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THE OFFICIAL MAGAZINE OF THE AMMONIA REFRIGERATION INDUSTRY ■ AUGUST 2022

CONDENSER

COSTA RICA MOVES ON MANDATORY IIAR STANDARDS

AMMONIA REFRIGERTION EDUCATION KEY TO ADOPTION

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AUGUST 2022

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CONDENSER STAFF

Publisher
Gary Schrift

Editor-In-Chief
Andrea Fischer

Staff Writer
Mindy Long

Creative Director
Bill Ellis

V.P. and Technical Director
Eric Smith

International Institute of Ammonia Refrigeration

1001 North Fairfax Street, Suite 503
Alexandria, VA 22314
www.iiar.org

Phone: 703-312-4200
Fax: 703-312-0065

president's MESSAGE

BY GARY SCHRIFT

It's that time of year again: after the conference and before we dive into the travel and rushed schedules of a new membership season. While there's always a lot going on, these last few days of summer are a great time to reflect on what it means to be an IIAR member and what new plans we have for the future.

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

Standards: These are the core of IIAR. These guidelines drive the growth of our industry by proving to code bodies, governmental departments, and end-users that natural refrigerants can be applied safely and managed efficiently for refrigeration and comfort cooling applications. We already know that natural refrigerants are safe for the environment. The standards ensure the safe use of natural refrigerants by dramatically reducing the chance of an accidental release and dramatically increasing the safety of personnel and neighbors of the facility.

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

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

Scholarship: Presently, through our Ammonia Refrigeration Foundation, recently renamed Natural Refrigeration Foundation, scholarships are provided annually to Junior and Senior level full-time college students pursuing a degree in engineering or related technical field leading to a career in the refrigeration industry. You may have met many of our scholarship recipients at our recent annual conference. I'm happy to report that this group is growing faster than ever, filling the pipeline of good candidates for employment by our members.

This vast resource of non-commercialized educational materials, many also available in Spanish, significantly supports all members concerned with the safe and sustainable design, installation, and operation of ammonia and other natural refrigeration systems.

Research: Research projects coordinated by the Research Committee and IIAR staff, and funded by the Foundation, resulted in the development of guidelines for Mechanical Insulation Installation and three computer programs available in conjunction with the IIAR Ammonia Piping Handbook. These reflect significant changes to the pipe sizing chapter, wet suction riser selection, and economic considerations.

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

Advocacy: Routine interaction with OSHA, EPA, CSB, and DHS has resulted in many past advancements of our mission towards safety but also the removal of regulations that were impractical to implement. We are actively engaging with OSHA on the development of an Emergency Preparedness Guideline that would recommend and allow the practical use of air-purifying respirators, with the CSB to remove the additional burden of reporting an ammonia release to the CSB when such releases are already reported to the NRC, and with the EPA in managing their expectations of the initiative to improve compliance with the General Duty Clause of the Clean Air Act at facilities with small ammonia refrigeration systems.

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

IIAR continues to focus on all of these things: regulatory initiatives, international outreach, standards development, and educational programs, giving us all a leadership role in the global cold chain.

Every IIAR program and initiative is made possible by your membership, and additionally, by your leadership as a volunteer.

I'd like to use this space this month to remind everyone to be sure to renew their IIAR membership and find a new way to get involved. It's the best way to make sure you connect with this ever-growing community of friends and colleagues who are passionate about natural refrigerants.

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chairman's MESSAGE

BY TREVOR HEGG

I'm always impressed by the incredible progress IIAR makes on our industry's goals every day and every week. It may be more exciting to write or hear about the big news – an updated standard, or a new member service – but just as important are the little things. Those things we don't see but are always going on in the background. They represent the steady work we do as an organization every day.

It may be more exciting to write or hear about the big news — an updated standard, or a new member service — but just as important are the little things.

In this issue, you'll read about many of these things. In one case, after months of background work by IIAR staff and members, in a dispute over whether or not an ammonia release at a power facility should be considered uncontrolled, an OSHA appeal was overturned.

While the case in question concerned TECO, a power company, IIAR believed the case's outcome would be crucial to the food industry and many other industries that use ammonia in their processes. IIAR teamed with the National Manufacturers Association and Edison Electric in filing an amicus brief to inform the court of the ramifications of an unfavorable decision and weigh these against the alternative.

As another example, our cover story about the adoption of IIAR's education program in Costa Rica – is just the first step in a much bigger effort – Costa Rica's plans to make those IIAR standards mandatory.

IIAR has steadily worked to build an international presence over years, looking for new opportunities to grow on the global stage and continuing to foster communication with all our international partners. That effort is paying off with well-developed educational programs that do more than just inform, they're helping new users of natural refrigerants grow faster and safer than ever before. IIAR leadership is taking an ever-active role in that effort – traveling to many industry events to represent IIAR, both here and around the world.

At headquarters, your staff is working hard to implement our new membership structure, also a process that is paying off. From its inception, the new membership program took months of dedicated time, devoted by our leadership and members, to craft something valuable that will carry IIAR into the future.

Our new membership structure took effect on July 1, and the changes are already increasing the value of IIAR membership, promoting recruitment and retention of members, and creating financial balance and sustainability for IIAR.

The IIAR board came to its decision to change the membership structure after convening a group of 23 IIAR members, and later, an executive committee task force who came together to discuss the issue and delve into ways membership could add value. Ultimately, a simpler IIAR rate structure was developed encompassing many new member benefits.

As part of the change, members receive access to one free IIAR training video (Series I, II, and III) annually, one free ANR course annually, and free access to digital versions of the ANSI/IIAR standards accessible both online and offline via an eReader application called eVantage, and free access to virtual conference content.

These advocacy efforts, membership changes, and educational programs, including our annual conference, represent the future of our industry, and your support of them is essential. Every IIAR program and initiative is made possible by your membership, and additionally, by your leadership and contributions as a volunteer.

I encourage everyone to get involved in your organization, whether it's volunteering on a committee or giving your input on an important issue – this is the background work that keeps us moving.

The ongoing support and participation of our membership make all of these projects and opportunities possible. Thank you for continuing to enrich our industry with your collaboration, input, and knowledge. I'm looking forward to keeping you updated on the progress of these projects and initiatives, and the many others we have slated for the rest of the year.

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COSTA RICA MOVES ON MANDATORY IIAR STANDARDS

AMMONIA REFRIGERTION EDUCATION KEY TO ADOPTION

All IIAR standards, including the Carbon Dioxide standard, ANSI/IIAR CO2, have been adopted within Costa Rica on a voluntary basis as National Norms, and the country is moving forward with its plans to make the standards mandatory. The next step is to prepare and educate industry professionals in the country on IIAR standards before the mandate takes effect.

"Costa Rica was already in the process of adopting the IIAR standards for ammonia refrigeration, so their next natural step was to educate their engineers and designers on proper design installation and maintenance of ammonia refrigeration systems," said Gary Schrift, president of IIAR.

This 'stepping stone' of the standards adoption process involves the implementation of a National Certification Program, which CIEMI (Colegio de Ingenieros electricistas, mecánicos e industrials/College of Electrical, Mechanical and Industrial Engineers), through CFIA (Colegio Federado de Ingenieros y Arquitectos/Confederation of Engineers and Architects), will be managing.

"We've been working for several years already on making the standards from IIAR the Costa Rican Norms. In order to make it mandatory, we need to have certification and people who can go and check and certify compliance with the norms," said Mario Mora Carli, a professor at the University of Costa Rica and the current vice chair for the Costa Rica and Caribbean IIAR Chapter.

Yesenia Rector, international director for IIAR, said the program will ensure that industry professionals can apply the standards before they are required to implement them. Certificate courses are already available in Spanish for the main IIAR standards.

"Now, in partnership with us, Costa Rica will sign up the professionals to take the certificate courses from IIAR. That will prepare the professionals in the industry so when the government says this is mandatory, they have the professionals who are prepared to implement the standard," Rector said.

This puts Costa Rica at the forefront of all other countries in the complete regulatory adoption of IIAR standards. "This represents the most organized and comprehensive industry educational approach that has been implemented in Latin America and demonstrates the commitment of Costa Rica's government and industry organizations to environmental responsibility and industry growth," Rector said.

Eric Smith, vice president and technical director for IIAR, said most countries have unique codes and standards that are developed by committees and legislatures within their countries. "Like states in the U.S., countries often reference codes or standards developed by code associations, which in turn often rely on standards developed by industry associations," he said.

For example, European countries have a country-wide code that will refer to ISO or EN standards. "Other regions develop their codes similarly by examining the content of various standards and deciding what they like the best. What is a bit unique in the case of Costa Rica is that the government has decided to embrace all IIAR standards, including the CO2 standard, without modification," Smith said. "Their refrigeration design code will be a direct reference to the standard, which has been translated to Spanish."

Usually, IIAR standards are used by many professionals in different countries as the best practices for ammonia refrigeration systems. "However, during the last few years, some of those professionals have realized that by implementing IIAR standards in their countries, the industry benefits with more efficient and safer systems," Rector said. "That has prompted them to reach out to key government institutions and propose the use of IIAR standards as a basis for their national norms."

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In Costa Rica, transitioning to the mandatory adoption of IIAR standards will take about two years. As the IIAR standards are revised, the country is revising and adopting standards to ensure a continuous improvement process and that standards are current.

FOCUSING ON EDUCATION

Costa Rica has many fine colleges that currently support the educational training of many of their engineering, architecture, and other disciplines. "But rather than start from scratch, they were aware of IIAR's many online training programs covering our standards and ammonia refrigeration," Schrift said.

CIEMI's certificate program in Refrigeration Systems Standards will ensure that the professionals in Costa Rica take the IIAR developed Certificate Courses for the IIAR 2, IIAR 4, IIAR 6 and IIAR 9 standards, using the IIAR Learning Management System. The education certificate program will take three years to complete and will be valid for five years. The program is based on IIAR's Academy of Natural Refrigerants courses that have been developed in Spanish and will be taken through the IIAR LMS.

Rector said there have been several important contributors to the effort, including Carli, David Solis, the IIAR chapter chair for Costa Rica and the Caribbean, Marco Calvo vice chair for CIEMI Costa Rica, Manuel Corella, a professor at the University of Costa Rica and a member of CFIA.

Schrift said IIAR's new membership structure is making the education possible. Before IIAR's new membership structure, the cost for taking the four to six needed IIAR training programs would have been thousands of dollars and possibly would not have been possible simply due to the cost to all of their engineers in the country. Now student pricing for membership is $100.

"And for any member, whether a student or regular member, each member receives one free Academy class and one free video series class each year," Schrift said. "So, for $100, Costa Rican engineers can join IIAR as a student and take two training classes each year."

Their curriculum requires an additional ANR class each year, and engineers will pay member pricing for it. Their program runs over a two-year period, so each engineer desiring certification in Costa Rica as an ammonia refrigeration engineer will join as a student member for two years and take their free classes and one paid class annually.

Schrift anticipates an initial flurry for the next two to three years as Costa Rica focuses on getting its technicians trained. "We're hopeful we'll continue to see growth as these engineers transition to become full-time, non-student members of IIAR and retain their membership," he said.

SETTING AN EXAMPLE

Costa Rica is recognized for embracing environmental causes. "Most of the country's electricity is produced by renewable energy, and they recognize that eco-tourism and sustainable agriculture is a significant driving factor of their economy. This focus on environmental and social well-being proliferates into decision making at nearly all levels of government," Smith said.

As such, officials there recognize that ammonia is the most energy-efficient refrigerant for their climate. They like

that ammonia is readily available and is environmentally friendly, so they want it to be used for their agricultural industry, but understand that safety is also essential to workers and the public.

"The thinking was that they should accept the standard in its entirety and recognize that the U.S. standard is robust and thoroughly vetted, in part because of the regulatory factors in the U.S. that demand it," Smith said.

This gives credence to IIAR as an international association and recognition of the excellent work that has been done by IIAR members through the years. "It is notable that several other countries look to IIAR standards when they develop their own ammonia refrigeration standards. It is understandable that countries wish to be autonomous, but it is also noteworthy that IIAR **standards are among the primary sources of reference**," Smith said.

Debbie Koske, a spokesperson at Calibration Technologies Inc., added that governments need to encourage the adoption of natural refrigerants to comply with international environmental agreements. "They also need to assure their safe use. As our climate continues to suffer, speed is of the essence. Rather than starting from scratch, governments can save time by pointing to the tried and true standards of IIAR," she said.

BENEFITTING OPERATORS

Adoption of standards and the training program will bring several benefits to those operating in Costa Rica. "As IIAR standards have consolidated design, installation, operation and maintenance for ammonia refrigeration in the United States, a similar benefit will be realized in Costa Rica," Smith said. "Rather than interpret how various codes apply to ammonia refrigeration, the IIAR standard will unambiguously be the required standard to follow."

This ensures that systems are designed and built to a minimum level of quality, owners' investments are protected, and workers and operators have the best opportunity for safe and environmentally conscious systems.

"Multinational companies, operating in various regions around the world, would prefer to have refrigeration systems that are consistently designed, maintained and operated and that they are equally safe and reliable regardless of where their investments are located," Smith said.

Carli noted that there is a lot of foreign investment in Costa Rica. "A lot of large international companies, like Cargill and Coca-Cola, want to comply. We need to have prepared engineers and technicians that are certified so they can go and make sure people comply with the norms," he said, adding that he has been working with customers who want to make all the necessary changes to comply with the norms. "They know it will be mandatory soon. Not only that, they see the benefit of having the IIAR-2 norm."

The hope is that more countries will recognize this desire and follow the lead of Costa Rica and others who have referenced or required adherence to IIAR standards. "There are countries, such as Ecuador and Columbia, that have adopted our standards. When we share this model with them, they may pick it up," Schrift said.

In Colombia, IIAR has been working with ICONTEC—the standards writing organization for Colombia—and its allied association, ACAIRE, to emulate Costa Rica's process. "More and more are following in Costa Rica's footsteps. This helps the industry tremendously, especially considering that Natural Refrigerants are the best option for having safe, energy-efficient systems that are environmentally friendly," Rector said. "We expect this will expedite the process, not only in Colombia but also in other countries such as Mexico, Argentina, Ecuador and Chile."

ADVANCING THE FUTURE

Koske believes the adoption of IIAR standards helps countries transition from ozone-depleting refrigerants to natural refrigerants like ammonia. "One of the barriers to making the transition to low GWP refrigerants is concerns arond safety. Adopting the IIAR standards and training operators accordingly takes the safety concerns out of the equation and makes it easier to choose ammonia," she said.

standards & SAFETY

BY TONY LUNDELL, CIRO, PMP,
IIAR SENIOR DIRECTOR OF STANDARDS AND SAFETY

What Happened to the IIAR Bulletins?

What happened to the IIAR Bulletins? Short Answer: The IIAR Bulletins were all "Superseded!"

Let's discuss the history of the onset of IIAR Bulletins and how their material was eventually distributed and captured to become superseded.

First, let's step back and discuss how IIAR Bulletins became numbered.

Before IIAR Guidelines and IIAR Bulletins were developed, IIAR Poster Boards were developed and numbered as follows:

Figure 1

IIAR Original Material Titles & Numbering

Poster Boards:

100 – First Aid for Ammonia Exposure
101 – Oil Draining Guidelines
102 – Minimum Protective Equipment for Mechanical Refrigerating Systems
103 – Safety Practices & First Aid
104 – Basic Preventive Maintenance for Mechanical Refrigeration Systems

These numbers were not included on the Poster Boards. A couple of Posters are shown as examples.

The first IIAR Bulletin developed as a guideline was R1.

Figure 2: IIAR Bulletin R1 - A Guide to: Good Practices for the Operation of an Ammonia Refrigeration System (1983)

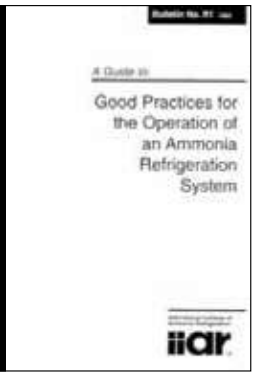
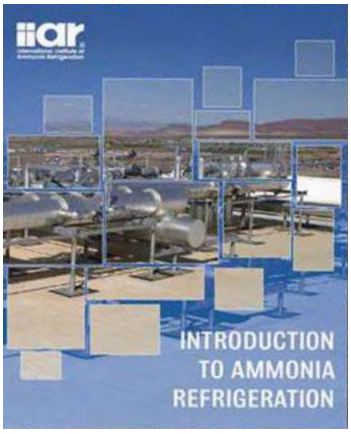


Figure 3:

Figure 3



Other information for Bulletin R1 was placed in IIAR Bulletin No. 109 and IIAR Bulletin No. 110. Information about the properties and uses of ammonia could be found in the Ammonia Natural Refrigerant of Choice (DVD). The Ammonia Natural Refrigerant of Choice information was also an IIAR Green Paper.

Before covering the development and numbering of the IIAR Bulletins and how they each were superseded by having their material embedded into the IIAR Suite of Standards normative and informative appendices, you need to know the following:

IIAR Bulletins were developed a long time ago. They were guidelines and not standards, and were not enforceable, unless adopted by an owner/employer under regulation as their Recognized And Generally Accepted Good Engineering Practice (RAGAGEP).

If adopted as RAGAGEP to meet OSHA's Process Safety Management (PSM) Standard and/or EPA's Risk Management Plan (RMP) Rule, and/or claiming to use to meet General Duty Clauses or other safety requirements, then they became enforceable by the regulating authority. If an owner/employer adopts a RAGAGEP and says they are doing it to meet a regulatory requirement, then it becomes enforceable and the owner/employer needs to be doing it to meet the regulating compliance. As usual, documentation is key to verify the RAGAGEP is being done as adopted and planned.

With the Poster Boards using numbers 100 to 104, developed IIAR Bulletins started numbering at number 105.

Following, you can see how Bulletin numbers 105 to 116 were utilized and how their materials, where applicable, were embedded elsewhere to permit them to be superseded:

- **IIAR Bulletin No. 105 - Guidelines for Application and Maintenance of Safety Pressure Relief Valves for Ammonia Refrigerating Systems (1998)**

  IIAR No. Bulletin 105 was integrated into ANSI/IIAR Standard 2-2008 and remains in future revisions.

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Aquilon DS™

Transcritical CO_2 Condensing Units

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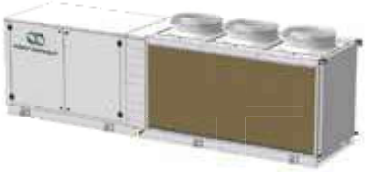

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- **Bulletin No. 106 - Guidelines for Prevention, Preparation, Response and Cleanup of Ammonia Releases (1998)**

  Bulletin No. 106 was never officially published.

- **Bulletin No. 107 - Guidelines for Suggested Safety and Operating Procedures When Making Refrigeration Plant Tie-Ins (1997)**

  Much of this information was embedded in ANSI/IIAR 5-2013 and now ANSI/IIAR 5-2019. Other information was embedded in ANSI/IIAR 4-2015 and now ANSI/IIAR 4-2020, as well as ANSI/IIAR 6-2019.

- **Bulletin No. 108 - Guidelines for Water Contamination in Ammonia Refrigeration Systems (1986)**

  There was some design material extracted from Bulletin No. 108 that was embedded into ANSI/IIAR 2-2021's and ANSI/IIAR 6-2019's normative material.

Because the remaining material was informative, ANSI/IIAR 2-2021 absorbed the informative design material in (Informative) Appendix P. Removal of Water from a Refrigeration System and ANSI/IIAR 6-2019 absorbed the informative (non-design) general material in (Informative) Appendix C. Water Contamination in Ammonia Refrigeration Systems.

The normative information for design was integrated into ANSI/IIAR 2-2021 and normative non-design information was integrated into ANSI/IIAR 6-2019. The Bulletin No. 109 (Informative) Ammonia Refrigeration System Safety Checklists – which were adopted by many owners/employers as their Recognized And Generally Accepted Good Engineering Practice (RAGGAEP) – were updated and became (Informative) Appendix B Ammonia Refrigeration System Safety Checklists in ANSI/IIAR 6-2019.

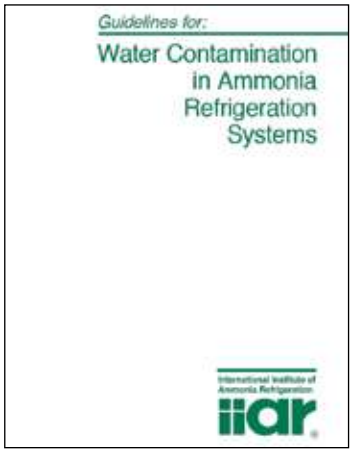


Figure 4. Bulletin No. 108 – Guidelines for Water Contamination in Ammonia Refrigeration Systems (1986)

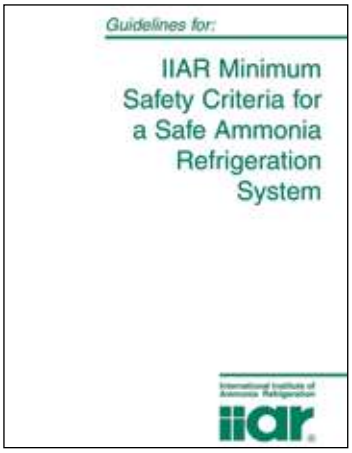


Figure 5. Bulletin No. 109 – Guidelines for IIAR Minimum Safety Criteria for a Safe Ammonia Refrigerating System (1997)

In general terms, where the historical so called "109's" were being used (i.e., the checklists), the owner/employer can continue and easily transition to use the 6-Bs (i.e., upgraded checklists) from ANSI/IIAR 6-2019, Appendix B (in place of the old 109s).

On March 18, 2001, the IIAR Standards Committee began the consideration to divide Bulletin No. 110 into the following three (3) documents:

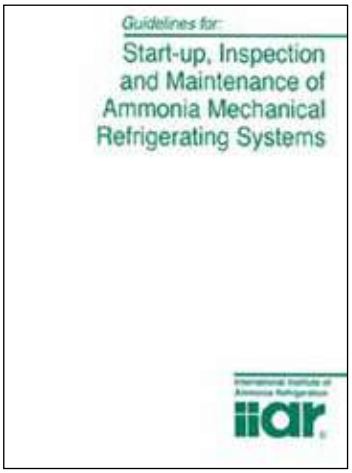
1) Startup
2) Inspection
3) Maintenance

After the onset of the consideration to divide IIAR Bulletin No. 110 into three (3) documents, number 110 would be for "Startup", and numbers 113 and 115 were put, respectively, as placeholders for "Inspection" and "Maintenance" (since numbers 112 and 114 were already taken/reserved). In regard to splitting up Bulletin No. 110's information, it was found that other material within the guideline besides, "Startup", "Inspection", and "Maintenance" needed to be placed elsewhere as well.

There were continued discussions and further observations done for months that led into a few years. Meanwhile, multiple model codes were embedding or trying to embed ammonia refrigeration requirements and regulatory agencies were referencing consensus developed standards.

For that reason, the consideration of dividing up the material eventually resulted in the decision to proceed and develop consensus developed IIAR Standards instead of having IIAR Bulletins as guidelines.

Figure 6



Early in 2007, the IIAR Standards Committee decided to pursue the development of an:

"IIAR SUITE OF STANDARDS"

On June 19th, 2007, the IIAR Board of Directors approved the plan to develop an "IIAR Suite of Standards". So, Bulletin No. 110 was eventually divided up and embedded elsewhere. The Ammonia Characteristics and Hazards section was embedded into the Ammonia Data Book. From the IIAR Bulletin No. 110 Table of Contents, you can see how the rest of the material was divided and embedded into the IIAR Suite Standards as follows:

- **Bulletin No. 111 - Guidelines for Ammonia Machinery Room Ventilation (1991, 2002)**

  The information contained in this bulletin was initially embedded in ANSI/IIAR 2-2008 and carried through subsequent revisions and addendums to ANSI/IIAR 2-2021.

- **Bulletin No. 112 - Guidelines for Ammonia Machinery Room Design (1998)**

  The information contained in this bulletin was embedded in ANSI/IIAR 2-2008 and carried through subse-

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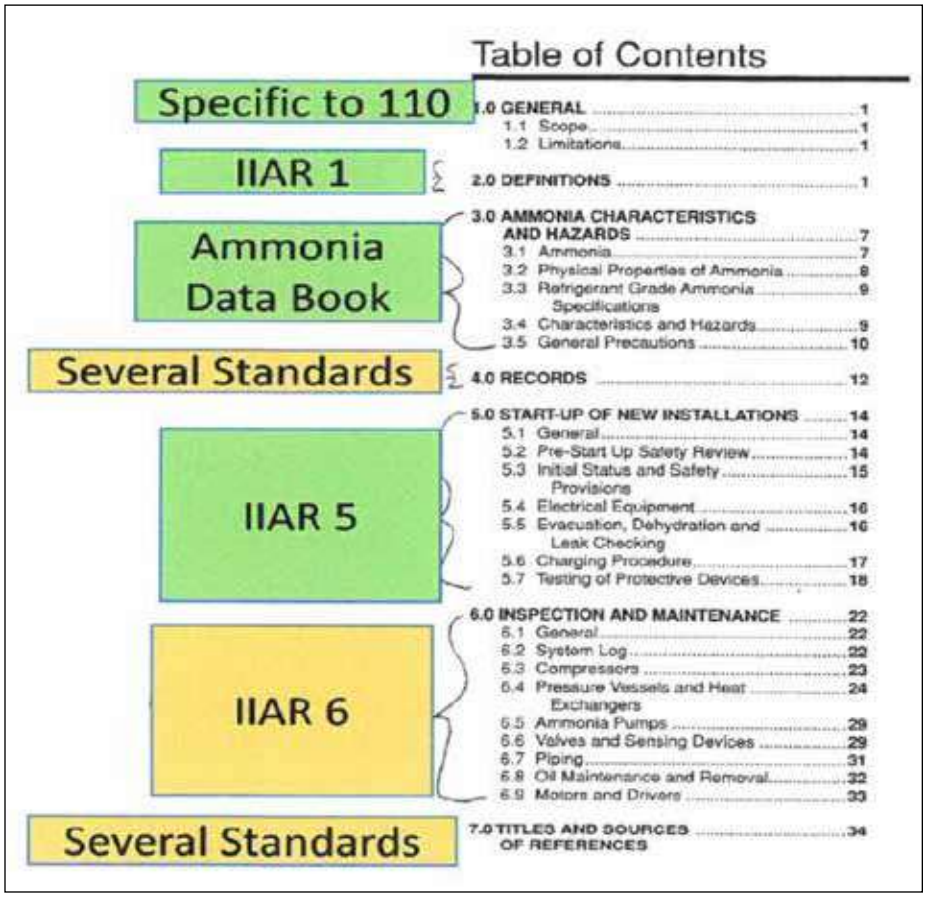
Figure 7. The Ammonia Characteristics and Hazards was first captured in the Ammonia Data Book.

As the individual Suite of Standards were revised or developed as new, the IIAR Bulletin No. 110 divided material was embedded where applicable in the normative sections or included in an (Informative) Appendix of the following standards (IIAR 1, IIAR 2, IIAR 5, IIAR 6, & IIAR 7).



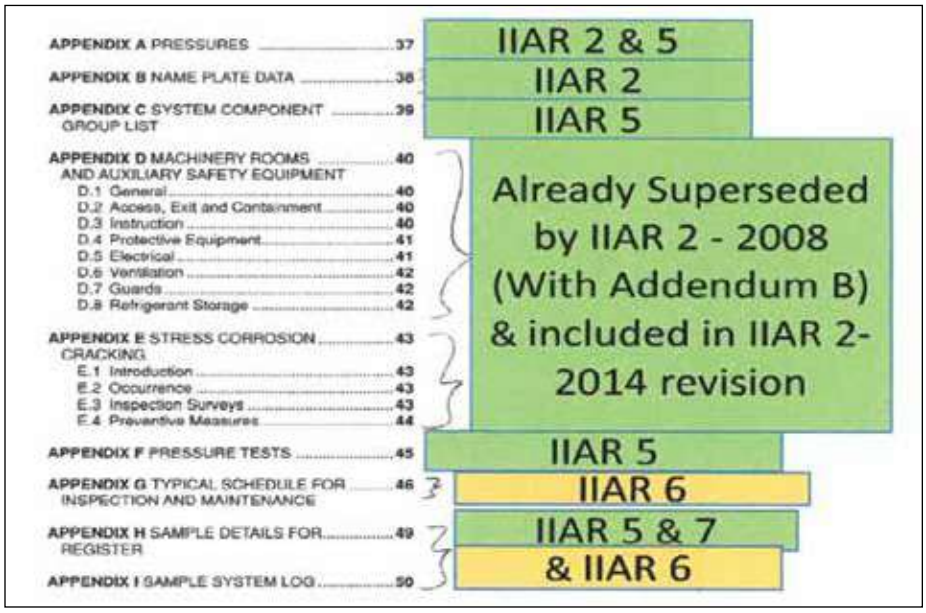
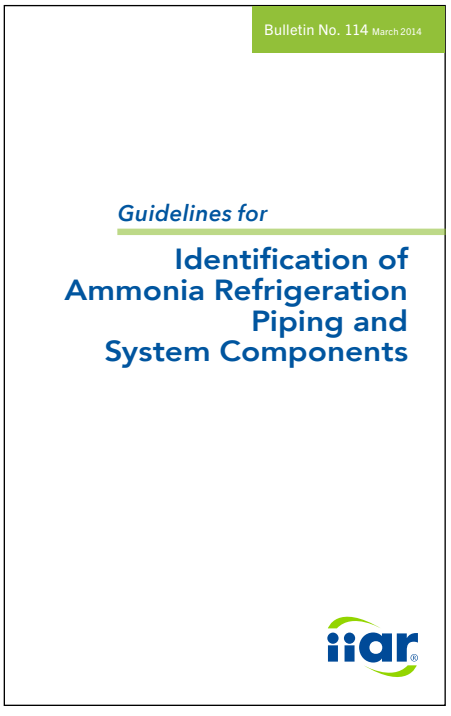


Figure 8



quent revisions and addendums to ANSI/IIAR 2-2021.

- **Bulletin No. 113**

  Was a placeholder if Bulletin No. 110 was split up.

- **Bulletin No. 114 – Guidelines for: Identification of Ammonia Refrigeration Piping and System Components (1991)**

  Bulletin No. 114 material was placed as Guidelines (and not a Bulletin anymore) in ANSI/IIAR 2-2021, Appendix Q. (Informative) Guidelines for the Identification of Ammonia Refrigeration Piping and System Components.

- **Bulletin No. 115**

  Was a placeholder if Bulletin No. 110 was split up.

- **Bulletin No. 116 – Avoiding Component Failure in Industrial Refrigeration Systems Caused by Abnormal Pressure or Shock (1992)**

  There was some design material extracted from Bulletin No. 116 that was embedded into ANSI/IIAR 2-2021's and ANSI/IIAR 6-2019's normative material.

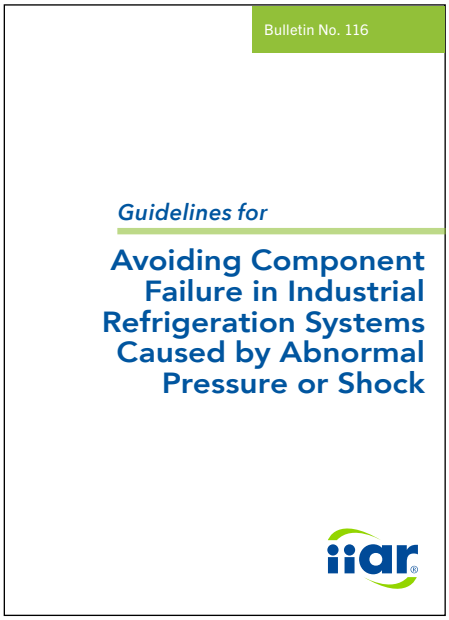
  Because the remaining material was informative, ANSI/IIAR 2-2021 absorbed the informative design material in (Informative) Appendix O. Designing to Avoid Component Failure Caused by Abnormal Pressure or Shock and ANSI/IIAR 6-2019 absorbed the informative (non-design) general material in (Informative) Appendix D. Avoiding Component Failure in Industrial Refrigeration Systems Caused by Abnormal Pressure or Shock.

  This should explain the history of the onset of the IIAR Bulletins, their evolution and growth, as well as, eventually how the decision to strive for developing "consensus" documents drove the development of the "IIAR Suite of Standards" which captured the applicable normative and (mainly) informative material of the IIAR Bulletins.

  So, what happened to the IIAR Bulletins?

  With consensus being the main driver, they were captured applicably elsewhere in the IIAR Suite of Standards, whether normatively or informatively, and then were superseded!

Figure 8



Automatic Oil Return Systems: Why, When, and How?

MONIKA WITT, TH. WITT

Safe oil draining is a subject that is well documented in IIAR publications, and workshops dealing with proper oil draining are always well-attended. Removing oil from an ammonia refrigeration system is routine maintenance that nearly every ammonia refrigeration system operator will encounter sooner or later.

One major advantage of ammonia systems is that oils are not normally soluble with ammonia and will therefore collect at the lowest spot in the system. However, accumulation of oil is gradual, and the location for accumulation must be suitable, i.e., calm enough, such that oil gets a chance to settle. In some instances, the operator may only use visual indication such as of heavy ice build-up on the oil drain vessel to indicate oil draining is required.

These conditions are often underestimated. In some locations, oil cannot be drained because there is too much turbulence/boiling of the refrigerant-oil mixture, even though the conditions would seem to be ideal.

It is particularly hard to drain oil at heat exchangers (HX) because there is nearly always too much turbulence during operation. Sometimes it can take several days of idling and warming up until oil settles from the HX surfaces and collects at the lowest spot. It is therefore recommended that oil is removed before it can even enter the evaporator and start decreasing the heat transfer capability and overall system performance.

Traditional common practice has been to collect the oil in a sump or the lowest part of the separator and route the ammonia/oil mixture to an oil drain vessel (oil pot) through a large connection on top of the oil drain vessel (refer to Fig. 1).

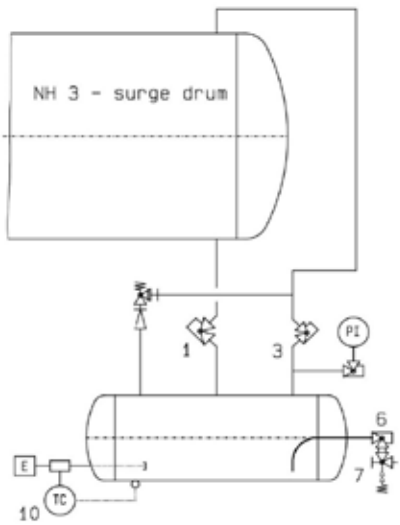
During normal operation, the refrigerant oil mixture enters through a sufficiently large valve (1), refer to Fig. 2. Generally, to remove the oil from the oil drain vessel, the supply line valve (1) and the equalizing line valve (3) are closed. Ambient heat will evaporate liquid ammonia and raise the pressure inside the oil collector vessel so oil can be drained through a stop valve (6) and a self-closing valve (7) into a suitable container. To speed up the process an electric heater element (10) can be used to evaporate the liquid refrigerant and increase viscosity. This is particularly helpful at low evaporating temperatures. The smell of ammonia usually cannot be completely avoided during the process of draining of oil. Drained oil is normally either discarded according to local environmental regulations or is recycled, but it is not normally re-used.

It is a good practice to dispose of the initial oil that is drained from a new system because it can contain dirt from pip-

In some locations, oil cannot be drained because there is too much turbulence/boiling of the refrigerant-oil mixture, even though the conditions would seem to be ideal.

Fig. 1. typical oil pot

Fig. 2: schematic of oil drain vessel piping



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ing and components that will be flushed out with the oil. Subsequently, the oil is mostly in good condition and could be re-used at least 2 to 3 times, depending on the outcome of the regular oil analysis that should be periodically conducted to check for contamination.

Using an automatic oil return system will not only save refrigerant oil (which has become quite costly) but also eliminates the need for manual oil draining. Overall safety is improved because oil draining is a potentially hazardous activity.

One method of automatic oil return, for systems up to 2800 TR (10 MW) is described as follows (larger systems can be equipped with two or more oil return pots in parallel). A vessel with an integrated mechanical valve that is activated with hot gas will collect the oil, refer to fig. 3. Like a manual oil collection vessel, the refrigerant/oil mixture enters through the top connection. Over time, liquid refrigerant boils off and escapes through the equalizing line into the separator and the vessel gradually fills with oil. The hot gas solenoid valve is opened when the oil sensor at the upper level of the oil collector vessel is reached. The hot gas entering pushes the mechanical valve upwards and the content of the vessel is pushed out through the discharge connection back to the compressor, refer to fig. 4. It is important the discharge tube inside the oil collector vessel does not extend all the way to the bottom. This ensures there is enough space for debris that collect within the lower part of the vessel which should not be conveyed back to the compressor.

The mechanical valve inside the oil collection vessel is designed with damping that avoids being moved up too quickly and protects against damage to internal components and seals. Once the oil has returned, the hot gas supply is stopped and an integrated hole in the mechanical valve will equalize the pressures between the separator and the oil collector vessel. This permits the mechanical valve to fall open by gravity and the cycle to commence again.

The selection of the correctly sized oil collector pot depends on the size of the system and the oil carry-over from the compressor. Unless otherwise declared, 15ppm oil carry-over can be assumed for new compressors and existing systems may go up to 30 ppm. While automatic systems could handle even more carry-over design improvements should be considered for a system that exhibits carry-over exceeding 30 ppm.

Activation of the hot gas supply can be accomplished with different methods, as shown in the following schematics A, B, and C. In all schematics, the oil collecting pot with an internal plug is shown as BDP.

Schematic A represents the most common method to activate the oil return cycle. This method uses an oil sensor (LS) installed at the upper level of the oil collector pot that activates the solenoid valve as

Schematic A

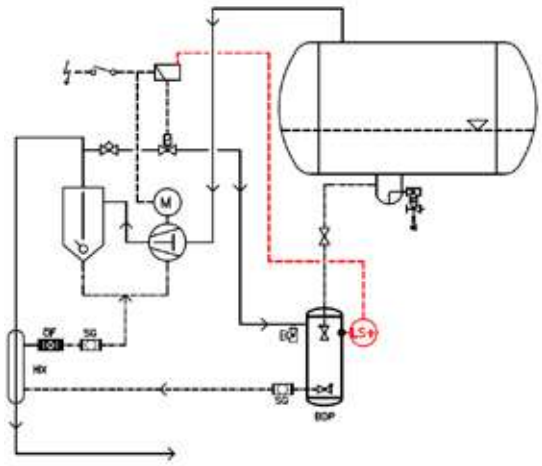
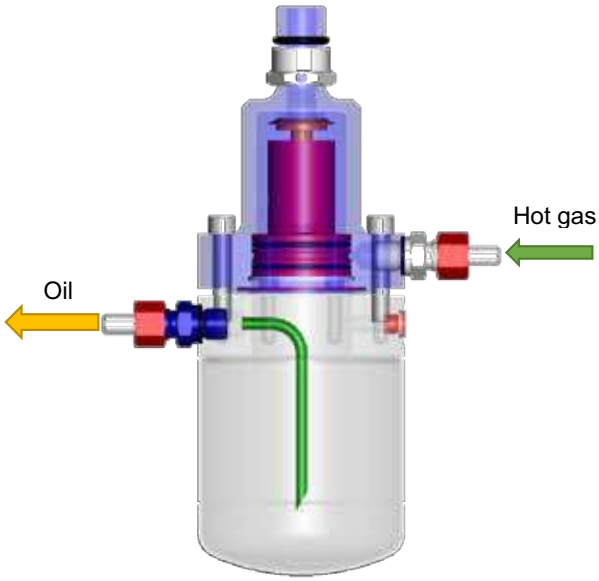


Fig. 3 automatic oil pot during oil collection

Fig. 4: automatic oil pot during oil return



mentioned above. The regulating valve behind the small line coming off the compressor discharge pipe will ensure that only a small quantity of hot gas at about 58-116 psig (4 – 8 barg) is taken to the BDP.

Although it is mostly oil that is pushed back to the compressor, there may still be some liquid refrigerant residue left in the returned oil. It is therefore recommended that the drained oil be passed through a heat-exchanger, shown in the schematics as a tube-in-tube heat-exchanger with hot gas in the inner pipe (HX). Any remaining liquid refrigerant is evaporated before oil is returned to the crank case of a reciprocating compressor (schematic A) or into the suction line of a screw compressor (schematic B and C). An oil filter (OF) in the outlet of the heat exchanger will ensure only clean oil is returned. Optional sight glasses (SG) are available and allow the returned oil to be visually checked.

Another option to actuate the solenoid hot gas valve that supplies the BDP is by a sensor installed at the low point of the oil separator (LLS) as shown in schematic B.

It is also possible to simply activate the oil return once or twice a day without a need for an oil sensor by means of a simple time control (as in schematic C). Note that using time control or level control on the compressor's oil separator will always require a heat-exchanger (HX) to be included downstream of the return line because the amount of liquid refrigerant in the oil is undetermined.

The hot gas needed to activate the automatic oil return system can also be taken from the top service valve of a high side float regulator (as shown in schematic C) when it is more convenient for installation.

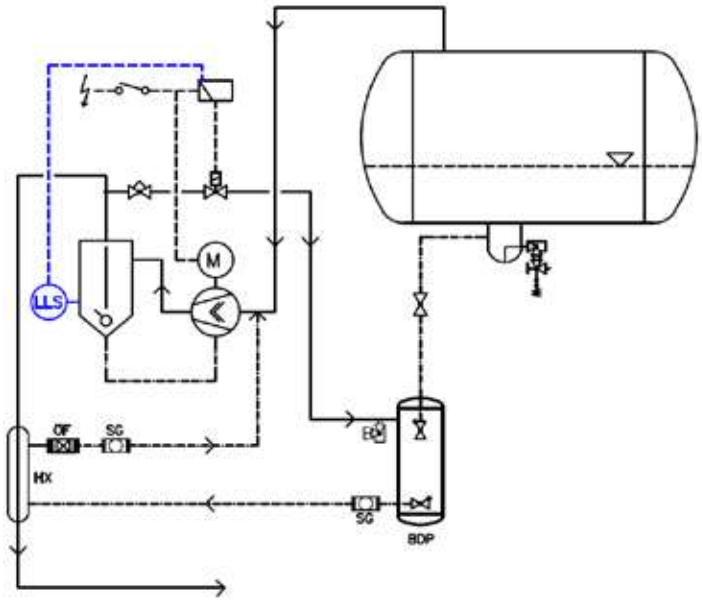
An advantage of taking hot gas from the high side float regulator is the lower temperature, as the gas is no longer superheated. This extends the lifetime of sealing materials. However, superheated hot gas from the compressor works as well.

Although such a design should provide maintenance-free operation, experience has shown that it is good to allow access to the oil collector vessel when needed (e.g., for cleaning when there is a high degree of oil contamination).

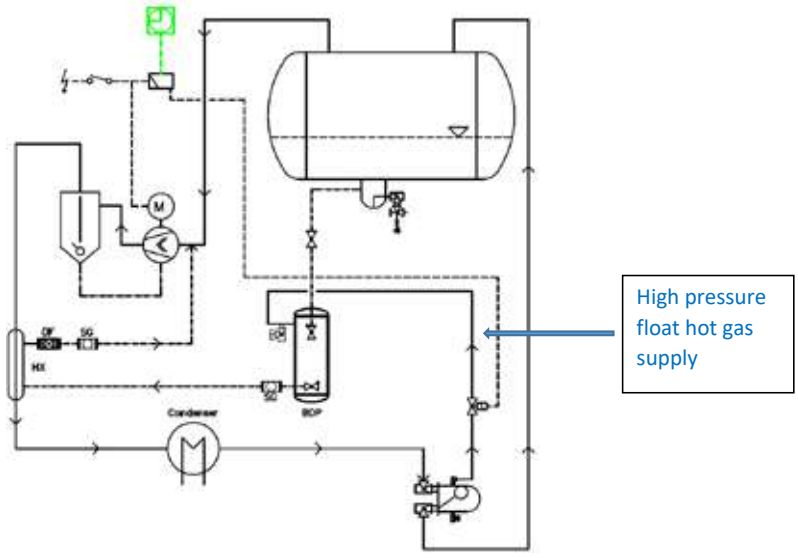
At evaporating temperatures below -22°F (-30°C) oil may not be viscous enough (like honey) and it has proven good practice to wrap self-regulating heat trace around the oil collecting pot to achieve higher oil viscosity.

In Europe, the use of automatic oil return systems typically pays back (or makes its ROI) after about two years of operation, just from the oil that is saved.

Schematic B – Liquid Level Sensor



Schematic C – Automatic Timer



IIAR Releases Second Edition of Guidelines on Manual Hand Valves

The IIAR Compliance Committee has updated the Guideline for Developing an Energy Control Plan for Manual Hand Valves and released a second edition.

"After a guideline has been out and used in the industry, members and users will ask questions and provide input for consideration to make the guideline even clearer to use or capture additional information that enhances its value as a practice," said Tony Lundell, senior director of standards and safety for IIAR. "An addendum typically will have minimal changes which could include simple edits, and/or provide statements that can add value to the guideline."

Accidents involving ammonia refrigeration systems, while rare, still occur. The initial guideline was developed to help avoid the inadvertent or accidental opening of manual valves which has been a cause of ammonia releases and should be avoided.

Although the U.S. Occupational Safety and Health Administration (OSHA) enacted the "The control of hazardous energy (lockout/tagout)" regulation in 1989 (Title 29 §1910.147), the industry has lacked clarity on applying this regulation to

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Tony Lundell, senior director of standards and safety for IIAR.

manually operated hand valves in ammonia refrigeration systems. "Historically, lockout/tagout programs have appropriately focused on hazardous electrical and mechanical energy," Lundell said.

The Guideline for Developing an Energy Control Plan for Manual Hand Valves in Ammonia Refrigeration Systems was designed to fill a gap in the industry by describing best practices. "This publication provides guidance to owners, operators, maintenance personnel, and contractors on applying an energy control program to manual hand valves in ammonia refrigeration systems," Lundell said.

IMPORTANT UPDATES

The main change in the second edition refines the definition and application of "exclusive control." Because this update occurred soon after its initial publication, and the changes are important but not extensive, IIAR provided those who purchased the first edition with changes to insert into their guideline.

"The second edition was developed in response to some observations by end users who were uncertain about implementing methods that rely on 'exclusive control' as it was defined in the first edition," said Eric Smith, vice president and technical director at IIAR. "Subsequently, the first edition was submitted to an attorney with extensive experience with industry applications of OSHA's lockout/tag out regulations. The attorney recommended a few changes to the first edition that draws on language from OSHA's regulations and an ANSI standard addressing energy control."

The attorney suggested that IIAR "tighten up" the guideline's definition of exclusive control by placing more conditions on it and aligning it more with OSHA's 29 CFR 1910.147(a)(2)(ii).

"This regulatory clause includes a note that certain 'minor servicing activities' are exempt from 1910.147's LOTO requirements provided that several prerequisites are met," Smith said.

These are 1) minor servicing must take place during normal operations; 2) be routine, repetitive and integral to the use of the equipment for production; and 3) utilize alternative measures that effectively protect employees.

"Information was also drawn from ANSI Standard Z244.1 that addresses alternate energy control methods under certain conditions," Smith said.

The IIAR Safety Committee proceeded to make some minor but important changes that enhanced the guideline's definition of "exclusive control" and included some additional suggestions for training, both of which support the spirit of the OSHA rules and the ANSI standard's language while maintaining a reasonable approach to simple operations involving little risk. The committee believes that using the guideline will provide LOTO methods acceptable to both industry and regulators.

Lundell said IIAR's guidelines are continuously improved. "When input is received that can make the guideline clearer and/or provide additional value, it is considered for implementation in an addendum or the next revision," he said, adding that this guideline is a tool to supplement an existing lockout/tagout program relative to manual hand valves in ammonia refrigeration systems.

Owners, owners' designated representatives, such as operators and technicians, and hired contractors can also use the guideline for developing a new energy control plan for their ammonia refrigeration system(s) and/or for a lockout/tagout procedure for a specific portion of the system(s) or for pieces of different equipment.

Natural Refrigerants Continue to Grow in Retail

Adoption of natural technologies in new and existing retail space is increasing as companies work to increase sustainability while meeting consumer, employer and shareholder expectations.

"Many retailers, especially national chains, are prepared to make very large investments to significantly reduce their carbon footprint by converting to naturals in existing stores," said Danielle Wright, executive director of the North American Sustainable Refrigeration Council.

More and more companies are realizing the importance of climate concerns. "I believe there is an increasing awareness and a resulting sense of urgency that we must act to address the climate crisis, as such all solutions are being explored and all stakeholders are applying pressure or at minimum beginning to ask questions," said Tristam Coffin, co-founder and chief operating officer of the consulting firm Effecterra.

Coffin added that the SEC's proposed rulemaking regarding climate disclosures has helped highlight these expectations.

NASRC recently published a free refrigerant transition hub (https://nasrc.org/hub) to help retailers navigate regulation changes implemented by the American Innovation and Manufacturing Act. The AIM Act, which was enacted in 2020 authorizes the Environmental Protection Agency to phase down hydrofluorocarbon refrigerant greenhouse gas emissions by 85% by 2036.

"HFC regulations from the AIM Act and several states are pressuring retailers to transition to climate-friendly refrigerants," Wright said. "Retailers need neutral information to help them make the right decisions. NASRC works in partnership with the supermarket industry, so we are uniquely positioned to identify the gaps in available resources."

Several national chain food retailers have committed to using naturals in all new store builds, with CO2 transcritical systems emerging as the predominant option. "For existing stores, we are seeing partial or full conversions to naturals although this is still logistically challenging and cost-prohibitive for many retailers," Wright said.

Coffin said natural refrigerant systems are picking up the pace in the U.S. "Commitments from several major retailers to install CO2 systems specifically has begun to send a market signal that demand for these solutions is increasing," he said.

Target has focused on natural refrigerants at its store in Vista, California. The location has a complex system of electrical, plumbing, solar and more that makes it the company's most sustainable store yet. The store also uses CO2 refrigeration to help reduce its emissions.

"Designing this project was intimidating at first, especially when you consider the moving target of energy consumption and all the stakeholders needed to pull it off," said Rachel Swanson, lead program manager, energy, for Target. "I'm so proud to see it come to life, and looking ahead, I'm excited to use what we learned here to help us achieve our goals and make a positive impact."

Many retailers are committing multi-million dollar budgets to overhaul their existing systems over the next 10-15 years, Coffin said.

Regulations are the core motivating factor for most retailers. "Not only the federal phasedown under the AIM Act but also HFC regulations at the state level," Wright said. "Everyone sees the writing on the wall and is planning to transition out of HFCs over the coming years."

Coffin agrees. "Regulation, specifically in California and those to follow in Washington and New York, but also the AIM Act federally were very much the trigger,

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but I do believe many organizations that have set climate commitments or at minimum have become much more cognizant of their carbon impact and the need to act is also a major driver," he said.

In addition, company climate targets are also playing an important role in accelerating this transition and putting pressure on retailers to get as close to zero emissions refrigeration as possible, Wright said.

Investor expectations are indirectly driving the move toward naturals because they are pressuring companies to set corporate climate targets and reduce overall greenhouse gas emissions. Since refrigerants represent a majority of company's baseline emissions, retailers can't achieve their targets without addressing refrigerant emissions. "Natural refrigerants are currently the only proven and market-ready option with zero or near-zero global warming potential," Wright said.

Curbside pickup exploded with the pandemic and has changed how some stores are designing their space. For example, many locations are adding more refrigeration in the back where they hold orders for pick up.

"There is a big opportunity to incorporate naturals when adding load to an existing store," Wright said. "For example, we know there is a big demand for CO2- or propane-based single condensing units to service this load type. Despite the demand, there are insufficient technologies available in the U.S. market today. For propane specifically, we are still waiting on EPA SNAP approval and building code updates to reflect the increased charge limit that would broaden its application."

Addressing existing facilities is more challenging than designing for new locations. "Added capacity or increased demand on existing facilities is only exacerbating this challenge," Coffin said. "However, I do believe there is an increased appetite or willingness to act especially as natural refrigerant distributed systems—smaller racks and condensing units—become more readily available. You will also see the use of self-contained mobile coolers utilizing R290 filling a lot of these gaps."

Coffin said the biggest challenge right now is the supply chain. "It didn't help that in the early days of the pandemic projects were put on hold and now a lot of retailers are trying to play catch up, so the demand for solutions/systems is high, but the ability for the supply chain to deliver is limited at best. This isn't specific to naturals, however," he said. "I do believe in some respects the pandemic has given everyone the time to reflect on how best to proceed into the future."

Wright said supply chain issues have disproportionately impacted the deployment of natural technologies. "We've heard that lead times for CO2 racks is over a year. The delays could compound over the next few years and hurt retailers' ability to meet regulatory deadlines," she said.

The federal phasedown of HFCs is expected to result in refrigerant shortages and significant price increases. In Europe, refrigerant prices increased by 900% following a similar HFC phasedown. Also, new legislation introduced in states such as California proposed to ban the sale and distribution of virgin HFC refrigerants as early as 2025, further driving the need for natural refrigerant solutions, NASRC said.

Even still, globally, naturals are synonymous with the latest advancements in refrigeration. "One of the biggest opportunities in the US is to increase the energy efficiency of CO2 transcritical systems. We are seeing new system configurations and components that improve the performance, especially in warmer ambient temperatures," Wright said.

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Circuit Court Supports Tampa Electric's Response to a Release

The Eleventh Circuit has rejected an appeal from the Occupational Safety and Health Administration in the case against Tampa Electric Co. and its response to an ammonia release at a power generating facility in 2017. The court of appeals upheld the finding that the release was controlled and the clauses pertaining to emergency response were not applicable.

"The finding of the court is important because it should permit our industry to respond to incidents that are controllable without necessarily assuming they are fully actionable emergency response scenarios requiring specialized hazmat teams with specialized equipment, such as self-contained breathing apparati," said Eric Smith, vice president and technical director for IIAR.

THE CASE

TECO uses ammonia to reduce nitrous oxide emissions which are a byproduct of power generation. Its plant was designed and built so that if an ammonia supply pipe becomes over-pressurized, ammonia is diverted to a sump—an underground water tank that absorbs and neutralizes the ammonia sent to it. Once the sump water becomes saturated with ammonia and is unable to absorb more, the system releases excess ammonia through the sump's vent pipe and into the outside air to prevent the overpressure from rupturing the supply pipe and causing a massive spill of ammonia.

When the system detected an overpressure in 2017, some excess ammonia was released through the sump vent, as designed, and an ammonia alarm sounded.

Specially trained technicians, called rovers, responded and helped put an end to the release. The technicians responding to the release used their training to ascertain the extent of the release, assess the problem, and stop the release, but they were not wearing self-contained breathing apparatuses (SCBAs). OSHA issued a two-item serious citation alleging violations of the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard, 29 C.F.R. § 1910.120.

TECO argued that the incident did not fall within the definition of an emergency response. The Occupational Safety and Health Review Commission (OSHRC), an independent tribunal, agreed and vacated OSHA's citation.

OSHA appealed.

IIAR believed the case's outcome would be crucial to the food industry and many other industries that use ammonia in their processes. IIAR teamed with the National Manufacturers Association and Edison Electric in filing an amicus brief to inform the court of the

ramifications of an unfavorable decision and weigh these against the alternative.

"We wanted the court to understand the importance of a decision and how it could have potentially affected our industry and potentially their industries," Smith said, adding that the amicus brief was accepted by the court. "We felt like it was influential in the court's decision."

Lowell Randel, senior vice president of government and legal affairs for the Global Cold Chain Alliance, said submitting the amicus brief was an easy decision. "The precedent of what the court decides could have long-ranging impacts on how OSHA handles these situations going forward. We wanted to make sure our voice was heard and that the precedent set by the court was in our favor and appropriate to what goes on in the industry," he said.

What's more, this was an opportunity for IIAR to get involved in a critical legal issue. "We work closely with agencies, stakeholders, and partners, and this showed IIAR can also be actively engaged when these issues elevate to a legal question and effectively represent the industry and its interests on another platform," Randel said. "It is an important case because it covered a question that can arise with OSHA in any ammonia release situation."

THE LATEST COURT ACTION

In rejecting OSHA's appeal, the court's decision focused on and was limited to the "uncontrolled release" issue. The court held that OSHA failed to show that the release was "uncontrolled."

"Thankfully, the court found that the release, in this case, was not uncontrolled and that Tampa Electric designed a response system to manage when and how to deal with releases and to what extent ammonia would be emitted in the event of a pipe over pressurization," Randel said. "The court basically found because Tampa Electric had those procedures in place, it was not by definition an uncontrolled release. Thus it did not trigger the HAZWOPER standard.

The court wrote, "[W]e are satisfied that Tampa Electric designed a response system to manage when, how, and to what extent ammonia would be emitted in the event of a pipe overpressurization and thereby adequately "controlled" the release."

Because the release wasn't uncontrolled, the response to it wasn't an 'emergency response,' and the HAZWOPER standard didn't apply to the rovers' conduct. "And because the HAZWOPER standard didn't apply, Tampa Electric didn't violate it," according to the decision.

Gary Smith, president and CEO of the Ammonia Safety & Training Institute, said the court's decision gives the use of industry best practices, such as the International Institute of Ammonia Refrigeration (IIAR) "Critical Task Guidance for Ammonia Refrigeration System Emergency Planning" document, a higher level of credibility for supporting the industrial and public safety response team as they address critical tasks such as incidental system control, emergency system control for a release within a hazard zone, and the ability for first responders with training and personal protective equipment to perform rapid entry rescue.

While the HAZWOPPER regulation has its place and is an important regulation, it shouldn't be the blanket response anytime there is an ammonia release. "The decision helped solidify that if a facility has a plan in place and they follow their plan, they're not going to automatically be thrown into the HAZWOPPER standard," Randel said.

The court's opinion is so narrow and so well grounded on the facts that no motion for reconsideration by OSHA is expected.

Although the court upheld the decision of the commission, it did not directly address other matters, including what factors constitute an emergency response or the extent of OSHA's authority over performance-based procedures.

"IIAR will be examining the court's decision and considering what our industry could and should do to affect reasonable responses to leak and release scenarios that can be addressed quickly and safely without the assistance of hazmat teams," Eric Smith said. "The recommendations provided in the 'Critical Task Guidance for Ammonia Refrigeration System Emergency Planning' will be significant for facilities to implement in the wake of this court decision."

Bonds, Interest Rates, and the Impact of Inflation

There are two fundamental ways that you can profit from owning bonds: from the interest that bonds pay, and from any increase in the bond's price. Many people who invest in bonds because they want a steady stream of income are surprised to learn that bond prices can fluctuate, just as they do with any security traded in the secondary market. If you sell a bond before its maturity date, you may get more than its face value; you could also receive less if you must sell when bond prices are down. The closer the bond is to its maturity date, the closer to its face value the price is likely to be.

Though the ups and downs of the bond market are not usually as dramatic as the movements of the stock market, they can still have a significant impact on your overall return. If you're considering investing in bonds, either directly or through a mutual fund or exchange-traded fund, it's important to understand how bonds behave and what can affect your investment in them.

THE PRICE-YIELD SEESAW AND INTEREST RATES

Just as a bond's price can fluctuate, so can its yield — its overall percentage rate of return on your investment at any given time. A typical bond's coupon rate — the annual interest rate it pays — is fixed. However, the yield isn't, because the yield percentage depends not only on a bond's coupon rate but also on changes in its price.

Both bond prices and yields go up and down, but there's an important rule to remember about the relationship between the two: They move in opposite directions, much like a seesaw. When a bond's price goes up, its yield goes down, even though the coupon rate hasn't changed. The opposite is true as well: When a bond's price drops, its yield goes up.

That's true not only for individual bonds but also for the bond market as a whole. When bond prices rise, yields in general fall, and vice versa.

WHAT MOVES THE SEESAW?

In some cases, a bond's price is affected by something that is unique to its issuer — for example, a change in the bond's rating. However, other factors have an impact on all bonds. The twin factors that affect a bond's price are inflation and changing interest rates. A rise in either interest rates or the inflation rate will tend to cause bond prices to drop. Inflation and interest rates behave similarly to bond yields, moving in the opposite direction from bond prices.

IF INFLATION MEANS HIGHER PRICES, WHY DO BOND PRICES DROP?

The answer has to do with the relative value of the interest that a specific bond pays. Rising prices over time reduce the purchasing power of each interest payment a bond makes. Let's say a five-year bond pays $400 every six months. Inflation means that $400 will buy less five years from now. When investors worry that a bond's yield won't keep up with the rising costs of inflation, the price of the bond drops because there is less investor demand for it.

WHY WATCH THE FED?

Inflation also affects interest rates. If you've heard a news commentator talk about the Federal Reserve Board raising or lowering interest rates, you may not have paid much attention unless you were about to buy a house or take out a loan. However, the Fed's decisions on interest rates can also have an impact on the market value of your bonds.

The Fed takes an active role in trying to prevent inflation from spiraling out of control. When the Fed gets concerned that the rate of inflation is rising, it may decide to raise interest rates. Why? To try to slow the economy by making it more expensive to borrow money. For example, when interest rates on mortgages go up, fewer people can afford to buy homes. That tends to dampen the housing market, which in turn can affect the economy.

When the Fed raises its target interest rate, other interest rates and bond yields typically rise as well. That's because bond issuers must pay a competitive interest rate to get people to buy their bonds. New bonds paying higher interest rates mean existing bonds with lower rates are less valuable. Prices of existing bonds fall.

That's why bond prices can drop even though the economy may be growing. An overheated economy can lead to inflation, and investors begin to worry that the Fed may have to raise interest rates, which would hurt bond prices even though yields are higher.

FALLING INTEREST RATES: GOOD NEWS, BAD NEWS

Just the opposite happens when interest rates are falling. When rates are dropping, bonds issued today will typically pay a lower interest rate than similar bonds issued when rates were higher. Those older bonds with higher yields become more valuable to investors, who are willing to pay a higher price to get that greater income stream. As a result, prices for existing bonds with higher interest rates tend to rise.

Example: Jane buys a newly issued 10-year corporate bond that has a 4% coupon rate — that is, its annual payments equal 4% of the bond's principal. Three years later, she wants to sell the bond. However, interest rates have risen; corporate bonds being issued now are paying interest rates of 6%. As a result, investors won't pay Jane as much for her bond, because they could buy a newer bond that would pay them more interest. If interest rates later begin to fall, the value of Jane's bond would rise again, especially if interest rates fall below 4%.

When interest rates begin to drop, it's often because the Fed believes the economy has begun to slow. That may or may not be good for bonds. The good news: Bond prices may go up. However, a slowing economy also increases the chance that some borrowers may default on their bonds. Also, when interest rates fall, some bond issuers may redeem existing debt and issue new bonds at a lower interest rate, just as you might refinance a mortgage. If you plan to reinvest any of your bond income, it may be a challenge to generate the same amount of income without adjusting your investment strategy.

ALL BOND INVESTMENTS ARE NOT ALIKE

Inflation and interest-rate changes don't affect all bonds equally. Under normal conditions, short-term interest rates may feel the effects of any Fed action almost immediately, but longer-term bonds likely will see the greatest price changes.

Also, a bond mutual fund may be affected somewhat differently than an individual bond. For example, a bond fund's manager may be able to alter the fund's holdings to try to reduce the impact

of rate changes. Your financial professional may do something similar if you hold individual bonds.

Bond funds are subject to the same inflation, interest rate, and credit risks as their underlying bonds, and if interest rates rise and bond prices fall, that can adversely affect a bond fund's performance. Before purchasing a mutual fund, you should carefully consider its investment objective, risks, fees, and expenses, which can be found in the prospectus available from the fund. Read it carefully before investing.

FOCUS ON YOUR GOALS, NOT ON INTEREST RATES ALONE

Though it's useful to understand generally how bond prices are influenced by interest rates and inflation, it probably doesn't make sense to obsess over what the Fed's next decision will be. Interest rate cycles tend to occur over months and even years. Also, the relationship between interest rates, inflation, and bond prices is complex and can be affected by factors other than the ones outlined here. Remember, investments seeking to achieve higher yields also involve a higher degree of risk.

Your bond investments need to be tailored to your individual financial goals and take into account your other investments. A financial professional may be able to help you design your portfolio to accommodate changing economic circumstances.

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Climate Change Policy in the Spotlight

iiar government **RELATIONS**

BY LOWELL RANDEL, IIAR GOVERNMENT RELATIONS DIRECTOR

President Biden has made addressing climate change a signature priority for his administration. Since his election, climate change policies have been at the forefront of agency actions, Congressional deliberations, and, most recently, before the Supreme Court. One of Biden's early actions was for the United States to rejoin the Paris Agreement. He then created the first-ever National Climate Task Force, with more than 25 Cabinet-level leaders from across agencies working together to advance ambitious goals including:

- Reducing U.S. greenhouse gas emissions 50-52% below 2005 levels in 2030
- Reaching 100% carbon pollution-free electricity by 2035
- Achieving a net-zero e missions economy by 2050
- Delivering 40% of the benefits from federal investments in climate and clean energy to disadvantaged communities

On July 20th, President Biden reiterated his position that climate change is a clear and present danger to the United States and announced his latest set of executive actions to address climate by "turning the climate crisis into an opportunity, by creating good-paying jobs in clean energy and lowering costs for families." The actions are intended to protect communities from climate impacts, including extreme heat conditions, and expand offshore wind opportunities and jobs in the United States.

The Federal Emergency Management Agency (FEMA) is announcing $2.3 billion in funding for its Building Resilient Infrastructure and Communities (BRIC) program for Fiscal Year 2022— the largest BRIC investment in history, boosted by the President's Bipartisan Infrastructure Law.

Protect Communities from Extreme Heat and Dangerous Climate Impacts: The Federal Emergency Management Agency (FEMA) is announcing $2.3 billion in funding for its Building Resilient Infrastructure and Communities (BRIC) program for Fiscal Year 2022— the largest BRIC investment in history, boosted by the President's Bipartisan Infrastructure Law. This funding will help communities increase resilience to heat waves, drought, wildfires, floods, hurricanes, and other hazards by preparing before disaster strikes. BRIC is among hundreds of federal programs that the Biden-Harris Administration is transforming to support the Justice40 Initiative and prioritize delivering benefits to disadvantaged communities.

Lower Cooling Costs for Communities Suffering from Extreme Heat: Today, the Department of Health and Human Services is issuing guidance that for the first time expands how the Low Income Home Energy Assistance Program (LIHEAP) can promote the delivery of efficient air conditioning equipment, community cooling centers, and more. In April, the Biden-Harris Administration released $385 million through LIHEAP to help families with their household energy costs, including summer cooling—part of a record $8 billion that the Administration has provided, boosted by the President's Bipartisan Infrastructure Law.

Expand Offshore Wind Opportunities and Jobs: The Department of the Interior is proposing the first Wind Energy Areas in the Gulf of Mexico, a historic step toward expanding offshore wind opportunities to another region of the United States. These areas cover 700,000 acres and have the potential to power over three million homes. President Biden is also directing the Secretary of the Interior to advance wind energy development in the waters off the mid- and southern Atlantic Coast and Florida's Gulf Coast —alleviating uncertainty cast by the prior Administration. These actions follow the President's launch

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of a new Federal-State Offshore Wind Implementation Partnership that brought together Governors to deliver cleaner, affordable energy, and new jobs.

President Biden has also indicated that he is considering the declaration of a national climate emergency. Such a declaration would unlock a series of powers that could enable the Administration to take additional executive actions to address climate change.

In addition, Democratic leaders in the Senate announced on July 27th that they have reached agreement on a budget reconciliation package that would raise an estimated $739 billion, with the revenue going to fund climate and health initiatives, as well as to reduce the budget deficit. While the legislation would amount to the biggest tax hike in years, it is a much smaller package than previously proposed under Biden's Build Back Better initiative. The legislation, called the Inflation Reduction Act, would invest $369 billion in domestic energy production and manufacturing activities with the goal of reducing U.S. carbon emissions by approximately 40% by 2030. An additional $64 billion is allocated to extend Affordable Care Act coverage for another three years. The proposal results in an estimated $300 billion deficit reduction through the following revenue provisions:

- 15% corporate minimum tax - raising $313 billion over ten years
- Prescription drug pricing reform - raising $288 billion
- Increased funding for IRS tax enforcement - raising $124 billion
- Closing the carried interest "loophole" - raising $14 billion

While the Biden Administration has been actively pushing for aggressive climate policies, some previous climate actions have been challenged in the courts, including the case West Virginia vs. EPA. On June 30th, the Supreme Court issued a major ruling that will effectively curtail some of the executive branch's power to regulate greenhouse gases and could have broader implications on future agency actions. By a vote of 6-3, the court agreed with Republican-led states and coal companies that the U.S. Court of Appeals for the District of Columbia Circuit was wrong when it interpreted the Clean Air Act to give the EPA expansive power over carbon emissions. The decision was written by Chief Justice John Roberts, who was joined by the 5 other "conservative" justices.

The case dealt with two regulations adopted during the Obama Administration under the auspices of the Clean Power Plan. The policies were meant to combat climate change by reducing carbon emissions from power plants by shifting electricity production to natural-gas plants or using renewable energy such as wind. The CPP set individual goals for each state to cut power-plant emissions by 2030. The policies were put on hold in 2016 due to legal challenges.

Chief Justice Robert cites the "major-questions doctrine" in his ruling, which is a judicially created approach to statutory interpretation in challenges to agency authority. When "major questions" are raised, the court must determine whether Congress explicitly intended to authorize the executive branch to adopt the policy being evaluated. Legal scholars believe that this adoption of the "major-questions doctrine" could have much broader effects than just EPA and impact other major policymaking efforts by the federal government.

The court's decision saying that agency efforts to curb emissions from power plants is a "major question" that Congress did not give EPA the authority to handle has led to a debate over other regulations that may or may not fall under the same label.

The court's decision saying that agency efforts to curb emissions from power plants is a "major question" that Congress did not give EPA the authority to handle has led to a debate over other regulations that may or may not fall under the same label. The court didn't clarify what might trigger the so-called major questions doctrine, but legal analysts suggest several initiatives could be vulnerable to challenges. The regulations that could be subject to the court's interpretation of a "major questions" issue could range from EPA's rules to boost car emissions standards, new climate accounting proposals from the Securities and Exchange Commission, and new Federal Energy Regulatory Commission initiatives. It is worth noting that the Supreme Court's ruling should not have any impact on EPA's implementation of the AIM Act, as Congress explicitly provided the agency with authority to regulate the production and consumption of HFCs.

It is expected that both the Biden Administration and the Democratically controlled Congress will continue to elevate climate policies in the future and the implications of the Supreme Court's ruling will likely be tested again in the future.

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Always Learning

KEM RUSSELL, P.E

The following are some examples of being willing to learn versus not being willing to try to learn.

EXAMPLE 1:

At a large (+2000 TR) low-temperature ammonia facility the processing of the product occurred over a short period, so it was extremely important that the system operated very well. The low-side of the system operated in a vacuum. Changes had been made to the high-side of the system to take advantage of discharge gas heat, which seemed to coincide with an unwanted increase in condensing pressure and an also unwanted increase in power usage. Some efforts had been spent to find the problem, but nothing changed until one person decided they were going to find out what was going on.

The system had an automatic purger that cycled through all purge points. Checking, they found the purger was operating correctly. What about the purge solenoid assemblies? Checking they found that all of the purge solenoids worked. They also checked the manual/automatic stem on each of the assembly solenoids and all were in the automatic position except one. What was the possible effect of this solenoid being manually opened? They didn't know, so they asked. The answer was that only one purge point should be purged at a time. Having two (or more) purging simultaneously may result in non-condensables flowing from one purge point to another due to even a small difference in pressure between the purge points. The end result could be that no actual purging gets done.

This person was willing to put in the effort to keep looking and ask questions which resulted in both better system performance and they learned a lot.

EXAMPLE 2:

Pressure relief valves are a very important device for every pressure vessel or piece of equipment requiring one. The function of a relief is affected by both the pressure loss to the inlet of the valve as well as the outlet or back-pressure on the valve. It is important to understand what a correct installation is so the relief valve can function as properly.

At an ammonia refrigeration facility, the refrigeration operator knew that relief valves are to be changed at least every five years. Since the last time many of the relief valves had been changed, relief valves had become available with removable cartridges. The operator thought this was great since this could make changing relief valves in the future easier, faster, and safer. So, the operator ordered a lot of the cartridge-style relief valves. He knew the inlet and outlet sizes required and the set relief pressure. What he didn't take time to understand and learn was would the new relief valves work with the pressure vessels and relief piping he had?

The relieving capacity of the new style relief valves installed was more than required for all but one vessel. The replacement on that vessel was the correct pressure setting and pipe connection size, but too small in relieving capacity. In addition, all of the other relief valves installed having more than the required relieving capacity meant that the existing relief discharge piping now had much more back-pressure than acceptable.

By not making the effort to learn about proper relief valve application the refrigeration operator had to re-order and replace again, all of the relief valves. A tough learning lesson but one that the operator probably won't forget.

EXAMPLE 3:

Many years ago, I worked for my dad's refrigeration company in the conversion of a Liberty ship (about 440 feet long) to a seafood processor. Some of the ship didn't need much conversion, just the addition of air-cooling units to store frozen products in the existing hold spaces. One of the higher decks was converted into the processing area, and I was given the task of removing a lot of unnecessary steel structure to make room for the many plate freezers that would be installed. Up to this time I had worked with not only my dad for many years but also people he hired as well as many of the people that operated ships and land-based facilities we did work for. Maybe I lived a somewhat sheltered life since the people I worked with were hard-working, very good at what they did, and mostly friendly. I had not yet learned that some people could be vastly different from what I was used to, and I would have to be willing to try really hard to learn how to get along with them. We had one man on the crew that not only tested me but others.

At the end of one work day, I had cleaned up my work area, properly coiled and secured the cutting hose and bottles, then asked my dad what else he wanted me to do. He told me to go help this other welder he had hired to clean up his area and welding gear.

I offered this man my help and he told me he didn't need my help with a lot of descriptive words I was not used to nor wanted to hear, and that I should go back to my mother. I was shocked that someone would talk to me like that! How was I supposed to work with or help this guy?

My help being rejected in a very unpleasant manner I went back to the top deck where I found my dad talking with Tiny the Chief Engineer of the ship. Tiny was the only name I ever knew for the Chief but that was an oxymoron. Tiny was about 6'-6" tall, big, and strong. With Tiny listening, I told dad what had happened. In his deep voice, Tiny said "Don't worry about it. That guy did the same thing to me, and I considered wrapping a 2" pipe around his head. I don't know what that guy's problem is, but he isn't going to be working here long."

Tiny was right. That guy wasn't working there the next day, which I wasn't too upset about, but I realized I did need to be willing to learn to work with and in a reasonable manner deal with all kinds of people. I don't know what happened to that guy, but I hope he started being willing to learn how to appropriately interact with others and improve his life too.

Learning is not a one-time thing, it is a lifelong thing. It's like breathing, don't let it stop. Be willing to continue to learn and keep trying. No matter how much you think you know you can always learn more.

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TECHNICAL PAPER #3

Managing Your Energy Costs: It Can Be Done!

JAMES MAJSAK, CONSTRUCTION MANAGER CROSSNOKAYE (SANTA BARBARA, CA)

ABSTRACT

All too often, energy management projects with good potential will fail for any number of reasons. Most of these failures will be a result of the project not addressing key requirements for success, or not meeting the expectations of all users throughout the organization. This report is intended to provide a 10,000-foot view on taking a holistic approach to energy management and reduce the risk of project failure.

The following topics will be discussed:

- Decoding Your Utility Bill - Unravelling the mysteries of electric utility bills and tariffs
- Energy Awareness - Understanding facility energy usage profiles
- Sub-metering - Justification and benefits of sub-metering equipment
- Energy Analytics - Transforming data into operational knowledge
- Refrigeration Industry Best Practices - Where are the energy savings opportunities?
- Project Development - Energy management project development best practices
- Selling It to Management - Presenting energy management projects for approval
- Evaluating Results - Confirming energy management project effectiveness

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INTRODUCTION

The role of refrigeration Energy Managers has changed significantly over the years. In the past, a majority of energy management revolved around negotiating the best utility contract once every few years and making sure the budget supported the anticipated cost.

Changes in the amount of real-time data available from utility companies along with new technologies for measuring and monitoring energy usage have resulted an opportunity for Energy Managers to take a more proactive role in reducing facility energy usage.

The energy management process now looks more like an ongoing cycle rather than the linear process it may have been in the past, as shown in Figure 1.

Taking a holistic approach to energy management will help ensure success for the energy manager, but it will also require additional effort to make sure all required areas of expertise are well-understood and all steps within the process have been completed. For this reason, it is always best to start with a simple energy efficiency measure as a pilot, and walk through the entire process end-to-end before attempting to complete more comprehensive energy management projects.

The sections below provide an overview on each functional area of a holistic energy management approach.

DECODING YOUR UTILITY BILL

Utility bills are often not immediately decipherable upon first glance, but it's important that Energy Managers dig into the details of these charges. Here are four good practices that can help develop a "facility profile."

Educate Yourself on the Basics

There are two components that make up a majority of most utility bills and it is important to understand the difference between them. The first component is consumption, typically measured as kilowatt Hours (kWh) and the secon component is demand, typically measured as kilowatts (kW). Figure 2 shows an example of the difference between these.

With reference to Figure 2, the following points should be noted:

- Consumption (kWh) – A measurement based on usage over time. In the example above, running five 1,000-watt bulbs for one hour would result in 5kWh of consumption.
- Demand (kW) – A measurement based on peak consumption during a specific timed interval, typically 15 minutes. This can also be 30 or 60 minutes, depending on the utility tariff rules. For most utility tariffs, the highest demand interval during the month determines the billed peak demand. For the example shown above, the peak demand measured would be 5kW.

Another way to think about kWh vs. kW is to compare the terms to a car odometer and speedometer. If you were billed for driving the same way you were billed for electric usage, you would be given a monthly charge based on the total miles driven (like kWh) and another charge based on the top speed you reached during the month (like kW).

While there are many more minimal charges on utility bills, and many variations on billing of consumption and demand, the examples above should provide the basic understanding required to review your electric utility tariff and associate the majority of the costs to your monthly utility bill.

Read Your Entire Utility Bill

The next step in the process is to review your actual utility bills. The format and methods of billing for energy will vary greatly based on the suppliers and utility tariffs selected. In some areas, energy procurement is deregulated so you may have two separate bills for the same account, with each having their own method of billing. Figure 3 shows a typical utility bill with notes on the different types of charges.

Notes:

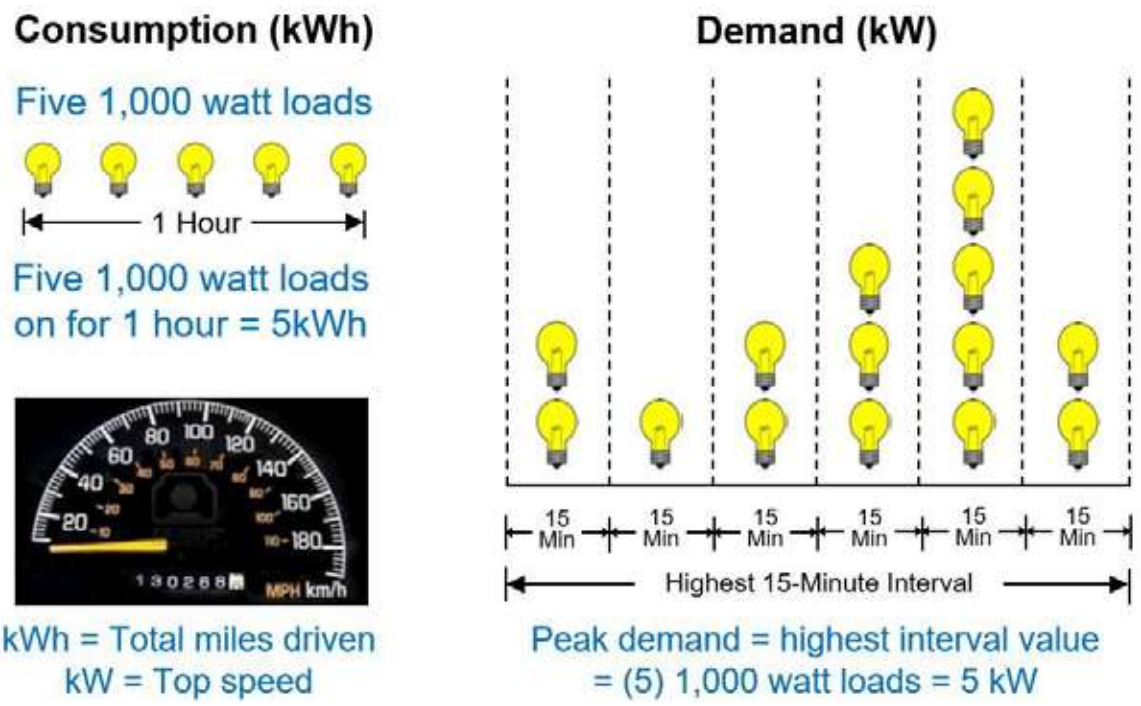
- The tariff code "TOU-8-D-RTP BIP" translates as "Time Of Use," "Demand Charges," and "Real Time Pricing" with "Base Interruptible Program" participation. This is very typical for an industrial account in a well-populated region of the country.
- The charges are segmented into "Delivery" and "Generation" classifications, as typically done for a deregulated market. Delivery is always provided by the

regional utility and generation may be provided by either the regional utility, or a third-party supplier, as desired by the customer.

- The utility bill shown covers the dates of May 4 - June 3, so there are 28 days billed during the Winter season which ends on May 31 and two days billed during the summer season.

Figure 1. Holistic approach to energy management

Figure 2. kWh Vs kW



- Delivery demand charges are segmented in different rate periods, with separate charges for each period. This includes seasonal and time-of-day periods.
- The Department of Water DWR bond charge is intended to recover the cost of the energy needed to provide water services during an energy crisis period.
- This facility participates in a demand response program (BIP) and receives a credit on each utility bill for compensation.
- Generation consumption charges are based on real time price, which varies every hour of the month based on regional weather and electric supply capacity.

Know Your Utility Tariff

It may be noted in the sections above that there are numerous variables when it comes to how customers are billed for energy usage. The details behind each of the charges shown are usually not provided on the utility bill. These details are typically published in a utility tariff rate sheet, as required by state or federal regulations.

Most public utility companies will post their tariff rate sheets on their websites, where customers can find their specific tariff by referencing the tariff code shown on their utility bill. Smaller municipal utility companies, or municipal groups that purchase power from outside resources, will have similar tariff worksheets but typically show less details than the larger public utility companies.

Utility tariffs will typically provide information on the following functional areas:

- **Applicability** – Which customers can request a specific tariff, and limitations on minimum and maximum peak demand (kW) levels for participants.
- **Territory** – Geographic territory where the tariff is offered.
- **Rates** – Costs for consumption (kWh) and demand (kW). Typically broken down by time-of-day and seasonal rates, with options for delivery at different voltage levels.
- **Time Of Day Details** – Specific time of day peak and off-peak periods.
- **Seasonal Details** – Specific date ranges for changing seasonal charges.
- **Demand Interval** – Description of how demand is measured and billed. This may include specific clauses where monthly billed demand can differ from measured demand or be based on peak demand from previous months.
- **Power Factor Charges** – Additional charges for power factor below specific levels.
- **Riders** – Temporary charges added to specific tariffs to recover costs from other programs or events that had a significant impact on the cost of energy.

Read Every Line, Understand Every Detail

As anyone will quickly see once they start looking into tariffs, there are many variations in the methods of charging customers for their energy usage. For this reason, it is always important to not only understand the charges shown on your utility bill, but to also understand conditions that may change the way you are billed from month to month. Below is an example of this:

Figure 3. Sample utility bill

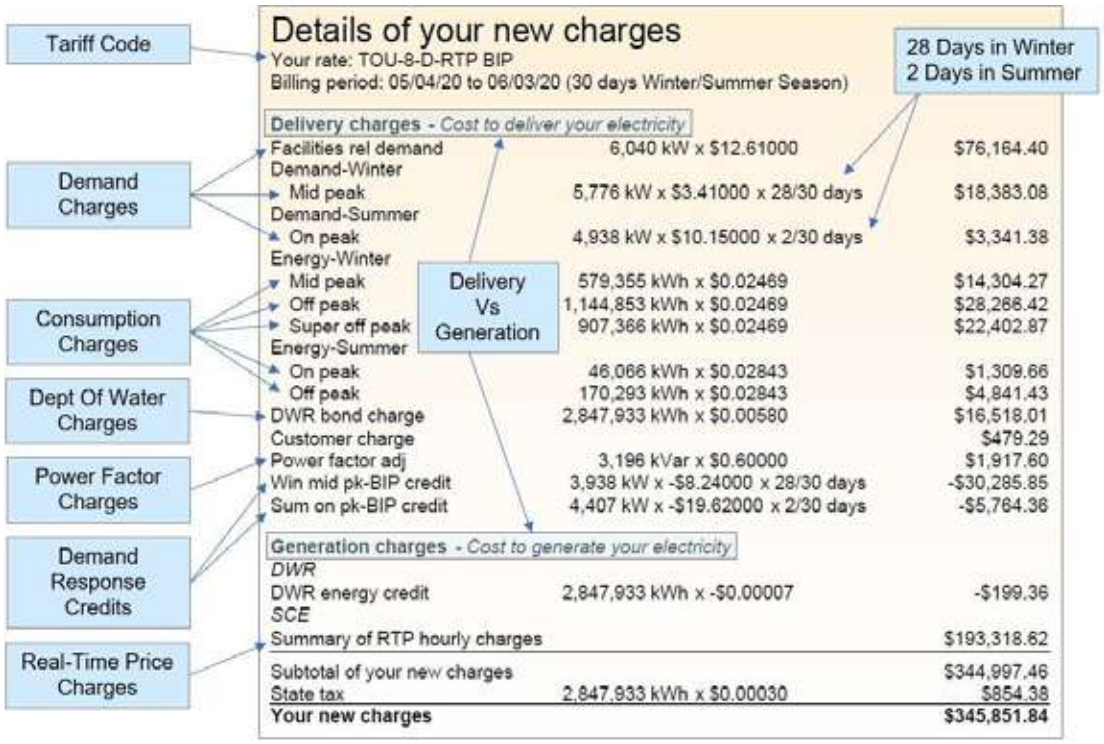


Figure 4. Utility summary data

ABC Refrigerated Rate 057

Acct: 1234567890 - 123 Main St. Anytown CT 06062

Energy Profile / 2020

Month	Rdg Last Date	Rdg Curr Date	Cycle Days	kWh's	Daily Avg	On-Pk kWh's	Off-Pk kWh's	On-Pk kw	Off-Pk kw	Peak kw	Billed kw	kVA	Load Factor	Power Factor
Jan	12/14/19	01/13/17	29	564,993	19,483		564,993		893	893	893	1120	91%	80%
Feb	01/14/20	02/13/17	29	598,016	20,621		598,016		904	904	904	1133	95%	80%
Mar	02/14/20	03/14/17	30	567,720	18,924		567,720		907	907	907	1128	87%	81%
Apr	03/15/20	04/12/17	27	576,288	21,344		576,288		972	972	972	1195	91%	81%
May	04/13/20	05/15/17	32	610,189	19,068		610,189		868	868	872	1087	91%	80%
Jun	05/16/20	06/15/17	29	516,525	17,811	40,938	475,587	839	835	835	872	1038	85%	81%
Jul	06/16/20	07/14/17	28	537,039	19,180	101,520	435,519	914	932	932	932	1159	86%	81%
Aug	07/15/20	08/14/17	29	633,355	21,840	113,423	519,932	1,012	983	983	1,012	1238	90%	82%
Sep	08/15/20	09/15/17	30	731,239	24,375	144,351	586,888	1,116	1,102	1,102	1,116	1368	91%	82%
Oct	09/16/20	10/13/17	27	683,067	25,299	71,576	611,491	1,130	1,120	1,120	1,130	1372	93%	82%
Nov	10/14/20	11/13/17	29	635,766	21,923		635,766		1,048	1,048	1,048	1269	87%	83%
Dec	11/14/20	12/12/17	28	601,518	17,911		601,518		828	828	837	1019	89%	81%
Totals :				7,155,715		471,808	6,683,907							
Average :			29	596,310	20,648	94,362	556,992	1,002	949	949	958	1,177	90%	81%

Tariff: Eversource Connecticut Rate 057 – Large Time-Of-Day Electric Service Manufacturers

Clause: "Distribution demand shall be the highest average 30-minute kilovolt- ampere (kVA) demand in the current month or the preceding eleven (11) months. The customer may, upon not less than three (3) months' prior written notice to the Company, decrease the Distribution Demand ratchet solely to reflect lower load levels resulting from demonstrable conservation and load management."

Impact:

- If the customer had a peak demand reading the previous month that exceeds the current month's value, they will be billed at the previous month's level for the current month as well as the next 11 months if no higher demand is recorded. This is known in the industry as a "demand ratchet" clause.
- If the customer takes conservation measures to reduce peak demand, they can request the demand ratchet be reset after only 3 months, saving 8 months of excessive charges.

As shown above, if a customer had never reviewed their tariff or understood the details behind their billing, they may have implemented a demand reduction project with no financial impact for the first 11 months and would not have known they could reset their billed demand after three months.

ENERGY AWARENESS

It's important to understand not only how your facility is billed for energy usage, but also how your facility consumes energy throughout the year.

Understanding Your Facility Profile

The best way to do this is by reviewing historical usage data over the last 12 months to understand not only how your facility operates on a month-to-month basis, but to also understand the impact of any weather or seasonal changes. There are three basic methods for doing this:

- Compile the kWh and kW reading provided on each monthly utility bill.
- Request summary usage data from your utility. This may come as monthly, daily or hourly data depending on your meter type and the capabilities of the utility company.
- Request interval meter data if your facility has an interval meter. This can typically be confirmed by the presence of an LCD display on the meter showing kW data. The resolution of the data will match your demand interval of 15, 30, or 60 minutes.

While the first two methods of collect-

Figure 5. Utility interval data

Date	Hour	Month	Day	Year	Hr	Min	Day of Week	Date Time	Kilowatt Demand	KVAR Demand
9/24/2000	15	9	24	20	0	15	4	9/24/20 0:15	5,491	2,369
9/24/2000	30	9	24	20	0	30	4	9/24/20 0:30	5,580	2,377
9/24/2000	45	9	24	20	0	45	4	9/24/20 0:45	5,622	2,340
9/24/2000	100	9	24	20	1	0	4	9/24/20 1:00	5,717	2,434
9/24/2000	115	9	24	20	1	15	4	9/24/20 1:15	5,721	2,356
9/24/2000	130	9	24	20	1	30	4	9/24/20 1:30	5,376	2,205
9/24/2000	145	9	24	20	1	45	4	9/24/20 1:45	5,219	2,206
9/24/2000	200	9	24	20	2	0	4	9/24/20 2:00	5,376	2,310
9/24/2000	215	9	24	20	2	15	4	9/24/20 2:15	5,311	2,272
9/24/2000	230	9	24	20	2	30	4	9/24/20 2:30	5,208	2,218
9/24/2000	245	9	24	20	2	45	4	9/24/20 2:45	5,121	2,223
9/24/2000	300	9	24	20	3	0	4	9/24/20 3:00	5,039	2,254
9/24/2000	315	9	24	20	3	15	4	9/24/20 3:15	4,848	2,128
9/24/2000	330	9	24	20	3	30	4	9/24/20 3:30	4,874	2,216
9/24/2000	345	9	24	20	3	45	4	9/24/20 3:45	4,728	2,085
9/24/2000	400	9	24	20	4	0	4	9/24/20 4:00	4,625	1,924

Figure 6. Cold storage facility interval data

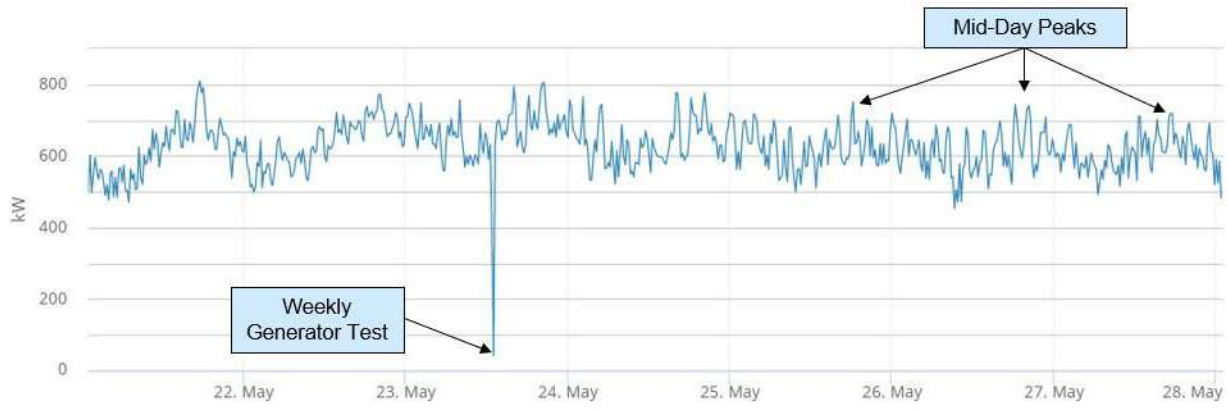


Figure 7. Blast storage facility interval data

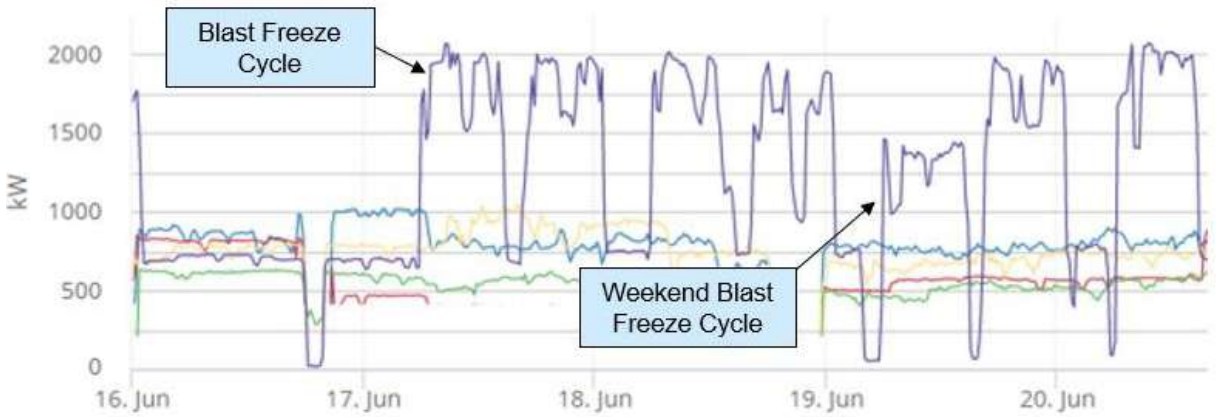
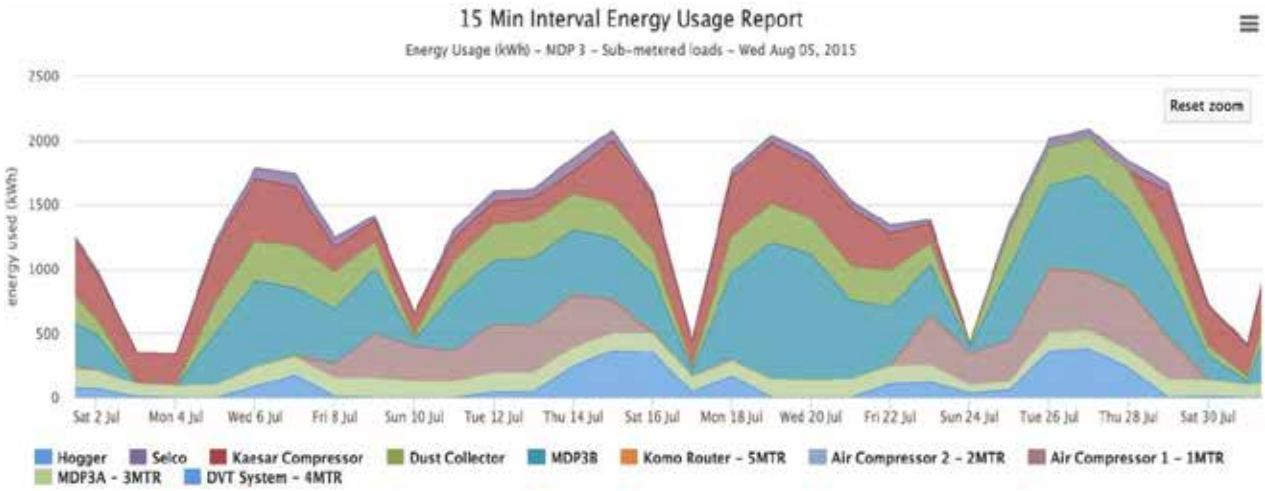


Figure 8. Sub-metered data graph



ing summary data will be much easier to achieve, they will only provide data that shows a simplified overview of your energy usage. Figure 4 shows an example of summary data delivered by a utility:

The third method of requesting interval data will provide the greatest resolution and show all peak events that impact your utility costs. Interval data is typically delivered to the customer as an electronic data fille, in CSV format. This is due to the large number of data points. For example: If the facility is billed on 15-minute demand intervals, they will receive 96 readings per day, 35,040 readings for the entire year.

Once the interval data is received, it can be imported into a variety of applications for analysis. Excel is a very popular and powerful tool for interval data analysis with the ability to add additional formulas, conditional formatting, and data graphs. Figures 6 and 7 show examples of graphing demand (kW) interval data for two facilities.

Cold storage facilities will typically show a repeatable pattern of energy usage day-to-day with seasonal trends of increased and decreased usage as the outside temperature varies. Any peaks occurring outside the normal patterns of usage should be investigated for energy efficiency opportunities.

Facilities with manufacturing processes such as packaging and blast freezing will show a less-repeatable usage profile. Changes in operations and the combinations of equipment running different times will result in a varied usage pattern with profiles from the larger loads being recognizable. While there may be changes in the facility's baseline usage during evenings and weekends, the usage profile shapes of the larger loads may remain the same.

SUB-METERING

While electric utility data provides an overview of energy usage from a utility billing perspective, sub-metering data will provide a more granular view as well as the impact individual loads have on overall energy usage.

Taking A Deeper Look

This data is valuable for a number of reasons:

Energy Awareness – Sharing of energy data for specific departments across the organization

Usage Allocation – Energy usage accountability for individual equipment or systems Utility Bill Verification – Comparison of totalized usage against monthly billed values Operations – Ability to measure the impact of operational changes on energy usage Equipment Performance – Monitoring of real-time energy usage for inconsistencies Asset Utilization – Tracking of run-hours and utilization for individual assets

Continuous Commissioning – Platform for M&V data and identification of new opportunities

The increased granularity of sub-metered data also allows for a much more powerful graphics that show the relationship between individual loads and their impact on overall usage. Figure 8 shows a typical graph from a sub-metered facility.

Another side benefit of sub-metering at the facility above was the ability for management to better understand how often specific equipment was in operation, which helped make better decisions on production bottlenecks, equipment capacity and scheduling issues.

Beside energy managers, there are many other groups inside, and outside, the organization that may find access to sub-metered data valuable for a variety of reasons. This includes the following:

Internal Resources – Maintenance, Engineering, Accounting, Facility Management and Corporate Management.

External Resources – Utilities Companies, 3rd Party Energy Suppliers, Energy Efficiency Companies, Engineering Firms/Contractors and Customers ISO 50001 Quality Managers.

Very often during submetering projects, there will be an unanticipated view of usage that provides value never considered in the original project plan. A good example of this was an accounting department that compared historical electric usage data to their operations schedule to accurately predict what the utility bill would be 2 weeks into every month. This provided a "crystal ball" view of future energy costs, which helped manage facility expenses.

Figure 9. Apophenia: The human tendency to perceive connections or meaningful patterns between unrelated or random things.

DATA ANALYTICS

While the previous sections outlined of the benefits of reviewing metering data, the next step is to perform an ongoing analysis of data for comparison against previous readings and correlation with data from other sources.

Transforming Data into Insights

The challenge in doing so is the need to work with very large amounts of data and the challenge of finding meaningful relationships between data sets that can provide insights. This is the role of an analytics software package.

The reason such packages exist is because manually interpreting data is a time- consuming process that often provides false results, due mainly to a human tendency to see connections and patterns where there are none. The formal term for this condition is "apophenia," and it is illustrated by the amusing images in Figure 9. The same goes for energy data trends.

There is a difference in the capabilities and roles of data collection vs. analytics.

A favorite expression is that "a good data collection package will allow you to dig through the numbers to see what happened, while a good analytics package will tap you on the shoulder and tell you when and where to look."

An effective data analytics package will provide the following:

- Analysis of both real-time and historical usage data
- Correlation and normalization of data from different data sources
- Automated identification of events hidden within large amounts of data
  - Usage patterns
  - Deviations & Failures
  - Opportunities for improvement
- Graphical reporting with a simplified view of complex issues
- Automated delivery of standard reports, KPI's and scorecards

It's All About the Rules

One of the most import features of an effective analytics package is the ability to define custom analytical rules to be applied against data to automatically identify critical events. Users should have the ability to define limits and functions that allow them to identify when equipment is running outside normal operational levels and trigger notifications before failure occurs. Figure 10 lists some examples from a typical refrigeration facility.

INDUSTRY BEST PRACTICES

Once you have the knowledge and data required to understand the presence and cost of inefficiencies, the next step is to identify the possible causes and take action.

What's Everyone Doing?

Figure 11 shows typical energy efficiency measures being performed at cold storage facilities.

Advanced Control Strategies

In addition to the measures above, recent advancements in refrigeration control systems have allowed for the development of specific energy saving strategies. This includes the following:

- Setpoint Optimization
- Automated Demand Stabilization
- Thermal Load Shifting
- Realtime Price Response

Setpoint Optimization

Setpoint optimization consists of monitoring the relationship between equipment running in coordinated groups then confirming each piece of equipment is coming on, and going off, at the proper time. Significant spikes in energy usage point towards a system that is possibly responding too quickly to process changes. Multiple pieces of equipment found running below their

Figure 10. Analytical rules for refrigeration equipment

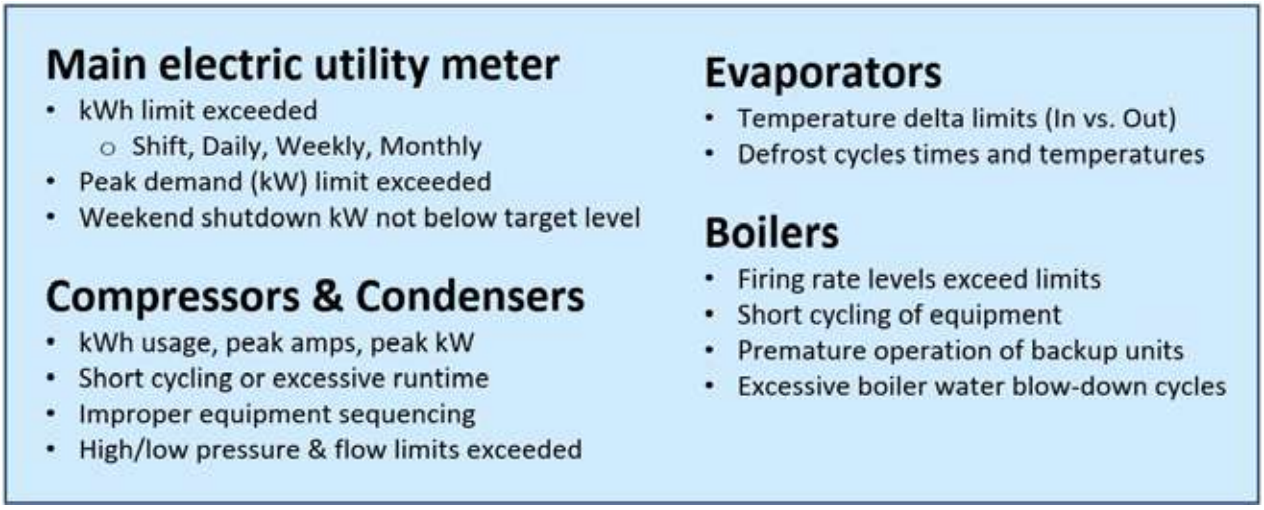
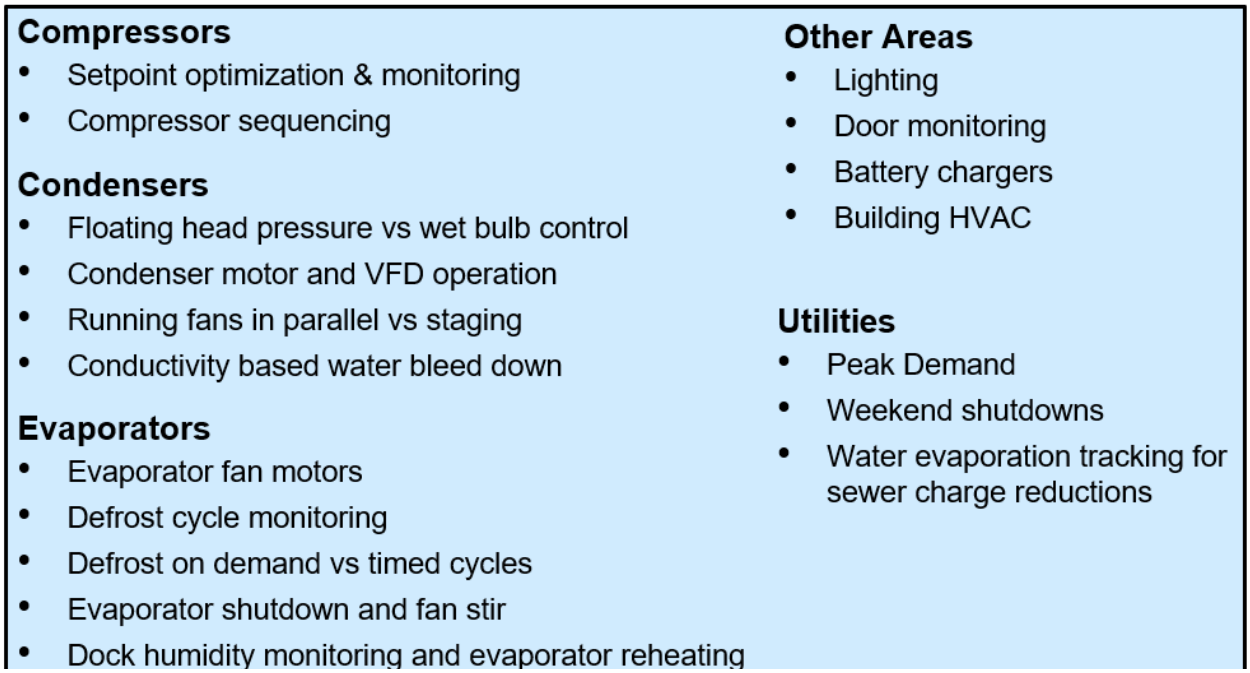


Figure 11. Energy efficiency measures for cold storage facilities.



maximum capacity may be a sign of setpoints for groups of equipment being too close to each other. Figure 12 shows peak demand trends before and after a setpoint optimization project.

The results of the project shown in Figure 12 are:

- Reduced overall peak demand, from 243 kW to 155kW (36.2% reduction)
- Reduced load factor (peaks & valleys) for more consistent operation of equipment
- Comp 1 and 2 are now handling most of the plant load
- Comp 3 is now running as a trim compressor with minimal runtime

Automated Demand Stabilization

Automated demand stabilization is the reduction of peak demand to a predetermined setpoint level. Performing a review of interval data and graphing demand (kW) over time will identify the opportunity for demand reductions (Figure 13). A facility with significant "peaks and valleys" in the data will be a good candidate. "Peaks" identify excessive usage, such as multiple facility loads running at the same time. "Valleys" identify intervals that loads can be shifted into by reducing their usage during a peak interval and recovering during the next interval.

One thing that cannot occur is constant reductions across all demand intervals. For this reason, if the facility has what is called a "flat" profile with minimal peaks and a consistent demand level, it may not be a good candidate for a demand stabilization project.

In most cases, demand stabilization can be achieved without any impact on facility operations or product quality. In the case of cold storage, product temperature should be monitored during load shedding operations to ensure there is no impact on stored product quality.

The results of the demand stabilization project shown in Figure 12 are:

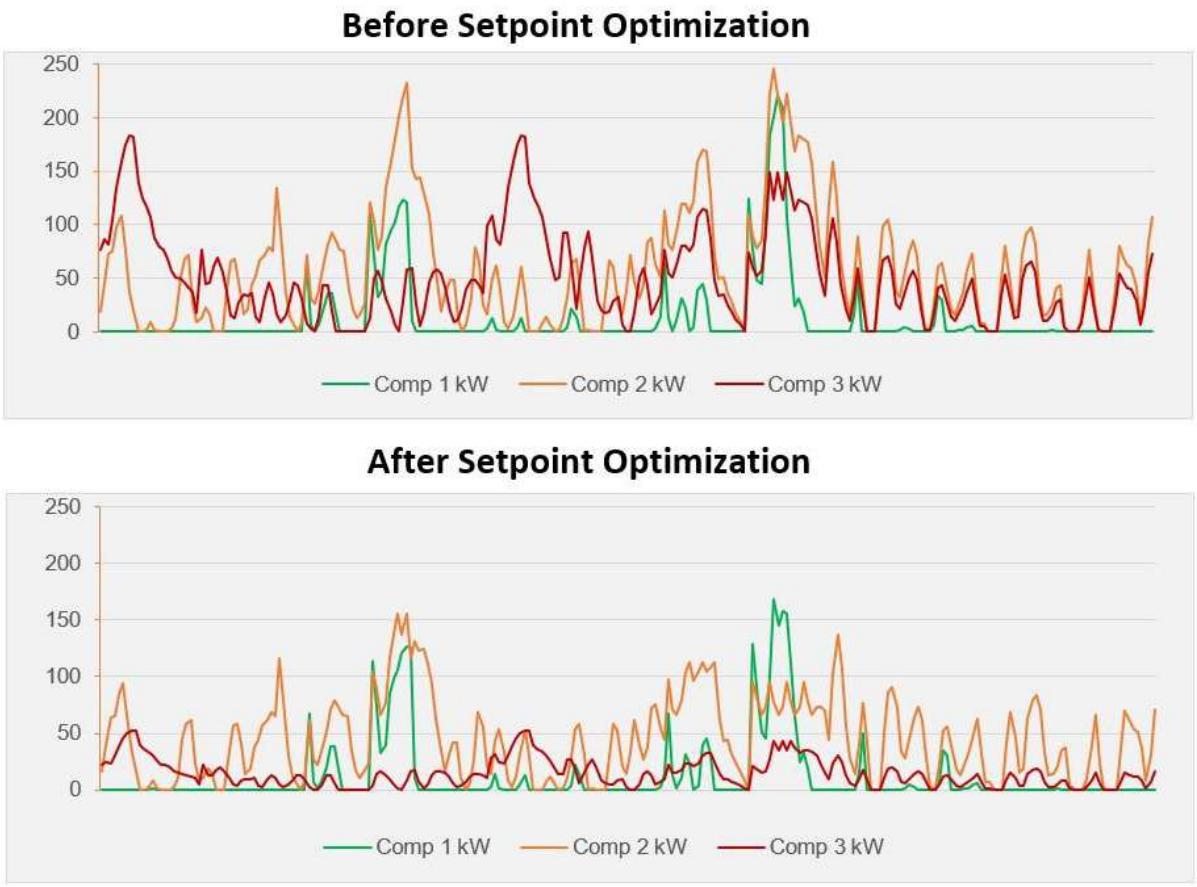
- Reduced overall peak demand from 3,400kW to 3,000kW (11.46%)
- Reduced monthly demand charges of $3,884 ($9.71/kW * 400kW Reduction)
- No impact on facility operations or product quality

Thermal Load Shifting

Thermal load shifting is a proactive approach to avoiding peak cost events. This strategy is specific to the cold storage industry, where energy can actually be stored by overcooling product then reducing equipment operation to ride through peak price events.

An important requirement for this strategy is to monitor product temperature as a load shedding constraint to protect product quality, but there is still a good opportunity for significant

Figure 12. Setpoint optimization, before and after.



savings even if you cannot load shed throughout the entire event.

Figure 14 illustrates to following steps of a thermal load shifting strategy:

1. A peak price event is identified by either utility notification or the monitoring of regional generating capacity and real-time pricing for the day of operation.
2. Over-cooling of product begins prior to the event start time, while energy cost is low.
3. The optimal energy reduction level is calculated to maximize reductions while protecting product during the event.
4. Energy is restored to normal operating levels once the event has ended, or if product temperature exceeds a setpoint limit.

Real-time Price Response

Figure 15 shows a successful attempt by a cold storage customer to reduce peak demand during an 11-hour peak price event. This customer was on a real-time price tariff with day-ahead notification of the following day's costs.

- The customer was able to reduce the facility load to a value below 250kW for the first four hours of the event.
- During the next seven hours of the event, the customer was required to expend some additional load, but still maintained peak demand below 708kW.
- During hour 23:00, the price was still high but the customer was needed to restore energy usage to normal levels to protect product.
- The estimated savings for the customer's price response was $36,817 for the day.

One interesting fact is that this data was from July 2017. While reviewing data for the same site from May 2020, a similar price peak occurred, but no action was taken! This may have been a manual response or a failure to understand that an automated system was no longer operational, but it is a good argument for continuous commissioning where energy management measures from the past are validated on a regular basis.

PROJECT DEVELOPMENT

So now we have a good understanding of utility billing and the facilities usage profile. We may have also installed submetering to better define the opportunity and have reviewed the data. We have a good understanding of industry best practices and control strategies and are now ready to develop a project! Now what?

Set Expectations Soon and Often!

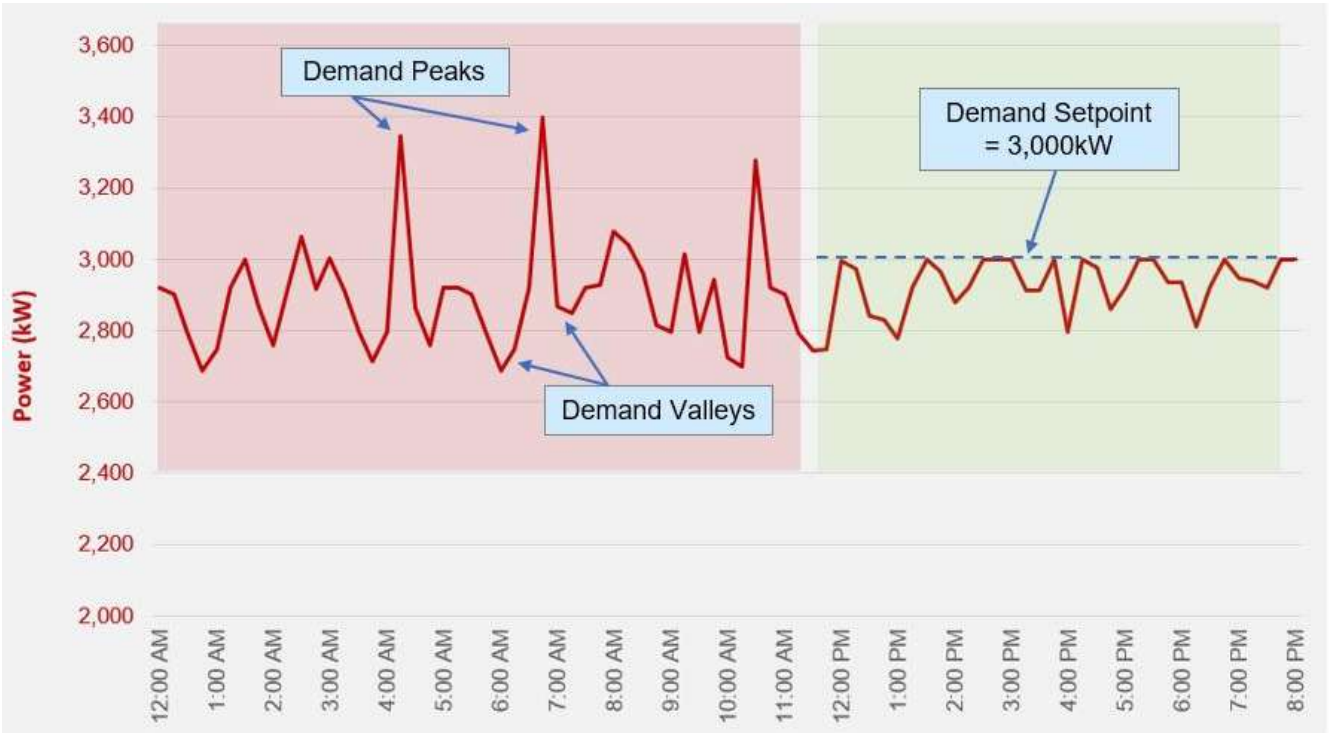
A good first step is to interview each person the project will impact and ask a few leading questions. This approach has a dual purpose. It allows you to get initial feedback on your project design, and also set users expectations on the benefits of the project.

"Leading questions," should be designed to answer your basic assumptions as well as letting end users realize what they don't know. Here are a few examples:

Employee Performance

- Which area of the facility currently

Figure 13. Automated demand stabilization



operates most efficiently?

- Which team is best at maintaining proper setpoints on their equipment?
- Which department is best at performing shutdown procedures nights and weekends?
- Is energy included in production metrics, like kWh/pound or kWh/pallet?

Facility Management

- Which facility loads use the most energy?
- Which facility loads are most impacted by changes in weather?
- Is energy metering part of any condition-based maintenance routines?
- Which systems have the most, and least, amount of downtime?

Operations

- Are there areas where seasonal products impact energy usage?
- What past operational changes have resulted in increased or decreased energy usage?
- How does this facility's energy usage compare to other similar sites?
- How does management current measure changes to trends in energy usage?

Know Your Costs – All of Them

Having an accurate estimate of all costs is a very important part of project development. Initially, the project return on investment (ROI) reviewed by management will be based on total project costs. Miscalculating these costs might result in a loss in future funding if your project has overruns and does not meet the proposed ROI.

It is also important to understand the difference between "direct" and "indirect" costs. Direct costs are typically the items you would expect for the implementation of most hardware and software products within a facility. Indirect costs are labor-based tasks related to an energy management project that are required to ensure project success. Figure 16 shows examples of both types of costs.

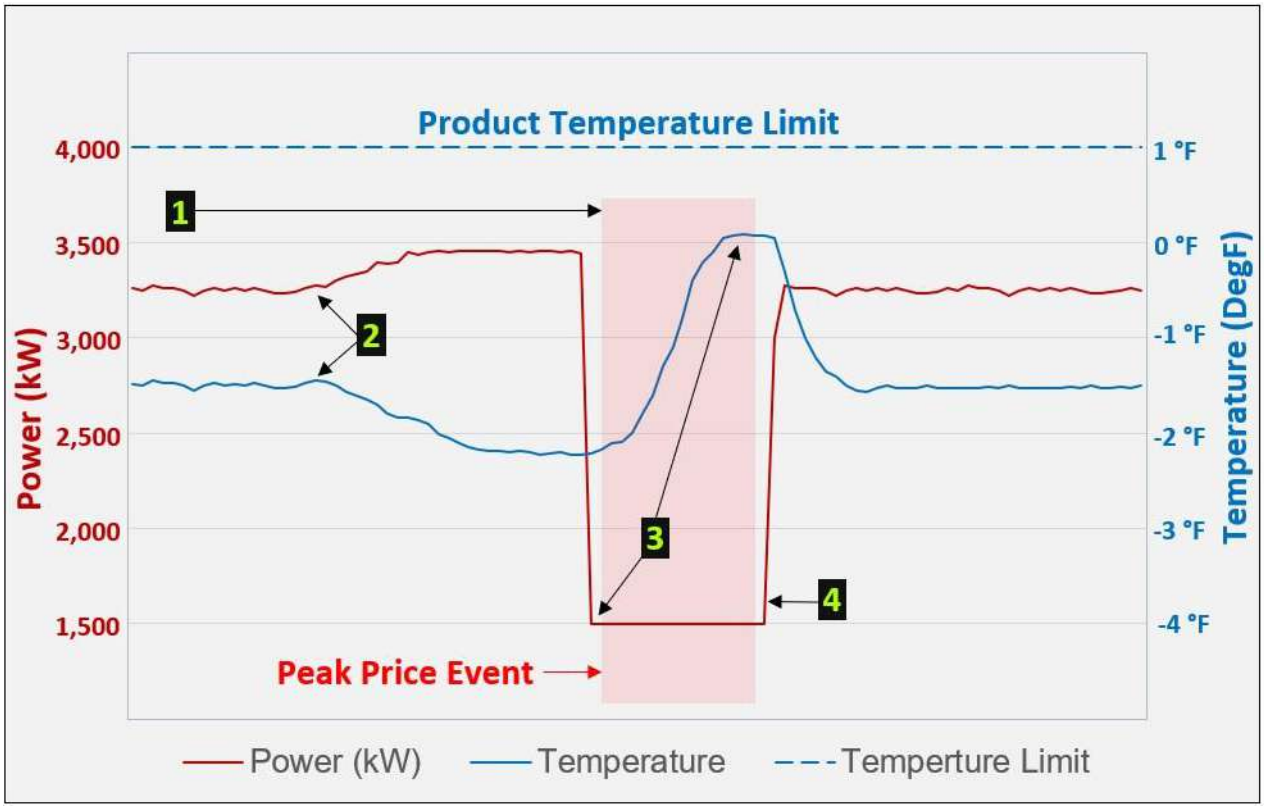
The indirect costs may appear to be "nice-to-haves," but they are actually critical to project success.

Developing a bulletproof baseline is essential because this defines the point where all project performance will be measured from. One of the most difficult things to do is negotiate where savings should be measured from after they have already been implemented.

Analyzing data properly can be a labor intensive and time-consuming process. Using an off-the-shelf analytics package is often the best solution, but software and licensing costs should be considered as well as the labor required to input the data and present results.

Reporting is an important step in promoting project success and lays the groundwork for future measures.

Figure 14. Thermal load shifting



Pushing data or delivering reports to users across the organization on a daily, weekly, or monthly basis will keep everyone active and engaged in the facility's energy management strategy.

Documentation of savings for management should be done outside of standard reporting. This is typically done on a quarterly basis, with the focus on energy costs reductions and trends in usage changes.

Now Sell It!

Once the project has been developed it is time to start selling. Why is this required? Some of the best projects never get off the ground because stakeholders are not aware of the impact of the project, or their expectations have not been properly set. It is important to be proactive and take the following steps before requesting project capital:

- Do your homework and investigate
- Develop a Return on Investment (ROI) strategy
- Clearly communicate the benefits

Do Your Homework and Investigate

Investigation consists of understanding how your project will be perceived by all those involved in approving it. The following list is a sample of questions you should have the answer to before proposing a project:

- ✔ Is the project in line with the company's strategic objectives?
- ✔ What existing problems does the project address?
- ✔ What resources are required for the project?
- ✔ What is the personality, role and internal politics of each project approver?
- ✔ Who are the decision influencers outside of the project approvers?
- ✔ What is your credibility with management?
- ✔ What will be the sources of any possible objections to the project?
- ✔ Who will receive benefits from the project?
- ✔ What are the financial and operational risks of not doing the project?

If any of the questions developed during the investigation phase cannot be answered, it would be a good strategy to hold off on proposing the project until they can be.

This is where the selling takes place, and you will most likely modify the scope of the project after speaking with the people needed to answer these questions. This will also provide a good opportunity to set everyone's expectations before the project is proposed.

Defining ROI

For energy efficiency projects, defining ROI can be a challenge. For simple prescriptive measures, like lighting projects, the savings are a matter of swapping old lamps with replacements that consume less watts. Determining the savings is a math problem.

For other types of energy efficiency measures that involve refrigeration and process controls, the impact of measures can be unclear and hard to measure, since it can be difficult to understand how the system would have continued to run without them. In these cases, a strategy of presenting ROI in qualitive terms instead of quantitative can be very effective. This can include the following approaches:

- Present the project as an investment, not an operational cost reduction.
- Address the fact there may be no clear ROI, with savings based on taking measures to address unexpected insights.
- Document savings expectations as ranges. Best-case and worst-case estimates with descriptions of any variables that can swing the savings either way.

Figure 15. Real-time energy pricing, July 10, 2017.

- Calculate a break-even timeline and describe how it will be tracked.
- Document the indirect benefits beyond utility cost savings. Include increased equipment reliability and fault avoidance opportunities.
- Reference similar project results from trade magazines, industry articles and DOE studies.

Effective Communication Is the Key

When presenting the project, make sure you clearly communicate the benefits. Below are a few strategies for doing this:

The simpler the better – Clearly define the opportunity in simplified terms with credible data.

Develop a value statement – Summarize the direct & indirect project value.

Present a risk statement – Present your knowledge of the project risks and steps that will be taken to avoid them, as well as recover if they do occur.

Use Visuals – Show savings opportunities in a graphical format. People tend to recognize and retain images more easily than words.

Sell It – Let your passion and enthusiasm show! If you come across as a true believer and advocate, management knows they are in good hands.

EVALUATING PROJECT EFFECTIVENESS

Once the project has been approved and the new measures are in place, what is the best way to determine the effectiveness? The answer to this question depends on your definition of effectiveness. For energy efficiency project, this is commonly measured as overall energy reduction or cost savings, but there are other items that should also be monitored to confirm the project is a success and the savings will continue:

- Review the measurement and verification methods used to document the savings.
- Evaluate what value the system is providing beyond energy cost reduction.
- Review the reports and dashboards made available to users. Confirm they are effective and understood by users.
- Work with management to promote energy data as part of their everyday decision- making processes.
- Confirm e-mailed reports are effective and reviewed by users.
- Identify future opportunities for expanding energy management.

The best method of making sure the above items are addressed is to designate a "Project Champion". This will be an individual that has the skills, time and patience to work with all end users to confirm project effectiveness. You may also have multiple champions working across different departments of the organization, but the goal is the same.

Remember, an energy management project is about understanding energy usage and not the technology, data and really cool analytics behind the final report presented to management. Users may not be technical and need systems that they can easily use and understand, with basic terms that relate to their job function.

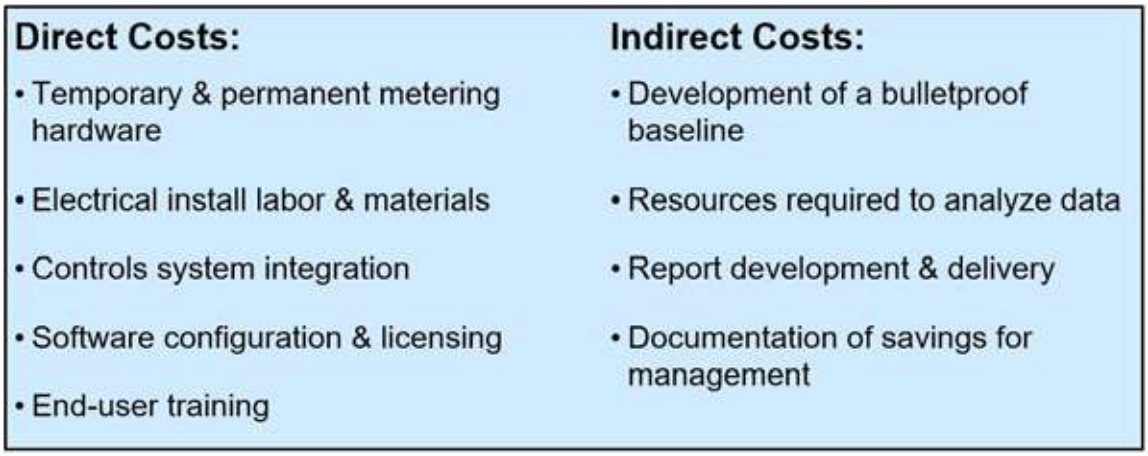
Some people may need more than just the bottom line. In these cases, don't provide only data and hope they will develop their own insights. Create graphics with simplified narratives explaining why the data indicates an opportunity for energy savings or confirms the effectiveness of measures already taken. If you find that management is not making energy data-driven decisions, provide an easy to access dashboard and push timed reports on a daily, weekly, monthly, or quarterly schedule to promote awareness.

CONCLUSION

Holistic energy management is often a repeating process of continuous commissioning. Many measures taken may not remain in place for extended periods of time, or facility systems may change while the energy efficiency measures in place remain the same. Changes in utility costs or tariff availability may also make some measures previously taken less cost effective, or make measure not taken in the past suddenly more attractive.

For these reasons, it is always a good practice to run past projects through the processes outlined in this document on a regular basis to confirm the value is still being captured, and no new opportunities are being missed.

Figure 16. Direct and indirect project costs



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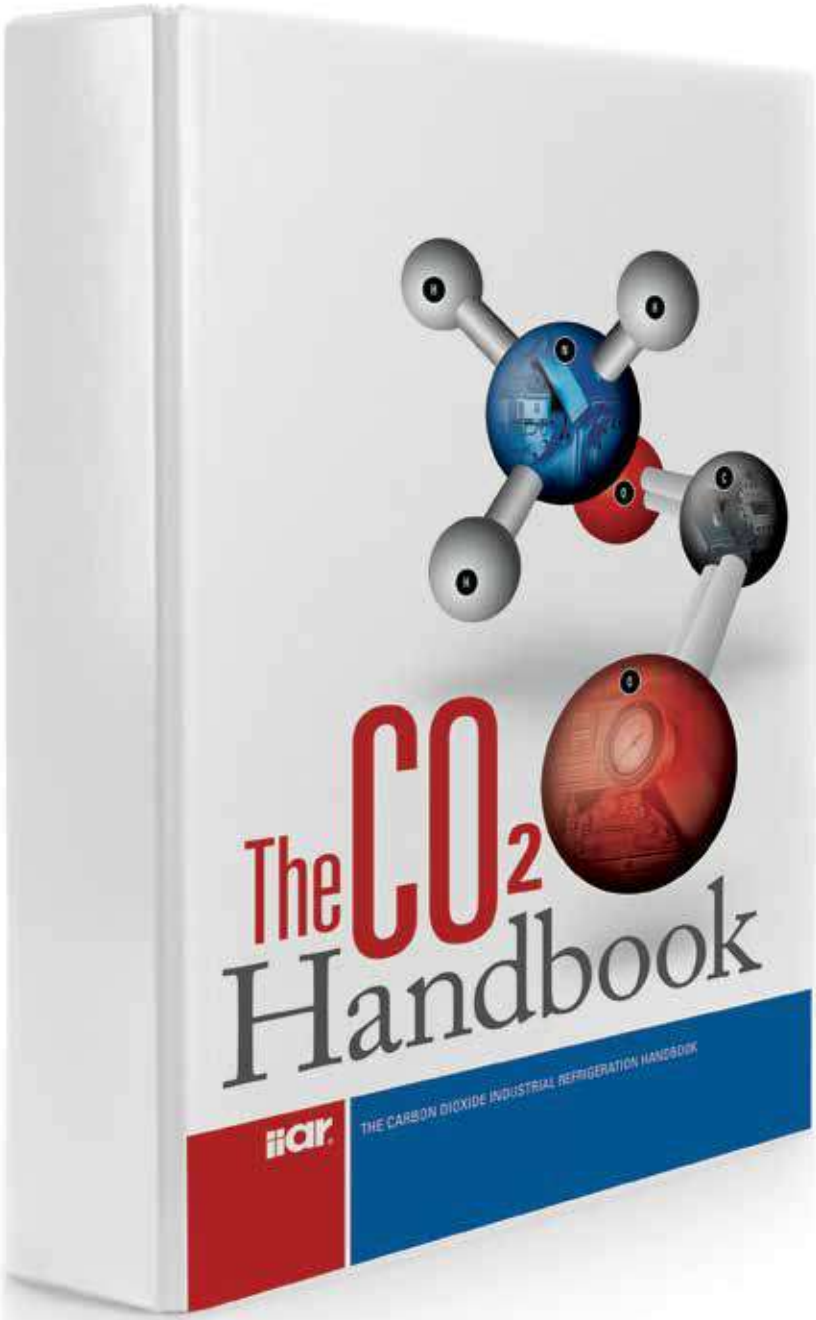

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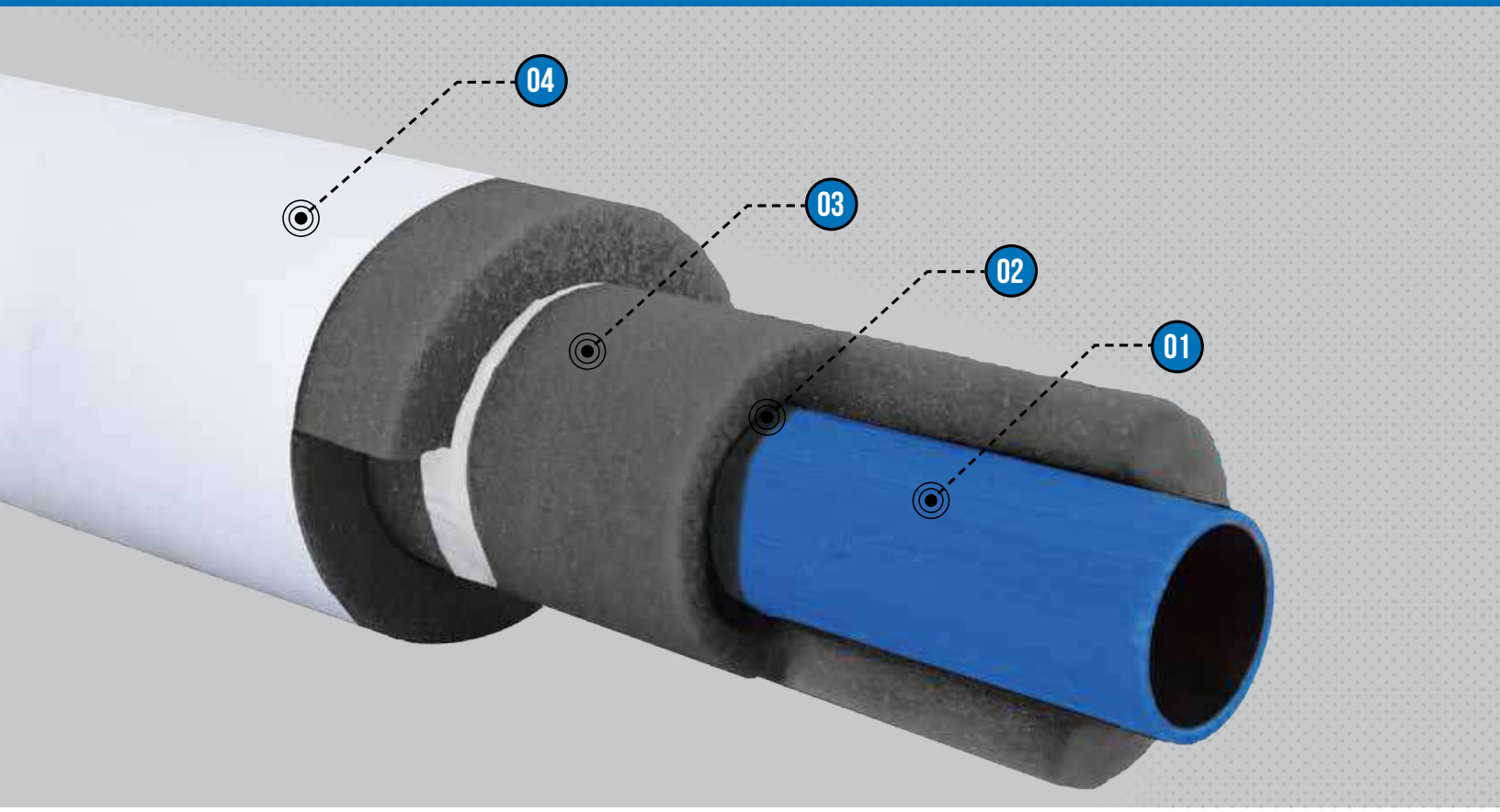

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