounds of anhydrous ammonia to enhance their compliance with the General Duty Clause of Section 112(r) of the Clean Air Act ("CAA"), 42 U.S.C. §(r)(1), and with Section 312 of the Emergency Planning and Community Right-to-Know Act (EPCRA), 42 U.S.C. § 11022. Failure to comply with these requirements puts the public at risk of exposure to anhydrous ammonia.

COMPLIANCE HELP

Go to https://www.epa.gov/enforcement/compliance-assistance-tools-and-resources-ammonia-refrigeration-sector for a list of compliance resources, including guidance documents and links to refrigeration-related trade associations.

HOW CAN I COMPLY WITH THE GENERAL DUTY CLAUSE (GDC)?

The goal of Section 112(r) of the Clean Air Act, 42 U.S.C. § 7412(r), is to reduce the risk of chemical accidents. Owners and operators of stationary sources producing, processing, handling, or storing extremely hazardous substances, including anhydrous ammonia, must:

1. identify hazards which may result from accidental releases using appropriate hazard assessment techniques;

2. design and maintain a safe facility, taking steps to prevent releases; and,

3. minimize the consequences of accidental releases that do occur. For more information on the General Duty Clause: https://www.epa.gov/sites/production/files/documents/gendutyclause-rpt.pdf.

This initiative focuses on the first duty listed above. Conduct a comprehensive hazard review of your refrigeration system to comply with the duty to identify hazards. Appropriate hazard identification techniques include standard industry checklists and What-if analyses. See the above link for more information. Trade associations may be able to help you find experienced consultants and hazard identification materials.

HOW WILL EPA'S INITIATIVE WORK?

Information Request: EPA has begun preliminary investigations into compliance with the General Duty Clause by facilities that it believes have fewer than 10,000 pounds of ammonia. The primary focus of this initiative is facilities with more than 1,000 pounds of ammonia. EPA will send a brief, targeted information request to selected facilities that it has reason to believe may be out of compliance.

Facilities will be required to respond to EPA answering four questions about their ammonia refrigeration systems, including whether a process hazard review has been performed. If a facility has not performed the required hazard review, the EPA will inform the facility that it has violated the first duty of the General Duty Clause.

Settlement: Unless a significant release has occurred at the facility, EPA will offer to resolve this violation for a discounted penalty, provided the company agrees to perform a hazard review of its system with the help of an expert. The company will also be required to meet with emergency responders and submit any missing Tier II forms.

Follow-up: EPA will inspect a small subset of facilities to determine if the initiative has improved compliance with the General Duty Clause.

HOW CAN I COMPLY WITH EPCRA?

Section 312 of EPCRA requires facilities to report the presence of certain chemicals, including anhydrous ammonia, to emergency planning and response agencies. The goal is to ensure that emergency responders and planners know what chemicals are on site should they need to respond to an incident and that people in the community can get information about chemicals in their neighborhood.

WHAT CAN I DO NOW TO AVOID A PENALTY?

If you haven't already done so, conduct a process hazard review. Companies that respond to the Information Request indicating that a hazard review has already been performed will not need to take further action under this initiative. To avoid EPCRA penalties, see if you qualify for penalty relief under EPA's Audit Policy. Go to https://www.epa.gov/compliance/epas-audit-policy#_bookmark3 for more information and to https://www.epa.gov/compliance/epas-edisclosure for EPA's web-based "e-Disclosure" portal.

EPCRA Inventory Forms (Tier II forms) are due annually by March 1.

For more information about EPCRA reporting, go to: https://www.epa.gov/epcra.

IIAR ENFORCEMENT AWARENESS:

General Duty Clause Requirements

Identify Hazards Using Appropriate Hazard Assessment Techniques

The United States EPA National Enforcement and Compliance Assurance Program implemented several national compliance initiatives (NCIs) effective for FY2020-2023. One of these NCIs is titled "Reducing Risks of Accidental Releases at Industrial and Chemical Facilities ."IIAR has received notice from the EPA and several end-users that one area of their focus is to determine whether facilities using hazardous chemicals have conducted a hazard analysis. The EPA is citing the Clean Air Act Section 112(r), which establishes the regulations of the Risk Management Program for facilities using large quantities of hazardous substances. EPA also cites the General Duty Clause, which is also a part of CAA 112(r) and applies to facilities that use any quantity of hazardous substances. In addition to its process safety management (PSM) regulations, the US Occupational Safety and Health Administration (OSHA) also enforces a general duty clause that requires a hazard analysis.

Most IIAR members will likely have a hazard analysis in place. However, if your facility does not, we encourage you to get this done soon. If you are a contractor, a consultant, or sell equipment or other goods, we encourage you to pass the word to your end-user clients, especially those with smaller facilities that might not have a hazard analysis in place.

At a minimum, a hazard or safety review is required and must be done for an ammonia refrigeration system "NO MATTER WHAT SIZE IT IS."

There are many IIAR members who can assist with establishing a hazard analysis and the other elements of a refrigeration management program, and IIAR offers several publications to aid in establishing a program based on the relative size of the system.

Here is more information about the general duty clauses for both OSHA and the EPA:

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) GENERAL DUTY CLAUSE (GDC):

Section 5(a)(1) of the Occupational Safety and Health Act (the "General Duty Clause") requires:

"Each employer shall furnish each of its employees with employment and a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees."

Employers can be cited for violation of the General Duty Clause if a recognized serious hazard exists in their workplace and the employer does not take reasonable steps to prevent or abate the hazard. The General Duty Clause is used only where there is no standard that applies to the particular hazard. The following elements are necessary to prove a violation of the General Duty Clause:

a. The employer failed to keep the workplace free of a hazard to which employees of that employer were exposed;

b. The hazard was recognized;

c. The hazard was causing or was likely to cause death or serious physical harm, and

d. There was a feasible and useful method to correct the hazard.

United States Environmental Protection Agency (US EPA) General Duty Clause (GDC):

Under the Clean Air Act Section 112(r)(1), the General Duty Clause states: "The owners and operators of stationary sources producing, processing, handling or storing such substances [i.e., a chemical in 40 CFR part 68 or any other extremely hazardous substance] have a general duty [in the same manner and to the same extent as the general duty clause in the Occupational Safety and Health Act (OSHA)] to identify hazards which may result from (such) releases using appropriate hazard assessment techniques, to design and maintain a safe facility taking such steps as are necessary to prevent releases, and to minimize the consequences of accidental releases which do occur."

THE OSHA AND US EPA GENERAL DUTY CLAUSES APPLY TO ALL SYSTEMS, SMALL OR LARGE:

OSHA's Process Safety Management (PSM) Standard 1910.119 and US EPA's Risk Management Plan (RMP) 40 CFR Part 68 requires a Process Hazard Analysis (PHA) for systems with 10,000 lbs or more of ammonia in a refrigeration system.

A system with less than 10,000 lbs but more than 500 lbs requires a hazard review at a minimum.

A system with 500 lbs or less requires a safety review and/or an environmental safety evaluation, at a minimum.

Due to the General Duty Clauses, all systems, no matter the size, require a hazard or safety review for an ammonia refrigeration system that will, at a minimum, "identify hazards which may result from releases using appropriate hazard assessment techniques."

It is of utmost importance to inform an employer, owner, operators, and clients, who have or are planning for an ammonia refrigeration system "to identity hazards which may result from releases using appropriate hazard assessment techniques."

The hazard techniques can be one or more of the following methodologies that are appropriate to determine and evaluate the hazards of the process being analyzed:

(i) What-if;

(ii) Checklist;

(iii) What-if/Checklist (most widely used for ammonia refrigeration systems)

(iv) Hazard and Operability Study (HAZOP);

(v) Failure Mode and Effects Analysis (FMEA);

vi) Fault Tree Analysis (FTA); or

vii) An appropriate equivalent methodology

TO MEET COMPLIANCE:

IIAR's Process Safety Management & Risk Management Program Guidelines & Templates can be used to meet General Duty Clause (GDC) & regulatory compliance for systems with 10,000 lbs or more of ammonia refrigerant.

IIAR's Ammonia Refrigeration Management (ARM) Guideline & Templates can be used to meet General Duty Clause (GDC) requirements for systems with less than 10,000 lbs but more than 500 lbs of ammonia refrigerant.

IIAR's Low Charge Ammonia Refrigeration Management (ARM-LC) Guidelines and Summary Guideline can be used to meet General Duty Clause (GDC) requirements for systems with less than 500 lbs.

Any questions, please contact your qualified refrigeration contractor (designer/installer/servicer), compliance service provider, or the IIAR (www.iiar.org).

EPA ENFORCEMENT INITIATIVE:

EPA is providing advance notice of an upcoming enforcement initiative so that you can take steps now (to avoid a penalty before the initiative begins. The initiative will focus on ammonia refrigeration facilities using fewer than 10,000 pounds of anhydrous ammonia to enhance their compliance with the General Duty Clause of Section 112(r) of the Clean Air Act ("CAA"), 42 U.S.C. §(r)(1), and with Section 312 of the Emergency Planning and Community Right-to-Know Act (EPCRA), 42 U.S.C. § 11022.

The goal of Section 112(r) of the Clean Air Act, 42 U.S.C. § 7412(r), is to reduce the risk of chemical accidents. Owners and operators of stationary sources producing, processing, handling, or storing extremely hazardous substances, including anhydrous ammonia, must:

1. identify hazards which may result from accidental releases using appropriate hazard assessment techniques;
2. design and maintain a safe facility, taking steps to prevent releases, and
3. minimize the consequences of accidental releases that do occur.

This initiative focuses on the first duty (1.) listed above. Conduct and document a comprehensive hazard review of your refrigeration system to comply with the duty to identify hazards. See the list above for appropriate hazard identification techniques.

HOW WILL EPA'S INITIATIVE WORK?:

Information Request: EPA has begun preliminary investigations into compliance with the General Duty Clause by facilities that it believes have fewer than 10,000 pounds of ammonia. The primary focus of this initiative is facilities with more than 1,000 pounds of ammonia. EPA will send brief, targeted Information Requests to selected facilities that it has reason to believe may be out of compliance. Facilities will be required to respond to EPA answering four questions about their ammonia refrigeration systems, including whether a process hazard review has been performed. If a facility has not performed the required hazard review, the EPA will inform the facility that it has violated the first duty of the General Duty Clause.

Settlement: Unless a significant release has occurred at the facility, EPA will offer to resolve this violation for a discounted penalty, provided the company agrees to perform a hazard review of its system with the help of an expert. The company will also be required to meet with emergency responders and submit any missing Tier II forms.

Follow-up: EPA will inspect a small subset of facilities to determine if the initiative has improved compliance with the General Duty Clause.

THE EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT (EPCRA):

EPCRA was authorized by Title III of the Superfund Amendments and Reauthorization Act (SARA Title III) and was passed in 1986 in response to concerns regarding the environmental and safety hazards posed by the storage and handling of toxic chemicals.

Section 312 of EPCRA requires facilities to report the presence of certain chemicals, including anhydrous ammonia, to emergency planning and response agencies. The goal is to ensure that emergency responders and planners know what chemicals are on site should they need to respond to an incident and that people in the community can get information about chemicals in their neighborhood.

EPCRA Inventory Forms (Tier II Forms) are due annually by March 1st.

For more information about EPCRA reporting, go to: https://www.epa.gov/epcra.

New York's Cap-and-Invest Proposal Could Aid the Transition to Low-GWP Refrigerants

New York has introduced the Cap-and-Invest Program to help the state achieve the greenhouse gas emission reduction requirements outlined in the State's Climate Leadership and Community Protection Act.

The program would set an annual cap on greenhouse gas emissions, which declines over time. A portion of the proceeds from the purchase of emissions allowances would fund the Climate Investment Account, which would support the transition to a less carbon-intensive economy.

"By providing funding to support the transition to low global warming potential (GWP) refrigerants, the Cap-and-Invest Program has the potential to accelerate the adoption of natural refrigerants statewide," said Danielle Wright, executive director of the North American Sustainable Refrigeration Council. "The funds would help New York State businesses get ahead of regulatory pressures and achieve corporate climate commitments by offsetting the cost of transitioning to future-proof natural refrigerants."

Low-carbon buildings have been identified as a proposed sectoral investment area for the Climate Investment Account. "That sector would include assistance to food retail stores located in disadvantaged communities to transition to low GWP refrigerants," Wright said. "This would open up opportunities for those funds to also support the transition for industrial and cold storage facilities in the future."

In a letter supporting the initiative, Gary Schrift, IIAR's president, wrote that the necessary standards, training and expertise are readily available for a safe and reliable transition to natural refrigerants and away from high global warming HFC refrigerants in both cooling and heat pump systems.

While HFCs were once considered a suitable replacement for ozone-depleting substances, Schrift wrote that they are super-polluting greenhouse gases and one of the most potent drivers of climate change. "Pound for pound, HFCs trap thousands of times more heat in the atmosphere than CO2," he explained.

Classified as short-lived climate pollutants (SLCPs), HFCs have a disproportionate impact on warming in the near term, making their mitigation significantly more urgent than other GHGs. "In New York State, HFCs make up 14% of all building sector emissions, making HFC emissions reduction one of the most powerful tools to achieve New York's mandate to reduce greenhouse gas emissions 40% by 2030 and 85% by 2050," Schrift wrote.

However, transitioning from existing HFC based refrigeration systems requires the full replacement of HFC-based refrigeration equipment with natural refrigerant equipment, representing an enormous cost to owners and operators. This cost burden is particularly challenging for small and independent food retailers and food retailers operating in disadvantaged communities.

"These businesses often lack the financial resources to transition their stores, risking increased costs to consumers, store closures, and the emergence of food deserts," Schrift said in the letter, adding that once businesses have transitioned to natural refrigerants, which are future-proof, systems will be functional for years.

Funding support is a critical solution to unlock the tremendous emissions savings potential of transitioning existing refrigeration facilities to low-GWP refrigerants. However, Wright said low-carbon buildings are one of many proposed sectoral investment areas for the Climate Investment Account, which means it is competing for funds.

"At this stage, letters of support are one of the most impactful opportunities to underscore the importance of incorporating refrigeration into the Cap-and-Invest Program," Wright said. "DEC and NYSERDA are still accepting comments on the program. I would encourage all stakeholders from the refrigeration industry to submit a comment of support that highlights the need for investment in the transition to low-GWP refrigerants."

Comments can be submitted at https://capandinvest.ny.gov/. Public input will inform the development of a regulatory proposal. Once that proposal is issued, there will be another public comment period before the final regulation is issued.

GOVERNMENT RELATIONS

BY LOWELL RANDEL, IIAR GOVERNMENT RELATIONS DIRECTOR

REGULATORY OUTLOOK
Under the Next Trump Administration

The 2024 election delivered Donald Trump a victory in the Electoral College, along with Republican majorities (albeit by thin margins) in both the House and Senate. As the President-Elect prepares to return to the White House he is beginning to bring forward nominees for key government posts that may shed light on regulatory policies impacting the industrial refrigeration industry. There are also clues from his first term about how a Trump Administration will address regulations.

On the campaign trail, Trump talked about the need to address burdensome regulations. His platform, titled "Agenda 47," also references the overregulation. The first point under Chapter Three of the platform states that “Republicans will slash regulations that stifle jobs, freedom, innovation and make everything more expensive.” Deregulation was also a theme of Trump's first term, where he instituted policies to limit the growth in regulation, such as requiring the removal of two regulations for every new regulation put in place. While it is unclear whether he will follow that same policy in his second term, it appears that tackling overly burdensome regulations will be on his agenda.

A usual practice of all new administrations is to issue a directive to withdraw all pending regulations of the previous administration and to defer the effective dates of recently published regulations. The Trump administration is also expected to rescind executive orders signed by Biden that are counter to Trump’s policy priorities. Rules completed late in the Biden term could also be subject to cancellation under the Congressional Review Act.

New to the second term will be an effort led by Elon Musk and Vivek Ramaswamy to establish a Department of Government Efficiency. Not many details are known as to how the new organization will operate, but both Musk and Ramaswamy have talked about the need to evaluate and pare back the current regulatory framework.

Below is an analysis of the regulatory outlook for two agencies with regulations impacting the industrial refrigeration industry, the Occupational Safety and Health Administration (OSHA) and Environmental Protection Agency (EPA).

OSHA

Under the previous Trump Administration, OSHA went the full term without a confirmed Assistant Secretary for OSHA. This appeared to limit major policy changes within the agency. However, the agency did shift toward less stringent regulatory actions and a greater focus on compliance assistance over punitive measures and high-profile press releases highlighting enforcement actions against employers. This approach is expected again in the next Trump Administration. It is also likely that recent Biden initiatives will be reviewed and possibly rolled back.

Some anticipated actions include:

- Emphasizing compliance assistance and expanding programs that encourage OSHA-employer collaboration, including Alliance, Strategic Partnership, Voluntary Protection, Challenge, and On-Site Consultation Programs.
- Reducing the use of press releases and data-sharing, likely with a more measured approach to public communications, including the severe injury dashboard.
- Reevaluating enforcement practices from the previous administration, potentially modifying policies such as instance-by-instance citation application and criteria for the Severe Violator Enforcement Program.

New to the second term will be an effort led by Elon Musk and Vivek Ramaswamy to establish a Department of Government Efficiency.

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 (continued from page 18)

Pending OSHA rulemakings that could be impacted:

- Changes to Process Safety Management remain on the agency's regulatory agenda. However, much like during Trump's first term, it is not expected that OSHA will move forward with the rulemaking process.
- President Trump may reconsider OSHA's "Worker Walkaround Representative Designation Process" rule, which allows some third-party representatives in inspections. The rule is also being challenged in the courts.
- The proposed "Heat Injury and Illness Prevention" rule, which has yet to be finalized, is not likely to move forward in its current form and could be scrapped in favor of guidance instead of regulation.
- The proposed "Emergency Response Standard" is still in the rulemaking process and could be shelved by the new administration, particularly given concerns about the rule's clarity and potential burden.
- The "Improve Tracking of Workplace Injuries and Illnesses" rule could also be revisited. The policy exemplifies regulatory shifts across recent administrations, impacting consistency in reporting requirements for employers and OSHA's policy direction.

Enforcement will continue as the new administration takes shape, but priorities will shift at the federal level. In response to some of these rollbacks and shifting priorities on the federal level, some states, like California, may intensify their enforcement efforts.

EPA

Trump has selected former Rep. Lee Zeldin from New York to lead the EPA. Zeldin has indicated that deregulation will be a top priority for him as EPA Administrator. A substantial shift in the EPA's focus is expected, marked by decentralized regulatory power at the federal level, a pivot toward fossil fuels, and fewer initiatives focused on climate change and environmental justice. This approach could reduce regulatory costs for businesses and influence international efforts aimed at reducing global emissions. In the previous Trump Administration, the U.S. pulled out of the Paris Climate Agreement, and there is potential to see similar withdrawals from international climate negotiations and commitments.

The Trump administration previously sought to reduce the EPA's budget by up to 30%, although Congress ultimately approved fewer cuts. Trump also froze hiring and aimed to reduce staff levels. Similar efforts are expected in his second term.

In his first term, Trump moved to reconsider the changes in the Risk Management Program (RMP) finalized by the Obama Administration. It is possible that history will repeat itself with the recent RMP changes instituted by the Biden Administration. The latest RMP Rule, "Safer Communities by Chemical Accident Prevention" was finalized in February 2024, but the compliance date for most provisions is not until 2027. The new EPA leadership could consider additional rulemaking to revise or rescind the Biden era RMP rule.

While it is widely expected that many climate policies will be rolled-back under the Trump Administration, it is not clear how that will impact regulations under the American Innovation & Manufacturing (AIM) Act. The AIM Act passed with bipartisan support and also has support from industry. These factors may keep AIM Act policies off the list of high priority roll backs.

As the transition to the new Trump Administration continues, IIAR will be closely monitoring developments, engaging with policy makers, and advocating for policies beneficial to the industry.

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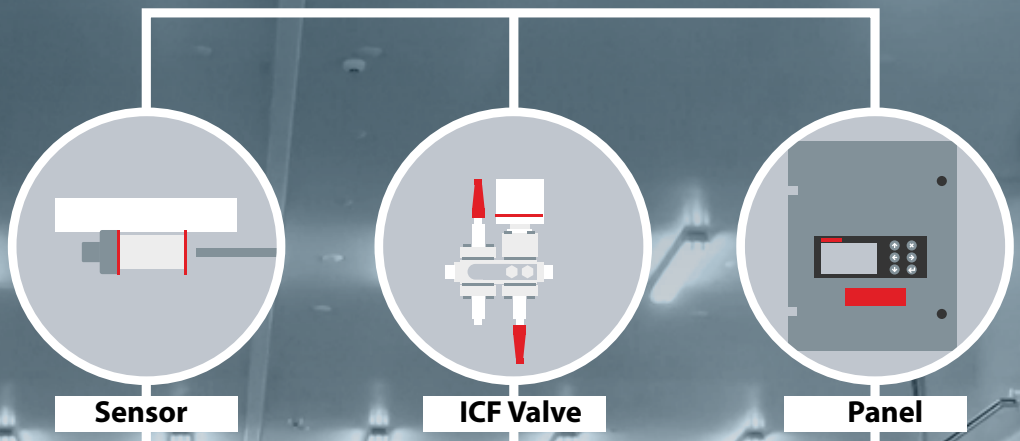

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How Cold is That Wind?

BY KEM RUSSELL

Sometimes, lessons need to be repeated, which can be a good thing depending on the experience you are going through for the lesson. Even tough lessons can help. As we slide into winter and the La Nina projections for the coming months, an experience I had last year was a lesson learned about "cold."

While skiing, an Arctic storm brought in not just more snow but also very cold temperatures and wind, which really affected the skiing conditions. This particular time it was so cold that even low temperature ski wax didn't help my skis to slide. The skis were slow and sticking to the snow. In addition, due to the -10°F temperature and the 20 to 30 mph wind, the end of my nose, and my skin below my goggles suffered the effects of wind chill known as frostbite.

So, what is this "wind chill"? We experience wind chill as a natural event and also use this effect in refrigeration.

Wind chill has been around since the dawn of time, and people experienced it, but this concept of wind chill wasn't developed till two U.S. researchers, Paul Siple, and Charles Passel, did tests they carried out during a U.S. Antarctic Service Expedition from 1939 to 1941. Their work examined the effect of wind in speeding up how quickly water froze in plastic cylinders. The resulting data on heat loss enabled Siple and Passel to estimate how quickly exposed skin might chill down at wind speeds of various strengths.

During my recent skiing adventure, I accidentally repeated the "water frozen in a plastic" bottle experiment. After about three hours, I returned to my car to eat lunch and found that my 700 ml plastic water bottle was nearly frozen solid. I took off the cap, and what little water was left splashed out onto the center console of my car, where it almost instantly froze. It was cold! With the outside temperature and the wind, the car struggled to heat up. Even after 35 minutes, the car temperature gauge barely rose above the cold mark!

What's happening with the cold temperatures and the wind effect?

Whether it's your body or a product you want to cool, they both contain heat. In this case, we are looking at the conditions where the inside is warmer than the environment. There is a thin boundary layer of warmer air just outside of you or the product. If air is moved across the surface, that boundary layer is disturbed, with this warmer boundary layer moving away from you or a product in the direction of the air movement. The heat inside is continually transferred to the boundary layer as long as there is some temperature difference between the outside environment and the inside. This boundary layer heat transfer process is convective cooling. In addition, moisture is also drawn to the surface of and possibly a product that adds to the cooling effect through evaporation.

One important fact to remember is that the final temperature of an object (you or a product) will be close to the temperature of the environment, not the wind chill factor.

The speed of the wind over the surface will affect the rate at which interior heat in you or a product is removed. When Paul Siple and Charles Passel did their Antarctic research they measured the heat loss from the water container in watts per square meter. Although informative for the research data this is not a heat loss rate that most people can easily relate too.

While wind chill is a commonly reported measurement in weather forecasts in the winter, it is somewhat problematic. One of the primary issues with measuring wind chill is that there is no global standard for determining the value. Another concern is that wind chill calculations do not account for factors such as relative humidity and solar radiation (solar heating on a bright day can somewhat counter the wind chill effect). Despite these issues, wind chill is still widely used and included in weather forecasts because, historically, the purpose of a wind chill index was to provide an indicator of the potential of getting frostbite.

Canadian meteorologists and not many other people used the wind chill formula from Siple and Passel until the 1970s, when they and their fellow meteorologists began converting it to the familiar temperature equivalents that allow forecasters to say, "It's 20 degrees this morning, but it feels like 4 out there."

With further research the wind chill formula was modified in 2001 after data was collected from volunteers who had temperature sensors placed on their faces and inside their mouths to measure heat loss. The volunteers were exposed

One important fact to remember is that the final temperature of an object (you or a product) will be close to the temperature of the environment, not the wind chill factor.

to various temperatures (as low as 14°F) and wind speeds (as high as 18 mph). The tests resulted in the wind chill chart that is presently used. See below.

The values in this scale tended to run higher (less extreme) for a given temperature and wind speed than the previous version of the scale. One reason is the height at which the wind is measured. The old formula used standard temperature measurements, taken at a height of around 6 feet (2 meters), together with wind measurements that are typically taken at 33 feet (10 meters). However, friction near the ground tends to reduce the wind speed to 6 feet (2 meters), which also happens to be close to the height of a typical adult's face.

The revised formula:

- It is based on a human face model,
- Incorporates modern heat transfer theory,
- Lowers the calm wind threshold to ≤ 3 mph,
- Uses a consistent standard of skin tissue resistance and
- Assumes the worst-case scenario for solar radiation (clear night sky)

Notice on the wind chill chart that across the top temperature is "°F", and down along the left side wind speed is in "mph". However, the numbers within the chart are actually expressed in temperature "like units", which nearly everyone is more familiar with. The wind chill index is not actually a real temperature but, rather, represents the feeling of cold on your skin.

The wind chill index chart could "generally" be applied to the resultant refrigerating effect on products being cooled. If using convective cooling, the temperature of the cold air exiting an evaporator and the airspeed going over the product gives a wind chill factor that results in a faster rate of heat removal than just being exposed to the environmental temperature in "still" air. Think, for example, of a blast freezer, tunnel freezer, or spiral freezer. Very low air temperature exits the evaporator, and there is high air velocity in a contained space where the air is directed to pass across all of the product in the space. Product heat is removed fairly quickly, which helps maintain product quality and increase the quantity of products being processed.

As more research is done, with improved measurement techniques and better-computerized calculations, the wind chill index will probably again be revised to give more "close to reality" effects. For the wind chill effect on humans, revision may take some time due to the variations in people. Large, small, muscular, or not-so-muscular all have an effect on how wind chill impacts a person. The bottom line is that this winter, dress appropriately for the conditions, and if it seems too cold, stay where it's warm. This isn't rocket science; it's just cold, hard fact . . . literally.

The wind chill index chart could "generally" be applied to the resultant refrigerating effect on products being cooled.

Temperature (°F)

Wind (mph)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
	5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
	10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
	15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
	20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
	25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
	30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
	35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
	40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
	45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
	50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
	55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
	60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes | 10 minutes | 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph) *Effective 11/01/01*

IIAR Presents at RETA's Annual Conference

IIAR recently presented the sessions IIAR Suite of Standards Update and Summary of Natural Refrigerants Codes & Standards at the RETA National Conference.

"RETA and IIAR simultaneously are marching/striving to continuously improve the refrigeration industry for its design, installation, startup, inspection, testing, and maintenance, as well as decommissioning where applicable, through training to make the refrigeration systems using natural refrigeration to continue in a safe manner," said Tony Lundell, IIAR's senior director of standards and safety.

The IIAR Suite of Standards Update covered the latest information on the nine ammonia refrigeration standards, IIAR 1 through IIAR 9, as well as the IIAR CO2 Standard and the IIAR HC Standard in development.

The Summary of Natural Refrigerants Codes & Standards covered the latest on a roadmap for the SNAP (Significant New Alternatives Policy) team approval for natural refrigerants. The session also covered ammonia, carbon dioxide, and natural hydrocarbon refrigerants and their occupancies. The IIAR HC standard is filling a gap for unlisted system applications that are larger than typical listed appliances. The standard will enable officials at the EPA SNAP Team to have a comprehensive safety standard to reference when considering expanding SNAP approval for hydrocarbon refrigerant applications.

Lundell, who facilitated the development of the standards, gave each of the presentations twice during the conference and led a question-and-answer session after each presentation.

RETA selected the topics from a provided list, and Lundell said attendees were eager to understand the latest status of where each standard is and what is happening with natural refrigerants. "The refrigeration industry amongst RETA and IIAR has many working persons that become enriched in understanding the latest information for natural refrigerant standards," he explained.

IIAR and RETA have also worked together to provide virtual presentations, including those in Africa, Wisconsin, Florida and Pennsylvania, as well as presentations at various RETA chapter meetings.

Lundell added that IIAR also delivered multiple presentations at Trident Seafoods during their PSM Conference, at the RefriAmericas event, and at the Ice Packing International Association meeting. "IIAR will plan to provide future presentations at RETA and other events," he said.

The standard will enable officials at the EPA SNAP Team to have a comprehensive safety standard to reference when considering expanding SNAP approval for hydrocarbon refrigerant applications.

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IIAR STANDARDS UPDATE

BY TONY LUNDELL, CIRO, PMP, IIAR SENIOR DIRECTOR OF STANDARDS AND SAFETY

IIAR 1: ANSI/IIAR 1-2022 Standard for Definitions and Terminology Used in IIAR Standards is presently in effect. It will be opened up for review starting in mid-2026 for its next revision with a targeted completion with ANSI approval in 2027. Rich Merrill serves as the IIAR 1 subcommittee chair and Tony Lundell, senior director of standards and safety at IIAR, is the IIAR staff facilitator. An IIAR 1 future revision considerations (FRC) list has captured suggestions and considerations for its next revision.

IIAR 2: ANSI/IIAR 2-2021 Standard for Design of Safe Closed-Circuit Ammonia Refrigeration Systems is presently in effect. It will be opened up for review in late 2024 for its next revision with a targeted completion with ANSI approval in 2027. Mark Bazis Jr. is the IIAR 2 subcommittee chair, Eric Smith is vice president and technical director at IIAR, and Matt Chojnacki, Tony Lundell and Eric Smith are the IIAR staff facilitators. An IIAR 2 FRC list has captured suggestions and considerations for its next revision.

IIAR 3: ANSI/IIAR 3-2022 Ammonia Refrigeration Valves is presently in effect. It will be opened up for review starting in mid-2026 for its next revision with a targeted completion with ANSI approval in 2027. Michael Trumbower is presently the IIAR 3 subcommittee chair, and Lundell is the IIAR staff facilitator. This standard provides minimum "performance criteria" requirements for ammonia refrigeration valves and strainers that are used in closed-circuit ammonia refrigeration systems. AN IIAR 3 FRC list has captured suggestions and considerations for its next revision.

IIAR 4: ANSI/IIAR 4-2020 Standard for the Installation of Closed Circuit Ammonia Refrigeration Systems is presently in effect. It will be opened up for review starting in early-2025 for its next revision with a targeted completion with ANSI approval within 2025. Brian Alleman is the IIAR 4 Subcommittee Chair.. Lundell is the IIAR staff facilitator. An IIAR 4 FRC list has captured suggestions and considerations for its next revision.

IIAR 5: ANSI/IIAR 5-2019 Standard for the Startup of Closed-Circuit Ammonia Refrigeration Systems is presently under revision. The IIAR 5 Subcommittee reviewed the comments and questions that were received in the pre-public review. The second (2nd) Public Review ended on October 25, 2024, receiving comments that are being reviewed. A third public review is targeted to occur in late 2024/ early 2025. The IIAR 5 revision is targeted for its completion with ANSI approval in early 2025. Nick Nechay serves as the IIAR 5 subcommittee chair, and Lundell is the IIAR staff facilitator. The revision addresses the standard to harmonize items with IIAR 2, IIAR 4, IIAR 6, and IIAR 7.

IIAR 6: ANSI/IIAR 6-2019 Standard for Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems is presently under revision. The IIAR 6 Subcommittee reviewed the comments and questions that were received in the pre-public review. "Functional Testing" of equipment, components, and/ or devices to clarify expected results was included, and an "out of service" section was added to sustain the minimum requirements of IIAR 6 while a closed-circuit ammonia refrigeration system is shut down for an off-season, such as down/off seasons for fruit and/or vegetable harvesting or for down/off seasons for fish catching (seafood). The second public review ended on October 25, 2024, and comments were received that are being reviewed. A third public review is targeted to occur in late 2024/ early 2025. The IIAR 6 revision is targeted for its completion with ANSI approval in early 2025. Jeff Sutton is the IIAR 6 subcommittee chair, and Lundell is the IIAR staff facilitator. The revision addresses the standard to harmonize items with IIAR 2, IIAR 4, IIAR 5, and IIAR 7.

IIAR 7: ANSI/IIAR 7-2019 Standard for Developing Operating Procedures for Closed-Circuit Ammonia Refrigeration Systems is presently under revision. The IIAR 7 Subcommittee reviewed the comments and questions that were received in the pre-public review. Several discussions have occurred to address regulated (i.e., PSM/RMP systems, larger systems with 10,000 lbs. or more) and non-regulated (i.e., General Duty Clause, smaller systems with less than 10,000 lbs.) sized closed-circuit ammonia refrigeration systems and addressed normative material versus informative/explanatory material. The first public review is targeted to be completed by yearend in 2024, and the ANSI Approval is targeted for completion by early-to-mid 2025. Lesley Schafer is the IIAR 7 subcommittee chair, and Lundell is the IIAR staff facilitator. The revision addresses the standard to harmonize items with IIAR 2, IIAR 5, and IIAR 6.

IIAR 8: ANSI/IIAR 8-2020 Standard for Decommissioning of Closed-Circuit Ammonia Refrigeration Systems is presently in effect. It will be opened up for review starting in early-2025 for its next revision with a targeted completion with ANSI approval within 2025. Lesley Schafer is presently the IIAR 4 subcommittee chair and Lundell is the IIAR staff facilitator. AN IIAR 8 FRC list has captured suggestions and considerations for its next revision.

IIAR 9: ANSI/IIAR 9-2020 Standard for Minimum System Safety Requirements for Existing Closed-Circuit Ammonia Refrigeration Systems recently had an Addendum A developed to address a scope change and an interpretation, provide a clear compliance deadline, address some simple edits, and provide an informative flow chart. Also, an IIAR 9 Checklist was developed as a tool. It will be opened up for its next revision with a targeted ANSI approval within 2025. Eric Johnston is the IIAR 9 subcommittee chair, and Lundell is the IIAR staff facilitator.

CARBON DIOXIDE (IIAR STANDARD):

IIAR CO2: ANSI/IIAR CO2-2021 Safety Standard for Closed-Circuit Carbon Dioxide Refrigeration Systems is presently in effect. It will be opened up in early-to-mid 2025 for its next revision. John Collins is the IIAR CO2 subcommittee chair and Lundell is the IIAR staff facilitator.

HYDROCARBONS (STANDARD IN DEVELOPMENT):

IIAR HC: IIAR HC-202x Safety Standard for Closed-Circuit Refrigeration Systems Utilizing Hydrocarbon Refrigerants is a standard presently in development. This standard pertains to utilizing "natural" hydrocarbon refrigerants that have zero ozone-depleting potential and ultra-low global warming potential. The committee reviewed and developed responses to one-hundred-sixty-one (161) comments received during the first public review. Joseph Pillis is the IIAR HC subcommittee chair, and Lundell is the IIAR staff facilitator. The IIAR HC's second public review started on October 25, 2024, and ended on December 9, 2024. Comments received from the second public review will be addressed and shown in the IIAR HC public review No. 3 in early 2025. This standard in development is targeted for an ANSI Approval within 2025.

Attendees at RETA's Conference Take Advantage of IIAR 6 Certification

IIAR held its first IIAR-6 certificate course at the 2024 RETA National Conference in October. The course features seven modules and covers everything from the purpose of the standard to safety systems.

"The course permitted a focused time to cover the entire course with great input that brought the registrant's knowledge and skill to a higher level for inspecting, testing, and maintenance of closed-circuit ammonia refrigeration systems," said Tony Lundell, IIAR's senior director of standards and safety.

Course participants must sequentially pass quick-check quizzes after each of the seven modules and then pass a final test in order to receive the certification.

Lundell led the course and was also involved with developing the standard. He said holding the course during the conference allowed registrants to focus on IIAR 6 without the risk of interruptions they would likely face if trying to complete it during working hours at their employer locations. Plus, they could ask each other questions as registrants or of Lundell as the instructor.

Course participants must sequentially pass quick-check quizzes after each of the seven modules and then pass a final test in order to receive the certification. Because the training was held in person, registrants had the added benefit of being able to raise their hand during each of the module reviews to ask questions, as well as being able to ask for a better understanding of what a quiz or test question was truly asking and receive clarification in a timeline manner.

"The IIAR had external support ready and on call during the entire training period. This included David Sainato, director of education, and member services manager, Lisa Berryman," Lundell said.

This was the first time IIAR provided an Academy of Natural Refrigerant Certificate Course in a classroom setting. The course ran over the course of three days—October 19-21—and was scheduled to harmonize with other RETA course's breakfasts, coffee breaks and lunches taking place during the conference.

All 26 participants passed the certification course. "The registrants can clearly see the IIAR 6 Standard's purpose and can support details of it at a new level than before," Lundell said. "Many verbal thank you's of appreciation were received directly after class or during the RETA Conference on Tuesday through Thursday, as well as some emails providing positive feedback and thank you's shortly after."

Lundell said his biggest takeaway from the session is that those in the refrigeration industry are interested in additional education to improve their working skills and sustain the ammonia refrigeration systems for their employers. "It clearly appears that more of the focused certificate courses can be done at future conferences and for companies that have multiple persons to be trained at their company locations," he said.

While this was the first time IIAR offered an Academy of Natural Refrigerant (ANR)

Certificate Course, the association has provided multiple presentations during each RETA Conference. Based on the feedback, Lundell said it is more than likely that future certification courses will be offered at RETA conferences. Training is also available for individual companies that request such and can be considered to be arranged at regional locations to provide training for multiple organizations at once.

SEE THE IIAR 6 CERTIFICATION COURSE SYLLABUS

The IIAR 6 certificate course provides detailed information on the ANSI/IIAR 6-2019 Standard for Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems and ensures those who complete it will be able to apply those requirements to a safely operated and maintained closed-circuit ammonia refrigeration system. The learning is separated into seven modules.

MODULE 1 - INTRODUCTORY MATERIAL

Module 1 reviews the introductory content of ANSI/IIAR 6-2019. This material includes the standard's purpose, scope and applicability to the inspection, testing and maintenance of closed-circuit ammonia refrigeration systems, along with key definitions. It also reviews the reference standards that informed development of the IIAR 6 standard and outlines the expected management responsibilities associated with oversight of an ITM program.

MODULE 2 - GENERAL ITM PROGRAM REQUIREMENTS

Module 2 covers minimum ITM program requirements, the relevance of recognized and generally accepted good engineering practices (RAGAGEP), addressing equipment deficiencies, frequency of ITM tasks and record keeping requirements.

MODULE 3 - ITM FOR COMPRESSORS, REFRIGERANT PUMPS AND CONDENSERS

Module 3 examines ITM tasks and indicated task frequencies for compressors, along with permitted and nonpermitted test methods for high-discharge pressure safety devices. Also addressed are ITM tasks and indicated task frequencies for refrigerant pumps and compressors.

MODULE 4 - ITM FOR EVAPORATORS AND PRESSURE VESSELS

The fourth training module in the IIAR 6 Certificate Course covers ITM tasks and indicated task frequencies for nine common types of evaporators (forced-air, shell-and-tube, plate-heat exchanger, scraped/swept surface heat exchanger, jacketed and crystallizer tanks, ice builder, bunker coil, make-up air/make-up hygienic with heat, and falling film heat exchanger). Also covered are ITM tasks and indicated task frequencies for pressure vessels, with a focus on pitting and appropriate test methods for inspection of pressure vessels.

MODULE 5 - ITM FOR PIPING AND SAFETY SYSTEMS

Module 5 begins with a look at ITM for piping, along with a focus on whether pitted or corroded piping requires further evaluation. Also addressed are ITM for transfer and non-transfer hoses, emergency ventilation systems, emergency shutdown switches, ammonia detection and alarm systems, computer-controlled safety systems, and emergency eyewash and showers.

MODULE 6 - ITM FOR OVERPRESSURE PROTECTION DEVICES, PURGERS AND AMMONIA REFRIGERANT AND SECONDARY COOLANTS

The sixth training module starts off with ITM for overpressure protection devices, with an emphasis on new guidance concerning replacement of pressure relief valves. Also addressed are ITM tasks and frequencies for purgers and ammonia refrigerant and secondary coolants.

MODULE 7 – APPENDICES

While the information found in the IIAR 6 appendices is informative and not a requirement of the standard, this seventh training module in the IIAR 6 Certificate Program provides the participant with valuable insight and interpretation into the normative text covered in the main body of the standard by reviewing the significantly expanded content of the appendices. This module covers Appendix C, "Water Contamination in Ammonia Refrigeration Systems," Appendix D, "Avoiding Component Failure in Industrial Refrigeration Systems caused by Abnormal Pressure or Shock," and Appendix E, "Risk Based Inspection, Testing and Maintenance."

FINAL CERTIFICATE EXAMINATION

The final certificate examination is given online, and no two tests are the same. To receive the certification, qualified registrants must successfully complete Modules 1-7, quick check quizzes, and the final exam, with at least 80% correct on each.

IIAR 6 CERTIFICATION PARTICIPANTS

During the RETA Conference, twenty-six individuals completed the IIAR 6 certification course. They are:

Juan Becerra, Jensen Meat

Evan Borland, Cooper River Partners LLC

Manuel Calderon, United States Cold Storage

Shawn Duffey, Mullally Bros Inc.

Doug Englebright, Mechanic Refrigeration Co. Inc.

Clayton Gasner, Gartner Refrigeration Inc.

Erich Golden, ISG Inc.

Martin Gonzalez, Kerry Inc.

Eric Hite, G&L Corp.

Clark Jackson, Gray Construction

Ricardo Jasso, United States Cold Storage

Roderick King, Kerry Inc.

Eric Mensah-Onumah, Airgas an Airliquide Co.

Deano Motes, Refrigeration Systems Construction and Service Inc.

Jameson Nuesse, E2 Industrial Refrigeration

David Paulson, McCain Foods USA

Ben Putz, Bassett Mechanical

Scott Rathman, Tyson Foods

Elliott Riley, The Brandt Companies LLC

James Royce, Wells Enterprises

Adam Stedronsky, Gartner Refrigeration Inc.

JP Stiffler, JS Compliance

Fardin Utama, Wells Enterprises

Steven Ventura, United Dairy Farmers

Nick Wisner, E2 Industrial Refrigeration

David Westerlund, McCain Foods USA

While this was the first time IIAR offered an Academy of Natural Refrigerant (ANR) Certificate Course, the association has provided multiple presentations during each RETA Conference.

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TECHNICAL PAPER #5

Cues and Confirmation Your Piping is in Jeopardy:

A COMPARISON OF 20+ YEARS OF NDT DATA WITH FIELD OBSERVATIONS

SUZY VOHSEN, DIRECTOR, MARKETING AND CLIENT SERVICES
LIXI, INC., AND GAMMA GRAPHICS SERVICES (GGS)

ABSTRACT

Ammonia refrigeration system managers are looking for more useful information regarding risk mitigation and compliance because they need to determine whether components are fit for service or vulnerable to damage, and when to act. Insulated piping is subject to corrosion under insulation (CUI), but some piping is more vulnerable depending on location, orientation, and/or function. A simple and affordable approach to regularly monitor the state of piping would be a useful tool for large industrial refrigeration facilities.

Refrigeration piping data from 20+ years of non-destructive testing (NDT) were directly compared with documented field observations, and specific physical characteristics were considered to identify patterns and validate evidence of weakness based on common factors. This quantitative information enabled the verification of primary CUI breeding locations and the presence of corrosion on bare and insulated piping.

Introduction

This paper discusses how corrosion presents on piping; common areas of susceptibility; general prevention measures; and classification and management of vulnerable areas. Armed with this material, system managers can conduct more effective assessments, make informed decisions related to prioritization and allocating funds, and avoid factors that induce corrosion. This paper will discuss the following issues:

- How CUI manifests and how to prevent it
- How to identify typical areas of susceptibility
- How to identify whether CUI is present
- How to identify whether CUI is likely to occur
- How to classify and prioritize vulnerable areas

The Greatest Threat to Piping is Corrosion

Corrosion under insulation (CUI), or external corrosion, is the primary damage mechanism that affects the integrity of ammonia piping. Moisture enters the insulation and becomes trapped against the pipe, vessel wall, or valve, and then corrosion forms on the surface. Corrosion does not exist for every instance of trapped moisture, but over time it can manifest and spread if not addressed. If left unattended, the developing corrosion gradually degrades the exterior wall of the piping, thinning the metal to the point of failure.

There is no universal solution for determining how much moisture will infiltrate the insulation or how quickly it will corrode the pipe. While some coastal regions experience higher levels of moisture contamination because of the environment, the upper and lower limits of the threat level and resulting damage varies based on many factors.

Corrosion has several predictable behaviors, including its occurrence in common areas and environments. However, biological growth on the jacketing or insulation and excessive ice build-up, which are visual indications that corrosion may be present, do not always occur. Corrosion often initiates without visual indications and persists for significant lengths of time before indications can appear, fully concealed by the jacketing and insulation that propagate it.

Moisture is usually introduced where insulation has deteriorated, at breaks in the insulation, where caulking has failed, or where damage has occurred as a result of impact, service operations, or weathering. Notably, all piping in an ammonia refrigeration system is subject to degradation, and preserving the vapor retarder is essential.

On average, 20% of aging ammonia refrigeration systems contain some level of rogue moisture in the piping insulation, but no systems exhibited moisture in 100% of the piping insulation, as seen in Figure 1. Protective measures to combat rogue moisture in the insulation have been partially effective, considering that these figures continue to decline (down from 30% in 2015). Furthermore, the lowest recorded percentage of water trapped in the ammonia piping insulation evaluated by visual inspection between June 2022 and May 2023 was ~10%, for ~40% of the systems, and the highest percentage of wet insulation was ~55%, for ~5% of the systems.

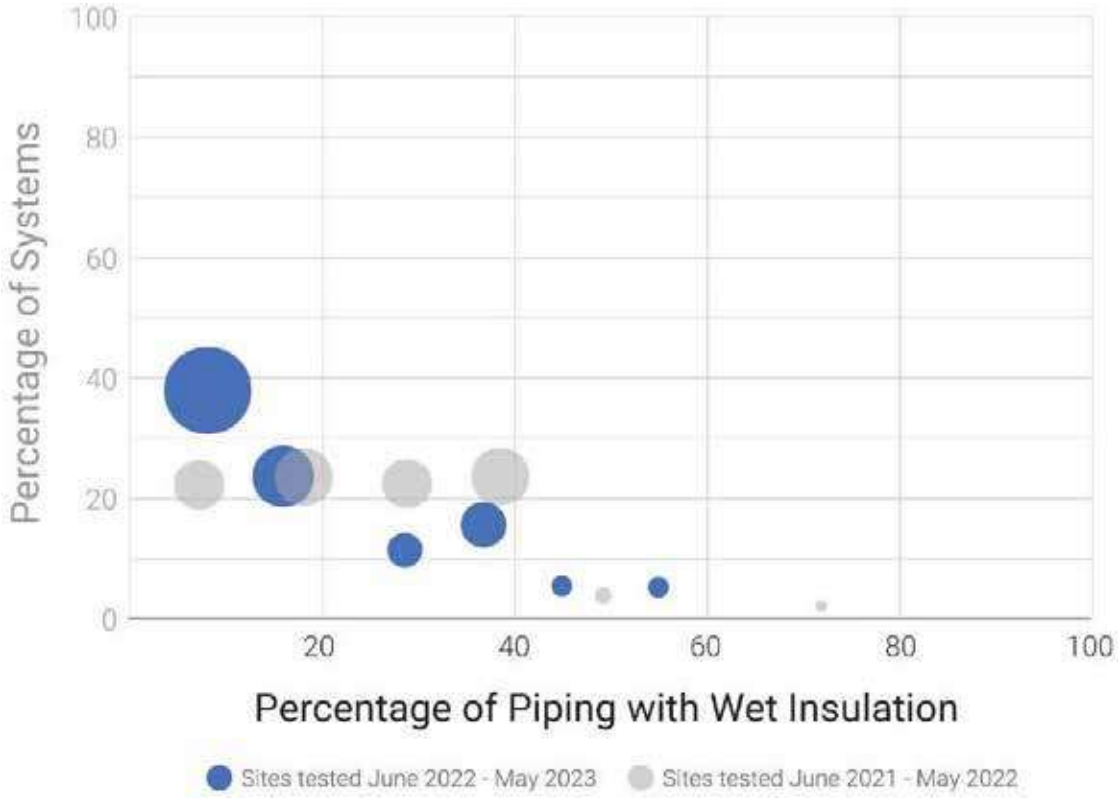


Figure 1. Based on a study of systems evaluated in the U.S. between June 2022 and May 2023.

Where CUI Degrades the Surface of the Pipe

Owing to the numerous factors involved, the progression time from moisture entering the insulation to the point of pipe failure varies widely across systems. Therefore, the rate at which external corrosion thins the pipe wall in an ammonia refrigeration system is not definitive. In particular, the ambient temperature and humidity are not constant or typically controlled. These variables also make it impossible to determine the distribution of corrosion around the circumference of the pipe. Frequently, moisture collects in concentrated areas on the pipe. Moreover, fully soaked insulation often leads to corrosion that forms evenly around the pipe, especially on vertical runs.

These conditions typically occur in thermal cycling areas, such as the section from the defrost condensate tee to the suction line, any other lines that are or will be above freezing, such as hot gas defrost lines, and equipment that is operated periodically. It is common to assume that suction lines are not susceptible because they are constantly operating below freezing. However, it only takes a few days above freezing for the ice to thaw and introduce moisture that begins to corrode the pipe. Furthermore, when these lines refreeze, they swell, and the corrosion and cracking are more destructive.

As seen in Figure 2, for example, pipe wall loss can be as high as 71% on low-temperature suction lines. In aggregate, 81% of systems exhibited pipe wall loss due to CUI on a suction line at the time of testing. Overall, 43% of the evaluated systems were reported to have areas with pipe wall loss of over 50%. The highest recorded loss, not including leaks that occurred as a result of complete metal integrity failure due to corrosion, peaked at 82% wall loss (or 18% remaining wall thickness).

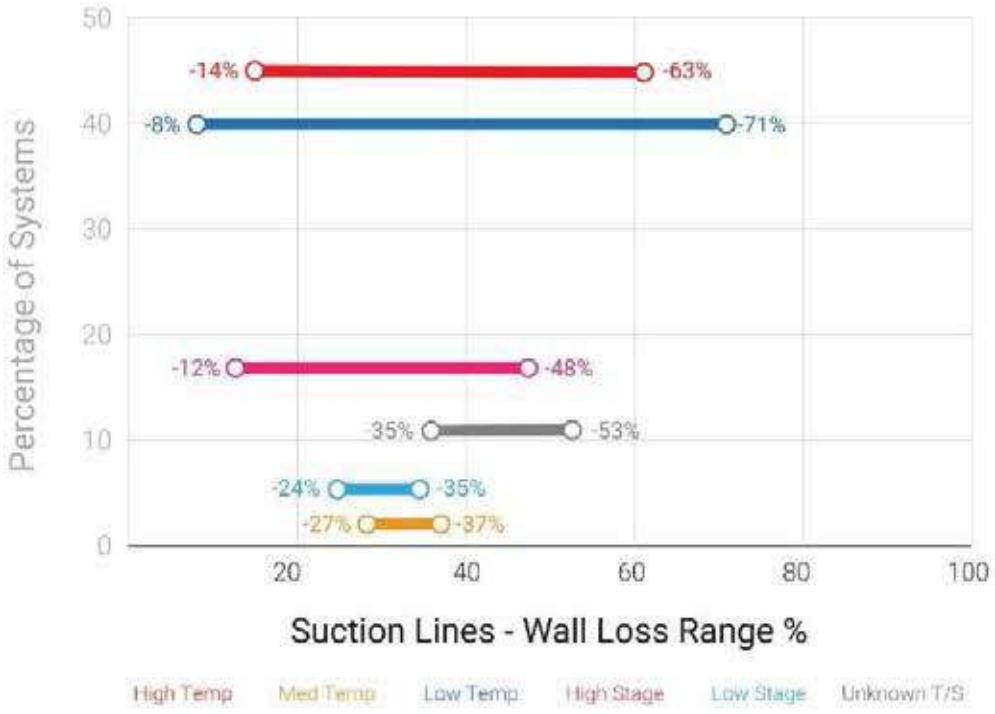


Figure 2. Based on a study of systems evaluated in the U.S. from June 2022 to May 2023.

Areas of Susceptibility

By employing practices to prevent and manage degradation, and with regular inspections, it is possible to predict the primary CUI breeding locations and detect where corrosion is present or may soon be present in the system.

Cues that the Piping is Compromised

Insulation conditions, such as damaged or missing components of the vapor retarder, can vary. Any damage can allow moisture through the vapor retarder, which is considered irreversible. The following cues should be regularly considered:

1. Jacketing separation (see Figure 3)
2. Holes in the insulation
3. Hail damage
4. Split seams
5. Crushing from physical damage
6. Weld strikes or other electrical damage that penetrate the jacketing

Figure 3. Jacketing separation and split seam

In addition to damage, which is a common catalyst for CUI, the areas where piping is most vulnerable are:

- The intersection of a pipe segment and major pieces of equipment
- Before and after pipe direction changes (e.g., elbows, tees, and reducers)
- Wall and roof penetrations
- Insulation terminations (e.g., valve groups and end caps)

The location of a component or structure can make it challenging to ensure piping integrity. It is necessary to regularly inspect:

1. Piping near condensers or a cooling tower area. This equipment can produce chemical and mineral-rich mists that are especially damaging to pipe jacketing and bare piping (see Figure 4). This mist can leave mineral deposits on metal surfaces, which are prone to corrosion unless cleaned and coated regularly. This is especially detrimental for piping that is not properly protected, like in areas where piping penetrates the walkways, or when the design does not allow for enough room to thoroughly inspect or properly maintain coatings.

2. Gravitational pooling also requires for consideration, specifically related to pump outs and roof penetrations (see Figure 5). Pump outs are commonly installed in the bottom of piping for proper function. However, this positions the piping precisely in the area that collects water after being compromised. Water collects in the lowest area, beneath the piping or in dips of the roof.

3. Any area where piping penetrates a boundary, such as a roof or wall, is difficult to inspect and maintain. Additionally, the piping is often uninsulated, leaving the bare piping exposed to moisture. In many systems, these areas are unprotected because they pass through a boundary. Integrity depends entirely on a secure adhesive or sealant, such as caulk, to provide weatherproofing.

4. Congested roof drains. Drains that are not regularly cleared can trap moisture and promote the growth of organic materials.

Figure 4. Chemically induced corrosion on bare piping.

Figure 5. Water pooling at the base of insulated ammonia piping at pump out.

Improper design, poor installation or maintenance, and use of the wrong materials can be equally devastating to piping and other components in ammonia systems. Look for:

1. Weak or missing gutters that are not properly channeling rain runoff away from the piping.
2. Poor or unmaintained caulking at insulation caps.
3. Screws in the jacketing.
4. Design configurations that collect or hold water such as insulated hand valves or other vertically oriented features. Although it may look good aesthetically, it may be destructive.
5. Be aware of how overlapping jacketing seams may allow water to collect. Seams placed on top of the piping, while quite common, invite water into the system.
6. Insulated-to-bare piping transitions at valve groups put stress on the unprotected bare piping, as well as the sealing. If not well maintained, the paint or coating can flake, and visible rust and corrosion soon follow.

7. Fiberglass and elastomeric foam insulation, commonly used for residential air conditioning and plumbing, are prone to waterlogging and should not be used (see Figure 6). Furthermore, elastomeric foam insulation is commonly glued to the surface of the pipe with no outer protection from the elements, which is a sign of imminent damage.

8. Improper pipe supports are hotspots for corrosion and mechanical wear on piping. Thermal piping expansion/contraction in ammonia refrigeration can create wear points on piping if not properly protected from the support itself. Tl threat is magnified if the bracket design does not allow for proper maintenance and coating of the piping.

9. Brackets covered by jacketing. Although it may look nice, it is another area where water is allowed to enter the system. Over time, thermal cycling causes enormous stress on the jacketing, which does not expand but separates at the seams.

Figure 6. Elastomeric foam insulation on ammonia piping.

Confirmation that the Piping is Compromised

Unfortunately, CUI does not always present itself visually and is commonly hidden. Non-destructive testing (NDT) is recommended to evaluate common areas of failure and locate the wet insulation and corrosion.

Conversely, when the corrosion has advanced, the system shows indications that the piping is compromised. Visible cues reveal that moisture is trapped in the insulation or corrosion is present on insulated piping. Look for:

1. Moisture dripping or ice forming around the pipes. This is a sign that the insulation is saturated, exceeding the containment of the jacketing. Ice build-up on insulation typically occurs when water has penetrated the vapor retarder, resulting in ice formations from the surface of the pipe to outside the insulation jacketing, all the way through the saturated insulation.
2. Biological indicators, such as algae, moss, or plants, growing on the insulation (see Figure 7).
3. Rust stains on the insulation jacketing. Rust staining or rust-colored water from within the jacketing occurs as a result of degradation in the piping or components contained inside the jacketing and insulation.
4. Rust stains on the floor of engine rooms. Often, this is found near valve groups where the defrosting process produces excessive water exposure.
5. Sagging areas on a long run of pipe.
6. Painted corrosion. If the surface is not cleaned of all rust before coating, the paint shields the active corrosion and exacerbates the issue.

Figure 7. Algae on the ammonia pipe jacketing.

Building a Framework for Corrosion Intervention

Considering that multiple variables cannot be determined, there is no reliable formula for deriving how much corrosion can occur or how quickly it will advance. Quantitative data reveals that piping exhibiting any of the aforementioned characteristics should be regularly monitored because the formation of CUI and thinning of pipe walls is imminent if not corrected.

Daily system walk-downs and mechanical inspections should be routinely performed to document the suspected areas. Further investigation, maintenance, or replacement of vulnerable or compromised piping in the system should be prioritized based on the level of severity. Because CUI does not always have visual indicators, further testing should be conducted at common areas of failure.

Classifying Severity

The first priority should be given to piping where leaks or fumes are present. Ammonia fumes are usually due to poor packing on the stems of solenoid valves that are actuated; tightening the packing nuts should resolve these leaks.

Where corrosion is present, the remaining pipe wall must be measured to make an accurate assessment of the severity, which is related to the level of priority. Corrosion on bare piping and CUI take on multiple forms and vary in terms of how aggressively they advance. Generally, blister rust is the most concerning form (Figure 8). If the piping shows layers of peeling rust (or blistering), the corrosion is advanced, and the remaining wall thickness is likely not suitable for operation. The general rule of thumb for companies that exercise a conservative approach is to immediately replace piping that exceeds 50% wall loss.

Figure 8. Blister rust/corrosion.

Pitting corrosion is the most common form of corrosion found in refrigeration systems (Figure 9). Pitting is usually a slow process that causes isolated, scattered pits over a localized area. Contrary to blister rust, pitting and swelling rust (Figure 10) both look severe, though oftentimes the piping can remain in service. Where piping has suffered wall loss in the range of 30%–50%, the pipe needs to be cleaned of all corrosion and coated to protect it from moisture.

Figure 9. Pitting rust/corrosion.

Figure 10. Swelling rust/corrosion.

Areas of wet insulation on piping with low wall loss (less than 30%) should be monitored for advancing corrosion. When replaced, a vapor retarder should be applied directly to the pipe surface, prior to installing the new insulation, to provide a water barrier and protect against infiltration.

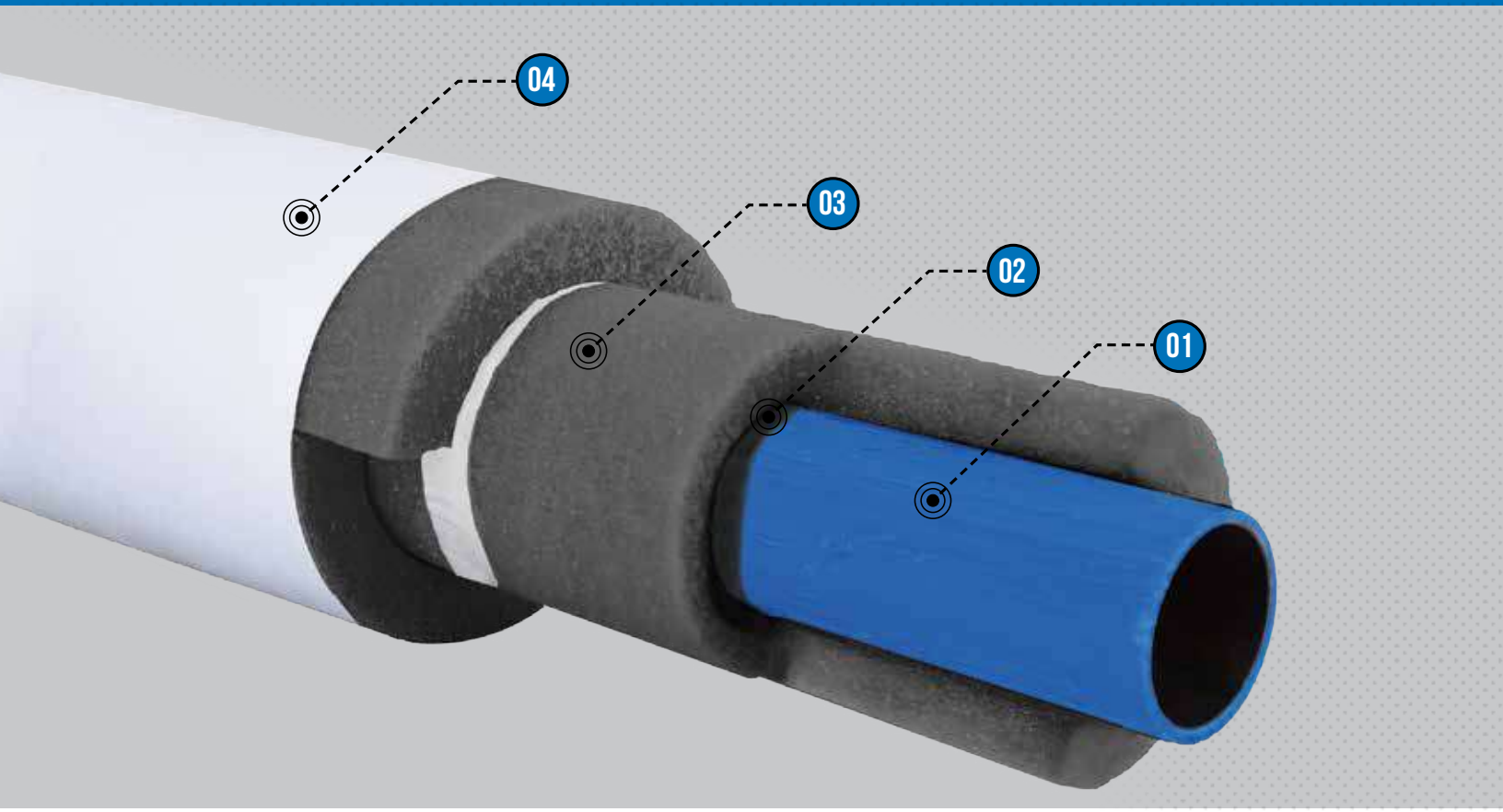
Damaged and split jacketing, failed caulking, compromised sealing points, and improperly oriented seams should be addressed promptly. Replace any wet insulation and clean the piping in these areas so that the joints and sealants do not trap existing moisture in the jacketing.

Finally, other vulnerable areas of the system, as a result of proximity or design, should be resolved and inspected regularly to prevent degradation.

Notes:

Notes:

THE OPTIMAL COLD SERVICE SYSTEM



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