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CONDENSER

INTRODUCING THE:

ACADEMY OF NATURAL REFRIGERANTS


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SEPTEMBER 2016

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INTRODUCING THE:

ACADEMY OF NATURAL REFRIGERANTS

chairman's MESSAGE

MARK STENCEL

"Education is simply the soul of a society as it passes from one generation to another"
— G. K. Chesterton (1874-1936)

IIAR, as an organization, has lost a number of our key members to the passage of time and with those, some of our history and some of the core of our knowledge. With the recent loss of our first Chairman, George Briley, we lost a great deal of knowledge and an industry leader who exemplified the desire to pass it on.

To have spent any time with George was to have sensed his passion for our industry, the inquisitiveness of his spirit and the easy-going manner in which he willingly shared all those lessons learned. He was a prolific writer, and as such, a great contributor to the written record of much of the success and change in the practice of industrial refrigeration.

In addition to his writing, his one-on-one ability to communicate was one of his defining characteristics.

Perhaps it was the combination of his boyhood spent growing up on a cotton farm, an intellect that enabled his high school graduation at the age of 16 and his digging of foxholes for US troops engaged in the Battle of the Bulge during World War II, but something in George's background yielded a man who combined a common touch, a depth of knowledge and a sense of service.

These are great attributes for any person or organization to strive for. George embodied them.

We, as IIAR members, are now called upon to serve the future of our industry with the knowledge we have gained.

Today IIAR, like many organizations – is challenged as our membership grows older – to gather the essence of our collective wisdom and ensure its passage from one generation to the next. We need to make the process easy to participate in and the goal achievable for anyone dedicated to its attainment. Further, we need to make the experience inspirational to those participating so they are compelled to add to that core knowledge and to pass it on.

Therein lay the roots of the newly formed IIAR Academy of Natural Refrigerants. Under this banner, we are developing our first course, a "learn at your own pace" curriculum that enables the participant to develop and demonstrate knowledge in our industry's definitive design safety standard, IIAR-2.

It is our plan to conduct testing on this material, in a controlled setting, at the IIAR 2017 Annual Conference. For those who have dedicated their efforts to the study of this important standard and pass the comprehensive assessment test, we will be awarding certificates, thereby documenting their competency in the knowledge of IIAR-2.

This IIAR Certificate Program has been reviewed with, and has been sought by, regulatory agencies seeking a standardized means to discern and document the attainment of best and safe practice knowledge by our industry's participants.

The intent is for future classes, testing and certificate documentation to expand these education services to encompass the full suite of IIAR Standards, the IIAR Piping Handbook, the CO_2 Handbook and an array of other IIAR publications.

This is a significant initiative, undertaken by the IIAR, to serve the needs of our members. It exemplifies the better part of our nature which seeks to enlighten others to the lessons in safety we have learned and to share openly to advance our industry and to advance the interests of the community at large.

The IIAR-2 Certificate Program and our future educational programs reflect the desire to pass forward a wealth of knowledge. The development of and passing on of knowledge is one of the original intents of IIAR's founders, people like George Briley. Our educational efforts challenge those that follow – to continue to improve and grow our body of knowledge and to enhance the manner in which we communicate it.

We look forward to the success of this program and to the continued expansion of services to our members.

The intent is for future classes, testing and certificate documentation to expand these education services to encompass the full suite of IIAR Standards, the IIAR Piping Handbook, the CO_2 Handbook and an array of other IIAR publications.

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president's MESSAGE

BY DAVE RULE

In this issue, we're presenting news on one exciting new activity in our industry and our organization – to build and deliver IIAR's first education program. IIAR is working harder than ever to deliver on its promise to membership: to broaden the reach of our member base by addressing major issues that are occurring in our industry to promote the ongoing growth and health of industrial refrigeration.

Whether those issues are regulatory or operational, our focus on standards creation and new emphasis on education is critical in answering and addressing the issues we face.

We're dealing with changes – both good and bad – that have resulted from the increased regulatory impact that the phase out of HFC's has had. Those changes, and others have made dealing with the regulatory environment the first thing on everyone's list.

IIAR has, over the last few years, significantly increased the regulatory outreach work we do as an organization. And at the core of that work is IIAR's standards building process.

I'm happy to report that the effort we have all put into that process over the years is paying off in a big way.

By building a close relationship with OSHA and EPA, as we develop our standards, we've succeeded in getting the support of these important agencies. Lately, both OSHA and EPA have endorsed IIAR standards and encouraged all their inspectors to use them. That's a big change from even a few years ago, when standards from other industries were applied to our facilities during inspections.

In the past we did not have a method to direct regulatory agencies on the guidelines they develop and use to audit our industry. But now that we've involved them in our standards creation process, they've bought in to our industry's efforts to participate in the regulatory environment.

Building on IIAR's successful standards strategy, the new education program will take this effort one step further, to educate both our own membership and the regulatory community on our standards, what they address and how they should be applied.

This issue's cover story dives into that subject in detail, with a review of the new IIAR Academy of Natural Refrigerants and the first education product we'll release, the IIAR-2 certificate. So in this column, I want to focus on what's coming next, after the IIAR-2 certificate.

As I mentioned, IIAR's new education program will reflect our standards development effort, so we're focused on the several new standards creation efforts underway this year.

First, the IIAR Standards Committee is writing a standard for "Safe Inspection, Testing and Maintenance of Closed Circuit Ammonia Refrigeration Systems." This standard, IIAR-6, will provide the industry with much needed guidance for maintaining ammonia systems and proper documentation to ensure safe and efficient operation. IIAR is addressing RAGAGEP with a standard to define practices for upgrading facilities, including incorporating existing safety and regulatory guidance.

We're also in the early stages of developing a CO_2 standard to cover installation and maintenance of CO_2 systems. This will be a significant standard because CO_2 technology is becoming more important than ever before.

The development of a CO_2 standard is also a hallmark moment for IIAR, because it represents the organization's expansion into new member sectors and a chance to define what future regulatory oversight will look like.

The supermarket industry is focused more and more on CO_2 technology, and the growing industrial applications for CO_2 are also garnering the attention of many.

Right now, there is no definitive standard for CO_2, so it is a big step for IIAR to take the responsibility on behalf of the industrial and commercial refrigeration sectors to define what the use of CO_2 should look like.

This effort has also been an exciting way to invite new refrigeration sectors to be part of the work of IIAR. We have made a concerted effort to reach out to the commercial, manufacturing and end user communities to ask them to participate in this standard's development.

Finally, this year we'll begin drafting a new ARM program that is specifically focused on low-charge, small package ammonia systems. While not a standard, this revamp of the ARM program – which was originally developed to address large systems under ten thousand pounds – will help define how smaller systems in commercial applications should operate.

From there, the new IIAR ARM program will help us provide the industry with training and guidance on small and package systems.

As an industry, our passion and dedication for what we do easily translates into the kind of "can do" attitude that is necessary to turn out much of the work I've described above.

I'll end this month's column with a challenge to IIAR members and nonmembers alike. This year, become your industry's best advocate by taking an active role in the work of your IIAR organization. Get involved in the work of the IIAR committees and lend your voice and experience to our industry.

With your help and hard work, IIAR and our industry is poised for unprecedented growth.

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INTRODUCING THE:

ACADEMY OF NATURAL REFRIGERANTS

IIAR is preparing to launch a new educational certificate program this fall that will provide industry training as well as an unbiased means to validate what participants have learned.

The IIAR Academy of Natural Refrigerants certificate program will allow design engineers, installers and responsible parties to show that they have received documented and standardized training. The program will begin with a training course on IIAR-2, the latest IIAR standard to be updated, and will expand to cover additional IIAR standards and other technical courses of study that are necessary for engineers working in the refrigeration industry.

"Our markets are growing and we are drawing new generations of talent into the use of natural refrigerants. It is our responsibility and challenge to be sure that the lessons we have learned are not only documented in our standards, but also effectively transferred to and absorbed by our industry's new participants, our next generation of leaders and the industry as a whole," said Mark Stencel, IIAR chairman and director of business development at Bassett Mechanical.

By taking part in the IIAR education program, end users, designers and manufacturers will be able to show they're familiar with the standard, which is particularly useful when regulators visit a facility, Stencel explained.

"Regulatory bodies concerned with worker and public safety, such as OSHA and the EPA, look to responsible technical associations, like the IIAR, to lead the way and to provide a means to help ensure that risks are mitigated as proven knowledge levels are employed by our industry's practitioners," Stencel said.

The Occupational Safety and Health Administration's standard on Process Safety Management of Highly Hazardous Chemicals (1910.119(g)) requires that employers provide workers who use, store, move, manufacture and handle chemicals with training on their hazards. Employers must also implement written operating procedures that provide clear instructions for working safely with such chemicals.

"OSHA does not require that each worker receive the same training. However, it may be advantageous to an employer that each worker receives similar training on operating procedures to assure consistency," an OSHA spokesperson said in a written statement. "Additionally, OSHA requires that employers keep records on employee training so that when employers conduct mandatory audits of the program, inconsistencies can be detected and corrected."

Because the first phase of the program is oriented towards IIAR's safe design standard, it's especially suitable for end users who ultimately hold responsibility for their facilities, for designers, for design/build contractors and manufacturers who orient their offerings to the safe design practices of the ammonia refrigeration community.

Under the IIAR Academy of Natural Refrigerants, the IIAR-2 certificate course will include eight training sessions, typically an hour or less, given as a PowerPoint presentation with a voiceover. "At the end of each module, there will be questions to check understanding, and then you can move onto the next module," said Bob Czarnecki, chairman of the IIAR standards committee and the primary author of the IIAR-2 course curriculum.

To receive an IIAR certificate, participants will be required to pass an exam; the goal is to administer the first certificate exam at the IIAR conference at the end of February, said Trevor Hegg, vice president of industrial refrigeration product development at Evapco Inc. "I expect the exams on future certificate programs to be done in person, but not always at the conference," he said.

Czarnecki said the program's content and exam will cover the full IIAR-2 standard. "It goes through the whole document to make sure we're bringing out everything that is a requirement and that it is loud and clear what the engineer is supposed to do," he said, adding that the training be applicable to a wide range of designers, operators and other end users. "The course curriculum is designed for the person who is new and unfamiliar as well as the engineer who has years of experience in the industry. The intent was to spell out every detail in the program."

"It gives them a good basis for dealing with regulators and inspectors and makes sure everyone is on the same page," Czarnecki said, adding that the

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Bob Czarnecki, chairman of the IIAR standards committee and the primary author of the IIAR-2 course curriculum

The IIAR education certificate program is being introduced with the IIAR-2 technical course consisting of eight modules and a comprehensive exam to demonstrate the participants understanding of our industry's most comprehensive safety design standard. The IIAR-2 Course will be the first of many training modules that will be developed by IIAR under its new "Academy Of Natural Refrigerants" education program.

The "Academy Of Natural Refrigerants" is a long term education program created by IIAR to address the growing need in our industry for technical training focused on refrigeration engineering. The Academy program will first address the IIAR suite of standards and then move into additional courses of study to address Ammonia Refrigeration Management, Process and Risk Management and more specific courses of study in engineering plant facility design and operation. The "Academy Of Natural Refrigerants" is being developed to provide engineering training for the commercial and industrial refrigeration sectors of our industry. The objective of the academy is to address the technical training needs of end-users, design build contractors, equipment manufacturers and consulting engineering sectors of the IIAR membership. The courses of study will offer valuable training for the full range of our membership, from the entry level engineer to those individuals that have been serving the industry for many years. Engineers working in our industry will want to obtain an IIAR academy certificate for each course of study to demonstrate their competency in refrigeration engineering and enhance their value in the industry.

The IIAR-2 course modules will begin to be offered in September with the first certificate examination being conducted in February at the IIAR annual conference in San Antonio, Texas. Additional examinations will be scheduled periodically for those entering the course of study at a later date. The IIAR-2 course and certificate examination is offered to IIAR members at $795.00. Non-members may participate in the course and obtain the IIAR-2 certificate at an introductory rate of $1590.00. Registration information for the IIAR-2 course and the Academy Of Natural Refrigeration's learning management system may be accessed at www.iiar.org or by contacting the IIAR Director of Education at 703-312-4200.

initial goal of the program is to enroll at least 100 participants, but he hopes there will be many more interested in the program.

IIAR opted to start with IIAR-2 because that standard was updated recently and is positioned to become the referenced ammonia standard for the industry. "A lot of material was added to IIAR-2," Hegg said. "Since so much effort was put into that standard and since it was so comprehensive, it makes sense to start with that document."

IIAR-2 was substantively expanded in its most recent release. "It has been written in the specific language of codes and is being adopted as an important portion of the codes that govern the construction of refrigerated facilities," Stencel said. He added that ignorance of the law is not an excuse and knowledge of the law provides invaluable guidance in making the best possible decisions.

The training will strive to ensure that the standard is clear. "Sometimes in the standards, language may not be as clear as you'd like, and with codes it seems like there is room for interpretation. We are trying to get away from that, make sure everything is clear, give insight and provide examples," Czarnecki said.

Hegg said IIAR members face a number of regulatory burdens, and properly documented training can benefit operators. "You get into a situation where OSHA may not be well versed in regards to specifics within our industry. If inspectors come in and question operating procedures in a facility, it is important for operators to have valid documentation of their training program and a clear understanding of industry standards," he said.

Ideally, regulators and inspectors will take the course to make sure everyone is familiar with the same rules and regulations. "It is for the benefit of the industry. Those participating with this program will help the industry in general," Hegg said.

IIAR will expand the certificate program to encompass the full suite of IIAR standards, the IIAR Piping Handbook, the IIAR CO_2 Handbook and an additional number of IIAR publications. "As our standards are maintained and updated via the ANSI process, the program is being designed to evolve and to validate and communicate an individuals' knowledge of best practices both today and in the future," Stencel said, referring to the American National Standards Institute.

IIAR-2 was substantively expanded in its most recent release. "It has been written in the specific language of codes and is being adopted as an important portion of the codes that govern the construction of refrigerated facilities."

Mark Stencel, IIAR chairman and director of business development at Bassett Mechanical.

Hegg said he believes the next greatest potential is in a certificate course for IIAR-6, which is related to maintenance. "If our engineers can obtain a certificate to show they have competence, it gives them industry recognized documentation to show they are doing things appropriately," he said.

IIAR's Dave Rule added that accomplishing the goals of the new program will also require full time leadership within the IIAR staff. He added that the organization has hired a new education director to manage the education program, the certificate and continuing education credits, the Learning Management System and other training efforts. The new director, David Sainato, will join IIAR this month.

"We are pleased that David Sainato will be joining the IIAR Team as the new Director of Education. David is a graduate of the University of Maryland with a BA in Behavioral and Social Sciences and a major in Government and Politics; minor in English. He has served as a Professional Education Manager at the American Association for Clinical Chemistry since 2002. In his current and previous work experience he has addressed many of the challenges and objectives IIAR will face in establishing a quality education program to serve the needs of our membership. David also has experience working with a highly educated membership base as well as technical and scientific data in the medical field which should prove helpful in transitioning to our industry," said Rule.

The IIAR Academy of Natural Refrigerants provides a structured means for the education of incoming professionals as well as an unbiased means for interested parties to discern proven and specific ammonia refrigeration and natural refrigeration knowledge. "It is intended, as well, to be a source of pride and a measure of commitment to professionalism in the practice of ammonia refrigeration," Stencel said.

He added that it is to IIAR's credit that they have begun the process of building a broad educational program with a focus on safety and have created a certificate program to measure and acknowledge comprehension of IIAR-2 as well as other standards and technical materials.

"Ammonia, applied and used properly, is highly efficient and safe, and is an environmentally sustainable refrigerant. Misapplied or misused, it has risks that cast a shadow on these wonderful attributes," Stencel said.

Hegg said, "People are excited about where IIAR is going. IIAR's mission includes providing education, and people are generally excited about the concept."

Designs, Upgrades Cut Costs for Ammonia Refrigeration Operators

It's common knowledge that efficiently built facilities allow operators to increase their profits by reducing energy spending. But ammonia refrigeration companies, contractors and end users may be unaware of some less common knowledge . . . that electric utilities offer incentives to companies that design and build or retrofit facilities to improve energy efficiency. Different programs offer various approaches and incentive structures to achieve savings, and regardless of the utility program, any owners and operators may be able to make the changes it takes to collect those incentives – at little-to-no cost.

Some utilities offer on-bill financing in which they make the operator an initial loan, which is paid back each month via the utility bill.

AVAILABLE FUNDING

Roughly two-thirds of utilities currently offer efficiency incentive programs, said Marcus Wilcox, chief executive officer of Cascade Energy. And they are doing it because they are required to by legislation, have capacity limitations or want to provide a customer service. "They could be short on production or distribution or the Clean Power Act will restrict their ability to use coal," Wilcox said, adding that some utilities simply want to focus on efficiency. "It broadens their portfolio," he said, adding that increasingly, utilities are seeing energy as a service rather than a commodity. Energy efficiency broadens the scope of these services.

The money to fund the incentives typically comes from funds utilities collect as part of their customers' bills. "Part of the rates their customers pay goes to fund energy efficiency programs. Often 2 to 4 percent of an electric bill goes into this program kitty," Wilcox said.

The programs vary by region and typically offer technical assistance and training in addition to incentives. "They may also fund energy management information systems —software that allows the customer to track energy use — or custom energy analysis and design consultations," Wilcox said. Available programs typically include both incentives and loans. "For the vast majority, it is simply called an incentive. When the project is done, the program verifies the savings the project delivers and will pay incentives based on that measured and verified savings," Wilcox said.

Some utilities offer on-bill financing in which they make the operator an initial loan, which is paid back each month via the utility bill. "The idea being the savings pay for it," Wilcox said. The types of funding available may vary depending on whether operators are undergoing new construction or addressing existing operations. A lot of industrial refrigeration projects require customized programs. "These are complex systems and complex upgrades. It requires modeling and work to determine the savings," Wilcox said.

On a retrofit in which operators are replacing or modifying a specific piece of equipment, utilities calculate the cost to be the entire cost of replacement whereas on new construction, they incentivize operators for incremental project costs.

For new construction, utilities may consider the state energy code. Certain states require certain energy efficiency minimums. "The utility program will fund energy efficiency above and beyond what is required," Wilcox said. An example is Title 24 in California, which has very specific minimum requirements for refrigeration system and refrigerated warehouse equipment, systems and overall design.

State requirements vary widely, and it can be more of a challenge to go above and beyond an aggressive state energy code on new construction, but it is possible, Wilcox said. He suggested operators begin working directly with their utility providers to learn about the specific incentives available in their areas. "Talk to the utility as early as possible, as most efficiency programs may not provide incentives for a project that is already underway or complete," he said.

THE SAVINGS

As an operator at a dairy processing plant, Todd Toburen worked with Cascade Energy to improve the dairy's energy efficiency. Less than a year ago, he became a technical advisor at Cascade Energy, but it was his first-hand experience as an operator that showed him how beneficial the programs could be.

While at the dairy, he took part in the Refrigeration Operator Coaching program that provides low-cost and no-cost solutions, used Cascade's best practices guide and invested in energy management software that gave him 15-minute snapshots of energy usage.

"We saved 1 million kilowatt hours. In Portland, Oregon, that equated to about $85,000 in annual savings," Toburen said, adding that Energy Trust of Oregon had an incentive program that the dairy was able to use. "It takes time and effort, but there is a payoff." To put this energy savings into perspective, the savings would power approximately 100 homes, as an average U.S. home uses around 10,000 kilowatt hours per year.

Toburen said energy efficiency programs bring everything together. "People are in the production business to produce a product, but at the same time, they are there to make money," he said. "The changes we made at the dairy were right in tune with saving the company money and still complying with all of the rules and regulations put forward by OSHA and EPA," he said.

The energy management software could also help operators identify problems with systems. "When you look at it and one week is high, you ask, 'Why is that?' Maybe you're drawing more amperage on something or you are using a compressor more," Toburen said, adding that he found it interesting to look at energy use. "You can go online and look day to day and compare apples to apples and see if changes you made have lowered your energy consumption."

As part of the ROC coaching program, operators take part in training. "I benefited the most from sitting in a classroom and having someone explain everything to me," Toburen said. "It gives people an idea of what it costs you to leave a door open or build up scale on your condensers. It makes you think."

The Refrigeration Engineers and Technicians Association also offers training for site personnel to gain the skills and information required to drive energy efficiency improvements on their own systems, Wilcox said. The program is called the Certified Refrigeration Energy Specialist training and certification.

Now that Toburen is out in the field, he said he sometimes gets pushback from operators when he suggests they make changes. Many times operators stick with what they're doing because they've always done it a certain way. "Or they'll say they tried it and it never worked," he said, adding that he works to get operators to have an open mind.

Wilcox said energy efficiency programs can get left in the dust because they aren't first and foremost on people's minds.

With new construction, the design process is long and complex and involves a lot of parties, which can hinder the adoption of energy efficient technologies. "Someone has to take ownership or participate in the energy efficiency program, and often that is not clear," Wilcox said.

Vendors may be hesitant to recommend customers look at a program because they don't want to delay a sale or hold up construction even though they may be aware of an energy saving opportunity or a more efficient piece of equipment, Wilcox explained.

"With most coils, ice forms and it takes energy to melt the ice off. It is important to upgrade the defrost configuration and controls so it is the most efficient defrost as possible. Also look at heat recovery. Every BTU of refrigeration load that a system provides goes to the outdoors. Energy analysis often indicates that it is a benefit to reclaim that heat so it can be used for wash-down water or other applications."

Marcus Wilcox, chief executive officer of Cascade Energy.

SYSTEM UPGRADES AND CHANGES

Operators have a number of options when looking at energy efficiency improvements, whether for new construction or upgrades. Wilcox said addressing energy efficiency during construction is cheaper. "If you don't do it then you'll have to do retrofits later and it will cost a lot more."

When looking at a new system, engineers should work to reduce the load from the beginning. "It could be with insulation, types of doors, or different forms of cooling and heat recovery," Wilcox said. The next step is to minimize system lift — the difference between the cold side and the hot side of a system. "It costs more to lift the heat if they are very far apart," Wilcox said, recommending that anyone looking to minimize lift should look at coil selection, part-load performance and system design to keep lift to a minimum. "Designers want the system to be able to trim or scale back in an efficient fashion," Wilcox said.

For operations, variable speed control in the fans and compressors can reduce energy use as well.

The next category the company works on is efficient defrost design. "With most coils, ice forms and it takes energy to melt the ice off. It is important to upgrade the defrost configuration and controls so it is the most efficient defrost as possible," Wilcox said. "Also look at heat recovery. Every BTU of refrigeration load that a system provides goes to the outdoors. Energy analysis often indicates that it is a benefit to reclaim that heat so it can be used for wash-down water or other applications."

Another way to reduce the energy use of the refrigeration system is to reduce condensing pressure. "There are misconceptions on what a system can run at and this should be considered," Toburen said. "If you can lower the head pressure, your compressor isn't going to work as hard."

Wilcox said operators can consider a central computer control system that manages everything with a focus on energy efficiency. There are also tune-up programs that utilize targeted cleaning, repairing and tuning of existing equipment.

Toburen admitted that from an operator perspective, energy efficiency was one of the last things he looked at. He changed his perspective once he learned more about the benefits energy efficiency provides. "I learned if I am doing it efficiently, I am doing it safely and I am doing the things EPA and OSHA want you to do to keep a facility running," he said. "It is one of those things you sit back and say, 'Why wouldn't you want to do it?'"

IIAR Remembers: George Briley

His nickname was "Mr. Refrigeration," which speaks powerfully about his influence on the ammonia refrigeration industry. George Briley's colleagues often said that he "developed the bible" for the industry. Within the International Institute of Ammonia Refrigeration, of which he was a co-founder, he was considered a true pioneer.

Briley died on June 17 at 90, leaving behind a legacy that included being one of the original founders of IIAR.

"George was an ammonia advocate," said Paul Selz, who worked with Briley for more than 20 years at Lewis Refrigeration and Refrigeration Engineering Corporation. "He really knew ammonia, he had one of the best engineering minds I've ever been around and he was a great teacher. He started the practical school for the operating guy when he was at RECO."

Briley was instrumental in founding IIAR, and he played a major role in IIAR-2 becoming the design standard for ammonia refrigeration systems as a complement to the ASHRAE-15 safety standard. Along with Chuck Hansen, Bill Richards and Don Niederer, Briley stepped forward in 1971 when there was an attempt to classify ammonia as a flammable gas under the National Electric Code. He pushed for the formation of a group that would advocate against the NEC proposal on behalf of the ammonia refrigeration industry.

With Briley providing his technical expertise, the newly formed IIAR was able to insert provisions into the ASHRAE-15 safety standard that stipulated that ammonia machinery rooms should have emergency ventilation. That led to the adoption of a footnote in the NEC that provided an exception for the use of ammonia in refrigeration systems that met ASHRAE-15. In other words, if ASHRAE-15 standards for emergency ventilation were followed when ammonia was used, it did not need to be treated as a classified electrical issue.

"That saved the industry from a lot of onerous regulations. George was one of the men who made that happen," Anderson said. "He was critical to the foundation and the original structure of IIAR."

Briley served IIAR in a number of capacities during his career, including as the organization's first chairman in 1971-73. He also hosted the first annual IIAR Conference in San Antonio. He presented many technical papers at IIAR conventions, covering such topics as a new concept for freezing carton products; ammonia absorption refrigeration; defrosting evaporators with water; energy cost comparisons between cryogenics and mechanical freezing systems; hot-gas defrost systems for large evaporators in ammonia liquid overfeed systems; and lubricant (oil) separation. He also served on numerous safety and standards committees.

Daniel Dettmers, now a research engineer at the University of Wisconsin-Madison, was in his 20s when he first met Briley at an industry meeting. "When I spoke, many of the older men were dismissive or tolerant at best," Dettmers recalled. "George, on the other hand, took the time to listen. In his deep, gruff voice he would either explain to me why I was wrong, tell me a story of how he tried something similar decades earlier or make the rest of the group listen. Very few argued with George or even less dared to interrupt him. He had the respect of the entire industry."

Briley was an expert in virtually every area of the industry. His contributions ranged from revolutionary developments with screw compressor packages to standard packaged equipment that simplified ammonia system installations. Automatic production food-freezing systems, process fluid chillers and skidded Petro Chemical compression packages were all designed under his engineering direction. He was also versed in compressors, centrifugals, ammonia absorption and all types of refrigerants and operating systems.

"He could sit down and design the system while I was still trying to find the data," Selz said. "He really understood refrigeration and he could talk about almost any system in great detail with anybody. He knew it back-and-forth, and he had a photographic memory."

Alex Gooseff worked under Briley for 15 years at Lewis Refrigeration and RECO. "George was probably the most well-rounded refrigeration person in our industry," he said. "A lot of us specialize in certain segments, but George worked in them all. Many a young engineer was trained by George Briley."

Raised on a small farm in Louisiana, Briley enlisted in the military after graduating from high school, serving as a combat engineer across Europe and during the Battle of the Bulge. One of his jobs was to head out in front of troops to clear mines and set up communication lines prior to battle. Discharged in 1946, he earned his degree in electrical engineering from Louisiana Polytechnic University in 1949.

After graduating summa cum laude, he joined the engineering training program at York Corporation in Pennsylvania. In 1961, he left York to become vice president at Lewis Refrigeration, remaining in that position for 14 years. He moved to San Antonio to work for RECO in 1975, and then launched his own business, Technicold Service, Inc., in 1990.

"He took RECO from a small company to becoming a major player in our industry," Gooseff said.

During his distinguished career, Briley, along with colleagues, held at least four U.S. patents for inventions such as a fluidized freezing method, slush ice maker and others. He was honored with ASRAE'S Distinguished Service Award in 1992 and the

George B. Hightower Tech Achievement Award in 2006.

He chaired ASHRAE's TC10.1 committee and was a member of numerous other committees. He also authored more than 30 articles for the ASHRAE Journal. "He wrote them in a user-friendly, simple-to-understand fashion," Gooseff said. "He was a great ambassador for industrial ammonia refrigeration. He went to Europe and to Asia to promote the safe uses of ammonia. He had a real passion for it."

In 2009, ASHRAE established the George C. Briley ASHRAE Journal Article Award, which annually recognizes authors for refrigeration-related contributions to the ASHRAE Journal.

Briley worked until he was 79, only stopping due to health issues. He is survived by his wife of 66 years, Phyllis; son John and daughter-in-law Rebecca; daughter Melissa Mieras and son-in-law Tom; and five grandchildren, Clif and Erin Briley; Ryan, Shawn and Michael Mieras.

Letter from the IIAR Board

It is with sadness that IIAR has learned of the passing of George Clifton Briley, P.E. George passed away peacefully in his home in San Antonio, Texas on June 17, 2016 at the age of 90 years, surrounded by loving family. George is survived by his wife Phyllis; son John and spouse Rebecca; daughter Melissa and spouse Tom; and five grandchildren.

George was an icon in the refrigeration industry, and he was one of the founding members of IIAR in 1971. His passion for our industry was highly evident throughout his long career through his many contributions to its advancement. Most of George's career was spent in design/build refrigeration contracting, but he spent a significant portion of his career leading the design and manufacture of refrigeration system components and he finished his career in a consulting engineering capacity. It is rare that someone has the diversity of experience in all segments of the refrigeration industry that George did; including all aspects of food and beverage production and storage, process cooling and petrochemical. He was deeply committed to the safe design and operation of ammonia refrigeration systems, and over his career he collaborated closely with safety code officials and organizations to ensure safety. George received several refrigeration patents over the years and wrote a plethora of articles in a variety of industry publications dealing with refrigeration equipment, system design, operational practices, and safety. He possessed a unique talent for presenting complicated material in an easy to understand format. With George's acquired broad knowledge of refrigeration and his commitment to sharing it, he rapidly became known to industry engineers by his well-earned nickname "Mr. Refrigeration".

After serving with the armed forces in Europe during WWII, George attended Louisiana Polytechnic University and graduated summa cum laude in 1949 with a degree in electrical engineering. He was recruited by York Refrigeration Corporation, undergoing extensive two year training in refrigeration. Subsequently, George worked for Lewis Refrigeration Company as vice president and later joined Refrigeration Engineering Corporation (RECO) as vice president of marketing. In 2003, George founded Technicold Services, Inc., a refrigeration consulting engineering firm.

As a key founding member of IIAR, George was elected as the first IIAR Chair, serving two consecutive terms 1971-1973 and also hosting the first IIAR conference in San Antonio in 1973. He remained active in IIAR in a variety of roles and received IIAR Honorary Life Member status in 2005. George was one of the first major gift donors to IIAR's Ammonia Refrigeration Foundation (ARF) and as such, recognized as a Century Club Member. Over the years, George contributed significantly to IIAR through work on numerous committees, in a variety of capacities.

Besides his many contributions to IIAR, George participated significantly in numerous other industry associations including ASHRAE and RETA.

George joined ASHRAE in 1953 and contributed to the advancement of refrigeration technology on many fronts including participation and development within the Standard 15 committee, Safety Standard for Refrigeration Systems, as well as several ASHRAE technical committees. He was the first columnist in the Refrigeration Applications column of the ASHRAE Journal, at one point contributing an article every month for a straight two-year period. In 2009, ASHRAE established the George C. Briley ASHRAE Journal Article Award which is named in George's honor for his many contributions to the publication over the years. This award recognizes select authors each year for outstanding refrigeration system article content, and serves to raise ASHRAE membership awareness and interest in Journal refrigeration articles. George was an ASHRAE Fellow/Life Member and received ASHRAE's Distinguished Service Award, the Distinguished 50-Year Member Award and the George B. Hightower Technical Achievement Award in recognition of his many contributions over the years.

Over the last 50 plus years George has made his mark on the refrigeration industry. He was well recognized as one of the first to volunteer for a difficult task. Those who have worked with George, and there are many in our industry, will be the first to tell you what an important figure he was in their career development, and what a force he was in the shaping of our industry. George was a leader, a mentor, and a contributor to the advancement of the industry as a whole. IIAR expresses it gratitude and respects for George's significant contributions to the refrigeration industry.

George Briley, "Mr. Refrigeration", will be missed by many.

IIAR Remembers: Joe Buck

Armed with a Master's degree in plasma physics, Joe Buck understood industrial refrigeration like few other people. As an engineer and a college professor, Buck was an inspiration to his colleagues and to hundreds of students who went on to careers in the refrigeration industry.

A long-time leader in the refrigeration industry, William Joseph (Joe) Buck, 70, died on May 22 from complications of pneumonia in Fairhope, Alabama.

"Joe understood the fundamentals of refrigeration and he also knew the physics behind what is going on with the refrigeration process," said Zahid Ayub, a long-time colleague who became a close friend of Buck while attending numerous IIAR and ASHRAE conferences through the years. "He had the Masters in plasma physics, so he was very knowledgeable in thermal dynamics. That combination of knowledge with practical experience made him stand out within the industry."

Buck was a major contributor to both IIAR and ASHRAE. He served on the board of directors of both organizations, was vice-president of ASHRAE, and was also a member of multiple industry committees, including Section 10 technical committees, the Refrigeration Committee and the Technology Council. He served as chairman of the IIAR's CFC Committee in 1989-90 and the Research Committee in 1990-91. He became an associate member of IIAR in 1980.

He was honored by ASHRAE as Engineer of the Year in 1985, and was given its Distinguished Service Award in 1992 and the Exceptional Service Award in 2003.

Buck was born in Mobile, Alabama and earned his degree at Auburn University, where he completed a significant portion of his doctoral research in atomic fusion. After serving in the U.S. Army, he embarked on a 40-year career as an engineer specializing in industrial refrigeration systems.

He was vice-president/sales engineer at Engineered Refrigeration Systems from 1978 to 2003, and was company president from 2003-04. After ERS was purchased by the CIMCO Refrigeration division of Toromont Industries in 2004, he served as president until his retirement last year.

"Joe was one of the leading advocates for ammonia refrigeration within ASHRAE," said Kent Anderson, a past president of IIAR. "He really tried to promote the understanding of ammonia refrigeration. He wanted people to know the basics, the principles and the technology behind it."

Ayub worked closely with Buck on numerous projects that required in-depth knowledge of specialized equipment. "He was very good at jobs working with extremely low temperatures," he said. "I worked with him on a project at a plant where fluid was being cooled at minus-80 to -90 degrees. It was the first of its kind. He was in charge of everything on the refrigeration side."

Throughout his career, Buck taught and mentored mechanical engineering students at the University of South Alabama. "I think he might have been most happy when he was teaching physics at the college level," Anderson said.

Rebecca Laughlin, an engineer at CIMCO, was inspired by Buck to return to school to obtain her mechanical engineering degree. "I considered him a friend and my mentor," she said. "He took the time to teach me countless lessons about refrigeration. His wealth of knowledge will be greatly missed."

He is survived by his wife, Gayle; two daughters, Jennifer Webb and Cheri (Jimmy) Lumpkin; three stepchildren, Ryan (Kelly) Foster, Kate (Brad) Davis and Dana (Prent) Davis; his father, Ken Eugene Buck; his sister, Marilyn Pace; as well as seven grandchildren.

Industry Groups to Launch OSHA Training on Ammonia Refrigeration

Beginning in early 2017 the Global Cold Chain Alliance, the IIAR and the Industrial Refrigeration Consortium will collaborate to present a training course for Occupational Safety and Health Act compliance officers focused on ammonia refrigeration systems. This course follows a very successful pilot class that was delivered in the fall of 2014, IIAR President Dave Rule said. It will cover technology, industrial ammonia refrigeration systems and the applicable recognized and generally accepted good engineering practices. The target audience for the class is field inspectors.

"In some situations, field inspectors coming into ammonia refrigerated facilities may have more familiarity with chemical plants and refineries. The RAGAGEP and technology used in ammonia refrigeration facilities are quite different than the RAGAGEP applicable in other industries. This course is specifically structured to provide the field inspectors with a better understanding of ammonia refrigeration technology and the RAGAGEP that is applicable in our industry," said Doug Reindl, a professor at the University of Wisconsin and a member of the IIAR board.

Don Stroud, chair of the IIAR government affairs committee and senior refrigeration engineer for Stellar, said it is to the industry's benefit to educate OSHA field inspectors so they aren't citing IIAR members for items that are not appropriate. "It's important that OSHA compliance officers are knowledgeable about what they are inspecting and the codes and standards that apply so the inspections can actually provide some benefit to the facility being inspected," he said.

The training draws on content from a similar face-to-face class that the Environmental Protection Agency has sponsored regionally for their inspectors for the past several years. "If EPA has extra space in a regional class, they open seats up to OSHA. OSHA had participated and saw a benefit," Reindl said.

A spokesperson for the Occupational Safety and Health Administration said the agency's mission is to ensure the protection of workers and to prevent work-related injuries, illnesses and deaths by setting and enforcing standards, and by providing training, outreach, education and assistance. "Training is an essential part of every employer's safety and health program for protecting workers from injuries and illnesses," the spokesperson said. "Development of the training class is a joint effort between OSHA and the Industrial Refrigeration Consortium, Global Cold Chain Alliance, University of Wisconsin and IIAR."

However, OSHA doesn't have the travel resources to send employees to face-to-face training events, so the agency was particularly interested in delivery options via the Web. The pilot program for the OSHA training was conducted through OSHA, the IRC and IIAR working together in the fall of 2014 and it consisted of instructor-led webinars in two-hour blocks held once a week for five weeks. The feedback was overwhelmingly positive.

Reindl is organizing the training, which is now slated to take place in early 2017 after being postponed due to OSHA budget issues. In addition to per-person fees for registration paid by OSHA, additional co-funding for the course is being provided by GCCA and IIAR with the IRC providing in-kind support.

Stroud said the need for training stems from the National Emphasis Program that started with the refinery industry and emphasized standards, guidelines, and recommended practices developed by the American Petroleum Institute.

"OSHA got educated on RAGAGEP applicable to the refinery industry; however, when they expanded the NEP to chemical facilities in November 2011, facilities with ammonia refrigeration systems and other chemicals regulated by process safety management started being inspected. Many field inspectors were familiar with API standards and tried to apply them to the design, maintenance and operations of ammonia refrigeration systems and that created problems," Stroud said.

As a result, there were a lot of citations given for ammonia refrigeration systems that weren't always appropriate, simply because field inspectors lacked a clear understanding of the RAGAGEP applicable to ammonia refrigeration systems. "It is a tremendous drain on a company's resources when they must utilize their engineering and operating personnel and outside attorneys to contest OSHA citations," Stroud said.

However, not fighting a citation creates challenges as well. "OSHA citations related to ammonia that are based on other industry practices and standards set a precedent for future citations and can lead to the creation of new RAGAGEP for the ammonia refrigeration industry," Stroud said.

What's more, past citations may serve as a catalyst for industry practices implemented purely to avoid OSHA citations. "With the alliance through the GCCA and the involvement of IIAR, we began to educate OSHA on the standards that apply to ammonia refrigeration systems so they would not have to rely on other industry standards that are not applicable," Stroud said.

IIAR has spent a significant amount of time working on its standards, which are now recognized by the model code bodies and OSHA. However, there is still a need to educate compliance officers that are arriving at a plant for an inspection and are not familiar with ammonia refrigeration systems, Stroud explained.

In addition to offering the training classes, IIAR has created a regulatory portal that provides access to IIAR standards and guidelines to help field inspectors understand the ammonia refrigeration industry and the RAGAGEP that applies.

The ammonia refrigeration classes that are scheduled to be presented in early 2017 will also be recorded to be used in future education programs. Through a special agreement with the IRC, both IIAR and the GCCA have plans to offer the classes on the regulatory website portal and other venues to provide OSHA and EPA field inspectors with additional access to the training materials.

Learning the Most Important Lessons

Have you ever thought back to when you were a kid, and wondered what you wanted to do and be when you grew up? How did that work out? Life certainly has a lot of twists and turns, and for many of us, landing in the industrial refrigeration field specializing in ammonia has been an interesting and sometimes amazing journey. This specific industry has incredible opportunities for anyone who wants to work hard, contribute, and improve from the many lessons to be learned.

Life certainly has a lot of twists and turns, and for many of us, landing in the industrial refrigeration field specializing in ammonia has been an interesting and sometimes amazing journey.

Likely, we can all admit that we have learned from past experiences both good and not so good, which have shaped the course of our lives. Working in industrial refrigeration for me started long before I even knew what refrigeration was, besides being cold. Maybe like many of you, you had similar thoughts on where your future might lay - I wanted to be an astronaut, a fireman, a forest ranger, a truck driver, a football star, etc. While I was this young dreamer, my dad would often take me to his workplace and I'd help some, and play some, as I was exposed to the world of welders, torches, heavy pipes and valves, and big noisy machines. I honestly didn't think about what I was experiencing or learning.

Growing up I often worked at the shop after school, cleaning, and also learning how to use a torch, a welder, and many other tools to both remove and build parts of refrigeration systems. During the summers I sometimes went on trips to big smelly refrigeration processing and storage facilities, and even up into Alaska to even smellier fish processing plants. I still didn't think much about all the experiences I was having, nor the things I was learning.

Graduating from high school I started thinking, what is it I would like to do? I didn't know, but I enrolled in a local college and started taking basic required courses. Maybe something would "click" or "fall in my lap" giving me future direction, I thought. During this time I continued helping in the shop and on various large and small refrigeration projects to earn money to pay for college, buy a car, and just have fun. At the time I didn't realize my "lap" was already filled with amazing opportunities in industrial refrigeration.

I graduated from college with a degree that was interesting, but in a field that was extremely difficult to find employment. My wandering path finally lead to the thought, "What about engineering and industrial refrigeration?" I went back to college and graduated (again) with a degree in mechanical engineering.

I am sure many of us have similar stories that have led us into the field of industrial refrigeration as we became engineers, contractors, manufacturers, salesmen, etc. As we each look back on our journey and the many opportunities we have had, and the experiences and lessons we have learned, I think it's clear that this really is an amazing field to be in, but our journey is not over.

What more can we do? You can share the lessons you have learned, the experiences and the knowledge you have gained. Obviously, participating in industry organizations like IIAR, RETA, ASHRAE can help you, as well as others. Your input by participating on committees, reviewing of developing Standards and other bulletins/documents, sharing of experience and knowledge by participating in workshops or giving a technical paper. All of these activities are extremely important. We each set an example in our participation that can inspire others to become involved, and to gain additional knowledge and understanding.

Refrigeration is critical to our society, to our health and wellness. This technology provides us with lifestyle possibilities that didn't exist 150 years ago. As a person involved in industrial refrigeration, how can you help others better understand refrigeration as well as realize how safe this industry is due to the design, codes, and standards that have been developed to provide guidance in construction, operation, and maintenance of systems and equipment?

One sure way do this is to become very familiar with the IIAR suite of standards. These standards are:

ANSI/IIAR Standard 1-2012 American National Standard for Definitions and Terminology Used in IIAR Standards

ANSI/IIAR 2-2014 American National Standard the Safe Design of Closed-Circuit Ammonia Refrigeration Systems

ANSI/IIAR Standard 3-2012 American National Standard for Ammonia Refrigeration Valves

ANSI/IIAR Standard 4-2015 Installation of Closed-Circuit Ammonia Refrigeration Systems

ANSI/IIAR Standard 5-2013 Start-up and Commissioning of Closed-Circuit Ammonia Refrigeration Systems

IIAR 6 (In the ANSI development/review process)

Working Title: Inspection, Testing, and Maintenance of Closed-Circuit Ammonia Refrigeration Systems

ANSI/IIAR Standard 7-2013 Developing Operating Procedures for Closed-Circuit Ammonia Mechanical Refrigerating Systems

ANSI/IIAR Standard 8-2015 Decommissioning of Closed-Circuit Ammonia Refrigeration Systems

IIAR 9 (In the ANSI development/review process)

Working Title: Recognized and Generally Accepted Good Engineering Practices (RAGAGEP) Standard for Closed-Circuit Ammonia Refrigeration Systems

We all have lessons we have learned. Share those lessons and we all can improve.

What more can we do? Sometime ago, for example, I was asked to give a presentation on industrial ammonia refrigeration at a regional ASHRAE meeting. I also did a webinar on the same topic, and later gave a tour of two ammonia refrigeration systems. Most of the people who attended these presentations had no idea of what was involved in the design, construction, or maintenance of these types of systems. To them the systems seem complex and complicated.

Besides being involved as I mentioned above and studying our industry's standards, you can also take the opportunity to talk to people both older and younger about our field of industrial refrigeration. Let them know of the wide variety of opportunities in this field. Many may be like myself, as I was growing up, and not realize how important, as well as interesting this field is. We all have lessons we have learned. Share those lessons and we all can improve.

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The Ammonia Refrigeration Foundation Celebrates 10-Year Anniversary

The Ammonia Refrigeration Foundation, which celebrates its 10-year anniversary in October, is dedicated to funding research projects and creating educational opportunities, and those efforts will continue to expand under the guidance of executive director Lois Stirewalt O'Connor and the Ammonia Refrigeration Foundation Board of Directors.

The Foundation's newly focused mission is 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 programs.

"Our goal is to ensure that every program is designed to support that mission," O'Connor said. "And we want to develop it even further. We intend to become more precise with our research so that we understand how it will impact policy with the federal government, how it will impact the end user and how it will address the needs of our membership. We also want to create additional educational alliances so that we can begin to address the growing need for experienced employees in all sectors of our industry."

O'Connor was brought aboard in March. She has extensive experience in fundraising and non-profit organization leadership and will lead the Foundation's growth and funding of initiatives that will benefit the industrial refrigeration industry for years to come. Previously, she served as senior director of advancement, programs and outreach for the Vietnam Veterans Memorial Fund. She has also served as director of advancement for the Air Force Association, where she closed out the Capital Campaign for the Air Force Memorial and the dedication. She also held roles in university advancement at American University and George Washington University.

Since it was founded in 2006 by the membership of the IIAR, the Foundation's partnerships and alliances have grown to include GCCA, RETA, ASHRAE, universities across the country, and other international trade associations.

The Foundation has completed numerous research projects of value to the IIAR, to its membership and to the industry that range from relief-valve analysis to new methods to determine correct pipe sizing for ammonia refrigeration systems. Among the important research projects that were completed over the past 10 years, several include: a study that was co-funded by ASME on low temperature piping criteria; development of a bench test procedure for post-mortem testing of safety-relief valves; a statistical analysis method for predictive valve replacement frequency; a quantitative risk analysis for various ammonia-release technologies; the investigation of entrance effects on two-phase flow in vertical suction risers; and a study on optimum pipe sizing.

As it looks toward the future, the Foundation will continue to fund research projects that search for solutions to broad industry needs that drive safety and the efficient design and operation of industrial refrigeration systems. Projects currently under review for funding include: the development of a mechanical insulation installation guideline for refrigeration applications; CFD modeling of an ammonia refrigerant leak in a machine room, and the evaluation of alarm sensor location with identified ventilation rates and leak dispersion; and analysis and correlation of data from ASHRAE RP-1327 (Flow in Two-Phase Ammonia Risers).

The Foundation will also enhance its educational alliances through its scholarship programs and internships. It currently awards scholarships to individual engineering students completing a selection process monitored by the IIAR Education Committee. The scholarships provide grant funding to students at the University of Wisconsin, Erie Technical College and Louisiana Technical College and other technical institutions. The goal of the scholarship program is to encourage young engineers to pursue careers in the industry.

"We have enhanced our alliances with academic institutions through education and internships so that we can become the catalyst for students transitioning from academia to a career in our industry," O'Connor said. "We want to be the pipeline to draw new engineering talent into our industry and to support the IIAR membership, and part of that is making sure they have the kind of young talent they need. We will begin to address the growing need for engineers in all sectors of our industry. We want to provide access to the best and the brightest."

Mark Your Calendar! The William E. Kahlert Memorial Golf Tournament

The Foundation is hosting the second William E. Kahlert Memorial Golf Tournament on Feb. 25 in conjunction with the IIAR Annual Conference in San Antonio, Texas. The tournament was introduced in 2016 at the IIAR Annual Conference to offer an opportunity for attendees to enjoy a day on the golf course, network with friends and business associations while supporting the Foundation's programs. For more information, please email: golf@nh3foundation.org.

As such, the Foundation has significantly expanded its scholarship program to bring award recipients in-house review and selection process monitored by the IIAR Education Committee, and to increase the number of annual scholarships in terms of size and duration. The Foundation has awarded three scholarships to date.

One scholarship recipient is working this summer as an intern with Basset Mechanical, an IIAR member company. "It is a great experience and opportunity for mechanical engineering students to learn about our industry in a hands-on environment," said Bob Port, of the Education Committee.

As part of the scholarship package, each recipient is invited to attend the IIAR Conference, and in an effort to enhance the experience and visibility of the industry to students, the Foundation, in conjunction with IIAR, has developed a specialized student track for all future IIAR conferences. The goal is to sponsor 10 students for 2017. A "Student Host Committee," in partnership with the IIAR Education Committee and the Foundation's board, will meet with student attendees and serve as sponsors during the entire event. Students will be actively involved in the conference, serving as room proctors, collecting papers and questions, while having the opportunity to listen and learn.

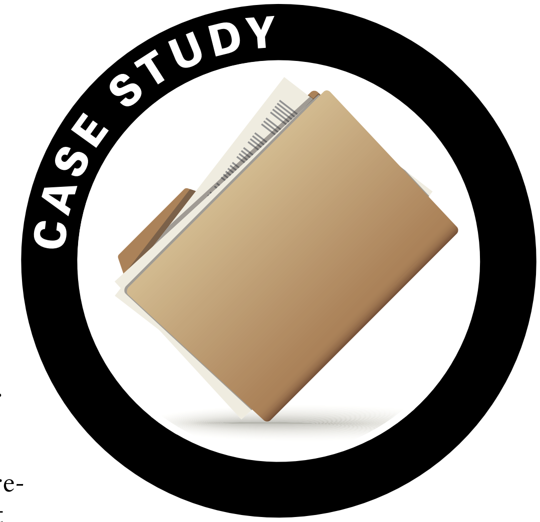
A number of new programs and initiatives are in place that will further expand the Foundation's reach. This year, the Foundation launched a new legacy planned giving program designed to expand the organization's outreach. The planned giving program and Legacy Society allows donors to make larger gifts than they could make from their current income. The Foundation has also approved its budget insuring the future of the outreach and research programs.

As a 501c3 nonprofit education and research organization, the Foundation is supported primarily by the IIAR membership. The new giving program, or annual fund, will support the base needs of the Foundation and allow for greater flexibility and outreach. IIAR members, friends and anyone interested in natural refrigeration can make donations online or through a link on the IIAR app while enjoying the benefits of a tax deduction for every dollar in support of the Foundation.

The Foundation's web site is now live, and features a survey in which visitors can help shape the future. The site also provides visitors the opportunity to sign up for monthly donations. The goal is for 300 individuals to pledge at the $150 level. This program is designed to allow everyone working in our industry the opportunity to give something back, no matter what the level, and to provide support for these important education and research programs. Please visit www.Nh3foundation.org

"My goal is to make sure everyone knows who we are and what we're doing," O'Connor said. "We want to educate people on why the Foundation is important, and to let them know that every individual and company member can play a role in the advancement of the Foundation's work. We will continue to be about education, research and training to address the important needs of the IIAR membership and the industry we support."

Reducing Ammonia Charge in a Field-Built System



As part of the push within the ammonia refrigeration industry to minimize ammonia system charges, some companies are turning to packaged systems to achieve lower charge, but it is also possible to reduce charge in field-built systems.

"There has been more pressure upon designers to figure out how to reduce the refrigerant charge. For a lot of projects the goal is to stay under 10,000 pounds to avoid Process Safety Management/Risk Management Plan," said Walter Teeter, chief executive officer of Republic Refrigeration Inc. and chair-elect for IIAR. He added that staying under 10,000 pounds can help the permitting process and reduce some of the regulatory expense in operating the system.

Identifying and combining engineering solutions to reduce charge can be done on new or existing systems, but Teeter said it is always easier to do it from the ground up. "You can be limited on what you can do in an existing location because of space constraints or what local municipalities will allow," he said.

When determining whether to utilize a field-built or a package system, Teeter said operators have to consider the size of the job as well as the economics involved. "There are certain system-size break points where the packages aren't as cost effective," Teeter said, adding that the actual cost on large systems may often be less for field-built systems than for package systems.

Ultimately, the size of the refrigeration system and the amount of ammonia used comes down to the end users' needs. "They have a certain number of cases or pallets they need to store, which dictates a certain size of building, and they want the most energy efficient building they can get for the best price," Teeter said.

Every refrigeration system is unique with different operation conditions, varying tonnage requirements and space requirements, but Teeter said operators can use multiple solutions to reduce charge. "It is a matter of doing the engineering mix," he said.

Republic Refrigeration Inc. recently built a cold storage warehouse that has a refrigeration load of 2400 TR with 1100 TR of that being blast freezing that will have a charge of less than 10,000 lbs. of ammonia when it is completely built out, Teeter said.

To determine the best solution, the customer needs to have a goal in mind. "Sometimes the goal is driven by corporate policies, sometimes it is driven by local regulatory issues because certain localities don't like to permit large charge systems," Teeter said. "Some companies may receive discounts in insurance rates by minimizing the potential of product exposure to the refrigerant used in the system."

If the goal is to stay under 10,000 pounds, it can be done by utilizing new design concepts for the plant site. "Some projects get so big there is no way you're going to stay under 10,000 pounds no matter what we do," Teeter said.

However, by using new product and design technology, the total charge of the system may still be resolved, which may reduce the regulatory burden in operating the facility.

To reduce charge, some operators are turning to CO_2-ammonia cascade systems, CO_2 volatile-brine systems, and secondary coolant systems which can be combined with other engineering solutions, Teeter said. "The big reduction is the decision to get to one of these alternate systems," he explained.

He added that there has been a move to change to 1.5-to-1 recirculation rates from 3-to-1 rates, which results in charge reduction. "Forever the industry had a rate of 3-to-1 for the recirculation rate which dictates certain liquid-line sizes. When you reduce the recirculation rates you can change the line sizes," Teeter said. "For a given tonnage, you need X amount of area for liquid to flow to the evaporators. If you go to a 1.5-to-one you cut the amount of liquid you're using in half. If you're moving half as much you can have smaller line sizes and significantly reduce the total refrigerant charge through system design."

With a direct-expansion ammonia design, the system is moving the exact amount of liquid it evaporates. Some manufacturers have been working to make these systems more reliable. Many of these new product designs help reduce the amount of ammonia used in the system. "The penalties of going to the DX aren't as great as they used to be," Teeter said.

Teeter said the technology is continuing to adapt and change, which allows the industry to offer systems with lower ammonia charge. That could be particularly beneficial as more and more end users move to natural refrigerants as hydrofluorocarbons and hydrochlorofluorocarbons are being increasingly phased out to meet government and regulatory requirements. "That drives people to look at ammonia systems where they may have not considered ammonia or other natural refrigerants before," he said.

Ventilating the Machine Room

Although proper design and installation of ventilation systems for machinery rooms to manage ammonia leaks is of critical importance to the industrial ammonia refrigeration industry, the design and safety standards set forth in the IIAR-2 standard remain a mystery to many designers and facility owners.

"That is part of the reason IIAR is instituting a certificate program," said Dave Schaefer, chief engineer at Bassett Mechanical in Kaukauna, Wisconsin. "Obtaining the IIAR-2 certificate will confirm that an engineer has studied the design and safety standards and have shown that the individual understands the requirements." He explained recommended practices for proper ventilation are just one of many important safety design elements found in IIAR-2.

The first step in properly ventilating a machinery room begins with the design of the ventilation system. In the event of a leak, it is vital that ammonia vapor is dispersed as high into the air as possible so that when it returns to ground level it is no longer hazardous to people. The IIAR-2 standard requires a minimum of 2,500 feet-per-minute discharge velocity. The discharge needs to be 20 feet from a lot line or building opening.

"You don't want to use mushroom-style or sidewall fans," Schaefer said. "You want to blast the ammonia vapor straight up into the air so it dissipates quickly into the atmosphere. You don't want it blowing into another part of the building. You want to get the discharge up and away from the facility and dilute it."

Fans must be sized appropriately in relation to the volume of the room so that they can provide at least 30 air changes per hour. "So in other words, you have to replace the air in the room every two minutes," Schaefer said.

A proper design brings fresh air into the room at one end and sweeps that fresh air across the room. It is most efficient to place exhaust fans on the roof above an area where an ammonia leak is most likely to occur, such as near re-circulators or other critical equipment in the machinery room. The design, which could also feature more than one fan, can also be used for temperature-control ventilation to cool the room and maintain the required machinery room temperature of 104 degrees or less.

Fan blades must be non-sparking so as not to ignite a fire. When the emergency exhaust system turns on automatically, the system should be controlled so that it must be turned off manually. The manual off control is required because the fan could be damaged if it is allowed to repeatedly cycle on and off and to assure the situation is under control before stopping ventilation.

If the ammonia vapor concentration were to reach a level of 40,000 ppm or more, turn the equipment in the machinery room off, including all compressors and pumps. The ventilation system needs to stay in operation in the event of an emergency, he said. The emergency ventilation system should be powered independently with a separate circuit from outside the machinery room. The ventilation system must have an Auto/On, be clearly identified and have a tamper-resistant start switch outside the primary door. Further, intake air dampers need to fail in the open position in the event of loss of power.

Facilities located in cold climates should consider heat trace and insulating the water lines in the machinery room. With the requirements for leak detection having been lowered from 1,000 parts-per-million to 150 ppm, water freezing becomes an issue because the ventilation system now will start operating at the lower 150 ppm level.

Management of the ventilation system requires monitoring the emergency ventilation fans on a 24/7 basis to ensure proper operation. "You have to ensure there is air flow across the fan with a pressure differential sensor or make sure the amp draw is sufficient," Schaefer said. "If it's not pushing the air, the fan motor won't draw as many amps. You have to make sure it's moving the right amount of air."

In the event of an ammonia leak, sweeping the room with fresh air requires the proper placement of the exhaust fan and intake air. The intake that provides fresh air could be a louver, a louver with a damper or a fan that supplies the air. "The designer needs to make sure the air doesn't short-circuit because you want to provide fresh air to every part of that room to keep the ammonia concentration to an acceptable level," Schaefer said.

One leak-related issue to be aware of is the presence of liquid ammonia on the floor. Spraying water onto the liquid ammonia will flash that liquid into the air and create a potentially high concentration of ammonia vapor in the room. The wiser option is to utilize absorbents or allow the liquid to boil off naturally.

Under IIAR-2 design and safety standards issued in 2014, the engine room must have continuous ventilation when it is occupied. Requirements now state that one-half cubic foot per minute, per square foot or 20 cfm per occupant is needed, or whichever is greater.

"We see a lot of machinery rooms that are not designed to IIAR-2 design and safety standards, so education in this area is very important," Schaefer said. "Ammonia ventilation systems are one of the most important safety systems we have, so they need to be designed and installed properly."

OSHA Convenes Small Business Panel on Potential Changes to PSM

iiar government RELATIONS

BY LOWELL RANDEL, IIAR GOVERNMENT RELATIONS DIRECTOR

In June 2016, the Occupational Safety and Health Administration (OSHA) convened a Small Business Advocacy Review (SBAR) Panel to get feedback from small businesses about potential changes to the Process Safety Management (PSM) regulation. The SBAR panel is a part of the Obama Administration's overall efforts under Executive Order 13650, "Improving Chemical Facility Safety and Security," which is intended to modernize policies to prevent major chemical accidents.

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The Executive Order came in response to the tragic incident in West, Texas, where there was an explosion at a fertilizer facility. It was originally assumed by the government that the incident in West was the result of management failures at the facility. However, the Bureau of Alcohol, Tobacco and Firearms announced in May 2016 that the explosion in West was caused by criminal activity. Despite the finding that the explosion in West was a criminal act, agencies including OSHA and the Environmental Protection Agency (EPA) are continuing to move forward with efforts to revise chemical safety regulations.

The SBAR panel solicited input from small businesses from PSM regulated industry, including two representatives from the ammonia refrigeration industry. The panel received both oral and written comments from the small entity representatives and released a report on August 1, 2016 with its findings and recommendations.

OSHA will take the panel's report into consideration as it begins drafting a formal Proposed Rule. The OSHA regulatory process is slower than that of agencies such as EPA. It is unclear when a Proposed Rule will be published, although it is unlikely to see a Proposed Rule in 2016. IIAR will continue to actively work with OSHA and industry partners to communicate concerns as the regulatory process moves forward.

Below is a summary of the major changes under consideration that would have an impact on IIAR members, industry concerns, and recommendations from the SBAR panel report:

SAFER TECHNOLOGIES AND ALTERNATIVES ANALYSIS

Current Policy: No requirement of analysis of safer technology and alternatives under PSM

Issue to Address: OSHA believes that safer technology and alternatives analysis may identify safer solutions to current risks that currently are being missed. This issue was also included in EPA's recent Proposed Rule on RMP.

Potential Change: Requiring employers to use the hierarchy of controls in considering safer alternatives and technology when identified hazards result in an employer-specified level of risk.

Industry Concerns: The regulatory burden of requiring costly IST reviews tends to stifle innovation. For businesses who are already looking to improve safety by implementing IST options, a formal IST review would add costs to a process by forcing them to document the activities they are already performing. Many businesses do not have the manpower or expertise to perform such analyses and lack the resources to hire it out cost effectively.

For those companies who do not implement IST options, the IST review would likely become a "paper exercise" where they document why it is "infeasible" to implement these options. If facilities are ultimately required to perform safer alternative options analyses and implementation plans, OSHA should not require that the analyses and/or implementation plans be submitted to the agency. Likewise, OSHA should not have any role in analyzing or approving such analysis.

SBAR PANEL RECOMMENDATIONS:

- Not require employers to adopt specified technologies or use prescribed chemicals. OSHA should retain the performance-based language of the PSM standard to allow employers maximum flexibility in evaluating safer technologies and alternatives in a manner appropriate to the nature and risks associated with their specific processes; and,

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OSHA Convenes Small Business Panel on Potential Changes to PSM

- Provide guidance to employers on ways that they could implement safer technology and alternatives analysis in a cost effective manner that minimizes paperwork burdens.

UPDATES TO RECOGNIZED AND GENERALLY ACCEPTED GOOD ENGINEERING PRACTICES (RAGAGEP)

Current Policy: There is no requirement that employers update RAGAGEP to reflect revisions made since the employer initially adopted it.

Issue to Address: RAGAGEP can change over time and OSHA is concerned that some facilities may not be implementing current best practices.

Creating a new regulatory requirement for periodic evaluations of RAGAGEP changes is not necessary. The Management of Change (MOC) and Process Hazards Analysis (PHA) sections of PSM and RMP are currently sufficient to identify risks without a stand-alone requirement for evaluation of RAGAGEP.

Potential Change: Require periodic review of current RAGAGEP and implementation of updates.

Industry Concerns: Creating a new regulatory requirement for periodic evaluations of RAGAGEP changes is not necessary. The Management of Change (MOC) and Process Hazards Analysis (PHA) sections of PSM and RMP are currently sufficient to identify risks without a stand-alone requirement for evaluation of RAGAGEP. It is through these processes that facilities evaluate not just RAGAGEP updates but other factors related to safety.

It would be unduly burdensome to require annual reviews, much less update all processes to maintain conformance with current standards without other design changes which could impose a significant economic burden. Costs will be extremely hard to estimate and it will be virtually impossible for businesses to adequately budget for and plan for changes to RAGAGEP. In many cases it is also impossible to conform with all RAGAGEP because of possible conflicting requirements. The MOC and PHA elements coupled with Employee Participation and Pre-Startup Safety Review are adequate for identification of new hazards created by process changes or to identify hazards based on incidents since the last PHA Revalidation.

SBAR PANEL RECOMMENDATIONS:

- Consider clarifying, if it chooses to pursue this option, that employers would only be required to track RAGAGEP that they have chosen to follow. OSHA should also only require employers to address new hazards identified by RAGAGEP updates, and not retroactively impose building and design requirements specified by the new RAGAGEP;
- Consider the timing of any periodic updates to RAGAGEP, including the possibility of having it coincide with the PHA update; and,
- Retain performance-based language to allow employers maximum flexibility in addressing RAGAGEP and similar issues in a manner appropriate to the nature and risks associated with their specific processes.

EXPANSION OF MECHANICAL INTEGRITY ELEMENT

Current Policy: Mechanical Integrity element, 1910.119(j), applies only to six explicit categories of equipment.

Issue to Address: OSHA contends that other types of equipment that do not fall in these six categories also have hazards that should be addressed by the Mechanical Integrity requirements

Potential Change: Expand 1910.119(j) to include all equipment deemed "critical".

Industry Concerns: The determination of what is safety-critical can be subject to broad interpretation. Absent clear direction from the agency, as is currently in place, businesses would feel very vulnerable in an enforcement setting. A business may, in good faith, assess and make equipment determinations, but fear that inspectors may not agree with their interpretations. Facilities must have clear guidance to understand what is expected and care should be taken to avoid penalizing facilities who have made equipment determinations in good faith.

SBAR PANEL RECOMMENDATIONS:

- Include the performance-oriented evaluation of critical equipment in the PSM standard; and,
- Develop guidance on how to determine whether an item of equipment is "critical" in order to minimize potential disputes between an employer and an OSHA inspector over what "critical" means.

EMERGENCY PLANNING

Current Policy: Employers must establish and implement an Emergency Action Plan

Issue to Address: PSM has no requirement for employers to coordinate with local emergency response authorities

Potential Change: Requiring emergency planning to foster coordination with local response, including:

- annual meetings with local responders

- emergency drills
- evaluation of local emergency response capabilities

Industry Concerns: Coordination with local emergency planning and response authorities is an important aspect of safety. However, additional regulation in this area is needed by OSHA because coordination is already specifically required in the RMP Rules, which apply to all PSM covered facilities in our industry. Enforcement of this issue is linked through Hazard Communication, Emergency Action and HAZWOPER Standards. The coordination with local agencies (e.g. LEPC, Fire Department, Police, etc.) is required by the EPA's Chemical Accident Prevention Provisions (40 CFR Part 68.95(c)). The issue of coordination is already well covered and that adding requirements would be redundant.

Many facilities may be in an area with LEPCs that are not very active or have volunteer fire departments that are stretched thin. A clearly defined reasonable level of coordination with planning and response authorities presents a significant challenge. If facilities are "required" to coordinate their response activities, OSHA must recognize that despite the best efforts of facilities sometimes the coordination is a "one-way" street.

Many facilities may be in an area with LEPCs that are not very active or have volunteer fire departments that are stretched thin. A clearly defined reasonable level of coordination with planning and response authorities presents a significant challenge.

SBAR PANEL RECOMMENDATIONS:

- If OSHA chooses to pursue this option, consider limiting coordination requirements to notifying and requesting coordination with outside emergency responders; and,
- Clarify any requirements for evaluations of local responders' capabilities, considering that local responders might not make information or resources available to the PSM facility.

THIRD PARTY AUDITS

Current Policy: Audit every 3 years by persons knowledgeable in covered process

Issue to Address: Audits done by independent third parties may be more effective

Potential Change: Require audits to be done by independent third parties

Industry Concerns: Compliance audits are useful tools for evaluating a facility's safety. However, a third party doesn't necessarily equate to more qualified or independent auditors. Facilities should have the flexibility to utilize internal safety experts from other facilities or corporate headquarters to perform audits. Often, internal auditors are more familiar with the process and the inherent risks. Internal audit teams are often more thorough than a third party and share best practices, company policies and experience from other facilities within the same company. Using internal auditors develops the auditing experience and expertise in-house where it is more accessible as opposed to losing it to a third party. Businesses should have the ability to identify the resources required to conduct audits whether it be by independent internal resource or a third party.

Hiring auditors can be a costly process. If a business has access to qualified internal auditors, they should have the flexibility to use them. In addition, IIAR is concerned that OSHA may follow the EPA's proposals for third party audits. EPA's proposed independence criteria are overly restrictive and could make it very difficult to find qualified auditors familiar with our industry that are not already providing services to the company in question.

SBAR PANEL RECOMMENDATIONS:

- Consider whether there are benefits to requiring third-party audits based on substantial evidence and whether a sufficient number of such auditors would be available at a justifiable cost;
- If OSHA chooses to pursue this option, evaluate the drawbacks of requiring third-party auditors, such as their lack of knowledge about a specific facility or its processes;
- If OSHA chooses to pursue this option, consider whether requiring a third party auditor be fully "independent" is necessary for an appropriate audit or investigation; and,
- If OSHA chooses to pursue this option, retain the performance-based nature of PSM in allowing employers to determine what types of audits are appropriate for their processes.

STOP WORK AUTHORITY

Current Policy: No requirement for employees to have Stop Work Authority

Issue to Address: No procedures and authority for operators to shutdown processes in imminent risk situations

Potential Change: Implement an SWA program

Concerns: The addition of a stop work authority requirement is redundant with current best practices and is not necessary. Current practices of most IIAR members include robust safety committees with employee participation. Additional regulatory requirements are not likely to add any safety value. Companies should maintain the flexibility to adopt stop work plans that fit appropriately with their individual facilities. Care should be taken not to micromanage this process, which could result in unnecessary work stoppages and create significant costs for small businesses.

SBAR PANEL RECOMMENDATIONS:

- In requiring the provision of SWA, consider giving employers flexibility to develop procedures that would mitigate the possibility that the authority might be used improperly (e.g., by disgruntled employees or contractors who have a conflict of interest); and,
- Use performance-based language that will allow employers flexibility in addressing SWA authority and similar issues in a manner appropriate to the nature and risks associated with their specific processes.

ROOT CAUSE ANALYSIS

Current Policy: Incident Investigation must include: "factors that contributed to the incident"

Issue to Address: Root cause analysis can identify systemic safety problems that need to be addressed

Potential Change: Requirement of a root cause analysis as part of any incident investigation

Industry Concerns: Sufficient flexibility is needed when conducting incident investigations, including any root cause analyses. Facilities should have the ability to select the appropriate investigation methodology for the situation and their facility. There are also concerns with the definition of "near miss". Facilities should be given deference in identifying what situations qualify as a "near miss" and trigger an investigation. What may be a "near miss" in one industry or facility may not rise to that level in a different setting.

Facilities should be given deference in identifying what situations qualify as a "near miss" and trigger an investigation. What may be a "near miss" in one industry or facility may not rise to that level in a different setting.

SBAR PANEL RECOMMENDATIONS:

- Retain the performance-based nature of the PSM standard by allowing employers to use any recognized method for determining the root cause of an incident or event; and,
- Clarify what types of incidents or classes of events would require a root cause analysis.

PROCESS HAZARD ANALYSIS MANAGEMENT SIGN-OFF

Current Policy: No requirement for affirmative management statement that PHA has adequately addressed all hazards found during the analysis

Issue to Address: Management sign-off can increase thoroughness of organizational review of the PHA

Potential Change: If management decides not to implement or make modifications based on PHA team findings, to document that the hazards identified in the PHA are adequately addressed

Industry Concerns: IIAR is concerned about the legal and enforcement ramifications of such a requirement for management sign-off and do not believe it is necessary. There is the potential for the agency to set up management for potential enforcement actions. Some managers would be reluctant to sign such a document without knowing the potential liabilities. This would require the retention of a lawyer to examine the documents, which will be costly for small businesses. This cost is not reflected adequately in the proposal.

SBAR PANEL RECOMMENDATIONS:

- Consider specifying the level of management sign off required and accepting sign off at the facility/plant manager level.

WRITTEN PSM MANAGEMENT SYSTEM

Current Policy: Various pieces of a PSM system must be documented in different PSM elements

Issue to Address: No required coordination of all written documentation into a single system, causing difficulties of updates/access to all relevant items of information

Potential Change: A requirement that employers develop and implement a written PSM Management system which would include written procedures for all elements specified in the standard, along with a records retention policy. Require additional management system elements including evaluation and corrective action of PSM program.

Industry Concerns: Requiring written PSM management systems, including additional management system elements is not necessary. Facilities are already required to document their PSM programs. Adding an additional paperwork requirement is not likely to add any safety value and will divert resources away from facility operations.

SBAR PANEL RECOMMENDATIONS:

- Consider the value of adding additional performance based management system elements and consider ways to minimize the cost and paperwork burden associated with this possible revision.

IIAR Partners with ASTI on First 30 Minutes

The International Institute of Ammonia Refrigeration is partnering once again with the Ammonia Safety Training Institute, ASTI, in its continuing effort to clearly define how to address the first 30 minutes of a response to an emergency involving ammonia, IIAR said.

The working title for the project is "A Practitioner's Approach to Emergency Operational Engagement." It will include training materials produced for the Occupational Safety and Health Administration and the Environmental Protection Administration, focusing on the development of a standardized Emergency Action Plan (EAP) along with a regional two-day training program.

The training program will be designed to educate the "three legs" of the EAP tripod: the ammonia refrigeration industry; public safety emergency responders; and the local, state and federal governmental oversight. Currently, there are plans for six training program sessions that will run until June 30, 2017. The first IIAR-ASTI joint training meeting is scheduled in the Denver region in November 2016.

An additional three regions will be scheduled in the first half of 2017 and IIAR said it hopes to expand the program in the 2017 – 2018 IIAR fiscal year.

In 2013, IIAR and the American Safety Training Institute, ASTI, teamed up to develop a training video and workbook called "Module 5 — Making the First 30 Minutes of Emergency Response Count."

"The 2013 video was geared around the key points concerning the first 30 minutes. Now we're looking at what the guidelines or standards should be regarding best management practices, which will lead to the development of recognized and generally accepted good engineering practices," said Gary Smith, president of ASTI. "We've done that in a general sense already by using logic regarding the response effort. But now we will develop RAGAGEP for an ammonia-specific emergency that can be referenced by public safety officials, the government and the industry as to what the challenges are in the first 30 minutes.

"Once we transition into RAGAGEP we will set national policy on what the requirements will be for the first 30 minutes of the emergency response and what the EAP will have in it regarding training, public safety, the planned response and the government expectations," he said.

ASTI and IIAR are working with OSHA and EPA so that these changes could then be used by private and public safety responders to demonstrate how they can address emergencies without being fully certified emergency response technicians. Smith said that future RAGAGEP guidelines will provide consistency and a starting point for how an individual facility operates and engages in the event of an emergency.

A series of safety days are being held this year to provide training, obtain feedback and gain a deeper understanding of current policies. "It's an opportunity to enhance the logic behind our best management practices and to learn what all the different players think of the concepts we're putting out there," Smith says.

As part of the IIAR's regulatory outreach program, the project will reach out to the state and local first-responder community, and will focus on the expectations from OSHA and EPA regional inspectors.

The first day of the regional training program will focus on basic ammonia refrigeration safety standards and guidelines as well as the basic ammonia closed loop system and other important regulatory issues facing the industry. The second day will be geared toward specific discussions that will outline the proposed RAGAGEP for early response to a release and the government expectations.

"We will cover the rationale and the work that is behind developing this proposed early response management standard so that people understand the logic of it," Smith said. "Right now there is not a real standard, so we're creating it. We have needed a national standard that gives first responders a better idea of the actions they should take to operationally engage life-saving procedures by rapid-entry rescue, and one that supports emergency shutdown operations that are more than just pushing a button and running."

Smith said the project is a major step forward for the ammonia refrigeration industry in addressing the immediate safety challenges during the first 30 minutes of an ammonia incident and in setting the table for handling the aftermath.

"We've been stuck in the mud in regards to our ability to address the first 30 minutes of any emergency involving ammonia," he said. "Right now the generally applied rules that government, public safety and the industry have to live by are across-the-board hazmat-related requirements that really put lots of limits on what you can do to address the first 30 minutes challenge. With this new program development we will now have guidelines or standards on a specific chemical, that being ammonia, which then gives us more specific-related things we can do to address those issues. That will help us to give emergency action plan responders more options on what they can do based on standard operating procedures."

Daily Inspection Webinar: Employee Participation & Training

Engaging employees and providing them quality training is critical when it comes to minimizing risks and protecting both on-site and off-site personnel, property and the environment, which is why employee participation and training are required parts of the process safety management and risk management plan programs, said IIAR in the latest member webinar to be released by the Institute.

Tony Lundell, director of standards and safety at IIAR, hosted the webinar to help owners, designers, in-house refrigeration operators and technicians understand how to engage employees in participation, and what should be included in initial and ongoing training. “The implementation of an effective training program is one of the most important steps an employer can take,” he said.

Employers have a number of responsibilities, including developing a written employee participation program. This includes consulting with employees on the conduct and development of process safety analyses and providing employees with access to the PHAs as well as all the other information required by the PSM elements.

Employee participation is one element of process safety management. This includes gathering system and equipment data, becoming familiar with systems and equipment, and verifying upkeep and planned changes. Lundell said employees can develop ‘what if’ questions and verify recommended corrective actions.

Employee participation provides an opportunity for employees to verify upkeep with planned changes, verify accuracy annually, and develop and adhere to other safe work practices. Employees can also submit corrective work actions, create a maintenance plan, and craft a quality assurance program in which they verify and ensure maintenance materials, spare parts and equipment are suitable for the process application.

Employees also should be able to fill out permits, perform permit work, facilitate others, verify and/or provide fire watch, and verify appropriate protective equipment, such as clothing, gloves, footwear, shields, blankets and fire extinguishers. “It is crucial they can verify if a fire extinguisher is filled with the proper chemical and it is ready to be used,” Lundell said.

During the webinar, Lundell explained that employee participation also relates to contractors. Employers can qualify candidates and do periodic field evaluations. “The employers need to ensure the safe work practices are being adhered to,” he said.

For a pre-startup safety review, employees should be involved. “They can document and complete each PSSR, perform the PSSR activity, facilitate others, ensure completeness, finalize each PSSR, verify if the startup can safely proceed and shortly after, review each startup for future improvement considerations to apply on the next one,” Lundell said.

Training is another element of PSM and it serves two general purposes: the employer gains a measure of assurance the employee can safely perform ammonia refrigeration work and employees can request improvements or develop more stringent safe work practices. “It establishes a method to communicate potential work concerns or emergency actions,” Lundell said.

During initial training, which applies to every employee, employees should receive an overview of the process and process standard operating procedures. “The training should also emphasize the specific safety and health hazards, emergency operations, shutdown procedures and other safe work practices applicable to the employee’s job task,” Lundell said. “If a new person comes on board or they change their assignment, they need to be trained.”

Anyone who comes onsite at a location, including employees providing incidental services, such as janitorial, vending or laundry services, needs orientation training to make them aware of potential hazards, Lundell said. “Can they explain the hazards with ammonia? Have they recently reviewed the safety data sheet? Do they know what to do if they smell ammonia? What if they smell smoke or see sparks? Are they aware of how safe work practices are used to avoid hazards?”

Employers are required to verify that the training has been completed and to ensure that it was understood, Lundell said. Training documentation includes the identification of the training, the employee name and some method of proving that the training delivered was understood. “The owner needs to designate someone responsible for meeting those elements,” he said.

Refresher training must be completed at least every three years, but employers can train more often if necessary. Together employees and employers can determine the appropriate frequency of refresher training.

There are a number of IIAR publications and training materials that employers can utilize, including the new IIAR educational certificate program. “The goal of the certificate program is to provide end users with a method to demonstrate personnel are trained in IIAR standards and safety materials and provide contractors with a method to demonstrate qualifications to work on ammonia refrigeration systems,” Lundell said.

The implementation of an effective training program is one of the most important steps an employer can take. “Safe work practices should be clearly communicated and become the culture. That means avoid taking shortcuts,” Lundell said.

The IIAR Employee Participation and Training Webinar, along with other webinar education materials is available to IIAR members at www.iiar.org on the membership page.

LOW RECIRCULATION RATE EVAPORATORS

JEFF WELCH, WELCH ENGINEERING CORPORATION

Fin coil evaporators with enhanced internal tube surfaces allow for optimum performance with a minimal overfeed rate. Reducing the overfeed rate requires less pumping power and smaller line sizes to the evaporator. Additionally, less compressor power is required for the same refrigeration capacity because the wet suction line pressure drop is reduced. Lower compressor power results in substantial electrical power savings over the life of the facility. With internal tube enhancement, topfed evaporators can perform as well as bottom-fed evaporators while using a reduced refrigerant charge during full and part load operation.

DESIGN HISTORY

Forced-air, tube, and fin evaporators have been used to refrigerate air for more than 75 years. In the 1960s, several papers documented the performance advantages of pumping ammonia through tubes with an excess amount of liquid, and pumped overfeed evaporators have been the popular choice for industrial ammonia refrigeration systems ever since.

Due to the high latent heat of ammonia, the quantity of liquid that enters an evaporator tube is very small, often occupying less than 2% of the cross-sectional area of the tube. For efficient heat transfer to result in optimum performance, excess liquid ammonia is pumped into the evaporator tube. This excess liquid "sloshes" around the inside perimeter of the tube ensuring a liquid ammonia film coats the inside of the tube to absorb large amounts of heat. If not for this excess liquid, more areas of the inside of the tube would dry, greatly diminishing the performance of the evaporator.

Tube and fin evaporators are generally multiple tubes high, and of a set length, to establish the face area of the evaporator. Typically, 6 to 12 rows of tubes are in the direction of airflow. Determining which of these tubes are in series and which of these tubes are in parallel relative to the ammonia flow, defined as circuiting, is the job of the evaporator designer. Two competing factors must be balanced in any circuiting choice. A longer circuit has more surface area so it will absorb more heat and vaporize more ammonia, creating a higher velocity within the tube. Higher-velocity vapor is more turbulent, which distributes the liquid ammonia via agitation against the full inner perimeter of the tube wall. A shorter circuit has less surface area and does not absorb as much heat or vaporize as much ammonia, resulting in less turbulence and ammonia liquid that settles along the bottom the tube. This leaves the upper portions of the inner tube perimeter dry, so no high heat transfer rate due to boiling can occur, and greatly reduces the evaporator performance.

However, the design factor to balance against velocity and turbulence is pressure drop. If the saturated suction temperature at the outlet of the circuit is -25°F, a 1.0 psi internal circuit pressure drop will result in a saturated evaporating temperature of -23°F at the entrance of the circuit. This is an 11% loss of log mean temperature difference with -15°F air on temperature. Bear in mind that temperature difference drives heat transfer.

Two factors, velocity and mass flow, primarily drive pressure drop within the circuit. Pressure drop is roughly proportional to the velocity squared. Therefore, in light of the previously described temperature penalties, pressure drop within the circuit must be great enough to establish turbulent flow, but not in excess of that. Circuit designers target a lower velocity with less pressure drop by adjusting circuit length or limiting the amount of excess liquid, referred to as overfeed or recirculation rate. Recirculation rate is defined as the total mass flow into the circuit or evaporator relative to the evaporated mass flow. As an example, three times the evaporation rate entering the evaporator is expressed as 3:1 recirculation rate.

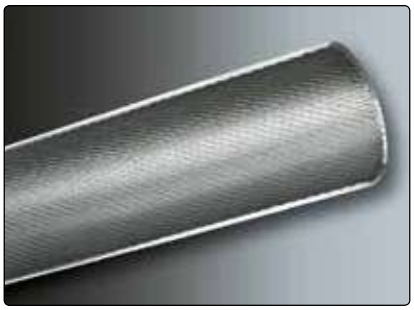
Contemporary evaporator designs typically call for 4:1 or 3:1 recirculation rates at the higher temperatures (40°F to 0°F) and favor 3:1 or 2.5:1 at the lower temperatures (-20°F to -45°F). The pressure/ temperature relationship of ammonia at the lower temperatures discourages higher pressure drops within the circuit due to the large effect on the evaporating temperature.

In addition to wetting the inside perimeter of the tube, the thermal conductivity of the tube and fin material must be considered. For many years, ammonia evaporators were constructed of carbon steel and hot dip galvanized after assembly, or they were aluminum tubes expanded into aluminum fins. In both instances the fins and the tubes have the same thermal conductivity. Heat transfer occurs equally along the perimeter of the tube and from the surrounding fin. Carbon steel has a thermal conductivity of 21 Btu/hr ft °F and that of aluminum is 118 Btu/hr ft °F.

DESIGN EVOLUTION

Within the last decade, stainless steel tubes expanded into aluminum fins have become the evaporator materials of choice. The high-conductance fin transfers heat to the tube very efficiently and uniformly around the tube perimeter. The thermal path with the least resistance to the liquid ammonia or other refrigerant is directly across the tube wall. Consequently, tube wetting directly affects thermal performance.

Fig. 1 Internally enhanced tube (courtesy of Evapco, Inc.).



A recent development in recirculated ammonia applications is the use of internal surface enhancement of stainless steel evaporator tubes as shown in Figure 1.

Such enhancement allows liquid ammonia to settle into depressions in the internal surface and migrate via helical grooves around the inner periphery of the tube.

This migration occurs at a significantly lower velocity than on a smooth tube and minimizes the performance differences between a top-fed and a bottom-fed coil. The improved wetting achieves greater design performance at lower overfeed rates. Laboratory testing has shown that the optimum overfeed rate for a 5/8 in. diameter internally enhanced tube is 1.2:1 and a 1 in. diameter internally enhanced tube is 1.8:1. This is significantly lower than the typical, accepted industry rates discussed previously.

Substantiating these laboratory results, the Air Conditioning, Heating, and Refrigeration Institute (AHRI), which publishes ANSI/AHRI Standard 420-2008, certifies the performance of these stainless steel, internally enhanced tube evaporator bundles. The standard is used as the basis to certify the performance of forced- circulation free-delivery unit coolers used in refrigeration. These AHRI-certified ratings are subject to independent testing per section 5.3 of the standard:

> Tolerances. To comply with this standard, any representative production unit selected at random, when tested at the Standard Rating Conditions, shall have a Gross Total Cooling Effect not less than 95% of its published Standard Rating and not exceed 105% of its Rated Power.

Independent AHRI certification reassures consumers that these reduced recirculation rates are valid and will not compromise performance.

Most recirculated ammonia evaporators utilize an orifice at the beginning of each circuit to meter the sufficient amount of ammonia into the circuit with the stated supply pressure in the liquid header. Designing ammonia evaporators at a 1.2:1 recirculation rate requires the use of smaller orifices. The popularity of screw compressors with high-efficiency coalescing oil separators and cooler discharge temperatures has resulted in much cleaner systems. Therefore, where evaporators are applied to new systems, the use of smaller orifices is not a concern. However, when low recirculation rate coils are applied to older, existing systems with a history of oil carryover or carbonizing problems, an alternate to small orifices should be considered. In this scenario, the alternate approach would be to design the replacement coil(s) based on a higher recirculation rate (i.e., 2:1) or, preferably, to utilize a liquid refrigerant distributor with a single larger orifice and individual distribution tubes. This design works well in providing uniform flow to each circuit, maximizing capacity as verified by laboratory testing.

APPLICATION ADVANTAGES

To illustrate the benefits of lower recirculation rates, low overfeed evaporators are compared with conventional units for a generic public warehouse facility with a shipping dock, freezer space, and six blast cells per the floor plan in Figure 2. Refer to Tables 1–3 for the evaporator comparisons, valve selections, and pipe selections.

Fig. 2 Generic public warehouse facility.

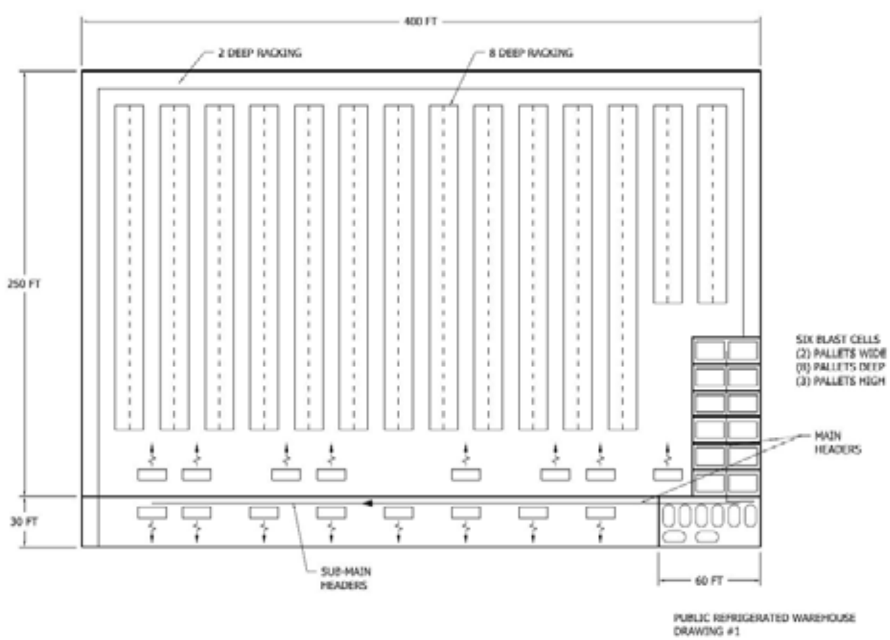


Table 1 Evaporator selection comparison

Room	DOCK		FREEZER		BLAST		
Room Tons	10.3	35.1	33.6				
Sat. Evap. Temp. (ET), °F	30	30	-20	-20	-45	-45	-45
Return Air Temp (RA), °F	45	45	-10	-10	-35	-35	-35
Temperature Difference (TD) (RA-ET)	15	15	10	10	10	10	10
Overfeed Rate, XX:1	1.2	3	1.2	3	1.8	2.5	1.2
Evaporator Type							
Feed Type	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom
Tube Material	SS - IE	SS	SS - IE	CS	SS - IE	CS	SS - IE
Fin Material	AL	AL	AL	GLV	AL	GLV	AL
Capacity, tons	10.2	10.4	35.1	35.2	33.7	33.6	33.3
Capacity, Btu/hr	122,400	124,500	421,200	422,400	404,400	403,704	399,960
Sp. Cap. Btu/hr-TD	8,160	8,300	42,120	42,240	40,440	40,370	39,996
Face Area, ft^2	14	14.9	70	66	92.13	90	70
Rows Deep	10	8	8	10	8	8	10
Tube dia., in.	5/8	3/4	5/8	3/4	1	3/4	5/8
Fins per in.	4	4	4	4	1.5/3	1.5/3	1.5/3
Surface Area, ft^2	2,392	1,650	9,587	9,795	9,497	7,552	8,316
Airflow, cfm	8,325	8,620	59,504	57,900	73,212	79,800	60,326
Ext. Static, "WC"	0	0	0	0	0.5	0.5	0.5
Face Velocity, ft/min	595	579	850	877	795	887	862
# Fans / Dia. in.	2 / 22	2 / 22	5 / 30	3 / 36	3 / 42	3 / 42	5/34
RPM	1,160	1,140	1,160	1,160	1,750	1,750	1,160
Nom. HP, ea.	0.75	0.5	3	5	10	7.5	5
Internal Volume, ft^3	1.74	2	6.82	10.4	16.17	11.5	8.52
Operating Charge, lb **	15.1	26.4	94.6	144.8	303.0	164.3	115.9
Dry Weight, lb	983	860	3,400	-	4,833	-	3,543
Operating Weight, lb	1,175	-	4,168	8,900	5,481	9,200	4,267
Ammonia Flow, GPM	0.84	2.14	2.56	6.42	3.49	4.84	2.30
Quantity	8	8	8	8	12	12	12
Totals							
Gross Capacity, tons	81.6	83	280.8	281.6	404.4	403.7	399.6
Airflow, cfm	66,600	68,960	476,032	463,200	878,544	957,600	723,912
HP	12	8	120	120	360	270	300
Internal Volume, ft^3	13.92	16	54.56	83.2	194.04	138	102.24
Ammonia Flow, GPM	6.7	17.1	20.5	51.3	41.9	58.1	27.6

Table 1 Evaporator selection comparison, cont.

Room	DOCK		FREEZER		BLAST		
Pump Power							
Hydraulic BHP at 30 psi	0.118	0.299	0.358	0.898	0.733	1.016	0.483
Pump efficiency, %	60	60	60	60	60	60	60
Motor efficiency, %	90	90	90	90	90	90	90
kW	0.163	0.413	0.495	1.241	1.012	1.403	0.667
Hr/yr	8760	8760	8760	8760	8760	8760	8760
kWh/yr	1,425	3,621	4,335	10,867	8,866	12,293	5,846
kWh/yr Savings	2,196		6,533		3,427		6,447
					1 in.		**5/8 in. Alternate**
		Total Annual kWh Savings			12,155		15,176
		Elect. Cost $/kWh			$0.10		$0.10
		Potential Pump Power Savings			**$1,215.53**		**$1,517.56**

Definitions for abbreviations in tables:

ET is saturated evaporation temperature for the ammonia exiting the evaporator.
RA is the return air temperature for the air entering the face of the evaporator coil.
TD is the temperature difference between the return air and the saturated evaporation temperatures.
SS stands for stainless steel.
IE stands for internally enhanced.
Al stands for aluminum.
CS stands for carbon steel.
GLV represents galvanized steel.
WC is a term representing in. of water column.
RPM is revolutions per minute.
HP stands for horsepower.
BHP stands for brake horsepower.
kW stands for kilowatt.
GPM stands for gallons per minute.
cfm stands for cubic feet per minute.

LIQUID LINES

Lower overfeed units require a lower volumetric flow rate, which leads to a smaller pump selection that requires less horsepower (see Table 1). In this instance, because a smaller capacity pump is not readily available, the pumping power is the same. Any liquid not used by the evaporators is still elevated in pressure and consumes energy whether it makes the trip to the evaporators or not. The lower liquid flow rate may result in reduced liquid header sizing. If not, the liquid velocity will be lower, resulting is less fluid momentum and pipe movement when solenoids close, which is a safer situation.

HOT GAS LINES

No significant difference exists between the required hot gas piping and valving as this is proportional to surface area and thermal mass. For bottom-fed coils, the orifice size functions as a metering device that the condensed ammonia must flow through. The smaller sizes may require slightly higher hot gas pressures to thoroughly expel the condensate before it can collect in the circuits. Top-feed coils will require a bypass to allow a sufficient quantity of hot gas to flow around the orifices or distributor.

SUCTION LINES

All recirculated ammonia systems will have some pressure drop from the evaporator to the compressor.

Minimizing this pressure drop will result in a more efficient refrigera-

Table 2 Suction valve group comparison.

Room	DOCK		FREEZER		BLAST		
Room Tons	10.3	35.1	33.6				
Sat. Evap. Temp. (ET), °F	30	30	-20	-20	-45	-45	-45
Return Air Temp (RA), °F	45	45	-10	-10	-35	-35	-35
Temperature Difference (TD) (RA-ET)	15	15	10	10	10	10	10
Overfeed Rate, XX:1	1.2	3	1.2	3	1.8	2.5	1.2
Evaporator Type							
Feed Type	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom
Tube Material	SS - IE	SS	SS - IE	CS	SS - IE	CS	SS - IE
Fin Material	AL	AL	AL	GLV	AL	GLV	AL
Liquid							
ICF Model	ICF-20-6-3RA						
Turns Open	1/4	1/2	1	1 3/4	3/4	1 1/4	3/4
Pressure Drop	18.7	17.37	15.87	15.09	15.82	15.21	15.82
Suction							
Stop Valve, Globe	2 in. SVA	2 in. SVA	4 in. SVA	4 in. SVA	4 in. SVA	4 in. SVA	4 in. SVA
Solenoid Valve	ICLX 32-NS40	ICLX 40-NS50	ICLX 100	ICLX 100	ICLX 100	ICLX 100	ICLX 100
Stop Valve, Angle	2 in. SVA	2 in. SVA	4 in. SVA	4 in. SVA	4 in. SVA	4 in. SVA	4 in. SVA
Total Pressure Drop	0.09	0.20	0.12	0.26	0.30	0.39	0.20

Definitions for abbreviations in tables:

ET is saturated evaporation temperature for the ammonia exiting the evaporator.
RA is the return air temperature for the air entering the face of the evaporator coil.
TD is the temperature difference between the return air and the saturated evaporation temperatures.
SS stands for stainless steel.
IE stands for internally enhanced.
Al stands for aluminum.
CS stands for carbon steel.
GLV represents galvanized steel.
WC is a term representing in. of water column.
RPM is revolutions per minute.
HP stands for horsepower.
BHP stands for brake horsepower.
kW stands for kilowatt.
GPM stands for gallons per minute.
cfm stands for cubic feet per minute.

Table 3 Evaporator piping comparison

Room	DOCK		FREEZER		BLAST		
Room Tons	10.3	35.1	33.6				
Sat. Evap. Temp. (ET), °F	30	30	-20	-20	-45	-45	-45
Return Air Temp (RA), °F	45	45	-10	-10	-35	-35	-35
Temp Difference (TD) (RA-ET)	15	15	10	10	10	10	10
Overfeed Rate, XX:1	1.2	3	1.2	3	1.8	2.5	1.2
Evaporator Type							
Feed Type	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom
Tube Material	SS - IE	SS	SS - IE	CS	SS - IE	CS	SS - IE
Fin Material	AL	AL	AL	GLV	AL	GLV	AL
Branch Piping							
Liquid							
Factory Conn., in.		3/4		1 1/4		1 1/4	
Nom. Pipe Size, in.	3/4	3/4	1	1	3/4	3/4	3/4
ΔP psi/100 ft	0.09	0.5	0.22	1.21	1.45	2.71	0.67
Velocity, ft/s	0.63	1.58	1.14	2.85	2.58	3.59	1.72
Suction							
Factory Conn., in.		2		4		5	
Nom. Pipe Size, in.	2	2	4	4	4	4	4
ΔP psi/100 ft	0.11	0.23	0.09	0.19	0.20	0.26	0.15
Velocity, ft/s	14.8	15	33.3	33.4	60.4	60.5	60.2
Main Headers							
	DOCK: 82 tons @ + 30°F		**FREEZER: 281 tons @ -20°F**		**BLAST: 404 tons @-45°F**		
Liquid							
Nom. Pipe Size, in.	1	1 1/4	2	2	2	2	2
ΔP psi/100 ft	1.25	1.67	0.31	1.8	1.27	2.4	0.58
Velocity, ft/s	3.02	4.23	2.23	5.56	4.55	6.31	3.03
Suction							
Nom. Pipe Size, in.	4	4	8	8	10	10	10
ΔP psi/100 ft	0.17	0.36	0.14	0.28	0.21	0.26	0.16
Velocity, ft/s	27.4	27.7	67.8	68	117.3	117.4	117.0

Table 3 Evaporator piping comparison, cont.

Room	DOCK		FREEZER		BLAST		
Sub-Main Headers							
	DOCK: 41 tons @ +30°F		**FREEZER: 140 tons @ -20°F**		**BLAST: 202 tons @-45°F**		
Liquid							
Nom. Pipe Size, in.	3/4	1	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2
ΔP psi/100 ft	1.22	1.93	0.3	1.75	1.24	2.33	0.57
Velocity, ft/s	2.51	3.77	1.85	4.63	3.8	5.27	2.53
Suction							
Nom. Pipe Size, in.	3	3	6	6	8	8	8
ΔP psi/100 ft	0.18	0.39	0.15	0.3	0.18	0.23	0.13
Velocity, ft/s	23.6	23.8	58.5	58.7	92.5	92.5	92.2

Definitions for abbreviations in tables:

ET is saturated evaporation temperature for the ammonia exiting the evaporator.
RA is the return air temperature for the air entering the face of the evaporator coil.
TD is the temperature difference between the return air and the saturated evaporation temperatures.
SS stands for stainless steel.
IE stands for internally enhanced.
Al stands for aluminum.
CS stands for carbon steel.
GLV represents galvanized steel.
WC is a term representing in. of water column.
RPM is revolutions per minute.
HP stands for horsepower.
BHP stands for brake horsepower.
kW stands for kilowatt.
GPM stands for gallons per minute.
cfm stands for cubic feet per minute.

tion system. From the recirculator vessel to the compressor suction, the dry vapor flow rates are the same for a stated load and will have the same pressure drop regardless of the evaporator brand. An arbitrary 1.0 psi pressure drop was assigned to the dry suction lines from the recirculator vessels to the compressors at each of the three temperature levels. This paper focuses on the wet suction pipes and valves from the evaporators

to the recirculator vessel. The pipe and valve sizes were selected for the higher overfeed evaporators and then rerated at the lower overfeed rates. The total pressure drop through the pipes and suction valve assemblies was determined using a publically available valve program that is available as a download from the Internet. The program takes the overfeed rate into account in the pressure drop calculations of the pipes and the valves.

For this study the evaporator operating pressures were held constant at 45.0 psig (30°F), 3.6 psig (-20°F), and 8.9 psia (-45°F) for either type of evaporator. Table 4 provides the summary and comparison of the wet suction pressure drops from the evaporators to the recirculator.

Thermosiphon-cooled screw compressors were selected using major compressor manufacturer's software. Each compressor was rated at the design evaporating temperatures (+30°F, -20°F, and -45°F), and an 85°F yearly average condensing temperature. In each instance the total suction line pressure drop was entered into the software and the kW/ton was derived. The savings in kW/ton is represented in the low overfeed unit columns in Table 5. This efficiency savings is then multiplied by the total tons per suction level and totaled for 6,000 operating hours per year, which allows for cycling off during temperature-satisfied periods and blast cell turnaround.

Table 4 Wet suction pressure drop comparison

Room	DOCK		FREEZER		BLAST		
Room Tons	10.3	35.1	33.6				
Sat. Evap. Temp. (ET), °F	30	30	-20	-20	-45	-45	-45
Return Air Temp (RA), °F	45	45	-10	-10	-35	-35	-35
Temp Difference (TD) (RA-ET)	15	15	10	10	10	10	10
Overfeed Rate, XX:1	1.2	3	1.2	3	1.8	2.5	1.2
Evaporator Type							
Feed Type	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom
Tube Material	SS - IE	SS	SS - IE	CS	SS - IE	CS	SS - IE
Fin Material	AL	AL	AL	GLV	AL	GLV	AL
Branch Piping							
Suction							
Factory Conn., in.	2	4	5				
Nom. Pipe Size, in.	2	2	4	4	4	4	4
ΔP psi/100 ft	0.11	0.23	0.09	0.19	0.2	0.26	0.15
Lineal ft	20	20	20	20	40	40	40
Fitting Allowance, eq. ft	14.7	14.7	24.6	24.6	24.6	24.6	24.6
Pipe ΔP psi	0.04	0.08	0.04	0.08	0.13	0.17	0.10
Suction Valve Station ΔP psi	0.09	0.2	0.12	0.26	0.3	0.39	0.20
Total Valve & Pipe ΔP psi	0.13	0.28	0.16	0.34	0.43	0.56	0.30
Main Headers							
	DOCK: 82 tons @ +30°F		**FREEZER: 281 tons @ -20°F**		**BLAST: 404 tons @-45°F**		
Suction							
Nom. Pipe Size, in.	4	4	8	8	10	10	10
ΔP psi/100 ft	0.17	0.36	0.14	0.28	0.21	0.26	0.16
Lineal ft	200	200	200	200	66	66	66
Fitting Allowance, eq. ft	12.6	12.6	17.1	21	24	24	24
Pipe ΔP psi	0.36	0.77	0.30	0.62	0.19	0.23	0.14
Suction Valve ΔP psi	0.04	0.08	0.08	0.18	0.24	0.32	0.17
Total Valve & Pipe ΔP psi	0.40	0.85	0.38	0.80	0.43	0.55	0.31

Room	DOCK		FREEZER		BLAST		
Sub-Main Headers							
	DOCK: 41 tons @ +30°F		**FREEZER: 140 tons @ -20°F**		**BLAST: 202 tons @-45°F**		
Suction							
Nom. Pipe Size, in.	3	3	6	6	8	8	8
ΔP psi/100 ft	0.18	0.39	0.15	0.3	0.18	0.23	0.13
Lineal ft	180	180	180	180	30	30	30
Fitting Allowance, eq. ft	6.8	6.8	11.4	11.4	14	14	14
Pipe ΔP psi	0.34	0.73	0.29	0.57	0.08	0.10	0.06
Wet Suction	**SUMMARY**						
Total Pipe and Valve ΔP psi	0.87	1.85	0.83	1.72	0.94	1.21	0.67
Savings, psi	0.98		0.89		0.27		0.54

Table 5 Compressor power comparison

Room	DOCK		FREEZER		BLAST		
Room Tons	10.3	35.1	33.6				
Sat. Evap. Temp. (ET), °F	30	30	-20	-20	-45	-45	-45
Return Air Temp (RA), °F	45	45	-10	-10	-35	-35	-35
Temperature Difference (TD) (RA-ET)	15	15	10	10	10	10	10
Overfeed Rate, XX:1	1.2	3	1.2	3	1.8	2.5	1.2
Evaporator Type							
Feed Type	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom	Bottom
Tube Material	SS - IE	SS	SS - IE	CS	SS - IE	CS	SS - IE
Fin Material	AL	AL	AL	GLV	AL	GLV	AL
Capacity, tons	10.2	10.4	35.1	35.2	33.7	33.6	33.3
Capacity, Btu/hr	122,400	124,500	421,200	422,400	404,400	403,704	399,960
Quantity	8	8	8	8	12	12	12
Evaporator Pres., psia	59.7	59.7	18.3	18.3	8.9	8.9	8.9
Wet Suction Loss, psi	0. 87	1.85	0.83	1.72	0.94	1.21	0.67
Dry Suction Loss, psi	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Total Suct. Piping Loss, psi	1.87	2.85	1.83	2.72	1.94	2.21	1.67
Compressor Configuration	High Stage		Single Stage—Econ.		Two Stage—Intercooled (30°F)		
Tons	583.5	572.5	280.0	264.3	238.7	227.5	246.3
BHP	455.8	456.1	536.5	527.2	481.1	476.5	484.1
kW	340.0	340.3	400.2	393.3	358.9	355.5	361.1
kW/ton	0.58	0.59	1.43	1.49	1.50	1.56	1.47
ΔkW/ton, 85°F Cond.*	0.012		0.059		0.059		0.10
Total Evaporator Load, tons	81.6		280.8		404.4		404.4
Compressor Savings, kW	0.95		16.47		23.83		38.92
Run Time, hr/yr	6,000		6,000		6,000		6,000
kWh/yr Savings	5,673		98,829		143,006		233,532
					1 in.		**5/8 in. Alternate**
		Total Annual kWh Savings			247,508		338,034
		Elect. Cost $/kWh			$0.10		$0.10
		Annual Compressor Power Savings			**$24,751**		**$33,803**

Definitions for abbreviations in tables:

ET is saturated evaporation temperature for the ammonia exiting the evaporator.
RA is the return air temperature for the air entering the face of the evaporator coil.
TD is the temperature difference between the return air and the saturated evaporation temperatures.
SS stands for stainless steel.
IE stands for internally enhanced.
Al stands for aluminum.
CS stands for carbon steel.
GLV represents galvanized steel.
WC is a term representing in. of water column.
RPM is revolutions per minute.
HP stands for horsepower.
BHP stands for brake horsepower.
kW stands for kilowatt.
GPM stands for gallons per minute.
cfm stands for cubic feet per minute.

The savings due to less mass flow in the wet suction lines are significant, approximately 247,500 kWh per year and 338,000 kWh per year if 5/8 in. internally enhanced tube evaporators are used in the blast cells.

SURGE VOLUMES

The refrigerant charge in an evaporator is a function of internal volume, circuit loading, and feed method.

At equal thermal capacities, a coil designed with smaller tubes will have less internal volume than a coil made with larger tubes. This can be observed in Table 1, which illustrates the charge for the ¾ in. tube coils relative to the 5/8 in. internally enhanced tubes. Furthermore a coil with 1 in. tubes has a greater internal volume than the ¾ in. tube coil.

All recirculated coil circuits should be designed to be free draining to allow hot gas condensate to drain from the coil and not accumulate and blanket the tube during defrost. If the circuit is top fed, the excess liquid is initially drained by gravity until the vapor velocity within the tube is sufficient to sweep any excess liquid down through the circuit. This feed method minimizes any excess liquid accumulation, which may be referred to as "ballast charge." Bottom-fed circuits will accumulate excess liquid in the bottom of the circuit until the vapor velocity is sufficient to sweep this accumulated liquid uphill through the circuit. It should be obvious that the ballast charge in a bottom-fed coil greatly adds to the operating charge relative to a top-fed coil, especially at part load where the vapor velocities are lower. Laboratory testing has determined a refrigerant charge ratio for top-feed coils to bottom-feed coils. At 25°F evaporating temperature, this ratio is 1.0, at 0°F it is 0.70, and at -20°F it drops to 0.63.

Table 6 highlights the charge difference that occurs in top- or bottom-feed evaporators. The design TD liquid charge and the liquid charge at part load, 3°F TD, are shown. This situation could occur toward the end of a blast freezer cycle or when the control system has no active feed solenoid control or a wide deadband. The table indicates two items of interest to the facility designer and owner. First, a major food processor has shown a direct correlation between increased plant safety and reduced ammonia charge. Top-feed, small-tube evaporators are an excellent choice to reduce the overall charge. In this generic warehouse example, the operating charge reduction is greater than 1,800 lb.

The second item of note is the surge volume requirement of the recirculators.

When an evaporator operates at part load, at a low TD, the amount of ballast liquid increases because significantly less vapor volume is present to displace the liquid and less velocity is available to sweep it from the tubes. This charge fluctuation from 100% design load down to a part load condition must be accounted for in the recirculator vessel design. For smooth, problem-free system operation, the internal volume of the recirculator vessel must be great enough to accommodate this ballast liquid as it leaves the evaporators when they are loaded up. At the same time, enough vapor separation space must remain in the vessel to prevent liquid carryover to the compressors.

Vessel designers refer to this as surge volume. Referring back to the blast freezing recirculator of the generic warehouse, this reduction in surge volume may be in excess of 40 ft3, which will definitely allow for a smaller vessel diameter and/or length.

The lower overfeed rate places less liquid in the wet suction headers under steady- state load when the vapor velocity is sufficient to drag liquid through the pipe. However, the liquid volume build-up during light load is a function of pipe slope. Therefore, surge volumes due to piping are not quantified in this paper.

SUMMARY

Use of low overfeed evaporators will reduce pressure drop in all portions of wet suction piping. This reduction in pressure drop will significantly reduce the work required at the compressor over the lifespan of the facility, resulting in electricity savings and lower overhead costs. Additionally, internally enhanced tubes allow the use of top-fed evaporators for a

Table 6 Evaporator charge and surge volume comparison

Room	DOCK			FREEZER			BLAST				
Room Tons	10.3			35.1			33.6				
Saturated Evaporator Temp (ET), °F	30			-20			-45				
Return Air Temp (RA), °F	45			-10			-35				
Temperature Difference (TD) [RA-ET]	15			10			10				
Overfeed Rate, XX:1	1.2	1.2	3	1.2	1.2	3	1.8	1.8	2.5	1.2	1.2
Evaporator Type	**Low Overfeed**	**Low Overfeed**	**Conven-tional**	**Low Overfeed**	**Low Overfeed**	**Conven-tional**	**Low Overfeed**	**Low Overfeed**	**Conven-tional**	**Alternate Low Overfeed**	**Alternate Low Overfeed**
Feed Type	Top	Bottom	Bottom	Top	Bottom	Bottom	Top	Bottom	Bottom	Top	Bottom
Overfeed Rate, XX:1	1.2	1.2	3	1.2	1.2	3	1.8	1.8	2.5	1.2	1.2
Tube Material	SS - IE	SS - IE	SS	SS - IE	SS - IE	CS	SS - IE	SS - IE	CS	SS - IE	SS - IE
Fin Material	AL	AL	AL	AL	AL	GLV	AL	AL	GLV	AL	AL
Capacity, tons	10.2	10.2	10.4	35.1	35.1	35.2	33.7	33.7	33.6	33.3	33.3
Face Area, ft²	14	14	14.9	70	70	66	92.13	92.13	90	70	70
Rows Deep	10	10	8	8	8	10	8	8	8	10	10
Tube dia, in.	5/8	5/8	3/4	5/8	5/8	3/4	1	1	3/4	5/8	5/8
Internal Volume, ft³	1.74	1.74	2	6.82	6.82	10.4	16.17	16.17	11.5	8.52	8.52
Operating Charge, lb**	15.1	15.1	26.4	59.6	94.6	144.8	190.9	303.0	164.3	73	115.9
Liquid Density, lb/ft³	39.96	39.96	39.96	42.2	42.2	42.2	43.3	43.3	43.3	43.3	43.3
Charge, ft³	0.38	0.38	0.66	1.41	2.24	3.43	4.41	7.00	3.80	1.69	2.68
% Liq. Vol.	0.22	0.22	0.33	0.21	0.33	0.33	0.27	0.43	0.33	0.20	0.31

Table 6 Evaporator charge and surge volume comparison, cont.

Room	DOCK			FREEZER			BLAST				
3 deg TD Charge, lb	30.80	30.80	N/A	105.49	167.45	N/A	271.08	430.28	N/A	127.00	194.67
Surge Volume, lb	15.70	15.70	32.0	45.89	72.84	175.6	80.18	127.27	199.2	54.00	78.79
Surge Volume, ft^3**	0.39	0.39	0.8	1.09	1.73	4.16	1.85	2.94	4.6	1.25	1.82
Quantity	8	8	8	8	8	8	12	12	12	12	12
Totals											
Internal Volume, ft^3	13.9	13.9	16.0	54.6	54.6	83.2	194.0	194.0	138.0	102.2	102.2
Total Surge Vol, ft^3	3.1	3.1	6.4	8.7	13.8	33.3	22.2	35.3	55.2	15.0	21.8
Total Surge Volume Reduction, ft^3	**3.3**	**3.3**	-	**24.6**	**19.5**		**33.0**	**19.9**		**40.2**	**33.4**
Total Charge, lb	120.8	120.8	211.0	476.8	756.8	1,158.6	2,290.8	3,636.2	1,971.9	876.0	1,390.5
Total Charge Reduction, lb	**90.2**	**90.2**	-	**681.8**	**401.8**	-	**-318.9**	**-1,664.3**	-	**1,095.9**	**581.4**

significant operating charge reduction and surge volume decrease.

REFERENCES

American National Standards Institute (ANSI) / Air Conditioning, Heating, and Refrigeration Institute (AHRI). (2008). "Standard for Performance Rating of Forced- Circulation Free-Delivery Unit Coolers for Circulation." *Standard 420.*

Definitions for abbreviations in tables:

ET is saturated evaporation temperature for the ammonia exiting the evaporator.
RA is the return air temperature for the air entering the face of the evaporator coil.
TD is the temperature difference between the return air and the saturated evaporation temperatures.
SS stands for stainless steel.
IE stands for internally enhanced.
Al stands for aluminum.
CS stands for carbon steel.
GLV represents galvanized steel.
WC is a term representing in. of water column.
RPM is revolutions per minute.
HP stands for horsepower.
BHP stands for brake horsepower.
kW stands for kilowatt.
GPM stands for gallons per minute.
cfm stands for cubic feet per minute.

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