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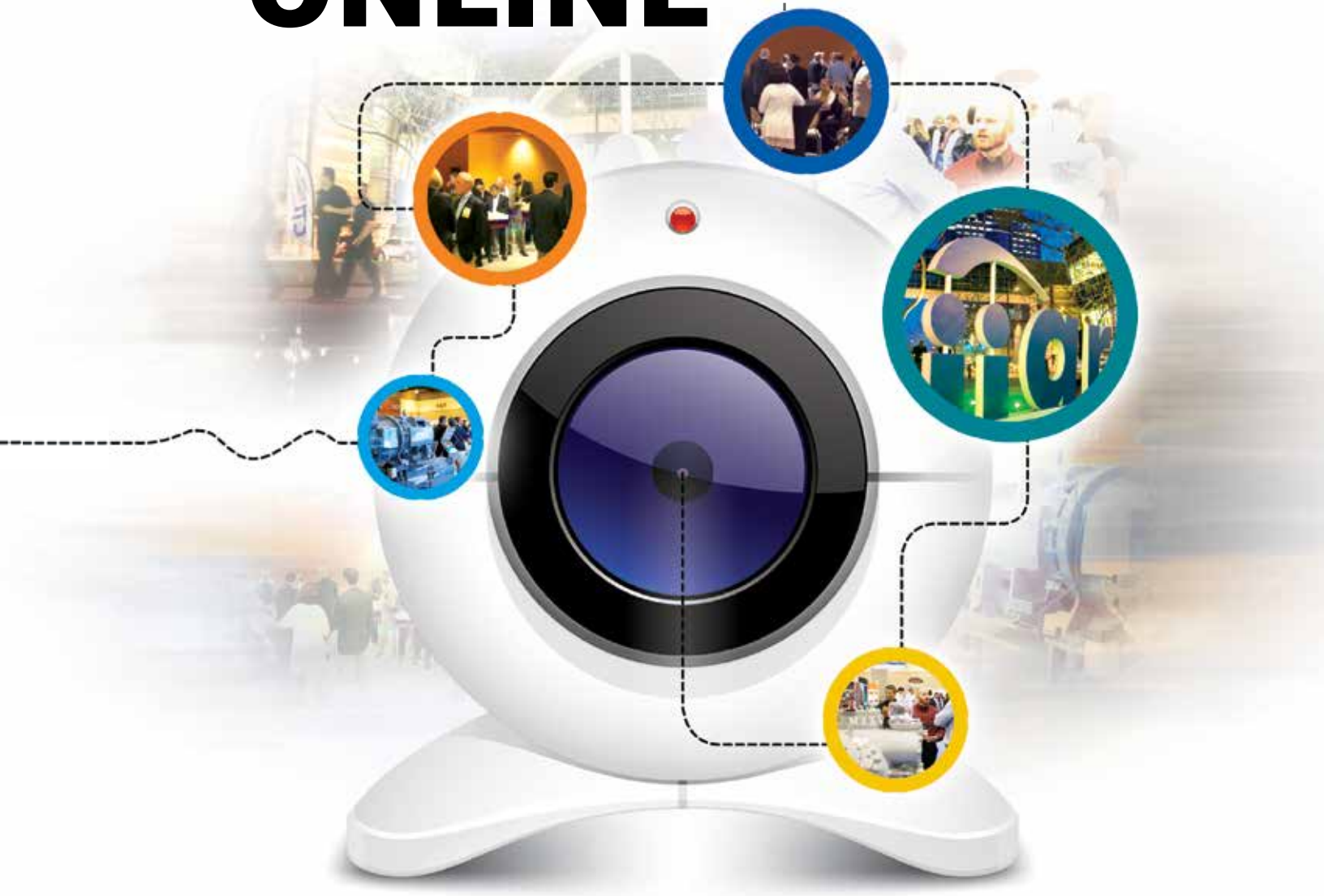
HOW THE PANDEMIC IS CHANGING TRAINING AND SUPPORT



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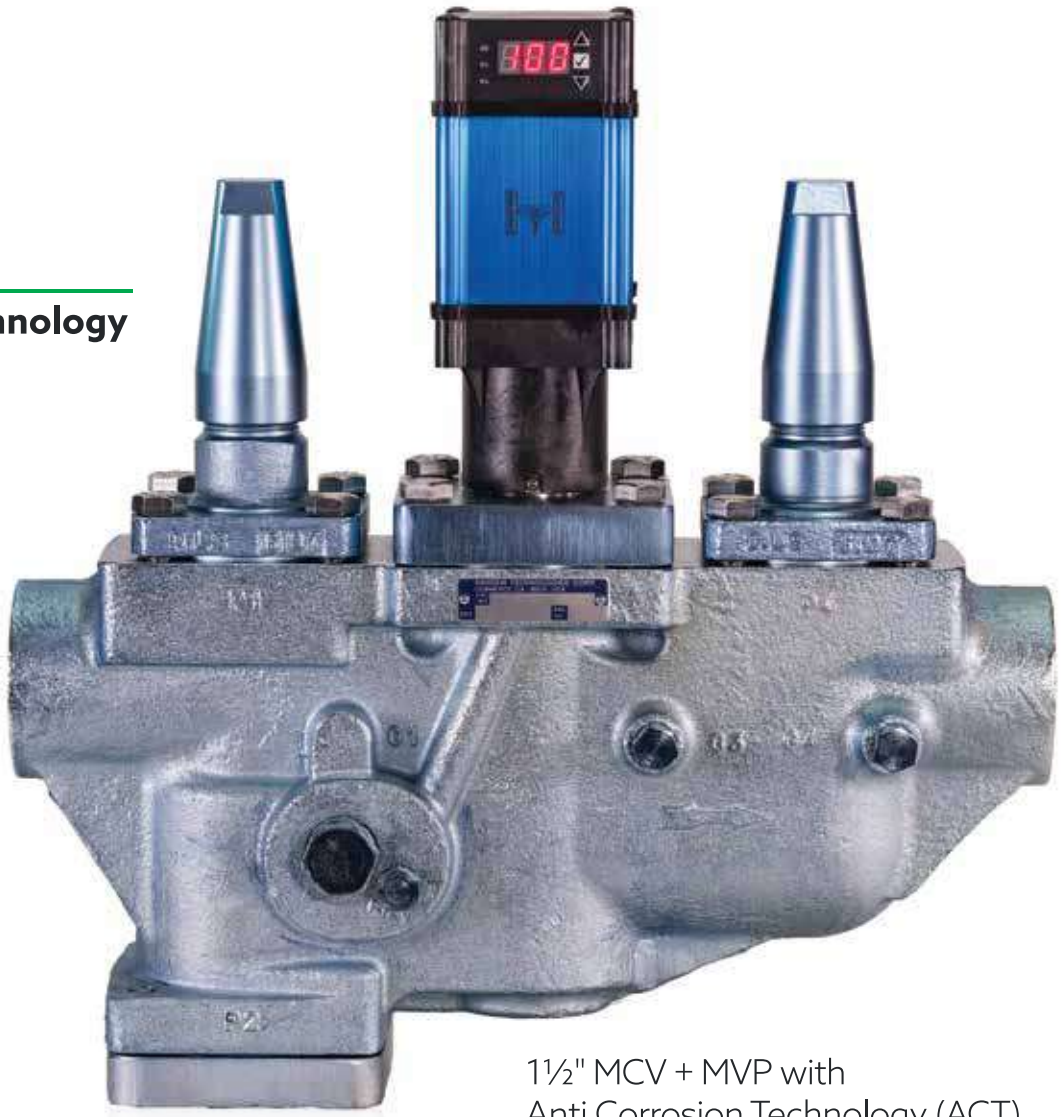

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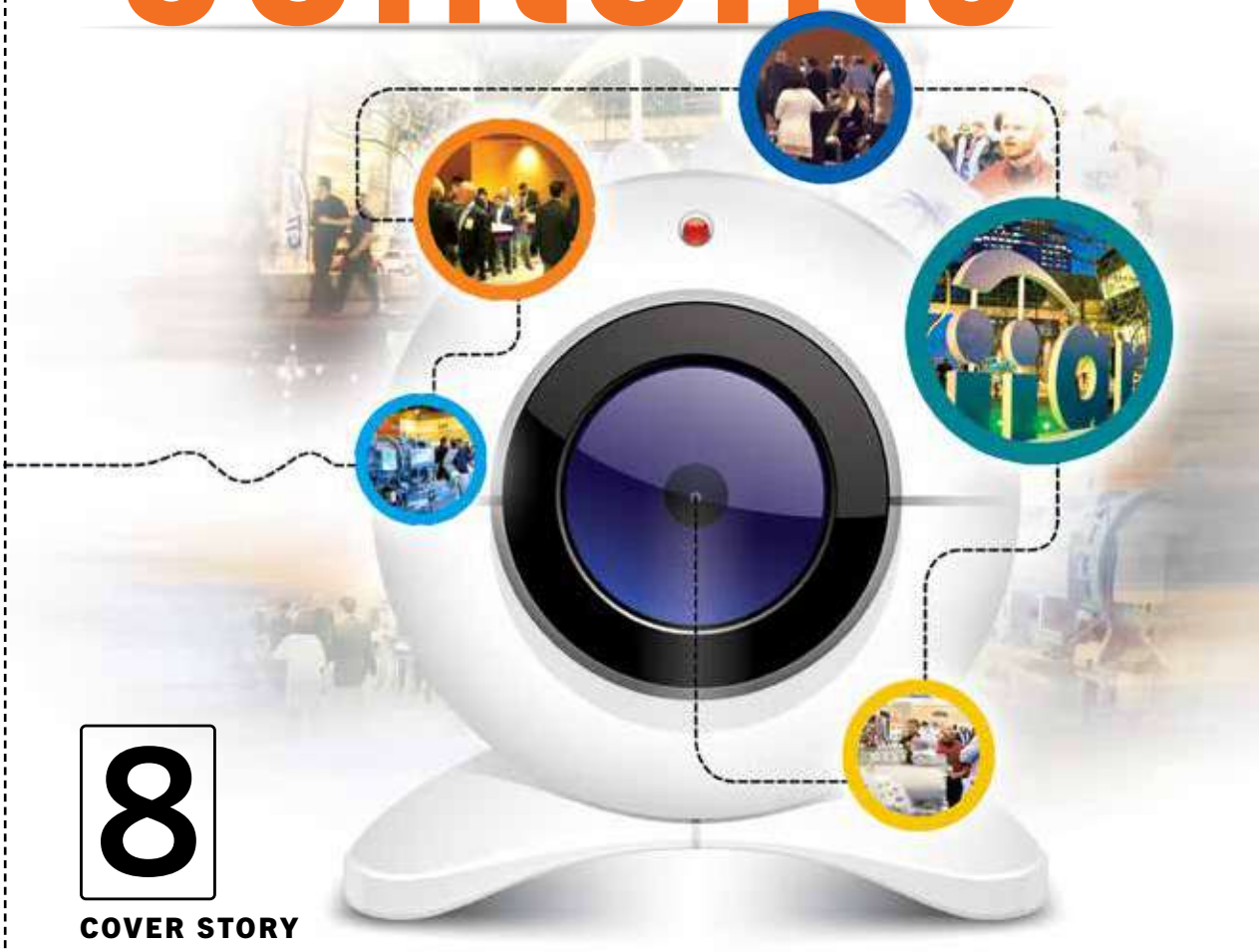

CONDENSER STAFF

Publisher
David Rule

Editor-In-Chief
Andrea Fischer

Creative Director
Bill Ellis

V.P. Marketing and Sales
Eileen McKeown

V.P. and Technical Director
Eric Smith

Staff Writers
Mindy Long
Rob Duca

International Institute of Ammonia Refrigeration
1001 North Fairfax Street, Suite 503
Alexandria, VA 22314
www.iiar.org
Phone: 703-312-4200
Fax: 703-312-0065

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COVER STORY

ONSITE TO ONLINE

HOW THE PANDEMIC IS CHANGING TRAINING AND SUPPORT

president's MESSAGE

BY GARY SCHRIFT

A Reminder of the Past and Present

First and foremost, I want to thank all IIAR members for your past support of IIAR through your participation in all the activities and programs that make our industry safer and more successful than ever before, especially for your most recent financial support and participation with IIAR's first-ever virtual conference.

Your grace and patience as we processed thousands of refunds from our canceled Orlando conference speaks volumes for the solidarity of our industry.

Presently we, the IIAR staff, and the many IIAR committee members continue with our mission to provide advocacy, education, and standards for the benefit of the global community in the safe and sustainable design, installation, and operation of ammonia and other natural refrigerant systems. Lots of words, but what specifically is being done to support our members and the industry as a whole?

I thought I'd take this opportunity to dive into the things I believe make this organization (and this industry) truly great.

Advocacy: Presently, through our Ammonia Refrigeration Foundation, scholarships are provided annually to Junior and Senior level full-time college students pursuing a degree in engineering or related technical field leading to a career in the refrigeration industry. The 9 scholarships awarded in 2019/2020 with 3-5 more to be added in 2020/2021 fill the pipeline of good candidates for employment by our members.

Research projects coordinated by the Research Committee and IIAR staff, and funded by the Foundation, resulted in a forthcoming guideline for Mechanical Insulation Installation and three new computer programs available in conjunction with the IIAR Ammonia Piping Handbook reflecting significant changes to the pipe sizing chapter, wet suction riser selection, and economic considerations.

Ongoing and proposed research projects will result in a better understanding of ammonia dispersion and detection in refrigerated space and engine rooms, estimating ammonia release quantities, and best piping practices to avoid hydraulic shock based on CFD modeling and comparisons to actual past events.

Routine interaction with OSHA, EPA, CSB, and DHS has resulted in many past advancements of our mission towards safety but also the removal of regulations that were impractical to implement. Presently we interfaced with DHS (FEMA) to secure free face masks for distribution to our members in the early days of the pandemic when PPE was difficult to secure.

We are actively engaging with OSHA and NIOSH on the development of an Emergency Preparedness Guideline that would recommend and allow the practical use of air-purifying respirators, with the CSB to remove the additional burden of reporting an ammonia release to the CSB when such releases are already reported to the NRC, and with the EPA in managing their expectations of the initiative to improve compliance with the General Duty Clause of the Clean Air Act at facilities with small ammonia refrigeration systems.

Lastly, work continues with the many code bodies of IMC, UMC, NFPA, and IFC, and having them continue to recognize IIAR standards and to remove any requirements that are conflicting with IIAR standards and potentially harmful to personnel and the ammonia industry if implemented.

Education: Presently we create and present bi-monthly on-line webinars, publish peer-reviewed technical papers, develop and update online videos providing training on basic refrigeration, service, and design, and produce and update online Academy Courses providing training on the many IIAR standards and guidelines.

This vast resource of non-commercialized educational materials, many also available in Spanish, significantly supports all members concerned with the safe and sustainable design, installation, and operation of ammonia and other natural refrigeration systems. These educational materials are continually being expanded and I feel it is possible to further integrate into the platform quality educational material from other affiliate organizations providing even more educational services to the world.

Standards: These are the core of IIAR. Currently, we have nine (9) ANSI certified Closed-Circuit Ammonia Refrigeration Systems standards, four of which were updated in 2019, and three of which are being updated in 2020. Spanish versions are updated when the English versions are complete.

New standards under development include Safety standards for Closed-Circuit CO_2 refrigeration systems and Hydrocarbon systems. Currently, we have six (6) Handbooks and Guidelines, five of which relate to Ammonia with a CO_2 Handbook recently updated in 2018. New guidelines are in development for Emergency Preparedness for an ammonia facility, Manual Hand-valve Management, and insulation installation.

IIAR was started as an Ammonia only organization. Most of our activity and work produced remains focused on ammonia. In the future, we are expanding to support all-natural refrigerants so natural refrigerants are safely applied to all cooling applications, which creates environmental safety and sustainability for our future world.

We invite you to become involved and encourage your friends and colleagues to become members and support our efforts to promote and defend our industry.

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chairman's MESSAGE

BY DAVE SCHAEFER

Nothing is More Constant Than Change

We are very happy to report that the IIAR-6 Standard for Inspection, Testing and Maintenance of Closed-Circuit Ammonia Refrigeration Systems is ready to go. A lot of effort went into the development of the Standard and now the class, by many volunteers on the Standards Committee and the IIAR Staff.

In my opinion, the three most important things we can do for ourselves and our industry is TRAINING, TRAINING AND MORE TRAINING. We need to have confidence that our refrigeration systems are being properly designed, installed and maintained. Proper training is imperative to having safe and reliable systems. Our refrigeration systems should always be treated with the highest level of respect, care and attention to detail.

The course delivery system for the Academy of Natural Refrigerants (ANR) has always been oriented to the busy and diverse schedules of the participants. This is even more critical when travel and budgets may be limited due to Covid-19.

Originally, classes were delivered via the internet and recorded so that making up missed sessions, on one's own time, would be easy. Testing, to attain the program certificate, was originally just available at the IIAR Conference. With the growing popularity of the IIAR courses, we saw the need to further decentralize course delivery and testing.

Little did we know that there would be a pandemic to further confirm the wisdom of using an online education delivery and testing system. Today, our Learning Management System enables program ANR students to access and learn vital information on the safe and effective use of natural refrigerants, and to demonstrate mastery of the course content, online and at the time of their choosing.

Here is a look at the Academy of Natural Refrigerants online training and the progress being made.

ANR CLASSES (ENGLISH VERSIONS):

Recently released & now available:

- IIAR-6 Standard for Inspection, Testing and Maintenance of Closed-Circuit Ammonia Refrigeration Systems
- Ammonia Refrigeration Management (ARM) Guidelines – for systems under 10,000 pounds of ammonia

Previously & now available

- IIAR-2 (2014) Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems
- IIAR-4/5/8 Standards for Installation, Start-up and Decommissioning
- Principles of PSM (OSHA)/ RMP(EPA)– for systems over 10,000 pounds of ammonia
- Process Hazard Analysis
- Series I Videos & Tests – Basic Ammonia Refrigeration Training Program
- Series II Videos and Tests – The IIAR Ammonia Refrigeration Safety Training Program
- Series III Videos and Tests – Removing Oil from an Ammonia Refrigeration System

Courses being considered and/or under development:

- IIAR-3 Standard for Ammonia Refrigeration Valves
- IIAR-7 Standard Operating Procedures
- IIAR-9 Standard for Minimum Safety Requirements for Existing Closed-Circuit Ammonia Refrigeration Systems - RAGAGEP
- Ammonia Piping Handbook
- CO_2 Handbook
- Management of Change and Pre-start-up Safety
- Mechanical Integrity
- Basic Design of Ammonia Refrigeration Systems
- Basic Refrigeration Applications
- Design of CO_2/NH_3 Cascade Systems
- Engineering Calculations for Compliance with PSM/RMP
- EAP Guideline ANR

ANR CLASSES (SPANISH VERSIONS)

Previously & now available:

- IIAR-2 (2014) Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems
- Series I Videos & Tests – Basic Ammonia Refrigeration Training Program
- Series III Videos and Tests – Removing Oil from an Ammonia Refrigeration System

Courses being considered and/or under development:

- IIAR-6 Standard for Inspection, Testing and Maintenance of Closed-Circuit Ammonia Refrigeration Systems
- Ammonia Refrigeration Management (ARM) Guidelines – for systems under 10,000 pounds of ammonia
- Safety Inspection Series for Ammonia Refrigeration Systems

Please check out the link to our website for further information on the classes and videos. If you have any questions, please see the frequently asked questions link or call the IIAR staff.

https://iiar.org/education

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ONSITE TO **ONLINE**

HOW THE PANDEMIC IS CHANGING TRAINING AND SUPPORT

As the COVID-19 pandemic sweeps across the globe, stay-at-home orders and social distancing have changed the way businesses operate. Every business function has been affected, including training, which is a critical component of the natural refrigerant industry. In response, people in the industry have turned to virtual options, leveraging technology that is already available and investing in additional tools.

"State and local policies have either prevented or significantly limited in-person gatherings that would be typical of in-person training and development," said Doug Reindl, a professor at the University of Wisconsin and a principal with the Industrial Refrigeration Consortium. "In addition, many corporations have crafted their own policies that prohibit non-essential employee travel and participation in events that would include these types of gatherings."

Benjamin Weser, manager, educational services at Emerson, which manufactures commercial and industrial refrigeration products, said that even though in-person training opportunities are limited, the need for training hasn't gone away. The industry had to quickly pivot to leverage other training solutions, such as streaming video, online self-paced courses and real-time webinars. "In fact, with many people staying home, there's been a window of opportunity for professional development," he said.

While the methods that industry educators use to deliver training during the pandemic have shifted, the goals remain the same. "We want to identify the learning needs of our customers and provide solutions that instill the knowledge and skills that will enable them to do their work effectively and efficiently," Weser said. "The limitations that currently apply to in-person training events provide an opportunity for educators in the industry to evaluate

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the virtual and on-demand training and support we offer our customers."

ONLINE LEARNING OPPORTUNITIES

Dave Schaefer, chief engineer for Bassett Mechanical, which provides custom-built mechanical contracting, metal fabricating and maintenance service solutions, said many of the industry's virtual learning capabilities were already in place. "This has forced us to use it, because in person isn't an option right now," he said. "It is forcing us to evolve and change"

Azane, a manufacturer of low-charge ammonia refrigeration solutions, has Web-based training courses that it regularly uses for various training topics. "The primary benefit is that they can be accessed 24/7 and reviewed several times to gain and maintain the required level of understanding and competency," said Caleb Nelson, vice president of development for Azane Inc.

Like many companies investing in training, Emerson said it already has a learning platform that enables the company to deliver learning virtually. Still, the company is now leveraging more of the system's capabilities, such as hosting video training events via its learning management system, due to social distancing requirements. "This lets us include activities like instructor equipment demonstrations via video, participant break-out group activities and quizzes," Weser said. "COVID-related limitations to in-person learning events highlight the need for companies to ensure that customers have multiple avenues for accessing information, support, and training on our products and solutions."

Weser said the use of Emerson's online learning platform has grown since COVID limitations began. "Beginning in April, we offered a promotion providing free access to a large chunk of our online training library and delivered a series of live online training courses," Weser said. "Since that time, we've had over 3,000 new user registrations on our website and over 7,000 online courses completed by those users. I think that reflects the enthusiasm among industry technicians for continuous learning on technical topics and a comfort level with using new technologies to participate in that training."

Schaefer said that nothing is as constant as change. "We're experiencing it at an accelerated pace because it has been required of us to do it," he said. "There are some folks out there that have relied so heavily on face-to-face over the years, they're having to scramble to understand how to get the class, conduct it and get the important information out to the students."

EFFECTIVE TRAINING

When creating an effective online learning experience, there is more to consider than simply setting up an account on the various platforms available for remote meetings and presenting the content virtually rather than in a classroom, Reindl said.

Reindl said each of the different platforms available for delivering training and professional development online has its own strengths and weaknesses, and there is no single solution that can meet all of the varying needs for each course event. "This can make it a challenge for the organization delivering the training to pick a single platform or technology," he said.

Customers need training that is current and relevant to the work they're doing. "Learners are less likely to retain information that they don't feel is applicable to their job," Weser said. "Learning essential service skills is always a value-add, but technicians also need learning that will keep them up to date on emerging technology."

Successfully delivering educational content online starts with having course instructors who are intimately familiar with teaching adult learners and developing and delivering educational content geared towards adults, Reindl said. "This includes establishing clear learning objectives for the course overall, based on the defined audience the training event is aiming to reach. The overall course learning objectives are then supported by the individual elements of the course with their own learning goals," he said.

Adults learn best when they're actively applying what they're learning. Therefore, manufacturers need to make training and support available to our customers that can be accessed on-demand, when its most needed and when it is being put directly into practice, Weser said.

Reindl said instructors should think of the overall course objective as building a wall. "The individual modules of the course are the bricks, and each one needs to be appropriately sized, configured and arranged. The foundation represents the knowledge, skill, and capabilities of the instructional staff. Without a strong and functional foundation, the wall will be of no use," he said, adding that each of the elements of the wall has to function together to create a finished end product that is structurally sound, functional and even aesthetic.

Keeping remote learners engaged is important and having opportunities for participants to interact with instructors synchronously delivering content is essential and is one strategy to keep them engaged, Reindl said. "Another facet of course engagement is having exercises or assignments that attendees work on between synchronous sessions. These 'homework problems' can be effective tools to reinforce concepts being present during the course," he said.

Schaefer said online programs need to have a feedback mechanism so the providers can know if an attendee understood the lesson. "You can tell a lot if you're with someone training them. You can tell if they understand from the visual, face-to-face interaction," Schaefer said. "If training is on the phone or if someone is watching a video, it is difficult. We have to make sure through some means of feedback the message was received. It is essential to understand if the point got across."

Attendees themselves need to commit to set aside the time to both participate and 'be there' during sessions, which means they need to put down phones, email and other things that distract their attention from online sessions, and to dedicate the effort to complete work outside of online session times, Reindl said. "Their commitment to the learning event doesn't start and stop just during the scheduled meeting times," he said.

Online learners should also be able to go back and review the material. "If it is just a One-And-Done where they can't review it later, I think that is a mistake," Schaefer said.

Glenn Barrett, engineering manager for D.C. Engineering, said refrigerant

compliance training, training on control systems and the algorithms used in the control systems, issues and solutions for new refrigerants, such as glide, system operating pressures, seem to have the most immediate benefit.

"Training on remote diagnostics of equipment, what to review and understand before sending a technician to the site, arming the site technician with information regarding what the problem is and how key operating parameters and variables are trending, will only shorten the time the technician is the in the store and the system is down or failing," Barrett said.

ONLINE LEARNING CHALLENGES

When sound principles are applied, online learning has been demonstrated to be equal to or even more effective than face-to-face learning. However, there are challenges.

"There's an opportunity to reach a larger audience in a virtual setting, but there are challenges with ensuring training is engaging for remote learners and that they walk away with the skills and knowledge the learning solution was designed to provide," Weser said.

One significant component of face-to-face learning events is the opportunity attendees have to network among themselves and with the instructors. "Networking is an intangible, but many attendees equate the value of networking to be equal or, in some cases, greater than the course itself," Reindl said. "Networking via online courses is exceptionally difficult and not the same as in-person."

Some professionals have said that they are getting 'screen fatigue.' "They are at their computers for their daily work, for virtual meetings and now for training. This will pass as the pandemic winds down, but it is something we don't often think about when we are focused on delivering online content," Reindl said.

Quality is always a consideration in deciding whether or not to participate in a given training event, Reindl said. "In the case of equipment-specific training, end-users are in a difficult position because their decision to specify and use a given manufacturer's valve, compressor, heat exchanger, etc., is rarely driven or even influenced by the quality of their product-specific training," he said. "If an equipment vendor provides poor training, end-users often have to rely on their contractor allies or other industry resources to wash the bad taste out of their mouth from the substandard training."

Weser said manufacturers play a big role in supporting customers as they use and maintain products and solutions. "Instructor-led and hands-on training plays an important role for customers, but an on-demand product and skill training is also significant," he said.

Even before the current limitations put on in-person training, technicians needed convenient and timely training and support. "To be productive in the HVACR industry, ongoing training is essential, but taking the time to train in a classroom can be difficult," Weser said.

One benefit of online learning is the ability to take advantage of multiple educational sessions. Schaefer said that typically at IIAR's annual conference, he can attend only a handful of sessions. This year the conference was virtual, and spread out over three weeks "This year, I could get almost all of the ones I needed. It is in some ways more efficient," he said.

Barrett said remote training and webinars are an effective way to reach a large number of people.

Even still, Nelson said the most effective approach to training is hands-on, and one of the best times to give this training is during system installation and commissioning/startup. "Proper understanding and operation of the system are very important to the system reliability and effective performance to a critical industry, so we haven't seen too many shortcuts or abbreviations to this process. It needs to happen and is, of course, considered 'essential' in many regards," he said.

SOCIAL DISTANCING AND RMP/PSM

Training is just one safety element that has been affected by COVID. Schaefer said PSM/RMP requirements are more challenging to meet, given social distancing requirements. "Process hazard analysis used to be the same group of people going through plans and point and looking at the same thing, now you're trying to describe it over the phone or six feet away. It takes longer to get the point across, and you wonder if the point is received correctly or not," he said.

Where things aren't practical right now, users have to document that they couldn't do it for safety reasons, Schaefer said.

Because President Trump included the food industry as essential to infrastructure, the refrigerant industry has more flexibility in steps it takes to ensure their operational continuity, Reindl said.

"For example, the essential infrastructure designation status enables plants to not be hampered by local restrictions which, in some cases, have been disorganized, confusing and/or politically driven," Reindl said. "Both OSHA and EPA have issued guidance to end-users with PSM and RMP covered processes on steps they can be taking to ensure their compliance through the pandemic period."

While there are aspects of PSM/RMP that can be accomplished remotely, much of the work requires people on-site doing inspections, tests, maintenance, repairs, etc. "There are no substitutes for these activities," Reindl said.

THE FUTURE

Training isn't the only thing that could change going forward. The need for social distancing could shift equipment expectations as well. "We have seen an increased interest in remote monitoring of systems, but more than that, packages that blend data acquisition with AI, which already knows how to decipher raw data and relay information to owners and operators in a language that means something," Nelson said, referring to "artificial intelligence."

Software that tells users what they need to fix, versus just giving a database of data without guidance to know what the data means is available and sorely needed, Nelson said.

Systems are becoming more complex and being able to address issues quickly is as important as ever. "One solution is additional remote connectivity and interoperability with control systems to allow remote experts the ability to quickly diagnose and provide solutions for issues in the field," Barrett said.

Those looking for online learning opportunities can start by checking IIAR's Academy of Natural Refrigerants, which has a list of available training classes, Schaefer said.

2020 iiar ONLINE CONFERENCE & VIRTUAL EXPOSITION

World's First Natural Refrigerants Virtual Conference a Great Success

On March 11 – just three days before the International Institute of Ammonia Refrigeration annual conference was scheduled to begin – the World Health Organization announced COVID-19 was officially a global pandemic. Immediately following that announcement, IIAR's board voted, for the safety of members and exhibitors, to cancel what would have been IIAR's 49th annual Conference and Expo.

"When the board made that decision, I was on an airplane to Orlando – where the conference was going to be held," said Gary Schrift, IIAR's president. "Our immediate task was to notify the membership of the decision."

During that tumultuous time, IIAR asked members and exhibitors to hold tight until questions could be answered and a plan was put in place, Schrift said. It was decided fairly quickly that the conference should still occur, but it should be held in a virtual space. Early May was selected as the date – an aggressive timeline, but a goal Schrift felt confident in setting.

Eileen McKeown, IIAR Vice President of Marketing and Sales, plays a key role in managing IIAR's conferences. She said the transition was complicated but ultimately was pleased with the successful pivot.

IIAR leadership wanted the virtual conference to be similar to the experience of an in-person event, so the challenge was daunting. It was decided that the event should take place over three weeks – rather than three days – to ensure attendees would have ample opportunity to attend sessions, learn from educational materials and meet virtually with exhibitors, she said.

By transitioning to a virtual event, not only was IIAR able to ensure the safety of presenters and attendees but also it was able to attract additional guests who might not have been able to attend an in-person event.

"I was [initially] surprised by how many people wanted to participate in the virtual event," McKeown said. "When we opened up registrations for the second time, we got new registrants for the event. That was impressive."

Technical papers and the workshop were broadcast twice during the three weeks, each followed by discussions with the speakers, providing the live-online audience an extensive list of opportunities for education, said Eric Smith, IIAR's Vice President, and Technical Director. With the exception of one, everyone who was scheduled to present at the in-person conference presented virtually.

By transitioning to a virtual event, not only was IIAR able to ensure the safety of presenters and attendees but also it was able to attract additional guests who might not have been able to attend an in-person event.

Overall attendance was robust, Smith said. "In some cases, attendance was more than what we might expect at a live conference," he said. "We believe that a lot of people who might not have had the opportunity to attend the live conference were able to attend the virtual conference – that was the plus side." International activity, for example, increased noticeably at the virtual sessions.

The use of a live question-and-answer platform added an important educational element to the sessions, Smith said. Attendees were able to enter questions as the pre-recorded presentations were running, and a moderator asked those questions to the speaker for a discussion once each presentation concluded. Some of these Q&As went well beyond their allotted time, indicating how well received the sessions were.

"That was a bit of an advantage and offered a little more insight than what we might normally get," Smith said. "We attempted to get every question answered."

In all, there were over 30 technical presentations and workshops offered. Some of the most popular included the regulatory and code updates, as well as the session on emergency response planning. Each offering was valuable in its own right, with mechanisms in place for audience members to document their attendance to receive continuing education credits.

"I'd say that every session was quite good," Smith said. "We were very pleased with the production of the world's first-ever virtual conference on natural refrigerants".

In addition to the wide variety of educational materials presented throughout the conference, this year's virtual "Sunday Session" focused on secondary coolants, looking specifically at the application and design of these systems.

"The use of secondary coolants in refrigeration systems is becoming more popular in both commercial and industrial refrigeration," Smith said. "This permits the refrigerant charge

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and equipment to be concentrated in a machinery room, much like common commercial a/c chiller systems."

The June 5 presentation helped familiarize end-users and designers with the range and properties of secondary coolants available and their applications. The session covered pumping and piping system design techniques to minimize energy costs and the use of carbon dioxide as a "volatile brine." Instructors demonstrated engineering calculations, and case study examples of successful applications.

The lead-off speaker, Dave Malinauskas, president of the session's sponsor, Cimco Refrigeration, said it is increasingly important for industry professionals to start discussing these new, hybrid systems which conflate smaller, low-charge ammonia refrigeration systems with other types of refrigerants.

While the necessity to transition to a virtual conference was out of anyone's control, Schrift said he was overwhelmed with the results. With only four weeks to plan the event, he said the conference's success was tremendous.

"There was no negative feedback," Schrift said. "Of all of the sponsors and exhibitors, I know of no one that said it wasn't worth it… it was very much a success."

McKeown agreed. She said she was most impressed by the conference's registrants, attendees, and exhibitors. "They were fully understanding of what was going on," she said. "They were disappointed they weren't able to engage with our show in a face-to-face way, but I was proud of the way everyone came together to help IIAR and support IIAR."

The success of this year's virtual conference has even spurred discussions on how to best incorporate a digital element at next year's 50th Anniversary event, the Natural Refrigeration Conference & Heavy Equipment Expo in Palm Springs, California, Schrift said. While it's still unclear how this might look, it's almost certain this expo will offer some sort of virtual supplement.

"How well [this event] went with such a short lead up time speaks volumes about our staff and our vendors who helped put this together, says Schrift. "The fact that it was backed up by so many positive comments – which I don't think were platitudes – confirms we should continue."

IIAR Congratulates 2020 Award for Presentation Excellence Winners

The coronavirus pandemic forced International Institute for Ammonia Refrigeration to tune in for an unprecedented virtual national conference, and IIAR officials said everyone from the conference attendees to the educational program presenters turned out to make the online conference one of the best.

Perhaps it was the prospect of ad-hoc entertainment such as intrusive pets, children, or spouses, but IIAR Educational Director David Sainato said, "this year's technical program was one of the strongest in recent history, as evidenced by the robust attendance for each session."

IIAR technical paper presenters embraced safe social distancing with the new format and didn't miss a beat presenting via webcast from their homes or offices, with active question-and-answer periods. Members followed up by choosing the top presentations through electronic voting.

The technical program schedule included 18 technical presentations in the two categories: commercial and industrial, with a wide range of topics that included safety, energy efficiency, best practices, maintenance, installation, and operating costs, addressing the industry's most timely and technologically significant issues.

Members voted electronically for the first time and picked two to receive the 2020 IIAR Award for Presentation Excellence, one each category in the industrial and commercial/retail categories.

THE WINNERS WERE:

- Technical Paper #7 (Industrial), "Review of Accidents in the Ammonia Refrigeration Industry," by Peter Jordan of MBD Risk Management Services, Inc.; and
- Technical Paper #15 (Commercial/Food Retail), "Study of Package Chiller Systems - Comparison of Natural (NH_3 and CO_2) and HFC Refrigerants," by John Collins, Zero Zone.

Because the education sessions, as well as the entire conference, were online, voting for the presentation excellence awards was pushed into an entirely electronic format, which Sainato said offered some unanticipated advantages.

Sainato said the necessary change to "all-electronic" voting this year was a good push to a more efficient, accurate, and reliable system for the long run, one that will better serve the organization, its members, and the environment.

"The virtual conference expedited the full implementation of digital ballots to vote and tally awards for excellent presentations," he said. "In years past we've relied heavily on a paper ballot system to tally votes for the awards."

"While we've moved towards electronic voting through the IIAR conference app, we still were making paper ballots available. But, when the in-person IIAR conference was canceled and we switched to the virtual conference format this year, the decision to rely solely on electronic voting was made for us, and we relied on the app to collect this year's votes."

In addition to voting electronically, attendees were asked to use the app to rate the sessions they attended, and Sainato said the digital format helped to collect more comprehensive feedback on the educational program as a whole in a level of detail that paper ballots did not offer. He said the app's ability to collate and organize feedback will help improve programming for the future.

"As we were forced to move from an onsite conference to an online model as a result of the pandemic, IIAR was grateful that our speakers agreed to stick with us and lend their time and expertise on behalf of the virtual conference. As a result, this year's technical program was one of the strongest in recent history, as evidenced by the robust attendance for each session," he said.

End Users Eye Natural Refrigerants

End users are increasingly looking to natural refrigerants to boost efficiencies and reduce their carbon footprints.

In his educational session at the IIAR 2020 Virtual Conference and Expo, Augusto Zimmermann, Senior Manager at Alternative Systems Global Center of Excellence, said there are several factors driving end users to consider installing natural refrigeration systems or using natural refrigerants in their facilities.

The main force behind this shift is the regulatory landscape that is driven by climate change, he said. This has precipitated a phase-out of synthetic refrigerants and an emphasis on sustainable practices to reduce environmental impacts.

Because of these pressures, the refrigerant landscape is evolving. There are only a few options for future-proofing facilities from upcoming changes in the regulatory environment, Zimmermann said, and those mostly involve transitioning from traditional hydrofluorocarbons (HFC) to natural refrigerants.

With the proper support, this transition does not need to be hugely disruptive and represents a large growth opportunity in the cold storage market, he said.

"We can identify two main players in types of projects. One is industrial ammonia refrigeration systems… the other is large commercial HFC systems. There is a good opportunity for natural refrigerant solutions to play in the space between the two," Zimmermann said, citing ammonia and carbon dioxide cascade systems and CO_2, transcritical booster systems. Both offer energy and cost savings.

There are several main ways that CO_2 transcritical booster systems can improve efficiency, particularly in warmer climates, Zimmermann said, and both solutions can be scaled up or down depending on facility size and capacity.

For climates that are conducive to the operation of an evaporative assisted gas cooler, system operators can use water to their benefit, effectively lowering the operating temperature of the gas cooler. "There are other solutions too, such as parallel compression and vapor and liquid ejectors that improve and enhance the efficiencies of the system," he said.

For ammonia/CO_2 cascade systems, ultra-low charges of ammonia can effectively reduce the operational costs and energy expenditures of a facility. Citing an end-user in Columbus, Ga., Zimmermann explained that their rooftop ammonia rack connects to an evaporative fluid cooler while downstairs in the machinery room a hybrid CO_2 rack was attached to a low temperature CO_2 direct expansion pump to cool freezers, and a medium-temperature C02 liquid overfeed system running the other system features.

That particular facility showed a rack energy improvement savings of 22 percent when compared to the operator's previous HFC system that it replaced.

As regulatory, social and financial pressures mount, it makes sense both from an ecological and economic standpoint to switch to natural refrigerants, Zimmermann said. "That's the bottom line for future proofing."

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Managing Change

Refrigeration facilities are not static entities. Changes to personnel, equipment, technology and procedures can all impact the operations. To ensure the safety of employees and the overall success of the operation, change must be managed appropriately.

Speaking at the IIAR 2020 Online Conference and Virtual Expo, Bill Lape, a Project Director for the Risk Management Group in SCS Engineer's Tracer Environmental Division, said that managing change is a key element of Process Safety Management (PSM) regulations.

Management of change is critical to ammonia refrigeration systems and the ability to evaluate if a change is likely to affect a facility's ammonia refrigeration system is critical for everyone's safety.

Lape opened his presentation by asking what regulatory bodies have to say about change management. Lape illustrated the need for change-management regulation, pointing to the Seveso directives, which the European Union wrote decades ago in response to a 7-ton dioxin release at a chemical plant that contaminated approximately seven square miles around the facility. Many other directives have been written since then that further qualify and quantify this need – specifically, the United States uses the PSM regulations (29 CFR 1910.119) and the risk management regulations (40 CFR 68.75(a)).

To understand what constitutes a change, it is important to define the term. Lape said CFR 68 defines change as the introduction of a new process, process equipment, or regulated substance, an alteration of process chemistry that results in any change to safe operating limits, or other alteration that induces a new kind of hazard.

Another important term to understand is Replacement-in-Kind. The center for chemical process safety defines this as an item that meets the design specification if one exists for the item it is replacing. This can be an identical replacement or any other alternative specifically provided for in the design specifications, as long as the alternative does not in any way adversely affect the function or the safety of the item or associated items.

This can get difficult, Lape said, and identifying what constitutes a change or a replacement in kind is important for facility managers and operators. Subtle changes in replaced equipment, such as the positioning of a valve lever, can have catastrophic impacts if operating procedures are not updated or training is not required – however, requiring these updates or training sessions is entirely dependent on the facility itself.

"There is no document anywhere that's going to say, 'this is a replacement in kind, this is not,'" Lape said. "It's entirely up to the individual facility and the conditions at that facility as to whether or not something is truly construed as a replacement in kind."

"What it boils down to is that facility personnel have to be comfortable with a situation that's deemed a replacement in kind that if they are questioned by an auditor or a regulator that they can justify it, and that justification is documented," he said.

When looking at the history of large-scale incidences in the chemical industry, a pattern begins to emerge. The root causes, Lape said, often have to do with a failure to manage change appropriately. Organizational and procedural changes were responsible for many of the notable accidents over the past 50 years.

To avoid problems, leadership needs to be mindful of any change that might affect the system's operation. For starters, Lape said this means being aware of any changes to the chemicals being used in, on or around the system itself, such as changes in compressor oil, changes to water treatment chemicals, changes to the purity of the ammonia used, changes to anti-seize compounds purchased from suppliers and even changes in sanitation chemicals in the facility. "This is one that is often overlooked," he said.

Operators must also be aware of any technological changes in the system. These might include transitioning from reciprocating to rotary-screw compressors, shifting from open frame pumps to hermetically sealed pumps, or moving from evaporative condensers to adiabatic condensers, using different styles of heat exchangers and changes in secondary coolants. While some of these shifts might not seem hugely significant, if they are not appropriately managed, they can create major issues.

Meaningful change can also take the form of equipment changes, such as replacements using models from different manufacturers, rebuilding or repairing components using third-party parts, or replacing condenser coils with new ones from the original equipment manufacturer.

Managing change should also be applied to procedural changes such as alterations to emergency action or response plans, facility changes like information technology networking, fire protection or cold storage racking changes, as well as personnel turnover.

The key to avoiding problems, Lape said, is to first identify a change and describe it in a manner so that its nature and extent may be conveyed to a knowledgeable and competent third party. This includes the reason for the change and how it will be accomplished.

"Do this by being clear. Use simple sketches, red-lined drawings, and marked up procedures," Lape said. "Be concise. The more words you put to it, oftentimes the harder it is to understand it. And [finally] be complete. Make sure you detail the materials, sizes, limits, and who are the stakeholders in the change. Who is going to be affected?"

On that note, Lape advised that when undergoing change, make sure that a team is assembled that represents each discipline represented in the facility; this includes operations, maintenance, engineering, environmental health and safety, and quality assurance. Each member should be knowledgeable about how the potential change might impact them specifically.

Ultimately, management of change is a process, not the form itself. A management-of-change form is used to document that process and helps ensure that no steps are overlooked, but the actual work consists of reviews and updates to equipment, personnel, and processes.

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Foundation Leaders Report Record Fundraising, New Initiatives

Despite the global health crisis and the International Institute for Ammonia Refrigeration's switch to an all-virtual annual conference, leaders of the Ammonia Refrigeration Foundation said they are optimistic for the future and steadfast in the Foundation's mission.

Incoming chairman Bruce Nelson said the pandemic has not affected the Foundation as it relates to its core mission, adding that he's hopeful operations will return to normal as soon as safely possible. "I see us returning to normal sooner rather than later," he said. "This is what we do as Americans – we rise to a challenge."

FOUNDERS SCHOLARSHIPS EXPAND

To that end, the Foundation's commitment to helping sustain the industry is unshaken. One of the main ways the Foundation accomplishes this, he said, is through the Founders Scholarship program.

In the last school year, 2019-2020, the Foundation supported a total of nine students through the Founder's Scholarships. "This is something I'm just thrilled about," Nelson said. "We were very successful in managing those scholarships."

When the scholarship began, it was limited to a small number of recipients. IIAR's Scholarship Subcommittee Chair Bob Port said that the program has grown significantly over the years, culminating with the most recent cohort of nine new and returning students.

"The big success [this year] was the numbers," Port said. Recipients had competed among 26 total applicants – the largest field the Foundation has seen. Additionally, the Foundation voted to double the number of scholarships awarded, helping the program expand significantly. This year three new juniors received scholarships as well as three seniors. Three more returning seniors continued their scholarships as well.

Although their educational experiences were disrupted by the pandemic, Nelson said many of the scholarship recipients were able to adapt to their new learning environments and thrive despite the upheaval. "I was relieved and happy to hear that – that all of our students were able to complete their studies effectively," he said.

Additionally, Nelson said he was happy to report all of the students felt very supported by the Foundation staff in the administration of their scholarships. "Each of them said they really appreciated all of the help and support – I felt really good about that. We're doing an excellent job, in my view, of supporting our scholarship students."

Nelson said he wants to encourage IIAR members to spread the word about the scholarship program. Several of this year's student group heard about the program through their families, and others in the past have applied because of family friends that work in the industry. Outreach is an important element of promoting the scholarship, but word-of-mouth is still a very powerful tool to that end.

> "As the Foundation Chair, one of my goals has become to encourage our board of directors and encourage the membership generally to be aware and communicate to coworkers and other companies in the industry to make them aware of the Founders Scholarships."
>
> – Bruce Nelson, incoming ARF chairman

"As the Foundation Chair, one of my goals has become to encourage our board of directors and encourage the membership generally to be aware and communicate to coworkers and other companies in the industry to make them aware of the Founders Scholarships," Nelson said. "I suspect that not everyone in our member companies is fully aware [of the program]."

There's an annual cycle of application, evaluation, and granting of scholarships. Right now, the window of application for the upcoming cohort has been closed, "but we'll be able to fund a significant number of scholarships again – that's great news," Nelson said. Additionally, Nelson encouraged students to continue to apply for the next scholarship cycle and to learn more on the Foundation website. "You can apply at any time," he said. "It's never too soon to start thinking about it."

FOUNDATION RESEARCH PROJECTS MOVE FORWARD

In addition to the continued prioritization of the scholarship program, the Foundation continues its mission to provide cutting-edge research to help industry members increase safety and efficiency in their facilities. "The research committee has been extremely active with a lot of committed members," Nelson said. "We've just completed piping research… [we're working] on moving the deliverables from the research project into our publications so that we benefit from that work for a long time."

While that process is ongoing, the Foundation's research arm keeps busy with other projects. Wayne Wehber, the Research Committee Chair, said there are currently three projects in the works.

The first is well underway: the project uses CFD simulations of ammonia dispersion within an engine room to determine appropriate ventilation rates.

"What we're trying to do is a complete analysis revisiting the question of 'what is the necessary ventilation that we need to have'," Wehber said, adding that while there are guidelines in the

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IIAR-2 standard, they were developed years ago without the technical rigor included in the current project.

"We're going to look at small and large machinery rooms and get a look at different ammonia leakage rates and types of leaks," Wehber said. "We're then going to evaluate different ventilation rates and configurations."

Wehber said right now the modeling is underway, and he expects to have initial findings by the 2021 IIAR conference. Ultimately those findings will be finalized and used to revise the IIAR-2 standard, and influence the design of engine rooms in the future.

Additionally, two other projects are currently in the planning stages. The first is a relief-valve piping sizing program that would develop a software tool and user's manual to help calculate appropriate sizing. The software will include the ability to have a library with published relief-valve data and components as well as non-standard data. The second is a proposal to develop a guideline to help estimate and report ammonia releases.

ANOTHER YEAR OF FUNDRAISING SUCCESS

The Foundation's educational offerings and research efforts are made possible with the financial support of the foundation's trustees and individual member donations. Joe Mandato, Chair of the Foundation Trustees, says that his fundraising efforts – while impacted by the COVID-19 outbreak – were largely successful this year.

Recognizing those who committed during the 2019/2020 fiscal year, there were a total of six trustee-level donors. The donors include RDS – its second pledge as a trustee -- and four new trustees: Calibration Technologies Inc., United States Cold Storage, Clauger North America, and R.E. Lewis Inc. One donor preferred to remain anonymous.

In terms of large individual contributions, Mandato said the Foundation is recognizing Bluvas and Associates and FES Southwest Inc. for donations of $10,000 each. Finally, the Kahlert Foundation donated $35,000, which was earmarked for course development at IIAR's Academy of Natural Refrigeration.

Additionally, this year's annual golf tournament – although canceled – still raised over $86,000, largely because individuals and companies donated their registration and sponsorship fees despite the cancellation. "It was a very successful event," Mandato joked. "I think the kudos go to those IIAR members and individuals who were willing to allow the monies they allocated for the golf tournament to be turned into a donation to the Foundation. It was very generous and very much appreciated."

Mandato also extended his thanks to Dennis Anderholm – chair of the tournament – and his volunteers for handling the cancellation with aplomb.

"There's an energy surrounding the Foundation and the activities it's doing for the good of the industry," Mandato said. "Overall, the future looks very bright."

Looking to the future of the Foundation, Nelson says he hopes the greater IIAR membership will get more involved in education and research initiatives. "There's always a need for dedicated, passionate committee members," he said. "It's such a noble mission – what we do at IIAR – and these two committees are particularly important to our membership and the public."

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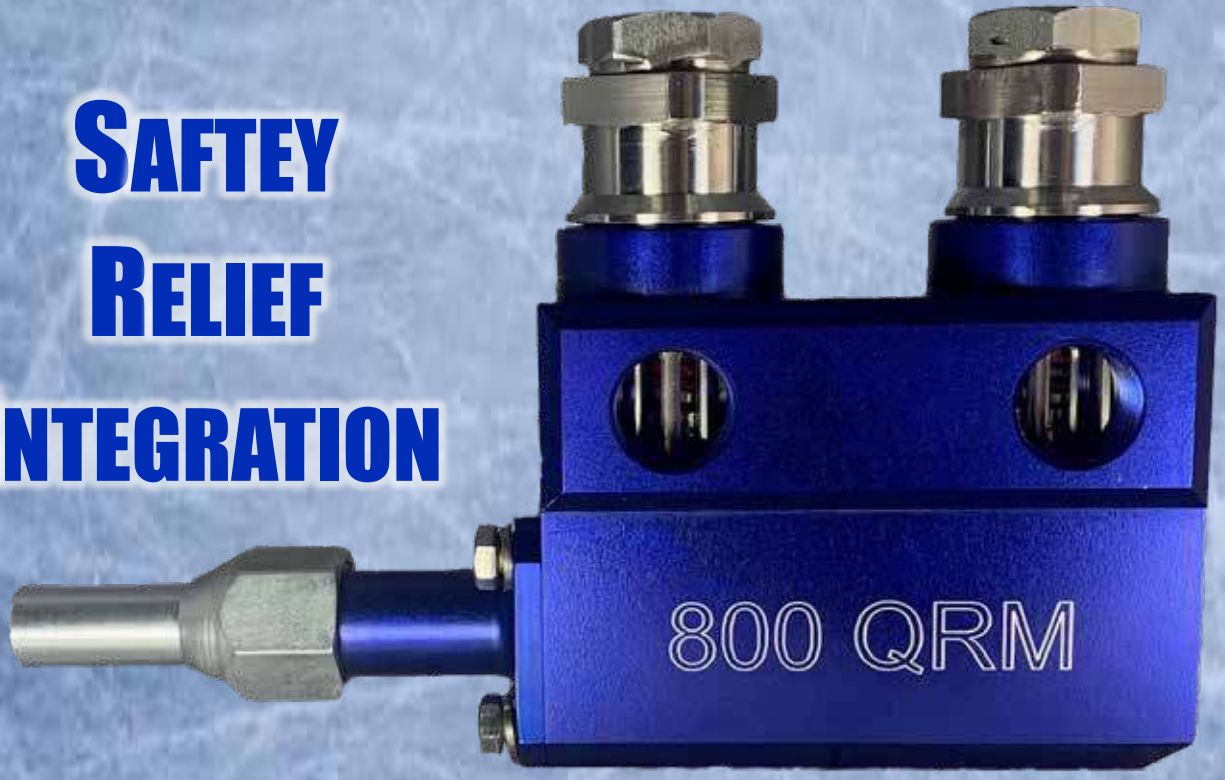

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How can I find water?

BY KEM RUSSELL

Thinking about water and where to find it, I go back a few years ago to when one of my daughters and I were hiking the Pacific Crest Trail (PCT). We planned to do a north bound hike, which starts at the U.S./Mexico border east of San Diego and heads to Canada. Hoping to avoid wet and cold weather (yes even in southern California), and to also avoid very dry conditions, we started hiking in mid-April. Fortunately, and unfortunately, the year we hiked it was one of the driest on record.

The desert section of the PCT is a long 700 miles of almost constant search for water. The focus of each day was finding the next water source, which were at times many miles apart. Finding water became a valuable skill.

During these weird COVID-19 days, weeks, and months, I found myself with some extra time on my hands and I started thinking about finding water, specifically finding how much water there might be in an ammonia system. I would guess a similar thought has crossed the mind of many refrigeration operators and engineers, but I have also been somewhat surprised that a lot of people never look into this. So, I started looking into how finding the water might be done, and the effects on increasing quantities of water in a system. Then a refrigeration technician and I did some testing.

I have, for a long, long time, heard water in an ammonia system isn't good. How come? I did some digging to find out the effect of excess water in an ammonia system. One of the helpful sources is IIAR Bulletin 108 "Guidelines for: Water Contamination in Ammonia Refrigeration Systems".

The first sentence in the preface of the bulletin was an eye opener "Water contamination of the ammonia refrigerant is common in many refrigerating systems."

What is used in industrial refrigeration systems is not just ammonia but "anhydrous ammonia," meaning free of water. What is used is 99.95% ammonia, with the other 0.05% being other contaminates. One of those contaminates is water. ANSI/IIAR Standard 2, in chapter 5, Table 5.2.2 Purity Requirements, shows that water content can be a minimum of 50 ppm to a maximum of 5,000 ppm. Since ammonia and water have a great affinity to each other, it is possible to, over time, increase that percent of water over the 5,000 ppm maximum.

As the percent of water in a system increases, it dilutes the ammonia, which changes the pressure-temperature relationship. From Bulletin 108, "At a given pressure the saturated temperature for anhydrous ammonia will be lower than the saturated temperature for an aqueous solution. As the aqueous solution becomes more dilute (water content is increased), the saturate temperature becomes higher."

The increasing percent of water in the system affects just about everything in the system. The bottom line is, as the water percent increases, the system has to work harder to maintain the desired refrigeration effect, which means more energy is used.

So, where am I going find the water in a system? Bulletin 108 gives some likely locations, such as: an LPR dropleg or pump discharge line; a Control Pressure Receiver (CPR) (transfer line between the transfer vessel and the CPR); a surge drum dropleg (oil drain valve). In a DX system it might be the suction accumulator. For additional insight read Bruce Nelson's IIAR 2010 paper "Thermodynamic Effects of Water in Ammonia Evaporator Performance".

Where is the water? Basically, the places in a system with the lowest pressure, which result in the largest difference between the vapor pressure of water and ammonia.

So, now we know where to look, how do we do it?

You don't just drain a sample into a pop can and see what's left once most of the ammonia evaporates. You need to be more precise. Bulletin 108 gives a list for an apparatus. You can also start by purchasing a graduated flask, such as from H.A. Phillips. The lesson we learned: it is not as simple as it looks, or sounds.

I sketched up an assembly based on what I had learned from various sources, and purchased a few simple parts from a chemical supplier on the web. Then I gave my sketch to the shop to build. Several suggested modifications later I saw the end result, and it took me a few seconds before I realized, "Hmmmm, I guess that's what I was thinking of."

The new sampling apparatus had a means to hold the flask, plus the addition of a vertical pipe that could be filled with water. The thought was that the vent from the hose used to fill the flask could be bled into the water. Also, after the sample is taken, a person may want to vent the hose into water instead of releasing it to atmosphere, depending on where you are. There was also a couple of ¼" valves to direct flow either to the flask or vent.

You might be wondering . . . why the hose? Why not open a valve at the sample point and drain into the flask? We learned two things. One, there are many places where it is very challenging to drain directly into a flask. So, having a hose allows you to get into a better, and potentially safer location. Two, as we found out, trying to control the sample flow with a typical drain valve (1/2", ¾", whatever) was very challenging. We found it best to have the ¼" stainless steel braided hose connected to the sample point, and a ¼" valve to control flow.

Before heading out to take samples I wrote up my best guess for a sampling procedure. One reason was that neither I, nor anyone else, had ever done an ammonia/water sampling test, and two, I wanted to pre-plan how to safely do the entire process and the PPE precautions that should be taken.

With apparatus in hand, well both hands, since the thing was almost tank proof except for the flask, we headed to a facility to do a test. The first machine room had a mechanical pumped recirculator, which should be a good sampling location. The recirculator had an oil pot, which we initially thought might be a good point to take a sample.

Another lesson learned: oil pots, droplegs, etc. are designed to retain oil.

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There should be very little or no oil in your sample, since the oil will take up volume in the sample, resulting in an inaccurate test. If you decide to take a sample from one of these locations, be prepared to spend time draining the oil so you can get a clean sample. After experimenting for a while we realized we needed to sample someplace else or this process was going to take us a lot longer.

Because this was a pump recirculator, there was an access valve with a pressure gauge on the outlet of the pump. Since the pump(s) were connected to the lower section of the LPR dropleg, this should be a good sample location. We connected the hose to the pump discharge gauge valve. Then before we started to take a sample we verified the machine room exhaust fan was operating, and also opened the roll-up access door into the machine room to allow good air-flow.

With the sample hose connected, water in the apparatus vent pipe, and the flask securely held in place, we were ready. The sample was to be 100 ml. That was another lesson learned. It is tough to get just 100 ml. The lower the pressure at the sample point, the easier it is to control the flow rate. On the first sample test, we overshot the 100 ml line by a lot, because we underestimated the flow rate, the vaporization that occurs from everything being cooled by the ammonia, and how much residual ammonia would be in the sample hose. On the third sample, we got very close to 100 ml's.

Now the slow part of the process begins. The sample needs to evaporate till all that is left is the ammonia/water mixture, and possibly (likely) some residual oil. Bulletin 108 suggested to have an 80°F to 90°F water bath to use as a heat source for the flask sample. The flask should not be heated quickly (accelerating vaporization) since this could result in some of the sample leaving the flask in the liquid state, which would offset the test results. We didn't use a water bath since the outside temperature was in the low 70's. However, if you have ever waited and watched a 100 ml sample evaporate, it is a very slow process. About as much fun as watching paint dry. It took over 45 minutes in our case, and we periodically heated the flask with our hands to add a small amount of heat and remove the insulating frost layer on the flask that kept building up.

When the sample was done evaporating I calculated the approximate water content based on the amount left from the 100 ml sample. In this first test, the water content was about 0.25%, which meant the system was pretty dry. We did a second test in another machine room, only this time from a Control Pressure Receiver. Learning more from this test too since the supply point pressure was 90 psig, which changed how much and how long the sample control valve is opened. However, after two tries we had a good sample, and the calculation showed this system was also pretty dry, about 0.34%.

Finding out how much water is in a system would be important information, and can help in deciding what might be done to get the water content percentage into the appropriate range. Doing the sampling process takes time, patience, and the use of appropriate PPE. The process is described in Bulletin 108 and other published literature. The key takeaway is that you will be learning some lessons on what works and what does not and realizing that just about every sample point is going to be a little different in what happens. Stay safe.

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SECURE Act Legislation Includes Retirement Plan Changes

The end of year SECURE Act legislation along with the recent economic stimulus package includes significant changes to retirement plans. The following provides a summary of the impact.

THE SECURE ACT

The Setting Every Community Up for Retirement Enhancements (SECURE) Act increases saving opportunities for Americans, with many of the provisions becoming effective January 1, 2020. The SECURE Act contains 29 separate provisions; below is a summary of some of the more substantial changes.

TOPIC	PRE-SECURE ACT LAW	NEW LAW	PLANNING CONSIDERATIONS
Age to Begin Required Minimum Distributions (RMDs)	By April 1 of the year after reaching age 70 ½.	By April 1 of the year after reaching age 72.	• If you turned age 70 ½ in 2019, you will have an RMD for 2019 and 2020. • If you turn age 70 ½ in 2020, your first RMD will be delayed until the year you turn age 72.
Beneficiary Payouts for IRAs and Retirement Plans "Stretch Provision"	Prior to 2020, non-spouse beneficiaries could generally elect: 1. Total distribution 2. RMDs each year based on the beneficiary's life expectancy 3. To deplete the account within five years Please Note: If an IRA owner/plan participant died in 2019 or prior, the non-spouse may continue pre-SECURE Act election.	If an IRA owner/plan participant dies in 2020 or after, a new 10-year rule will apply. The new rule requires the inherited IRA/retirement account to be depleted within 10 years (by December 31 of 10th anniversary of death). Exceptions include spouses, minors, disabled or chronically ill individuals, and non-spouse beneficiaries that are no more than 10 years younger than the deceased. Once a minor reaches the age of majority, the 10-year rule begins.	• Consider amending beneficiary designations to include a spouse as beneficiary. • Review conduit and discretionary trust language to determine whether the provisions continue to align with your estate planning needs. • Consider strategic Roth conversions to eliminate or minimize taxation for beneficiaries. • If an IRA or retirement plan account owner passed away in 2019 (within the last nine months) with a spouse listed as primary beneficiary and contingent beneficiaries designated, the spouse may want to consider disclaiming part or all of the inherited account in order for the non-spouse contingent beneficiaries to stretch RMDs over their life expectancies.
Traditional IRA Contribution Age Limit	Traditional IRA contributions were no longer allowed starting in the year an individual reached age 70 ½.	Beginning in 2020, traditional IRA contributions are allowed at any age, as long as the account owner (or spouse if married filing jointly) has earned income.	• Are you or your spouse still working and eligible to make deductible traditional IRA contributions? • Do after-tax Roth IRA contributions fit better into your estate or tax planning? • Deductible traditional IRA contributions may reduce the amount of your current and future qualified charitable distributions (QCDs).
Compensation for IRA Contributions	Earned income (such as salary, wages, commissions, and income from self- employment), as well as nontaxable combat pay, or taxable alimony was required to make an IRA contribution.	In addition to the forms of compensation previously mentioned, taxable stipends, non-tuition fellowship pay, and tax-exempt "difficulty of care" payments may be used to contribute to an IRA beginning in 2020.	• If you are a graduate or postdoctoral student, consider funding an IRA with taxable stipends or non-tuition fellowship payments. • If you are a home healthcare worker, consider funding an IRA with tax-exempt "difficulty of care" compensation.

TOPIC	PRE-SECURE ACT LAW	NEW LAW	PLANNING CONSIDERATIONS
Penalty-Free Withdrawals for Birth or Adoption of Child	IRA/retirement plan distributions were generally taxable as ordinary income and subject to a 10% early withdrawal penalty prior to age 59 ½. Certain penalty exceptions may have applied.	Allows a $5,000 penalty-free IRA/retirement plan withdrawal to cover expenses related to the birth or adoption of a child.	• If both parents have an IRA or retirement plan, each may take a $5,000 penalty-free withdrawal ($10,000 combined) to cover expenses for the same child. • Withdrawal must occur during the one-year period beginning on the date the individual's child is born or legal adoption of an eligible adoptee is finalized.
529 Plan Eligible Expenses	529 Plan funds could be distributed tax-free to cover qualified higher education expenses (undergraduate or graduate), such as tuition, books, and room and board. Additionally, funds could be used to pay up to $10,000 of K-12 tuition costs per year (subject to state law). sisters, and step-brothers.	In addition to the tax-free distributions previously mentioned, 529 Plan funds may be distributed tax-free to pay for registered apprenticeships. 529 Plan funds may also be used to pay down student loans (subject to a lifetime limit of $10,000).	• The $10,000 lifetime limit is a per-person limit; therefore, an additional $10,000 may be distributed to satisfy outstanding student debt for each of a 529 Plan beneficiary's siblings. The beneficiary's siblings include brothers, sisters, step-
Kiddie Tax Calculation	As of January 1, 2018, under the Tax Cuts and Jobs Act (TCJA), a child's net unearned income in excess of specified levels was taxed according to the tax brackets used for estates and trusts.	Beginning in 2020, a child's net unearned income in excess of specified levels is taxed at the parents' tax rate if higher than the child's tax rate. This reverts back to pre-TCJA rules.	• The first $1,100 of unearned income or earned income plus $350 (not to exceed the standard deduction) is exempt; the next $1,100 of taxable income is taxed at the child's tax rate. Any taxable income over and above is taxed at the parents' tax rate. • You can elect to make this retroactive for 2018 and 2019.

RETIREMENT ACCOUNT DISTRIBUTIONS RELIEF IN RESPONSE TO COVID-19

Congress has issued an economic stimulus package to help individuals and businesses endure financial hardship caused by the COVID-19 pandemic. As has proven essential in other financial emergencies, allowing retirement plan participants to have access to their retirement funds can help lessen the negative financial impact of being out of work for a continuous period of time.

Here are the distribution relief options available for retirement accounts:

- Retirement plan loan distribution limits doubled and repayment terms softened
- Special hardship distribution options introduced
- Required minimum distributions (RMDs) for 2020 postponed

Retirement Plan Loan Distributions

Congress has proposed changes to some of the existing rules for taking a loan distribution from a retirement plan along with adding some special features to help qualified individuals get back on their feet. These changes:

- Double the current plan loan limits to the lesser of $100,000 or 100% of the vested account balance
- Allow existing repayments and interest to be delayed during the months following the pandemic for up to 12 months

Hardship Distributions for IRAs and Retirement Plans

The stimulus package also provides the opportunity for qualified individuals to take a special hardship distribution of up to $100,000 from their IRA or retirement plan.

Who is a qualified individual?

- Anyone who contracts COVID-19
- Anyone who has a spouse or dependent who contracts COVID-19

- Anyone who experiences financial hardship from quarantine, being laid off, furloughed, a reduction of work hours due to the virus, or due to lack of child care due to the virus.
- Anyone who meets certain other factors as determined by the Secretary of the Treasury.

What are the special withdrawal provisions?

The new provisions allow individuals to:

- Withdraw up to $100,000 or 100% of the vested account balance
- Avoid the 10% early withdrawal penalty if below age 59½
- Take up to three years to repay the distribution to their retirement account
- Stretch income reporting over three years to lessen ordinary income tax implications

Considerations for Taking Advantage of One of the Distribution Relief Options

- Your ability to pay the money back to your retirement account within the allotted time
- Potential significant tax implications if the money is not recontributed to the plan
- Selling securities to take the withdrawal means potentially selling positions that are currently undervalued, thus locking in your losses
- Opportunity costs of getting out of the market now, especially if your asset value is down – by selling shares and receiving the cash, your money is no longer benefitting from compound and tax-deferred growth over time

Consider using other sources of capital before taking advantage of these special distribution options and consult your Stifel Financial Advisor before making this decision.

Required Minimum Distributions (RMDs)

Under current rules, required minimum distributions (RMDs) must be taken annually from IRAs and retirement plans generally for anyone age 72 and older. Concern has been raised about individuals taking RMDs from IRAs and retirement plans when there has not been enough time to recover account losses as a result of COVID-19; therefore, a temporary waiver for calendar year 2020 allows individuals to forgo the distribution. This waiver includes distributions that were required to be taken by April 1, 2020.

The IIAR and ARF reserve investment funds are currently managed by Stifel Financial Services under the investment policy established by their respective board of directors. Members of IIAR may use the services of Stifel for personal and business investments and take advantage of the reduced rate structure offered with IIAR membership. This information is for educational purposes only. Stifel does not provide legal or tax advice. You should consult with your legal and tax advisors regarding your particular situation. For additional wealth planning assistance, contact your Stifel representative: Jeff Howard or Jim Lenaghan at (251) 340-5044.

Critical Tasks for Emergency Action Planning — IIAR's new Guidance Document

When handled correctly, ammonia is one of the safest gases to work with, Gary Smith, president and CEO of the Ammonia Safety and Training Institute, said in his presentation at IIAR's Virtual Conference and Expo.

Over 5 million tons are used every year in approximately 7,000 facilities across the country with significantly fewer incidents per facility when compared to other chemicals.

"That's not to say ammonia isn't dangerous," Smith said. "What it is to say is that we can do better – we could have such a great record that we could have no losses, no deaths, no serious injuries – everybody wins. That's our goal."

Emergency action planning is critical to the successful and safe operation of an ammonia facility, Smith said, discussing an upcoming IIAR guidance document aimed at helping address the lack of pre-event readiness associated with safe work practices and need to provide respiratory protection to escape an ammonia release in the industry. The document is currently in draft form and should be available to the public soon.

Smith said that 30 years of evidence suggests that most ammonia-related deaths and injuries could have been prevented if victims were wearing air purifying respirators (APRs), and that the majority of major incidents could have been avoided or consequences mitigated if better emergency planning had been in place.

The guidance document, *Emergency Action Plan Guidance* for an Ammonia Facility seeks to take the complex nature of dangerous ammonia events and offer straightforward recommendations for respiratory protection, training criteria to help employers develop clearly defined emergency action plans to assure a higher level of life safety for operators, responders, employees, contractors, visitors and community members.

In decades past, the conventional wisdom was centered on a team of technician-level trained responders entering immediately dangerous to life or health (IDLH) emergencies with fully encapsulated entry suits. The time to respond, set-up and enter a simple ammonia leak could take hours.

Many employers who had organized their plant hazmat team found that the cost and work hours to maintain the team was too much. The industry began to rely on public safety hazmat response rather than complying with the then-new regulatory push for an emergency response plan.

Some facilities which could respond to ammonia incidents demobilized their hazmat team and joined the others who relied on public safety services to handle the hazmat emergency.

Previously, codes required the employers to maintain two self-contained breathing apparatuses (SCBAs) located within or near the machinery room. However, the move to demobilize hazmat teams played a part in the removal of the SCBA requirement within the model codes. The concern was if SCBA's were on-site, untrained persons would use them and potentially cause additional injury.

No significant life safety substitutes replaced the two SCBA requirements, and there have not been any new Occupational Safety and Health Administration (OSHA) requirements that would require advances in PPE for high-risk critical task performance for those who choose the emergency action plan approach.

The pending IIAR guidance document aims to meet the industry's need to develop clear and well-considered guidelines on how to accomplish a deeper level of engagement of the elements of an Emergency Action Plan (EAP.) Evidence shows that the nonengagement, "push a button and run," EAP logic, has resulted in unacceptable loss of life, off-site consequences and property damage, Smith said.

IIAR's guidance document indicates that the first priority of an EAP should be evacuation and rescue. When developing the EAP, employers need to set the level of engagement, their PPE preparedness, and training for operators and responders. "The best way out is to prepare to escape before the emergency event, and the best rescue is to not have victims," Smith said.

The IIAR guidance document includes recommendations for placement and use of the general PPE for operators that are addressing an ammonia leak and getting out of harm's way. There are five different categories:

1. Operators preparing to open an ammonia system posing IDLH threat;
2. Working on the system after it has been depressurized and evacuated;
3. Mechanical damage while working near a live ammonia system;
4. Employee, contractor or visitor entering the danger area;
5. Employee, contractor or visitor who may be forced to pass through an IDLH area.

Ultimately, the clear and unequivocal guidance is that all personnel conducting line and equipment openings must wear a full-face APR. Situations that pose a significant threat of creating an IDLH circumstance must wear a NIOSH 14G certified full-face gas mask with an ammonia canister.

"We're chasing perfection. The vision is no deaths, no serious injuries. We can live on with ammonia in the long term and not have the anxiety and fear and the community problems we have because of the misconceptions of what ammonia is instead of what it could be. We'll chase that perfection, and we'll achieve excellence," Smith said.

EPA Announces Termination of Enforcement Discretion, Region 1 Reports Results of GDC Pilot Program

iiar government RELATIONS

BY LOWELL RANDEL, IIAR GOVERNMENT RELATIONS DIRECTOR

TERMINATION OF EPA COVID ENFORCEMENT DISCRETION POLICY

On June 29th, EPA announced the termination date of its temporary enforcement discretion policy contained in a March 26th memorandum entitled: "COVID-19 Implications for EPA's Enforcement and Compliance Assurance Program". The policy was instituted with the recognition that travel restrictions and stay-at-home orders may impact the ability of some facilities to meet certain compliance requirements during the pandemic. It is important to note that entities should continue to make every effort to comply with their environmental compliance obligations and the policy applies only to situations where compliance is not reasonably practicable as a result of COVID-19. EPA believes that as more parts of the country reopen, these situations will become fewer and fewer.

EPA indicated in the original memo that the policy is temporary and the agency would provide notice to the regulated community when the policy would be terminated. EPA has determined that it is appropriate to expressly include a provision in the temporary policy that specifies a termination date. EPA selected August 31, 2020, as the termination date for the temporary policy. According to EPA, this date reflects the appropriate balancing of the relevant factors; it recognizes that the circumstances surrounding the temporary policy are changing, but also ensures that there is adequate time to adjust to the changing circumstances. While the broad discretionary policy will end on August 31st, EPA has noted that nothing in the termination of the policy would limit the ability of the EPA to exercise enforcement discretion on a case-by-case basis regarding any noncompliance, including noncompliance caused by the COVID-19 public health emergency. This includes the situation in which a person or entity makes a reasonable attempt to comply with guidance from the Centers for Disease Control and Prevention or other agencies regarding actions suggested to stem the transmission and spread of COVID-19, which the person or entity reasonably deems applicable to its circumstances.

IIAR members are encouraged to fully document any situations where compliance is not possible due to COVID-19. This documentation should take place as it happens, and not recorded after the fact to justify non-compliance. In addition, IIAR members should document their plans to return to compliance once conditions permit. These efforts to demonstrate due diligence and good faith will be critical when explaining the facilities actions to EPA.

IIAR members are encouraged to fully document any situations where compliance is not possible due to COVID-19. This documentation should take place as it happens, and not recorded after the fact to justify non-compliance.

EPA REGION 1 GENERAL DUTY CLAUSE PILOT RESULTS

On July 23rd, the Environmental Protection Agency's (EPA) Region 1 reported on its activities to implement a pilot program focused on improving safety of industrial refrigeration facilities in the Northeast with less than 10,000 pounds of ammonia. The pilot program, launched in 2018, was initiated due to the high number of ammonia facilities in the region not subject to the Risk Management Program (RMP) and the perceived risks represented by these General Duty Clause (GDC) facilities. EPA estimates that approximately 80% of the ammonia refrigeration facilities in New England have fewer than 10,000 pounds of ammonia and so are subject to the GDC instead of the RMP regulations.

Through its GDC Initiative, EPA Region 1 is working to improve compliance with the first GDC requirement -- that facilities must identify hazards

that may result from accidental releases using appropriate hazard assessment techniques. EPA has completed three rounds of the GDC Initiative, reaching hundreds of facilities in the region. Included in these activities has been ammonia safety trainings in all six New England states, an ammonia refrigeration webinar, training specific to ice rinks, ammonia table-top emergency response exercises, and informative letters and emails to facilities with ammonia refrigeration systems and their contractors.

EPA has issued information request letters to 50 companies under the pilot and entered into Expedited Settlement Agreements (ESAs) with seven facilities that had not yet completed process hazard reviews. Facilities that have not completed process hazard reviews are subject to enforcement action. Under the GDC pilot, EPA is offering reduced penalties for facilities that complete a process hazard review with assistance from a third-party expert and meeting with emergency responders to plan for a potential release from the facility. EPA has announced that all 50 of the facilities contacted thus far have reported that they are now in compliance with the first duty of the GDC, 34 of those (including the ESAs) occurring after the start of outreach about the Initiative. EPA Region 1 is planning to conduct additional compliance assistance activities and send another round of information request letters to facilities.

Facilities in Region 1 with less than 10,000 pounds of ammonia are strongly encouraged to ensure that they are taking appropriate action to comply with the General Duty Clause. Other EPA Regions have expressed interest in the Region 1 program, and it is possible that other regions may implement similar programs. IIAR's Ammonia Refrigeration Management Program (ARM) can assist facilities in meeting these requirements.

IIAR's International Activity Grows Despite Pandemic

[global VIEW]

The global health crisis has impacted nearly all aspects of the refrigeration industry, and by extension, the International Institute of Ammonia Refrigeration and its committees have had to adapt to the changing landscape. Against this headwind, IIAR's International Committee, led by Yesenia Rector, has been working to expand the Institute's footprint beyond North America.

Activity in Costa Rica has been very encouraging, Rector said. Costa Rica has already adopted IIAR Standards 2, 4 and 8, and authorities there are now looking to do the same with IIAR Standards 3, 5, 6, 7 and 9. "We expect to see this adoption by as early as the beginning of next year," she said. "They're actively working on that."

Costa Rica's wholesale codification of all of IIAR's Standards into national norms is important for two reasons, Rector said. First, it will greatly improve the safety and efficiency of the industry in the country, which will in turn reflect positively on the industry on a global scale. Second, it increases IIAR's visibility and authority as a standards-creating body.

Once the standards are adopted, Rector said, the next step is to educate, train and certify industry professionals – an effort that is also ongoing in Costa Rica. IIAR along with its Costa Rican partner CIEMI (College of Industrial Electrical and Mechanical Engineers) is offering Spanish-language materials from IIAR's Academy of Natural Refrigerants for local industry professionals. There are 32 individuals currently taking the course, which is delivered online through IIAR's learning management system.

Rector said she hopes Costa Rica can serve as a model for the rest of the world. "The idea is that once our standards are codified anywhere in the globe, they will come to IIAR to seek further education," she said. "That's where IIAR will take the leading role."

This Costa Rican model is starting to play out in Colombia. Rector said she has been meeting with the county's code-writing bodies, who are interested in following the same process as Costa Rica. "We're in the beginning stages, of course, but they are motivated," she said, adding that the educational component of the process is already in motion. Working with its national partner ACAIRE (Asociación Colombiana De Acondicionamiento Del Aire Y De La Refrigeración), Colombia's first online course on IIAR-2 is set to begin in late August.

Educational tracks are also set up in Argentina through the country's IIAR chapter, which are open for registration through the middle of September, Rector said.

Looking farther into the future, the international committee hopes it can resume its in-person events. As of now, there are events planned for May 2021 in Lima, Peru, and Guayaquil, Ecuador. A trade show is also planned in Mexico in 2021.

Beyond Latin America, IIAR is getting very close to securing a partnership with a new organization in Spain.

"AEFYT [Asociación de Empresas de Frío y Sus Tecnologías] already signed the MOU, and our board is about to sign," Rector said. "This will be another organization being added to our allied associations across the globe. It's great – we're looking forward to working with them, and we can be very effective partners in the industry."

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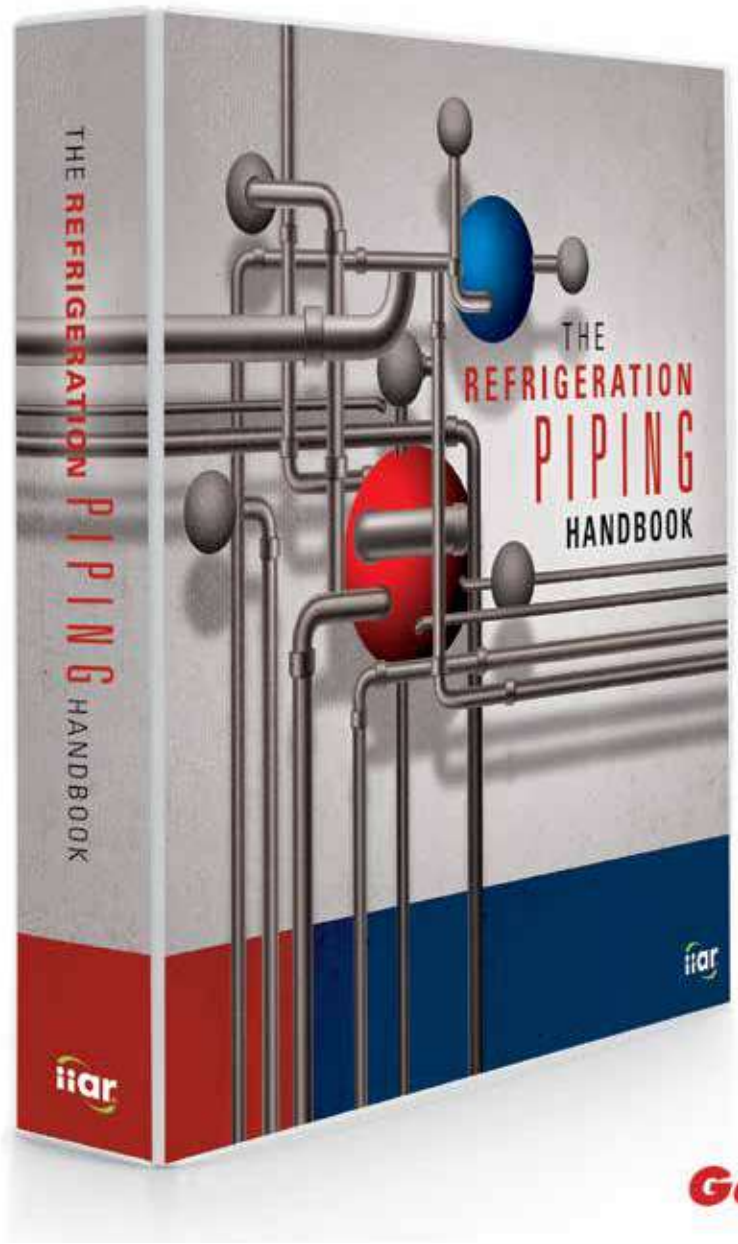

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Case History: A Study of Incidents in the Ammonia Refrigeration Industry

Peter R. Jordan, Senior Principle Engineer, MBD Risk Management Services, Inc.

ABSTRACT

In June of 2005, the author initiated a project to collect data related to ammonia incidents using information from publicly available sources. For the past 14 years, the data have been input into an Excel spreadsheet every day. This information was analyzed and compared with historical incident data available from the U.S. Environmental Protection Agency's Risk Management Plan database and a 2008 IIAR survey. The hope is that analyzing these incidents will highlight industry policies and practices that can prevent and/or mitigate the consequences of future incidents in the ammonia refrigeration industry, thereby improving overall industry safety.

ACKNOWLEDGEMENT

The success of the 42nd Annual Meeting of the International Institute of Ammonia Refrigeration is due to the quality of the technical papers in this volume and the labor of its authors. IIAR expresses its deep appreciation to the authors, reviewers and editors for their contributions to the ammonia refrigeration industry.

ABOUT THIS VOLUME

IIAR Technical Papers are subjected to rigorous technical peer review. The views expressed in the papers in this volume are those of the authors, not the International Institute of Ammonia Refrigeration. They are not official positions of the Institute and are not officially endorsed.

International Institute of Ammonia Refrigeration
1001 North Fairfax Street, Suite 503
Alexandria, VA 22314

+ 1-703-312-4200 (voice)
+ 1-703-312-0065 (fax)
www.iiar.org

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Introduction

The Occupational Safety and Health Administration (OSHA) published the Process Safety Management (PSM) standard, 29 CFR 1910.119, as a Final Rule on February 24, 1992. The U.S. Environmental Protection Agency (EPA) issued the Risk Management Program (RMP), 40 CFR Part 68, as a Final Rule on January 31, 1994. The purpose of these regulations is to prevent accidental releases of chemicals that could pose a threat to human health and the environment.

IIAR members have struggled to answer some basic industry-related questions since the earliest days of the PSM standard and the RMP rule. For example,

1. How many incidents occur in the ammonia refrigeration industry?
2. What are the consequences of these incidents?
3. What are the most common causes of the incidents?
4. What can be done to prevent and/or minimize the consequences of these incidents?

This paper focuses on the efforts made to answer these questions.

EPA RMP Database

In 2004, IIAR formed an Ammonia Release Task Force. The mission of the task force was to collect and compile information on all ammonia releases throughout the industry (IIAR 2004). The data collected would be used to identify the areas of greatest need for attention to help the industry reduce the number of releases.

One of the first actions this task force accomplished was to collaborate with the U.S. Chemical Safety and Hazard Investigation Board (CSB) to review five-year accident history data contained in EPA's RMP database. Facilities are required to report accidental releases from covered processes that have significant on-site or off-site impacts in the five-year accident history section (Section 6) of the RMPs submitted to the EPA. Significant on-site and off-site impacts are defined as accidental releases that result in on-site deaths, injuries, or significant property damage; or known off-site deaths, injuries, evacuations, sheltering in place, property damage, or environmental damage.

CSB provided the IIAR Ammonia Release Task Force a spreadsheet that included more than 600 ammonia refrigeration incidents contained in RMPs submitted between 1994 and 2004 (CSB 2004). Based on analysis of these incidents, the task force came to the following conclusions:

1. The following industry sectors had the most incidents reported in the five-year accident history database:

    a. Red meat and poultry processing facilities,

    b. Cold storage facilities,

    c. Frozen food facilities, and

    d. Dairies and related facilities.

2. Facilities may have been unsure of the five-year accident history requirements and may thus have overreported ammonia incidents to the EPA. Almost half of the five-year incidents reported to the EPA during this period had no on-site or off-site impacts listed in Section 6.9 (On-Site Impacts) or Section 6.10 (Known Off-Site Impacts) of their RMP submissions. If an incident had no on-site or off-site impacts, it should not have been reported in the five-year accident history.

3. Approximately half of the releases were reported to be from valves and piping.

4. Approximately half of the reported incidents were related to equipment failure and approximately half were related to human error. Contributing factors related to equipment failure included overpressure scenarios, process design failures, and unsuitable equipment. Contributing factors related to human error were maintenance activities, improper procedures, and management error.

The information provided by EPA and CSB proved valuable, but it was only a first step. Based on a review of RMP five-year accident histories, ammonia incidents were clearly occurring, but the root causes of these incidents were not immediately identifiable. The task force felt that additional work was needed.

IIAR Industry Section Meeting

The next step taken by IIAR's Ammonia Release Task Force was to obtain ammonia incident data directly from industry representatives. In June of 2006, the task force set up a meeting in Arkansas with representatives from five companies in the poultry processing sector. During this meeting, the following ground rules were established:

1. All participating companies were to benefit from this meeting because the goal was to identify industry-specific recommendations designed to reduce the number of ammonia incidents occurring at industrial ammonia refrigeration facilities.

2. No information was to be documented that would identify the company associated with any ammonia incident.

3. No marketing was to occur in Arkansas; the task force had nothing to "sell" except safety.

4. The poultry processing sector was to be the first of at least five industry sector meetings to be conducted.

The hope was that the meeting participants would be free to discuss actual incidents that occurred at their facilities. Specifically, the task force would attempt to determine the following information:

- What were the root causes of these ammonia incidents?
- What were the consequences of these ammonia incidents?
- What recommendations were made/can be made to prevent future incidents?

IIAR's Ammonia Release Task Force assumed that industry representatives would be willing to discuss ammonia incidents at their facilities openly provided that the incident information was de-identified. Five ammonia incidents were discussed

with five poultry processers during the initial meeting, in which the task force promised neither to take notes nor to release the results of these discussions due to the sensitive nature of the incident data. However, because no information was recorded or analyzed, the main goals of the meeting were not accomplished. After additional attempts to overcome this shortcoming, the task force abandoned the idea of obtaining ammonia incident data during industry sector meetings, recognizing that any data obtained during these meetings was too sensitive to be released to the industry at large.

IIAR Ammonia Incident Survey

In May of 2008, IIAR tried a different approach to collecting ammonia incident data, sending a questionnaire to all IIAR members. The stated intention of the questionnaire was to obtain ammonia incident information to assist IIAR members in the proper and safe handling of ammonia as a refrigerant. Also noted on the questionnaire was that all collected information would remain anonymous.

The questionnaire included the following 12 questions (IIAR 2008):

- What organization does your facility belong to?
- What region is your facility located?
- Which category does your facility fall under? More than 10,000 pounds of ammonia? Less than 10,000 pounds of ammonia?
- Which of the following best describes your facility (i.e. Cold Storage Facility, Dairy Facility, Frozen Food Production, etc.)?
- Based on your experience, where in the system do most of the ammonia releases occur?
- What are the areas where most ammonia releases occur (not included in question #5)?
- Based on your experience, what are the most common causes of ammonia releases?

- What are the most common causes of ammonia releases (not included in question #7)?
- During the past five years, how many ammonia releases amounting to at least 100 pounds has your facility experienced?
- What type of response resulted from the ammonia releases?
- What factors most commonly lead to ammonia releases?
- Which areas should the IIAR focus on?

IIAR summarized the ammonia incident survey results in October 2009. More than 500 facilities in the ammonia refrigeration industry provided ammonia incident information. Approximately 80% of the responses came from facilities housing more than 10,000 lb of ammonia and thus most likely subject to OSHA's PSM Standard and EPA's RMP Rule. More than 20% of the responses were from facilities storing less than 10,000 lb of ammonia and thus were most likely subject to OSHA and EPA General Duty Clauses. The greatest number of responses came from cold storage facilities (33%), frozen food production facilities (16%), and meat processing facilities (11%).

Figure 1 shows that more than two-thirds of the facilities responding to the survey had no ammonia releases of at least 100 lb during the five years preceding the survey. Thirty-one facilities (6%) had three or more releases of at least 100 lb during this same period, and nine facilities reported that they had experienced 10 or more incidents during the preceding five years in which more than 100 lb of ammonia was released.

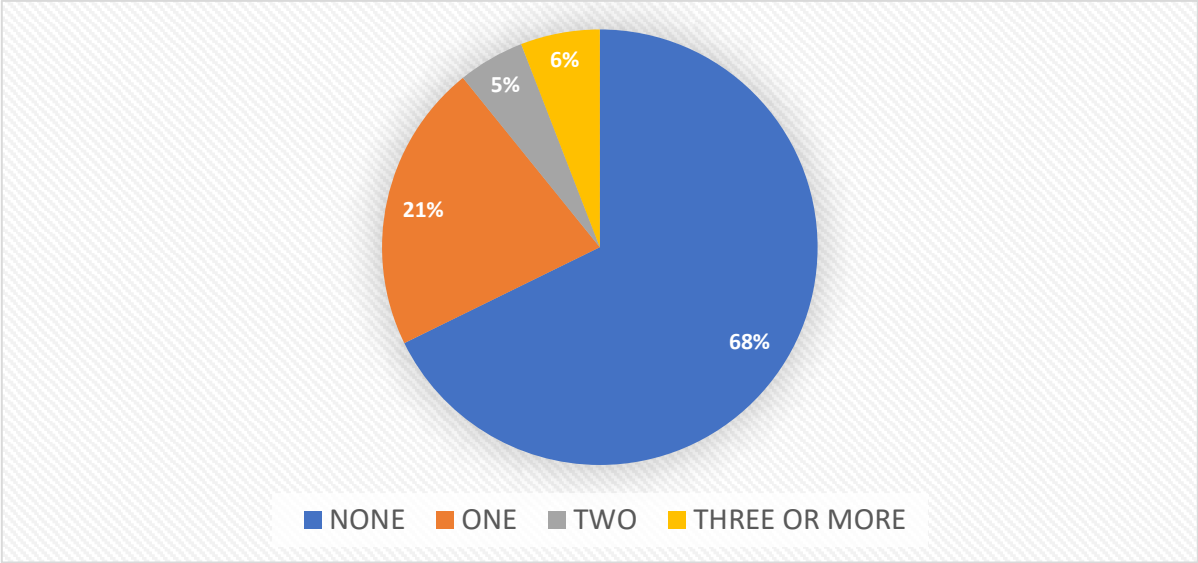

Figure 1. IIAR survey: Releases greater than 100 lb.

Figure 2 summarizes the consequences of the releases reported in the IIAR survey. Facilities were evacuated in approximately one-quarter of the releases, and off-site consequences occurred in 10% of the releases. Only 3% of the releases resulted in injuries.

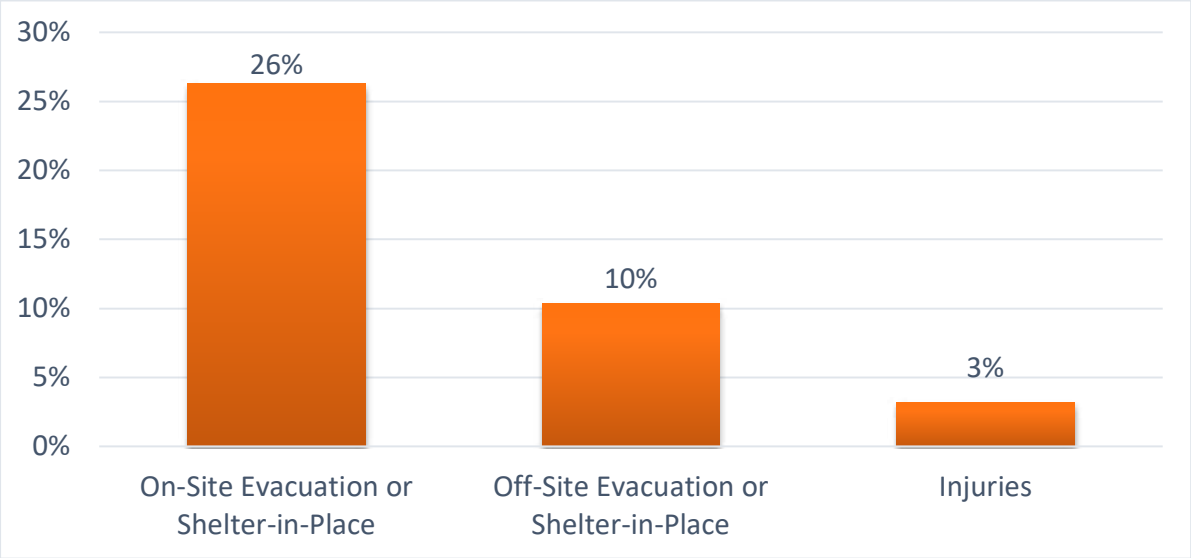

Figure 2. IIAR survey: Percentage of facilities experiencing a consequence of release.

Questionnaire respondents indicated that equipment failure caused approximately 60% of the reported incidents. The top five reported causes of equipment failure related to

- Leaks from mechanical seals,
- Corrosion,
- Relief valve opening prematurely,
- Hydraulic or thermal shock, and
- Failure of safety cutout.

Questionnaire respondents reported that human error caused 37% of the incidents. The top five reported causes of human error related to

- Improper training,
- Improper maintenance procedures,
- Oil draining procedures,
- Line opening procedures, and
- Improper valve opened or closed.

Ammonia Incident Database

To discover the root causes of the incidents described in RMPs submitted between 1994 and 2004, an effort was begun in June of 2005 to collect in an Excel spreadsheet the ammonia incident data reported via publicly available sources. The vast majority of the information contained in this "Ammonia Incident Database" was obtained via Google Alerts. Google Alerts is a content-change detection and notification service offered by the search engine company Google. The service sends emails to users when it finds new results—such as web pages, newspaper articles, blogs, or scientific research—that match a user's search term (Wikipedia 2019). The search term used to generate the Ammonia Incident Database was "ammonia."

Additional information in the Ammonia Incident Database was obtained from incident reports posted on the Chemical Safety Board's website. A conscious decision was made not to supplement the Ammonia Incident Database with information obtained from any other source, including first-hand knowledge of any incident, to enable analysis of "raw" data obtained from consistent sources.

Each day, the publicly reported ammonia incidents were reviewed and entered into the Ammonia Incident Database along with the following information:

1. Source of the information;
2. Date and time of the incident;
3. Company involved, including location;
4. Amount of ammonia released;
5. Release duration;
6. Off-site response personnel involvement;
7. Consequences of the release;
8. Release location; and
9. Cause of the release.

When preparing this technical paper, the Ammonia Incident Database was modified by restricting incidents included in the database to those that occurred in the United States and Canada. Incident data from other countries was excluded for two reasons. First, U.S. and Canadian incident data came from a wide range of events and included incidents that resulted in relatively minor consequences. Incident data from other countries tended to include only reports of incidents with catastrophic consequences. Second, the database compiler had extensive knowledge and understanding of the practices followed at facilities operating ammonia refrigeration systems in the United States and Canada, but limited experiences regarding the practices followed in the rest of the world.

The goal of the Ammonia Incident Database is to compile details regarding contemporary events, analyze that data, and compare the results with historical incident data in an attempt to answer the following questions:

1. Have the number of incidents increased or decreased?
2. What were the consequences of the incidents?
3. In what daypart did the incidents occur?
4. Which industry sectors were responsible for the incidents?
5. In which geographic regions did the incidents occur?
6. Where in the facility did the incidents occur?
7. What were the most common causes of the incidents?
8. How effective are ammonia mitigation systems?
9. What can be learned from incidents resulting in catastrophic consequences?

The remainder of this paper will address these questions.

Analysis of Ammonia Incident Data

An analysis of the of the Ammonia Incident Database indicates that intensive safety efforts are underway in many segments of the refrigeration industry, but also that there's still a way to with regard to ammonia release prevention programs.

1. Have the Number of Incidents Increased or Decreased?

Figure 3 answers the question concerning the changes in incident numbers—a question that always arises when analyzing or developing safety procedures for the industrial ammonia refrigeration industry. Between 2008 and 2018, ammonia incidents per year reported in the Ammonia Incident Database was relatively constant, averaging 64 reported incidents in the United States and Canada per year. Thus, the number of incidents neither increased nor decreased—it remained essentially constant during that time period.

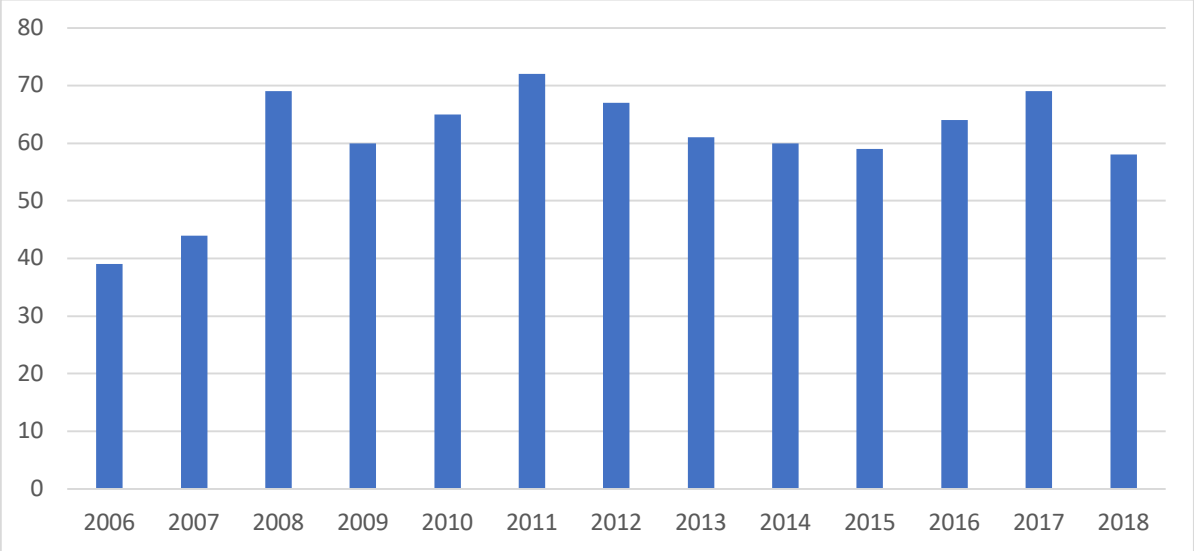

Figure 3. Ammonia Incident Database: number of incidents.

2. What Were the Consequences of the Incidents?

Two assumptions were made when determining the consequences of the ammonia incidents:

1. No off-site consequences were assumed to have occurred if people were ordered to move simply to improve emergency vehicle access to the site. This is consistent with EPA guidance for the preparation of the RMP's five-year accident history (EPA 2009).

2. EPA defines "injuries" for the five-year accident history as any effect that results either from direct exposure to a chemical or from indirect consequences caused by an ignition of a chemical vapor cloud (e.g., a window shattering after an ignition) and that requires medical treatment or hospitalization (EPA 1994). Medical treatment means treatment, other than first aid, administered by a physician or registered professional personnel under standing orders from a physician (EPA 1994). When analyzing the incident data, all persons taken to a hospital were assumed to have been provided with medical treatment and were thus injured.

When data obtained via the IIAR survey was compared with data from the Ammonia Incident Database, more on-site and off-site consequences were reported for incidents in the Ammonia Incident Database than were reported in the IIAR survey (see Figure 4). This is not surprising given that incidents reported via publicly available sources were more likely to result in consequences. Approximately 93% of the incidents in the Ammonia Incident Database resulted in on-site consequences vs. 26% in the IIAR survey. Likewise, 33% of the incidents in the database resulted in injuries vs. 3% in the IIAR survey. The incidents recorded in the Ammonia Incident Database from June of 2005 to September of 2019 resulted in more than 1,500 people requiring treatment for exposure to ammonia. Though the majority of injuries were relatively minor, it

still averaged to one person in the United States or Canada being treated for ammonia exposure every 2.5 days.

The following additional information was gleaned from the Ammonia Incident Database:

- Off-site responder personnel (e.g., the fire department) responded to virtually all (99%) of the incidents.
- The average duration of each incident was approximately four hours.
- The average amount of ammonia released during each incident was calculated to be 2,900 lb, although the accuracy of this figure is questionable because
  - No release amount was reported for the majority of incidents in the database;
  - Numerous incident reports identified "small releases" but no quantity, and the event was not included in the calculations; and
  - The relatively high estimate was skewed by several large ammonia releases in the database.

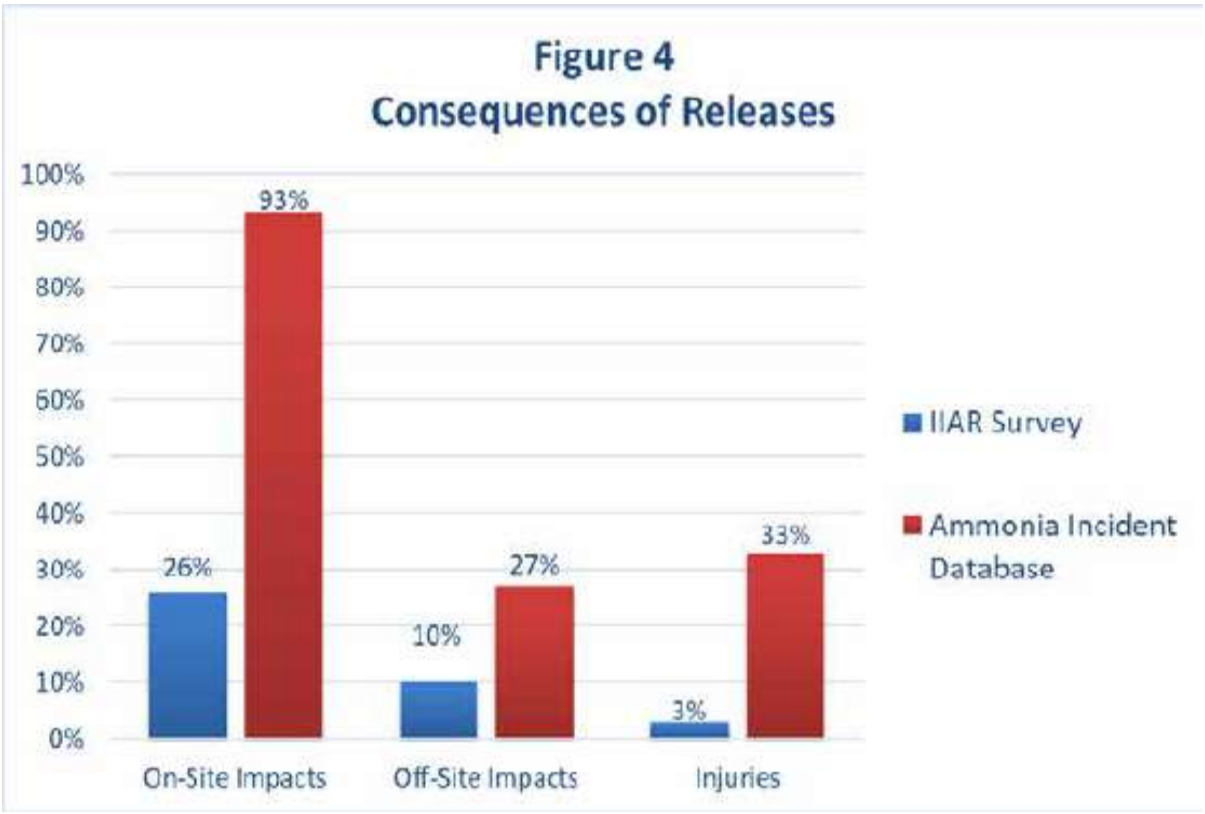

Figure 4. Consequences of releases.

3. In What Daypart Did the Incidents Occur?

The time of day may have affected the timing of ammonia incidents. For example, more ammonia incidents may have occurred during off-shifts because less experienced personnel may have worked during these shifts.

For the purposes of the analysis, each incident was placed into one of three shifts:

1. First shift: 8:01 a.m. to 4 p.m.;

2. Second shift: 4:01 p.m. to midnight; and

3. Third shift: 12:01 a.m. to 8:00 a.m.

Figure 5 shows that almost 75% of the incidents occurred during the first and second shifts, which may reflect that these were the shifts when maintenance and repairs were typically performed. But the bottom line is that incidents occurred during all three shifts.

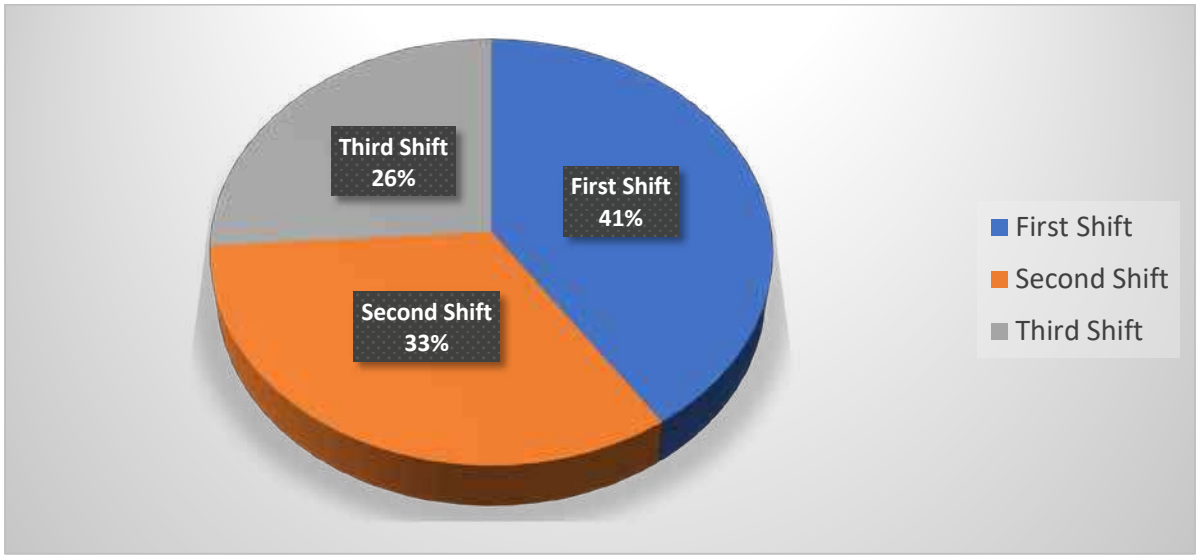

Figure 5. Ammonia Incident Database: incident time period.

The Ammonia Incident Database was examined to determine whether the ammonia incidents display seasonal variation. Figure 6 shows the breakdown by calendar quarter of incidents that occurred during the time period covered by the database. Approximately 60% of the incidents occurred during warm weather periods (second

and third quarters). This may have been due to the seasonal operation of many facilities. For example, vegetable and fruit processing facilities were more likely to be operational during warm weather periods. In addition, warm weather periods were more likely to result in higher system head pressures, which could have led to more releases from pressure relief valves.

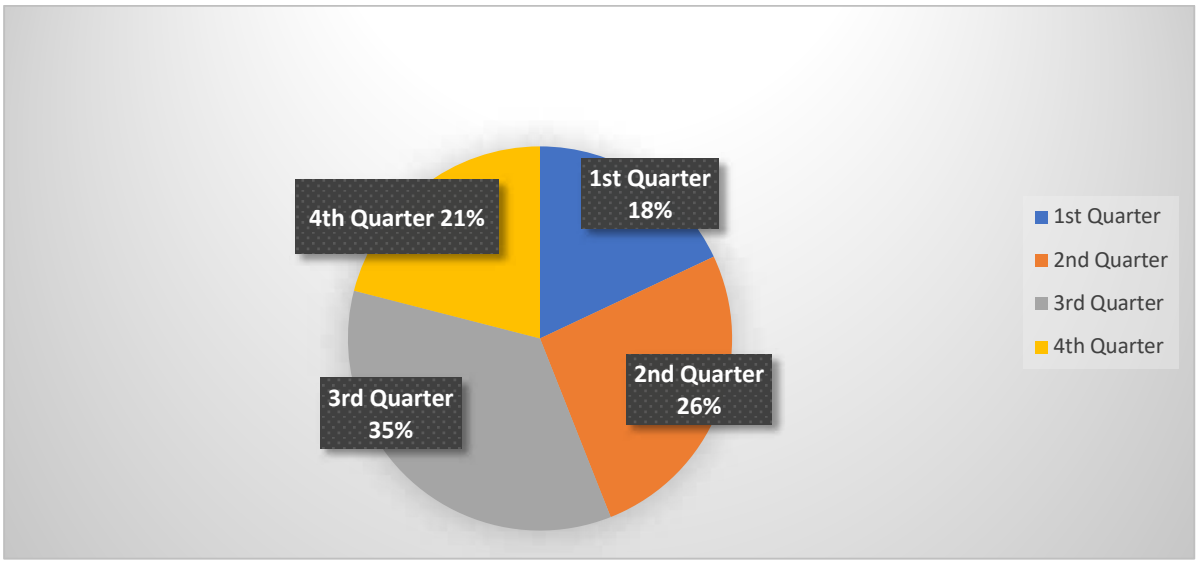

Figure 6. Ammonia Incident Database: seasonal variations.

4. Which Industry Sectors Were Responsible for the Incidents?

Table 1 summarizes incidents by industry. Four of the top five industry sectors on this list (meat and poultry processing, cold storage, dairies, and frozen food) were the top four industry sectors in EPA's RMP five-year accident history database. Three industry sectors at or near the top of the list were not present in EPA's database: ice rinks, beverage, and fruit and vegetable facilities. These three industry sectors were probably not included in EPA's database because many of these facilities contained less than 10,000 lb of anhydrous ammonia and/or were located in Canada and thus not subject to EPA's Risk Management Program.

IIAR survey data indicate that some facilities had more incidents than others. A similar trend was noted in the Ammonia Incident Database. When companies in one industry sector were compared with similarly sized companies in the same industry sector, the number of incidents sometimes varied significantly. For example, Company A in one industry sector had 29 incidents in the database, whereas Company B in the same industry sector had only four incidents.

Industry Sector	Number of Incidents
Meat and poultry processing	159
Cold storage	134
Ice rinks	103
Dairy and related facilities	80
Frozen food	75
Beverage	71
Fruit and vegetables	71
Ice plants	48
Seafood processing	30
Bakeries	18
Total in all industry sectors	789

Table 1. Ammonia Incident Database: industry sectors.

5. In Which Geographic Regions Did the Incidents Occur?

Tables 2 and 3 show the number of incidents in each region in the United States and Canada for the time period June 2005 through September 2019. Regions with higher numbers of incidents, for example, EPA Region 4 (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee) and EPA Region 5 (Illinois, Indiana, Minnesota, Ohio, and Wisconsin), appeared to reflect the total number of meat and poultry processing, cold storage, and dairy facilities located in these regions. The relatively low number of incidents in EPA Region 2 (New York, New Jersey, Puerto Rico, and U.S. Virgin Islands) most likely reflected the relatively small number of facilities operating ammonia refrigeration systems in this region. In Canada, the location of ice rinks appeared to have the greatest effect on the number of incidents occurring in each region.

EPA Region	Number of Incidents
EPA Region 1	53
EPA Region 2	27
EPA Region 3	71
EPA Region 4	132
EPA Region 5	106
EPA Region 6	93
EPA Region 7	51
EPA Region 8	32
EPA Region 9	93
EPA Region 10	68
Total in all regions	726

Table 2. Ammonia Incident Database: EPA Regions in the United States.

Region in Canada	Number of Incidents
Atlantic	13
Quebec	8
Ontario	27
Prairies	37
British Columbia	28
Territories	1
Total in all regions	114

Table 3. Ammonia Incident Database: regions in Canada.

6. Where Did the Incidents Occur?

Figure 7 shows the location within the facilities where incidents occurred. More incidents occurred in machinery rooms than in production areas (i.e., indoor areas other than the machinery room), probably because of the relatively large concentration of refrigeration equipment in machinery rooms. Approximately half of the incidents occurred outdoors. The majority of the outdoor incidents (~73%) in the Ammonia Incident Database were releases from pressure relief valves, and most of the releases from pressure relief valves resulted in injuries and/or off-site consequences.

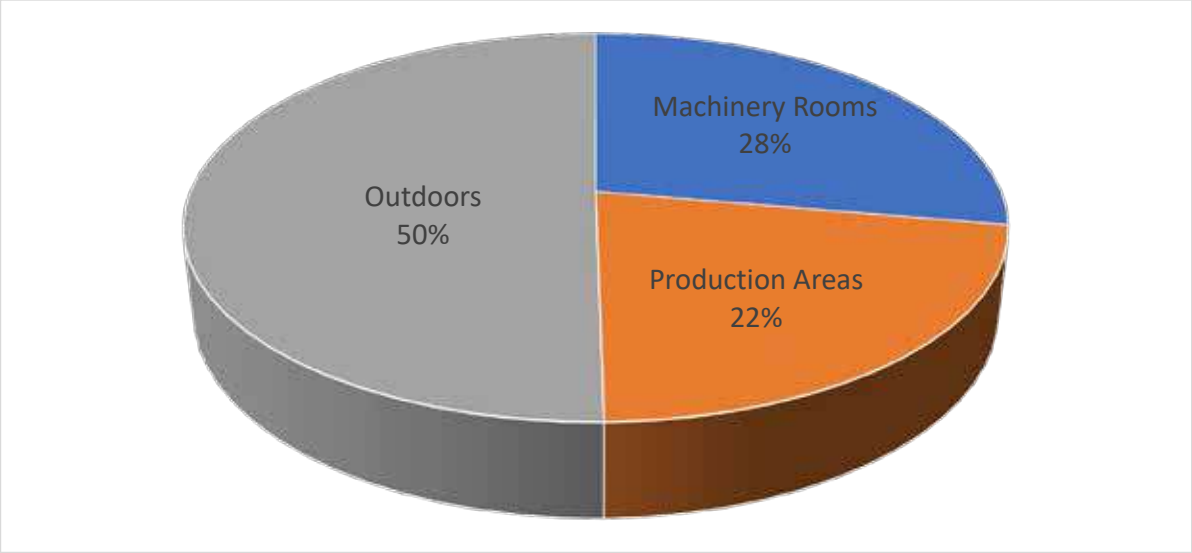

Figure 7. Ammonia Incident Database: incident location.

Figure 8 summarizes the equipment where releases occurred as reported in the IIAR survey and the Ammonia Incident Database, which indicate that 60 to 65% of the releases occurred from flanges, joints, valves, and piping. This was consistent with EPA's RMP database, which reports that approximately half of the releases originated from valves and piping.

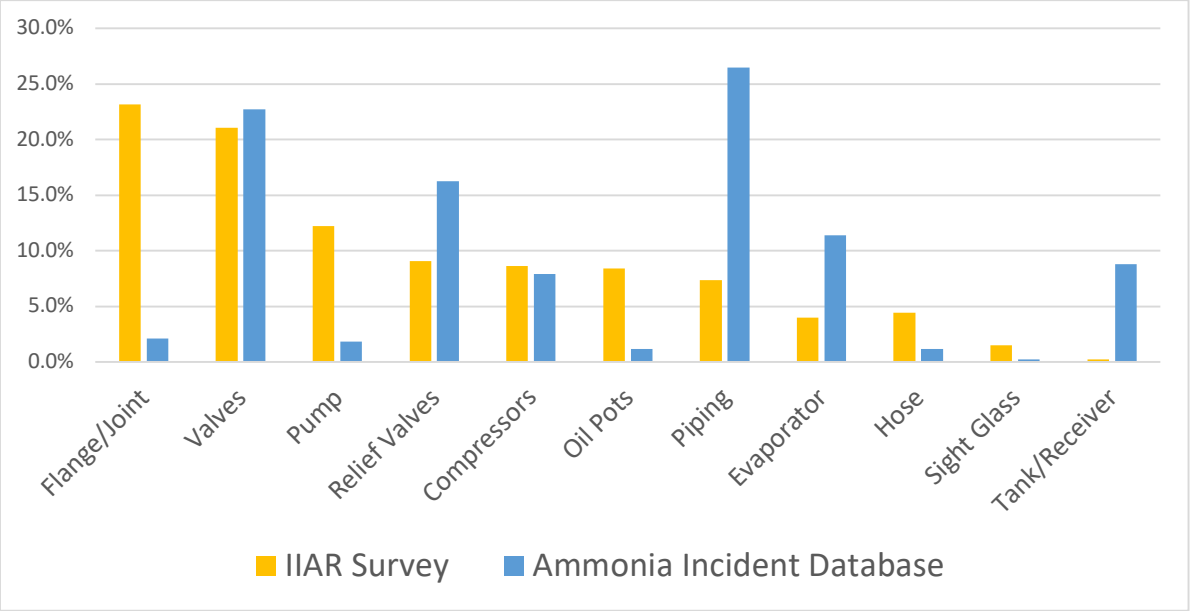

Figure 8. Equipment where incidents occurred.

7. What Were the Most Common Causes of the Incidents?

Figure 9 shows the breakdown of incidents caused by human error, equipment failure, and external events in EPA's RMP database, the IIAR survey, and the Ammonia Incident Database. Each database indicates that a similar number of incidents (between 37 and 48%) were due to human error. The biggest discrepancies were in the number of incidents caused by equipment failure (41% in the Ammonia Incident Database vs. 60% in the IIAR survey) and the number of incidents related to external events (15% in the Ammonia Incident Database vs. 1% in the RMP database and 3% in the IIAR survey). Causes of external events included fires, impacts from motorized equipment (such as forklifts), weather-related events, and damage due to structural or building failure.

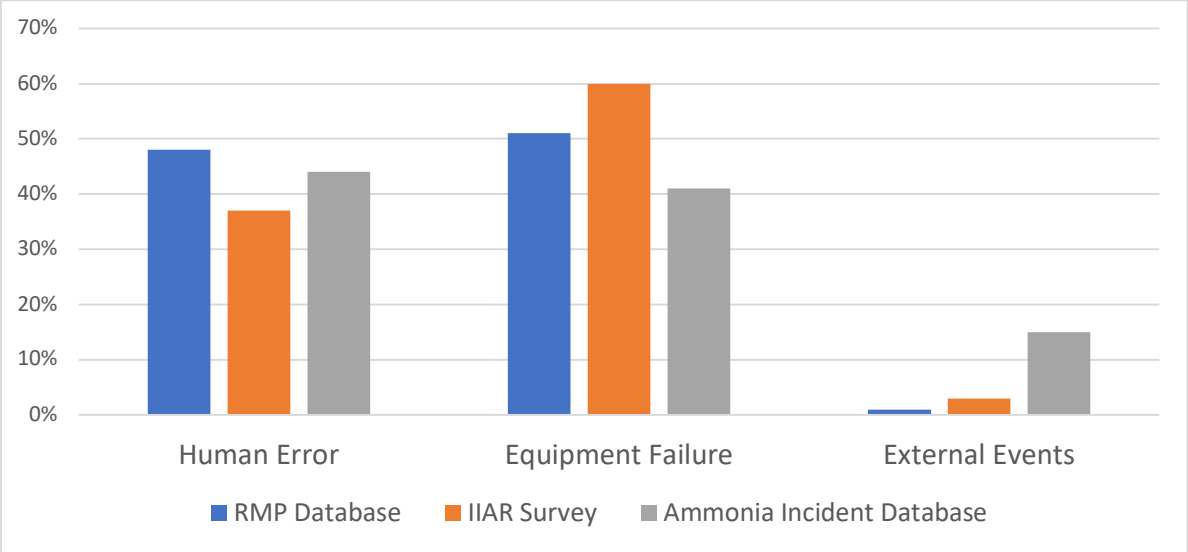

Figure 9. Causes of releases.

Table 4 summarizes the incident causes recorded in the Ammonia Incident Database. Note that no cause was identified for approximately two-thirds of the incidents. More than one-quarter (27%) of the incidents were related to line-opening operations. The database contained numerous comments referring to "residual ammonia was left in the equipment" and "the release occurred when equipment was opened while performing maintenance."

When related causes were combined into one group, the largest percentage of incidents (36%) was caused by equipment failures (faulty equipment, leaks from seals/gaskets, corrosion, and faulty pressure relief valves). The second largest group of incidents (33%) was caused by human errors (line opening, liquid transfer, oil draining, and improper valve opening).

Incident Cause	Percentage of Incidents in Database		Ammonia Safety Program Elements
Faulty equipment	17%	36%	System design (IIAR 2; IIAR 9) Hazard analysis Mechanical integrity program (IIAR 6-2019)
Leak from seal/gasket	9%		
Corrosion	6%		
Relief valve fails open	4%		
Line opening	27%	33%	Line opening procedures (IIAR 7) Operating procedures (IIAR 7) Maintenance procedures (IIAR 6) Training
Transferring liquid	3%		
Oil draining	2%		
Improper valve opened	1%		
Loss of cooling	7%	10%	System design (IIAR 2; IIAR 9) Hazard analysis
Expansion/contraction	2%		
Hydraulic or thermal shock	1%		
Impact from motorized equipment	6%	9%	System design (IIAR 2; IIAR 9) Hazard analysis Training
Structural or building failure	3%		
Decommissioning	5%	6%	Decommissioning procedures (IIAR 8) Installation procedures (IIAR 4) Start-up Procedures (IIAR 5)
Commissioning	1%		
External fire	5%		System design (IIAR 2; IIAR 9) Hazard analysis Hot work permit procedures
Ammonia theft	<1%		System design (IIAR 2; IIAR 9) Hazard analysis

Table 4. Ammonia Incident Database: incident causes.

For each group of incident causes, Table 4 lists general ammonia safety program elements that could have been used to prevent these incidents from occurring and/or minimize the consequences of the incidents. Many of these elements are directly related to current ANSI/IIAR standards.

This technical paper is not the first document to review actual incidents in the ammonia refrigeration industry. In 2001, EPA issued an updated alert on the "Hazards of Ammonia Releases at Ammonia Refrigeration Facilities." The recommendations included in this alert are strikingly similar to the items contained in the ammonia safety program elements column in Table 4. For example, the EPA alert presents the following recommendations:

- Establish training programs to ensure that knowledgeable personnel operate and maintain the ammonia refrigeration system.
- Develop and require refrigeration personnel to follow written, standard procedures for maintaining the system, including such routine practices such as oil draining.
- Provide barriers to protect refrigeration equipment, i.e., lines, valves, and refrigeration coils, from impact areas where forklifts are used.
- Develop and maintain a written preventive maintenance program and schedule based on the manufacturer's recommendations for all of the refrigeration equipment.

8. How Effective Are Ammonia Mitigation Systems?

Members of the IIAR Standards Committee spend countless hours discussing the design of mitigation systems for an ammonia refrigeration system. To aid in these discussions, the Ammonia Incident Database was reviewed for clues on ammonia mitigation systems.

Overpressure protection devices are crucial to the design of a safe ammonia refrigeration system. As mentioned earlier in this paper, the majority of outdoor releases (~73%) noted in the Ammonia Incident Database were from pressure relief

valves. And most of the releases from pressure relief valves resulted in injuries and/or off-site consequences. Where identified, one of five root causes was typically listed as the reason for improper opening of the pressure relief valve:

1. Loss of cooling in the system,
2. Overheating of equipment,
3. Extreme environmental conditions,
4. Power failures, and
5. Relief valve malfunctioned.

The first four root causes are related to the design and operation of an ammonia refrigeration system. The fifth root cause is related to the mechanical integrity of pressure relief valves. Hazard analyses should be conducted to identify the potential circumstances that are causing these pressure relief valves to open. Additional emphasis must also be placed on the design, operation, and maintenance of overpressure relief protection systems.

While reviewing the Ammonia Incident Database, a significant amount of time was spent trying to determine if any conclusions could be reached regarding safe operation of ammonia detection systems, emergency ventilation systems, and emergency shutdown systems. However, very few incidents in the database (fewer than 10) discussed ammonia detection systems, emergency ventilation systems, or emergency shutdown systems, so no conclusions were reached. The publicly available information was primarily based on initial incident reports, and any evaluations of mitigation devices most likely occurred at a later date and not publicly available. The only way to obtain data on ammonia mitigation systems seems to be obtaining incident investigation reports directly from facilities that operate ammonia refrigeration systems.

9. Incidents with Catastrophic Consequences

The Ammonia Incident Database indicated nine incidents that resulted in fatalities at facilities operating ammonia refrigeration systems and two incidents resulting in fatalities at ammonia storage terminals. Table 5 summarizes these incidents. Two issues must be emphasized based on a review of these catastrophic incidents:

1. Nine of the 11 incidents were related to line opening, liquid transfer, or oil draining operations. This supports the hypothesis that these operations are the most hazardous conducted in the ammonia refrigeration industry.

2. Three of the 11 incidents involved persons trapped in limited access areas. The location of ammonia equipment and possible escape routes must be considered during the design of the system and all subsequent hazard analyses.

When designing, operating, maintaining, and especially when conducting a hazard analysis of an ammonia refrigeration system, the following questions must be addressed for every scenario that could potentially result in an ammonia release to prevent incidents with catastrophic consequences:

1. How can the ammonia release be prevented?

2. How can the ammonia release be detected?

3. How can the persons in the area escape from the ammonia release?

4. How can the ammonia release be stopped?

5. How can the area be ventilated?

Location of Incident	Reported Causes and Contributing Factors
EPA Region 9	Release from an oil drain line (improper valve opened) Person trapped in limited access area
British Columbia	Old, obsolete equipment Corrosion Line opening during emergency repair Alarms tied to ammonia detector(s) disabled
EPA Region 1	Ruptured ammonia line Person trapped in limited access area Emergency shut-off device may not have functioned
Ontario	Release from oil drain line
EPA Region 9	Release from an ammonia valve (improper valve opened) Person trapped in limited access area
EPA Region 4	Release during line opening procedures (wrong line opened)
EPA Region 4	Release during line opening procedures (wrong line opened)
EPA Region 4	Release when transferring liquid ammonia (wrong hose used)
EPA Region 5	Release when transferring liquid ammonia (hose not properly connected)
EPA Region 7	Release when transferring liquid ammonia (leak from open line) Person trapped in limited access area
EPA Region 7	Release when transferring liquid ammonia (valve broke while it was being removed)

Table 5. Ammonia Incident Database: incidents with catastrophic consequences.

Conclusions

This paper assumes that (a) the number of ammonia incidents in the United States and Canada could be significantly reduced and (b) a study of previous incidents could help to determine the best methods for preventing and/or minimizing the consequences of future incidents. Through a review of incident data submitted to the EPA, incident data collected in response to an IIAR questionnaire, and incident data collected via publicly available sources, the following conclusions were reached for facilities operating ammonia refrigeration systems:

1. The ammonia refrigeration industry should continue to promote inherently safer technologies, including designs that minimize the total ammonia charge and designs that eliminate the use of ammonia equipment outside of machinery rooms (Jordan 2009).

2. Faulty and poorly maintained equipment were responsible for the largest number of incidents. These incidents are preventable through improvements to the system design (IIAR 2; IIAR 4) and mechanical integrity procedures (IIAR 6). In addition, facilities should identify and replace older, obsolete equipment on a timely basis.

3. Line opening operations, along with liquid transfer and oil draining operations, were responsible for the second largest number of incidents and the majority of incidents with catastrophic consequences. These incidents are preventable through the application of engineering controls (such as spring-loaded valves and pump-out systems (Engle et al. 2006)) and administrative controls (such as line opening procedures (IIAR 7), written operating (IIAR 7) and written maintenance procedures (IIAR 6), and training for system personnel). In addition, during liquid transfer operations, facilities must ensure that the transfer line/hose is suitable for

ammonia, has been properly maintained, and contains appropriate devices to limit the size of an ammonia leak if the line/hose were to rupture.

4. The design and operation of the ammonia refrigeration system should address persons who could be trapped in limited access areas when ammonia is released. Specifically, the following options should be considered, preferably in this order:

   a. Relocate the ammonia refrigeration equipment,

   b. Provide a secondary (back-up) emergency exit, and

   c. Provide personal protective equipment (PPE) that would enable personnel to escape the area in an emergency.

5. The majority of the outdoor releases (~73%) identified in the Ammonia Incident Database were releases from pressure relief valves. Hazard analyses should be conducted to identify the potential circumstances that cause these pressure relief valves to open. Additional emphasis must also be placed on the design, operation, and maintenance of the overpressure relief protection systems.

6. Additional emphasis is needed to protect refrigeration equipment from motorized equipment, especially forklifts, and from damage caused by structural or building failures.

7. Many incidents occurred during the commissioning and the decommissioning of ammonia refrigeration systems. IIAR has written standards addressing these situations (IIAR 4; IIAR 5; IIAR 8).

8. Fires affecting ammonia refrigeration systems were responsible for approximately 5% of the incidents in the database. These incidents may be prevented and/or minimized through the implementation of hot work permit procedures, the relocation of flammable materials, and improvements to fire suppression systems.

9. Adverse incidents continue to occur in the ammonia refrigeration industry (approximately one incident every three to six days), and these incidents often result in people being injured and sent to the hospital for treatment (more than 1,500 during a 14-year period).

Finally, IIAR and its members should continue the study of incidents in the ammonia refrigeration industry. Specific recommendations along these lines include

1. Contact EPA and/or the Chemical Safety Board to determine if additional, up-to-date data can be obtained from EPA's five-year accident history database.

2. Contact IIAR members to determine if they would be willing to share, on a confidential basis, reports conducted to investigate incidents that have occurred in their ammonia refrigeration systems.

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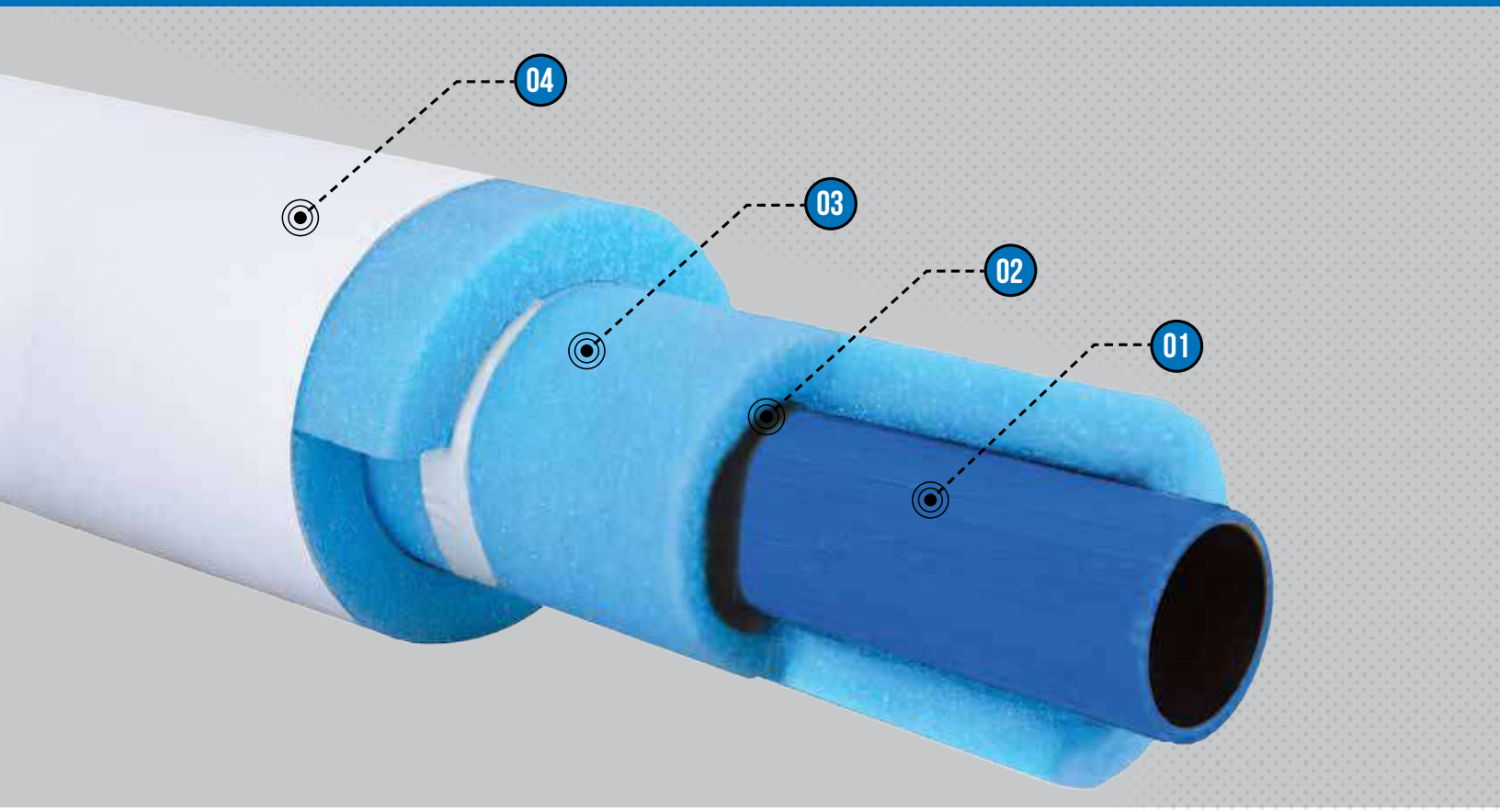

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