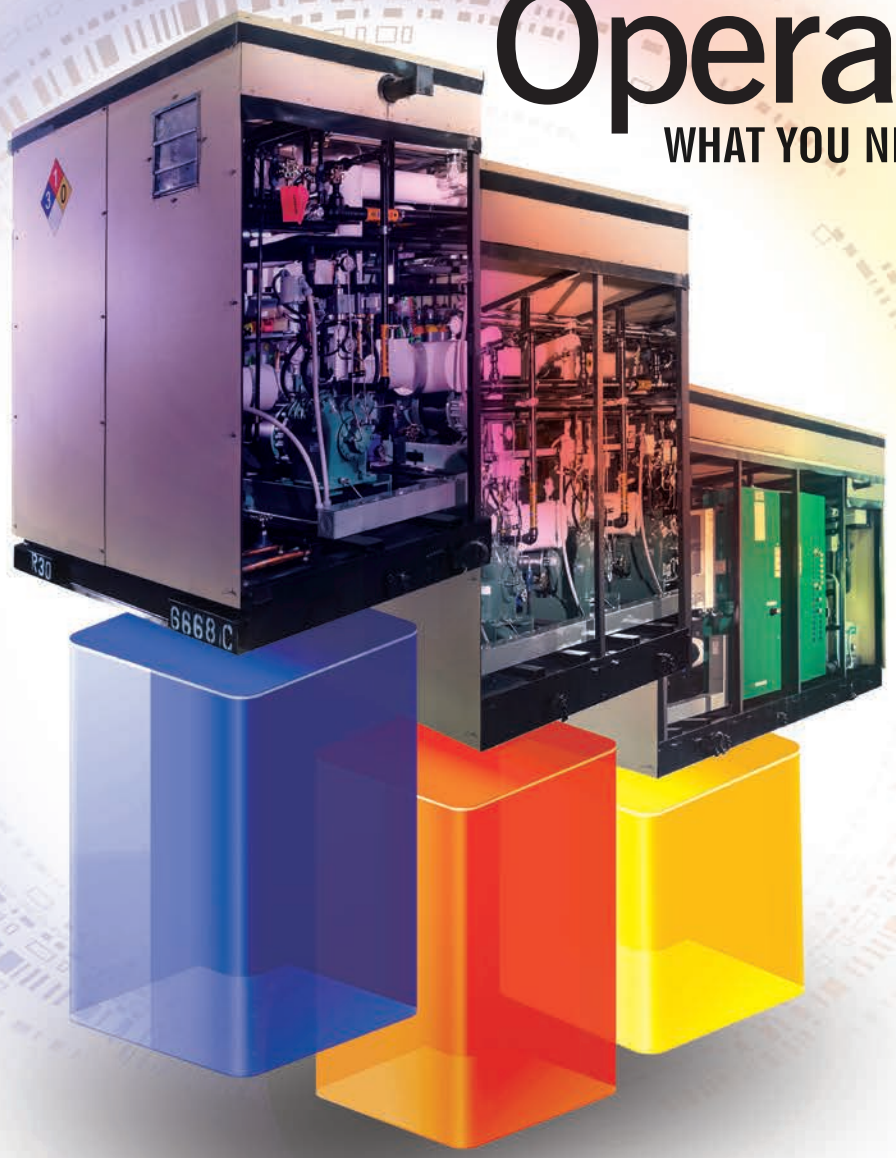
iiar THE OFFICIAL MAGAZINE OF THE AMMONIA REFRIGERATION INDUSTRY ■ JUNE 2016

CONDENSER

From Regulation to Operation

WHAT YOU NEED TO KNOW



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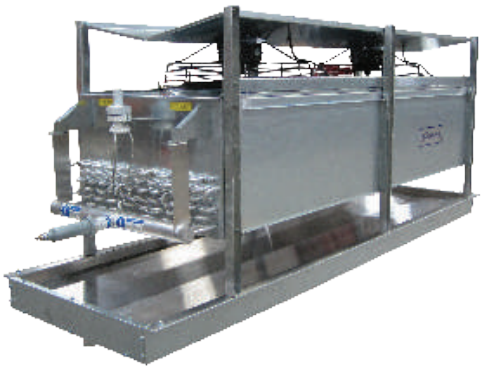

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chairman's MESSAGE

MARK STENCEL

Now that the IIAR conference has ended and we're back at work, your IIAR Board of Directors, IIAR Staff and member volunteers are putting forth great effort to carry the momentum of our Orlando Conference forward into the rest of the year.

We're building upon our industry's body of knowledge, influencing code development with our Standards, working with regulators at OSHA and the EPA and developing new educational programs for our members.

It is your support that makes this organization what it is, so if you have recently joined IIAR, welcome. I encourage you to look for ways to get involved in our member volunteer work.

If you are already actively engaged in our committees and programs, I encourage your continued participation and thank you for your help in enabling our natural refrigeration industry to meet the new challenges ahead.

We have a great launch pad for the journey ahead, having just concluded the most successful Conference and Exhibition in IIAR's history. The exchange of knowledge, understanding of developments and value of the networking that occurs at this event energizes our industry. The financial success that our organization derives from the IIAR Conference enables us to enhance services, such as our advocacy programs.

Our advocacy programs, which focus on significant regulatory developments impacting our industry, resumed immediately following the 2016 IIAR Conference.

Immediately after that conference, IIAR Government Relations Director, Lowell Randel, spoke at a public hearing hosted by the EPA regarding proposed changes to the Risk Management Program (RMP) rule.

We're building upon our industry's body of knowledge, influencing code development with our Standards, working with regulators at OSHA and the EPA and developing new educational programs for our members.

The EPA's proposed rule changes included new requirements for independent third-party audits by PE licensed auditors.

They also include root cause analysis after near misses and annual emergency response coordination with local emergency planning organizations. These are all important regulatory concerns for our industry.

As an example, consider that the proposed EPA independence requirements for auditors bars them from conducting services or consulting for the owner or operator within the last three years – or providing such services for a period of at least three years following the audit.

In a review of his discussions with IIAR members who conduct audits as well as other contracted services, Lowell advised the EPA panel that he asked these members to quantify the number of clients for whom they solely performed audit services. Unsurprisingly, the answer was zero.

EPA's proposed independence requirements would therefore effectively disqualify our industry's most qualified auditors. As it is not EPA's intent to negatively impact the professionalism of compliance audits, it is important for this message and for IIAR's voice to be heard.

These are the sorts of regulatory issues that require attentiveness and action on the part of IIAR. And this is the type of realistic, pragmatic advocacy we intend to continue to provide.

We are also moving forward this year on other key initiatives, such as our major educational initiative, the IIAR-2 certificate program, which will document core knowledge in the safe design of ammonia refrigeration systems.

Following our successful IIAR-2 education program, as presented in Orlando, both our members and regulators reached out to us to provide an enhanced, documented training program. We are responding.

I am very aware of the contributions of all those who have built and continue to build the IIAR, and as your new chairman, I feel a great sense of responsibility to honor those efforts through my own commitment in the year ahead, to help us to advance the causes and to address the needs of our members.

We are all fortunate to be part of a vibrant, vital and growing organization that advances the virtues of environmental responsibility, energy efficiency and safe practices.

As members, your ongoing work and participation make all of our activities possible. Thank you for enriching our industry with your support.

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president's MESSAGE

BY DAVE RULE

There's a lot going on at IIAR headquarters these days. We're growing and expanding with new initiatives, programs and goals for the new membership year. That growth just reflects the expansion of our industry in general. New technologies like low charge systems, greater adoption of CO_2, and other developments are taking natural refrigerants in new directions, and IIAR is helping pave the way.

Your staff and dedicated Board of Directors are focused on membership and committee work that will address the trends that are already shaping the future of this industry.

I'll use my column this month to give you an update on those projects and initiatives, all of which have prepared us to look forward to the next year as our membership continues to grow, thanks to the invaluable experience and participation of our members.

First, no post-conference message is complete without mention of our industry's biggest event, the IIAR Industrial Refrigeration Conference & Exhibition, which was held this year at the end of March in Orlando, Fla.

I'm proud to announce that our most recent event was a great success, showcasing the work of the IIAR on so many levels.

As part of a volunteer membership, we provide the essential technical standards, educational tools and other materials we depend on as an industry to improve the efficiency and safety of natural refrigerants.

This year's outstanding technical paper program was no exception. Among the highlights were papers on CO_2 systems, commercial applications for natural refrigerants and low charge systems.

It is always exciting to participate in an event where the enthusiasm and dedicated work of our membership – represented by end-users, engineers, contractors, manufacturers, faculty and students from around the world – is on full display, and this year was no different.

Our attendance numbers, exhibitor and sponsor support were at record-breaking levels.

The IIAR Conference isn't the only place we're seeing growing involvement from our industry. Our membership numbers are on the rise again this year, and we're working hard to bolster even more support with our 2016-2017 membership drive.

If you are working with a company or individual who is not a member, I encourage you to share your experience and the value you've found in being an IIAR member.

With today's rapidly changing regulatory environment and evolution in system technology, it is imperative that those working with ammonia and other natural refrigerants become an IIAR member and participate in our industry.

Depending on your contractor or engineer to keep you informed of these changes and regulatory responsibilities does not adequately protect your interests or meet the needs inherent in operating a safe and efficient refrigeration system.

To meet those member needs, IIAR is moving forward on a number of significant programs across IIAR committees.

The Education and Marketing committees are developing IIAR's new Engineering Certificate program with the first curriculum training mandate focused on the IIAR-2 standard, to be introduced in early October.

Member engineers from all sectors of our industry will have the opportunity to complete this course work and take an exam at the 2017 IIAR Conference to obtain a certificate demonstrating their knowledge and understanding of the design safety standard of the industry.

Additional certificate programs on IIAR standards and other engineering design practices are planned following the 2017 conference.

The IIAR Safety and Standards and Compliance committees are also working to produce important member resources. The Safety committee is reviewing the IIAR Series I videos and developing a safety webinar presentation for later this fiscal year.

The IIAR Standards and Compliance committee is moving forward on writing the IIAR-6 standard for maintenance and the new RAGAGEP standard to provide guidance for existing plant facilities. The committee is also reviewing updates for the Ammonia Data Book and the ARM manual.

Meanwhile, the Government Relations and International Committees are working to expand IIAR's influence. The Government Relations committee is coordinating efforts with the IRC to provide a second refrigeration training webinar series for OSHA inspectors. Also, a new program is being developed to assist plant facilities in training and communications in emergency preparedness and coordination with the first responder community. And the International Committee is embarking on an aggressive effort to expand the IIAR chapter program in the Americas, China and India.

This is an exciting time to be a member of IIAR and participate in the many programs that are underway to improve the operations and safety of our industry.

Our success in these projects is directly related to the dedication and hard work of the many volunteer members serving on the various technical committees, executive committee and the board of directors.

These individuals have been and will continue to be our most valuable resource. I'm looking forward to working with the IIAR community this year to achieve all of our goals, and I invite everyone to participate in IIAR to help us fulfill the important mission of our organization.

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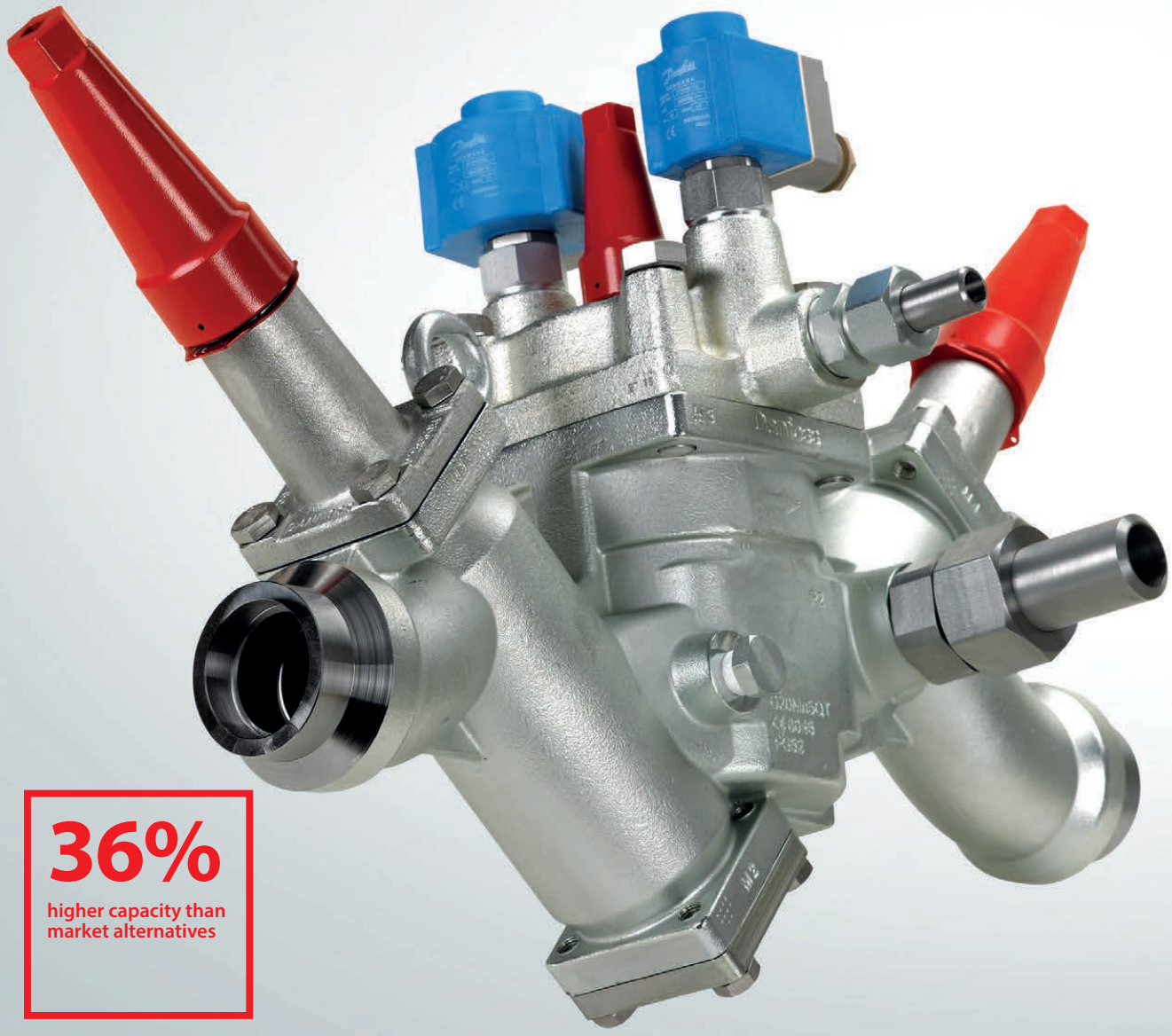

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From Regulation to Operation

WHAT YOU NEED TO KNOW

Owners and operators of ammonia refrigeration equipment have a number of regulatory-driven documentation requirements, and the level of understanding regarding those requirements can vary from company to company.

The challenge for facility owners and operators begins when they aren't aware of the regulatory requirements that apply to the ammonia equipment they have and use in their facility.

"There are many who are keenly familiar with the regulations, codes and standards that need to be enforced, but we are aware that there are a number of smaller facilities that are not familiar with the regulations," said Eric Smith, vice president and technical director for the International Institute of Ammonia Refrigeration.

While most in the industry understand the basics of regulation and the documentation necessary to operate a facility, not understanding nuances beyond, or even within the Occupational Safety and Health Administration's Process Safety Management (PSM) and Environmental Protection Agency's Risk Management Plan can pose a risk.

"There are users who are not aware of [some important] requirements," said Doug Reindl, a professor at the University of Wisconsin and a member of the IIAR board. "They don't know what they don't know."

Bob Czarnecki, chairman of the IIAR standards committee, said it is understandable that there is some confusion surrounding safety requirements. "End users are in the business of making food. They're not in the business of refrigeration systems," he said. "If they are not complying, it is because they are unaware."

RAGAGEP

Smith said confusion is often found among operators that use less than 10,000 pounds of ammonia, since they don' t have the same documentation requirements that OSHA and EPA have set for operators using more than 10,000 pounds. In addition, both large and small facility operators often struggle with decisions and documentation requirements related to updating existing systems to current safety standards design.

Under PSM, facilities using more than 10,000 pounds of ammonia are required to document their generally accepted good engineering practices, or RAGAGEP. They are able to determine their own RAGAGEP, but it has to be compliant with the PSM elements and a documented set of industry standards.

"They must state which RAGAGEP they are following. If they fail to declare which RAGAGEP standards they're following, they leave themselves susceptible to OSHA and EPA inspectors applying RAGAGEP standards that perhaps aren't suitable for a refrigeration system," Smith said.

Most companies use IIAR standards and bulletins as their RAGAGEP for ammonia safety standards. "IIAR standards are written as enforceable requirements and provide mandatory requirements for safety design, maintenance, system changes and general operation. IIAR bulletins were not written as a standard but provide informative language as an industry guideline. This has sometimes led to unclear direction and unjustified citations," Smith said. "Informative language is avoided in standards development, so informative

appendices are used to further explain the mandatory requirements without unintentionally creating an unenforceable requirement."

Reindl said, "The four PSM elements that OSHA most frequently cites include mechanical integrity, process-hazard analysis, process-safety information, and operating procedures."

As a best practice, every location should designate a facility representative to ensure they're completing the required documentation and training, said Tony Lundell, IIAR director of standards and safety.

"They need to make sure the ammonia refrigeration systems are installed correctly, are being operated, inspected, and maintained safely. Even if a contractor is hired to operate and maintain the system, the owner is completely responsible for all inspections, testing, maintenance, and operating procedures for that specific ammonia refrigeration system, no matter who does it, whether an in-house employee or a contracted employee" Lundell said.

Czarnecki said as part of PSM, operators are required to conduct a mechanical integrity audit periodically. "That is basically an inspection and some testing of your system – is anything rusty, is there significant corrosion that would indicate a concern that the pipe is thinner than it should be, is there moisture, is there frost — you have to determine what you're going to do to correct it and how you're going to confirm it gets corrected per your RAGAGEP," he said, adding that the facility representatives need to act on the recommendation of the audit.

Jett Stiffler, owner of JS Compliance, said, "It is essential that the management team observes Process Safety Management activities and prioritizes those activities based on audit indicators that propose 'red flags' and could cause a hazardous condition. For instance, a Process Hazard Analysis recommendation or a Mechanical Integrity Inspection recommendation that is a Level 1 equals a High Priority action item."

Reindl said owners are also required to audit their PSM/RMP programs for regulatory compliance at least every three years. "The good news is that the compliance audit provides the owner operator a "pulse check. The bad news is a lot can slip in three years," he said.

FACILITIES UNDER 10,000 POUNDS

While systems over 10,000 pounds require RAGAGEP documentation, systems under 10,000 pounds must adhere to the general-duty clause, which requires operators to provide a safe work place that will not harm anybody. "You have to know what you are doing and you should have operating and maintenance procedures documented and applied to your system. The General Duty Clause says you must make sure it isn't going to harm anybody," Lundell said.

Reindl said smaller end users frequently ask if they have a covered process. "They get wind that there are regulatory requirements and they start reaching out and saying, 'Does this apply to me?' It is still a bit of a challenge for them," he said.

While the bulk of the country is held to the 10,000-pound standard, California required documenting the accidental-release prevention program at 500 pounds, said Bill Greulich, principal at Kensington Consulting. "I'd suggest as a general duty virtually everybody irrespective of charge should meet the requirements of that reduced program," he said. They often overlook the fact that the general duty clause applies to their system.

As a best practice, Czarnecki said that throughout his career, he created an ammonia safety program for facilities that used under 10,000 pounds of ammonia. "It made sure you adhered to the general-duty clause. If you have a release of 400 pounds you're going to be subject to the same scrutiny as if you had a release of 30,000 pounds. It is just that under 10,000 pounds, you aren't required to have the same documentation," he said. "There isn't a rule out there that says you have to abide by PSM, but in essence you do."

Lundell said, "The IIAR has developed the Ammonia Refrigeration Management Program (ARM) which has been applied in the industry for a few years now for systems under 10,000 pounds."

THE GROWTH OF LOW-CHARGE SYSTEMS

The growth of new types of equipment, such as low-charge systems that use approximately 500 pounds of ammonia or less, could drive growth among contractors and consultants that can help operators understand their documentation requirements. Smith said there are several areas of potential growth for low-charge systems, including grocery stores, commissaries and cafeterias.

However, Smith said some people may be reluctant to try using ammonia where they might otherwise use a synthetic refrigerant. "It boils down to not so much a fear of the chemical but a fear of the regulation surrounding it," he said.

Smith said service and documentation for low-charge systems could become a growing service area for contractors, engineers and consultants.

He added that there needs to be a means of compliance that is easier but is just as safe as it has been for industrial systems. "One of the most appealing things about low-charge systems is that many manufacturers will use stainless steel components and one of the technical problems of corrosion will be reduced," he said. In addition, many of the new systems will include factory designed packages that provide built-in monitoring and other safety systems.

There is also a proposal to develop a refrigeration management program for low-charge systems. "The goal, should it be accepted, would be to reduce the amount of documentation and paper burden required for owning an ammonia system provided that manufacturers can provide enough instruction and documentation to maintain and install systems appropriately," Smith said. He added that it would give operators a way to comply with EPA and OSHA general duty clauses that isn't as burdensome as compliance for larger systems.

Czarnecki said the growth of low-charge systems could create new opportunities for contractors and consultants. "Owners just don't have those people on staff and would use outside contractors. The outside contractor is still the responsibility of the facility," he said.

"You could have places like supermarkets that are going to CO_2 in the freezers or the coolers. Right now they're condensing [the secondary loop] with Freon, but in the future, hopefully they'll condense or cool with ammonia. All of those people are going to use outside service organizations.

They're not going to have somebody on staff for [smaller systems]. That is where contractors could see an opportunity down the road," Czarnecki said.

The type of safety requirements for cold storage can vary based on if it is in a commercial or industrial area. "That is largely defined by the model building codes. Typically, commercial is open to the public whereas industrial is restricted to the public and only employees or guests are permitted and present on site," Smith said. "In some cases there can be a mixed occupancy and it is really a matter of public access or no public access."

CONTRACTOR BEST PRACTICES

Even if operators hire contractors to help them install and maintain equipment or document safety procedures, Reindl said operators are responsible for meeting all the necessary regulatory requirements. "For some people, that accountability means they will want to know more about the requirements and understand them and not blindly trust the people working for them. Some people will say, 'I'll just trust you're going to take care of it,'" he said. "If it is a smaller company, they typically rely on a contractor to guide them on what the requirements are." Nevertheless, this does not release management and owners of their regulatory responsibility.

Reindl said, "There are contractors that are well plugged in to the requirements of PSM/RMP while others view these regulatory requirements as solely the owner's responsibility. There is a parallel to what you see with end users. Some contractors are really good and will try to inform their end-user customers of the refrigeration-related regulatory requirements and others carry their customers along kicking and screaming."

Smith said there is a section on contractor qualifications within PSM. "With a large system, it is absolutely a requirement for contractors to be fully trained and it is incumbent on the owner to make sure their documentation is in order," he said. "The same thing is applicable for smaller systems."

The same accountability holds true for owners when purchasing equipment. "You better know what you're buying and you better know that it is compliant with the RAGAGEP that you have declared," Smith said. "If you don't know, it is incumbent on you to hire somebody that does know and ensure equipment is properly integrated into your system."

When hiring design-build installation contractors, Greulich said owners and operators should know what their code compliance is relative to the installation and if it is being done properly. "A lot of people hire consulting engineers or consultants and then they assume it is done properly. They need to take ownership of what it is they're paying people to accomplish for them," he said.

QUESTIONS FREQUENTLY ASKED

Smith said IIAR receives questions ranging from engineering technicalities to proposed government regulations. One of the most common questions members ask is whether or not they are compelled to comply with recently developed or revised standards. "They ask if they have to update their existing system to be compliant if it is built and operated under older standards, and the answer to that is that it depends on whether or not they are making major changes to their system," Smith said.

One level of guidance is whether or not a project is large enough to require a permit. That isn't a legal statement, but it could be used to justify whether or not a system is being updated or merely maintained. "In PSM-regulated facilities, any change in design or components must be accompanied as a management of change (MOC) procedure unless it is like-for-like replacement (i.e. replacement-in-kind)", said Lundell.

Lundell said another common question asked is about the maximum intended refrigerant inventory. "Some will say they operate at certain levels but the inspector wants to know the maximum intended inventory. You can use your operating level as your maximum intended inventory or have a separate maximum intended inventory. But, you need to know and this needs to be confirmed and the proper documentation provided so you can advise the inspector when asked," Lundell said.

STAFF RESPONSIBILITIES

Stiffler said governmental changes, interpretations and updated regulations make it imperative for executive and top-level management teams to be informed and educated on their responsibilities related to the hazards within their facilities. This applies to both large and smaller facilities.

"Unfortunately for the busy plant manager with many other demands in running the day-to-day operation of the facility, the burden of compliance is going to continue to be in the forefront of government with NEP inspections, audits and regulation changes in regards to OSHA 1910.119 PSM Program and the EPA's 40 CFR Part 68 Risk Management Plan," she said.

Reindl said that for the most part, large companies understand PSM and RMP at a corporate level. At the individual facility level, the responsibility shifts to the plant manager. "They have varying levels of detailed understanding of PSM and RMP," he said.

Stiffler said that if top management fails to lead the way to a viable and sustainable safety culture in their organizations and facilities, their contractors, vendors and plant personnel may or may not see the need for safety excellence or will have difficulty getting executive approval for sustaining or upgrading the systems. "It is necessary to have some type of management approach to process safety in order to allow for the planning of needed resources and activities to prevent future events," she said.

Owners can ensure their personnel know what they need to know by connecting them with professional organizations, such as IIAR, for training or conducting in-house training. "Those are pretty standard approaches," Reindl said.

Greulich said safety is a continuous process. "There are many, many good people who work really hard at it, but there are still a good chunk of people who think these programs are binders on the shelf," he said. "Most folks feel validated because they haven't had trouble yet," he said. "That in and of itself isn't necessarily a good measure of having all the right things covered."

Smith said, "A bad mark by people who are not aware of safety protocols is a bad mark on the entire industry, so we hope that everyone will ask whether or not the facility workers and operators are members and if they aren't, encourage them to become members and participate in organizations like the IIAR and the Refrigerating Engineers and Technicians Association.

New Programs, Initiatives Take the Foundation to the Next Level

The Ammonia Refrigeration Foundation, IIAR's education and research foundation, is launching an effort to expand the outreach of the organization through a new legacy planned giving program.

At the same time, leaders said the Foundation would build its visibility and impact this year by celebrating its 10-year anniversary with renewed attention to mission, scholarship, talent development and research.

At the helm of these efforts are Lois Stirewalt O'Connor, the Foundation's new Executive Director, and Tom Leighty, the Foundation's new Chairman.

The two said they would work to expand the group's funding to ensure the safe, reliable and efficient use of ammonia and other natural refrigerants.

The Ammonia Refrigeration Foundation was originally founded, organized and funded by the membership of IIAR. A 501c3 nonprofit education and research organization, it has expanded and focused on its mission: ***To support research for the safe, reliable and efficient use of ammonia and other natural refrigerants, and to promote the development of industry talent through scholarships, academic alliances and outreach.***

Executive Director Lois Stirewalt Connor said a number of new programs and initiatives are underway that will make the Foundation even stronger and more relevant to the industry in the coming years.

NEW PROGRAMS

As a 501c3, The Foundation is supported primarily by the IIAR membership. There is now a greater effort placed on expanding its outreach and impact. Communicating the importance of educational alliances and research of the Foundation as it relates to the industry, are all part of this.

"In our Foundation, a solid core of annual financial support is necessary to fulfill our mission," O'Connor said, adding that a new giving program, or annual fund, is often called the bread and butter of any non-profit organization. "It supports the base needs and allows for greater flexibility and outreach."

"Many organizations miss great opportunities in funding their education and research initiatives because they do not embrace all avenues of financial support or engagement," she said. Starting July 1, 2016 members and friends of IIAR and natural refrigeration, can easily make donations online to the Foundation. Donations can also be made through a link on the IIAR App.

The purpose of the new giving strategy is to encourage the IIAR membership, and those of other affiliated organizations, to become engaged in the future of natural refrigeration.

Another opportunity for membership to consider is the new Planned Giving program, and Legacy Society. Planned giving, sometimes referred to as gift planning, can be defined as a method of supporting a non-profit or charity and enables donors to make larger gifts than they could make from their current income.

Lois shares that she "looks forward to reaching out to each and every one

Meet Lois Stirewalt O'Connor

Lois Stirewalt O'Connor has joined the Ammonia Refrigeration Foundation to lead its new fund-raising, outreach and educational efforts. O'Connor joined ARF after serving as senior director of advancement, programs and outreach for the Vietnam Veterans Memorial Fund, the organization authorized by the U.S. Congress to build a national memorial dedicated to all who served with the U.S. armed forces during the Vietnam War.

Lois Stirewalt O'Connor, Executive Director of the Ammonia Refrigeration Foundation

O'Connor has also served as the director of advancement for the Air Force Association and has held roles in university advancement and development at American University and at George Washington University.

"We are very excited by the addition of Lois O'Connor to our organization," said Marcos Braz, former ARF chairman and president of MRBRAZ & Associates, a refrigerated facilities and industrial refrigeration design company based in Azle, Texas. "Her deep experience in program development, outreach and advancement will serve to lead and grow the foundation in new ways."

of our IIAR membership to encourage involvement, outreach, and support." Over the next few months, a variety of offerings will be communicated.

Benefits and information about all of these new initiatives can be found on the organization's new website, NH3foundation.org.

THE FOUNDATION SCHOLARSHIP

The Scholarship Program has been a vital part of the Foundation's outreach. The industry will continue to support students going forward, and presented two students, Andrew Re and Jacob Upton, with Foundation Scholarships this year.

Re, a mechanical engineering student at the Milwaukee School of Engineering, is a dean's list and honor roll student. He also holds an Academic Merit Scholarship and has interned with Bassett Mechanical Contractors. He is slated to graduate in May, 2017.

Upton is a mechanical engineering student with an HVAC&R concentration at California Polytechnic State University, San Luis Obispo. He serves as vice president in the student ASHRAE chapter and a member of the National Society of Sales Engineers. He has interned with Air Treatment working in support of technical sales functions, is a dean's list student and holds several scholarships associated with his organizational activities. He is expected to graduate in June 2017.

GOLF TOURNAMENT

IIAR members and industry partners showed their support as part of the 2016 William E. Kahlert Memorial Golf Tournament benefitting The Foundation. The event was a success, raising over $39,000.The Foundation would like to thank the sponsors of the 2016 Golf Tournament: Baltimore Aircoil, Independent Refrigeration, Dual Temp, General Refrigeration Co., Gartner Refrigeration, Colmac Coil, Airfoil Impellers, Kahlert Foundation, SGS Refrigeration, DEEM, Jamison Door, Logic Technologies, Marcos Braz and Innovative Refrigeration.

Save the date, Feb. 25, 2017, for the next Foundation golf tournament, which will be held in conjunction with the IIAR conference in San Antonio, Texas.

MEET LOIS STIREWALT O'CONNOR

Lois Stirewalt O'Connor has joined the Ammonia Refrigeration Foundation to lead the foundation's new fundraising, outreach and educational efforts. O'Connor joined ARF in March and came to the foundation with a substantial background in advancement and development in the nonprofit sector.

Previously, she served as senior director of advancement, programs and outreach for the Vietnam Veterans Memorial Fund, the organization authorized by the U.S. Congress to build a national memorial dedicated to all who served with the U.S. armed forces in the Vietnam War.

O'Connor has also served as the director of advancement for the Air Force Association and has held roles in university advancement and development at American University and at George Washington University.

"We are very excited by the addition of Lois O'Connor to our organization," said Marcos Braz, former Foundation chairman and president of MRBRAZ & Associates, a refrigerated facilities and industrial refrigeration design company based in Azle, Texas. "Her deep experience in program development, outreach and advancement will serve to lead and grow the foundation in new ways — ways in which members of our association and our industry aspire."

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EPA Adds New Refrigerants to Phase-Out List

The Environmental Protection Agency has released its latest proposed rule that would make changes to the Significant New Alternatives Policy program, further restricting uses of what it terms higher global warming potential refrigerants, including HFCs.

"The EPA is continuing its march forward revisiting the acceptable alternative lists under the SNAP program. They made some revisions last year, and now they're proposing additional changes in the latest Federal Register notice," said Lowell Randel, director of government affairs for IIAR. "That is going to make it that much more attractive to look at utilizing natural refrigerants like ammonia and CO_2."

IIAR said key staff members last year attended the EPA's Significant New Alternatives Policy (SNAP) stakeholder meeting on September 11th. The EPA's SNAP program evaluates and regulates substitutes for the ozone-depleting chemicals that are being phased out under the stratospheric ozone protection provisions of the Clean Air Act (CAA). The intended effect of the SNAP program is to promote a smooth transition to safer alternatives.

IIAR continues to monitor the SNAP program as the EPA identifies alternatives to refrigerants that are currently being considered for draw down due to their ozone-depleting and high global warming potential, the organization said.

Within the new proposed rule, EPA specifically cited ammonia as a viable alternative in a number of places. EPA wrote, "In the original SNAP rule, EPA noted ammonia has been used as a medium- to low-temperature refrigerant in vapor compression cycles for more than 100 years. Ammonia has excellent refrigerant properties, a characteristic pungent odor, no long-term atmospheric risks and low cost."

The proposed rule applies to refrigerants used in new cold storage warehouses. "By saying they are not going to allow the use of those refrigerants in new facilities, they're saying, 'this is where we're going in the future,'" Randel said.

EPA has not defined a set compliance period, but Randel said he doesn't expect a long transition time. "If you're looking at a new facility, you will look to see what your viable options are for the new facility," he explained.

EPA accepted comments until June 2. "Once they've received the public comments, they'll go through those and publish a final rule," Randel said, adding that he expects to see a final rule by the end of the year.

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IIAR Standards Shaping RAGAGEP

Awareness of International Institute of Ammonia Refrigeration's IIAR-2 standard is increasing among regulatory agencies, and is beginning to shape recognized and generally accepted good engineering practices, industry and government sources said.

"There are a number of advantages in having an organization like IIAR come out with standards that are applicable to their own industry," said Jim Lay, safety engineer, process safety management at the Occupational Health and Safety Administration. "To have clear, easily understood practical guidance on safe system designs and maintenance practices is extremely valuable."

Peter Thomas, president of Resource Compliance Inc., said regulators want good information. "They aren't trying to be tricky or apply things inappropriately or make people spend money. They want to learn and want a good resource just like everyone else," he said.

As the first comprehensive standard for the safe design of closed-circuit ammonia refrigeration systems, IIAR-2 was designed to serve as the single authoritative source document on such systems. "Having regulatory agencies turn to IIAR standards is good for both private industry and the regulators," Thomas said.

"OSHA, the Environmental Protection Agency and other regulatory agencies are going to have to rely on private industry literature when they make industry standard decisions. Having something written specifically for our interest is best for us and the safest," he said.

Lay said Recognized and Generally Accepted Good Engineering Practices (RAGAGEP) are a key component of the Process Safety Management standard. "It is a management system-based standard and the RAGAGEP aspect of it gives the employer flexibility to select the codes and standards they are going to comply with," he said. "Once they do that, OSHA wants them to actually comply."

Bob Czarnecki, chairman of the IIAR standards committee, said the point of IIAR-2 was to serve as the primary source for the safe design of refrigeration systems. "The goal for IIAR is to have their standards become RAGAGEP," he said. "The whole idea is to get a RAGAGEP out there that we have input on that applies to our industry and have the inspectors agree with it. Hopefully the end users are adhering to best engineering practices."

Thomas recently received a memo from an inspector who referenced IIAR-2 standards. "One jurisdiction in California in Monterey County was making it clear they are using the IIAR standard for their standard," he said.

In the memo, the county inspector wrote, "One of the primary sources of RAGAGEP is IIAR. Others include, but are not limited to, ANSI, ASHRAE, California Mechanical Code, California Fire Code, NFPA, etc."

"Historically, IIAR published bulletins to document baseline safe maintenance and operation guidelines, like IIAR B109, or IIAR B110," the inspector wrote, adding that in the past year or so, these bulletins are being replaced with ANSI/IIAR Standards 1 through 8.

Thomas said he delivered a presentation to California regulatory personnel in February on the importance of IIAR standards in understanding RAGAGEP, which he said helped inform inspectors on the latest standards.

"My goal was to explain that for ammonia refrigeration systems, RAGAGEP of choice are the IIAR standards 1-8 with 6 still being developed," Thomas said. "It's great to see the hard work of the IIAR and Standards Committee reaping its intended result."

Thomas said it is important that regulatory agencies have the information they need. "The goal now is to get the word out and to make sure people know the standards exist and how they should be applied," Thomas said.

Czarnecki said many inspectors have a petroleum or chemical background. "They aren't necessarily refrigeration people, so they tend to fall on their sources, such as the American Petroleum Industry," he said. "Have we gotten totally away from that? Probably not. Are we moving in the right direction? Absolutely."

OSHA has access to the IIAR website, all of their documents and all of their standards at no charge. "They can reference the information all they want," Czarnecki said, adding that IIAR has worked to train OSHA inspectors to get them to use IIAR information as RAGAGEP. "In the past, inspectors have cited all kinds of best practices that don't necessarily apply to the ammonia refrigeration industry."

Lay said IIAR has documents that are clear and straightforward, which is an advantage both for the employers, their facilities and the inspectors. However, he noted that OSHA does not select the RAGAGEP employers must use. "The employer selects the RAGAGEP. If they fail to do so and our inspectors discover hazards, we will refer to applicable standards," he said.

Lay said many of OSHA's programs are administered at the state level. "There are 26 state plans," he said, adding that OSHA has 10 regions. "One of the concerns industry always has is variability in how standards are being enforced region to region. IIAR has been very proactive reaching out to OSHA to offer resources to help mitigate that concern."

OSHA has modified and made more intensive training for compliance officers to help them have a better understanding of the systems they will be enforcing.

Getting IIAR standards recognized by jurisdictional code is an important part of using the standards for RAGAGEP, Czarnecki explained. "IIAR-2 is recognized in the codes. We made a good stride recently here and got ourselves on an even footing with [the American Society of Heating, Refrigerating, and Air-Conditioning Engineers]," he said.

"We have gotten feedback on IIAR-2. Regulatory agencies like it and they are recognizing it as good RAGAGEP for ammonia refrigeration systems," Czarnecki said.

Lay said he has had a positive experience working with IIAR. "They listened to us and we listened to them," he said.

Thomas said he has not witnessed anything but positive reactions from regulating agencies, EPA and OSHA, regarding IIAR's standards. "I think IIAR has a strong reputation in the regulatory community," Thomas said.

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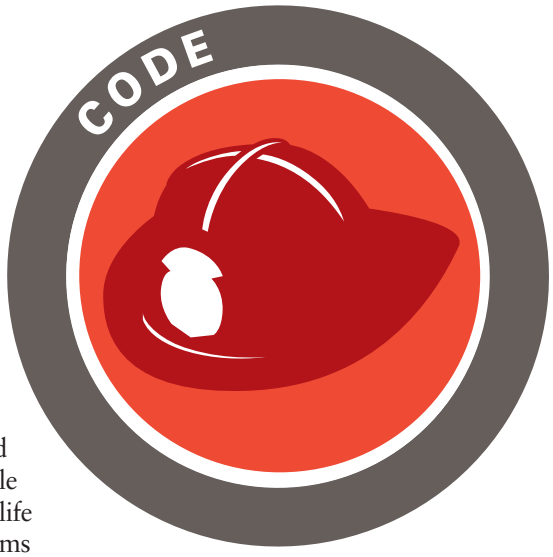
IIAR Recognized for Standards Development



With the completion of IIAR-2 – the first comprehensive standard for the safe design of ammonia refrigeration systems – along with a companion suite of IIAR standards addressing installation, commissioning, operations and decommissioning, IIAR has evolved to become internationally recognized as a standards development organization, or SDO, said Jeffrey Shapiro, P.E., IIAR's code consultant and president of International Code Consultants.

"I've never seen an industry group move as quickly as IIAR has."

Jeffrey Shapiro, P.E., IIAR's code consultant and president of International Code Consultants

SDOs play an important role in supplementing model codes, such as building, fire and mechanical codes, to address special topics in greater detail than prescribed by codes themselves. In the case of ammonia refrigeration, model code adoption of IIAR standards cements IIAR's position as the authoritative source for industry regulations, said Shapiro, who has been IIAR's code consultant for nearly 20 years.

"IIAR has transitioned from an organization that was largely responsive to whatever regulatory agencies sent our way to an organization that sets the course for our industry by developing comprehensive standards and getting those standards adopted into law," Shapiro said. "IIAR's technical experts are highly qualified to guide our industry's regulatory affairs and are better suited to that role than others who are less familiar with our industry."

IIAR's transformation is the result of a decision by the organization's board of directors in June 2012, which supported growing IIAR-2 from a traditional standard into a more comprehensive document that could serve as both a code and a standard. The board also directed IIAR to transition IIAR bulletins and guidelines into adoptable, enforceable standards that thoroughly track the life cycle of ammonia refrigeration systems from design all the way through decommissioning. Shapiro strongly supported the board's decision to make IIAR responsible for its own regulatory destiny.

"In the matter of four years, IIAR has almost reinvented itself with how we deal with regulatory aspects of ammonia refrigeration. That much of a spin in such a short time frame is remarkable," Shapiro said. "I've never seen an industry group move as quickly as IIAR has."

Shapiro presented an update on IIAR's progress in standards development and adoption at the 2016 International Institute of Ammonia Refrigeration Industrial Refrigeration Conference and Exhibition and will present a webinar in June offering a greater level of detail.

During the presentation, Shapiro offered a comprehensive review of the major changes in the latest codes and standards affecting the ammonia refrigeration industry, such as updates to refrigerant-gas detection alarm system requirements, classified electrical equipment and allowances for some refrigeration equipment to be located outside of machinery rooms.

Shapiro also described for attendees how IIAR standards are achieving broader acceptance as model code reference standards, including:

The International Fire Code, 2018 edition. The 2018 edition of the International Fire Code will recognize as mandatory standards:

- ANSI/IIAR 2-2014, *Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems*
- ANSI/IIAR 7-2013, *Developing Operating Procedures for Closed-Circuit Ammonia Mechanical Refrigerating Systems*
- ANSI/IIAR 8-2015, *Decommissioning of Closed-Circuit Ammonia Refrigeration Systems*

The International Mechanical Code, 2018 edition. The 2018 edition of the International Mechanical Code will recognize as mandatory standards:

- ANSI/IIAR 2-2014, *Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems*
- ANSI/IIAR 3-2012, *Standard for Ammonia Refrigeration Valves*
- ANSI/IIAR 4-2015, *Installation of Closed-Circuit Ammonia Refrigeration Systems*
- ANSI/IIAR 5-2013, *Start-up and Commissioning of Closed-Circuit Ammonia Refrigeration Systems*

NFPA 1 Fire Code, 2018 edition. The 2018 edition of the NFPA 1 Fire Code will recognize as mandatory standards:

- ANSI/IIAR 2-2014, *Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems*

- ANSI/IIAR 7-2013, *Developing Operating Procedures for Closed-Circuit Ammonia Mechanical Refrigerating Systems*
- ANSI/IIAR 8-2015, *Decommissioning of Closed-Circuit Ammonia Refrigeration Systems*

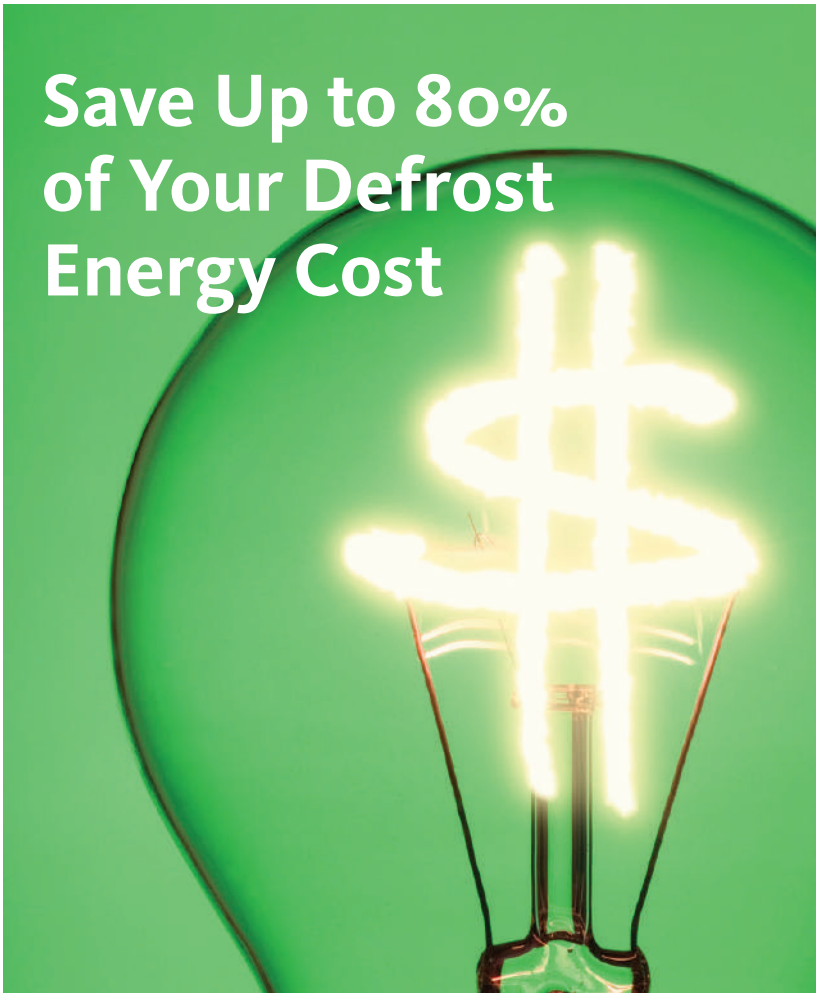
The Uniform Mechanical Code, 2018 edition. The 2018 edition of the Uniform Mechanical Code is on track to entirely defer to IIAR Standards for regulation of ammonia refrigeration systems, with UMC Chapter 11 no longer applying to such systems. This recommendation was approved by the UMC Technical Committee in May 2016, and unless there is a successful public comment to the contrary, the UMC will defer to the following mandatory standards:

- ANSI/IIAR 2-2014, *Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems*
- ANSI/IIAR 3-2012, *Standard for Ammonia Refrigeration Valves*
- ANSI/IIAR 4-2015, *Installation of Closed-Circuit Ammonia Refrigeration Systems*
- ANSI/IIAR 5-2013, *Start-up and Commissioning of Closed-Circuit Ammonia Refrigeration Systems*

National Electrical Code, 2017 edition. The National Electrical Code will recognize an IIAR standard for the first time with IIAR 2-2014, *Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems* being referenced for electrical classification of areas containing ammonia refrigeration systems.

Shapiro said the inclusion of IIAR-2 as a reference standard in the National Electrical Code (NEC) is particularly noteworthy because the NEC is the only model code that has been adopted by all 50 states.

Going forward, he said IIAR will continue to be very busy with development of new standards covering operations, IIAR-6 and regulations for existing ammonia refrigeration facilities (including recognized and generally accepted good engineering practice, or RAGAGEP), IIAR-9. In addition, an update to IIAR-3, which covers ammonia refrigeration valves, will begin soon.



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Applying Natural Refrigerants to New Applications

Is it feasible to apply low-charge ammonia technology in an application that has traditionally been dominated by the use of HFCs and other synthetic refrigerants? That's what a big-end user wanted to know when it approached Azane Inc., a package supplier based in California, to manufacture a low-charge ammonia chiller that provides chilled water to a HVAC air conditioning system.

"When the industry thinks of HVAC, they don't think ammonia because the HVAC world has been dominated by synthetic refrigerants in packaged systems," said Caleb Nelson, vice-president at Azane, Inc. "We couldn't use ammonia in an HVAC packaged air-handler system because you can't risk leaking it into the airstream that is feeding the building. But this project is an example of how ammonia can be an ideal refrigerant when you're providing air-conditioning with chilled water coming from a chiller."

Historically, people have thought of using ammonia mainly as a refrigerant and not for comfort cooling, but there is a growing trend that began in Europe in which large companies in the United States are deciding to apply natural refrigerant systems in new and diverse applications. Several major food producers have publicly stated their desire to phase out or reduce HFCs to meet current and pending federal restrictions and regulatory requirements.

"What companies are realizing is the need to start finding different ways of applying this type of refrigeration," said David Blackhurst, director at Star Technical Solutions, which owns Azane, Inc. "They are realizing that going straight to synthetics is not the smartest move. All of the big guys are looking for alternative ways [to create] refrigeration."

By using a low-charge ammonia chiller for comfort cooling, the big-end user decided to invest in a system that promises to be financially beneficial, will fly under the radar of federal regulatory requirements and is considered safer to operate.

"It's a natural system, so they won't have to worry about replacing it in 10 years because it gets legislated out. You could call it future-proof," Nelson said. "Although upfront costs are higher, the system will last 50 to 75 percent longer because it is more robust and built to a different standard than HFC systems. A total cost of ownership benefit can be realized when you consider the longer life and the fact that an ammonia system will be 20 to 25 percent more efficient than an HFC system starting on day one.

"From a safety standpoint, the only thing flowing to and from the package is chilled water. And in the event of a leak, as soon as it's automatically detected at 25 ppm, the automatic, immediate response is to ramp the condenser fans to 100 percent speed to dispel and divert ammonia, pushing it 30 to 40 feet above the unit where it will dissipate and most likely go unnoticed," Nelson said.

"Since the air-cooled condenser fans are integrated with the unit, if you do the math, we'll realize about 10,000 fresh air changes per hour inside the unit in the event of a leak. This is over 300 times the code requirement for air changes when there's a leak in a machinery room," he added.

The decision to shift from synthetic refrigerant to ammonia in an HVAC application is also a significant step for the ammonia refrigeration industry due to the big-end user's high profile. "They can be the leaders in paving the way for others to understand this technology," Nelson said. "Decisions they make are more profound because they are helping to create a market for the new applications."

The system Azane built provides 300 tons of cooling at a charge level of 1.65 lb/TR and utilizes a tube and fin condenser that also directly cools the compressor oil with ambient air. The package includes a flooded plate-and-frame evaporator that provides a level of stability and increased efficiency because it can operate with no superheat that allows the suction pressure of the compressor to increase. This represents just one of the advantages of using an azeotropic refrigerant such as ammonia instead of a blended synthetic refrigerant where flooded operation would not be possible.

There is a healthy level of forgiveness and resiliency in the system as well, which is important for a low-charge system. Minor refrigerant losses and overcharging of refrigerant will not negatively affect the performance of the system, due to the design of the surge vessel above the flooded evaporator. While this vessel is meant to be nearly dry during normal operation, there is enough refrigerant present and enough empty volume available to allow for some variance in charge. Even extreme levels of overcharging would not result in liquid floodback to the compressor due to the sizing of the surge vessel.

Air-cooled options are rare in packaged ammonia systems, but they are especially valuable in areas with high water costs or water shortages. "In most locations, we can show that an air-cooled solution can compete with the efficiency of an evaporative condensed system even in the hottest climates," Nelson said.

In the final analysis, the project is expected to show that ammonia in a low-charge system can perform superbly in an HVAC application.

"It's not all hypothetical talk anymore," Nelson says. "People are actually doing it."

Designing for DX Technology: Four Steps

The movement toward low-charge systems is growing in popularity in the ammonia refrigeration industry for several reasons, and one effective way to significantly reduce ammonia charge is to design and operate evaporators using DX [direct expansion] technology.

The reduction in the amount of ammonia charge needed to refrigerate a facility reduces the risks associated with an ammonia release, both to people and to products. A smaller system ammonia charge also offers the potential for reduced regulatory requirements in large facilities and opens the industry to potential new applications for ammonia in smaller commercial systems.

The use of DX ammonia can reduce the evaporator charge by as much as 30 to 50 times compared with bottom-feed flooded or pumped designs. In other words, when the evaporator is operated with DX ammonia, it contains only 1/30th to 1/50th the amount of ammonia used in traditional pump ammonia evaporators, significantly minimizing safety risks. In addition to reducing the ammonia charge, DX technology also reduces power consumption compared with pump recirculated systems by eliminating the need for the liquid overfeed pumps, and by minimizing suction line pressure losses – a result of operating suction lines dry instead of wet. Finally, because of smaller vessel and line sizes and the elimination of the recirculator package found in a pumped ammonia system, the comparative initial cost of a DX ammonia system is lower.

The reduced risk associated with ammonia leaks combined with excellent energy efficiency makes DX ammonia attractive for smaller commercial systems, such as food service distribution centers, which have been traditionally cooled by HFC refrigerants.

"The application of direct expansion with ammonia in low temperatures is something we haven't been able to do until now. This technology allows the application of DX ammonia to freezers, blast freezing and other low-temperature applications," said Bruce Nelson, president of DX system manufacturer Colmac Coil Manufacturing and author of the DX Ammonia Piping Handbook.

In other words, when the evaporator is operated with DX ammonia, it contains only 1/30th to 1/50th the amount of ammonia used in traditional pump ammonia evaporators, significantly minimizing safety risks.

The magnitude of the reduction in ammonia charge made possible by DX ammonia also reduces regulatory requirements of the Environmental Protection Agency, Occupational Safety and Health Administration and the Department of Homeland Security, and potentially cuts insurance risk and premiums. That is because DX technology allows the building of a large cold storage facility, one with up to 1,500 tons of refrigerating capacity, using a total on-site ammonia charge under the 10,000-pound regulatory threshold.

"Once you get over 10,000 pounds all three federal agencies take an intense interest in what you're doing," Nelson said. "With the new DX technology now available, you can operate a large facility with only six to seven pounds of ammonia per ton of refrigeration. When you use secondary fluids to cool the higher temperature rooms, you can drive that down to less than three pounds of ammonia per ton of refrigeration."

Before designing and installing a system using DX technology, Nelson said the following four steps should be followed:

1. The evaporator must be carefully selected to include the proper type of tubing which includes an internal enhancement designed specifically for DX ammonia. The high ratio of vapor to liquid specific volume of ammonia at low temperatures, combined with its very high latent heat of vaporization, causes an unavoidable separation of vapor and liquid phases inside evaporator tubes. This separation of phases causes the liquid ammonia to run along the bottom of the tubes, leaving the top of the tubes completely "dry." The result is extremely poor evaporator performance and lower-than-expected suction. The new DX technology solves this problem with an enhancement technique that mitigates that separation to improve performance even at low temperatures.
2. The system must be designed to capture and remove water from the ammonia. Even small amounts of water in the ammonia will significantly penalize DX ammonia evaporator performance.

Water must be effectively removed during operation, particularly in freezing systems that operate at suction pressures below one atmosphere (in a vacuum). The negative effect of small amounts of water on evaporator performance has not been fully recognized in the past, but must be addressed during the design of the DX ammonia system. With the Low Temperature DX Ammonia system, it is possible to successfully apply DX ammonia at suction temperatures down to minus-50 degrees F.

The negative effect of small amounts of water on evaporator performance has not been fully recognized in the past, but must be addressed during the design of the DX ammonia system.

3. There must be proper piping for handling defrost condensate. In a pumped ammonia system, defrost condensate is normally returned to one of the recirculator vessels where it is simply pumped back out, or "recirculated," to the evaporators. In a DX system the defrost condensate is not recirculated and so must be carefully considered in the system design. The best approach is always to return defrost condensate to the high-pressure suction accumulator or intercooler, where it can be used to do useful work such as subcooling high-pressure liquid and intercooling booster discharge gas.
4. Proper control and distribution of the expanded ammonia to the evaporator coil is critical for good performance. Using an electronic expansion valve with its matched superheat controller is key to stable control of the evaporator. A suitable refrigerant distributor is also important to ensure uniform delivery of the expanded ammonia to all of the evaporator circuits while also allowing unrestricted flow of hot gas during defrosting.

In summary, DX ammonia technology offers three major benefits. First is the inherently safer design resulting from the significant reduction in ammonia charge. Second, DX ammonia reduces power consumption and operating costs making it attractive not only for industrial facilities but also for commercial applications previously dominated by HFCs. Finally, the cost of installing DX ammonia is lower than traditional pumped ammonia designs.

"First and foremost, DX ammonia technology reduces the amount of ammonia needed to refrigerate a facility, so it is inherently a safer technology," Nelson said. "You're also offering the end user the very attractive benefits of lower first cost and lower operating costs."

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EPA Issues Proposed Rule on RMP

iiar government RELATIONS

BY LOWELL RANDEL, IIAR GOVERNMENT RELATIONS DIRECTOR

On March 14, 2016, the Environmental Protection Agency (EPA) published in the Federal Register a proposed rule to modernize the Risk Management Program. The rulemaking comes as a part of the Obama Administration's efforts to implement Executive Order 13650 – Improving Chemical Facility Safety and Security. The Executive Order was issued in response to an incident at a fertilizer plant in West, Texas in April 2013.

*(**Note:** The Bureau of Alcohol, Tobacco and Firearms has since ruled the incident in West to have been a criminal act. Despite the finding that what happened in West was not an accident, the EPA has shown no signs of slowing its efforts to move forward with amending the RMP regulation.)*

Since the Executive Order was signed, agencies including EPA, the Occupational Safety and Health Administration (OSHA) and the Department of Homeland Security (DHS) have been considering regulatory changes to their chemical safety and security programs. One of the first steps taken by EPA was a Request for Information (RFI) seeking input on nineteen possible changes to RMP. IIAR led a coalition of industry partners in responding to the RFI and expressing concerns with the suggested changes to RMP.

After gathering input through the RFI process, EPA began developing a Proposed Rule to change RMP. Because of the significant impact the rule would have on regulated small businesses, EPA convened a Small Business Review Panel to gain insights from small businesses subject to RMP. Lowell Randel, IIAR Director of Government Relations, actively participated in the panel process. EPA published the Proposed Rule shortly after the Small Business Review Panel completed its work.

In its Proposed Rule, EPA is proposing changes to RMP in the following areas:

- Independent Third Party Audits
- Root Cause Analysis
- Inherently Safer Technology Assessments
- Emergency Response Enhancements
- Enhanced Availability of Information

A summary of the proposed changes, along with some of the key industry concerns follows below:

Summary of Major Provisions

Independent Third Party Audits

The proposed rule would require regulated facilities contract with an independent third-party to perform a compliance audit after the facility has a reportable release. Compliance audits are required under the existing rule, but are allowed to be self-audits (i.e., performed by the owner or operator of the regulated facility). The independent third party audits apply only to the first audit following an accident/reportable incident.

The Proposed Rule includes some strong restrictions on auditor independence that are causing concerns with industry. Independent auditors could not have performed any services other than audits for the last three years, and would be prohibited from doing any non-audit work for three years after the audit. Many third party firms in the industrial refrigeration industry, offer audits as only one of many services. If enacted, the independence criteria will effectively disqualify some of the most qualified third party firms in our industry from conducting audits after reportable accidents.

The Proposed Rule also lays out a list of auditor qualifications. Most of the proposed qualifications are reasonable, such as knowledge of the type of facility being audited and training in conducting RMP audits. However, the proposal includes a requirement that the audit team have a Professional Engineer (PE), which many think is too narrow a qualification. IIAR has commented to EPA that they should add additional options to demonstrate that an auditor is qualified, not just having a PE.

Industry concerns:

- The agency has provided insufficient cost/benefit analysis for the audit restrictions and underestimates the cost burden on facilities.
- The assumption that non-associated audits are always better is not well founded in the available data.
- Restrictions on who can conduct audits may lead to problems with qualified auditor availability.
- All qualified auditors, regardless of current or prior connections with the facility or company should be allowed to conduct audits.

Root Cause Analysis

The proposed rule would require facilities to conduct a root cause analysis as part of an incident investigation of a catastrophic release or an incident that could have reasonably resulted in a catastrophic release (i.e., a near-miss). Within 12 months, facilities must complete a root cause investigation that identifies the fundamental reason why an incident occurred and the correctable failures(s) in management systems for all RMP reportable incidents and near miss incidents. The report would not need to be submitted to EPA, but must be retained by the facility for at least 5 years. EPA will expect any corrective actions to be addressed in a reasonable time. Facilities may risk enforcement exposure for corrective actions identified in the report that are not addressed.

continued on page 26

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OSHA Initiates Small Business Review Panel on PSM Regulation

Industry Concerns:

- A clear definition of "near miss" is needed to ensure consistent application across regulated facilities.
- Setting the bar too low for triggering analysis could lead to less reporting.
- Flexibility on "root cause" analysis is needed.

Inherently Safer Technology Assessments

The proposed rule would add an element to the process hazard analysis (PHA), which is updated every five years. Specifically, owners or operators of facilities with Program 3 regulated processes in North American Industrial Classification System (NAICS) codes 322 (paper manufacturing), 324 (petroleum and coal products manufacturing), and 325 (chemical manufacturing) would be required to conduct a safer technology and alternatives analysis (STAA) as part of their PHA, and to evaluate the feasibility of any inherently safer technology (IST) identified. ***This provision would not apply to the industrial refrigeration industry.***

Industry Concerns:

- While this provision would not apply to industrial refrigeration, the establishment of this precedent could lead to a slippery slope and future application to other industries.
- Mandated alternatives analysis adds significant costs and the agency has not demonstrated sufficient cost-benefit analysis.

Emergency Response Enhancements

The proposed rule would require owners or operators of all facilities with Program 2 or 3 processes to coordinate with the local emergency response agencies at least once a year to ensure that resources and capabilities are in place to respond to an accidental release of a regulated substance. As a result of improved coordination between facility owners and operators and local emergency response officials, EPA believes that some facilities that are currently designated as non-responding facilities may become responding facilities.

Additionally, facilities would be required to conduct notification exercises annually to ensure that their emergency contact information is accurate and complete. This provision is intended to reduce the impact of accidents by ensuring that appropriate mechanisms and processes are in place to notify local responders when an accident occurs.

Facilities subject to the emergency response program requirements of the rule (or "responding facilities") would be required to conduct a full field exercise at least once every five years and one tabletop exercise annually in the other years. Responding facilities that have an RMP reportable accident would also have to conduct a full field exercise within a year of the accident.

Industry Concerns:

- A clear and consistent definition of "coordination" is needed.
- EPA should recognize facility due diligence to engage with responders, even when responders do not reciprocate.
- The change could lead to non-responding facilities to become responding facilities.
- Costs associated with transitioning from non-responder to responder are significant.

Enhanced Availability of Information

The proposed rule would require all facilities to provide certain basic information to the public through easily accessible means such as a company website. If no website exists, the owner or operator may provide the information at public libraries or government offices, or use other means appropriate for particular locations and facilities. In addition, facilities would be required, upon request, to provide the Local Emergency Planning Committee (LEPC), Tribal Emergency Planning Committee (TEPC) or other local emergency response agencies with summaries related to: their activities on compliance audits (facilities with Program 2 and Program 3 processes); emergency response exercises (facilities with Program 2 and Program 3 processes); accident history and investigation reports (all facilities that have had RMP reportable accidents); and any ISTs implemented at the facility.

The proposed rule would also require all facilities to hold a public meeting for the local community within 30 days after an RMP reportable accident. This provision is intended to give first responders and members of the community easier access accident information.

Industry Concerns:

- Public meetings were required through the RMP program in the past and proved to provide little to no value. Questionable benefits do not justify the costs involved.
- The time period (30 days) to conduct a public meeting after an accident is insufficient. Companies have 12 months to complete an incident investigation and the amount of information available within 30 days will be minimal.

Compliance Dates

EPA's proposal includes its current thinking on compliance dates for facilities to implement the rule changes. Below is the proposed timeline for the various requirements based on the effective date of the Final Rule.

1 year: Emergency response coordination activities.

3 years: Owner or operator of a non-responding facility source to develop an emergency response program following an LEPC or equivalent's written request to do so.

4 years: Comply with new provisions, unless otherwise stated.

5 years: Correct or resubmit RMPs to reflect new and revised data elements.

IIAR again led coalition efforts to send a strong message to EPA about industry concerns with the agency's proposal and will continue to actively engage with the EPA as the process moves forward. Because the RMP rulemaking is a high priority for the Obama Administration, it is expected that a Final Rule will be published before the end of 2016.

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Evaluating Safety in CO_2 Systems

The use of carbon-dioxide refrigeration systems has been gaining in popularity in recent years as an alternative to ammonia systems, as companies learn about their energy efficiency, safety benefits and resiliency.

Although CO_2, like ammonia, is classified as a "natural refrigerant," there are a number of differences between the two refrigerants, related to the significantly higher operating pressure of CO_2 systems that are critical to understand from a safety perspective. And engineers must take into account those differences when designing and building a C02 system.

"It starts at the design process and continues through to what needs to be understood from an operational standpoint," says David Blackhurst, director at Star Technical Solutions. "When working with higher pressures you have to define your pressure envelope and the operating parameters under pressure. A typical ammonia system would be designed with a high pressure side rating of 250 psig, but with CO_2 it could be around 750 psig for a cascade or subcritical system operating with hot-gas defrosting and as much as 1,750 psig for a transcritical system. So you need to design for components that can withstand those pressures."

Among the considerations when designing and operating a CO_2 system is to avoid situations when liquid CO_2 can be trapped, be prepared for cross-contamination by being able to promptly respond to a leak that causes ammonium carbamate, carefully consider the location of pressure relief valves and CO_2 detectors and guard against water contamination.

CO_2 has a high coefficient of thermal expansion, so the system can fail in areas where liquid becomes trapped and warms up, creating extremely high pressures. Designers must identify those potential areas and either include some form of pressure control within that section or make sure it is not isolated once the system is operating. A fail-safe measure could include having two valves that can't be closed simultaneously, with one valve locked in open position.

"If you have to close CO_2 valves for whatever reason, it must be done in a considered and deliberate manner," Blackhurst says. "Trapped liquid is a big issue because if liquid on the low pressure side is at -40 degrees, is constrained between two closed valves, and then rises to say 32 degrees, that part of the system will be under enormous pressure."

Cross-contamination in a cascade system is another CO_2 issue. Cascade refrigeration plants feature an intermediate heat exchanger that has condensing CO_2 on one side and ammonia on the other side that is evaporating. If a leak occurs, the CO_2 will always flow to the ammonia side due to CO_2's higher pressure. Therefore, it is important to select the most appropriate type of heat exchanger with the least opportunity of allowing CO_2 to leak into ammonia.

If such a leak does take place, a white, crystalline compound called ammonium carbamate is formed that will clog up the internals of the ammonia system. A good way to limit the damage from cross-contamination is to design the overall system with two separate ammonia circuits. If one circuit is contaminated because its intermediate heat exchanger fails, the second circuit would allow the plant to keep running at half capacity.

Another option is to install fast-acting valves in the ammonia lines around the intermediate heat exchanger so the detector can quickly pick up ammonium carbamate and contain the contamination to a localized area.

"If you lose cooling through cross contamination it could take weeks to deal with it," Blackhurst said.

The design and location of pressure relief valves in a CO_2 system differs from an ammonia system. With an ammonia system, typically the pressure-relief valve is local to the vessel and connected to it by a short stub of piping. Ammonia passing through the pressure relief valve discharges either to a diffusion tank or to the atmosphere, via a length of pipe. But CO_2 gas passing becomes a solid as it passes through the pressure relief valve and is dropped to atmospheric pressure. Therefore, the pressure relief valve must be positioned at the point of discharge so that the solid material will be blown into the atmosphere. Otherwise, the pressure relief valve could become blocked preventing adequate pressure relief from the vessel in question.

Another difference between CO_2 and ammonia systems is the amount of water contamination that each system can tolerate. The CO_2 in a refrigeration system should contain less than 10 parts-per-million of water.

If the system is not dry the water in it will manifest in different parts of it as water, ice and a crystallized structure composed of CO_2 and water particles that look like ice. "It's important to know the quality of the CO_2 that you're buying, and also to make sure all the water is out of the system before you begin to charge with CO_2," Blackhurst says.

Finally, the proper placement of CO_2 detectors is a critical safety measure. Although CO_2 is not toxic or flammable, you are still dealing with a vapor that if undetected can cause death at high enough concentrations, he said.

The threshold limit value for CO_2 is 5,000 ppm (0.5 percent). That is the highest concentration that a worker can safely be exposed to for up to eight hours. The National Institute for Occupational Safety & Health (NIOSH) IDLH limit for CO_2 is 40,000 ppm (4 percent). The setting of CO_2 detectors should therefore be a minimum of 5,000 ppm and an absolute maximum of 40,000 ppm.

It is also important to bear in mind that CO_2 is 1.5 times heavier than air, so careful consideration must be given to locating sensors where CO_2 might leak and concentrate, such as in stairwells or basement areas. One should also consider the level of ventilation in the space.

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Qualifying Ammonia Refrigeration Contractors

Business owners and operators must take steps to ensure that contractors working on or near ammonia refrigeration systems have the necessary qualifications and work experience to help employers understand their responsibilities related to ammonia refrigeration contractors, and demonstrate their proficiency in working with the system, Tony Lundell, IIAR director of standards and safety said. Lundell led an IIAR webinar in April entitled, "Qualifying Ammonia Refrigeration Contractors."

As a best practice, owners and operators should be sure to obtain and evaluate a contractor's hazard communication plan, verify training, and conduct periodic field evaluations.

"The employer needs to ensure that all ammonia refrigeration contractors, subcontractors, and their employees are fully aware of the potential hazards involved with a process which leads to reduced risks of accidents and improved safety," Lundell said.

During the webinar, Lundell discussed several Contractor Qualification (CQ) Documents from the IIAR PSM/RMP Program Guidelines, including: CQ-1: Contractor Qualifications and References Questionnaire, CQ-2: Confirmation Letter: Safety Communications, CQ-3: Contractor Employee Acknowledgement Record and CQ-4: Contractor Employer Evaluation.

Owners and operators can begin the process of qualifying an ammonia refrigeration contractor by writing a letter that asks for the contractor's current equipment operating licenses and certificate of insurance. They can also reach out to the contractor's insurance agency for the experience modification rating (EMR).

"Call the insurance company and get their EMR, which will compare them to other contractors," Lundell said. "You can learn a lot from your contractor's behaviors and their cultural practices by reviewing their forms."

Employers can also request contractors' Occupational Safety and Health Administration forms, which allow a potential employer to verify the contractor's culture and behaviors. "You know how many times they've had an injury or concerns of illnesses," Lundell said.

The forms include OSHA Form 300: Log of Work-Related Injuries and Illnesses, OSHA Form 300: Summary of Work-Related Injuries and Illnesses, and OSHA Form 301: Injury and Illness Incident Report. All of the forms are available at OSHA.gov, Lundell said. IIAR can also provide these forms upon request.

Contractors should also provide information on the related training their employees have completed as well as safety and welding manuals they have developed. Lundell asked: "Have they completed IIAR, RETA or ASTI training? What certificates do they hold? Can they demonstrate knowledge of the IIAR standards?"

Lundell said potential employers should compare that information with their training requirements to identify a gap. "They can confirm whether or not the contractor can verify the training of their employees," he said.

Operators should ensure that their contractors have actual hands-on experience. "Having knowledge of a system is one thing, but they have to be able to prove they have experience working on or near a typical system," Lundell said. He added that employers can ask contractors for their ammonia-related work experience and training verification records to see what they've historically designed, built, installed, operated or provided service for in the past. "Ask if they have special certifications or certificates and if they can provide references," he said.

Contractors must wear the appropriate attire and personal protective equipment if they are working in or near production.

The webinar explained how and why certain standards apply to ammonia refrigeration contractors, including:

- OSHAs Process Safety Management (PSM) 29 CFR 1910.119 with focus of Section (h)
- EPAs Risk Management Plan (RMP) 40 CFR 68 with focus on Section 68.87 for Program 3
- IIARs PSM/RMP and ARM Program Guidelines specific to the ammonia refrigeration industry
- IIAR Related Publications and the IIAR Suite of Standards
- Related Terms between OSHA and the EPA.

IIAR members have access to view a recording of the webinar in the Members Section of the iiar.org website.

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- **Workers' Compensation:** Statutory Limits
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2015–2016 Year at a Glance

- **Publication of ANSI/IIAR 2**
- **Monthly member Webinar series**
- **Release of the IIAR Member App**
- **New education programs promoting member interest before EPA and OSHA**

What's on the horizon for IIAR...

- **The 2017 Natural Refrigeration Conference & Heavy Equipment Expo, February 26 – March 1 in San Antonio, TX.**
- **The addition of the IIAR Basic Ammonia Refrigeration Training Program (Series I): Vessels.**
- **First Public Review of IIAR 6 & IIAR 9**

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IIAR Submits Formal Questions on Eyewash, Safety Showers

from the technical **DIRECTOR**

BY ERIC SMITH, P.E., LEED AP, IIAR VICE PRESIDENT AND TECHNICAL DIRECTOR

The revision of IIAR-2 involved discussions of many philosophical and practical matters. Among the topics discussed was that of the need for eyewash/safety showers in areas other than machinery rooms, and specifically in cold environments such as a freezer or on the roof. Hoping to gain insight on OSHA's intent, IIAR submitted some formal questions regarding risks and the need for eyewash/safety showers. The paraphrased letter and OSHA's response follows.

Directorate of Enforcement Programs (DEP) — OSHA
December 17, 2014

RE: IIAR Request for Interpretation on Hazards and Eyewash Safety Shower Situations

We are writing to you for guidance and interpretation regarding the application of eyewash/safety showers. There are two issues for which we would like to have a formal response. The first issue is related to the identification of risks. 29 CFR 1910.151(c) states: "Where the eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use."

The ammonia refrigeration industry has interpreted that identified risks exist only when maintenance occurs that involves the deliberate opening or the potential uncontrolled opening of a system. This is because there is such a very low probability that equipment, valve stations and piping will have ammonia leaks and there is virtually no likelihood that people will be exposed to ammonia unless they are performing such operations that open the system.

This reasoning is supported by the approved use of portable eyewash/safety showers for some procedures. It is further supported by an OSHA interpretation letter to Mr. Donald Bossow on June 1, 2009, reply 2 wherein the response includes the following statement: "…If hazardous materials are present at a worksite in such a way that exposure could not occur (for example in sealed containers that will not be opened, or caustic materials in building piping), then an eyewash or emergency shower would not be necessary. However if the building piping containing caustic materials has, at certain locations, a spigot or a tap from which the contents are to be sampled or withdrawn, then, certainly , an eyewash and/or emergency shower would be needed where this task is to occur".

For some maintenance functions, such as oil draining, equipment replacement and valve and piping maintenance or repair, it is clear that a risk exists. However, other maintenance items present virtually no risk of exposure, even though they involve the ammonia system. Examples of these types of maintenance functions are, service of control systems, cleaning of coils, lubrication of bearings, fan replacement etc. where there is no intention of opening or repairing the pressure containing envelope of the system. Further, it is the opinion of the industry that the mere existence of a system or portion of a system does not constitute a risk in and of itself. Confirmation or clarification of these assumptions is desired because end users have been fined for not having eyewash and safety showers installed near valve stations and other equipment, even though the valve stations and equipment are not often or ever serviced in a manner that would involve potential exposure. To be clear, most companies procedurally require that portable eyewash safety showers are to be accessible where permanent ones are not available and when maintenance is required that involves potential exposure.

The second issue relates to the practical use of eyewash/safety showers and potential alternatives to their requirement. Refrigerated facilities are often very expansive, and much of the equipment, piping and valve stations are located along roofs or within refrigerated areas. Permanent eyewash/safety shower stations, or even tepid water loops for temporary drenching connections can present a tremendous capital cost as well as operating and maintenance

costs in such conditions because of the need for freeze protection of water piping. While temporary portable eyewash/safety showers are often a good alternative, their use in cold weather conditions or in cold or subfreezing rooms is impractical. Water in portable units cannot be kept at required temperatures. Further, use or testing of any type of eyewash safety shower used in cold conditions can present potential for hypothermia or even create a slip/trip hazard – the last thing that is needed when evacuation is necessary. Even the testing of permanently installed units can present potential hazards.

We propose that an alternative to eyewash/safety shower requirements would be the procedural requirement for personnel to don a minimum of Level C personal protective equipment (PPE) when performing tasks that can potentially lead to exposure – i.e. tasks that could compromise the pressure containing envelope of the system, as identified in companies' process hazard analysis (see attached excerpt from IIAR's Introduction to Ammonia Refrigeration, PPE Levels of Protection). A literature review indicates that a concern of regulatory agencies regarding PPE is that often people do not use their PPE, or that even when they do, they can still be exposed through gaps in the normal PPE. This concern has led to the requirement of eyewash/safety showers even if procedures state PPE is to be worn, i.e. PPE is no substitute for eyewash/safety showers. But because of the potential risks of using eyewash and safety showers in cold surroundings, we submit that the use of higher level PPE should be acceptable in lieu of providing either permanent or temporary eyewash/safety shower equipment.

We do not expect that companies would rely exclusively on PPE over the use of permanent or portable eyewash stations. Higher level PPE is also expensive, but moreover can be cumbersome to work in. However, when faced with the potential risks of hypothermia or trip hazards, this is a preferred method.

We would appreciate your written concurrence with these assumptions and proposals or provide the agency's expectations regarding the identification of risks and the use of PPE as they relate to eyewash/safety shower issues described here.

After many months of circulation and review by OSHA's technical and legal departments, the following response was returned including the paraphrased questions:

Question #1: *Would OSHA accept the use of personal protective equipment in lieu of permanent or portable eyewash/safety showers in cold environments?*

Reply #1: *No. OSHA would not accept the use of personal protective equipment in lieu of eyewash/safety showers regardless of the environment. Further, there are emergency eye wash and safety shower products that have built-in heating elements for maintenance operations in cold environments.*

Question #2: *If the ammonia refrigeration is in a sealed container (sic) where there is no intention of opening or repairing the pressure-containing envelope of the piping system, does 29 CFR 1910.151 (c) require an eyewash or emergency shower?*

Reply #2: *No. However, as you recognized in your letter, for some maintenance operations, such as oil draining, equipment replacement, and valve and piping maintenance or repair, there is potential for exposure to ammonia. In those circumstances, the standard requires the employer to provide facilities for quick drenching or flushing of the eyes or body.*

Thank you for your interest in occupational safety and health. We hope you find this information helpful. OSHA's requirements are set by statute, standards, and regulations. Our letters of interpretation do not create new or additional requirements but rather explain these requirements and how they apply to particular circumstances. This letter constitutes OSHA's interpretation of the requirements discussed. From time to time, letters are affected when the Agency updates a standard, a legal decision impacts a standard, or changes in technology affect the interpretation. To assure that you are using the correct information and guidance, please consult OSHA's website at http://www.osha.gov.

The response above is poignant for our industry. It is our estimation that the response is both positive and negative. The response clearly indicates that just because ammonia equipment and piping is present doesn't automatically mean that a risk exists. Taking this logic a bit further, a facility does not need to provide an eyewash/safety shower everywhere there are ammonia refrigeration components. But if there is a plan to open the system, the use of PPE is not a substitute for a "facility for quick drenching or flushing of the eyes or body". A "facility" could be any method such as portable unit or hoses (and a suitable nozzle) with an appropriate supply of water at the appropriate temperature. ANSI/ISEA Z358.1 provides the requirements for flow rate and temperature, as well as maintenance for permanently installed stations. While the response did not address the possibility of slip/trip hazards or hypothermia, we must presume that OSHA regards these possibilities as minimal compared to not having the ability to dilute an ammonia exposure.

Building designers and owners should account for the need for occasional maintenance that includes opening the system. Water supply or a means to provide portable eyewash/safety showers on roofs, in process areas or other places should be considered. As always an evaluation of costs and benefits is appropriate.

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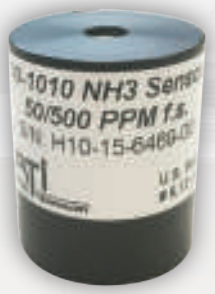

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"Economizers are widely used, as a relatively low-cost way to provide an improvement in overall energy efficiency in many refrigeration plants," said Joe Pillis, director of engineering, industrial refrigeration, at Johnson Controls.

Any pressure between suction and discharge can be located by drilling holes through the casing of a screw compressor. An economizer is simply a special port that is located at an optimized location as a secondary suction port, into which additional gas can be drawn from higher pressure sources.

Economizers provide sub-cooling of the condensed liquid going to the evaporator, resulting in an increase in capacity and efficiency. Some of the liquid from the condenser is evaporated to the lower pressure at the economizer port in order to refrigerate the remainder of the condensed liquid before it goes to the evaporator. The colder liquid provides an increase in refrigeration tonnage at the evaporator and an overall increase in system efficiency.

Compression efficiency tends to be higher with economizers because the overhead frictional losses to run the compressor do not increase with additional gas flow. "So it's almost like the additional gas that you can shove into the economizer port is being compressed in a friction-less compressor," Pillis said. "You don't have to pay for the losses a second time. That's partly where the energy efficiency comes from."

The other advantage is that the added gas flow only has to be compressed from the higher economizer pressure to discharge, instead of all the way from suction to discharge, he said. Economizers can add 10 percent to 30 percent to the capacity of a single compressor, with a five-to-15 percent improvement in efficiency, depending on the evaporating temperature.

By contrast, a side-load uses the same economizer port on the compressor but instead of providing sub-cooled liquid to the primary evaporator, it provides the suction for a higher temperature evaporator. Side-loading can eliminate the need for a dedicated compressor on a higher temperature evaporator load, while efficiently adding that load to the economizer port on a compressor that is already running.

Many cold-storage warehouses have loading docks with high temperature evaporators running directly off the economizer port. This avoids the energy waste of using a backpressure regulator to service the dock with the primary low temperature suction, saves the cost of a dedicated "dock compressor," and provides the same "friction-less" compression advantage enjoyed with the use of the economizer.

As an example, a screw compressor sized for 100 TR for a minus-10 degree cold-storage room can easily provide the suction for a 65 TR dock load at 35-degree room temperature, while providing efficient compression for the added capacity.

More energy savings can be produced when using economizers with variable speed drives (VSD). Variable speed drives boost the part-load efficiency of screw compressors compared with those using slide valves for unloading. With economizers and side-loads, the slide valve remains in the fully loaded position while capacity is regulated by speed. The economizer port maintains the same in relation to suction pressure while the compressor unloads. Therefore, the economizer can be used at all part-load conditions and the efficiency improvement is always available.

One of the newer efficiency boosting systems available today is the combination of variable-volume ratio compressors with adjustment of the volume ratio depending on the loading at the economizer port. Some of these compressors have a significant increase in internal thread pressure from the economizer or side-load gas flow. Adjusting the volume ratio down to account for the added gas flowing to the economizer port reduces the power significantly and avoids over compression.

The economizer might also lead facility owners to consider installing a less expensive single-stage compression system. Although a two-stage compression system remains more efficient, especially at low evaporator temperatures, the difference in savings becomes much less significant when using an economizer on a single-stage compression system. At minus-15 degrees evaporator temperature to 95 degrees condensing, the gain in HP/TR between a single-stage and two-stage compression system is about 17 percent. However, the difference in efficiency between an economized single-stage compared to a two-stage system drops from 17 percent to 5.4 percent.

"With the amount of money needed to install a two-stage compression system, a lot of people might look at only a five-percent difference and go with the economized single-stage design," Pillis said.

REDUCING AMMONIA REFRIGERANT CHARGE IN SKATING RINK REFRIGERATION SYSTEMS

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Refrigeration designers for ice-skating rinks operated by the city of Montreal said that they were able to reduce the systems' ammonia charge through a design that uses a liquid leg raised to the mid-height of the plate heat exchanger and employs what the designers' report said is an innovative equilibrium vessel.

Montreal owns and operates 47 refrigerated skating rinks and aims to replace its systems that use hydrochlorofluorocarbon refrigerants that are being phased out by the Montreal Protocol.

The city is turning to ammonia refrigeration systems for the rinks, which are subject to stringent safety codes and guidelines. The report's authors said the city's installations exceed the "strictest of these standards" through the use of ammonia (air) washers in the machinery room, neutralization tanks and reduced ammonia charge.

The paper describes an innovation for the project consisting of an equilibrium vessel that is designed to simplify the system, minimize refrigerant charge, minimize controls and "avoid the need for a refrigerant operating level control and a high pressure receiver."

So far, the city has completed work on 14 arenas, with 11 in the design stage and four under construction, with the entire project slated to be finished by 2020.

INTRODUCTION

The refrigeration industry is slowly returning to the use of ammonia as a replacement to the hydrochlorofluorocarbon based refrigerants such as R-22. These HCFC refrigerants are no longer the preferred choice of the refrigeration industry due to their environmental impact and will soon be phased out by government regulations adhering to international treaties (Montreal Protocol).

Ammonia is classified as a $B2L_3$ type refrigerant which means it is both toxic and mildly flammable[6]. To reduce the risk of exposure due to component failure, accident or human error, the installation must adhere to the stringent safety codes and guidelines published by CSA, IIAR, ASHRAE, the province and municipalities.

The city of Montreal has installations which exceed the strictest of these standards. The City's initiative to lowering both the risk and the level of exposure includes, ammonia (air) washers in the machinery room in case of refrigerant leak, neutralization tanks and reduced ammonia refrigerant charge.

CRITICALLY CHARGED SYSTEMS [4]

"…Critically charged system is a type of refrigeration system whose refrigerant charge is limited in such a way that if the entire charge is located in the evaporators, it is not possible for liquid refrigerant to be entrained in the compressor suction line."

In this report we will explain the methods we applied to reduce the total refrigerant charge and to achieve a refrigeration system design containing only 2.25 lbs/TR.

The U-tube separator (1) assembly includes the liquid leg (7), the wet vapor riser (8) and the plate heat exchanger (evaporator) (2), designed to work with an equilibrium vessel (9), a level column (3) and a high level safety cut-out switch (4). The separator uses directional change, baffles and centrifugal action to achieve vapor / liquid separation. Compared to a conventional surge drum vessel, this U design occupies less physical space, is furnished pre-assembled and ready to install without the need of field erected support structure.

The refrigerant to brine plate and frame evaporator (2) was selected for optimum performance utilising gravity feed to thermosiphon motion and a mid-level liquid refrigerant charge. This partially flooded design optimizes refrigerant boil-off and vapor superheat. According to the plate manufacturer design engineers, «The flooded plate evaporator can be more efficient if the liquid leg level is up to mid height of the plate heat exchanger, maximising usage of the plate surface to produce phase change of the refrigerant». The brine flow was reduced to 451 usgpm (about ½ of the typical industry design) at 4°F temperature differential allowing for lower operating costs.

The 4 inch column (3) and sight glass assembly (13) allows visual liquid refrigerant level verification and charging calibration. Added to the column is a level float switch (4) which provides a cut-off protection against liquid carryover in the suction and refrigerant overcharge.

The oil pot (5) was selected for a volume (V_5) equal to the volume of the liquid leg accumulator (6) x 1.1 (V_6 *1.1 *where accumulator volume* = V_6).

Table #1 illustrates pipe volumes and corresponding ammonia holding capacities for typical oil pot diameters.

The pre-assembled liquid leg (7) and wet vapor riser (8) are both 4" in diameter.

The equilibrium vessel (9) was designed like an accumulator and its role is to prevent liquid refrigerant from exceeding the maximum operating level (12) when the oil pot is completely filled with oil. The vessel volume (V_9) = (V_6+V_5)*(1.1).

Sight glass (10) corresponds to the minimum liquid level (or ½ H where H=height of the heat exchange plates) for a correctly charged system with a refrigerant filled oil pot (5), whereas an oil pot filled with compressor oil would have a liquid ammonia level corresponding to sight glass (11). Should liquid exceed level indicator (12), the compressors must be immediately stopped and not permitted to operate until refrigerant charge (or anomaly) is corrected.

Service receiver is not shown (14). This vessel is not in the direct refrigerant flow containing only refrigerant vapor and used to stock liquid refrigerant when service conditions call for a system pump-down.

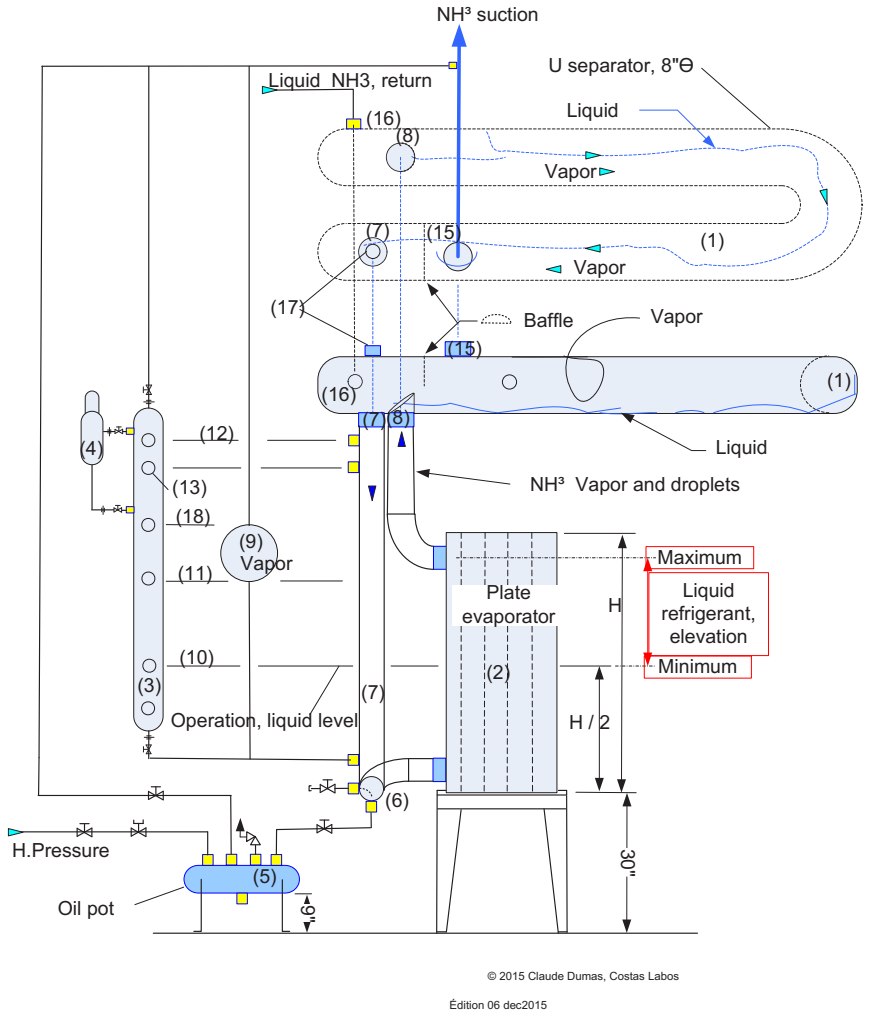
The suction port (15) is located at the top of the "U"-TURN separator, whereas port (16) identifies the liquid feed connection. The spare port (17) can accommodate the level sensor of an electronic transmitter (not used). Sight glass (18) corresponds to the top (crown) of the equilibrium vessel.

The liquid refrigerant and brine enter the heat exchanger at ports (6) located at the bottom and move upwards in a co-current (parallel) flow. The co-current flow permits a more significant refrigerant phase change at the base of the heat exchanger. The figure 3 also shows the collection of oil in case of insoluble oil heavier than the refrigerant.

INNOVATION

The innovation in this project is the use of an equilibrium vessel (9) designed to simplify the refrigeration system, minimize refrigerant charge, minimize controls, and avoid the need for a refrigerant operating level control and a high pressure receiver.

Fig. 1 U-TUBE separator with partially flooded evaporator



THE RISK VS. THE REFRIGERANT CHARGE

The first project for which the City implemented its policy to use ammonia as an alternative refrigerant in an indoor Arena was the Arena Raymond Bourque. The two rinks' refrigeration system used two flooded shell and tube evaporator (one for each rink), a high pressure refrigerant receiver, an evaporative condenser and an ammonia charge of 1500 lbs. See Table 2, Arena R-Bourque.

Given the amount of ammonia introduced to the arena's refrigerant system and the refrigerant's toxic nature, a risk assessment study was commissioned.

The report confirmed the direct link between the level of risk and the quantity of ammonia present in a system and recommended that "…priority be given to minimizing the refrigerant charge, thus reducing the risk from an accidental leak".

With ammonia reduction in mind, the move to drastically decrease the refrigeration charge came quickly – the critically charged design was introduced.

First we listed and identified all the refrigeration components and specifically tagged those with large volume or ammonia stocking potential (ex: surge drum [level], shell and tubes evaporators, evaporative condenser, high pressure receiver, oil pot, piping carrying liquid, liquid leg, sight glass column, etc).

In our design we:

a- Replaced the evaporative condenser by an ammonia to a glycol (solution) plate heat exchanger coupled with a glycol solution fluid cooler.

b- Replaced the shell and tube condenser by a compact welded plate heat exchanger.

c- Selected a plate and frame evaporator for optimal efficiency in a thermosiphon mode and partial flooded condition.

d- Replaced the conventional surge drum and related supporting structure with U-tube separator thus reducing the space footprint and installation time.

Note:

--Given the critically charged design, neither the U-tube separator nor a conventional surge drum should contain liquid refrigerant.

— The designer is not obliged to

use the "U" separator to achieve the efficiency of a critically charge refrigeration system like ours.

e- Eliminated two isolation valves used for service (and calibration) between the evaporator and surge drum. This allowed smaller liquid leg and wet riser piping (reduced from 6" to 4"), thus reducing the refrigerant charge.

f- Eliminated the operating level control.

g- Modified the piping and removed the high pressure receiver from its initial as a charge balancing function to simply a service receiver, thus under normal operating conditions containing vapor only.

h- Introduced an equilibrium vessel to account for level function resulting from oil displacing liquid ammonia in the oil pot.

i- Specified two independent refrigeration systems, 71 TR each, for two rink arena. This allows separate refrigerant charge (less than 175 lbs/system), smaller emergency ventilation system, minimizing the risk and less refrigerant loss in the event of a complete circuit leak.

j- Reduced the oil pot from an 8" to a 4" diameter, thus reducing its holding volume by 75%.

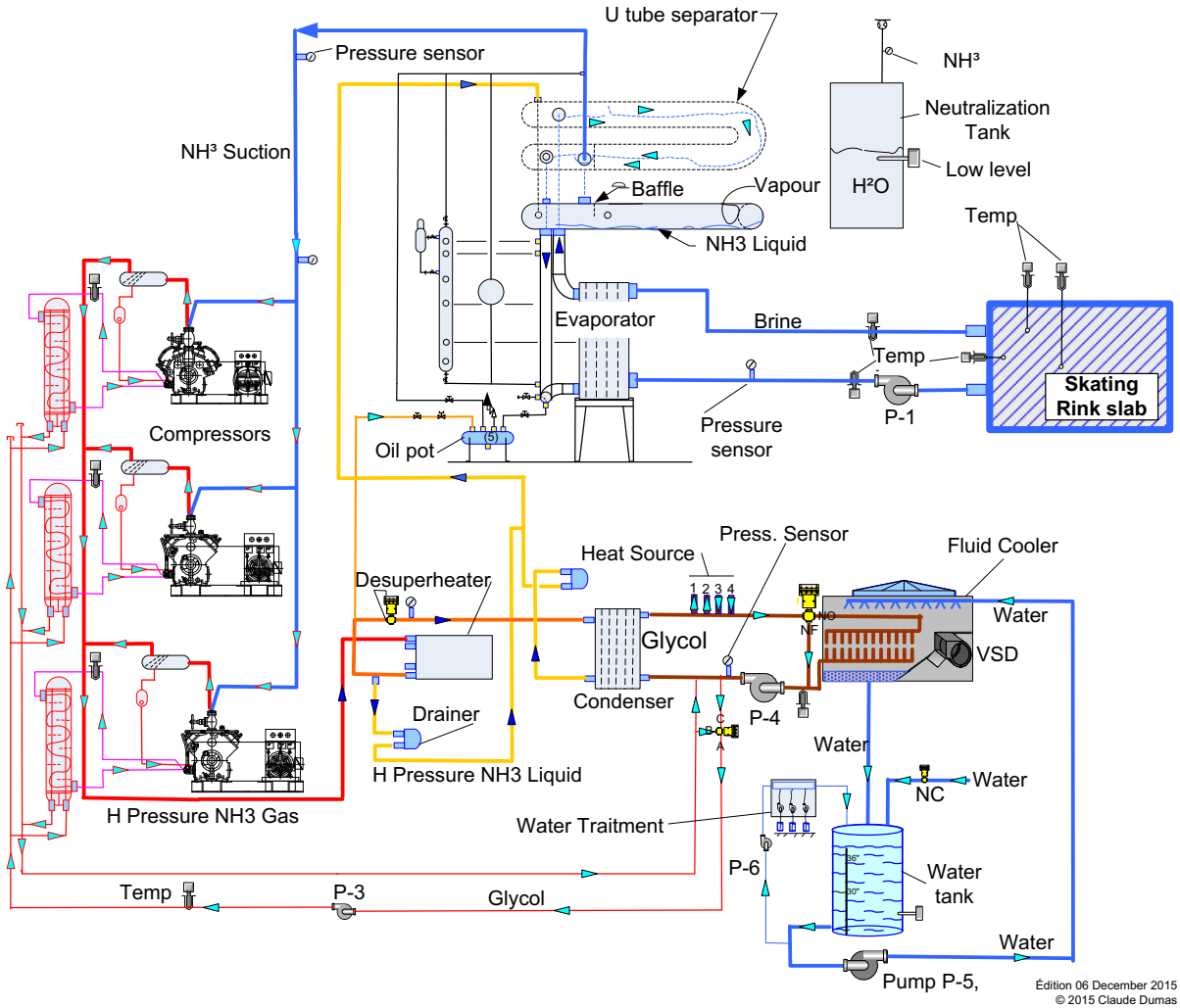
k- Reduced liquid carrying pipes diameters and length.

For example, at 6°F one linear foot of a 4" pipe can contain 3.63 lbs of liquid ammonia whereas one linear foot of an 8" pipe can contain 14.27 lbs of liquid. Refer to Table 1 for typical pipe diameters and corresponding liquid and vapour content.

Montreal owns and operates 47 refrigerated skating rinks of which 41 are located indoors and 6 are located outdoors. Presently, 14 arenas have been completed, 11 are in design stage and 4 are now under construction. Eleven more will be added to the list and respecting the HCFC-22 phase-out protocol - completion is expected by year 2020.

The 14 ammonia rink refrigeration systems designed, built and commis-

Fig. 2 The complete refrigeration system with reduced ammonia charge



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sioned are listed and shown on Table 2, mostly sized for 71 TR capacity and varying quantities of refrigerant with the more recent charged with less than 175 lbs of ammonia (a ratio of 2.46 lbs/TR). Furthermore, three (3) are noteworthy: Ahuntsic, where we realized a charge of 168 lbs for 71 TR (a ratio of 2.37 lbs/TR); M-Brodeur, where 145 lbs for 88 TR (a ratio of 1.65 lbs/TR) were used; and Saint-Charles where the charge was set at 160 lbs of ammonia for 71 TR (a ratio of 2.25 lbs/TR). See Table 2 for the refrigerant charge and the ratio realized in our skating rinks.

Our focus over the past several years, and fourteen (14) skating rink refrigeration systems completed, was always to **reduce the risks through prudent design and implementation aimed at minimizing the ammonia refrigerant charge, surpassing industry standards and never compromising safety and performance.**

On numerous occasions we needed to guide the industry players, whether they were suppliers or contractors, towards changing the paradigm that more is better does not apply to critically charged refrigeration systems.

Many times we gave order to the contractors to remove excess refrigerant in the system.

Note:
U= U tube separator.
SD= Surge drum separator.
TR= TON of refrigeration

* System: Flooded, critical charge, Plate type evaporator and condenser, fluid cooler. Build as per a standardized drawings and specifications.

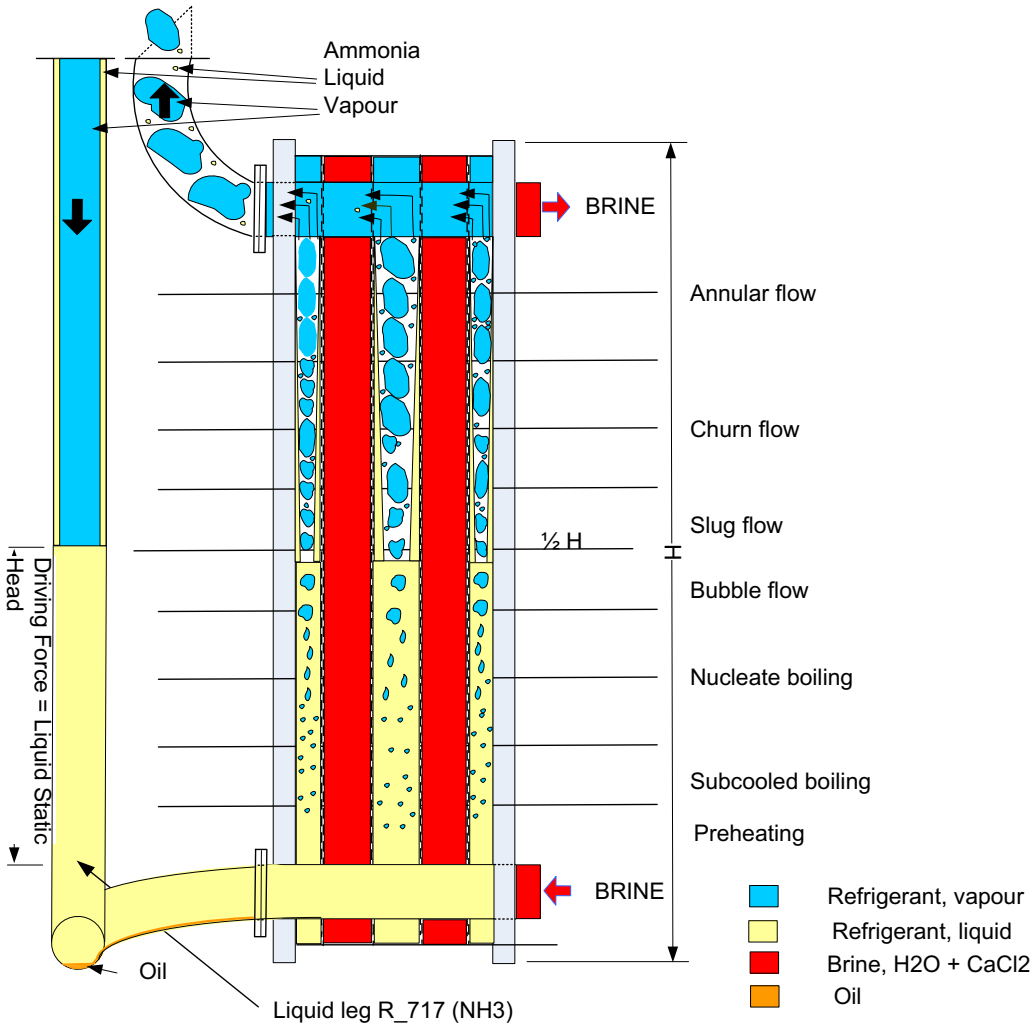
† System: Flooded, two shell and tubes evaporators, high pressure receiver, evaporative condenser.

CONCLUSION

The use of a factory supplied U-tube separator assembly, with a compact liquid and wet vapour riser and a simple-fit to the top of the plate heat exchanger frame, facilitates the installer's job, minimizes the space footprint and reduces installation time. See Fig. 2.

The use of an equilibrium vessel (9) is our innovation; an added protection de-

Fig. 3 The Plate Heat Exchanger as a thermosiphon evaporator, refrigerant R-717



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signed to accommodate refrigerant mass displaced by oil migration and safeguard the compressors from potential liquid slugging. This design minimizes refrigerant charge and avoids level feed controls.

The designer is not obliged to use the "U" separator, he can use a surge drum to achieve the efficiency of a critically charge refrigeration system like ours - simply follow the outlined instructions. A surge drum would have a larger foot print and require an added support structure; however, an equilibrium vessel would not be needed.

To reduce the risk (from ammonia exposure), we have prioritized the need for and the commitment to minimizing the ammonia charge in the refrigeration system; this is why in adjusting the liquid leg, the liquid evaporator level and introducing the equilibrium vessel, we have significantly reduced the refrigerant charge from many of our systems.

The message to remember is:
The flooded plate evaporator can be more efficient if the liquid leg level is up to mid height of the plate heat exchanger, maximising usage of the plate surface to produce phase change of the refrigerant. This is a revelation coming from the design engineer working for a plate manufacturer. See Fig. 3.

REFERENCES:

[1]: Ammonia refrigerant is identified by ASHRAE Standard 34 as number R-717, incidentally its molecular weight is 17 while its formula is NH_3.

[2]PBA is the consulting engineering firm Petropoulos, Bomis & Assoc. Inc. experts in ammonia refrigeration.

[3] ASHRAE Standard 34-2013,

Page.9, TABLE 4-1,. Refrigerant Data and Safety Classifications.

Page16, FIGURE 6.1.4,. Refrigerant Safety Group Classification….. A2L and B2L are lower flammability refrigerants with a maximum burning velocity of ≤ 3.9 in./s (10 cm/s).

[4] In accordance with CSA B52-13, P. 18,

[5] For more information about our refrigeration systems go to the following webpage: http://pages.videotron.com/NH3/text/publications_cdumas.html. The title of the file is: « Mise aux normes du système frigorifique de l'aréna Ahuntsic, Réfrigérant R-717.»

[6] Lecompte Michel «Nouvelles normes de réfrigération», ASHRAE-Montréal conférence, 11 Janvier 2016, page 20/32, «EPA, Alternatives for Refrigeration Applications»

Table 1 Typical Pipe Diameters and Corresponding Liquid and Vapour Content

		Weight (lb) of R-717 per linear foot of pipe at 6°F	
Diameter	*Volume ft³/ft.*	*Liquid lb/ft.*	*Vapour lb/ft.*
1" *	0.0050	0.21	0.001
2" *	0.0206	0.84	0.003
3"	0.0513	2.11	0.006
4"	0.0884	3.63	0.011
6"	0.2006	8.24	0.025
8"	0.3474	14.27	0.044

**schedule 80*

Table 2 Refrigerant Charge and the Ratio Realized in Our Skating Rinks

			R-717 charge vs. TR in our skating rinks				
	Arena	**Separator**	**YYYY**	**TR**	**Lb(R-717)**	**Lb(R-717)/TR**	**Skating rink size**
01	R-Luongo *	SD	2015	88	250	2.84	85'x200'xR=28'
02	Chaumont *	U	2015	71	175	2.46	85'x200'xR=28'
03	St-Charles *	U	2015	71	160	2.25	75'x175'xR=25'
04	D-Harvey *	SD	2014	71	200	2.82	85'x200'xR=28'
05	C-Jetté *	SD	2014	71	200	2.82	85'x200'xR=28'
06	M-Brodeur *	U	2014	88	145	1.65	85'x200'xR=28'
07	Ahuntsic *	U	2013	71	168	2.37	85'x200'xR=28'
08	P-Marquette *	SD	2012	71	200	2.81	75'x175'xR=25'
09	P.P.Morin *	SD	2012	94	225	2.39	85'x200'xR=28'
10	M-Normandin *	SD	2011	71	225	3.17	85'x200'xR=28'
11	C-Houde *	SD	2010	71	225	3.17	85'x200'xR=28'
12	H-Morenz *	SD	2010	71	225	3.17	85'x200'xR=28'
13	H-Bourassa *	SD	2010	71	350	4.93	85'x200'xR=28'
14	J-Lemaire *	SD	2010	114	500	4.38	85'x200'xR=28'
	One double rink done prior to our up to standard project						
15	R-Bourque #A †	SD	2007	152	1500	9.87	85'x200'xR=28'
16	R-Bourque #B †	SD	2007				85'x200'xR=28'

Note:
U= U tube separator.
SD= Surge drum separator.
TR= TON of refrigeration

* System: Flooded, critical charge, Plate type evaporator and condenser, fluid cooler. Build as per a standardized drawings and specifications.

† System: Flooded, two shell and tubes evaporators, high pressure receiver, evaporative condenser.

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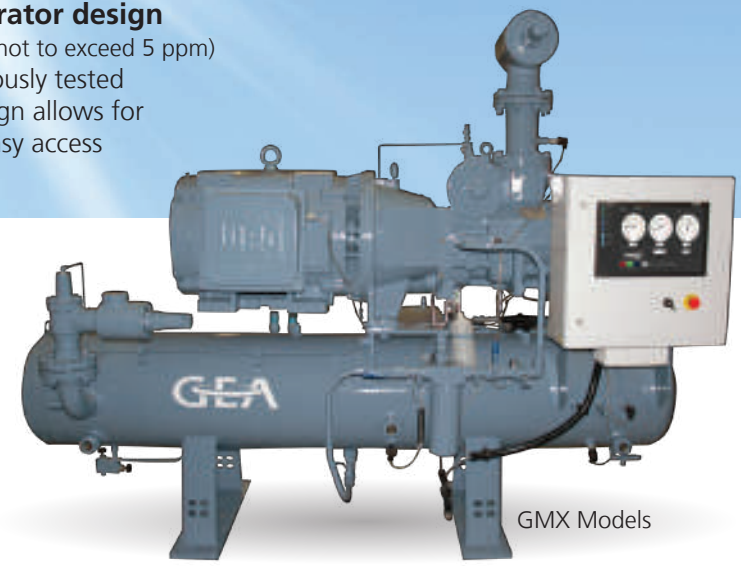

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