February 2013

# Condenser

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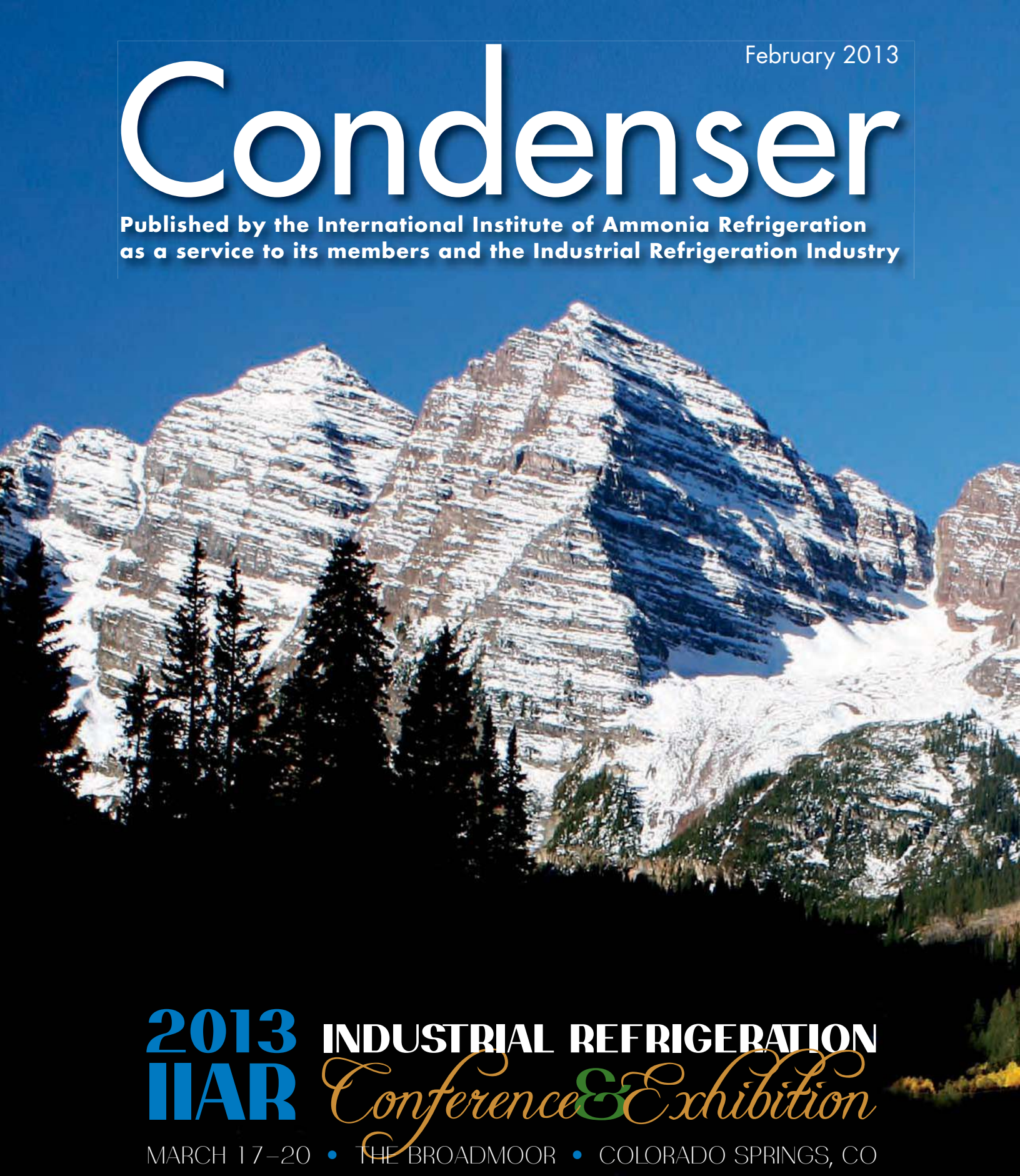

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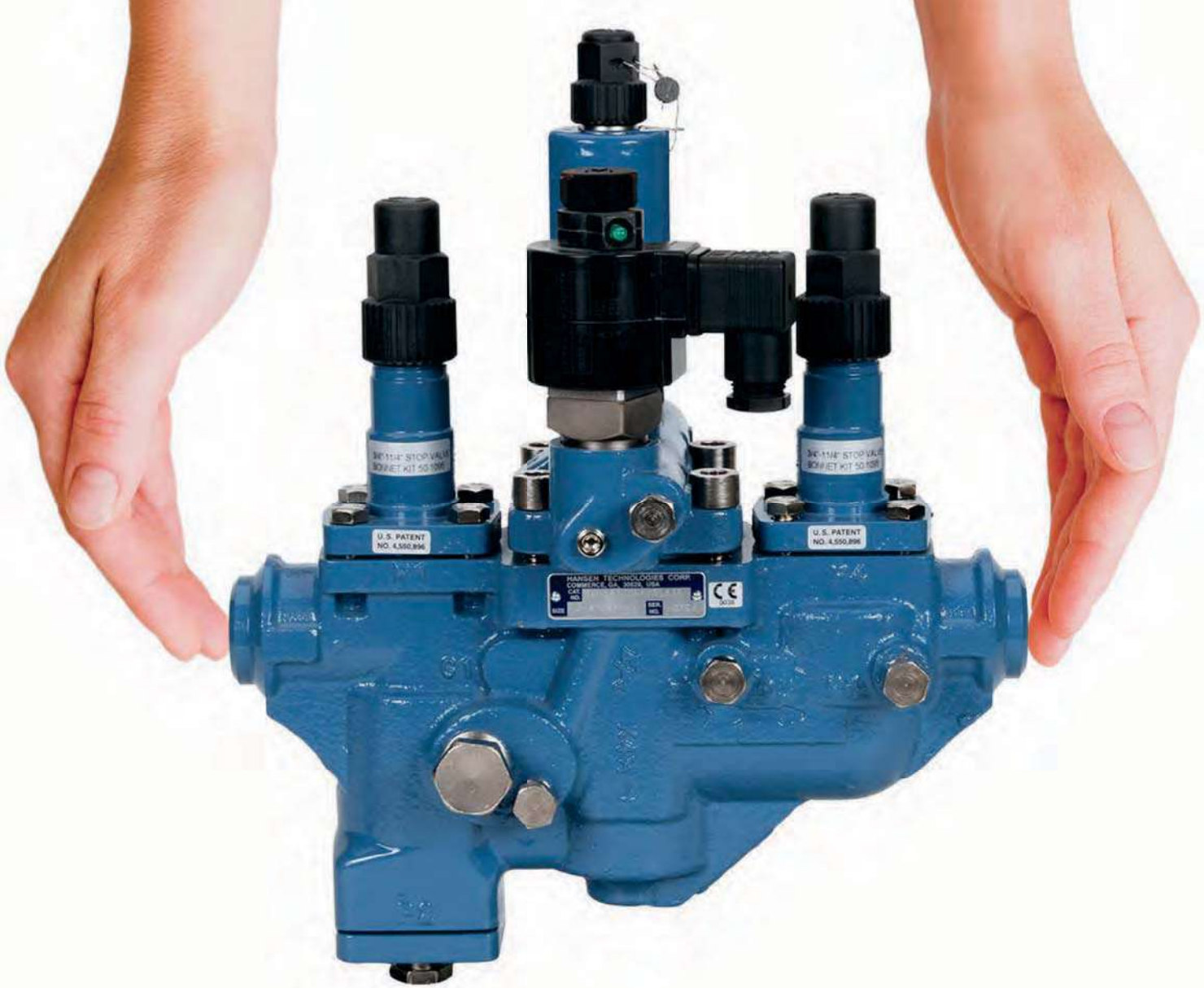


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# Chairman's Message

By Joe Mandato

Final preparations are being made for the 2013 Industrial Refrigeration Conference & Exhibition in Colorado Springs and that means my term as IIAR Chairman is almost complete. We have had many accomplishments during the past year; too many to recognize them all here, and there are many more to look forward to in the coming year under the leadership of Bob Port, IIAR Chairman 2013-2104.

It has been my pleasure to serve in this leadership role. I want to thank the Executive Committee, the Board of Directors, the Committee Chairs and all of the members who volunteer their time and energy for their support during my term. IIAR has made great strides to accomplish many important objectives in 2012, and as we look ahead to 2013, we will be building on these accomplishments.

One of my goals as Chairman was to encourage and support the productivity of IIAR's committees. This year, we made progress towards reaching that goal with the addition of a two meetings for Committee Chairs and Vice-Chairs to review their active projects. These meetings proved to be a great opportunity for IIAR's committee leadership to exchange ideas and keep abreast of important strategic initiatives which were being addressed within the individual committees.

IIAR's volunteer members represent End-users, Engineers, Contractors, Manufacturers and Educational Institutions, all dedicated to the advancement of the safe use of natural refrigerants in the refrigeration industry. I am pleased to report that the dedication of our members who volunteer to work on the committees has resulted in the completion of many significant projects which in turn has helped to create positive, forward moving momentum for the entire organization.

Beyond our commitment to standards development, code and education, the IIAR leadership has taken steps to improve the effectiveness of our advocacy program in support of IIAR member companies. This renewed commitment has been growing over the last several months as a result of the Board of Director's approval in June to establish a Government Relations Committee. The new committee's purpose is to support the work of Lowell Randel, IIAR Government Affairs Director, to effectively influence government policy and to inform IIAR members of changes and trends in government activities.

IIAR's success is due in large part to the hard work of the volunteer members who serve on the working committees and task forces, the executive committee, and board of directors. Under their leadership, our organization has successfully delivered the message that IIAR is an effective advocate for the use of natural refrigerants in industrial refrigeration applications, and is the most comprehensive source of technical information on the topic, both in the U.S. and around the world.

Perhaps one of the most important initiatives IIAR is engaged in is global outreach. Over the past year, we continued to build our global presence, strengthening relationships, and confirming IIAR's international brand. That effort is more important than ever before, as technology advances open up new applications and opportunities for ammonia and other natural refrigerants.

We're looking forward to welcoming back many international delegations to our conference this year, marking the continuation of IIAR's effort to build strong international relationships.

I am also very pleased to report on two exciting initiatives, the $CO_2$ workshop and a new ARF fundraising effort. IIAR's newest conference-related event is a special workshop, focused exclusively on $CO_2$ systems, which will be held on Sunday, March 17. New in 2013, the workshop expands the training resources of the industry, continuing a valuable training initiative which started with the IIAR ammonia safety training event offered at the 2012 conference. If you have not signed up for the $CO_2$ Workshop, I strongly encourage you to consider doing so prior to the conference.

Lastly, I want to make you aware of the special fund raising program which is focused on individual member donations to the Ammonia Refrigeration Foundation, to be used for funding specific projects. Please turn to the ARF section of this issue of the Condenser to read more about how you can get involved in supporting the foundation.

This year has been an exciting one for our organization. International outreach, advocacy, education, and improving communication have been the focus of my term as your chairman.

I am now looking forward to the coming year as I make the transition from IIAR Chairman to ARF Chairman. In this new role, I'll be focused on taking ARF in an exciting new direction that will support the foundation and expand its vision. Over the next year, I hope to raise the level of ARF fundraising and expand ARF's research and scholarship opportunities.

Of course, without the support and dedication of all of IIAR's members, none of these past or future objectives could become a reality. I want to thank everyone who has had a role in advancing IIAR's mission this year. Thanks to you, we're off to a great start in 2013! iiar

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# MAXIMIZING EFFICIENCY OF CARBON DIOXIDE REFRIGERATING SYSTEMS

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## Introduction

The return of Carbon Dioxide as a refrigerant is probably un-stoppable because it is much more environmentally friendly than most of the non-flammable, non-toxic refrigerants currently in use. However, it is worth considering the reasons why industry departed from it in the 1940s.

The two main reasons were low efficiency of systems using carbon dioxide and the high pressures at which carbon dioxide systems operated.

Low system efficiency is a fundamental objection to the use of carbon dioxide in refrigerating systems. It is the object of the present article to indicate methods of mitigating this defect as far as it is possible.

High operating pressure is not a fundamental objection to the use of carbon dioxide. Development of improved materials and methods has removed most of the objections to use of pressures required for carbon dioxide refrigeration. In particular, the development of hermetic and semi-hermetic compressors has obviated the difficulties associated with use of shaft seals or, even worse, packed glands at high pressure differences.

There are significant advantages in terms of component and pipe size as well as advantages in heat transmission in using high operating pressures. These advantages are among the reasons why the, otherwise rather mediocre, refrigerant, R-410A, is increasingly being used.

On balance, the advantages accruing from the high pressures at which carbon dioxide refrigeration systems operate probably outweigh the disadvantages.

Design of refrigerating systems to maximise efficiency depends to a great extent on the properties of the refrigerant being used. In simple theory, efficiency of the Carnot cycle does not depend on properties of the working fluid but real life, especially when using carbon dioxide, is rather more complicated.

## Properties of Carbon Dioxide

Carbon dioxide is a colourless, odourless gas at room temperatures and pressures. It is essential to the cycle of life and is present in the atmosphere at about 370 ppm(v). Carbon dioxide is of low toxicity and is present in the air that we breath out at a concentration of about 30% ( 300,000 ppm(v)). Carbon dioxide is harmful to humans at between 3% and 10% in air because it interferes with the breathing reflex. This is not a major problem in the design of refrigerating systems using carbon dioxide but it should not be overlooked.

Figure 1 shows a Mollier diagram for carbon dioxide for pressures between 4BarA and 200BarA.

The basic figure was obtained from ASHRAE Handbook 2005, Fundamentals, but the critical point and the triple point have been emphasised because they are important to an understanding of the unique properties of carbon dioxide as a refrigerant.

*Maximizing Efficiency of Carbon Dioxide Refrigerating Systems continued on page 8*

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*Maximizing Efficiency of Carbon Dioxide Refrigerating Systems continued from page 6*

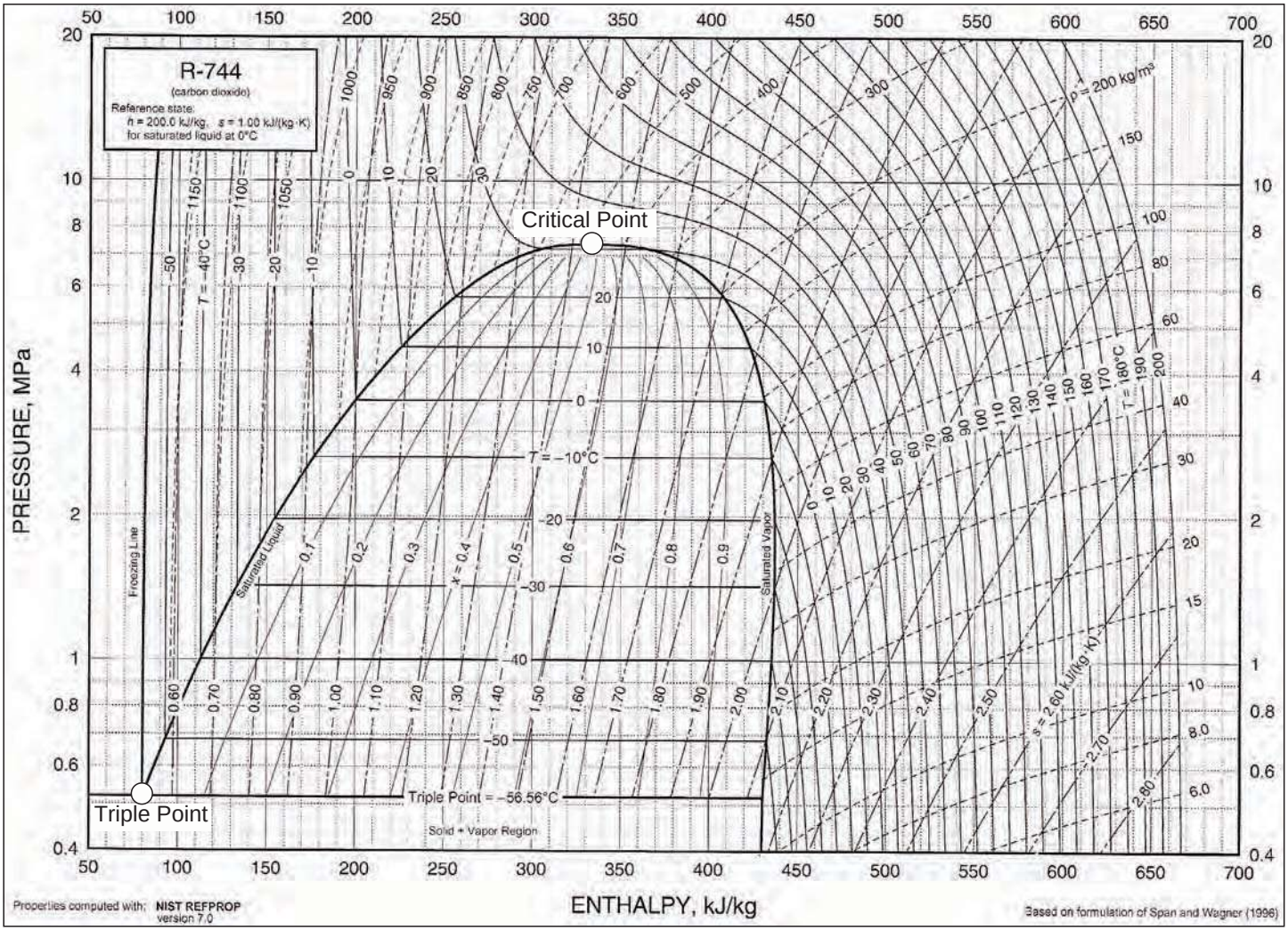


Figure 1

The saturation pressure of carbon dioxide at 0°C is 34.85 Bar. This can be compared with the saturation pressure of ammonia at the same temperature which is 4.29 Bar.

Critical pressure and critical temperature of carbon dioxide are 73.7 Bar and 30.98°C.

Critical pressure and critical temperature of ammonia are 113.3 Bar and 132.2°C.

As there is zero latent heat at the critical point, it is obvious that the relatively efficient Rankine cycle cannot operate at or above the critical temperature. Methods of improving cycle efficiency described in this paper depend on increasing the available latent heat of evaporation in the refrigeration cycle.

The critical temperature of 30.98°C is so low that it will be exceeded in many applications of refrigeration, though not necessarily all the year round.

Another point of interest is that the triple point of carbon dioxide is -56.57°C at a pressure of 5.18Bar. At the triple point, a substance is on the boundary between solid, liquid and vapour states. Any reduction in pressure will turn it into a solid. Carbon dioxide is unusual among refrigerants in that it cannot exist as liquid at atmospheric pressure. Most people will be familiar with solid carbon dioxide and with the effect of liquid carbon dioxide, sprayed into the atmosphere, turning into vapour and white powder.

Another feature of carbon dioxide is that it evaporates at well above atmospheric pressure throughout its operating range. This is a significant advantage compared to ammonia which evaporates at sub-atmospheric pressure at temperatures below -33.3°C.

Properties of carbon dioxide are significantly different from those of all other practical refrigerants.

It would be unwise to design carbon dioxide refrigerating systems based on experience of other refrigerating systems. It is advisable to go back to first principles.

## Methods of Improving System Efficiency

As previously indicated, most methods of improving efficiency of carbon dioxide refrigerating systems depend on increasing the amount of latent heat of evaporation that can be used during the refrigeration cycle. There are several ways in which this can be done. Some of these ways can be combined to produce even greater improvements in efficiency.

### Systems using carbon dioxide as a volatile secondary refrigerant

Carbon dioxide has very good heat transfer and transport properties and is therefore ideally suited for use as a volatile secondary refrigerant. A volatile secondary refrigerant system is one in which the circulating liquid refrigerant is allowed to extract heat by evaporating at more or less constant pressure before being drawn to a condenser where it is re-liquified without need for re-compression. Circulation may be by pump or by other means such as gravity.

Advantages include high coefficients of heat transfer, low mass flows relative to refrigerating duty and the simplicity of not requiring a compressor for the carbon dioxide. Such systems can be oil-free.

Condensation is usually well below critical temperature. Large amounts of latent heat are available.

It has been found that, when used in European supermarket systems, the system efficiency is comparable to, or even greater than, system efficiency of conventional direct expansion halo-carbon systems. Reasons for this surprising result include the small temperature differences at which carbon dioxide condensers and evaporators can operate, the significant pressure drops in halocarbon return lines of existing systems and the fact that more effective primary refrigerants, such as ammonia or propane, can be used.

Use of carbon dioxide as a volatile secondary refrigerant has proved to be practicable and efficient provided the evaporating temperature is not too low. The method could be applied to air conditioning and would be especially beneficial when using chilled ceilings.

However, the primary refrigerant must always evaporate at a temperature lower than the evaporating temperature of the carbon dioxide. This becomes a disadvantage at low evaporating temperatures, especially if the primary refrigerant is ammonia. At low evaporating temperatures it has been found better to use a cascade system.

### Systems using carbon dioxide in cascade with another refrigerant

The first large modern carbon dioxide/ammonia refrigeration system was installed by Star Refrigeration Ltd in 1992 for Nestle at Hayes in Middlesex, England. The installation was for the freeze drying of coffee and produced several MW of refrigeration at temperatures below -50°C.

Cascade refrigerating systems using carbon dioxide and ammonia for the freeze drying of coffee have become the de-facto standard for this type of production worldwide.

Intermediate temperatures for such systems are well below the critical temperature of carbon dioxide. Large amounts

*Maximizing Efficiency of Carbon Dioxide Refrigerating Systems continued on page 20*

# IIAR Code Advocacy Update

By Jeffrey M. Shapiro, PE., FSFPE

## The Future of IIAR 2

### Our Little Baby is Growing Up

First issued in 1974, IIAR 2 is about to reach its 40th birthday. As a connoisseur of codes and standards, I can think of no other document that better captures the values and the mission of IIAR. Written over the years by individuals with some of the most recognizable names in the industry, IIAR 2 provides the primary basis for IIAR's self-determination of the regulatory environment for design and installation of ammonia refrigeration systems.

The decision to develop and administer our own regulations comes with tremendous responsibility to ensure fairness, openness and technical validity in achieving decisions that balance safety, equipment options, installation concerns, operational concerns and cost. IIAR has embraced these challenges in the ongoing development of IIAR 2, and as a result, the document has thrived to become firmly established as the de facto national standard for design and installation of ammonia refrigeration systems.

In the past few years, IIAR 2 has achieved "adoption by reference" status in both of the U.S. model mechanical codes, and we are now seeking similar recognition in model fire codes. "Adoption by reference" status means that IIAR 2 automatically assumes the force of law when a jurisdiction adopts a model code that includes the IIAR 2 reference.

For example, the 2012 International Mechanical Code (IMC) states in Section 1101.6 "Ammonia-refrigerating systems shall comply with this code and, except as modified by this code, ASHRAE 15 and IIAR 2." Chapter 15 of the IMC then references a specific edition of IIAR 2 that is legally adopted and enforceable in any jurisdiction adopting the IMC. With the Uniform Mechanical Code containing a similar reference and model fire codes likely to do the same in 2015, IIAR 2 will be adopted as law in literally tens of thousands of jurisdictions throughout the United States and around the world. That's an achievement that firmly establishes IIAR as the focal point of the ammonia refrigeration industry.

**Next step…becoming an adult:** Since its inception, IIAR 2 has remained aligned with its original purpose by closely focusing on equipment and machinery room design and installation. To address additional aspects of refrigeration safety, IIAR 2 has maintained a symbiotic relationship with ASHRAE 15, *Safety Standard for Refrigeration Systems*. That relationship includes IIAR 2 relying on ASHRAE 15 as a technical supplement and having ASHRAE 15 rely on IIAR 2 for regulations that are unique to the design and installation of ammonia systems. To facilitate harmony between the documents, the ASHRAE 15 technical committee includes representation from the ammonia refrigeration industry, and members of the ASHRAE 15 committee participate in the development of IIAR 2.

In the past few years, particularly with the increasing popularity of ammonia as a natural refrigerant, the need for clear and concise regulation of industrial ammonia refrigeration systems has never been greater. However, under the current system, we simply cannot achieve that goal. This is partly true because, to determine the regulations for designing and installing an ammonia system, you have to review IIAR 2, ASHRAE 15 and the applicable mechanical code. Then you must digest the order of authority for these documents when conflict or overlap occurs, with the mechanical code requirements taking precedence over their referenced standards. Next, there is an assumption that IIAR 2 should supersede ASHRAE 15 for ammonia systems based on the "specific prevails over general" rule that codes operate under (contrary to popular belief, the most restrictive provision doesn't always apply…but that's a topic for another article).

To those of us who are users of ASHRAE 15, it's probably fair to say many will agree it's a challenge to quickly find and figure out how to apply regulations that govern industrial ammonia refrigeration. That's no particular fault of the ASHRAE 15 document itself, but rather a consequence of ASHRAE 15 having such a broad scope, applying to all refrigeration systems and all refrigerants in all applications. So, the question arises, can IIAR 2 assume a standalone role in the world of standards to become a single source document? It is my opinion that the answer to that question is "yes," and it is further my opinion that IIAR 2 assuming that role is in the public interest.

**Letting go of a teenager:** Without suggesting that ASHRAE is a parent of IIAR 2, it is a fact that ASHRAE 15, with roots dating to the 1930s, has a few more years under its belt. The relationship between these two documents has been mutually beneficial, and strong ties remain between IIAR and ASHRAE. There is no reason for any of that to change. However, stepping to the next level offers new opportunities to both IIAR and ASHRAE.

*Code Update continued on page 29*

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# IIAR Government Affairs

By Lowell Randel, IIAR Government Affairs Director

## Regulations in 2013: A Look Ahead

The November 2012 elections brought no change in the balance of power in the Federal Government. President Obama won a second term, the House of Representatives remains controlled by Republicans, and the Democrats retained their majority in the Senate. With no changes in the balance of power, major legislative efforts will require some level of compromise.

However, in the area of regulations, the Obama Administration will be able to advance its agenda without Congressional approval. The Republican controlled House will actively be conducting oversight of federal agency activity, but oversight does not diminish the broad discretion and authority of agencies to promulgate and enforce regulations.

In its first term, the Obama Administration was very active in creating new regulations and enforcement programs, many of which impacted the industrial refrigeration industry and business in general. A good example of this is the National Emphasis Program for Chemical Facilities (NEP) administered by the Occupational Safety and Health Administration (OSHA). In addition to new programs like the NEP, OSHA has also increased its penalties and become more aggressive with its enforcement activities.

Over the first three years of the Obama Administration finalized 106 major regulations which added $46 billion in annual regulatory costs. There are currently over 4,100 pending regulations in the pipeline, many of which are economically significant (meaning they will cost the economy $100 million or more). To further illustrate this point, from 2009 to 2011, over 600 economically significant regulations were placed into the pipeline and 193 have been finalized.

An additional indication of regulatory activity is the number of pages in the Federal Register. The Federal Register is the publication where agencies are required to release information about regulations and provide the opportunity for public comment. The average number of pages in the Federal Register has risen during the Obama Administration to over 81,000 pages per year.

In 2012, there was a slowdown in regulatory activity. In fact, the Obama Administration missed the last two deadlines requiring publication of the government's regulatory agenda (April 2012 and October 2012). Many believe that this was due to the election and the Obama Administration's reluctance to release economically significant regulations before the election. At the time of the election, there were over 150 regulations awaiting review by the Office of Management and Budget (OMB). Seventy eight percent of the regulations awaiting review were been pending at the office for more than 90 days, the maximum time allowed. Of the pending regulations at OMB, the following agencies have the highest number awaiting action: 29 from the Environmental Protection Agency (EPA), 16 from Health and Human Services (HHS), 11 from Department of Labor (which includes OSHA) and 10 each from the Departments of Energy and Transportation.

In January, the Obama Administration finally released its regulatory agenda for Fall 2012. The following is a summary of some of the major regulatory issues impacting the industrial refrigeration industry that are expected to receive attention during President Obama's second term.

### Occupational Safety and Health Administration (OSHA)

With another four years of the Obama Administration, companies should be prepared for OSHA to continue its emphasis on aggressive enforcement. Efforts like the Severe Violator Enforcement Program and the National Emphasis Program for Chemical Facilities will continue to see much activity from the agency. As a reminder, at least 25 percent of all NEP inspections will be in ammonia facilities. Industry is also experiencing an increase in OSHA utilizing the General Duty Clause. This is particularly evident in facilities with less than 10,000 pounds of ammonia. OSHA is using the General Duty Clause in such facilities and expecting facilities to implement process safety management like standards to control hazards. For IIAR members with less than 10,000 pounds of ammonia, it is more important than ever to make sure you have an active safety plan in place. Read more about this issue and what you can do on page 30 of this issue of *Condenser*.

In 2013, OSHA will also continue its implementation of the Globally Harmonized System of Classification and Labeling of Chemicals. Under the regulation issued in 2012, chemical manufacturers and importers are responsible for providing information about the identities and hazards of chemicals they produce or import. This includes specific criteria for classification of health and physical hazards, as well as classification of mixtures. Chemical manufacturers and importers will be required to provide a label that includes a harmonized signal word, pictogram, and hazard statement for each hazard class and category. The harmonized system also requires employers to use a 16 section safety data sheet.

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*Government Affairs continued from page 12*

Employers are required to train workers by December 1, 2013 on the new labels elements and safety data sheets format to facilitate recognition and understanding. Training should address workers, emergency responders, and those involved with preparation of labels, SDS and HazCom strategies as part of risk management systems.

In addition to current enforcement efforts, it is likely that new regulations such as the Injury and Illness Prevention Program (I2P2) will begin to move through the regulatory process. I2P2 is a new regulation being developed by OSHA that would establish a requirement for employers to find and fix potential workplace hazards regardless of whether they specifically relate to an existing OSHA standard. OSHA sites the use of I2P2 type programs in a number of states as demonstrating the success of this proactive approach to preventing workplace injuries. However, there are concerns about the costs and burdens that would be placed on employers if the new program goes into effect.

Some are likening I2P2 to the General Duty Clause on steroids. Much like the General Duty Clause, it is feared that OSHA will use the I2P2 standard to cite employers for failing to address a hazard, even if it there is not an established hazard specific standard. For example, some believe that I2P2 may be a way for OSHA to address ergonomics without advancing a rule on that specific topic.

Dr. David Michaels, Assistant Secretary of Labor and head of OSHA, has made the implementation of I2P2 one of his top priorities. However, progress on the proposed I2P2 rule was slowed because of the election. With the election complete, it is widely speculated that OSHA will now move forward with promulgating the I2P2 regulation.

## Environmental Protection Agency (EPA)

While no regulatory changes are expected to the Environmental Protection Agency's Risk Management Program (RMP), EPA will continue an active program of enforcement under the Risk Management Program (RMP). IIAR members are encouraged to make sure that their plans are current and operating effectively. EPA does have a large number of high profile regulations in the pipeline touching a wide variety of industries and issues.

Regulations restricting greenhouse gas emissions could have the most overall impact on the economy. With Republicans maintaining control of the House, "cap and trade" legislation is unlikely to pass. As a result, the Obama Administration is looking to curb greenhouse gas emissions through regulations. While early regulatory efforts are expected to focus on the energy production sector such as coal, EPA is likely to expand these restrictions across other industries. It has been estimated that EPA proposals would cost between $300 and $400 billion a year and ultimately raise gas and electricity prices. As a non-greenhouse gas emitting refrigerant, ammonia has a good story to tell and IIAR will continue to build its relationships with EPA to promote the environmental benefits of ammonia.

Another major EPA proposal is to tighten the ozone standard. This would likely place over 600 counties in "non-attainment" status which would severely limit these counties' ability to pursue economic development. These and other EPA regulations are pending release from OMB and could begin to move through the regulatory process in 2013. While these regulations do not directly impact ammonia refrigeration, the economic impacts of such regulations could impact companies.

## Department of Homeland Security (DHS)

The Department of Homeland Security (DHS) continues to further implementation of the Chemical Facilities Anti-Terrorism Standards (CFATS) program. One of the main issues currently receiving attention if personnel surety. In 2011, DHS invited public comment regarding its proposal to collect information under what they are calling the CFATS Personnel Surety Program (PSP). Under the program, facilities would be required to submit to DHS personally-identifying information regarding individuals seeking access to restricted areas and critical assets at the facility. DHS would then arrange for these individuals to be checked against the FBI's classified Terrorist Screening Database (TSDB).

IIAR, along with a number of like-minded industry organizations sent a letter to DHS expressing concerns with the Department's PSP proposal. The letter argued that the PSP program, as proposed by DHS, is unnecessarily prescriptive on how facilities meet the risk based performance standard on personnel surety and in many cases is duplicative. The proposal did not recognize the many facility workers who possess security credentials already subject to review by DHS. As a result of these concerns, DHS withdrew its information request and sought further input from industry on the PSP program. Representatives from IIAR participated in a call with DHS to further discuss concerns about proposals that would place additional personnel surety responsibilities on employers in the industrial refrigeration industry. A follow-up letter was also sent by IIAR to DHS.

It is expected that a revised PSP proposal will be released by DHS in 2013. IIAR will continue to work with like minded organizations and DHS is this proposal moves forward.

These are just a sampling of some of the major regulatory efforts that the industrial refrigeration industry will likely face during President Obama's second term in office. In response to increased regulatory activity, IIAR has recently created a Government Relations Committee to further guide IIAR's government relations program. The committee, chaired by Mark Stencel of Emerson, has already held strategy sessions to discuss the impacts of government policies on the industrial refrigeration industry and develop a proactive strategy for the future.

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# Ammonia Refrigeration Foundation UPDATE

## ARF Needs Your Help!

One of the most important activities in the industrial refrigeration industry is the advancement of technology through research and education. The Ammonia Refrigeration Foundation is dedicated to this goal, enabling IIAR to advocate for code and government policy changes which benefit the industry in design, construction and the operation of increasingly safer and more efficient systems.

Since its founding, ARF has awarded a number of scholarships and completed several significant research projects designed to answer critical questions related to making the refrigeration system safer and more efficient.

We recently introduced a new program that focuses on individual donations to ARF, to be used specifically for funding these projects.

The new annual fundraising program is designed to allow every corporate and individual stakeholder in our industry to make a 100 percent tax deductible donation to help underwrite the cost of ARF Research Projects.

The fund raising goal for the fiscal year ending June 30, 2013 is to raise $50,000. This will only happen with a broad response from IIAR Corporate and Individual Members, such as you.

Please take a few minutes to review, complete and return the form below. Your investment in the refrigeration industry today will help ensure that systems designed with ammonia and other natural refrigerants will continue to be the best technical solution, in terms of safety, efficiency and environmental stewardship, to advance the global cold chain for generations to come. ■ar

Your donation plays an important role in the future of ARF research. ARF has provided suggested giving amounts for each member type, but all contributions are welcome. If you choose to make a donation, please fill out this form and send your contribution to ARF headquarters.

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☐ Yes, please include my name and donation in the ARF Annual Report – August 2013 *Condenser*.

# Remembering Bill Bowles

By Andrea Fischer

The ammonia refrigeration industry lost one of its most devoted advocates and enthusiastic mentors last year with the passing of Bill Bowles, former IIAR Chairman, president of Evapco and first chairman of the Ammonia Refrigeration Foundation. Although Bill had retired from the industry, he remained personally invested in its success, serving on IIAR's ARF Board of Directors as Chairman of the Trustees and as Vice Chairman of Evapco's Board of Directors through 2012.

"Engineering mentors in this industry are readily available. Executive mentors such as Bill are rare," said Jeff Welch, president of Welch Engineering Corporation. "His no-nonsense, get it done, approach to decision making was as refreshing as it was inspirational. I hope he realized the length of his shadow. His presence in the industry will be missed in many ways."

Described by friends and colleagues as an "action oriented person," Bill was dedicated to his projects and focused on accomplishing his objectives, especially when they were part of larger efforts to advance the industrial refrigeration industry.

"Bill had a special interest in IIAR. He was willing to invest his own time, money and leadership in this association to make it as good as he could make it," said IIAR Chairman Joe Mandato. "He not only had a solid plan for the association but he also had a real vision for the future."

Part of that vision was to establish the Ammonia Refrigeration Foundation as a vehicle to create the financial structure and support to carry out research projects on behalf of the industry and offer scholarships to ensure the development of future generations of engineers.

"Bill recognized the necessity of funding industry research in order to create a more sustainable community during a time when IIAR itself and the sustainability of the organization was being challenged," said IIAR President Bruce Badger, who added that Bowles then volunteered to lead the newly formed Ammonia Refrigeration Foundation. "That was so typical of Bill's optimism and willingness to be the first in line to help when asking others to contribute."

Within ARF, Bill accepted the responsibility of soliciting large contributions from the industry, a role he conceptualized and then worked hard to build with the ARF trustee's program, which requires a minimum $50 thousand donation to ARF to join.

"Bill not only came up with the idea of the trustee giving structure for ARF, but he accepted the responsibility for soliciting those large donations on behalf of the industry, and had a lot of success," said Mandato. Bill eventually raised initial funding of nearly 1.5 million dollars for ARF.

Lending his leadership skills to IIAR was a pursuit that was also very important to Bill, said Mandato. "As IIAR Chairman, Bill was able to apply his own sense of discipline and his business philosophy to the work and structure of the association. He set the framework for the level of success we have today."

Specifically, the idea of managing by objectives within the association – so that IIAR committees had a process to get projects done – was a concept introduced during Bill's tenure, said Mandato. "During his year as the IIAR Chairman and later through his ongoing involvement with the executive committee, Bill helped to establish a framework for how the association would work in the future. We still follow that framework today."

Professionally, Mandato and Badger, who were both hired by Bill at one point in their careers, said they remember him as a dedicated mentor and friend. "Bill recognized that everybody approached their job with their own experience, but he always had a clear direction for the business and for the people who worked for him. As a manager, he was good at providing a vision and then allowing you to carry it out."

Bill Bowles was born and raised in Leonardtown, Maryland. He graduated from St. Mary's Ryken High School in 1966 and earned a degree in history from St. Mary's College of Maryland.

Bill began his professional career in industrial refrigeration at Baltimore Air Coil, where he went to work in 1972, and was eventually promoted to vice president.

In 1990, he joined Evapco Inc. as Executive Vice President and assumed the role of President a year later. He retired from Evapco in 2004, but remained active as a member of the company's Board of Directors. **ar**


by Chris Combs, International Programs Director

## Australia's Clean Energy Future, the ARA and Prospects for Natural Refrigerants

Aiming to cut pollution while creating incentives for energy efficiency, the Australian Parliament passed the Clean Energy Future legislation on November 8, 2011, introducing a new carbon pricing scheme to be structured in two phases. The first three year phase, starting July 1, 2012, the carbon price is set at $23 (this article refers to the Australian Dollar which is equal to about US$1.06 as of January 11) per ton and is subject to rise by 2.5% per year in real terms. During the second phase beginning July 1, 2015, the carbon price will be determined by the market under a flexible emissions trading scheme with an annually adjusted price ceiling (starting at $20 above the expected international price) and floor (initially $15) in effect during the first 3 years. The stationary energy sector, industrial processes, fugitive emissions, and heavy vehicle commercial transport are among the areas covered by the legislation.[1]

The primary impact on the refrigeration and air Conditioning (RAC) industry occurs indirectly through a complementary measure established under Australia's Ozone Protection and Synthetic Greenhouse Gas (SGG) Management legislation rather than the carbon pricing scheme described above; however the rate of the new levies on HFCs are based on the carbon price established by the Clean Energy Future legislation, and will be adjusted in future.

The SGG Management legislation applies equivalent carbon pricing to hydrofluorocarbons (HFCs) according to their global warming potential (GWP); price increases on HFC refrigerants are expected in the range of 300 to 500%. For example, this year's levy on HFC134A with a GWP of 1300 would be about $30 per kilogram ($13.64 per pound) while the levy on R404A with a GWP of 3260 is about $75 per kilogram ($34.09 per pound). According to IIAR member Stefan Jensen, the levy is also intended to encourage increased recycling of SGGs, enhance service to existing equipment to minimize leakage, and increase the use of equipment designed specifically for lower GWP refrigerants (as long as the applicable safety standards and regulations are followed).[2]

The Australian Government has announced several programs to assist the private sector in adjusting to the changes made by the new legislation including grants for associations and NGOs to deliver information about energy efficiency to businesses and community organizations, grants for research to promote innovation in low emissions technologies, grants for food businesses and other business sectors to invest in energy efficient and low emission processes and equipment, and funding for educators providing essential knowledge and skills for the delivery of low emission applications.[3] In July of this year the Government will begin providing funding to a new refrigerant recovery program providing financial incentives for the verified destruction of waste SGGs and ozone depleting substances, formerly run by industry.[4]

### Concerns Regarding the HFC Levy and the Alternative (Natural) Refrigerants

Refrigerants Australia (RA), an organization whose members include the Australian divisions of DuPont, Honeywell Polymers and Australian industry groups such as the Refrigeration and Air Conditioning Contractors Association and the Air Conditioning and Refrigeration Equipment Manufacturers Association, has long been the leading voice of opposition to imposing a carbon price on fluorocarbon refrigerants. According to the RA website, the levy will cost the RAC industry about $270 million in the first year. The website foresees unintended consequences and costs that are not easy to estimate and which may vary depending on the circumstances of the affected business. It also warns of severe penalties on companies that attribute price increases to the carbon price without being able to substantiate these claims.[5]

The RA and its President Stephen Anderson argue against the HFC levy from an economic and business perspective, asserting that an "inelasticity of demand" exists in the refrigerant market, a claim their critics point out is not supported by the experience in Denmark and Norway. Anderson makes the case that the levy will not be effective in eliminating HFC use due to the fact that, with most of the existing RAC equipment installed in Australia, the choice for

1 Clean Energy Future site: http://www.cleanenergyfuture.gov.au/clean-energy-future/an-overview-of-the-clean-energy-legislative-package/

2 Examples from presentation by Stefan Jensen prepared for Eurammon

3 Department of Climate Change and Energy Efficiency website: http://www.climatechange.gov.au/government/clean-energy-future/legislation.aspx

4 Stefan Jensen's presentation

5 http://www.refrigerantsaustralia.org/carbon.html

*Global View continued on page 28*

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*Maximizing Efficiency of Carbon Dioxide Refrigerating Systems continued from page 9*

of latent heat are thus available, leading to high system efficiencies.

Ammonia is an excellent refrigerant provided the evaporating temperature is not too low. However, at low evaporating temperatures, below, say, about -35°C, the specific volume of ammonia becomes very large and it is therefore necessary to employ large and expensive compressors with correspondingly large friction losses.

It is more economic in total system cost to use a carbon dioxide/ammonia cascade refrigerating system than a two stage ammonia system at evaporating temperatures lower than somewhere in the range between -30°C and -40°C, depending on the equipment being used and depending on the condensing temperature.

The carbon dioxide compressor would require about one eighth of the swept volume of an ammonia compressor to produce the same amount of refrigeration.

Cascade systems have been applied to low temperature cold stores, to blast freezers and to plate freezing systems with very good results.

It is relatively easy to apply carbon dioxide to large systems using either the volatile secondary method or the cascade method. However, even simpler systems are required for small to medium sized refrigerating systems.

## Systems using only carbon dioxide

It is clear that air cooled systems using carbon dioxide will reject heat to atmosphere at temperatures above 31°C from time to time.

There is an optimum supercritical discharge pressure at which system efficiency is greater than at any other supercritical discharge pressure. It is not generally realised how low this efficiency is compared to system efficiency at most sub-critical discharge pressures.

Figure 2 shows ideal COP for carbon dioxide refrigerating systems against discharge pressure in BarA.

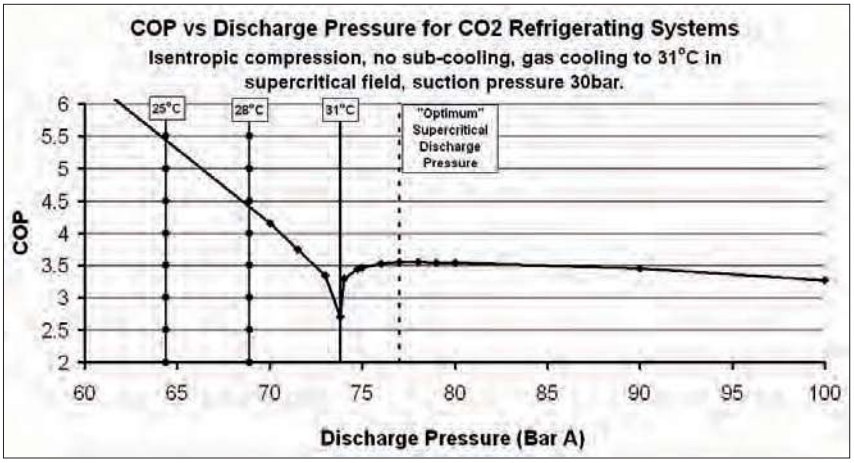


Figure 2

It can be seen that, as the discharge pressure rises, COP falls to a minimum at about 74 BarA. However the COP rises sharply as the critical pressure is passed and reaches a maximum supercritical COP of just over 3.5 at about 77BarA under the conditions given. The "optimum" supercritical COP is much lower than the sub-critical COP at a condensing temperature of 28°C.

Year-round condensing temperatures of 28°C or lower can be achieved in many regions of the world by use of evaporative condensers. It is very desirable to avoid rejecting heat in the supercritical region if at all possible.

Whether or not a carbon dioxide refrigerating system is operating in a trans-critical cycle, it is always desirable to find ways of increasing the available latent heat of evaporation

### *Small fully sealed systems*

Small single-stage carbon dioxide systems using hermetic and semi-hermetic compressors have been used for several years in drinks dispensers and other applications where it is desired to avoid use of halo-carbon refrigerants or their flammable replacements. Such systems are now proven in practice and produce system efficiencies comparable to efficiencies achieved in practice using halo-carbon refrigerants. However these efficiencies are very low compared to what is theoretically attainable.

### *Supermarket systems*

Carbon dioxide systems of various types have come to dominate supermarket refrigeration in Northern Europe. In general, year-round system efficiencies are higher than system efficiencies for comparable halo-carbon refrigerant systems, though, in summer, the halocarbon systems are usually somewhat better.

Most supermarket refrigerating systems operate at two or more temperature levels. The high temperature levels use multiple, trans-critical semi-hermetic compressors rejecting heat to air- cooled gas coolers that function as condensers in cooler weather. In many instances the air for the gas coolers is cooled adiabatically by water spray during warm weather thus limiting power required for the compressors and improving efficiency.

The low temperature levels use sub-critical semi-hermetic carbon dioxide compressors rejecting heat to the high stage system either by cascade or directly to the high stage suction.

As yet there is no consensus as to the best type of system.

In many cases, system efficiency is improved by sub-cooling the high pressure carbon dioxide fluid in heat exchange with mains water that is heated to domestic hot water temperatures. This provides

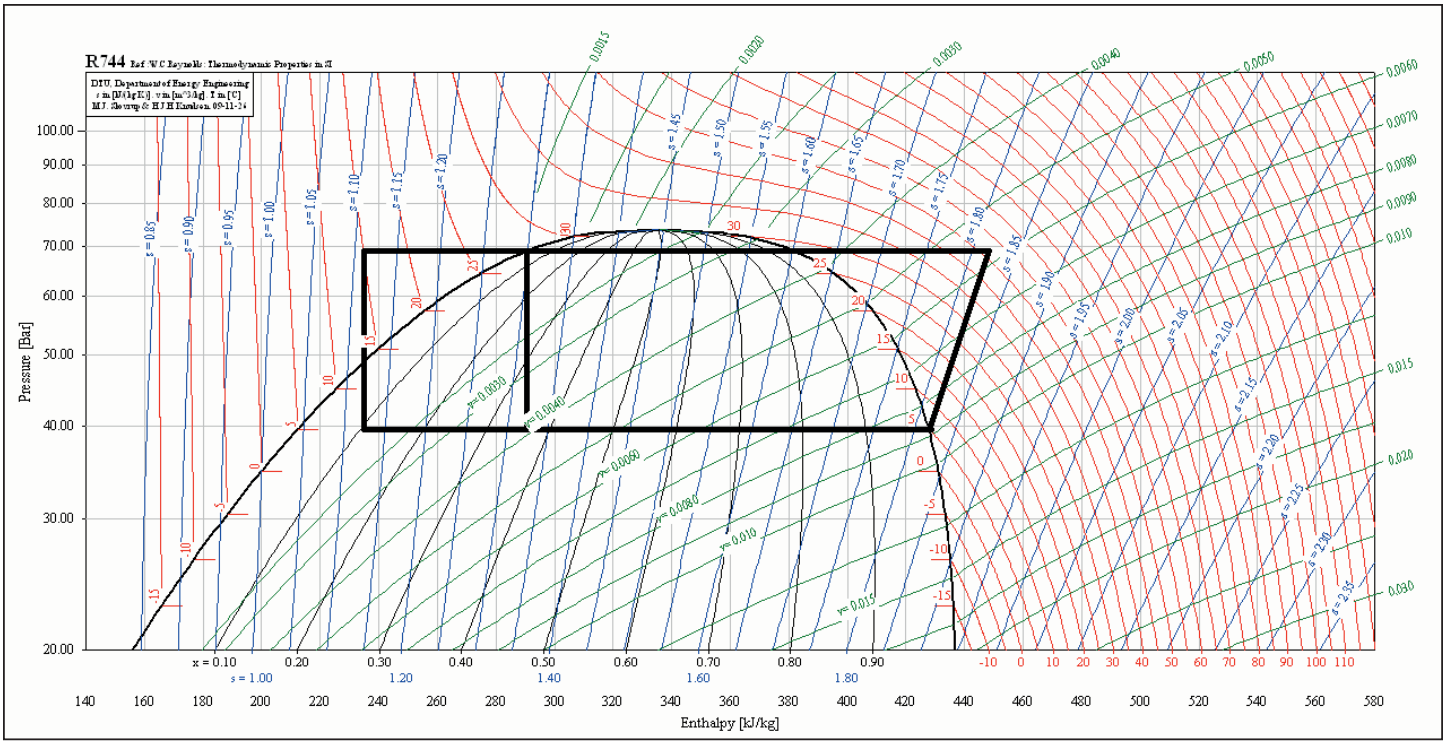


Figure 3

"free" hot water and improves performance of the refrigerating system.

Figure 3. shows that the output and the COP of a carbon dioxide system can be increased by 33% merely by using mains water to sub-cool the refrigerant to 15°C. The resultant hot water is cheaper than free!

### *Car air conditioning systems*

The dominant refrigerant for car air-conditioning remains R134a, though it is scheduled for replacement by refrigerants with lower global warming potential.

Carbon dioxide is one such refrigerant though it has not yet found the world-wide acceptance that would be required in this market.

To be successful, carbon dioxide systems must become as reliable, as compact and as cheap as the well-established halo-carbon systems.

In the writer's opinion, carbon dioxide systems for cars must be fully sealed, economised, two stage systems with electronic speed control powered from the car's electrical system. Some early designers fell into the trap of copying what had been done before for halocarbon systems. It now seems obvious that high pressures associated with carbon dioxide militate against use of shaft seals and that the required variable refrigerating capacity of a sealed system is better performed by electronic speed control than by varying swept volume at constant speed.

Experience with supermarkets and with Eco-cute water heaters suggests that year-round performance of an economised two-stage carbon dioxide system should be able to match performance of single-stage halo-carbon systems.

Unfortunately it is not possible to apply the trick of sub-cooling using mains water in a car but significant improvements in efficiency can be made by using two stage compression with economising even though the pressure ratio might not require more than one stage for mechanical reasons.

It is also possible to use the method of parallel compression whereby a parallel system using the same refrigerant is used to sub-cool the main flow of high pressure refrigerant. The parallel compression system not only improves efficiency but it provides higher capacity than would have been achieved from the combined swept volume of the compressors used without sub-cooling by parallel compression.

The advent of the electric car will provide an opportunity for carbon dioxide systems because heat rejected from a carbon-dioxide system can be used to replace waste heat from the internal combustion engine that will have been replaced by a much more efficient electric motor. Carbon dioxide systems should be well placed to provide the heating and de-humidification that is required during winter months as well providing cooling in the summer.

### *Water heating systems*

One of the great success stories in the application of carbon dioxide is the development of all-electric water heating in Japan using carbon dioxide in heat pumps.

Conditions in Japan, which has very little indigenous fuel resource, favour this type of heating but the development has been so successful that it will be applied all over the world even in energy rich countries.

The system, which has the generic name "Eco-cute" is a prime example of improving efficiency by using sub-cooling to increase available latent heat of evaporation.

Mains water is heated to domestic hot water temperatures in counter-flow heat exchange with supercritical carbon dioxide in a heat pump system where the heat source may be ambient air or waste water.

In general, no use is made of the refrigerating effect but several similar systems have been installed where the heat source is chilled water returning to the water-chiller of a conventional air-conditioning system. By this means use is made both of the refrigerating effect and of the heating effect.

*Systems using evaporative condensers*

There is no fundamental reason why evaporative condensers should not be designed for use with carbon dioxide refrigerating systems. This would have the advantage of allowing year-round sub-critical operation in many parts of the world. In addition, the mains water supply for evaporation and for blow-down could be used for sub-cooling with the benefits already described.

Unfortunately the amount of make-up water required is relatively small compared to the beneficial sub-cooling that could be provided from larger flows of water.

A system has been designed that uses an evaporative condenser in conjunction with a water heater to produce system efficiencies that are comparable with, or which exceed, efficiencies of conventional refrigerating systems.

The circuit diagram is shown in figure 4.

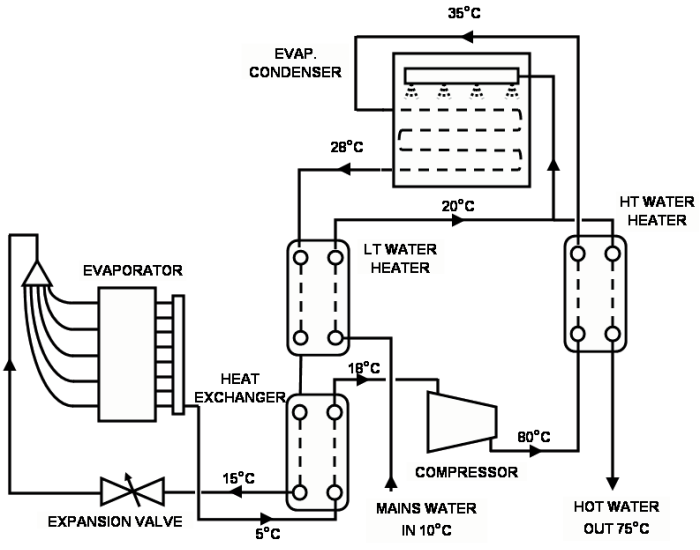


Figure 4

The circuit includes a compressor, an evaporator, an evaporative condenser and three heat exchangers. Carbon dioxide is compressed to (say) 70 BarA and fed through a counter-flow, second stage, water heater to an evaporative condenser. In the condenser, the refrigerant is condensed to liquid at about 28°C. Liquid refrigerant leaves the condenser at about that temperature and passes through a first stage water heater before passing through a liquid to suction heat exchanger on its way to the expansion device. After the expansion device, the refrigerant extracts heat in the evaporator before returning to the compressor via the suction/liquid heat exchanger.

Efficiency of the refrigerating system is improved by sub-cooling in two stages while maintaining a low discharge pressure by using an evaporative condenser.

The proposed cycle is illustrated on a Mollier diagram shown in figure 5.

For a cycle as illustrated, where the evaporating temperature is +5°C and the condensing temperature is 28°C, the COP of the system as a refrigerator would be 5.31, assuming an isentropic efficiency of compression of 65%. The COP of the system as a water heater would be 2.05.

Operation of the system at lower evaporating temperatures would provide more hot water.

It is rather difficult to compare performance of a carbon dioxide system of this special type with conventional systems using R404A or R410A because assumptions have to be made about the operating conditions that would apply. Assumptions also have to be made about how compressors on the various refrigerants would perform under these operating conditions.

An active spread sheet was prepared for the system illustrated in figure 4 using manufacturer's data. From this sheet it was possible to calculate COP (r) and COP(h) as well as temperatures and pressures round the system.

It was assumed that the conventional systems on R404A and on R410A would use air cooled condensers and that the refrigerant would condense at 15K above ambient temperature. This is a relatively conservative assumption because air cooled systems are often designed to operate with much larger temperature differences.

It was assumed that relative humidity of the air varied linearly from 45% at 31°C (22°C wet bulb) to 75% at 15°C (12.5°C wet bulb). This is typical of temperate climates but is not representative of dry climates nor is it at all representative of tropical climates.

Figure 6 shows variation of compressor COP(r) in ambient temperatures ranging from 10°C to 31°C.

It can be seen that the special carbon dioxide refrigerating system is consistently more efficient than conventional air cooled systems on halo-carbon refrigerants even though the temperature difference of the air cooled system was restricted to 15K.

Pump and fan power are not included in the model. In general, fan powers for air cooled condensers would be greater than fan powers for equivalent evaporative condensers. The model is, therefore, not biased in favour of the evaporative condenser system.

*Maximizing Efficiency of Carbon Dioxide Refrigerating Systems continued on page 24*


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*Maximizing Efficiency of Carbon Dioxide Refrigerating Systems continued from page 22*

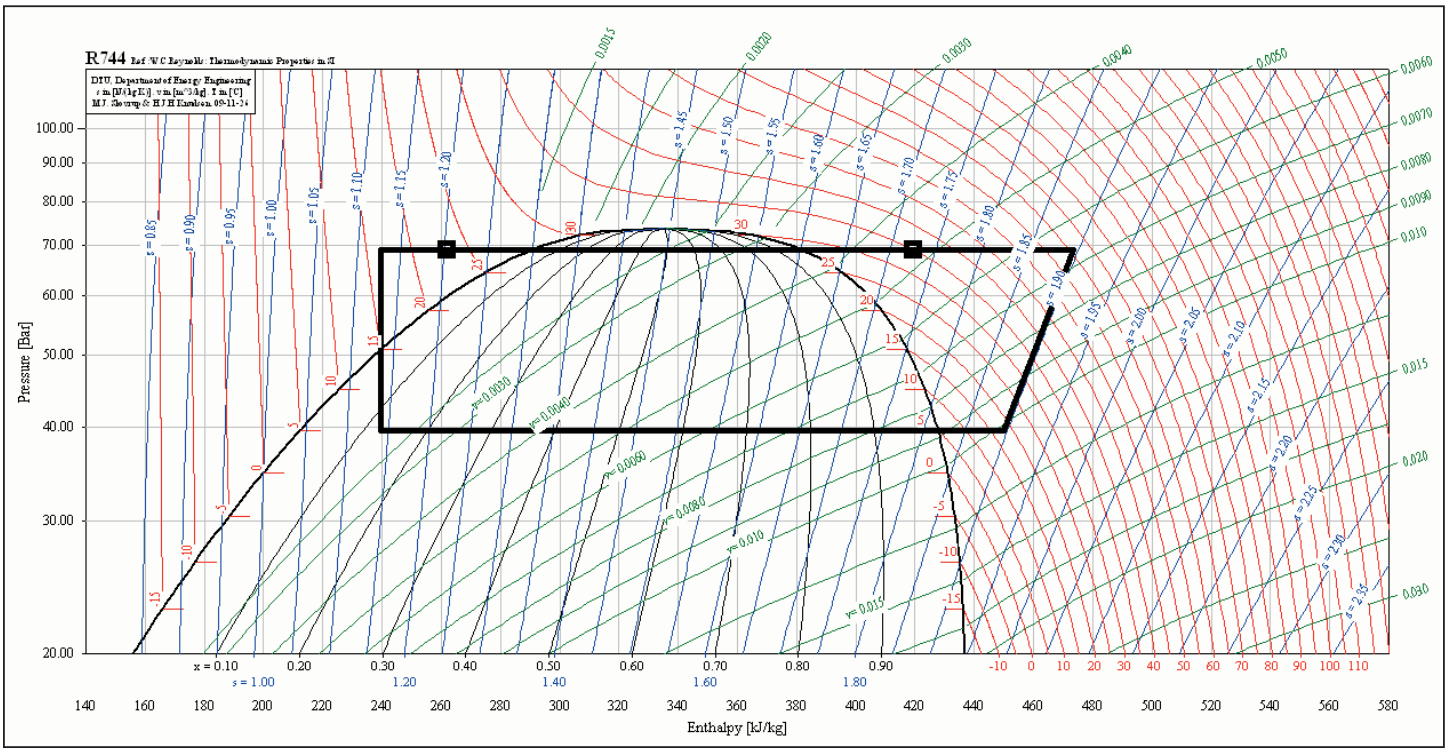


Figure 5

## Acknowledgements

I would like to thank Danish Technical University for use of their refrigerants program, Coolpak, that produced many of the diagrams and calculations for the paper.

## Conclusions

1. Carbon dioxide refrigerating systems are sufficiently different from conventional refrigeration systems to justify a return to first principles at design stage.
2. The high pressures at which carbon dioxide systems operate provide benefits that outweigh any disadvantages.

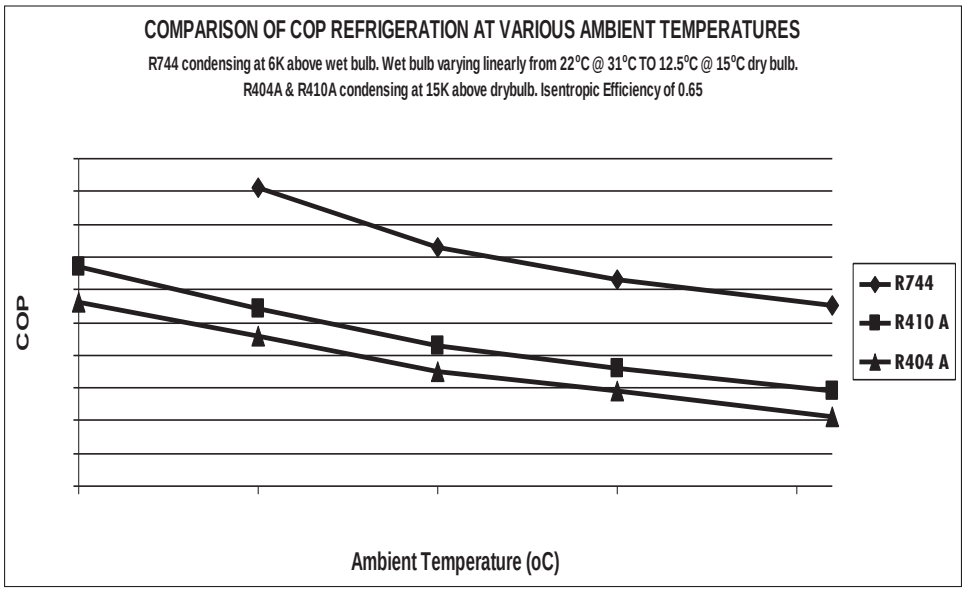


Figure 6

3. Efficiency of carbon dioxide systems can be increased to match efficiencies of conventional systems but only at cost of increased complexity.
4. Trans-critical operation should be avoided if possible because it implies low efficiency except in the special case where water can usefully be heated from mains temperature to high temperature.
5. All valid methods of improving efficiency of carbon dioxide refrigerating systems depend on increasing the latent heat available for evaporation.
6. A system has been designed that allows carbon dioxide systems to be operated at efficiencies that exceed efficiencies of conventional air cooled systems.

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# Correction

A story by Forbes Pearson, entitled "Further Improvements in Ammonia Low-Pressure Receiver Systems," which appeared in the November 2012 issue of the Condenser, erroneously referred to "Figure 7" when describing "remote print-out of site readings."

Instead of referencing this illustration as "Figure 7," the text should have referenced "Figure 8," which was left out of the paper entirely. This may have puzzled some readers.

Remote monitoring and recording of system performance is a very valuable tool and is not now prohibitively expensive. There is almost no limit to the amount of data that can be recorded and transmitted almost instantaneously.

Two figures that illustrate this idea and were left out of the original publication of this paper appear below.

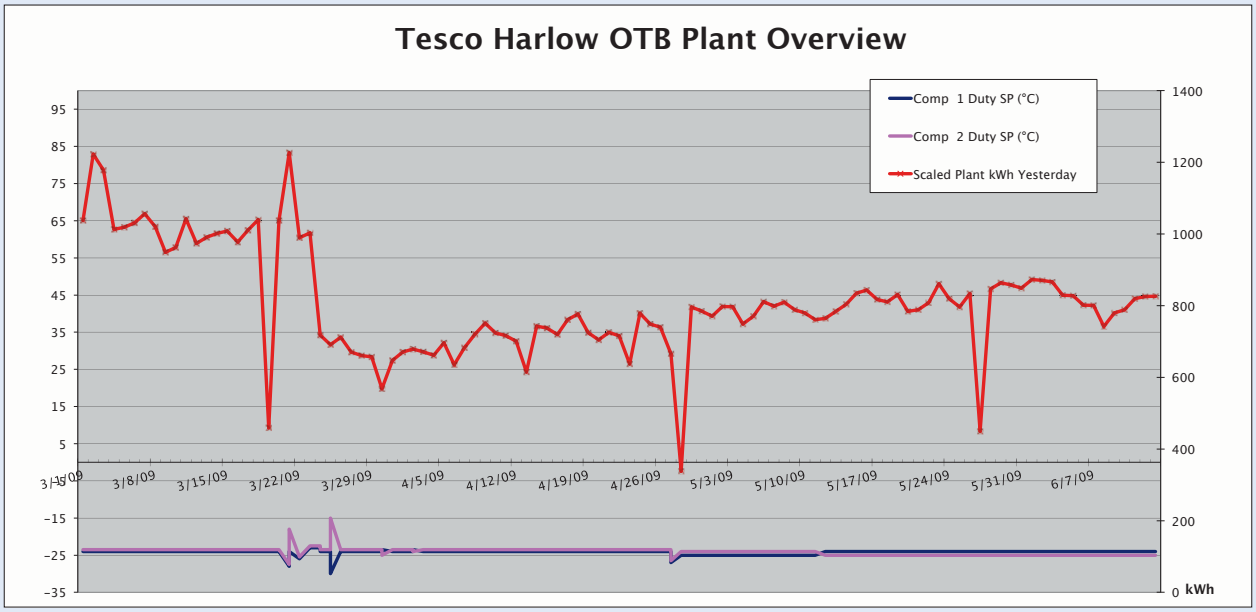


Figure 7

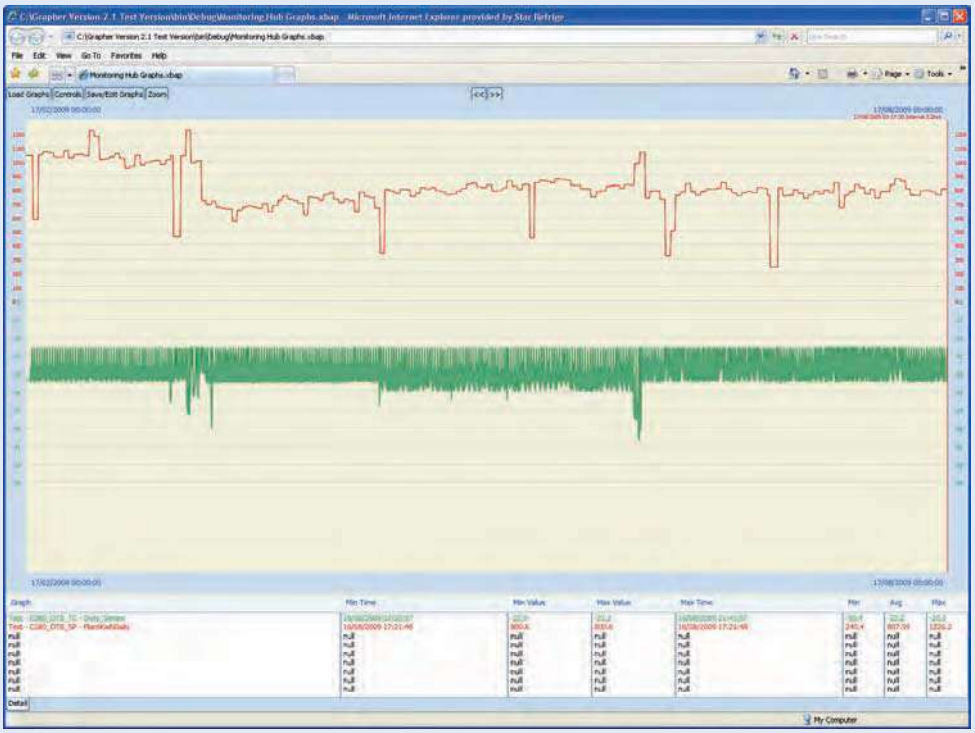

Figure 8

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*Global View continued from page 18*

using HFC refrigerants such as R410a has already been made; this choice has been determined to a great extent by global equipment manufacturers rather than Australian contractors and consumers. Furthermore, they argue, the increased refrigerant cost would not make a significant enough price difference at the retail level, for example a domestic air conditioner or a car with air conditioning, to have a big impact on consumers' decisions. As an example of the ineffectiveness of government efforts to raise refrigerant prices in order to discourage use, Anderson cites the experience of the United States in the 1980s when taxes on CFCs led to an explosion of refrigerant smuggling. As an alternative to tax, RA favors an approach to managing HFCs and limiting refrigerant emissions under the framework of the Montreal Protocol and Australian regulations already in place prior to the HFC levy.[6]

The RA also challenges the carbon price approach to HFCs from a safety standpoint. It alleges that the alternative hydrocarbon refrigerants which are exempt from the levy are very dangerous. Anderson emphasizes the flammability of hydrocarbon refrigerants; for example, he warns of the risk of companies simply switching to hydrocarbon gases to avoid the high costs of replacing HFC refrigerants without investing in the equipment needed. Adding hydrocarbons to non-hydrocarbon equipment, as is most of the RAC equipment in Australia according to Anderson, could lead to additional incidents like the large industrial fire that was caused in this manner in New Zealand.[7]

## The Australian Refrigeration Association and Prospects for Natural Refrigerants

Perhaps it is most fitting to introduce the Australian Refrigeration Association (ARA) in the context of this controversy over the impact of Australia's clean energy legislation on the RAC industry. The ARA and its website, www.ausref.org.au, were formally launched on May 2, 2012 at an event in the New South Wales Parliament. What sets the ARA apart from other Australian refrigeration and air conditioning industry associations is its enthusiasm for the government's carbon pricing scheme for HFCs. The ARA aims to work with the RAC industry to successfully manage both the challenges and opportunities created by the HFC levy and the coming HCFC phase out. ARA's mission statement regards "the transition of the industry to safe, efficient and sustainable technology and management practices" as a critical issue and states that one of its immediate goals is to cause the RAC industry "to adapt a comprehensive strategy to increase energy efficiency and reduce refrigerant and greenhouse gas emissions in all RAC sectors." Next to the mission statement on the ARA website appears a chart forecasting global $CO_2$ and HFC emissions until 2050, further highlighting the association's commitment to environmental sustainability, making it an instinctive ally of natural refrigerants.[8] Given that, it is no surprise that several IIAR members are among the founding members listed on ARAs website.

As for the concerns about the impact of the carbon levy expressed by Refrigerants Australia, ARA's President, Tim Edwards, has publicly described their comments on hydrocarbons as scaremongering. Edwards notes that it is common knowledge among refrigeration technicians that there are dangers with all refrigerants; careful handling is required equally for both fluorocarbons and the natural refrigerants. The central issues are economic efficiency and environmental impact; and, as Edwards points out, natural refrigerants are preferable to HFCs on both counts. He adds that hydrocarbon refrigerants already have a proven track record of safe and efficient use, citing the fact that there are over 400 million domestic refrigerators using hydrocarbons worldwide and extensive use in the automotive air conditioning service market with a negligible record of safety issues. Furthermore, the Consumer Goods Forum, a group comprising many of the leading global food suppliers and retailers, endorses natural refrigerants as safe, energy efficient and environmentally friendly. The ARA stresses that the idea behind the carbon legislation is to encourage the transition from fluorocarbons to natural refrigerants, which Australia's HVAC&R industry should embrace rather than fear. Any safety incidents that occur with natural or any other refrigerants are a result of the failure to follow industry standards and safe work practices. The risks of ignoring safety standards apply to all refrigerants and should therefore not be regarded as something unique to natural refrigerants.[9]

In light of the need for increasing awareness on the proper handling of natural refrigerants, ARA offers access to a set of government-subsidised training units on the safety and legal requirements for the handling, use and storage of natural refrigerants. Three separate units are available covering hydrocarbons, $CO_2$ and ammonia. A second set of three units corresponding to each of the refrigerants just mentioned covers the installation and commissioning of systems, components and related equipment.[10]

6 http://www.climatecontrolnews.com.au/news/preparing-for-the-carbon-tax

7 http://www.climatecontrolnews.com.au/news/carbon-tax-ignites-explosive-debate

8 http://www.ausref.org.au/index.php/about-ara/our-mission

9 http://www.ausref.org.au/index.php/24-ara-content/media-releases/51-media-release-refrigerants-australia-scaremongering-all-refrigerants-have-risks

10 http://www.ausref.org.au/index.php/2012-10-15-13-37-09/course-information

IIAR member John Mott acknowledges that the Australian RAC industry faces a number of real challenges related to the HFC levy in the short term. These include a frenzy of efforts to reduce loss of synthetic coolants that could prove to be costly for many small HFC contractors, not to mention the real risk of desperate "maverick contractors" dropping HCs into large systems not designed for HCs with disastrous consequences that could represent a major setback for natural refrigerants. On the latter point, he adds that efforts are under way to finalize the publication of an HC code of practice as soon as possible. He emphasizes that education and communication are crucial for the transition to the widespread use of HCs. Another difficulty is his observation that the Australian government, so far, has done little in the way of offering financial support for this transition which represents a "massive and expensive challenge" for all the players in the refrigeration industry; he concludes that a lobbying effort is required to prod the government to play its promised roll in providing financial support for this endeavor.[11]

Hydrocarbon refrigerant manufacturers and distributors have experienced a substantial spike in demand during 2012, and it is believed that most of this is from the long-established automotive air-conditioning service market. There also appears to be increasing interest in HCs from the transport refrigeration sector, where the high leakage rates of HFC R404a are now a significant cost burden, and as understanding spreads of the significant fuel savings from HCs that are available to trucking companies operating refrigerated trailers on long journeys between State capitals. Reduced refrigerant and fuel costs are more than sufficient to justify the application of sophisticated leak detection and alarm systems by prudent operators. While the requirement for gaining manufacturer's approval of system modifications remains a contentious issue between supporters and opponents of hydrocarbon refrigerants, there is hope that development of the hydrocarbon code of practice may provide greater clarity and guidance than currently exists.[12]

Mott paints a brighter picture for the long term outlook, expecting the achievement of "a semi-orderly progression to natural refrigerants." Most of the Australian supermarket industry has accepted $CO_2$ cascade technology; the number of $CO_2$ cascade systems in operation today is approaching 100 and he expects the remaining 3400 or so supermarkets to be updated with this technology over the coming decades. End users have recently begun to adopt transcritical $CO_2$ systems; IIAR member and ARA Board member Klaas Visser has been a pioneer in this effort which he refers to as the "revival" of $CO_2$ as a refrigerant (given that $CO_2$ was widely used as a refrigerant in the late 19th and early 20th centuries).[13] As for hydrocarbons, Mott notes that many HC "mini-chillers"(<500 grams) have been installed for air conditioning in remote areas, HC commercial chillers (<60 kg per circuit) are beginning to be installed for air conditioning and other purposes, and many refrigerators for home use are now available with HCs. Aldi supermarkets use self-contained HC freezer cabinets from Austrian manufacturer AHT. Last but not least, new installations of ammonia chillers for air conditioning and process applications continue to appear in Australia.[14] iar

[11] e-mail from John Mott, January 2013

[12] Paragraph by Brent Hoare of the Green Cooling Association

[13] Klaas Visser's French Refrigeration Journal Article, 2011

[14] e-mail from John Mott, January 2013

*Code Update continued from page 10*

For example, the technical committee that writes ASHRAE 15 is facing new challenges, particularly with respect to incorporating the new Group 2L refrigerant class. Much of the effort associated with integration of Group 2L refrigerants is focused on human comfort air conditioning systems; however, because ammonia is classified as Group 2L, any integration of this new category into ASHRAE 15 must be done with an eye on the affect on industrial ammonia systems. If ASHRAE 15 were modified to simply reference IIAR 2 for industrial ammonia systems, this issue and the challenge of sifting ammonia regulations out of the complexity of ASHRAE 15 would be resolved.

On IIAR's side, the Standards Committee, which is charged with maintaining IIAR 2, faces a significant challenge of incorporating regulations for topics that have previously been entrusted to ASHRAE 15. That work is already well underway, and the current objective is to have this work completed for incorporation into the 2014 update of IIAR 2.

In summary, some may wonder whether things can simply continue as they have for the past 40 years, and the answer to that question is "yes." But, the more important question is "can we do things better and better serve the public interest by developing IIAR 2 into a standalone standard for industrial ammonia systems?" The answer to that question is also "yes." To get there will require a consensus of the industry that IIAR 2 is ready to come out from under the wing of ASHRAE 15, and that should be a popular topic of discussion over the next year or two. iar

# IIAR Program Answers Industry

## with Small Facility Safety Guidelines

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?

Enter the Ammonia Refrigeration Management Program, a program built by the International Institute of Ammonia Refrigeration to help 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.

Dean Foods' Basel agreed, saying, "Our job has always been to operate a safe ammonia system. There are certain basic things that everyone in our industry must be aware of, but the rest of the safety process is often determined by what each plant decides to do depending on its workforce and size, and that's where the process can get confusing."

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

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.

"With larger facilities, we've got more people and we've been following PSM since the 90's. As an industry, we're required to have operation and maintenance procedures written down and we have a more formal infrastructure run by employees with developed skill sets and specialists with a specific knowledge of PSM/RMP," said Basel.

"That capability doesn't necessarily apply to our small facilities, but we still need a way to do the same thing at the small facilities we operate in order to meet safety requirements. ARM allows you to formalize training and procedures and document what you have, how it works and how it should be maintained."

Peter Jordan, senior principle engineer at MBD Risk Management and past IIAR Chair, said the genesis of IIAR's ARM program came as OSHA and the industry as a whole turned its attention to safety practices at small facilities as process safety management became an industry standard at larger facilities.

"At the time, it was known that a number of larger companies were developing programs for their smaller facilities – to reflect the spirit of PSM/ RMP – but also to respond to the general duty clause. The idea was that the industry as a whole was looking for a way to apply these practices to smaller facilities," said Jordan.

With ARM, IIAR formalized the effort to extend broader industry knowledge and safety practices to smaller companies and facilities.

"We basically took apart process safety management to look at what is absolutely necessary to have a safe system, and we tried to make that as simple and straightforward as we could. There are certain basics across the industry that ARM identifies, as well as suggested practices that may or may not apply to small facilities," Jordan said.

The end result was a program that includes ten general elements that a facility operating with less than 10,000 pounds of ammonia should consider including in its program as well as specific guidelines contained in these elements that may or may not be appropriate for every facility given the wide range of operating conditions and acceptable safety management practices.

For smaller facilities, ARM is on its way to becoming a standard industry resource.

"Forty percent of my plants are following programs developed with ARM because they those plants are small operations," said Basel. "And the reason is that I can't impose a PSM program on a plant with two people in it. At small facilities, there's simply not the skill sets or the manpower to get that done."

Basel added that his company has used ARM as a way to outline basic practices and set up essential training for the number of small facilities it operates. "We are implementing ARM for small facilities at Dean Foods because we have so many of them. If you use ammonia, even if it is a small amount, you need to operate your plant safely. ARM says, 'here's what you need to do,' even if you don't have enough people to implement a PSM or handle the paperwork that goes with it."

Long term, said Basel, the company hopes to institute ARM as a formal program that covers all of the company's small facilities.

"We really think this program would be great for every smaller plant we operate, and it's also a great tool for smaller, independent facilities without the resources of a large company behind them," said Basel. "We've been very successful with the ARM plan in the plants where we've instituted it, and we've had a lot of success with the EPA as well."

"ARM is an important program for everyone who operates small facilities in our industry, it makes us operate our systems smarter and it's a really great starting point for smaller facilities and companies because it guides them through the process of maintaining their systems safely," said Marrella. "ARM is really an essential tool for anyone running a facility with under 10,000 pounds of ammonia." iar


# Industrial Refrigeration Conference & Exhibition Slated for Colorado Springs

This year, IIAR's 2013 Industrial Refrigeration Conference & Exhibition will be hold at one of the organization's most beautiful conference locations, the Broadmoor Hotel and Resort in Colorado Springs, Colorado, March 17–20. With the usual emphasis on a well developed technical track, including a special focus on $CO_2$, this year's program will encompass many of the industry's most important subject areas.

From an examination of the prospects of ammonia based ocean thermal energy conversion systems, to a variety of in-depth case studies, IIAR's technical program promises to deliver new perspectives and useful information.

This year, IIAR is extending a special welcome to members and attendees with a new educational event, a special workshop focused exclusively on $CO_2$, on Sunday March 17.

New in 2013, the workshop expands the training resources of the industry, continuing a valuable training initiative which started with the IIAR ammonia safety training event offered at the 2012 conference.

The workshop has been designed by IIAR's $CO_2$ Committee to provide practical training on this technology, which has only recently emerged as both a primary refrigerant and a low temperature partner for ammonia in cascade systems.

This event is offered in conjunction with the 2013 annual conference, and is a great deal for any conference attendee. The price for the four-hour training session is less than the member price of the $CO_2$ handbook, provided as part of the workshop.

Another exciting event being held in conjunction with the conference is the Ammonia Refrigeration Foundation's 2013 fundraising golf tournament, held this year on one of the Broadmoor's spectacular PGA caliber golf courses on March 16.

Set high in the Cheyenne Mountain foothills of Colorado Springs with stunning views and challenging but enjoyable terrain, the Broadmoor has earned a reputation as one of the world's best golf destinations.

Each ARF tournament contributor will hold a place of honor in the history of the Ammonia Refrigeration Foundation. As a sponsor, an investment in the Ammonia Refrigeration Foundation will pay dividends through research and education in years ahead.

IIAR's Conference & Exhibition would not be possible without the focused dedication and involvement of its members. The work of IIAR volunteer members makes it possible to foster an environment of collective education and exchange of ideas through the technical program sessions and workshops.

IIAR sponsors and exhibitors also play an invaluable role in bringing the newest products and technologies to industry professionals. Attracting the most qualified business leaders and peer-to-peer networking groups, the conference is the largest gathering of industrial refrigeration decision makers in the industry.

As an IIAR member, you have access to the best forum in the world for industrial refrigeration professionals who want to stay educated on the issues they face in their day-to-day business environment. IIAR is continuously working to broaden the scope of the industry by fostering a valuable exchange of ideas and knowledge. The IIAR Conference & Exhibition is an important part of that effort. We hope to see you there!

# Conference Sponsors

Exhibit Hall Lunch – Monday, March 18

Afternoon Break – Tuesday, March 19

Registration Maps

Afternoon Break – Monday, March 18

Continental Breakfast – Monday, March 18

Bookstore

Morning Break – Monday, March 18

Water Bottles

Regulatory Update Lunch – Tuesday, March 19

Note Pads

Registration Bags

Pocket Schedule

$CO_2$ Program

Chairman's Reception Exclusive

Morning Break – Wednesday, March 20

Hotel Room Keys

Monday Night Banquet

Morning Break – Tuesday, March 19

Luggage Tags

International Dinner

Badge Lanyards

Continental Breakfast – Tuesday, March 19

Continental Breakfast – Wednesday, March 20


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## CARBON DIOXIDE TRAINING PROGRAM • Sunday March 17, 2013 • 1:00 PM – 5:00 PM

With the ever increasing awareness of the benefits Natural Refrigerants have for the environment there has been a renewed emphasis in the use of Carbon Dioxide ($CO_2$) as a refrigerant for the Industrial Refrigeration Industry. Naturally occurring refrigerants like Ammonia ($NH_3$) and Carbon Dioxide ($CO_2$) are by definition environmentally neutral. Unlike CFC and HCFC halocarbon refrigerants, natural refrigerants have zero Ozone Depletion Potential (ODP) and have zero or extremely low Global Warming Potential (GWP). Because of its low environmental impact and operational efficiency, $CO_2$ is coming into wide use in both industrial and commercial refrigeration systems worldwide. The need for more guidance and information on the subject of $CO_2$ in Industrial Refrigeration has never been greater.

This year at the 2013 Industrial Refrigeration Conference & Exhibition in Colorado Springs, CO, IIAR will offer a half day $CO_2$ Training Program. This Program will focus on the industrial use of $CO_2$ cascade systems with Ammonia as well as trans-critical systems using only $CO_2$ and will incorporate a comprehensive range of practical, experience-based information from some of the best minds in our industry.

Brian Marriott – $CO_2$ Program Moderator

### Speakers

Hernan Hidalgo – Danfoss Industrial Refrigeration A/S
Charles Kulp – United States Cold Storage, LLC
Andy B. Pearson, Phd – Star Refrigeration Ltd.
Ronald C. Worley – Nestle USA Corporate Engineering

*Takes place in Colorado Hall*

### Program Outline

- A brief recount of the history of $CO_2$ utilization in Industrial Refrigeration and introduction of the speakers
- Practical safety, design and operating considerations for $CO_2$/ammonia cascade and tans-critical systems gleaned from extensive contracting experience applying these technologies in industrial refrigerating systems
- Lessons learned through the startup, commissioning and operation of $CO_2$/ammonia cascade refrigeration in a large green field food production and low temperature freezing facility
- Brief coffee break
- Design optimization of $CO_2$/ammonia cascade technology in the public refrigerated warehouse industry sector through extensive experience and data gained from the design, construction and operation of this technology in several installations
- Design considerations and the practical application of trans-critical $CO_2$ refrigeration in commercial and small industrial installations including an overview of currently operating systems in various global regions
- Question and answer forum with the program speakers
- Program closing comments and provision of PDH/CEU code.

For a registration fee of only $300 you will receive a newly updated IIAR Carbon Dioxide Handbook (a $350 member value all by itself) as well as 4 hours of supplemental experience-based education with copies of the annotated program presentations to take home with you. This program is assigned four PDH/CEU units and validation forms will be included in the attendance package.

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**Class size is limited, so make sure to register for this event early.**



## Saturday, March 16

| | | |
|---|---|---|
| 8:00 a.m. – 2:00 p.m. | ARF Golf Function – Paid Registration | Colorado Hall and Winter Course |
| 12:00 p.m. – 5:00 p.m. | Board Luncheon and Meeting – Invitation Only | Donald Ross Room/ Robert Trent Jones Room |
| 1:00 p.m. – 5:00 p.m. | Registration Open | Broadmoor Hall Registration |
| 1:00 p.m. – 5:00 p.m. | Exhibitor Setup | Broadmoor Hall |

## Sunday, March 17

| | | |
|---|---|---|
| 7:00 a.m. – 12:00 p.m. | Committee Meetings | Broadmoor West |
| 8:00 a.m. – 5:00 p.m. | Exhibitor Setup | Broadmoor Hall |
| 10:00 a.m. – 5:00 p.m. | Registration Open | Broadmoor Hall Registration |
| 1:00 p.m. – 5:00 p.m. | $CO_2$ Training Program – Paid Registration – *Sponsored by CIMCO Refrigeration* | Colorado Hall |
| 5:30 p.m. – 6:00 p.m. | First Timer's Reception | Colorado Hall |
| 6:00 p.m. – 7:00 p.m. | Chairman's Reception – *Sponsored by Republic Refrigeration, Inc.* | International Center |

## Monday, March 18

| | | |
|---|---|---|
| 7:00 a.m. – 5:00 p.m. | Registration Open | Broadmoor Hall Registration |
| 7:30 a.m. | Continental Breakfast – *Sponsored by Summit Refrigeration Group* | International Center Foyer |
| 8:00 a.m. | Zumba Class – Spouse/Guest Registration Required Breakfast starts at 8:00 a.m. | Robert Trent Jones Room |
| 8:00 a.m. | IIAR Business Meeting | International Center |
| 8:30 a.m. | Ed Viesturs – Plenary Speaker | International Center |
| 9:15 a.m. | Exhibit Hall Opens | Broadmoor Hall |
| 9:30 a.m. | Technomercial – Frick by Johnson Controls – LaZerWeld Plate & Frame Heat Exchangers "An Efficient, Sustainable Solution for Heat Recovery" | Broadmoor Hall |
| 10:00 a.m – 12:00 p.m. | Concierge Services and Broadmoor History – Spouse/Guest | Donald Ross Room |
| 10:00 a.m. | Break – Exhibit Hall – *Sponsored by Parker-Hannifin* | Broadmoor Hall |
| 10:30 a.m. | Technomercial – Hansen Technologies – MVP Multi-Valve Platform: The Modular Control Solution for Quick, Easy Interchangeability and Cost Efficient Servicing | Broadmoor Hall |
| 11:30 a.m. | Technomercial – MYCOM (Mayekawa USA, Inc.) – Second Nature: Mycom's New Trail for Refrigeration Technology | Broadmoor Hall |
| 12:00 p.m. | Lunch – Exhibit Hall – *Sponsored by EVAPCO, Inc.* | Broadmoor Hall |
| 12:30 p.m. | Technomercial – Colmac Coil Manufacturing, Inc. – How Colmac A+Series™ Air Coolers Can Reduce Your System Ammonia Charge | Broadmoor Hall |
| 1:15 p.m. | Exhibit Hall Closes | Broadmoor Hall |
| 1:30 p.m. | Technical Paper #1 – Prospects of Ammonia Based Ocean Thermal Energy Conversion (OTEC) Systems | Colorado Hall AB |
| | Workshop #1 – Ammonia Gas Detection | Colorado Hall DE |
| | Trabajo técnico #1 – Movimiento y manejo de amoníaco líquido y aceite dentro de sistemas de refrigeración | Colorado Hall C |
| 2:15 p.m. | Technical Paper #2 – Ammonia in Traditional HFC Territory: How Does it Compare? | Colorado Hall AB |
| | Workshop #2 – Non-Destructive Testing | Colorado Hall DE |
| | Trabajo técnico #2 – Estudio de un caso real de golpe hidráulico en tuberías de refrigeración con amoníac | Colorado Hall C |
| 2:30 p.m. – 4:00 p.m. | Wine Tasting – Spouse/Guest Event – Pre-Registration Required – space is limited | Summit Restaurant |
| 3:00 p.m. | Break – *Sponsored by MRBraz and Associates, PLLC* | Colorado Hall Foyer |
| 3:30 p.m. | Technical Paper #3 – Design Methodology and Impact of Cross Flow Heat Exchangers | Colorado Hall AB |
| | Workshop #3 – Multiple Causes of an Ammonia Accident | Colorado Hall DE |
| | Trabajo técnico #3 – Conceptos básicos de psicrometría para aplicarse en proyectos de refrigeración industrial | Colorado Hall C |
| 4:15 p.m. | Technical Paper #4 – Leveraging Energy Efficient Lighting Technologies to Reduce Wasted Heat and Operating Costs | Colorado Hall AB |
| | Workshop #4 – Insulation Condensation | Colorado Hall DE |
| | Taller #1 – Humedad en sistemas de refrigeración industrial | Colorado Hall C |

# PROGRAM SCHEDULE

## THE BROADMOOR • COLORADO SPRINGS • COLORADO • MARCH 17-20

| | | |
|---|---|---|
| 6:00 p.m. | Reception | International Center Foyer |
| 6:30 p.m. – 10:30 p.m. | Banquet – *Sponsored by GEA Refrigeration North America, Inc.* | International Center |

## Tuesday, March 19

| | | |
|---|---|---|
| 7:00 a.m. – 5:00 p.m. | Registration Opens | Broadmoor Hall Registration |
| 7:30 a.m. | Exhibit Hall Opens | Broadmoor Hall |
| 7:30 a.m. | Continental Breakfast – Exhibit Hall – *Sponsored by Farley's S.R.P., Inc.* | Broadmoor Hall |
| 8:00 a.m. | Technomercial – Airgas Specialty Products – Safety: It's Either Respect or Regret | Broadmoor Hall |
| 8:00 a.m. | Breakfast and Massage – Spouse/ Guest Event – Pre-Registration Required | Donald Ross Room |
| 9:00 a.m. | Technomercial – EVAPCO, Inc. – Understanding the International Building Code (IBC) and its Impact on Refrigeration Equipment | Broadmoor Hall |
| 9:30 a.m. | Break in Exhibit Hall – *Sponsored by Airgas Specialty Products* | Broadmoor Hall |
| 10:00 a.m. | Technomercial – Vilter Manufacturing, LLC– Heat Pumps: The next generation | Broadmoor Hall |
| 10:30 a.m. | Exhibit Hall Closes | Broadmoor Hall |
| 10:30 a.m. | Exhibitor Advisory Committee Meeting | Colorado Hall C |
| 10:45 a.m. | Technical Paper #5 – Ice Rink Case Study: Comparing Trans–critical $CO_2$ Direct System with an Ammonia Heat Recovery System | Colorado Hall AB |
| | Workshop #5 – Mechanical Integrity Procedures | Colorado Hall DE |
| | Trabajo técnico #4 – Ineficiencias térmicas y termodinámicas sobre aspectos energéticos en una planta productora de hielo | Colorado Hall C |
| 11:30 a.m. | Technical Paper #6 – Case Study: Use of Outdoor Dispersion Modeling Systems in Ammonia Refrigeration Facility Design | Colorado Hall AB |
| | Workshop #6 – Next Generation of Valves | Colorado Hall DE |
| | Trabajo técnico #5 – Comparando la construcción de evaporadores de amoníaco: ¿Cuál es mejor? | Colorado Hall C |
| 12:30 p.m. – 1:45 p.m. | Regulatory and Code Update Lunch – *Sponsored by Vilter Manufacturing, LLC* | International Center |
| 1:45 p.m. – 3:15 p.m. | Board Meeting – Invitation Only | El Pomar Room *room subject to change |
| 2:00 p.m. | Technical Paper #7 – Heat Transfer Rates and Refrigeration System Performance | Colorado Hall AB |
| | Workshop #7 – Fire Protection for Refrigerated Facilities | Colorado Hall DE |
| | Portuguese Workshop #1 – Gerenciamento de Custos de Energia em Armazéns Frigoríficos | Colorado Hall C |
| 2:45 p.m. | Technical Paper #8 – Proper Application and Sizing of Metering Devices | Colorado Hall AB |
| | Workshop #8 – Personal Protective Equipment | Colorado Hall DE |
| | Taller #2 – La cadena de frío en Latinoamérica | Colorado Hall C |
| 3:00 p.m. | Exhibit Hall Opens | Broadmoor Hall |
| 3:30 p.m. | Break in Exhibit Hall – *Sponsored by Colmac Coil Manufacturing, Inc.* | Broadmoor Hall |
| 4:00 p.m. | Technomercial – Vahterus Oy – Vahterus Combined: An Integrated Solution for Flooded Applications. | Broadmoor Hall |
| 6:00 p.m. – 7:00 p.m. | Exhibitor's Reception | Broadmoor Hall |
| 7:00 p.m. | Exhibit Hall Closes | Broadmoor Hall |

## Wednesday, March 20

| | | |
|---|---|---|
| 7:00 a.m. – 9:00 a.m. | Registration Open | Broadmoor Hall Registration |
| 7:30 a.m. | Exhibit Hall Opens | Broadmoor Hall |
| 7:30 a.m. | Continental Breakfast – Exhibit Hall – *Sponsored by MYCOM (Mayekawa USA, Inc.)* | Broadmoor Hall |
| 9:30 a.m. | Exhibit Hall Closes | Broadmoor Hall |
| 9:00 a.m. | Panel #1 – Research Update | Colorado Hall AB |
| | Panel #2 – The Road to Natural Refrigerants | Colorado Hall DE |
| 10:30 a.m. | Break – *Sponsored by Howden Compressors, LLC* | Colorado Hall Foyer |
| 11:00 a.m. | Closing Forum – Alarms and Detection | Colorado Hall AB |
| 12:30 p.m. | Conference Adjourns | |

# KEYNOTE SPEAKER

## ED VIESTURS

Washington resident Ed Viesturs is widely regarded as this country's foremost high-altitude mountaineer. He is familiar to many from the 1996 IMAX documentary EVEREST and in 2002, he was awarded the historic Lowell Thomas Award by the Explorer's Club for outstanding achievement in the field of mountaineering.

Viesturs is a professional mountaineer and works as a design consultant for several prominent outdoor equipment manufacturers such as Eddie Bauer/First Ascent and Grandoe Gloves. He also represents companies such as Rolex and the Seattle Seahawks.

Viesturs has successfully reached the summits of all of the world's fourteen 8000-meter peaks without supplemental oxygen, an 18 year project he christened Endeavor 8000. His goal was completed on May 12, 2005 with his ascent of Annapurna one of the world's most treacherous peaks. He is one of only a handful of climbers in history (and the only American) to accomplish this. That year Viesturs was awarded National Geographic's Adventurer of the Year.

During the 18 year span to climb the world's highest peaks he went on 29 Himalayan expeditions and reached the summit on 20 of these occasions and stood on the top of Everest seven times. Viesturs motto has always been that climbing has to be a round trip. All of his planning and focus during his climbs maintains this ethic and he is not shy about turning back from a climb if conditions are too severe. In spite of his conservative attitude Viesturs has been one of the most successful Himalayan climbers in American history.

**Monday, March, 18** | 8:30 a.m. | International Center

# TECHNICAL PAPERS

## 2013 TECH PAPER SCHEDULE

Technical Paper #1
Prospects of Ammonia Based Ocean Thermal Energy Conversion (OTEC) Systems
Monday, March 18 | 1:30 p.m. – 2:15 p.m.

Technical Paper #2
Ammonia in Traditional HFC Territory: How Does it Compare?
Monday, March 18 | 2:15 p.m. – 3:30 p.m.

Technical Paper #3
Design Methodology and Impact of Cross Flow Heat Exchangers
Monday, March 18 | 3:30 p.m. – 4:15 p.m.

Technical Paper #4
Leveraging Energy Efficient Lighting Technologies to Reduce Wasted Heat and Operating Costs
Monday, March 18 | 4:15 p.m. – 5:00 p.m.

Technical Paper #5
Ice Rink Case Study: Comparing Trans-critical $CO_2$ Direct System with an Ammonia Heat Recovery System
Tuesday, March 19 | 10:45 a.m. – 11:30 a.m.

Technical Paper #6
Case Study: Use of Outdoor Dispersion Modeling Systems in Ammonia Refrigeration Facility Design
Tuesday, March 19 | 11:30 a.m. – 12:15 p.m.

Technical Paper #7
Heat Transfer Rates and Refrigeration System Performance
Tuesday, March 19 | 2:00 p.m. – 2:45 p.m.

Technical Paper #8
Proper Application and Sizing of Metering Devices
Tuesday, March 19 | 2:45 p.m. – 3:15 p.m.

*All Technical Paper sessions will take place in Colorado Hall AB*

## 2013 PROGRAMMA EN ESPAÑOL

Trabajo técnico #1
Movimiento y manejo de amoníaco líquido y aceite dentro de sistemas de refrigeración
Monday, March 18 | 1:30 p.m. – 2:15 p.m.

Trabajo técnico #2
Estudio de un caso real de golpe hidráulico en tuberías de refrigeración con amoníac
Monday, March 18 | 2:15 p.m. – 3:30 p.m.

Trabajo técnico #3
Conceptos básicos de psicrometría para aplicarse en proyectos de refrigeración industrial
Monday, March 18 | 3:30 p.m. – 4:15 p.m.

Taller #1
Humedad en sistemas de refrigeración industrial
Monday, March 18 | 4:15 p.m. – 5:00 p.m.

Trabajo técnico #4
Ineficiencias térmicas y termodinámicas sobre aTrabajo técnicoectos energéticos en una planta productora de hielo
Tuesday, March 19 | 10:45 a.m. – 11:30 a.m.

Trabajo técnico #5
Comparando la construcción de evaporadores de amoníaco: ¿Cuál es mejor?
Tuesday, March 19 | 11:30 a.m. – 12:15 p.m.

Taller #2
La cadena de frío en Latinoamérica
Tuesday, March 19 | 2:45 p.m. – 3:15 p.m.

## 2013 Programa Português

Workshop #1
Gerenciamento de Custos de Energia em Armazéns Frigoríficos
Tuesday, March 19 | 2:00 p.m. – 2:45 p.m.

*All Spanish Language and Portuguese Language sessions will take place in Colorado Hall C*

# WORKSHOPS PANELS FORUMS

## 2013 WORKSHOP SCHEDULE

Workshop #1: Ammonia Gas Detection
Monday, March 18 | 1:30 p.m. – 2:15 p.m.

Workshop #2: Non-Destructive Testing
Monday, March 18 | 2:15 p.m. – 3:30 p.m.

Workshop #3: Multiple Cases of an Ammonia Accident
Monday, March 18 | 3:30 p.m. – 4:15 p.m.

Workshop #4: Insulation Condensation
Monday, March 18 | 4:15 p.m. – 5:00 p.m.

Workshop #5: Mechanical Integrity Procedures
Tuesday, March 19 | 10:45 a.m. – 11:30 a.m.

Workshop #6: Next Generation of Valves
Tuesday, March 19 | 11:30 a.m. – 12:15 p.m.

Workshop #7: Fire Protection for Refrigerated Facilities
Tuesday, March 19 | 2:00 p.m. – 2:45 p.m.

Workshop #8: Personal Protective Equipment
Tuesday, March 19 | 2:45 p.m. – 3:15 p.m.

*All Workshop sessions will take place in Colorado Hall DE*

## 2013 PANEL & FORUM SCHEDULE

Panel #1: Research Update
Wednesday, March 20 | 9:00 a.m. | Colorado Hall AB

Panel #2: The Road to Natural Refrigerants
Wednesday, March 20 | 9:00 a.m. | Colorado Hall DE

Closing Forum: Alarms and Detection
Wednesday, March 20 | 11:00 a.m. | Colorado Hall AB

# 2013 TECHNOMERCIALS

**Technomercial #1: Frick by Johnson Controls**
LaZerWeld Plate & Frame Heat Exchangers "An Efficient, Sustainable Solution for Heat Recovery"
Monday, March 18 | 9:30 a.m. – 10:00 a.m.

**Technomercial #2: Hansen Technologies**
MVP Multi-Valve Platform: The Modular Control Solution for Quick, Easy Interchangeability and Cost Efficient Servicing
Monday, March 18 | 10:30 a.m. – 11:00 a.m.

**Technomercial #3: MYCOM (Mayekawa USA, Inc.)**
Second Nature: Mycom's New Trail for Refrigeration Technology
Monday, March 18 | 11:30 a.m. – 12:00 p.m.

**Technomercial #4: Colmac Coil Manufacturing, Inc.**
How Colmac A+Series™ Air Coolers Can Reduce Your System Ammonia Charge
Monday, March 18 | 12:30 p.m. – 1:00 p.m.

**Technomercial #5: Airgas Specialty Products**
Safety: It's Either Respect or Regret
Tuesday, March 19 | 8:00 a.m. – 8:30 a.m

**Technomercial #6: EVAPCO, Inc**
Understanding the International Building Code (IBC) and its Impact on Refrigeration Equipment
Tuesday, March 19 | 9:00 a.m. – 9:30 a.m.

**Technomercial #7: Vilter Manufacturing, LLC**
Heat Pumps: The next generation
Tuesday, March 19 | 10:00 a.m. – 10:30 a.m.

**Technomercial #8: Vahterus Oy**
Vahterus Combined: An Integrated Solution for Flooded Applications
Tuesday, March 19 | 4:00 p.m. – 4:30 p.m.

*All Technomercials will take place in Colorado Hall*

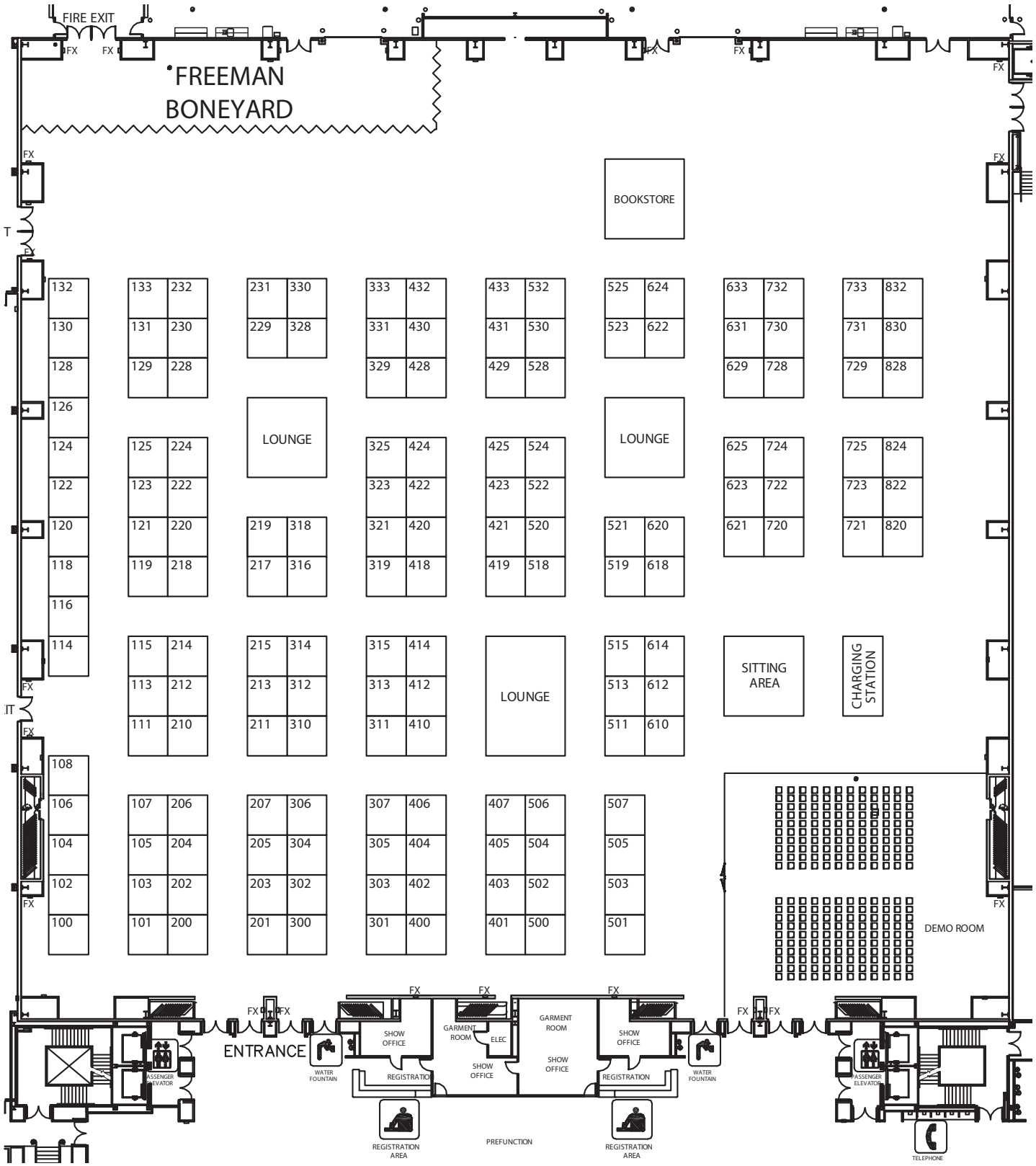
# COMMITTEES

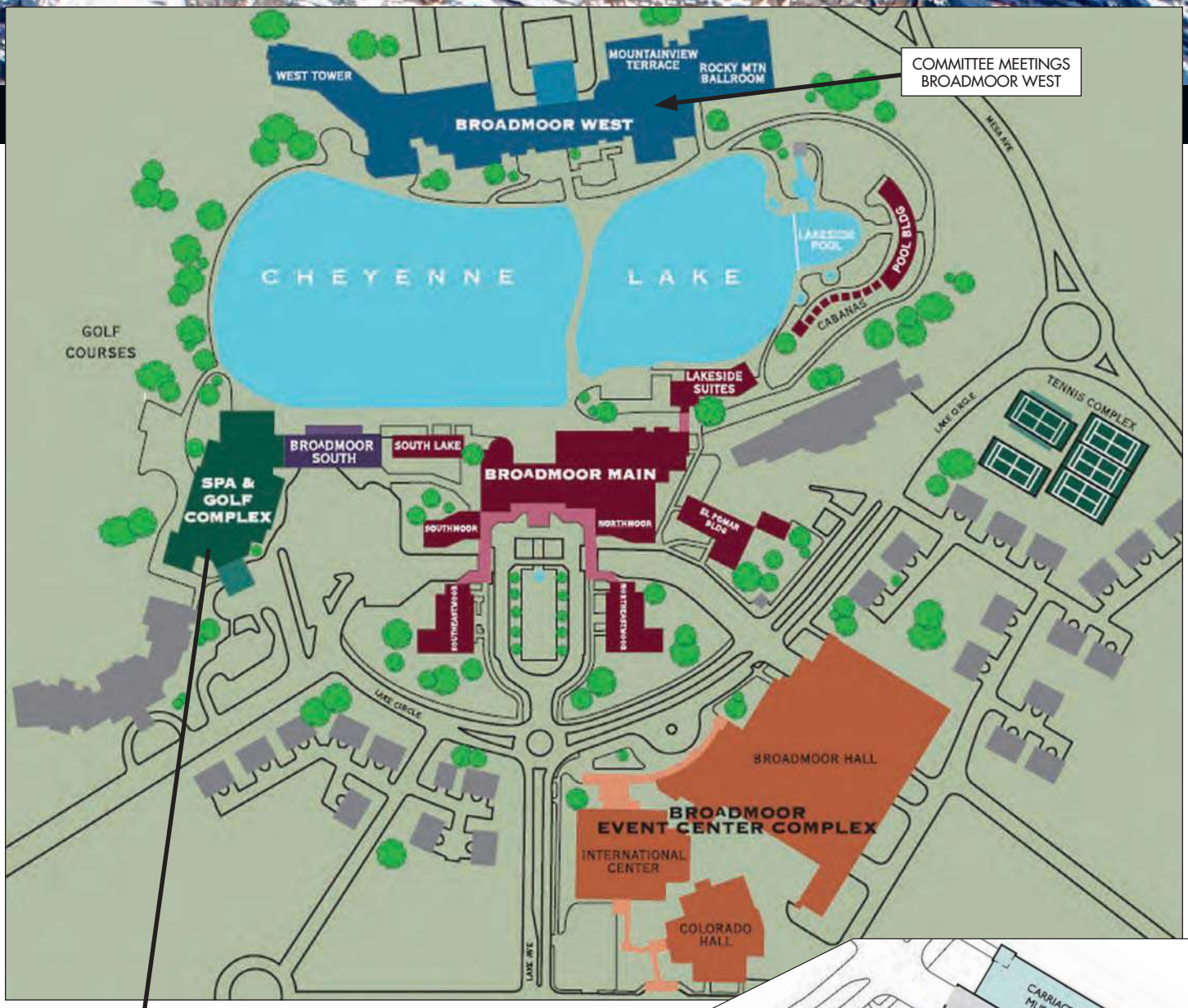
## 2013 COMMITTEE MEETINGS

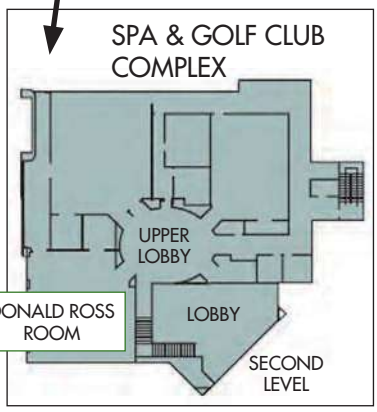
| Committee Name | Day | Time | Location |
|---|---|---|---|
| Safety | Sunday | 7:00 a.m. – 11:00 a.m. | Divide I |
| Latin America | Sunday | 8:00 a.m. – 8:45 a.m. | Rocky Mountain D |
| Government Relations | Sunday | 8:00 a.m. – 12 p.m. | Louis Stratta |
| Education | Sunday | 8:00 a.m. – 12 p.m. | Divide II |
| Piping | Sunday | 8:00 a.m. – 12 p.m. | West Ballroom AB |
| Standards | Sunday | 8:00 a.m. – 12 p.m. | Rocky Mountain A |
| Marketing | Sunday | 9:00 a.m. – 11 a.m. | McGrew |
| Code | Sunday | 9:00 a.m. – 12 p.m. | Rocky Mountain C |
| International | Sunday | 9:00 a.m. – 12 p.m. | Rocky Mountain B |
| Research | Sunday | 9:00 a.m. – 12 p.m. | West Ballroom CD |
| Exhibitor Advisory | Tuesday | 10:30 a.m. – 11:30 a.m. | Colorado Hall F |
| Ammonia Foundation | Wednesday | 7:00 a.m. – 8:30 a.m. | Colorado Hall F |
| $CO_2$ | Wednesday | 7:00 a.m. – 9:00 a.m. | Colorado Hall C |

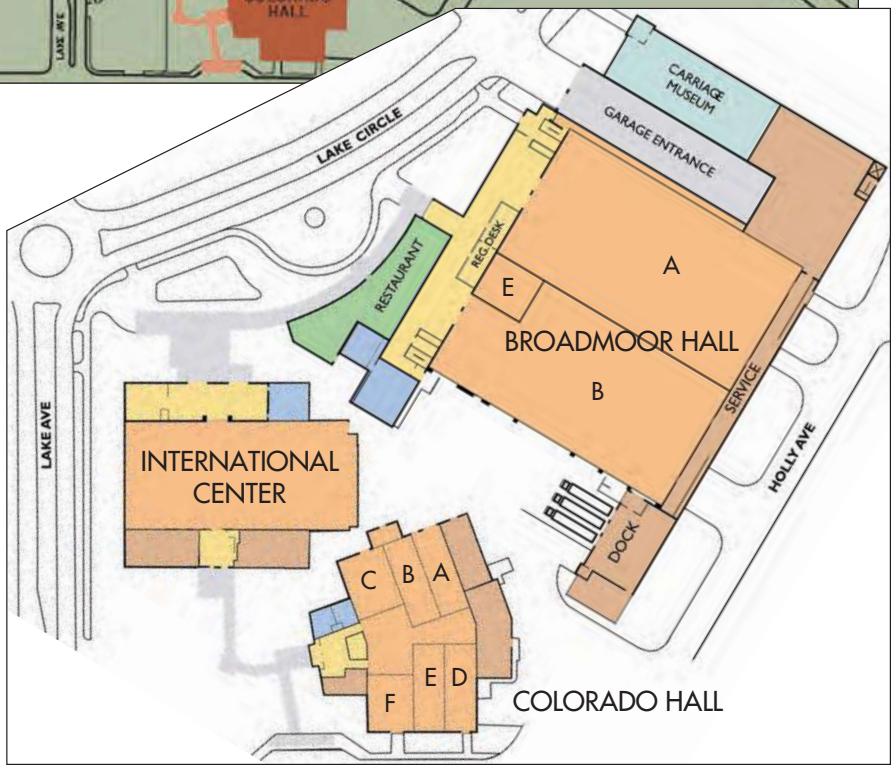
# EXHIBIT HALL FLOORPLAN

## THE BROADMOOR • BROADMOOR HALL






# HOTEL MAP
## THE BROADMOOR

**AAIM Controls** . . . . . Booth #400
From starters and drives to PLC systems and microprocessor designs, AAIM Controls has the expertise for all your automation requirements with over 90 years of combined refrigeration controls experience.

**A. Blasquez E. Refrigeración Industrial S.A. de C.V.** . . . . . Booth #620
A. Blasquez E. Refrigeraciòn (ABE) is the largest ammonia refrigeration contractor company in Latin America, specializing in refrigeration systems for breweries, beverages, food and cold storage industries. ABE, your refrigeration partner in Mexico.

**Acuren** . . . . . Booth #222
Acuren's industry-leading mechanical integrity services for ammonia refrigeration systems include Corrosion Under Insulation Scanning (CUI), Computerized Radiography (CR), API Tank and Vessel Inspections, and our exclusive inspection data management system, DMAPS.

**Advanced Energy Control** . . . . . Booth #330
AEC is a refrigeration and energy management controls company to the cold storage and food processing industries that provides the most comprehensive energy management systems on the market today.

**Airfoil Impellers**. . . . . Booth #306
Cast aluminum fan blades, machine room exhaust fans, product cooler fans, blast freezer fans, and general ventilation fans.

**Airgas Specialty Products** . . . . . Booth #305, 307
Airgas Specialty Products offers anhydrous ammonia, pump-outs, field service, safety video, safety training, and Cold Flow Sampler (for determining water in ammonia).

**Alfa Laval** . . . . . Booth #129
Manufacturer and supplier of semi-welded plate heat exchangers, gasketed heat exchangers and 100% stainless steel fusion-bonded heat exchangers for applications as condensers, evaporators, oil coolers, and economizers.

**American Industrial Refrigeration (AIR)** . . Booth #425
AIR is your premier industrial refrigeration contractor; a division of Corval Group, Inc. AIR has been providing design/Build engineering and installation, customized packaging skids, superior quality shop fabrication, parts and field service technicians across the U.S. and International markets since 1978.

**Ammonia Process Safety Management (APSM)** . . . . . Booth #319
APSM provides PSM software and services for effective compliance management.

**Ammonia Refrigeration Foundation (ARF)**. . . . Booth #524
ARF is a non-profit research and education foundation organized by members of the International Institute of Ammonia Refrigeration (IIAR) to promote educational and scientific projects related to industrial refrigeration and the use of ammonia and other natural refrigerants.

**Analytical Technology, Inc.** . . . . Booth #503
ATI designs and manufactures a complete line of ammonia gas detectors both fixed and portable and additionally gas detectors for 32 other toxic and combustible gases.

**Armstrong International, Inc.** . . . Booth #111
Armstrong provides intelligent system solutions that improve utility performance, lower energy consumption, and reduce environmental emissions while providing an "enjoyable experience."

**Ashworth Bros, Inc.** . . Booth #124
Ashworth is the world's largest manufacturer of conveyer belting and offers 24-7-365 nationwide service on every brand of spiral freezer including self-stacking. Emergency repairs, reconfiguration, relocation, refurbishments, upgrades, and preventative maintenance programs.

**ASTI** . . . . . Booth #431
ASTI was established in 1991, in recognition of the long standing need for training in the safe handling of ammonia, a chemical used widely throughout many areas of industry and agriculture. ASTI offers training in accordance with OSHA Standard 1910.120(q) - emergency response to hazardous substance releases.

**Bacharach, Inc.** . . . . . Booth #523
Fixed, continuous monitors for the detection of gases including ammonia, CO, $CO_2$, CFCs, HFCs, CH4, and more featuring multiple alarm, sensor and relay configurations. From one to 64 points, the units are ideal for chillers, walk-in freezers, public spaces, physical plants in commercial and industrial applications.

# EXHIBITOR LISTING

**Baker Inspection Group, LLC** . . . . . Booth #100
Mechanical Integrity and Process Safety Management Consulting; Testing & Inspection, NDT.

**Baltimore Aircoil Company** . . . . . Booth #201, 203
BAC is a worldwide manufacturer of heat transfer and ice thermal storage products. BAC's products include evaporative condensers, cooling towers, closed circuit cooling towers, ice thermal storage systems and equipment controls.

**Bitzer Canada, Inc.** . . Booth #721
$NH^3$ Direct Drive Screw Compressors with displacements ranging from 59 to 377 CFM. OS85 series includes slider control for infinite or stepped capacity control. Optimized for parallel compounding.

**Calibration Technologies** . . . . . Booth #316
Calibration Technologies is a manufacturer of gas detection equipment, specializing in Ammonia. CTI's engineers and technicians have over 30 years of experience in system design, sales, and field service. Calibration Technologies provides detection for NH3, CO2, CO, H2S, H2, O2, CH4, R22 and more in a variety of industries including cold storage, food processing, sea vessels, chemical plants, and many others.

**CAMCO Lubricants** . . Booth #422
Nationally known for both the CAMCO 717 series ammonia refrigeration oil and for high-quality food-grade lubes for all air compressors, gear, hydraulic, vacuum, and grease applications.

**Carnot Refrigeration, Inc.** . . . Booth #116
Carnot Refrigeration designs and manufactures state-of-the-art customized systems using environmentally friendly methods. It specializes in refrigeration systems for supermarkets, refrigerated warehouses, and arenas.

**Century Refrigeration, a division of RAE Corporation** . . . . . Booth #820
Century Refrigeration is the leader in Comdustrial™ Refrigeration Systems: The ideal balance of commercial and industrial refrigeration markets. We offer flexibility in design surrounded by durability in construction

**Chester-Jensen CO., Inc.** . . . . . Booth #217
Chester-Jensen manufactures air agitated ice builders, instant chillers, plate heat exchangers and other heat transfer equipment.

**CIMCO Refrigeration** . . . Booth #530, 532
CIMCO Refrigeration specializes in the engineering, design, manufacture, installation, and service of industrial, process cooling, and recreational refrigeration systems. With key locations across North America and around the world, we provide unique cooling solutions to meet our client's needs.

**Colmac Coil Manufacturing, Inc.** . . . . . Booth #321, 323, 325
From its newly opened second factory in Illinois, Colmac is supplying its Aircoil™ and custom aluminum, stainless, and galvanized steel evaporators to Midwest and Eastern markets.

**Concepts and Designs, Inc.** . . . . . Booth #733
Concepts and Designs is a premier supplier of dehumidification systems for humidity and condensation control. Dehumidification provides a permanent solution to avoid contamination hazards in compliance with USDA, zero tolerance.

**Cool Air Incorporated** . . . . . Booth #420
For over 30-years, Cool Air Incorporated has provided quality ammonia leak detection systems and equipment. Please review our new website @ www.coolairinc.com for all of our product line and calibration videos.

**Cornell Pump Company** . . . . . Booth #500
Cornell Pump presents the latest innovations in refrigerant pumps including their new high-pressure, low-speed 2.5 CBH. Cornell also manufactures high quality glycol and chiller pumps.

**Cyrus Shank Company** . . . . . Booth #311
The Cyrus Shank Company manufactures and sells industry-leading relief valves and other products for the refrigeration industry such as relief valves, shut-off valves, bolted bonnet shut-off valves, flanged valves, expansion valves, needlepoint valves, check valves, three-way valves, line valves, purge valves, manifolds, brass valves, etc.

**Danfoss** . . . . . Booth #401, 403
Danfoss' complete line of refrigeration valves and electronic controllers includes assembled valve stations in one shared housing and weld-in motorized, solenoid and control valves designed to 754 psg.

**Delta Tee International, Inc.** . . . Booth #504
Delta Tee manufactures heat exchangers, pressure vessels and systems, complete capabilities in designing and manufacturing shell and tube heat exchangers for refrigeration, air conditioning, chem-process, food and other applications.

**DHS, NPPD, Office of Infrastructure Protection**. . . . . Booth #633
The Department of Homeland Security Chemical Sector works with critical infrastructure partners on a voluntary basis to develop, coordinate, an implement programs to increase chemical facility protection and resilience. The Chemical Sector and the products it produces are essential to many facets of modern life including a safe water supply, energy production, increased food production, housing, health care, computer technology, and transportation.

**Digital Lumens, Inc.**. . Booth #729
The digital Lumens LED-based Intelligent Lighting System is proven to reduce warehouse and cold storage facilities' lighting electricity expenses up to 90% while improving light levels.

**Draeger Safety** . . . . . Booth #310
Draeger offers a full line of fire and gas detection equipment for the ammonia industry. The DraegerSensor is the foundation for success in the ammonia industry market. With the new Flame 5000, Draeger can now provide a full safety system covering flame and gas detection.

**DualTemp Companies**. . . . . Booth #329
Providers in the finest of design, construction, installation, service, and supplies for the industrial refrigeration market. Dual-Temp also provides equipment, training, and supplies to meet all your safety requirements.

**Duna-USA, Inc.** . . . . . Booth #731
PUR + PIR Insulation

**EcoClear** . . . . . Booth#723
EcoClear, a GPM company, is an environmental cleaning company specializing in HVAC and facilities cleaning that promotes surface hygiene protection of energy savings of commercial, manufacturing and processing facilities.

**EVAPCO, Inc.** . . . . . Booth #410
EVAPCO is a worldwide leader in the design and manufacture of industrial refrigeration system components. A broad line of ammonia air unit evaporators, critical process air systems, evaporative condensers, water treatment systems, packaged recirculators, pressure vessels, hydrocooling coils, and ice builders can shipped from one of 19 manufacturing facilities in 9 countries around the world. With an on-going commitment to Research and Development, EVAPCO provides the most advanced products in the industry-Tomorrow's Technology… Available Today!

**Extol of Ohio, Inc.** . . . Booth #720
Extol fabricates and distributes STYROFOAM™, isocyanurate, cellular glass, perlite, and phenolic insulation for piping equipment. Complete valve system, contoured heads, fittings, PVC, aluminum, vapor, and weather barrier caulks and coatings. Extol also provides specification assistance. Extol offers materials for refrigeration chilled water, steam, and process systems.

**Farley's S.R.P., Inc.** . . . . . Booth # 106, 108
Our Mission: To support and provide the highest quality of parts, equipment and service while offering very competitive prices. All delivered efficiently by friendly, qualified personnel with "Farley's personal touch service guarantee" Providing "Getability" Since 1978.

**Frick by Johnson Controls** . . . Booth #610, 612, 614
A full line of refrigeration equipment for most applications. Rotary Screw Compressor Packages and PacChillers with Variable Speed Drive, Condensers, Evaporators, AcuAir Hygienic Air Handlers, Vessels, Controls, and Replacement Parts.

**Gamma Graphics Services** . . . . . Booth #228
Gamma Graphics provides non-destructive testing (NDT) services on ammonia refrigeration piping. We are able to identify corrosion on wet or saturated insulation without having to cute holes or breach the vapor barrier on piping in any way. We also provide conventional ultrasonic inspection services on ammonia vessels.

# EXHIBITOR LISTING

**Garden City Ammonia Program (GCAP)** . . . . Booth #104
Garden City Ammonia Program, known as GCAP, has been providing education for the industrial ammonia refrigeration & boiler operator for efficiency, safety, and compliance is nine years old. Our Ammonia Boot Camp, National Emphasis Program, and the New Process Safety Management Training are the newest in the industry. Our private technical school has $CO_2$, Ammonia, and Boiler equipment for hands-on training.

**Garden City Community College (GCCC)**. . . . . Booth #406
Ammonia Refrigeration, Boiler, PSM/RMP, Adv RETA Prep, "Hands-On" Ammonia Refrigeration training since 1996, 4 1/2 Day Format–Earn College Credit–Degree Opportunities Conforms to OSHA & EPA regulations.

**GEA Refrigeration North America, Inc.** . . . Booth #623, 625
GEA Refrigeration North America, Inc. manufactures and markets GEA FES, GEA Aerofreeze and GEA Intec industrial refrigeration and freezing equipment for the North American markets. Products include rotary screw and reciprocating compressor packages, spiral, tunnel and carton freezing equipment, custom engineered refrigeration systems, heat exchangers and advanced microprocessor controls.

**GEA PHE Systems** . . . Booth #621
GEA PHE Systems- manufacturer of FlatPlate® heat exchangers perfect for ammonia refrigeration applications with flow rate up to 1,645 tons. Products meet ASME/CRN requirements, manufactured in York, PA.

**GF Piping Systems** . . Booth #312
COOL-FIT® ABS Plus is complete pre-insulated plastic piping system for glycol and secondary cooling piping systems. It is UV resistant, vapor-tight, and 100% water-tight and requires minimum installation time.

**GfG Instrumentation** . . Booth #219
GfG Instrumentation develops and manufactures portable gas detectors, fixed systems, and respiratory airline monitors; protection from combustibles, oxygen hazards, and toxic gases.

**H.A. Phillips & Co.**. . . Booth #211
We manufacture valves, level eye sight glasses, liquid level controls, ASME pressure vessels, gas pressure recirculation systems, and mechanical pump recirculator packages. We also distribute Danfoss valves and controls.

**Hansen Technologies** . . . Booth #519, 521
Hansen Technologies offers innovative industrial refrigeration solutions to meet your application needs, including: multi-valve stations, control, shut-off, pressure-relief and solenoid valves, regulators, pumps, auto-purgers, level controls and safety detection systems.

**HCR Division Jamison Door Company** . . . . . Booth# 822,824
HCR/Jamison Door will feature HCR Air Door Technology and BMP Rollup Door.

**Hench Control, Inc.** . . Booth #220
Hench Control is a manufacturer and service provider of modular energy management systems for industrial refrigeration which quantifiably cut energy cost, improve profitability, and significantly reduce the $CO_2$ footprint for the environment.

**Henry Technologies** . . Booth #229
Heat Exchangers, Condensers, Chillers, Pressure Vessels & HVAC/Refrigeration Components. Henry Technologies Ltd. takes pride in providing high quality HEX / PV to our global partners in industrial and commercial applications. Customer Satisfaction, Quality Designs, Product Quality and On Time Deliveries are our primary goals. Let Henry Technologies Ltd. be a partner to your future successes.

**Hermetic Pumps, Inc.** Booth #501
Hermetic Pumps has over 40 years experience in handling refrigerants in canned motor pumps and has over 50,000 units installed. Hermetic is the only manufacturer that offers a canned motor pump specifically designed for refrigerants.

**HillPHOENIX** . . . . . Booth #402
HillPHOENIX specializes in the design and manufacturing of halocarbon, carbon dioxide transcritical and secondary refrigeration systems for commercial warehousing and industrial refrigeration applications.

**Honeywell Analytics** . . . . . Booth #123, 125
Honeywell Analytics manufactures the industry's most complete range of monitoring instrumentation for ammonia and other refrigerant gases. We offer fixed-install units (Manning), portable services, controllers, service/support second to none.

**Howden Compressors, Inc.** . . . Booth #507
Howden Compressors offers the most complete range of screw compressors available in the world for virtually any compressor application- refrigeration to gas reliquification, gas compression or cryogenics, and more.

**Industrial Consultants, LLC** . . . . Booth #315
Industrial Consultants- your compliance connection for OSHA and EPA related training and services including HAZMAT, refrigeration, PSM/RMP, lockout/tagout, confined space, and incident command.

**Industrial Refrigeration Technical College**. . . . Booth #301
Industrial Refrigeration Technical College (IRTC) training lab features VFD compressors, Quantum, G-Force micro's, VFD condenser, VFD evaporators, hygienic unit, liquid recirculation, thermosyphon oil cooling, plate chiller, autopurger, and PLC controls.

**Industrial Service & Fabricators, Inc.**. . . Booth #205
Industrial Service & Fabricators custom designs and fabricates pressure vessels, tanks, and liquid recirculator assemblies. Products include recirculators, receiver intercoolers, accumulators, surge drums, and oil pots.

**Innovative Refrigeration Systems** . . . . . Booth #300
Innovative Refrigeration Systems specializes in customized turnkey industrial refrigeration systems. We design and build computer-controlled ammonia refrigeration, large tonnage Freon systems, and large $CO_2$ systems for the cold storage and food process markets.

**Insul-Therm International, Inc.** . . . Booth #128
Insul-Therm International is a leader in the fabrication and distribution of insulation products for refrigeration and process systems. Our product offerings include TRYMER™, STYROFOAM™, SARAN™, Foamglas, Mylar, and many other lines.

**Integrated Circuit Systems, Inc.** . . . . . Booth #328
ICS is a system integrator working primarily in the industrial refrigeration sector. ICS provides turnkey solutions in engineering, specifications, control code, development, graphical interface, operation evaluation, and control panels.

**ISEL**. . . . . Booth #433
For more than 20 years, International Specialty Engineered Lubricants (ISEL) has been manufacturing fluids for the ammonia refrigeration industry, including compressor lubricants, liquid transfer pump fluids and rust-prevention gels.

**ISN** . . . . . Booth #432
ISNetworld is a global online contractor management system for over 270 owner clients and 45,000 contractors/ suppliers, connecting corporations with safe reliable contractors.

**Isotherm, Inc.**. . . . . Booth #107
Heat exchangers, chillers, condensers in shell-and-tube and plate-and-frame configurations. Pressure vessels and recirculator packages. Design and fabrication per ASME VIII Code. Special enhanced surface tubes for $NH_3$ and $CO_2$ applications. Titanium and Ti-Tec tubes for RSW applications. High pressure $NH_3/CO_2$ cascade condensers.

**ITW Insulation Systems** . . . . . Booth #333
ITW Insulation Systems supplies TRYMER™ polyisocyanurate pipe insulation and XPS pipe insulation billets, former products of Dow Chemical Company. Additionally, ITW specializes in aluminum and stainless steel jacketing, sheets, and elbows.

**Kathabar Dehumidification Systems** . . . . . Booth #210
Kathabar Dehumidification Systems, Inc. (KDS) is the most diverse dehumidification company in the world- offering five (5) liquid desiccants and the silica gel desiccant wheel. Liquid desiccants reduce energy usage up to fifty percent by eliminating frost/ ice buildup on evaporator coils thus eliminating the defrost cycle completely. Kathabar designs and manufactures liquid desiccant and dry desiccant systems for a wide range of applications for industrial, commercial, institutional, and green/LEED facilities.

**Krack Corporation** . . . . Booth #103, 105
Krack Corporation offers a complete line of evaporators, condensing units, and condensers for your commercial refrigeration needs as well as engineered solutions for your industrial refrigeration projects.

**Lanham Insulation, Inc.**. . . . . Booth #404
For More than 30 years, Lanham Insulation has provided unparalleled quality and reliability in mechanical insulation services. From inception, our expertise and pursuit of excellence have earned us the trust and confidence of our customers. The Lanham team of industry-leading insulation professionals focuses exclusively on the complete success of each project, to ensure the highest levels of safety, quality, and efficiency. Our fundamental mission is to deliver complete satisfaction with superior quality and value.

# EXHIBITOR LISTING

**Lanier Technical College** . . . . . Booth #832
The Georgia Ammonia Refrigeration Program at Lanier Technical College is dedicated to providing the ammonia refrigeration industry with the best, state-of-the-art, hands-on, live system training in ammonia refrigeration system operation, maintenance, and support.

**Logic Technologies, Inc.** . . . . . Booth #207
Logic Technologies, the industry's foremost leader in factory automation and computer controls, provides turnkey, state-of-the-art automation systems for ammonia formulization and production, and is setting the standard for today's automation.

**Logix** . . . . . Booth #418
Logix Refrigeration Energy Management Systems provide energy-efficient operation of refrigeration equipment with documented savings up to 40%. No other refrigeration energy management system is easier to use or more capable.

**LUDECA, Inc.** . . . . . Booth #115
LUDECA, Inc., leading provider for Preventive, Predictive, and Corrective Maintenance Solutions including Laser Coupling Shaft Alignment and Belt Alignment tools; vibration analysis and balancing equipment; software, services, and training.

**M&M Refrigeration, Inc.** . . . . . Booth #421
M&M Refrigeration manufactures both reciprocating and rotary screw compressor packages, packaged refrigeration systems, pressure vessels, and microprocessor control systems.

**Marking Services, LLC** . . . . . Booth #314
Marking Services is your partner for ammonia refrigeration pipe labels, valve tags and signage materials and services. In addition to the manufacture of identification products, we provide turnkey services for material installation and P&ID updates/creation.

**McCormack Coil Company** . . . . . Booth #414
McCormack Coil, a subsidiary of EVAPCO, is a manufacturer of a complete line of evaporator coils and specialty finned-tube heat transfer products for the ammonia refrigeration industry. Specializing in high quality aluminum construction, McCormack Coil Company catalogs over 35,000 standard fan/coil combinations to meet your industrial refrigeration application requirements.

**MIRO Industries, Inc.** . . Booth #231
MIRO Industries, Inc. provides solutions for supporting rooftop pipe, conduit, duct and walkway systems that prevent damage to the roof membrane.

**MRBraz and Associates, PLLC** . . . . Booth #506
Industrial Refrigeration engineering for cold storage and food processing facilities. Our design approach is environmentally friendly and promotes energy efficiencies with highest center of safety to operate.

**Multi-Wing America** . . Booth #428
High efficiency low noise fan blades, diameters from 7 inches to 9 feet.

**MYCOM (Mayekawa USA, Inc.)** . . . . . Booth #204, 206
The MYCOM TRUE Touch compressor control panel complements the industry leading efficiency of Mycom compressors and superior package design by offering features such as a user friendly touch screen interface, remote panel monitoring, and a USB interface.

**Nantong Square Cold Chain Equipment Co, Lmtd** . . . . . Booth #131, 133
Leader in freezer manufacturing and refrigeration systems in China.

**NIKKISO Pumps America** . . . . . Booth #121
Canned motor seal-less pumps for ammonia refrigeration.

**Nomaco Insulation** . . . . . Booth #302, 304
Cryoflex insulation addresses the key concerns of the industrial refrigeration industry with exceptionally low water absorption and vapor permeability rates, Cryoflex acts as a second vapor barrier that helps prevent moisture penetration.

**North Star Ice Equipment Corporation** . . . . . Booth #505
The world leader in industrial ice equipment for over 60 years, North Star Ice Equipment manufactures premium, high capacity industrial flake ice makers and automatic ice storage and delivery equipment for a wide variety of applications. Products include stainless steel and carbon steel flake ice makers ranging in capacity from 5 to 58 tons per day, and storage systems ranging from 21 to 280 tons per unit.

**Omega Thermo Products, LLC** . . . . . Booth #213
Heat exchangers/evaporators, including falling film chillers, ice machines, cooling tables/conveyor, cooling jackets, and specialized cooling/cryogenic equipment.

**Owens Corning** . . . . . Booth #722
From a leader in Fiberglas™ Pipe Insulation comes the new Owens Corning FOAMULAR® extruded polystyrene (XPS) fabrication billets. You now have a choice for your XPS pipe insulation requirements. Benefits include exceptional thermal efficiency, long service life, reduced overall installation costs and manufactured in the USA. All of this brought to you by the same trusted company you can count on for FOAMULAR® cold storage floor applications.

**Parker-Hannifin** . . Booth #405, 407
Parker Refrigerating Specialties manufactures both industrial and commercial refrigeration control valves, mechanical float switches, electronic liquid level controls, and industrial service valves. Additionally, Parker's herl brand includes shut-off, expansion, hand check, safety, and overflow valves for all common refrigerants including ammonia and $CO_2$.

**Paul Mueller Company** . . . . . Booth #218
Paul Mueller will feature their falling film chiller, semi-welded plate and frame heat exchanger, brazed plate heat exchanger and heat recovery equipment.

**Paulsen Pipe, LLC** . . . Booth #114
National carbon pipe distributor with a focus on the refrigeration market. Stocking low temp seamless, ERW, A106B/C, I.D. cleaning services, cut to length.

**PermaTherm, Inc.** . . . Booth #230
PermaTherm is a premier manufacturer of pipe insulation, serving the ammonia refrigeration and cold chain industry for over 20 years. As a leading design manufacturer and supplier of rigid pipe insulation, PermaTherm has developed a complete pipe insulation system for the ammonia refrigeration industry with millions of linear feet of trouble-free pipe installed throughout the country. The PermaTherm pipe insulation system provides superior thermal performance and environmental attributes, while yielding tremendous savings at every phase of your project!

**Petrochem Insulation** . . . . . Booth #202
Petrochem is a nationwide specialty contractor with 39 years of experience in the field of refrigeration systems insulation. Additional services from our eleven regional offices are siding, scaffolding, coatings and abatement.

**Phoenix Air Systems** . . . . . Booth #424
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**Polyguard Products, Inc.** . . . . . Booth #629, 631
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**Process Compliance, Inc.** . . . . . Booth #122
PCI specializes in compliance services for OSHA 1910.119 Process Safety Management and EPA 40 CFR Part 68. Five-year mechanical integrity, PHA, RMP, training, ultra-sonic thickness testing, and total PSM management.

**Professional Rebuild & Optimal Services, LLC** . . . . . Booth #132
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**PSRG, Inc.** . . . . . Booth #429
Process safety and risk management; specializing in $NH_3$ systems, full service OSHA/EPA compliance and EHS training.

**Quote Express** . . . . . Booth #313
Quote Express estimating software enables you to save time and maximize profits by automating your estimating process. Most estimators are trained in a single afternoon. With Quote Express, it's easy to generate precise, reliable, and fast bids.

**Refrigerated & Frozen Foods Magazine** . . . Booth #430
Refrigerated & Frozen Foods is the only publication dedicated to the fastest growing segment of the food-beverage industry – the value-added convenience chilled & frozen foods segment.

# EXHIBITOR LISTING

**Refrigeration Systems Company (RSC)** . . . . . Booth #419
Refrigeration Systems Co. (RSC) is celebrating 50 years, working nationwide in the cold storage construction and industrial refrigeration industry. Our experienced team of project engineers, service technicians, and installers are ready to assist you. Regardless of the project size, RSC is only a phone call away.

**Refrigeration Valves & Systems Corp. (RVS)**. . . . . Booth #412
RVS is a preferred supplier of innovative industrial refrigeration products including factory assembled, packaged recirculation systems and ASME pressure vessels of all types and sizes. RVS, a subsidiary of EVAPCO, is committed to providing superior technical support and the highest quality products with fast, on-time shipments to meet your construction schedule.

**Republic Refrigeration** . . Booth #511, 513, 515
Industrial refrigeration system design, packaged refrigeration systems, equipment skids, pipe installation, refrigeration controls, control and power wiring, parts, service quality, integrity, and performance. We do it right the first time!

**RETA** . . . . . Booth #130
RETA exists to enhance the professional development of industrial refrigeration system operators and technicians through training and education events focused on safe and efficient operation.

**RV Cooling Tech, S.L.** . . Booth #113
Manufacturers of screw compressor packages, compact chillers and auxiliary elements.

**Sampson Community College** . . . . . Booth #232
Sampson Community College is home to North Carolina's only ammonia refrigeration program. This unique training facility provides prospective technicians the necessary skills required for the safe handling of ammonia in industries. The program offers a great balance of classroom instruction & laboratory experience.

**Schneider Electric** . . . Booth #728
Schneider Electric manufactures industrial refrigeration solutions including AC motors, variable speed drivers, and system controls specifically designed for the industrial refrigeration market focused on control and energy efficiencies.

**SCS Tracer Environmental** . . . . . Booth #318
Environmental engineering and consulting services focusing on PSM & RMP compliance for ammonia refrigerated facilities.

**Select Technologies, Inc.** . . . . . Booth #101
Select Technologies, Inc. specializes in food plant equipment integration with ammonia refrigeration, process, HVAC, and product handling. Services include design-build-installation, production line relocations, mechanical, electrical, PLC automation, and IT integration.

**SHECCO** . . . . . Booth #730
Shecco is a market development company for natural refrigerants. Activities include ammonia21.com, ATMOsphere America and market research.

**SmartWatt Energy** . . Booth #303
SmartWatt Energy is a leading provider of turnkey energy-efficiency solutions, specializing in the provision of comprehensive energy efficiency solutions for cold storage and food processing facilities.

**Standard Xchange division of Xylem, Inc** . . . . . Booth #423
Semi-welded and brazed plate heat exchangers.

**Stellar**. . . . . Booth #200
Stellar is a fully integrated firm focused on design, engineering, construction, and mechanical services worldwide. In addition to its Jacksonville, Florida headquarters, Stellar maintains more than 20 strategic technical support and refrigeration parts locations throughout the United States. For almost 25 years, Stellar has been the leader in designing, fabricating, installing and maintaining industry best ammonia refrigeration systems. Stellar also provides expert compressor rebuilding and remanufacturing services, safety compliance and PSM programs, condensation control, mechanical integrity, thermal services, automation and replacement parts.

**Summit Industrial Products** . . . . . Booth #331
Summit Industrial Products manufactures ammonia compressor lubricants using various base fluids: from NSF-certified H1 PAOs to Alkylbenzene (AB), AB/PAO, Polyglycol and API Group II fluids. Summit Products deliver value and cost benefits like thermal efficiency, increased reliability, reduced oil carryover, extended oil drains, and cleaner lubricating systems. $NH_3/CO_2$ cascade systems? Bring'em on! For

lubricant-related technical expertise and used oil analysis support, let's talk.

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Summit Refrigeration Group is a full service, customer oriented, design/build industrial refrigeration contracting company specializing in food processing plants, multi-temperature distribution centers and specialized process cooling. Summit provides services and contracting for customers nationwide.

**Tanner Industries, Inc.** . . . . . Booth #212
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Temprite specializes in energy-efficient coalescent and conventional oil separators and refrigerant oil management products, including oil level controls and oil reservoirs, for all refrigerants from ammonia to $CO_2$ (R744).

**TH. WITT** . . . . . Booth #214
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**Thermal Seal Duct Systems** . . . . . Booth #725
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**Tranter** . . . . . Booth #119
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VaCom Technologies provides integrated control solutions for industrial refrigeration systems, focusing on technologies for energy efficiency, system integration and performance monitoring to achieve reliable operation and enterprise connectivity.

**Vahterus Oy** . . . . . Booth #224
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**VRTX Technologies** . . . . . Booth #118
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**Wagner-Meinert, LLC** Booth # 724
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# From the Technical Director

by Eric Smith, P.E., LEED AP, IIAR Technical Director

## Alarms and Detectors

The topic of alarms and detectors is often discussed in this publication and several others. Perhaps the reason that it is discussed so much is that there is not clear, written, single source guidance on how to handle the various aspects surrounding ammonia alarms and detectors. As part of a major revision of IIAR Standard 2, the IIAR will be attempting to provide clearer guidance and we request the assistance of IIAR members. As is done with many controversial or difficult issues, IIAR will be conducting a panel session at the annual conference to get feedback from the audience. If you have an interest in this important topic, please plan to attend the final session on Wednesday, March 20. The panelists will be industry experts who deal with codes, emergency response, design and maintenance. Note that this panel will focus on the use of alarms and detectors, and not the technology or selection of them. To support this effort, we ask that you consider the following aspects, and come prepared with questions, suggestions, and anecdotes.

Among a litany of questions that likely surround alarms and detectors are:

What are the minimum code requirements? Oddly, this is not made clear enough in existing documents, and people have different views on what is written. For many years, it has been perceived that the only definite requirement is to have one detector – located in the machinery room. However, ASHRAE 15 exceptions on charge limits for industrial occupancy would indicate otherwise. Further, the latest edition of IIAR 2 requires at least two detectors, set at different concentrations. There are also new code body proposals that could require detector/alarm systems be approved by authorities having jurisdiction. What might this approval entail? Would it be applicable to existing facilities? What if a facility wanted to add a detector? Would this require re-approval? There are also proposals that ammonia detectors be "listed" by nationally recognized testing agencies (such as UL). Is this necessary or will it simply raise the costs of detectors and provide no additional level of surety? Is the industry ready for such a change?

Should relief vent lines be required to have ammonia detection? What should be done if a vent line detector is activated? Naturally, the concentration of ammonia in a relief header will be high, but this is not a good indicator of whether there is a serious problem, or a short term relief valve "puff."

Should every storage or production room have a detector and/or alarm? If an interstitial space has ammonia equipment, but is not normally occupied, should the space be treated differently?

Should concentration levels, as indicated by detectors, initiate different responses? For example, a 25 ppm concentration level is common when service work is being performed. But if no work is being done and this concentration is reached, should employees leave the area? Or should levels be as high as 300 ppm before employees leave? Can two different alarms be used for different action levels? Does this expect too much from employees?

What are the mechanisms that could distinguish small releases that occur during maintenance and unintended, unpredicted releases? Is there, or should there be a difference if a release occurs in a machinery room versus an occupied storage room or production room?

Should ammonia detection systems be tied to the fire alarm panel? Although this seems to be common, it also can be problematic if fire companies show up expecting a fire, but are unprepared for an ammonia release. Another problem is that they might show up for a minor release due to maintenance. Related: shall notification of detection be facility-wide or only to a designated monitor?

Should back up power be required for alarm/detection systems?

What color should ammonia alarms be? Should this be distinct and defined? One user has complained that local officials wanted a unique color, but would not say what it should be. In any case, red is an indicator of fire. And fire evacuations can be treated differently than ammonia release evacuations.

How do employees know if they should evacuate or shelter in place? Should detector/alarm systems be integral in this decision? Is a public address (PA) system adequate for this? Is it possible or reasonable that a PA system be tied to the ammonia detection system?

Should there be more definitive guidance within standards on the placement of detectors? For example, ammonia released in very low temperature rooms or freeze tunnels behaves differently than in higher temperature rooms.

Is it ever appropriate to over-ride detectors if daily routines such as high humidity clean up shifts create false positives? Is it appropriate to over-ride detectors if maintenance is being performed? Is there an acceptable compromise?

How extensive should additional functions of the refrigerant detection system be? For example, shall they be used for automatic equipment shut down? Does reliance on detection/alarm systems create a false sense of security? In other words, will the presence of this equipment make people believe that risks are reduced? What is expected by OSHA and the EPA? Is this beyond the minimum requirements? What are the financial implications of more detectors and alarms in initial and ongoing costs?

And perhaps most importantly, how far should IIAR go in establishing guidance to answer these questions? When consider this, we must bear in mind the adage "If we don't establish guidelines ourselves, someone else will do it for us." **ear**

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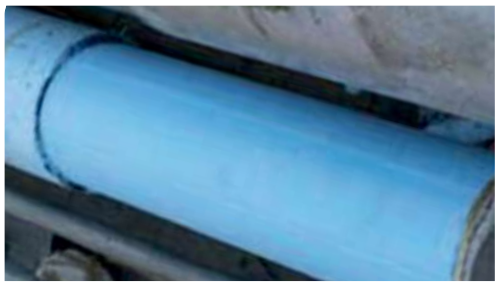

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