iiar THE OFFICIAL MAGAZINE OF THE AMMONIA REFRIGERATION INDUSTRY ■ JUNE 2014

CONDENSER

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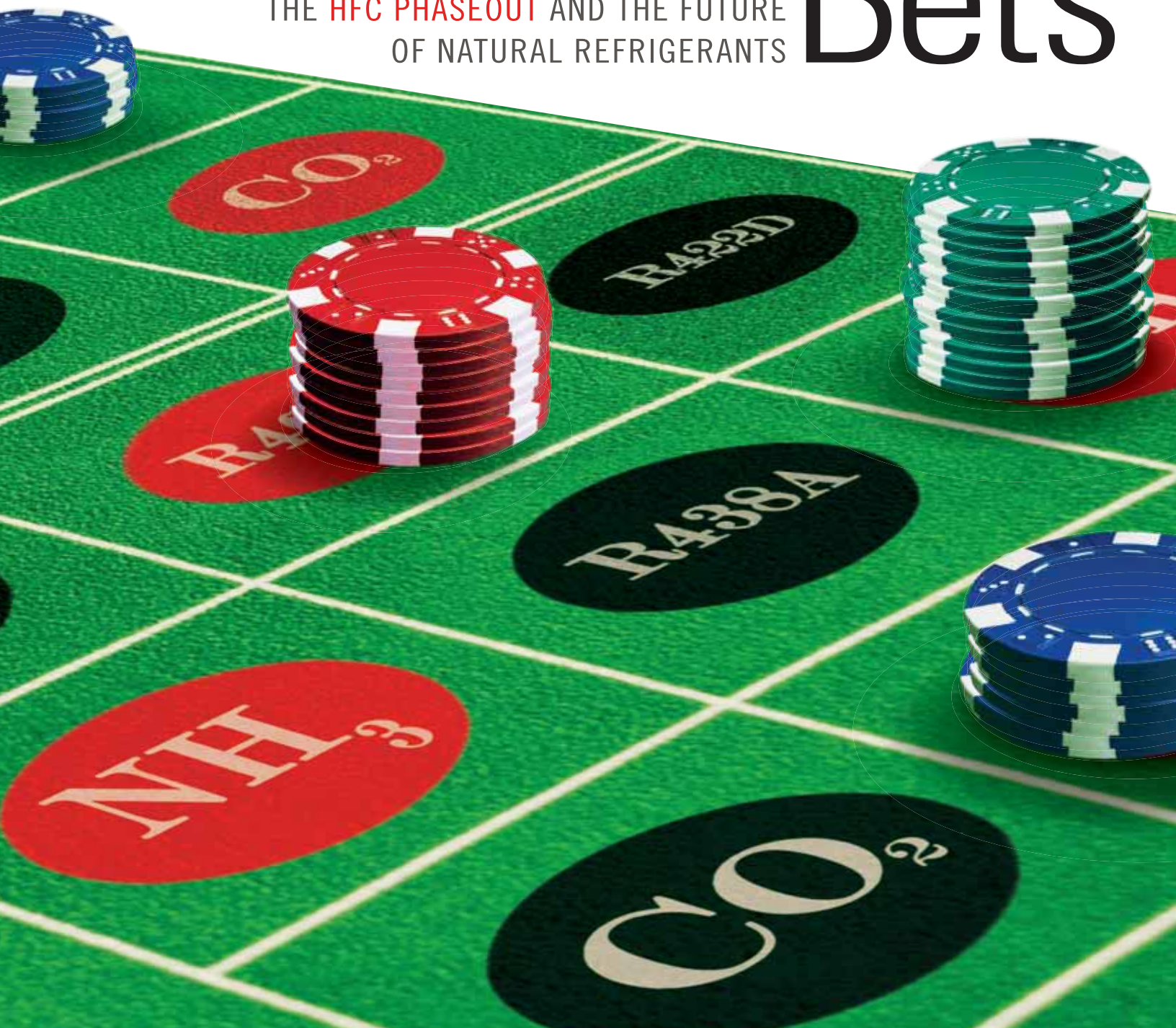
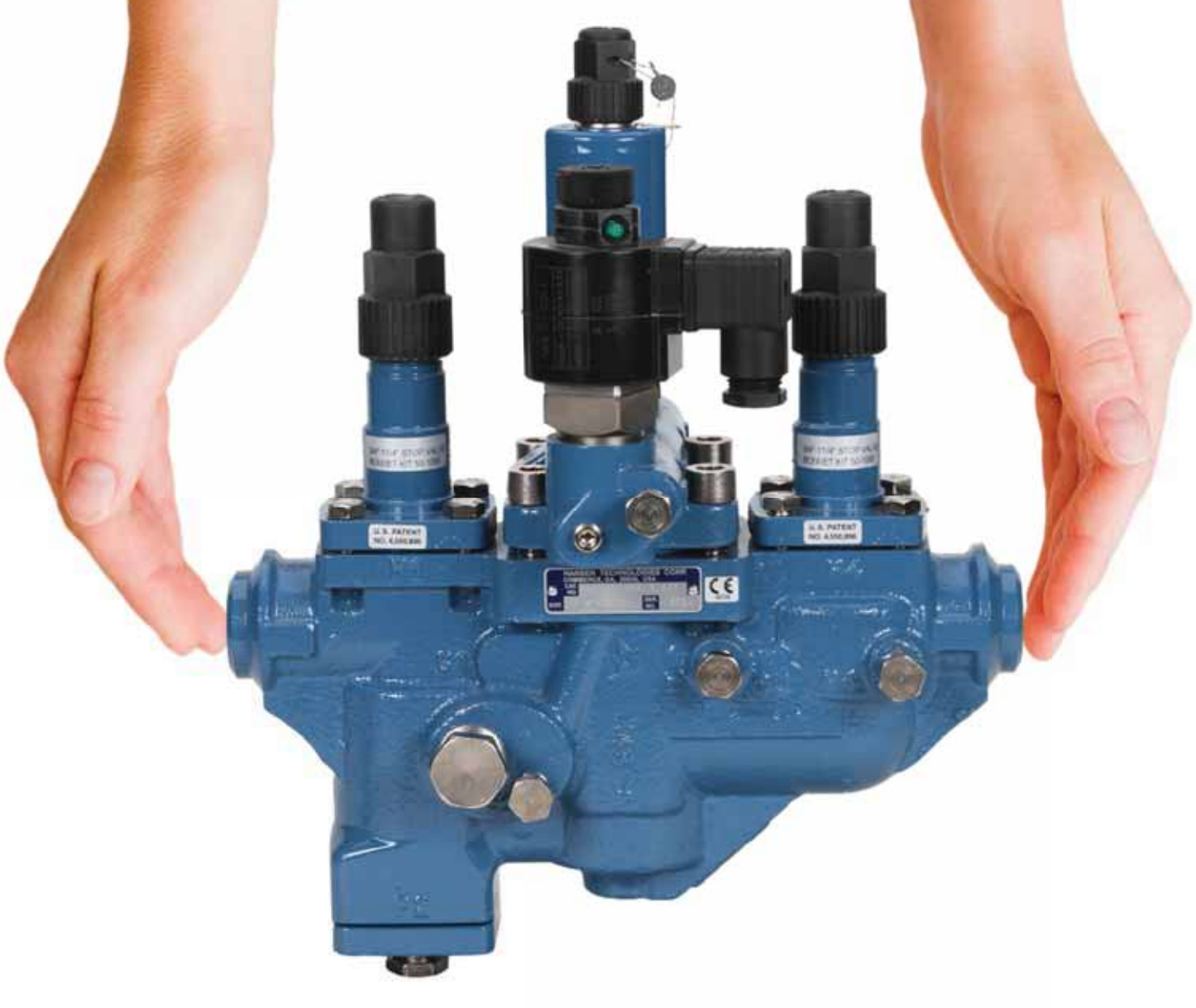
THE HFC PHASEOUT AND THE FUTURE OF NATURAL REFRIGERANTS





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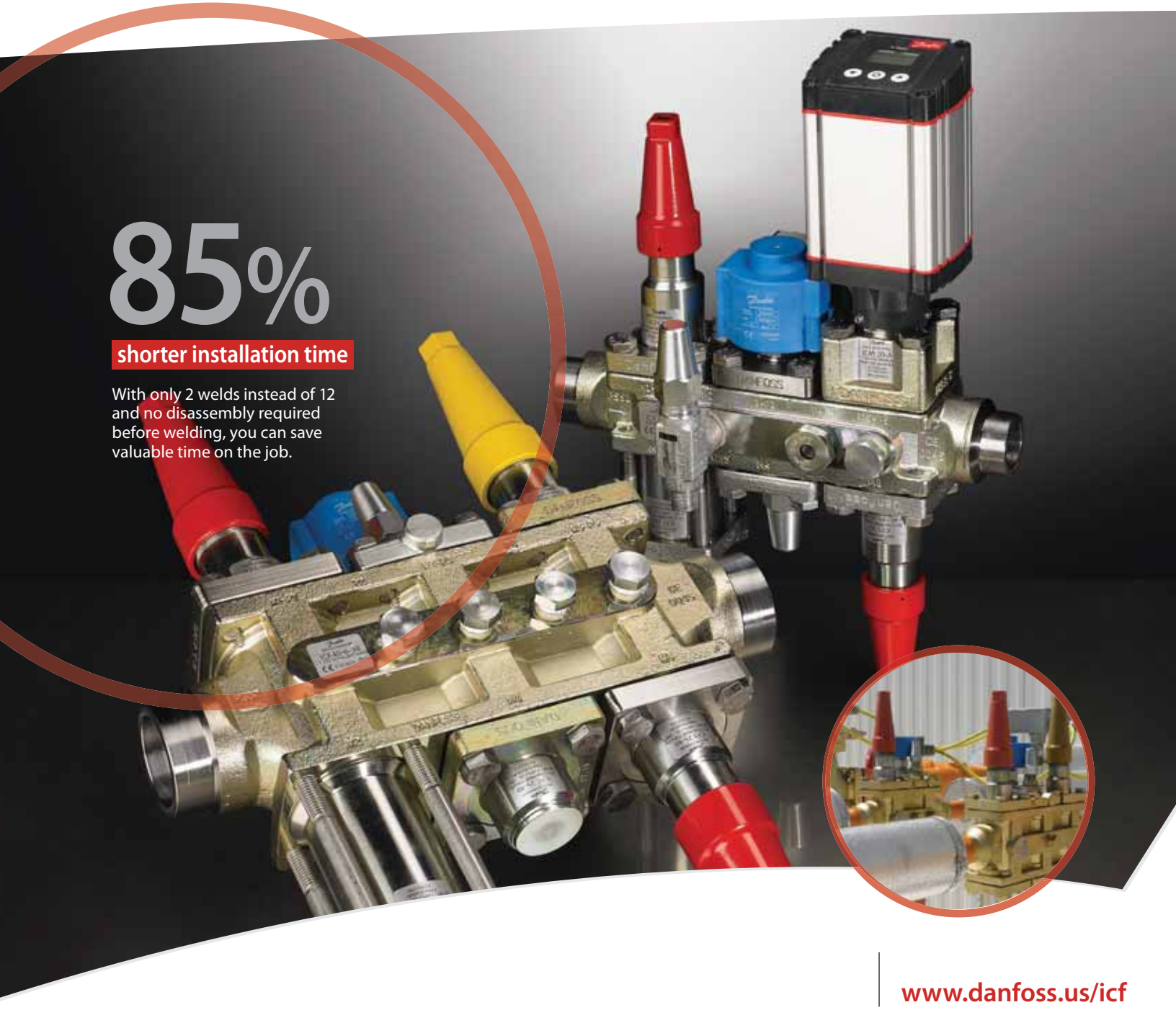

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contents

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COVER story

12

Refrigeration technologies like synthetic replacements for HFCs, low charge ammonia and CO_2-based systems are growing like never before ahead of a planned phaseout of R-22 in the United States.

Although most players in the industrial refrigeration industry have been taking a hard look at replacements for refrigerants targeted by the Environmental Protection Agency for many years, they may no longer have much time to decide which new technology is their best bet for the future.

chairman's MESSAGE

MARCOS BRAZ

Now that the IIAR conference, with its committee meetings, networking events and technical discussions has ended and we're all back at work, it's time to set some new goals and carry the momentum of our recent meeting into the rest of the year.

I'd like to take this opportunity to call for your increased participation and leadership in IIAR's committees.

As your new chairman, my first priority this year is to welcome the new members in the U.S. and across the world as we encourage your continued participation and focus on creating the growth that will help our natural refrigeration industry meet the new challenges ahead.

This year's Industrial Refrigeration Conference & Heavy Equipment Show was our first major step in that direction, and I'm very pleased to report that the event again saw record-breaking numbers of attendees and exhibitors, and added important alliances through signed MOU's with organizations like ASHRAE and RETA.

We also brought exciting news with publications and technical papers. The new and revised CO_2 Handbook showcases not only the latest knowledge available to the industry, but the technical strength of our committee work. We also just finished the first public review of the IIAR-2 standard and completed IIAR-5 and IIAR-4.

IIAR's 2014 show was one of our best conferences yet, exceeding and surpassing expectations, primarily because of the support and hard work of our members, so I'd like to extend special thanks and appreciation to all who contributed their time and financial support to this year's event.

We welcomed over 130 exhibitors participating in our exhibit hall this year, representing a more diversified cross-section of our industry and the largest exhibit floor ever. Many unveiled new products, and there was an impressive display of larger equipment.

The IIAR technical program was also a success, with eight technical papers, eight workshops, a research panel, an international panel and a closing forum discussing the characteristics and applications of small charge systems, which was of this year's hottest topics.

As dedicated as our members are to making this organization a success we also count on our very talented and dedicated staff lead by our president Dave Rule.

I encourage you to get to know them and connect with them at our conferences and meetings. They do a lot of "behind the scenes" work, and it is their hard work that allows us to continue to support a vibrant and dynamic, growing, association.

Our organization's strength also lies in the work of its membership, coordinated and lead through our Committee Chairs and their voluntary work. And I should not forget the outpouring of enthusiasm of each one of our members when it comes to sharing knowledge and new ideas.

I'd like to take this opportunity to call for your increased participation and leadership in IIAR's committees and development of technical papers. Our publications are second to none, addressing new trends and introducing new technologies, and you, as an IIAR member have the opportunity to contribute to them directly.

Another area that will receive my focus as your chairman this year is expanding our interaction with our association partnerships by exchanging technical information and resources. IIAR will continue to grow as a resource for the educational and training materials that make our industry safe and enable the use of new natural refrigeration technologies.

Resolving some of the most complex scenarios we are facing with the phase-out of synthetic refrigerants will depend on the ability of IIAR's membership to continue to develop those resources and communicate the potential of new technologies.

We'll continue to foster communication with all of our partners with which we have signed MOU's, while at the same time looking for new opportunities to grow our presence on the global stage.

To that end, we'll also be focused on the work of our committees this year, especially government relations, where we've continued to build relationships on behalf of our industry, carrying the torch on initiatives with the Department of Homeland Security, EPA, OSHA and many other government organizations.

I'm looking forward to working together with you as your chairman this year. As members, your ongoing work and participation make all of our activities possible. Thank you for enriching our industry with your support.

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president's MESSAGE

BY DAVE RULE

There's a lot going on these days, both in our industry and at IIAR's headquarters. Regulatory issues have seen an increased focus for our organization while new technologies like low charge systems continue to grow in importance.

As your president, it has been my honor to lead your staff and work with our dedicated Board of Directors on several new projects and initiatives that address the trends and challenges that will have a major impact on our industry in the next five years.

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

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

Our most recent annual conference demonstrated the successful work of the IIAR on so many levels. As part of a volunteer membership, we provide the essential technical standards, educational tools and other materials we depend on as an industry to improve the efficiency and safety of natural refrigerants.

You can read more about the conference, including our groundbreaking attendance, in the message from your new Chairman, Marcos Braz, and a special post-conference feature story, both in this issue.

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

One new dimension of our program in 2014 was the participation of Department of Homeland Security Director of Infrastructure Security Compliance, David Wulf.

Engaging with IIAR on the Chemical Facility Anti-Terrorism Standards program is a major goal of the Department this year, and one that Mr. Wulf communicated to our Board and membership in two special sessions.

As a special guest at IIAR's meeting, he shared information on the DHS regulatory program and invited IIAR members to get involved in the stakeholder discussions that are currently advancing the mission of his division.

Given our organization's focus on regulatory issues, fostering a close relationship with DHS as well as other government agencies – like OSHA and EPA – will be a continued priority for IIAR in the coming year.

Informing the regulatory environment is increasingly important, especially as new technologies that make use of ammonia and other natural refrigerants open the door to new commercial applications and present new ways to meet the nation's environmental goals.

The move towards systems that make use of low charges of ammonia was one subject I heard discussed over and over again at our recent annual meeting.

This change has major implications for our entire industry especially when it comes to changes in design, the use of ammonia, CO_2 as a secondary refrigerant and even regulatory issues.

Part of the reason this year's conference saw record attendance levels was because many of the new technologies that were on display at our show have the potential to shape how we do business in the future.

IIAR will continue the momentum started at our conference with one important new project we'll be unveiling this year: the addition of a web-based learning management system.

With IIAR's new LMS, we'll be providing several key capabilities we've heard members request.

Our new system will allow us to provide videos, webinars and other training materials that can be accessed electronically on a subscription basis. These materials will help us support the training needs of our members and their facilities as well as provide a platform that members and regulators will be able to use to access major IIAR publications on their computers, tablets and other mobile devices.

With this project, and our continued publication of industry news and reference material like the recently released CO_2 Handbook, IIAR's prospects for growth this year are very strong.

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

These individuals have been and will continue to be our most valuable resource. I invite everyone to participate in IIAR and I look forward to working with all to fulfill the global mission of our organization.

IIAR Thanks our conference sponsors for a successful 2014 event

IIAR Shatters Attendance Records, Sets New Goals at Conference

The International Institute of Ammonia Refrigeration hit record attendance numbers, signed agreements with ASHRAE and RETA and drew participation from the Department of Homeland Security at its Conference & Heavy Equipment Show, an event that marked a variety of transitions and new initiatives for the association this year.

The three days of networking at industry sponsored events was an opportunity for IIAR conference-goers to meet other professionals in the industry while taking advantage of the technical knowledge and resources available on the exhibition floor and at technical program presentations.

"This was such a great conference on a number of levels. We saw a record total turnout, including the largest-ever number of international attendees and exhibitors," said 2014 Conference Chair Tom Leighty. "We had more participants than ever from the end user environment, and the technology showcased on the exhibit hall floor was really an amazing testament to the advances our industry is making."

The conference, which was held at the Renaissance Nashville Hotel and Convention Center, March 23 – 26, drew over 1,500 attendees, many of whom were new to the event.

IIAR president Dave Rule said the increase in international attendance at this year's event underscores the growing momentum of natural refrigerants around the world, a trend that was on display on IIAR's exhibit hall floor.

"The exhibit hall floor was very impressive this year in terms of the quality and diversity of the products on display," he said. "With more international exhibitors participating than ever before, it demonstrated that IIAR is growing and our industry is gaining importance, not just here, but around the world."

The enthusiasm and dedication of the organization's membership was also on display. Attendees representing a significant cross section of IIAR participated in committee work, discussed new ideas presented in technical papers and focused on safety in two special pre-conference training sessions.

"This level of participation really shows the strength of our membership," said Rule. "Just walking through the conference rooms and the exhibit hall, I could see and hear the excitement surrounding the different types of technology that are beginning to develop."

One of the always popular subjects being discussed at IIAR's conference was the development of small charge systems. But, said Rule, the excitement went beyond small charge, encompassing the many new components and systems that are changing the industry and making it more efficient.

"New design is everywhere these days. So much new technology is being developed by manufacturers. From new designs in controls and valves to changes in larger equipment design, we're finding ways to operate much more efficiently using smaller amounts of refrigerant in our systems."

Rule said such conversations about efficiency and charge levels will grow ever more important in the coming years as the industry looks for ways

to control energy costs and minimize the impact the regulatory environment can have on operations.

"When we talk about reducing charge, there's a regulatory component to consider," he said, adding that reducing the amount of ammonia in a system, even if the total charge remains above ten thousand pounds, makes it easier to manage a system.

"Reducing the charge of a system can provide a company with several advantages when it comes to managing regulatory issues around that system, and ultimately, that reduction lowers the operating costs over the lifecycle of a package being installed."

Industry input on regulatory issues was also an important theme at the recent meeting, which featured a special panel on Department of Homeland Security initiatives, led by DHS Director of Infrastructure Security Compliance, David Wulf.

According to Wulf, who also participated in a meeting with IIAR's Board of Directors, engaging with IIAR on the Chemical Facility Anti-Terrorism Standards program is a major goal of the Department this year.

As a special guest at IIAR's meeting, he shared information on the DHS regulatory program and invited IIAR members to get involved in the stakeholder discussions that are currently advancing the mission of his division.

The Department's participation was significant for IIAR because the regulatory environment is growing and its impact on the industry is emphasized more than ever before, said Rule.

"It is very important that our membership has the opportunity to interact directly with government officials, and not just rely on IIAR to interact on their behalf," he said. "DHS participation in our meeting this year was significant because it allows the industry to have a two-way conversation and gives regulators like David Wulf the opportunity to lay out the plan the government is developing and discuss the direction they're taking with their programs."

Given the organization's focus on regulatory issues, fostering a close relationship with DHS as well as other government agencies – like OSHA and EPA – will be a continued priority for IIAR in the coming year.

"Informing the regulatory environment is increasingly important, especially as new technologies that make use of ammonia and other natural refrigerants open the door to new commercial applications and present new ways to meet the nation's environmental goals," said Rule.

Meanwhile, IIAR's Leighty emphasized the organization's ongoing effort to provide special educational programs at each conference, in addition to the traditional IIAR technical paper presentations.

"We continued to offer in-depth training sessions on the Sunday before the start of the conference," he said, adding that the two back-to-back sessions, one emphasizing Safety Training and the other focused on Process Safety Management, were integral to IIAR's educational goals this year.

"We're trying to increase the in-depth technical training available to our members and provide any resources that can help end users, contractors and engineers – especially those just coming into our industry."

Leighty added that IIAR signed two new MOU's, or Memorandums of Understanding, with organizations RETA and ASHRAE, which will help it further the industry's safety goals by working more closely on shared initiatives.

Rule said that the MOUs will help IIAR more closely coordinate industry

responses to requests for information, or RFI's, from regulators.

"We've already worked together with RETA on an OSHA RFI earlier this year," he said. "That kind of coordinated response is so important because it shows that the recommendations we put forward have support from a broad segment of our industry."

Looking forward, this year's conference set IIAR up to pursue a number of exciting projects and work goals, thanks in no small part to the hard work of its staff and membership, said Leighty.

We're thankful for "the talents and resources that our members bring to this organization, especially the effort of all of our staff in making such a large event a great success," he said.

"We're getting ready for another great show in San Diego next year," he said. "And we're excited to carry the energy of our sponsors, exhibitors and members into the next IIAR event."

IIAR's 2015 Industrial Refrigeration Conference & Exhibition will be held March 22 – 25 in San Diego, California.

IIAR Names Member of the Year, Honorary Life Member

MEMBER OF THE YEAR

IIAR recognized its board member, Tom Leighty, by naming him Member of the Year in 2014. The Member of the Year award is usually given to one recipient a year in recognition for outstanding service to the organization. "Tom is an enthusiastic and dedicated volunteer who has contributed so much to the success and growth of our organization," said IIAR president Dave Rule.

Leighty was recognized for his over 20-years of service on IIAR's Standards Committee, which recently culminated in the release of the IIAR-2 standard, the cornerstone of IIAR's new suite of standards, for its first public review. Leighty leads the sub-committee in charge of the development of IIAR-2.

"Tom has given so many years of service to this organization and he has been instrumental in the development of IIAR-2, which is a significant milestone for our organization," said Rule. "Tom is passionate about this industry and passionate about this organization, so we are honored to recognize him for all of his work."

The Member of the Year award is given to individuals who make outstanding contributions to the ammonia refrigeration industry through their service to the association over the preceding year.

"This is a significant award, and it's hard to choose just one member every year to receive it. We chose Tom this year to recognize his substantial work on IIAR-2, but also to thank him for the many years he has worked in service of this organization," said Rule.

IIAR Chairman Marcos Braz (right) and President Dave Rule (center) present Tom Leighty (left) with IIAR's Member of the Year award.

Bruce Badger thanks IIAR after being named an IIAR Honorary Life Member.

HONORARY LIFE MEMBER

IIAR's 2014 honorary life member, Bruce Badger, was recognized by IIAR for the constant work he has done on behalf of the industry while holding several leadership and volunteer positions. The honorary life membership award is given by IIAR to members whose service extends well beyond their traditional terms of office and who have made contributions that have a lasting impact on the industry.

"Bruce has done so much to further the goals of our organization and our

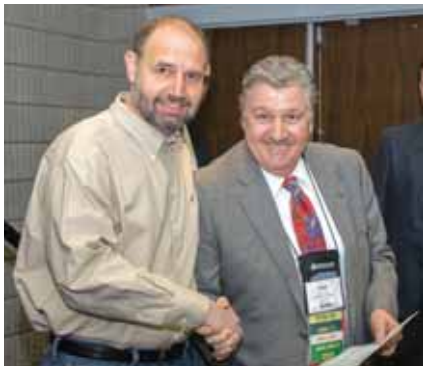
industry," said IIAR president Dave Rule, pointing to Badger's years as president of the association and his work as a volunteer member.

"He has made an incredible contribution both as a volunteer and as our past president. That dedication helped IIAR grow into the organization it is today. He took a leadership position at headquarters when the association was experiencing difficulty financially and he set it on a strong financial footing," said Rule.

"Bruce was able to give our organization the momentum it needed to grow into a very positive organization with strong prospects for growth."

IIAR Award for Presentation Excellence Winners Recognized for Technical Paper Contributions

The IIAR Award for Presentation Excellence, for the 2014 IIAR Industrial Refrigeration Conference & Heavy Equipment Show was presented this year to Peter Jordan of MBD Risk Management Services, Inc. and Alessandro da Silva of Bitzer. The IIAR Award for Presentation Excellence, formerly the "Andy Ammonia" award is determined based on the results of the technical paper evaluation forms completed by those who attend technical paper sessions. Jordan won the award for his paper, Layers of Protection in an Ammonia Refrigeration System. The purpose of the paper was to describe the use of Layers of Protection Analyses (LOPAs) to analyze specific scenarios in two ammonia refrigeration systems. The LOPAs were able to formally analyze the reliability of these systems and, to a certain extent, produce results which can provide guidance throughout the industry. Meanwhile, Alessandro da Silva won the award for his Spanish language paper, Una visión general de la aplicación de CO_2 en supermercados en Brasil. The paper gave an overview of experience obtained from the application of CO_2 in refrigeration for supermarkets in Brazil.



Peter Jordan and Alessandro da Silva are presented with the IIAR Award for Presentation Excellence

Board of Directors

First Row Seated L-R: Linda McDaniel, Walter Teeter, Tom Leighty, Marcos Braz, Mark Stencel, Harold Streicher, Eric Johnston, Dave Rule

Second Row Seated L-R: David Blackhurst, John Collins, Bent Wiencke, Jim Adler, Trevor Hegg, Paul Bishop, Doug Reindl, Dave Schaefer

First Row Standing L-R: Delmar Lehman, Don Stroud, Don Hamilton, Bruce Nelson, Brian Marriott, Bob Czarnecki, John Gay

Not Pictured: Robert Port, Jr., Martin Timm, Michael Lynch, Jeremy Klysen, Jeff Welch

Place Your Bets

THE HFC PHASEOUT AND THE FUTURE OF NATURAL REFRIGERANTS

Refrigeration technologies like synthetic replacements for HFCs, low charge ammonia and CO_2-based systems are growing like never before ahead of a planned phaseout of R-22 in the United States.

And although most players in the industrial refrigeration industry have been taking a hard look at replacements for refrigerants targeted by the Environmental Protection Agency for many years, they may no longer have much time to decide which new technology is their best bet for the future.

Several new signs from the regulatory environment are pointing to a timeframe that calls into question the viability of a "wait and see" approach, removing the prospect of a more gradual transition or a temporary switch to HFC refrigerants not yet targeted for phaseout.

In California, new regulations – which the Obama administration has said will serve as a model for the U.S. phaseout – have made the continued use of R-22 and future use of HFC-based refrigerants all but impossible.

Meanwhile, U.S. involvement in international agreements like the Montreal Protocol, indicate that regulators are planning to closely replicate the accelerated timetable seen in the European Union.

Whether it's a move toward synthetics or an investment in natural refrigerants, one thing is clear: companies should plan now for an HFC phaseout that could happen much faster than expected, or risk the expense and downtime of an unplanned transition later.

If California is the model for the rest of the country when it comes to the HFC phaseout, the rest of the industry should take notice, said John Scherer, manager of engineering for Los Angeles, Calif.-based LA Cold Storage. "Right now, if you're using over 50 pounds of HFC or HCFC refrigerants in the state, you're subject to some very strict regulations."

"It's a juggernaut in this state. There is no specific phaseout [for refrigerants other than R-22], but there might as well be, because compliance is something very hard to attain and the consequences of not complying are very high," he said. "We're working with people everyday who say 'I can't do this anymore' and they're converting to small charge ammonia systems."

The nationwide R-22 phaseout is still the only program with a set timeframe, with the EPA's published schedule calling for an end to R-22 production by 2020. The lack of a published timeframe for HFC refrigerants, however, should not be seen as a sign that their phaseout schedules will be long, or will happen in the same way, said Derek Hamilton, U.S. Business Development Manager Azane Inc, the US subsidiary of Star Refrigeration.

"A large portion of the refrigeration industry is waking up to the fact that this is really happening.' They didn't take the R-22 phaseout seriously enough, and now they're making decisions on a timetable they are not comfortable with. The message here is to take the HFC phaseout seriously. It's going to happen, and there are signs that the U.S. is moving more quickly than people really expected," said Hamilton.

And regardless of how quickly or stringently the U.S. moves to phaseout HFCs, making a non HFC-based technology decision to replace them is the only real option for industrial refrigeration in the United States," said Jerry Von Dohlen, president of Newark & Port Newark Refrigerated Warehouses, adding that as a practical matter it makes no sense to replace an R-22 system with an HFC system that itself may need to be replaced a few years down the road.

"No one in their right mind should make the decision to jump out of the R-22 frying pan into the HFC fire, because they'd be spending a lot of money to get there and would have nothing to show for it long term," said Von Dohlen.

"We must go to ammonia or CO_2. With HFC [replacements for R-22] you're just buying a small amount of time for a lot of cost and not much efficiency. We've come full circle and the only viable system is ammonia and ammonia CO_2," he said.

While manufacturers and end users who have long relied on ammonia and CO_2-based systems see them as the obvious best choice, synthetic refrigerant replacements with zero global warming potential may also gain a foothold in the race to find the best technology to adapt to a phaseout, if chemical companies are successful in developing them fast enough.

John Galiher, CEO of Preferred Freezer Services, said that his company is leaving the door open to the possibility of such refrigerants, by planning for an HFC phaseout responsibly but not making the conversion of some of the company's older facilities just yet.

"We're experimenting with some of the better HFC replacements," he said. And like many companies faced with the phaseout decision, Galiher doesn't see ammonia or CO_2 as the only option.

"We're embracing all the latest technologies. Every facility we've built was designed to run on ammonia knowing that [an HFC phaseout] could happen one day. We don't have to convert yet, so why rush? The technology is changing so fast we're not ready to commit yet," he said.

As an industry, "we're rethinking modern and future ammonia designs," said Galiher. "There's a race among system designers and equipment manufactures completely centered on smaller more efficient and safer systems. You can see that happening in all the designs. Whoever comes up with the best balance of cost effective environmental friendliness and efficiency is going to win that race."

Nevertheless, a bet on synthetic refrigerant-based systems may bring its own challenges, said-Azane's Hamilton, who pointed to EU regulations that all but specify the use of natural refrigerants.

"Speaking from the experience we're seeing in Europe – going from R-22 to [synthetic] HFCs and then to natural refrigerants such as ammonia – there is a clear pattern in the direction of the legislation. Every time the legislation is catching up [to replacements with lower global warming potential], and every time, the threshold for an acceptable global warming potential is lowered. Those thresholds are decreasing and decreasing. It's only a matter of time until you need to move to natural refrigerants," he said.

"Even if there is [a synthetic zero-gwp HFC replacement] that comes on the market, we firmly believe that it's only a matter of time that the industry and the government will push towards natural refrigerants. Everything else is just a stepping stone," said Hamilton.

While a number of new blend refrigerants are coming on the market that may address the global warming potential issue, they also come with concerns surrounding issues with performance, application, toxicity and blend separation, said Dave Rule, IIAR president (turn to page 30 in this issue of the Condenser for a practical overview of the implications of replacing an HFC system.)

"As the EPA begins to step up its program to eliminate the use of high global warming potential refrigerants, virtually everyone dealing with refrigeration will be faced with some difficult decisions over the next five to ten years," he said.

And natural refrigerants will play a key role in many of these decision processes. "With the introduction of new equipment technology, new design concepts and low charge ammonia systems coupled with secondary refrigerants, our industry will have new opportunities to apply these systems in applications that have never been considered in the past."

The race to develop zero-global warming potential synthetic refrigerants and make ammonia and CO_2 systems more efficient and safer than ever before may not be over, but it is already opening the door to new applications for natural refrigerants and bolstering the U.S. market for small charge systems.

"The low and very low charge systems are going to revolutionize the application of ammonia," said LA's Scherer. "They're below the EPA thresholds," for regulations that have the biggest impact on the industry and new designs will offer major advances in efficiency both within the industry and in non-traditional applications, he said. "We're really gaining steam on this. It's something that's going to happen in a big way."

Azane's Hamilton agreed, saying the huge potential market for low charge systems is the reason that his company has started to manufacture Star's low charge ammonia technology in the U.S.

As the U.S. industrial refrigeration industry plans for its future, it would be well served to look to world-wide trends, specifically in places like Australia and Europe where regulations are prompting a shift towards ammonia and other natural refrigerants, said Newark's Von Dohlen. "Our country is not the only one progressively pushing towards natural refrigerants. Literally the whole world is making the change; this is where the world is going."

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IIAR Builds Coalition to Comment on Proposed PSM Changes

iiar government RELATIONS

BY LOWELL RANDEL, IIAR GOVERNMENT RELATIONS DIRECTOR

The Obama Administration continues its work under the Executive Order entitled: Improving Chemical Facility Safety and Security that was signed in August 2013. One of the key issues for IIAR is a Request for Information, RFI, issued by OSHA addressing potential changes to Process Safety Management, PSM, regulations.

In response to the RFI, IIAR established a task force to examine the proposal and identify potential areas of concern. The task force developed a set of detailed comments that were submitted to OSHA in March. IIAR reached out to partner organizations to build a coalition around the comments.

As a result of these efforts, the Global Cold Chain Alliance, International Association of Refrigerated Warehouses, American Meat Institute, American Frozen Food Institute and Refrigerating Engineers and Technicians Association joined with IIAR in submitting the comments.

Below is a summary of some of the key changes proposed by OSHA and the coalition's response:

OSHA Proposal: Revising the PSM Standard to Require Additional Management-System Elements

Executive Order 13650 requires OSHA to "identify issues related to modernizing the PSM standard." When OSHA promulgated the PSM standard in 1992, the standard adopted management-system elements based on best practices from industry at the time.

However, best practices have continued to evolve since 1992 and additional management-system elements may now be recognized to be necessary to protect workers. In the RFI, OSHA sought public comment on additional management-system elements that would increase worker protection if required under the PSM standard.

Coalition Response:

The coalition commented that revising the PSM Standard to require additional management-system elements raises a number of questions and concerns. Because the PSM Standard is supposed to be performance-based, we are opposed to requiring specifying management-system metrics required by those subject to the standard.

Requiring facilities to use and share metrics is more prescriptive than a performance-based standard should mandate. In addition, the PSM Standard already includes management practices in almost all elements.

OSHA Proposal: Amending Paragraph (d) of the PSM Standard to Require Evaluation of Updates to Applicable Recognized and Generally Accepted Good Engineering Practices (RAGAGEP)

The current PSM standard requires employers to document that covered equipment complies with Recognized and Generally Accepted Good Engineering Practices, RAGAGEP. However, the PSM standard does not require employers to evaluate updates to applicable RAGAGEP or to examine new RAGAGEP after evaluating and documenting compliance with current standards.

OSHA invited comments on the best approach to revising paragraphs in the PSM standard to require employers to evaluate updates to applicable RAGAGEP that could help prevent or mitigate accidents.

Coalition Response:

The coalition responded that IIAR standards represent the most applicable RAGAGEP for the ammonia refrigeration industry. These standards should be the primary source material for OSHA inspectors in ammonia refrigeration facilities. However, it is important that facilities maintain the flexibility to define the RAGAGEP for their facilities. The addition of a requirement to evaluate updates to applicable RAGAGEP is not necessary.

The Management of Change, MOC, and Process Hazards Analysis, PHA, sections of PSM and RMP are sufficient to identify risks without a stand-alone requirement for evaluation of RAGAGEP.

Furthermore, it is likely impractical for covered facilities to update all processes to maintain conformance with current standards without any other changes in design. 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.

Adoption of requirements of a revised code or standard at a specific facility should still be left to the determination of the facility.

OSHA Proposal: Clarifying the PSM Standard by Adding a Definition for RAGAGEP

The term RAGAGEP is mentioned in the current PSM standard, but it does not provide a definition. OSHA has requested comment on whether inclusion of a RAGAGEP definition would be appropriate.

Coalition Response:

The coalition agreed that adding a definition for RAGAGEP could be useful to help owners better understand requirements under the standard. A definition for RAGAGEP may also be helpful in reducing the instances of OSHA inspectors citing standards that are not as applicable to a given type of facility.

For example, there have been occasions where OSHA inspectors have applied other industry standards to

continued on page 18

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IIAR Builds Coalition to Comment on Proposed PSM Changes

ammonia refrigeration facilities. Better defining RAGAGEP can reduce the misapplication of standards by inspectors and facilitate better understanding and application by facility owners.

A definition of RAGAGEP should include methods and "whys", but not go so far as how to do something like inspect, which becomes a maintenance procedure. A definition of RAGAGEP should not take away the ability of a facility to identify which RAGAGEP they are applying to their operations.

OSHA Proposal: Expanding the Scope of Paragraph (j) of the PSM Standard to Cover the Mechanical Integrity of any Safety-Critical Equipment

The current PSM standard requires employers to implement an ongoing mechanical-integrity program with respect to their PSM-covered processes. OSHA sought comment on whether all equipment the employer identifies as critical to process safety-critical equipment should be covered under mechanical integrity.

Coalition Response:

The coalition responded that conceptually, the proposal to expand the coverage of the mechanical integrity element to all safety-critical equipment seems reasonable. For the ammonia refrigeration industry, covered facilities already must identify components, controls and PM frequency for them in accordance with OEM recommendations. In addition, IIAR is currently working on IIAR-6 that will be designed to specify the mechanical integrity requirements for all safety-critical equipment in an ammonia refrigeration system.

However, for such a change to be effective, a workable definition of "safety-critical" must be developed. The determination of what is safety-critical can be subject to broad interpretation.

For example, the loss of any utility within the control of the owner could be construed to represent a significant risk to the process, even when the process is designed to safely shutdown on a loss of utilities. However, there would likely be no special requirement for the utilities out of control of the owner.

OSHA Proposal: Expanding the Scope of Paragraph (l) of the PSM Standard with an Explicit Requirement that Employees Manage Organizational Changes

The existing PSM standard does not explicitly state that employers must follow management-of-change procedures for organizational changes, such as changes in management structure, budget cuts, or personnel changes. OSHA requested comment on whether organizational changes should be included in the standard.

Coalition Response:

The coalition's response stated that there is some merit in expanding the Management of Change requirements to include organization changes, as long as there is clear guidance on what organizational changes qualify. We believe that the majority of organizational changes do not rise to the level of requiring inclusion in Management of Change. In the spirit of performance based standards, facility owners should be given a sufficient level of flexibility to design their own programs to meet the requirement.

OSHA Proposal: Revising Paragraph (n) of the PSM Standard to Required Coordination of Emergency Planning with Local Emergency-Response Authorities

OSHA has suggested that revising the PSM standard to require facilities to coordinate emergency planning with local emergency-response authorities could help prevent or mitigate accidents by allowing first responders to develop the appropriate strategies in advance of their arrival. The agency sought comment on how this could be achieved.

Coalition Response:

The coalition agreed that coordination with local emergency planning and response authorities is an important aspect of safety. Such coordination is already specifically required through EPA regulations such as Hazard Communication, Emergency Action and HAZWOPER. As a result, there is not a direct benefit of OSHA adding this recommendation into the PSM code.

Rather than additional regulations to PSM, OSHA should reference other federal codes applicable to emergency response such that there is not a burden created if one code is updated while another is not. This could cause contradiction and complexity/confusion for implementation. We believe the proposed change is a duplication of efforts by regulatory bodies.

OSHA Proposal: Revising Paragraph (o) of the PSM Standard to Require Third-Party Compliance Audits

The current PSM standard requires facility audits every three years, but does not specify who should conduct the audits. OSHA is proposing to require these audits be done by third parties.

Coalition Response:

Compliance audits are useful tools for evaluating a facility's safety. However, IIAR is concerned about the intended definition of "third-party." Third-party audits should not be limited to hiring outside personnel to perform the audit. Facilities should have the flexibility to choose external parties as well as utilize internal safety experts from other facilities or corporate headquarters to perform audits.

In addition to responses directly related to questions raised in the RFI, the coalition also raised the importance of investments in training and safety. Currently, penalties associated with citations result in payments going directly to the U.S. Treasury. Under this system, funds associated with citations are purely punitive and end there.

IIAR strongly believes that these resources would be better placed by directing them to investments in training and upgrading safety programs. Such a mechanism would facilitate a greater engagement between companies and the agency in addressing deficiencies and developing stronger safety programs.

The RFI represents a first step towards regulatory changes to PSM. OSHA will need to initiate a formal rulemaking process that would likely include a proposed rule where further public comment would be solicited. This can be a lengthy process, but given the high priority placed on the Executive Order by the Administration, additional agency actions are expected. IIAR and its partners will continue to work closely with OSHA and other relevant federal agencies as implementation of the Executive Order continues.

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Learning a Valuable Lesson About Experience

BY KEM RUSSELL

We can all learn some valuable lessons from other people's challenging experiences, and those lessons are even more important when they help others prevent future accidents.

Astronaut Mike Mullane, who spoke at the March 2014 IIAR Conference, had a lot to say about learning safety lessons from experience. In his presentation, Mike outlined the problems that can occur when "normalization of deviance" causes oversights that lead to horrific accidents – like the space shuttle Challenger disaster – even in environments where people have huge amounts of safety experience.

The lesson learned in these situations, it turns out, is not about the factors that create safety, but rather how vigilant we are in remembering their importance.

Another way we can look at this concept is by thinking about safety in terms of "experience complacency." In this column, I'll describe two experiences, one outside and one inside the ammonia refrigeration industry that illustrate how experience complacency can lead to trouble.

As a volunteer Search and Rescue responder in one of the nation's most rugged wilderness areas, I often see the consequences of experience complacency firsthand. In one case, I was involved in a search and rescue effort to find a missing long distance hiker eight days after she went missing.

She had walked over 2,200 miles in about four months and had reached a resupply location where she stopped to check in with family members and restock supplies.

This is where she made her first oversight, one that was entirely due to the kind of confidence that puts experienced people in harm's way when they are dealing with the kind of routine judgment calls they make every day.

While at the small resupply town, the hiker called her father to check in. He mentioned that the weather was changing and a storm was coming. Her response was, "no problem Dad. I've been wet before and I've just hiked over 2,200 miles. A little rain storm isn't going to stop me!"

At this point, it's interesting to note that rather than prompting just one risky decision, experience complacency happens when confidence in experience prompts a person to make several small bad decisions, or ignore a string of small clues that the developing situation is out of the norm.

The next day another man spoke to the hiker about the coming storm, but she again said she would be fine. That afternoon, she got a ride up to the trail and with a light rain falling, headed out. Those who dropped her off wondered how she was going to do in the rain and with a storm on its way, but she was a long distance hiker, she should know what she's doing, right?

The answer is actually yes, she did know what she was doing, *just not in this situation*, and her own experience prevented her from seeing the very warning signs an experienced hiker should see, precisely because they came slowly, as a series of small decision points.

The next day, the weather was still wet, and as she gained elevation, it got progressively worse. By early afternoon, as the rain mixed with snow made hiking further that day a bad idea, she set up her tent, crawled into her warm sleeping bag and tried to sleep as the weather beat down.

But the next morning, she opened the tent to step outside and found three feet of new fallen snow. After four months of effort, hiking in the heat, the rain, the wind, at low and high elevation she knew she would not be going any further.

After that, the weather remained bad for several more days before it finally started to improve. By now, the hiker was at serious risk, with no way to call for help. A helicopter was even sent into the area to rescue another group of hikers, but no one knew she was near.

Throughout the week, other aircraft searched for her, but could find no trace of her presence on the mountain. Finally after seven days, she decided to head across country searching for a way to a lower elevation.

After a struggle through deep snow she made it below the snow line and reached a forest service road where a man riding a motorcycle found her and directed her to a search and rescue vehicle less than a fourth of a mile away.

On entering the search and rescue command post, she ran to her father with words I won't soon forget, "Dad, I thought I was going to die! I thought I was going to die!"

Our hiker's experience over the previous several months had shown her she could do some amazing things. She could walk thousands of miles, handle rugged mountain terrain, and keep going when she was hungry and thirsty. It had also shown her the very real danger of experience complacency.

She had become complacent due to her past experience, and too confident in what she could handle. With a storm coming, she had ignored the signs and suggestions from other people, a level of complacency that nearly cost her life.

At the surface, this example of an overconfident hiker may seem like it stands alone, simply as a warning of the limitations of any human in a threatening environment. But our hiker was extremely experienced, not unlike the professionals at mission control in the days leading up to the Challenger disaster.

Looking closer, this is a lesson on the importance of vigilance, and never taking experience for granted, in any field. Experience complacency can set in anywhere.

Now let's look at an incident that occurred within the ammonia refrig-

eration industry. In this case, a new employee was moved into the refrigeration department at a large ammonia facility. Being new to refrigeration, his responsibilities would be limited until he was properly trained and had sufficient experience.

The more experienced refrigeration personnel on staff began educating the new guy on how to properly perform some of the commonly required tasks, one of which was the draining of oil from oil pots.

At this point, the new employee's training was being carried out correctly. There was a written oil pot draining procedure, which the new employee was required to read and understand. After that, he observed one of the experienced refrigeration men perform the oil drain procedure then under supervision he did the procedure himself.

As the training process went along, this newer refrigeration employee finally became qualified to perform the oil pot draining procedure without supervision. He had the training, he had done the procedure himself while under supervision and he felt confident he could do it alone.

However, as he began to perform the oil draining procedure, he neglected to follow important steps in the written procedure on which he had been trained. In other words, *he didn't have experience with his own experience*.

Again, several errors, all caused by complacency, combined. He did not wear the appropriate personal protective equipment, then he opened the incorrect sequence of valves applying higher than recommended pressure to the oil pot. Finally, when he incorrectly opened the drain valve, the pressure in the oil pot blew oil and ammonia out of the drain valve covering one of his hands.

He suffered blistering to his thumb, forefinger, mid-finger, and the back of his hand. Again, experience complacency almost cost a life. He was very lucky blistering is all that happened.

So what's the lesson learned from these two stories? The answer is that whether a person has weeks, months, or years of experience, becoming complacent is far too easy.

Not following safety procedures exactly, in every case, in any field where missteps can end in real harm, can lead any person with any level of experience to ignore the signs and warnings of potentially serious situations.

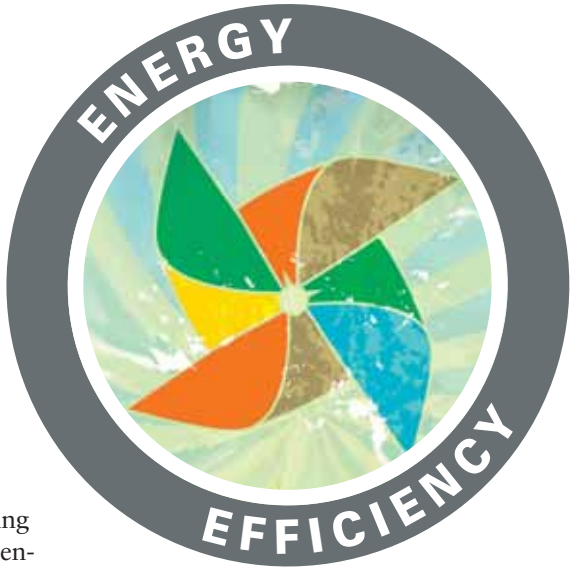
In a nutshell, experience inappropriately applied or ignored can be dangerous.

If we accept that simple idea, we don't have to make mistakes ourselves to learn. We can learn from the experiences of other people, and remember the importance of doing the right thing no matter what, even if our own experience tempts us to consider deviation from the norm.

One of the great men in ammonia refrigeration was Mr. Milton Garland. Mr. Garland worked in our industry for many decades, and he credited his long life (he was over 100 years old) to the fact that he "never did anything stupid."

Experience complacency can lead to a series of bad decisions that can hurt you or those around you. Don't be the one with the story. Don't make your experience one where you say, "I thought I was going to die!"

Look to Set Points to Boost Efficiency



In a large facility, it goes without saying that increasing overall efficiency will save large amounts of money every year in operating cost. But that savings is often dependant on implementing, and following up on, several best practices in myriad different places throughout a system.

When margins are tight, there are many ways to increase overall efficiency, reaping energy gains without a capitol investment.

To figure out how to implement an energy savings plan without an investment, that will result in a meaningful impact on the bottom line, Keith Nienhaus, project manager at Hixon Architecture, Engineering, Interiors, recommends starting small: by taking a close look at system set points to find sustainable ways to get more out of your energy dollars.

Nienhaus' recommendations, which are outlined below, were given during a recent webinar hosted by Food Engineering Magazine, entitled "Saving Energy Without a Capitol Investment."

In any facility, energy comes in various forms and is used at different quantities, so the first step in finding potential savings is to figure out where any excess energy is being used.

According to a Hixon poll, the areas of steam process and refrigeration were the top areas where energy conservation opportunities were the greatest.

Within these areas, Nienhaus said, managers should prioritize the evaluation of set points, or system operating points, with the goal of identifying the minimum thresholds required for different utility systems, and running them no higher than absolutely necessary.

For compressed air, said Nienhaus, "the rule of thumb is that each two PSI reductions are going to give you about a one percent increase in your system efficiency."

In the case of a steam system, in a dairy facility for example, that small savings can add up. Nienhaus cited one such facility that reduced steam system pressure by 20 PSI to save over $30,000 in one year, just by changing system set points.

For a refrigeration system, paying close attention to condensing temperature can lead to the biggest payoffs. The rule of thumb here is that decreasing ammonia refrigeration system condensing temperature by just one degree Fahrenheit, results in a one percent efficiency gain, said Nienhaus.

However, "if you're trying to lower your condensing temperature and you can't get it any lower than it already is, that could be due to a number of things."

In that case, looking deeper may reveal other reasons for an inability to lower condensing temperature. "Maybe you have non-condensables in the system, scaling on your condenser coils, or a fan or pump that's not operating and you didn't realize it," he said.

If non-condensables are found, that's something that can easily be taken care of with an auto purger, a piece of equipment which is often overlooked.

"If you don't have an auto purger, we strongly recommend adding one, and if you do, make sure it's functioning," said Nienhaus. "They tend to be one of those items that sits on a wall and everyone assumes it's doing what supposed to do, but oftentimes we'll be in a facility and we'll take a look at it and see it hasn't been functioning in years, so if you've got it, make sure it's working."

Another important refrigeration system operating point that deserves special attention is suction temperature. Raising the suction temperature just one degree Fahrenheit will yield a two percent increase in system efficiency, said Nienhaus.

He added that facilities should look at smart ways to accomplish that goal, for instance, by varying temperature according to off-production times.

"Even if you can't raise that suction temperature year round due to the product you're handling, you have non-production times – say weekend evenings or even holidays – that can be valuable windows for savings."

In fact, any non-production times represent opportunities to raise the suction temperature and earn energy savings until a facility gets back into production. Here, "a refrigeration system can be a big energy hog, so again, that little percentage can add up to some big money."

Nienhaus also pointed to hot water temperature and room air temperature as areas where monitoring set points can pay off.

"Again, with your hot water system, you should run it as low as possible," he said, adding that although temperature thresholds are typically driven by sanitation requirements, facilities often run hotter than necessary.

And when it comes to cooling, "don't keep rooms any colder than they need to be," he said. "Typically process and production requirements drive temperature requirements, especially for rooms like freezers, coolers and production spaces. If you take a hard look at those room temperatures, you may find you can run at a slightly higher temperature than you have been for years, so take a hard look at those room temperatures."

"Just because something has been running a certain way for years, that's no reason not to question it," he said. "Don't let complacency stop you from looking for some easy energy savings."

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Brazil Event Highlights New Technologies

BY CHRIS COMBS

A group of Brazilian associations including ASHRAE's Brazil Chapter, ABRAVA, ASBRAV and ANPRAC held a seminar on industrial and commercial refrigeration in the city of Porto Alegre, Brazil, April 2-3.

The program focused on three main areas the organizers wanted to highlight for Brazil's refrigeration sector: safety in refrigeration installations and the corresponding standards, the commissioning of refrigeration installations and new technologies that utilize natural refrigerants, including CO_2 and HC's.

In 1997, and then again in 1999, ABIMAQ (the Brazilian Association of the Machinery and Equipment Industry) hosted an industrial refrigeration workshop in São Paulo, Brazil. IIAR was represented at both events by the author of this article and with technical presentations from two distinguished IIAR members including Ron Cole at the first event and the late Don Siller at the second. Since these two meetings, there has been a significant lack of technical events for Brazil's refrigeration sector.

According to ASHRAE Brazil Chapter President Mario Alexandre Möller Ferreira, the idea of "&R" comes from the acronym "HVAC&R." He points out that many of the associations representing this sector often overlook the "R." So the intention of the "&R" event was to reaffirm the importance of refrigeration and revive the discussion of several important subjects related to it in the region.

Recognizing IIAR's important work in the refrigeration sector, the ASHRAE Brazil Chapter reached out to IIAR to support and participate in the 2014 meeting. The local organizers believe this will represent a revival of the refrigeration workshops held in Brazil in the late 1990s, and always in collaboration with IIAR.

One of the local associations, ASBRAV (the Brazilian Association of Refrigeration, Air Conditioning and Ventilation), expects that the event will be held annually from now on with the support of entities like ASHRAE, ABRAVA, universities and industries of the sector, and IIAR.

The recent event in Porto Alegre was a success and exceeded the expectations of the attendees that filled the event room of the Deville hotel in Porto Alegre for the presentations. There were about 200 participants, including technicians and engineers from the refrigeration industry, university professors as well as end users from the many meat packing plants in Brazil's southern region.

Recognizing IIAR's important work in the refrigeration sector, the ASHRAE Brazil Chapter reached out to IIAR to support and participate in the 2014 meeting.

Brazilian and international speakers participated in the program consisting of fourteen technical presentations as well as five technical panels or debates on key themes of the meeting (safety, standards in Brazil and where they are headed, new requirements for new systems and commissioning and new refrigeration system technologies).

Safety, reduced charge ammonia installations and the application of HCs and CO_2 stood out at the event. Representing ASHRAE, Doug Reindl of the University of Wisconsin began the technical program speaking about refrigerant inside and outside of the machinery room, showing various important application examples. In a second presentation, Reindl gave an overview of ANSI/ASHRAE Standard 15 while pointing out the latest revisions and updates.

IIAR Chairman Marcos Braz made three separate presentations related to the central themes of the meeting. First, he outlined the requirement for mechanical refrigerating systems with ammonia according to ANSI/IIAR Standard 2-2008. Then he presented a detailed case study of a retrofit in which an R22 system was replaced with a reduced ammonia charge air cooled DX ammonia/glycol unit applied for air conditioning for the 25,000 square foot commercial offices of a large supermarket chain.

The compact skid mounted unit was charged with less than 45 kg of ammonia, having a higher COP than the R22 system it replaced, provided economic benefits to the facility while meeting important design requirements in terms of safety, low charge and reliability, not to mention environmental sustainability.

The new IIAR Chairman's final presentation covered the topic of start-up and commissioning as described in ANSI/IIAR Standard 5-2008 and concluded with a shorter discussion of ANSI/IIAR Standard 7-2013 on the development of operating procedures. Braz pointed out that although the requirements of the latter standard help support compliance with PSM and RMP, they are recommended for any country.

Tomaz Cleto, director of Yawats Engenharia, Engineering, and the President Elect of the ASHRAE Brazil chapter, rounded out the discussion of standards with a presentation about

continued on page 26

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the Brazilian standard ABNT NBR 16069:2010 on refrigeration system safety. He followed that with his talk covering ASHRAE's guideline on commissioning refrigeration systems.

Besides IIAR, one other international organization –GIZ– supported the "&R" Workshop. GIZ is the German corporation managing much of the German government's international development and cooperation initiatives worldwide, including the Proklima program which promotes environmentally friendly cooling technology worldwide on behalf of Germany's Federal Ministry for Economic Cooperation and Development, BMZ, and the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, BMUB.

GIZ's Rolf Huehren discussed the safe use of hydrocarbons in refrigeration; and made an additional presentation on the application in supermarkets, providing several examples from European manufacturers.

Hernan Hidalgo of Danfoss presented "Trends with Natural Refrigerants in the Global Cold Chain" including a discussion of the several refrigeration components available in the market. John Ritmann of Bitzer spoke about ammonia refrigeration systems and highlighted the launch of an ammonia refrigeration package using multiple screw compressors.

Carlos Suffert of SPM Engenharia, Engineering, surveyed experiences with HCs in the commercial or supermarket, and industrial sectors using practical examples. Jose Castro Chagas, Industrial Director for JCI Latin America, discussed the application of CO_2 in industrial refrigeration, also providing practical examples.

Finally, Alessandro da Silva, a specialist in natural refrigerants, discussed the evolution of the application of CO_2 in both the industrial and commercial sectors in Brazil. Coincidently, Alessandro won the "Andy Ammonia" award for presentation excellence for his presentation of this topic that was among the papers published in Spanish for the Industrial Refrigeration Conference in Nashville.

Developing Guidelines for Smaller Facilities

The ammonia refrigeration industry continues to experience an increase in enforcement activities that utilize OSHA's General Duty Clause, specifically in facilities with less than 10,000 pounds of ammonia, where OSHA expects process safety-like standards to be in place.

While larger facilities – those that use less than 10,000 pounds of ammonia – have long been subject to formal federal safety requirements, the question of how to develop guidelines that work just as well for smaller systems, those under 10,000 pounds, has often been a murky issue.

The consequences of an operation-related incident are not murky. When it comes to safety, prevention is the most important factor in avoiding those potential consequences. Whether a facility is working with 900 pounds or 90,000 pounds of ammonia, the risks of an incident are similar. The severity of a potential problem could be less with a smaller facility, but the risk is still there.

As the industry sees a greater prevalence of smaller systems put on the market to replace synthetic refrigerants, as well as increasing OSHA awareness of the potential hazards of those systems, industry safety practices go a long way in protecting the reputation of smaller facilities.

For example, a smaller facility may not see the level of off-site consequences an incident at a larger facility would see, but it would certainly face on-site consequences, an outcome no company can afford, especially when such an incident could prompt local news media coverage.

Given those challenges, how should a small ammonia refrigeration facility determine the practices that are the most efficient for its own operations in the face of so much conflicting and often redundant information about safety practices that may or may not actually apply to smaller operations?

The Ammonia Refrigeration Management Program, a program built by the International Institute of Ammonia Refrigeration, helps small facilities answer that question by helping them develop a good safety plan focused on prevention.

Traditionally, larger ammonia refrigeration facilities – with charges greater than 10,000 pounds – have been required to comply with OSHA's Process Safety Management Program and EPA's Risk Management Program requirements. In part because of those regulations, in place since the 1990s, the most common misconception among smaller facilities has been that they are exempt from compliance issues because the size of their charge is less than 10,000 pounds. Nothing could be further from the truth, said Larry Basel, past president of IIAR and Director of Environmental Health and Safety for the East Region at Dean Foods.

"Sometimes it's hard to determine what all those safety factors are and how they should be applied unless they are laid out according to the institutional knowledge of the industry, and that's where the Ammonia Refrigeration Management Program is an incredibly valuable tool," said Basel.

In addition to the safety and public relations considerations, there is a regulatory compliance issue for smaller facilities. The general duty clauses of OSHA and the EPA, cover every refrigeration facility, including those with less than 10,000 pounds of ammonia. These regulations can be found in 29 USC 654(a)(1) (OSHA) and the Clean Air Act Section 112(r)(1) (EPA). They set a minimum safety standard and place responsibility on employers to keep workers and neighbors safe from hazardous chemicals.

The IIAR's ARM program is one tool any small facility can use to meet the challenges posed by a regulatory environment – an environment that often delivers non-prescriptive specifications for safety. Drawing on the cumulative experience of the industry, ARM helps companies and facilities identify the specific safety practices they should pursue, answering the common question: What basic safety processes should small ammonia refrigeration facilities observe and how should they build a safety program that is suited to their unique operations?

While safe and efficient operation has always been a driving force behind the innovations of the industry, even larger companies with multiple small facilities are turning their attention to safety programs as they increasingly expand their operations beyond a central, large facility, to facilities with less than 10,000 pounds of ammonia.

As the industry continually evolves to meet the demands of a complex regulatory environment and fast-paced supply chain, the need to develop and implement ARM programs at small facilities is indeed a challenge faced by everyone in the industry, said Jim Marrella, Co-chair of the IIAR ARM task force and Coordinator of OSHA and EPA Compliance and Training for United States Cold Storage.

"The operation of a safe and efficient system is our primary goal, but over the years the definition of what exactly that means has evolved through the work of IIAR and its members as well as members of the regulatory community," said Marrella.

The ARM program is a streamlined version of the Institute's PSM/RMP compliance guidelines, he added.

The ARM Program addresses topics such as the management system, documentation, contractors, mechanical integrity, and emergency response, and simplifies the record keeping and program maintenance elements of the more complex PSM and RMP requirements.

Deep Cleaning Evaporator Coils Reduces Energy Costs and Eliminates Contamination Risks

from the technical DEPARTMENT

TONY LUNDELL, IIAR ASSISTANT TECHNICAL DIRECTOR, CIRO, PMP

When evaporator coil surfaces become coated with foreign particles, dust, dirt, pollen, bacteria, and mold, the ability to transfer heat is greatly reduced. Coils with a layer of dust the thickness of a dime lose up to 21 percent in efficiency. The build-up of these migrated or growing substances insulates the surfaces, which degrade the cooling capacities.

Living pathogens may develop, such as salmonella or listeria that could transfer to the area food processing equipment surfaces. Dirty evaporator coils increase discharge head pressures; reduce compressor capacities, increase delivered supply air temperatures, cut the system's refrigeration effect, and overall increase energy usage.

Food processing area evaporators and HVAC unit evaporators need to be deep cleaned to reduce operating costs and avoid contamination risks.

All the equipment in the area of the evaporators must be protected, checked, and cleaned after the evaporator coils deep cleaning is completed. An unfortunate issue occurred at a food plant when an overhead coil had not been visually inspected or cleaned for a period of time.

The room temperature became a challenge to meet, so the coil was visually inspected. The maintenance personnel were surprised to find the coil fins were plugged with contaminants and air borne debris. The in-house sanitation crew was scheduled to clean the coil that night during the area sanitation period and following production.

The sanitation crew cleaned the production equipment during the routine sanitation period and then they proceeded to clean the evaporator coil. Unfortunately, the coil cleaning procedure caused contaminate particles to reach the surfaces of conveyor belts below. These surfaces were only rinsed off during the cleaning process.

A few days later, an outbreak of contamination occurred, which caused many illnesses and even deaths of customers who consumed the product that touched the conveyor belt surfaces.

Deep cleaning of the coil surfaces needs to be done with trained personnel and should be completed before the production area equipment sanitation period occurs.

All production equipment must be cleaned and sanitized after the coil cleaning is done to assure the sanitation procedures are not compromised. The sanitation process needs to include a systematic approach that is proven and effective in removing surface containments that are both visible and not visible.

DEEP CLEANING

So what does it mean to deep clean? Simply put, deep cleaning allows coils to operate as designed without major losses in efficiency. For most industrial cooling systems, the process involves cleaning equipment that utilizes high-volume heated water and specialized cleaners.

It's not the pressure that is important, but the technique that is used. Small pressure washers, that use 1 to 3 gallons per minute at 2000 to 3000 psi, generally cause more harm than good. One of two things occurs: coil fins are flattened over, and due to the high pressure, that causes a further reduction in the coil heat transfer performance. From the outside, the coil appears to be clean to the first tube, but a dissection of the coil would reveal that a lack of water volume actually causes dirt to be pushed into the coil, and creates more of an impaction. The coil performance is again degraded and the risk of contamination of the production line is further increased.

Don't forget to clean fan blades and squirrel cages. Dirty fan blades can reduce up to 25 percent in airflow efficiency and allow for the contaminants and airborne particles to be spread throughout the production area.

CLEANERS

Coil cleaners fall into four basic categories: acids, alkalines, solvents and detergents. It is important to use the right chemical for the right application to ensure the coil surfaces are not damaged and to provide proper cleaning. No matter what recommendation a chemical manufacturer makes, it isn't a good idea to leave a chemical on any surface without thoroughly rinsing the coil prior to returning to service.

Continued use of caustic chemicals will shorten the useful life of your equipment. Many maintenance personnel are given the "it's a non-acid cleaner, so it's safe" line. Don't be misled by claims that a product is safe for your equipment. Rinse it, then rinse some more to protect the service life of your equipment.

PROTECTANT COATINGS

The HVAC/R industry continues to expand the use of coil coatings. Epoxy based coatings have been around for some time but a new process known as nanotechnology is making an appearance. Nano-coatings offer the advantages of: self-cleaning, antimicrobial protection, anti-corrosion and moisture control, to name a few.

Nano-coatings on HVAC/R coils look promising in extending equipment life and increasing overall energy efficiency over the life of the equipment. While the chemistry of these Nano-coats may vary, they fall into two basic categories: water attracting and water repelling.

They both have their pros and cons and ultimately depend on the end user's needs. Some coatings have added components such as zinc to inhibit microbial growth. An entire article can be written on their antimicrobial properties, but for the sake of this article, any microbial claims should be recognized by an EPA registration. For more information on nano-coatings, contact a specialized coil-cleaning contractor.

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Editor's Note

As the industrial refrigeration industry in the U.S. looks to the question of long term viability of HFCs, many are turning to the lessons learned by the industry in Europe, where the R22 phase out process is nearing completion.

Europe has set out its timetable for the phase down of HFC refrigerants, with production being cut to 21percent of current levels by 2030. Bans on the sale of new equipment into the market are due to take affect shortly and will result in a complete ban by 2022.

In the technical paper presented in this issue of the Condenser, Dr. Robert Lamb, Group Sales and Marketing Director of Star Refrigeration Ltd., offers a primer for the technical decisions and other challenges facing any facility planning for a phase out.

While utilizing systems that leverage "drop-in" refrigerants is an option, several challenges that boost the possibility of leakage include higher system operating pressure, shrinkage of existing seal and gasket materials and the general condition of plant into which the new refrigerant has been retrofitted.

The author concludes that a switch to natural refrigerants can help a company avoid the double step of moving to HFC blends and then having to switch again at a later date, while adding the benefit of improved reliability and efficiency.

R22 PHASEOUT: CHALLENGES AND OPPORTUNITIES

DR. ROBERT LAMB, GROUP SALES AND MARKETING DIRECTOR OF STAR REFRIGERATION LTD.

The phasing down of R22 production is well underway and operators are now looking for guidance on what options are available for replacing R22 in their existing systems. A wide range of 'drop in' refrigerant options are available to retrofit existing systems, typically consisting of blends of hydrofluorocarbons, or HFCs.

These have been developed to operate at similar pressures to R22 at specific operating conditions and requirements with minimal modifications to the system. Alongside these are the existing HFC refrigerant such as R404A and R507 which can also be retrofitted in R22 systems, albeit that this might require significant changes to the system design to provide the same cooling performance. Finally, there is the option to move to natural refrigerants including ammonia, hydrocarbons and CO_2. This may be possible with modifications to an existing system but in most cases, it is more cost effective to install a new plant.

At first glance, with so many options available it would suggest that the transition from R22 to an alternative fluid is going to be easy. It is only when getting into the detail that the challenges appear. Plant condition, refrigerant glide, material compatibility, oil, cooling capacity, power, leakage, down time and system pressure are just a few of the issues operators need to look into when changing refrigerant.

There is also the question of long term viability of HFCs. Fortunately, the US can look to Europe during this time of transition and take advantage of the lessons learned from their R22 phase out process which comes to a conclusion at the end

of 2014. The US should also note that Europe has set out its timetable for the phase down of HFC refrigerants, with production being cut to 21percent of current levels by 2030. Bans on the sale of new equipment into the market are due to take affect shortly and will result in a complete ban by 2022.

perature (-40°F to +50°F) and pressure.

When assessing options for an alternative refrigerant all these criteria need to be considered and there are also non-technical criteria including future legislation (e.g. HFC phase down), corporate environmental commitments (natural refrigerant policy) and the affect on the business' operation (e.g. maintaining cooling and temperatures during the change over period).

When assessing options for an alternative refrigerant all these criteria need to be considered

When The Time Comes To Change . . .

R22 refrigeration system designs differ in many ways. These include system type (e.g. pumped circulation, direct expansion), material of construction (e.g. steel, copper), equipment type (compressors, condensers, evaporators), capacity and power consumption (from a few HP to thousands of tonnes), tem-

SYSTEM DESIGN

The two most common refrigeration system designs are direct expansion (DX) and pumped circulation. Direct expansion is widely used in small to medium sized applications and has the advantages of low capital cost, low refrigerant charge and relative simplicity. Pumped circulation is typically used for medium to large scale applications with distributed pipe work and evaporators.

'Drop-In' refrigerants

The use of a 'drop in' refrigerant may be an option but the following should be considered:

Leakage – Evidence from conversions carried out in Europe suggests that HFC refrigerants are far less forgiving in terms of leakage than R22. Where systems have a history of leakage and this can't be resolved, the use of drop in refrigerants should not be considered on both commercial and legislative ground. At prices in excess of $20/lb it could be extremely expensive and it is likely that knowingly adding a replacement gas to a leaking system is contravening environmental legislation. This is certainly the case in Europe under the f-gas regulation.

Even if an existing R22 system doesn't have a history of gas loss, changing to HFCs could result in leakage. Factors contributing to this

increase risk of leakage include higher system operating pressure, shrinkage of existing seal and gasket materials and the general condition of plant into which the new refrigerant has been retrofitted.

Particular areas of concern are seals on compressors and valves which may swell when in contact with R22 and mineral oil but then shrink back to their original size or less when in contact with HFCs and the replacement oils. An overhaul and replacement of seals and gaskets should form part of any replacement gas assessment process and included into the cost of the works.

Where copper has been used for heat exchangers and piping, it is possible that this has work hardened over time and whilst the original material may have been suitably rated for R22 its strength may have weakened over time. This is of particular concern for evaporators with hot gas or electric defrost.

Oil Change – In addition to changing refrigerant, where mineral oil is currently used, experience in Europe has indicated that this should be replaced with POE oil. POE is miscible with mineral oil so it is not crucial to ensure every last drop of mineral oil is removed and the system is flushed through. But, every attempt to flush the mineral is important to remove as much as possible.

Operating Pressure – Changing refrigerant could result in higher operating pressures at design conditions due to the different properties of the new fluid. When assessing the suitability of an alternative refrigerant, consideration should be given to these new operating pressures and whether the existing system components are suitably designed. This includes an assessment of the pipe work and vessel design pressures along with thickness tests and visual inspection for signs of corrosion. Pressure relief valves should also be assessed for the new operating pressures and changed where necessary.

In addition to the theoretical assessment, strength and tightness tests should be carried out to ensure that the rating of components and pipe work is still valid. Corrosion and work hardening may well have reduced the strength of the system and its components.

Change In Capacity – Many of the 'drop in' HFC refrigerants have a temperature glide, which affects heat exchanger performance and leads to a loss of cooling capacity. Where an application is already marginal in capacity (particularly during warming summer months), moving to a drop in replacement may worsen the situation.

Application Temperature – It is crucial that the refrigerant type is matched to the application. Differing blends have been developed for low, medium and high temperature application and using a refrigerant for the wrong applications could result in significant loss in performance and damage to components.

Refrigerant Glide – R22 is a single component refrigerant which boils and condenses at a fixed temperature. Many of the replacement refrigerants are blends of fluids which boil and condense over a temperature range often referred to as 'glide'. Glide has two significant affects on system performance.

Firstly, it results in a reduction in heat exchanger performance when the original evaporator or condenser has been designed for R22. For systems where there are one or more receiver vessels (e.g. surge vessels for pumped circulation plant or high pressure receivers), it can also lead to separation of the blend components and a change in the circulating refrigerant composition. This results in a reduction in cooling capacity and performance.

Long Term Future Of HFCs – The US has followed Europe in the phasing out of CFCs and HCFC refrigerants. With Europe now adopting a timetable for HFC phase down, it is highly likely that the US will follow this lead. Replacing R22 with a replacement HFC gas may buy you time but eventually, the system will need replacing.

It has to be remembered that converting from R22 to a 'drop-in' HFC doesn't provide a new system. The same problems you've always had won't go away and in most cases, they are likely to get worse and new challenges will appear.

'Drop in' refrigerants have been viewed as temporary solutions by many in Europe, enabling the customer to continue operating the system but in the knowledge that it is only a matter of time before it needs to be replaced. They have been widely used in small to medium sized DX applications but less so in large flooded systems and rarely for pumped circulation applications.

NONE 'DROP IN' HFC REFRIGERANTS

The challenges with replacing R22 with widely used HFC refrigerants including R404A, R507 or R134a are the same as those highlighted above but there are further complications including:

Oil – It is necessary when changing from R22 to other HFC refrigerants such as R404A, R507 or R134a that all mineral oil is removed and the system flushed. This is time consuming and will add to the conversion time.

Capacity – The thermodynamic properties of these refrigerants are different to R22 and will lead to a change in cooling capacity, operating temperature/pressures, pipe work pressure drop and overall performance. It is likely that considerable changes have to be made to the system design including replacing major components (compressors, heat exchangers) and pipe work in order for the system to provide a similar cooling capacity. This typically makes conversion unattractive from a capital cost prospective.

HFC refrigerants have been retrofitted to some applications, mainly DX but in most cases either a drop in fluid is used or the entire system replaced with a new HFC plant.

NATURAL REFRIGERANTS

The uncertainty over the future of HFC refrigerants has resulted in an increased interest in the use of natural refrigerants. For small to medium scale applications (up to 50TR), hydrocarbons and more recently CO_2 have grown in popularity. In some cases, CO_2 has been used in cascade with HFC or hydrocarbon plant.

Larger scale applications have typically switched to direct ammo-

nia or ammonia with secondary glycol or CO_2. Customers have installed new equipment alongside the existing R22 equipment and carried out a phase changeover as the challenges associated with converting the existing equipment are too complicated and costly. There are some examples of reusing existing pipe work, for example where R22 has been pumped through the floor of ice rinks and has been replaced with volatile secondary CO_2 but the main refrigeration plant has been replaced.

NON-TECHNICAL CONSIDERATIONS

As refrigeration engineers, we often focus on the 'technical' part of R22 phase out but there are other challenges that need to be considered. These include:

Company Environmental Policy – A growing number of businesses of all sizes have environmental policies which will aid in determining the technical solution for R22 phase out. For example, growing number of businesses, particularly those with links to Europe, have made pledges to move towards natural refrigerants.

The uncertainty over the future of HFC refrigerants has resulted in an increased interest in the use of natural refrigerants.

Long Term Future Of HFCs – The US has followed Europe in the phasing out of CFCs and HCFC refrigerants. With Europe now adopting a timetable for HFC phase down, it is highly likely that the US will follow this lead. Replacing R22 with a replacement HFC gas may buy you time but eventually, the system will need replacing.

Conversion Period – Changing refrigerant isn't simply a case of removing the R22 and having the new solution up and running the same day. The system may be out of operation for a period of time which could range from days to weeks depending on the size and complexity. For small, simple DX system undergoing a refrigerant change, this may take a matter of days. For larger, central pumped circulation systems it could take more than a week just to remove the refrigerant.

Maintaining Production/ Storage – Where the end user has a large, distributed system it is typically the case that loss of cooling for a prolonged period (weeks or months) is not an option. For these applications a new refrigeration system is typically installed alongside the existing plant. Major equipment

items, pipework and valves stations are installed and prepared for operation before existing R22 equipment is replaced as part of a phased programme.

Two System Operating Together – The necessity to keep existing R22 plant running whilst new plant is commissioned means that two systems are often operating at the same time. This brings challenges including:

Machinery Room – There may be insufficient space in the existing machinery room for new equipment and this may mean a new room is required. It may be possible through careful planning to develop a changeover program to remove R22 plant on a phased basis to make room for new equipment. Where ammonia is being used as the replacement fluid, additional consideration has to be given in terms of the existing machinery room electrical installation, ventilation and gas detection.

Electrical Supplies – It may be necessary to provide power to the new equipment prior to decommissioning the R22 plant. The additional power to run the new and existing equipment in parallel has to also be considered and this may require the site incoming supply to be increased.

Building Structure – Where new equipment is installed in place of existing, an assessment of the existing building structure has to be carried out to determine whether steelwork is of a suitable size. In cases where new equipment is operating alongside existing R22 plant, an assessment must be also be made as to whether the building is capable of taking the combined weight of both systems.

Customer Disruption – Installing new equipment on an operational facility can be challenging. Particular attention has to be taken to times for access to production/storage chambers. Typically, this can mean out of hours working and protracted programmes with permission for access being withdrawn at the last minute to challenges elsewhere in the business.

NEXT STEPS

For customers with R22 refrigeration systems, phase out is a reality and needs to be on your agenda today. Experience is Europe has shown that those businesses who have addressed the issue of phase out early have benefited in the long term. A plan should be developed to look at alternatives to R22 and assess the business impacts in terms of capital and program.

Those customers who have switched to natural refrigerants have avoided the double step of moving to HFCs and then having to switch again at a later date. They have also reaped the added benefit of improved reliability and efficiency.

The key is to plan early and ensure the R22 phase out is built into your business plans as early as possible.

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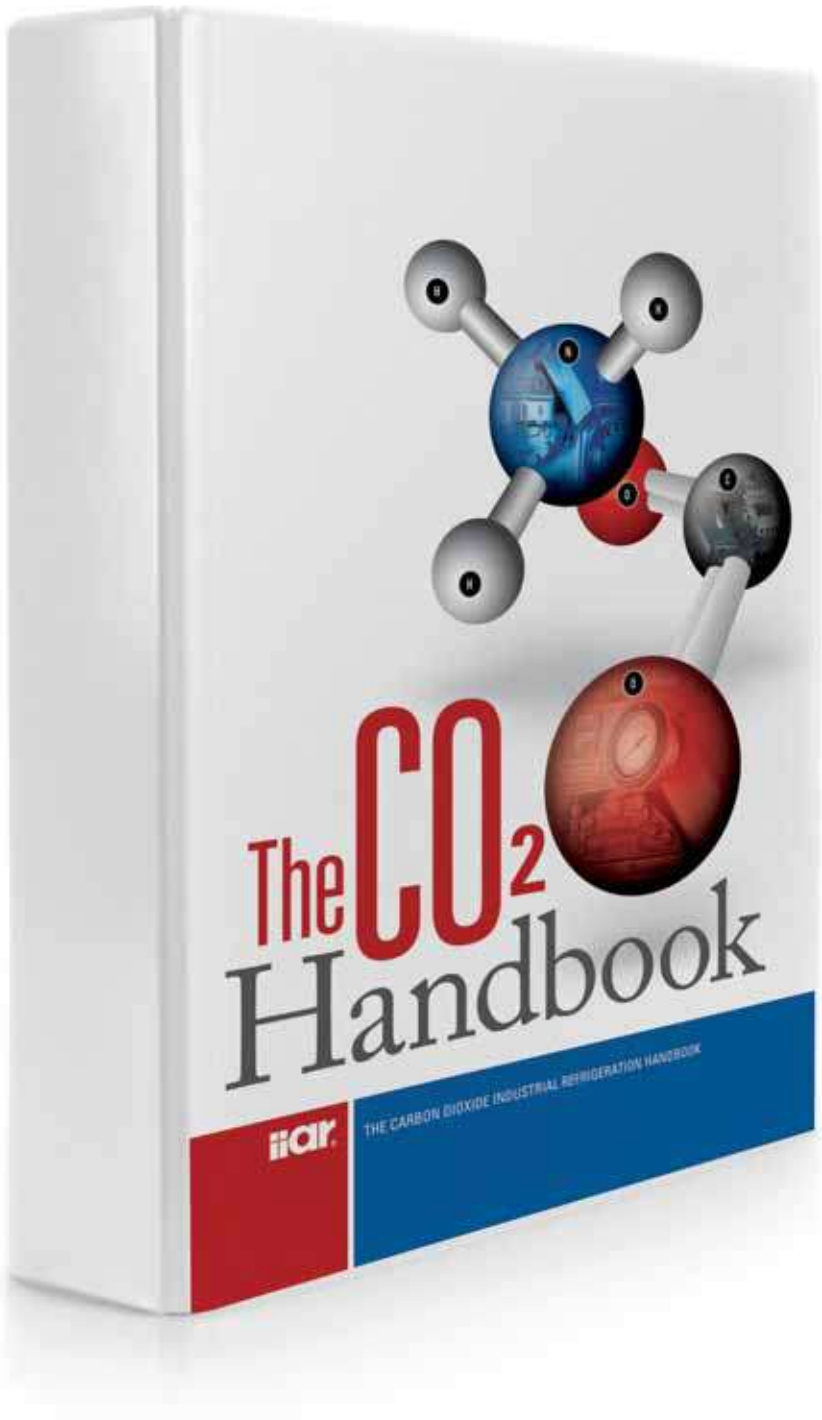

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