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CONDENSER

the first 30 minutes

EMERGENCY RESPONSE: Know what to do before the clock starts ticking

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letter from the EDITOR

The cover of the Condenser may have gotten your attention this month. The phrase "emergency response" and the bright hue we often associate with a warning can be jarring. But warnings, in whatever form they come, are vital to our safety, because they remind us to take stock of the resources around us and proceed with caution, armed with the tools we need to avoid a threat or render it inert.

Like the signs in your machine room, a warning refocuses our attention on the questions we can't afford to stop asking, no matter how familiar the answers become.

This month's cover story asks the question: how practical is your approach to emergency response? Perhaps no other industry is as dedicated to safety as the ammonia refrigeration industry. As individual companies, we have mountains of PSM/RMP compliance documentation and entire departments dedicated to every facet of safety. As an industry organization, we develop standards that inform government regulations and perform research that leads to new technology.

But when it comes to that chaotic first window of time following the discovery of a threat, is your company prepared to spring into action with a well practiced plan?

In this issue, we're refocusing attention on the practical, real-world implementation side of emergency response planning, both at an individual level, with a feature story on "the first 30 minutes," and at an industry-wide level, with the questions raised by Gary Smith of ASTI in his technical paper addressing the most effective use of personal protective equipment.

In this issue, we're refocusing attention on the practical, real-world implementation side of emergency response planning.

This is a great time to re-evaluate our emergency response strategies. With the horrific explosion in West, Texas barely in our rear-view mirrors, many of us have been newly reminded of the misperceptions that often surround our industry.

Within hours of the explosion, at least three national broadcast networks were erroneously attributing the cause to anhydrous ammonia, with little or no apparent understanding of the science to back up their conclusions.

Ironically, it is the ammonia refrigeration community that is leading the charge in the development of a response plan that could become the government model for all U.S. chemical industry emergency planning. The truth is we've never been more dedicated to expanding the safety of our industry.

Although there are many reasons the assumptions that were made following the West incident were categorically incorrect (read more about this in Jeff Shapiro's column on page 18), the media attention we received has nonetheless directed a spotlight on the safety of our industry. How we respond — whether we remain silent out of fear of being further misunderstood, or become our own vocal advocates — will make all the difference.

Let's get the conversation started.

MAY 2013

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the first 30 minutes

EMERGENCY RESPONSE:

Know what to do before the clock starts ticking

In an emergency situation, the correct response in the first thirty minutes will effectively contain most potential threats, before they have enough time to grow into an unmanageable problem. Your outcome depends on your plan. Is it ready for action?

IIAR THANKS OUR CONFERENCE SPONSORS FOR A SUCCESSFUL 2013 EVENT

Exhibit Hall Lunch – Monday, March 18

Afternoon Break – Tuesday, March 19

Registration Maps

Afternoon Break – Monday, March 18

Continental Breakfast – Monday, March 18

Bookstore

Morning Break – Monday, March 18

Water Bottles

Regulatory Update Lunch – Tuesday, March 19

Note Pads

Registration Bags

Pocket Schedule

CO_2 Program

Chairman's Reception Exclusive

Morning Break – Wednesday, March 20

Hotel Room Keys

Monday Night Banquet

Morning Break – Tuesday, March 19

Luggage Tags

International Dinner

Badge Lanyards

Continental Breakfast – Tuesday, March 19

Continental Breakfast – Wednesday, March 20

chairman's MESSAGE

BY BOB PORT

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

At headquarters, that means everyone is working hard to make sure our recent leadership transition is going smoothly. As your new chairman, my first priority this year is to welcome our new president, Dave Rule and make sure our staff is well situated under his leadership.

In any transition, the potential exists for something to fall through the cracks, but Dave and your staff are enthusiastically working to make sure that doesn't happen as they prioritize new projects and carry forward the work that's already been done.

As Bruce Badger steps down from his staff leadership position, he's leaving big shoes for all of us to fill. In the international arena, IIAR has established close ties with organizations in India and China. We'll continue to foster communication with all our international partners while at the same time looking for new opportunities to grow as a presence on the global stage.

We'll also be focused on the work of our committees this year, especially government relations, where we've started to build relationships on behalf of our industry, carrying the torch on initiatives with the Department of Homeland Security, EPA, OSHA and many other government organizations. Additionally, the work of the CO2 Committee will receive my full attention as your Chairman, as we finalize and publish the CO2 Handbook by the end of this year.

Meanwhile, two interesting projects with the potential to expand IIAR's reach will also have my attention this year. First, I'd like to explore how we work with, interact and leverage relationships that already exist in Washington to enhance our government relations efforts on behalf of our industry. Many of our member companies have a strong lobbying presence that would be beneficial to IIAR. How we learn as an organization to support the existing efforts of end-user and other members in this arena will determine how effective we are in our government relations efforts. I'd welcome any communication, suggestions or offers of support on this initiative.

As your new chairman, my first priority this year is to welcome our new president, Dave Rule and make sure our staff is well situated under his leadership.

My second project this year will be to explore ways to use the vast technical resources of our industry to bring insurance company guidelines and recommendations more in line with current code.

I view these projects, and my tenure as your Chairman as parts of a new phase of IIAR leadership. As we begin this new phase together, I hope you feel free to contribute with the new ideas and level of participation that has become the hallmark of this group.

Speaking of participation, no post-conference Chairman's column would be complete without giving recognition to the outpouring of support and record-breaking attendance of IIAR members.

This year was one of our best conferences yet. The packed technical paper sessions, workshops and technomercials were the usual highlights of our annual meeting, as well as the exhibit hall, which was crowded this year with a record-breaking number of exhibitors and sponsors, representing manufacturers, service providers and educational organizations.

While it's hard to turn our attention away from all the excitement of our most recent conference, it's time to start thinking about how to use that renewed enthusiasm in the coming year to strengthen IIAR's member presence and plan for our next event.

The IIAR Industrial Refrigeration Conference & Exhibition, Heavy Equipment Show will be held March 23 – 26 in Nashville, Tennessee.

If you have a Technical Paper or a workshop that you would like to present in Nashville, please contact Eric Smith at IIAR headquarters to submit your abstract as soon as possible (turn to page 20 for more information). Technical Paper and session topics are the fabric of IIAR meetings, and will be selected quickly to allow presenters plenty of time to prepare their presentation.

I'm looking forward to accomplishing several goals as your Chairman this year. As members, your ongoing work and participation make all of our activities possible. Thank you for continuing to enrich our industry with your support. ■

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president's MESSAGE

BY DAVE RULE

Over the years, I've enjoyed the professional support, technical guidance and personal friendship that are only possible when one belongs to a group as enthusiastic and hardworking as IIAR. As an IIAR member and former committee chair, I came to the annual conference every year excited about the new ideas and projects that advance the work of our industry.

This year, I attended the annual meeting in a new role that was a great honor to accept, the position of IIAR president.

I'm stepping into this position as a longtime member of this industry and I'm looking forward to the opportunity to serve the board of directors and you, the members of this organization.

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

Nowhere was this more evident than at our recent conference, where the excitement and dedicated work of our membership – represented by end-users, engineers, contractors, manufacturers, faculty and students from around the world – was on full display.

The accomplishments of this group are unparalleled in our industry, especially those made possible by the leadership of our previous president, Bruce Badger. Under his tenure, some significant and far reaching initiatives have been put into place that will serve as a solid foundation for the growth of IIAR in years to come.

Our membership outreach programs have shown continued success through both domestic and international growth. Working closely with the international committee and its chairman, Paul Bishop, the IIAR's alliance programs have continued to increase the organization's influence as we build sound relationships around the world.

Government advocacy, process safety materials and code development programs have also grown under Bruce's leadership. These successes are a reflection of the strong involvement of our membership and a renewed enthusiasm to make IIAR the primary source of technical information, safety standards and effective advocacy for the use of natural refrigerants in industrial refrigeration.

Looking forward, I see an opportunity to continue to build on these strategic initiatives and expand the organization's leadership in promoting the safe and efficient use of ammonia and other natural refrigerants.

We will focus our efforts on growing our membership through international outreach programs and a renewed emphasis on demonstrating the value and extensive resources of IIAR for the domestic industrial refrigeration community.

Working with the new government relations committee, the organization will pursue a number of new initiatives designed to strengthen our advocacy programs and ensure that IIAR members are informed of pending legislation and trends in government activities as they develop. Most importantly, we will continue to focus our efforts on the financial stability of the organization while providing for the essential needs of our membership.

The future of IIAR is bright, with strong membership enthusiasm and support. Our success is directly related to the dedication and hard work of the many volunteer members serving on the various technical committees, executive committee and the board of directors.

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

IIAR Committees Announce New Meeting Structure

The IIAR committees have always been the workhorses of the ammonia refrigeration world, vetting technical information, creating new industry guidance and contributing to the formation of standards.

This year, the activity of those committees will get special attention from IIAR, said IIAR Chairman Bob Port, who added that IIAR's Immediate Past Chair, Joe Mandato last year began an initiative to open communication between all of IIAR's committees with the introduction of twice yearly formal update meetings.

The meetings were established during Mandato's term as IIAR Chairman and have already started to pay off in the form of increased collaboration on many projects, said Port.

"We had two committee chair and joint chair teleconferences last year that were very successful in terms of circulating news about what everyone is doing and identifying where the opportunities for collaboration exist," said Mandato. "We'll continue the meetings this year. It's a great way to get an update on our committee work, and a great place to exchange ideas."

The IIAR committees have always served as a forum for the open discussion and advancement of the important issues we face in our industry, said Port.

Not only do IIAR committees represent the collective interests of ammonia refrigeration professionals, but the work they accomplish provides an important foundation for many of the Institute's long-term goals.

Some IIAR committees have been in existence since the formation of the organization, and others are newcomers, added in recent years in response to new issues or needs. However, all ten of them continue to accomplish the goals the ammonia refrigeration industry has set forth. IIAR's ten committees include: Code; Education; International; Marketing; Piping; Research; Safety; Standards; CO2; and the newest addition, Government Relations.

Any IIAR member is invited to participate in the work of the organization's committees, either by serving as an active member or by bringing an important issue to the attention of the appropriate committee.

This year, the IIAR committees will be looking to expand their scope of work and project goals to move some important ideas forward, and that will take even more participation from IIAR members, said Mandato. "We're always looking for new committee members. Joining a committee is a great way to support our industry." ■

the first 30

EMERGENCY RESPONSE: KNOW WHAT TO DO BEFORE THE CLOCK STARTS TICKING

In most situations, the correct response to a threat involving ammonia in the first thirty minutes after it is identified will effectively contain most potential hazards, before they have enough time to grow into an unmanageable problem. Preparation can mean the difference between a disorganized response and the ability to shut down a potential incident when time matters the most.

Within a community as conscientious about preparing for and responding to risk as the ammonia refrigeration industry, there isn't an issue more fundamental than safety.

Yet, emergency planning can take so many forms that companies often drift from one end of the preparedness spectrum to another without a measure of the practicality of their response plan in a real-world environment.

"In our industry, we've placed a serious emphasis on safety, but we need to take a look at how that extends to development and planning," said Fred Walker, Vice President of Engineering Support for Americold. "Creating a good plan and training for that plan are two different things. If you don't do both, a response effort doesn't work."

The Ammonia Safety and Training Institute, an organization with the mission to "make ammonia the safest managed hazardous material in the world," has created a response plan and training guideline it hopes will see widespread industry adoption.

The organization's project, called "the first thirty minutes plan," is a comprehensive framework detailing the basics of a practical response, said ASTI President Gary Smith.

"Almost everybody in this industry has emergency plans, but in many facilities they're located in a binder somewhere in an office," said Smith. "The idea of how to make those plans work operationally, to make them into a reality, in many cases hasn't been flushed out."

One reason for that is the emphasis the industry places on prevention, said Ward Miller, Health and Safety Director for ConAgra Foods.

"From a response standpoint, obviously prevention is the first step, and we accomplish that by paying a lot of attention to process safety management and maintenance. As an industry, we're very good at prevention," said Miller. Nevertheless, "a risk management plan will identify risks, but there should also be a solid plan in place that is practiced on a regular basis. The first time you go through those steps should not be when you're dealing with a release."

Because the nature of any incident involving ammonia grows with time, there is no room for a learning curve. That's why the idea of responding with a practiced strategy in the first thirty minutes is at the heart of ASTI's plan, said Smith.

Often, a threat can start out so small that it can be contained immediately without escalating into a release requiring a full scale response.

"As an industry, we see small issues all the time, but how we deal with them determines if they become an emergency or not," said Michael Chapman, Manager of Process Safety and Risk Management Programs for Tyson Foods.

minutes

Chapman, a 22-year veteran of the fire service, said in many cases he has witnessed throughout his career, a proactive approach to training could have introduced options that weren't accessible by the time outside emergency response teams got involved in an incident.

"Many times, these incidents could have been mitigated and solved quickly, but the people involved weren't prepared. Because they couldn't respond effectively, the incident turned into an emergency."

Another factor that can often be a barrier to the development of a "first thirty minutes" plan is a reluctance to assume a formal role in a response, said Smith. Often, companies feel that they don't have the resources to "become emergency responders," or they simply assume that a responding fire department, contractor or even the 911 emergency network will be better equipped to deal with an incident than they are.

However, "this plan really is in the scope of the experience we have as an industry," said Smith, adding that the ASTI plan focuses on simple action any designated professional can take to secure the safety of everyone in a facility and control a situation immediately.

"You don't have to be an emergency responder to make a difference here if you have the training and awareness you need," said Tyson's Chapman. "You can minimize an emergency because you are the only one that has the power to take action in the most critical time window."

That's because it will take at least thirty minutes for an outside response team to respond, assemble and establish control of the incident.

Generally, by the time a facility discovers it has a leak on its hands, the clock has started ticking, said Americold's Walker. "The ideal situation is to take the proper steps to establish a safe environment right away, get the problem under control and manage it until emergency teams show up."

At that point, handing the situation over to an outside team means that responders have a head start in dealing with the issue and in most cases can simply continue the response process and shut the problem down.

The alternative, doing nothing until response teams arrive, will mean that valuable time is lost and the problem has had an opportunity to grow out of control, possibly requiring a much higher level of response by the time personnel is in place to deal with it.

"By the time the first wave of responders, usually the fire department, arrives on the scene, the volume of the leak is increasing unchecked. Then, there's an even longer delay if a more sophisticated team, for example a Hazmat team, needs to be called in," said Walker.

Whether a company is depending on its own employees and safety contractors to respond with the knowledge necessary to handle an emergency, or relying on outside teams, disorganization will hinder the response if specific roles are not designated ahead of time.

"I've been involved with teams that are well trained when it's time to act, and those that are not," said Miller. "The teams that are well trained have much better outcomes. The value of following a plan for the first thirty minutes is in understanding what everybody's roles are."

In fact, said Smith, the backbone of "the first thirty minutes" plan is a specific framework for roles and responsibilities that should be designated ahead of time and assumed immediately as soon as a threat is detected.

While the four roles specified under ASTI's first thirty minutes response plan may seem involved outside of the context of the full plan – with all its accompanying material and checklist information – the procedures outlined by ASTI are actually very simple, said Smith.

"Over the last five years, we've created checklists and guidelines that operationally connect a response plan to action," he said. "The methodology is simple to follow, and it accomplishes what we actually need to accomplish in an emergency."

Smith added that the origin of the emergency plan created by ASTI was developed in part due to a mandate from the Clean Air Act that was implemented by the White House in the early 1990's. The National Response Team, led by the Environmental Protection Agency was asked to look at the status of public and private emergency response in the U.S. After considerable evaluation it was recommended that all public agencies and industries develop an integrated contingency plan for emergency response that they called the "One Plan."

"What we're doing with emergency response for ammonia refrigeration has implications beyond our industry,"

he said. "Our plan will be the hallmark for emergency response plans at all of the nation's chemical facilities."

Nevertheless, said Tyson's Chapman, ASTI's first thirty minutes plan is already starting to benefit ammonia refrigeration. "Safe handling is what we're all about in this industry, and this plan contributes a lot to the work we're doing in the safety arena. We're hoping the industry will adopt it."

Meanwhile, the plan may get more attention in the next few years with the release of a safety training video, currently being co-produced by ASTI and IIAR.

The video will feature interviews with participants of the first thirty minutes plan, and provide an overview of its basic structure, said IIAR President Dave Rule. "ASTI, and the companies that have adopted this plan are helping our industry lead the way in safety planning and emergency response. We're excited to bring all the knowledge and expertise of IIAR members to that process," he said.

ASTI'S FOUR EMERGENCY LEADERSHIP ROLES

According to ASTI, any facility planning a response should identify and train personnel to assume four primary command team roles: plant incident commander (plant administrator); lead responder (systems operator); notification unit leader (administrative role); and evacuation group supervisor (lead supervisor).

Each role assumes several specific responsibilities according to four main objectives: discovery; initial response; sustained response and termination of an emergency.

It is important to note that the actions listed in the discovery and initial response phases can be accomplished by using an emergency action plan, or EAP, rather than an emergency response plan, or ERP, said ASTI President Gary Smith. The key factor is to assure that the engagement of the hazard zone control plan occurs by plant responders working outside of the area designated as "immediately dangerous to life and health" (IDLH) which is 300 part-per-million (ppm) for ammonia.

The command team and response checklists designed to be engaged during the four phases of response are designed for an all-hazards response, he said. In other words, the same command team and the same basic approach to emergency command and control works for fire, chemical release, medical emergency, or any other emergency event.

Under the ASTI plan, the discovery objective begins with an alert process that notifies the plant incident commander and the command team with the first details about the incident. Those details, said Smith, include questions that address who, what, where, and issues surrounding life safety concerns. The plant incident commander , or IC, will assume command and announce the hazard zone location, level of concern (1-incidental, 2-contained but not controlled, 3-emergency out of control), an established isolation zone distance (NH3 100' to 1,000'), and the location of an incident command post.

INCIDENT COMMANDER

The incident commander's responsibility is then to establish a life safety objective designed to prioritize personnel safety and to initiate an emergency control plan based upon the location of the hazard zone. The mechanical room, roof-top condensers and pipelines, cold room would have a two page hazard zone checklist associated with different life safety and emergency control plan expectations, said Smith.

The incident commander's announcement of those critical details engages the command team on pre-determined initial response actions identified in the Hazard Zone Emergency Shut-Down Operations Checklist.

LEAD RESPONDER

Meanwhile, the lead responder's responsibilities are to size-up life safety within the area of origin of the release or fire, and initiate an emergency shut-down. The discovery objective in this role is to: size-up and secure life safety; clear the emergency zone and perform decontamination and first aid for those escaping.

NOTIFICATION LEADER

The notification leader, meanwhile, is responsible for performing notification and documentation throughout an emergency. In the discovery phase, the notification leader: engages pre-authorized notifications from ASTI's hazard zone checklist for the level of concern communicated by the plant incident commander; assigns a notification team to accomplish the notification assignments; and coordinates with the plant incident commander to assure that regulatory notifications are made within a 15 minute time-line.

EVACUATION GROUP SUPERVISOR

The fourth role, that of evacuation group supervisor, exists to assure "life safety in the isolation zone." The discovery objective in this role is: to review ASTI's hazard zone checklist and engage evacuation concerns for the level of concern established by the plant incident commander; assure safe movement out of the isolation zone according to the LANCE protocol; secure movement in and out of the isolation zone from non-essential personnel; and establish safe refuge locations outside the evacuation meeting spot or inside refuge areas.

Next, the first-in fire response will require immediate access to the plant incident commander, said Smith, adding that the fire officer in charge will want an explanation about where the emergency zone is located and what is happening with the spread of the emergency threats. As part of the plan, the fire officer asks questions about the life safety status and location of evacuated personnel, said Smith. The fire office will also ask about what is expected from their support. The first-in fire officer will likely assume command if public safety resources are needed to contain and control the emergency event, he said. The plant incident commander will become a liaison to public safety incident commander and together they review a situation status report and jointly create an incident action plan for on-site and off-site response objectives. This process follows pre-determined teaming guidelines provided within the ASTI One Plan.

Finally, when the emergency is under control and a hazard analysis reveals that it is safe to begin clean-up and recovery operations the incident commander must issue a public safety termination proclamation form to formally end the emergency. The command team assumes responsibilities for engaging the business recovery plan. ■

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Monitoring Recent OSHA Enforcement Trends

iiar government RELATIONS

BY LOWELL RANDEL, IIAR GOVERNMENT RELATIONS DIRECTOR

The Occupational Safety and Health Administration continues to be a major focus of IIAR's government relations efforts, including the work of the newly reconstituted Government Relations Committee. IIAR members are reporting that OSHA has become increasingly active with inspections and enforcement activities. The National Emphasis Program for Chemical Facilities, or NEP, is a major reason OSHA inspection of ammonia refrigeration facilities has increased. This article will examine some of the recent trends in overall OSHA enforcement over the last few years and take a closer look at the results of the first full year of the NEP.

OSHA INSPECTION DATA FY2009 – FY2013

OSHA reports its inspection data by fiscal year. As such, the last full fiscal year of statistics available is FY 2012. However, OSHA has preliminary data covering the first few months of FY 2013 that will also be used to show trends. In FY 2012, OSHA conducted a total of 40,691 inspections. This is over 1900 more inspections that were conducted in FY 2009, showing a roughly five percent increase in inspections over the period. Digging deeper into the statistics, 62 percent of inspections in FY 2009 were programmed inspections, while 56 percent of inspections in FY 2012 were programmed. So far in FY 2013, 59 percent of inspections have been programmed, which is the average percentage over the period from FY 2009 to FY 2013.

In FY 2009, 17 percent of all inspections were based on complaints. The number in FY 2012 was 23 percent and so far in FY 2013 24 percent of all inspections has been initiated due to complaints. The percentage has increased each year since FY 2009, showing a clear trend of increased complaints triggering OSHA inspections. Some would contend that this trend is due to increased union activity and messaging from OSHA encouraging workers to alert the agency to workplace hazards.

While there has been an increase in overall inspections from FY 2009 to FY 2012, the total number of violations issued in FY 2012, 78,727, is less than any of the years between FY 2009 – FY 2011. The high watermark for violations issued was 96,742 in FY 2010. The average number of violations from FY 2009 to FY 2012 was 87,161. The percent of inspections with violations being contested rose from seven percent in FY 2009 to eleven percent in FY 2012. The percent of inspections deemed "in compliance" averaged just under 25 percent during the period in question, meaning that roughly one in four OSHA inspections has not resulted in any violations.

Another interesting aspect of OSHA inspection data is the number of violations issued by establishment size. By far, the majority of OSHA inspections take place at smaller establishments. In FY 2012, 54 percent of all inspections occurred in workplaces with 25 or fewer employees. Seventy-five percent of all inspections were in establishments with 100 or fewer employees. The relative number of violations is consistent with this breakdown. Fifty percent of violations occurred in workplaces with 25 or fewer employees and 70 percent of violations were in establishments with 100 or fewer employees.

For those inspections where violations have been cited, the percentage of violations classified as serious has remained steady over the period at an average of 75 percent. However, the average penalty amount per serious violation has increased significantly. In FY 2009, the average penalty for a serious violation was $970. In FY 2012, that number more than doubled to a level of $2,153 per violation. The increase in penalties for serious violations is by design, as OSHA revised its penalty structure in FY 2011. OSHA has been successful in achieving its goal of increasing the penalties for serious violations.

For general industry, the most cited standards from FY 2009 to FY 2012 were:

1. Hazard Communication
2. Electrical, Wiring Methods
3. Lockout/Tagout
4. Respiratory Protection
5. Powered Industrial Trucks
6. Machine Guarding
7. Electrical, General Requirements
8. Bloodborne Pathogens
9. Personal Protective Equipment
10. Guarding Floor and Wall Openings

By examining the last four years of OSHA inspection data it is clear that OSHA has intensified its enforcement activities. Not only is OSHA conducting more inspections, but the average penalty for serious violations has increased significantly. There are some indications that the trend of increased overall inspections may reverse in FY 2014 due to budget constraints. In the President's recently released FY 2014 budget request, OSHA anticipates inspecting 1,711 fewer worksites than it did in FY 2014.

However, the reduction in overall inspections in FY 2014 may not translate into fewer inspections of ammonia refrigeration facilities. The President's budget suggests that OSHA will be targeting its inspection resources on refineries, chemical plants and facilities where emerging chemical and health issues could arise. This seems to indi-

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cate that efforts such as the National Emphasis Program for Chemical Facilities will continue to intensify.

NATIONAL EMPHASIS PROGRAM FOR CHEMICAL FACILITIES — FIRST YEAR RESULTS

The National Emphasis Program for Chemical Facilities (NEP) began as a pilot program in 2009 and transformed into a full national program in November 2011. The purpose of the chemical facility NEP is to reduce or eliminate workplace hazards associated with the release of highly hazardous chemicals (HHCs). Ammonia is included in the HHC category and inspections of ammonia facilities with over 10,000 pounds of ammonia are specifically included in the NEP. The first year of results from NEP inspections is now available.

It is important to note that the NEP is being implemented in both federal OSHA states and OSHA state plan states. Data from both the federal and state inspections is available and will be discussed separately below.

Federal OSHA inspectors conducted a total of 205 inspections during the first year of the NEP. Programmed inspections made up 127 of the total, while 78 of the inspections were unprogrammed (resulting from an accident, complaint or referral). The majority of NEP inspections took place in three of OSHA's ten regions. Regions 4, 5 and 6 accounted for 121 inspections, or 59 percent of all inspections in the first year. Region 4 encompasses much of the southeastern United States. Region 5 covers many Midwestern states and Region 6 covers parts of the Gulf coast and southwest.

One explanation for the higher number of inspections in Regions 4 and 6 is that just prior to the chemical NEP OSHA conducted a National Emphasis Program for Petroleum Refineries. This is relevant because Region 4 and Region 6 include a large number of petroleum refineries. The chemical NEP requires that inspectors meet certain training and experience requirements. Many inspectors from Region 4 and Region 6 had already met these requirements because of the petroleum NEP, so these regions were better placed to conduct more chemical NEP inspections in the first year. This also sheds light on why some IIAR members who have been through an NEP inspection have reported inspectors citing American Petroleum Institute standards during inspections. This could be because many inspectors had just gone through the petroleum NEP and were more familiar with API standards than the more applicable IIAR standards.

Process Safety Management accounted for 740 of the violations representing almost 64 percent of all federal NEP violations in the first year.

From the 205 federal NEP inspections, OSHA issued 1160 violations. These violations resulted in $4.8 million in proposed penalties, for an average of $4000 per violation. It is important to note that these numbers are for initial proposed penalties and do not reflect any reductions that may occur.

Process Safety Management accounted for 740 of the violations representing almost 64 percent of all federal NEP violations in the first year. The average proposed penalty for PSM violations was $4,800, which is 20 percent higher than the overall penalty average. Total proposed penalties for PSM was over $3.5 million.

Four PSM elements made up over 73 percent of all PSM violations. The four most frequently cited PSM violations were for: Mechanical Integrity (21.3 percent), Process Safety Information (20.3 percent), Process Hazard Analysis (17.5 percent), and Operating Procedures (14.5 percent). The most frequent non-PSM citations included Lockout/Tagout, Hazardous Waste and Emergency Response, Respiratory Protection, Record Keeping and Guarding Openings.

OSHA State Plan states conducted 29 inspections in the first year, 25 of which were planned/programmed inspections. Of these 29 inspections, 20 occurred in the Region 5 states of Illinois, Indiana, Michigan and Minnesota. This could be attributed to the presence of OSHA personnel in this Region who have specific expertise in the area of PSM and follows the high number of federal NEP inspections in Region 5.

State plan NEP inspections resulted in 149 violations, 118 of which were for PSM. Initial penalties for state plan inspections totaled $1.5 million and the average initial penalty per violation was $10,000. Again, these statistics are for proposed penalties. While the average proposed penalty in state plan inspections is more than twice the federal average, there are indications that many of the final penalties are being reduced significantly and align more closely with the federal average.

The five most frequently cited PSM elements account for over 80 percent of the PSM violations. The top five PSM elements in state plan states are: Mechanical Integrity (26.3 percent), Process Hazard Analysis (21.2 percent), Process Safety Information (16.1 percent), Operating Procedures (8.5 percent), and Contractors (8.5 percent).

IIAR GOVERNMENT RELATIONS ACTIVITY

IIAR recognizes OSHA's recent trends towards more active enforcement and inspections impacting the ammonia refrigeration industry. As a result, IIAR continues to actively engage with OSHA regarding the agency's overall enforcement activities and specifically the NEP for chemical facilities. The newly reconstituted IIAR Government Relations Committee is focusing much of its attention on OSHA. At the 2013 IIAR Conference, the Government Relations Committee met to discuss strategies to address OSHA policies and programs. Among the strategies identified were: educating OSHA inspectors about IIAR standards and the ammonia refrigeration industry, developing mechanisms to collect IIAR member regulatory experiences and answer industry questions, and exploring partnerships with like-minded groups to engage policy makers in Washington, DC. IIAR government relations will continue to pursue these and other strategies to promote and protect the interests of our industry. ■

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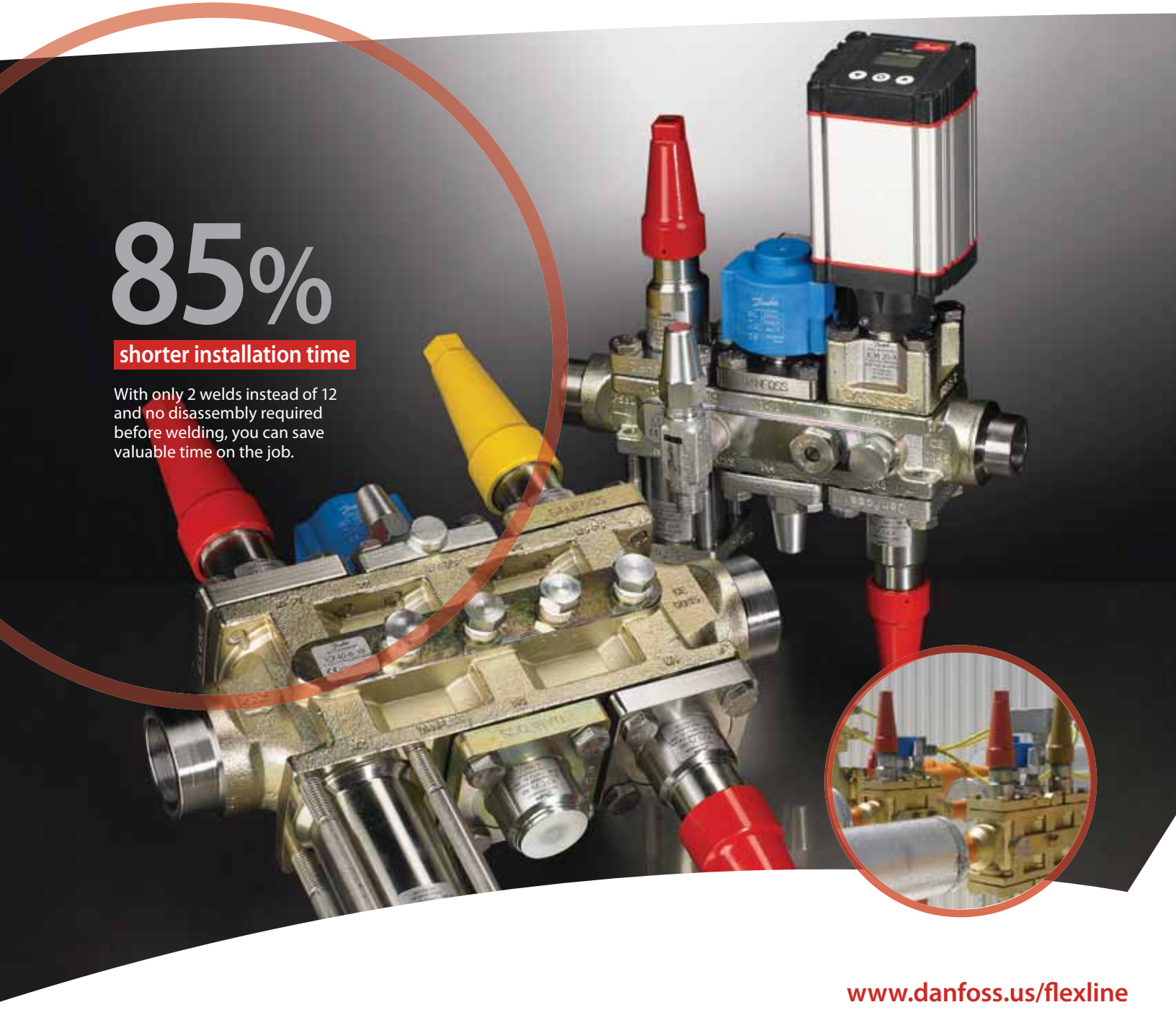

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A Preview of the 2015 Codes

iiar code advocacy **UPDATE**

BY JEFFREY M. SHAPIRO, P.E., FSFPE

Before I begin my regular column, I would like to spend a moment in remembrance of the horrific tragedy that occurred in the town of West, Texas on April 17. As I write this article, a memorial service is taking place to honor the ten emergency responders who selflessly gave their lives in the service of their community when they responded to a fire at a fertilizer depot in the heart of town.

As a member of the fire service for many years, I give frequent thought to a program called "Everyone Goes Home," which is led by the National Fallen Firefighters Foundation. The program includes 16 underlying safety initiatives designed to ensure that, at the end of each shift, emergency responders are safely returned to civilian life until their next shift begins. Tragically, on April 17, everyone did not go home.

There are many families of these fallen heroes who are now left to pick up the pieces of their lives and try to find a path forward. NFFF, which is a well-established non-profit charity, provides a variety of resources to assist in that process. Perhaps you've been wondering, after seeing the news stories on this event, what you can do to help the families of those who didn't make it home. Making a donation to the "West, Texas Firefighter and EMS Fallen Hero Fund" through the NFFF was my method of choice. In fact, at the ICC code development hearing this week, firefighter boots were placed near the conference hall to allow all participants to contribute via a single pooled donation.

If you would like to make a contribution, there's a link at www.firehero.org.

At this point, there has been much speculation as to the root cause and contributing factors in the West, Texas, incident, and some have mentioned or pointed to anhydrous ammonia as playing a role. Perhaps we'll know more when the incident investigation has been completed, but given the devastation of the scene, I would not be surprised to find out that we'll never conclusively know the full story. Nevertheless, initial media reports mentioning anhydrous ammonia as having played a part were irresponsibly speculative given the lack of any evidence to support such claims. On the contrary, an event of this nature is certainly not characteristic of anhydrous ammonia, either historically or scientifically.

The past week continued IIAR's successful path of promoting the safe and efficient use of ammonia refrigeration through reasonable and appropriate code regulations.

With news reports and social media naming anhydrous ammonia as possibly having played a part in the West incident, it is incumbent on those of us in the ammonia refrigeration industry to be familiar with a few basic facts as we face inquiries from concerned citizens and, or regulators about the safety of anhydrous ammonia as a refrigerant. These include:

1. Although anhydrous ammonia was kept at the site of the West incident, no evidence has been presented to link anhydrous ammonia to what occurred.
2. Anhydrous ammonia is not known, either historically or scientifically, to produce an explosion of the type that occurred in West. Other chemicals stored on the site known to have a higher probability of being the source of this type of blast are being scrutinized.
3. Anhydrous ammonia in refrigeration systems is much more stringently regulated than anhydrous ammonia in agricultural applications. The ammonia refrigeration industry is a passionate advocate for regulations and facility and personnel safety programs that help to ensure the safe use of ammonia in refrigeration systems. Speaking of safety regulations for ammonia, I'll now return to our regularly scheduled program…

PREVIEW OF THE 2015 CODES

The past week continued IIAR's successful path of promoting the safe and efficient use of ammonia refrigeration through reasonable and appropriate code regulations. At the International Code Council code development hearing in Dallas, Texas, we presented several proposals to the International Fire Code for the 2015 edition, all of which were accepted by ICC's Fire Code Development Committee. They include:

- Completing our initiative to permit the use of tamper-resistant covers, such as plastic cover boxes, in lieu of break-glass style covers for ventilation system and equipment shutdown emergency controls located outside of machinery rooms. Break-glass style enclosures have the associated risk of broken glass when operated and the challenge of maintaining a "striker" at the box to ensure that the pane can be broken in an emergency.
- Clarifying that emergency pressure control systems (EPCS) are only required for permanently installed refrigeration systems. The current

continued on page 20

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code text implies that EPCS might be required for portable or temporary systems, as well as permanent, and that was never the intent of the provisions. EPCS, which provide a redundant means to intercept an otherwise uncontrolled overpressure event, were created as a basis for replacing outdated code requirements for Fire Department "Dump" boxes, and those boxes were never required for portable or temporary refrigeration systems.

- Rewriting the provisions for termination of overpressure relief piping to make it clear that it is permissible to internally vent overpressure from one part of a system to another, rather than discharging to a treatment system or atmosphere, if the system is designed for this.
- Providing an adoption-by-reference for IIAR-2 in the International Fire Code. Given that the IFC has construction regulations related to such topics as vent termination, emergency pressure control systems and refrigerant leak alarms, it is appropriate for the IFC to reference and, to the greatest extent possible, coordinate with IIAR-2.
- Place "discharge to atmosphere" on a par with other permissible methods of emergency pressure relief venting, such as venting to water tanks or other treatment systems, which have previously been the "default" requirement for relief vent discharge. In restructuring the IFC provisions, it will be clear that venting to atmosphere is an option, not an exception, under the base requirements. The limitations remain that, in order to vent to atmosphere, the designer must demonstrate in plan submittal that atmospheric discharge will not cause a health, environmental or fire risk and gain approval by the local fire official, but these hurdles can be overcome in many cases using scenario analysis and modeling of release scenarios with one or more software programs.

All of the foregoing recommendations to accept these proposals will be subject to further review and public comment before they become final. Final consideration of any recommended changes will occur at the ICC final action hearing, which will take place in Atlantic City, NJ in October 2013.

IIAR also has a number of proposals that have been introduced to the Uniform Mechanical Code for the 2015 edition of that document. In addition to technical changes, the 2015 UMC will most likely have a significantly different "feel" from prior editions based on a major effort by the publisher to do an editorial overhaul of the document. Specific changes proposed by IIAR (which have not yet been acted on) include:

- Adding an allowance to install refrigeration equipment outdoors. Technically, the UMC currently requires all major equipment to be installed indoors in a refrigeration machinery room.
- Modifying the provisions for refrigerant detection alarms such that they are not tied to the power and supervision requirements that apply to fire alarm systems.
- Clarifying the requirements for emergency control of ventilation systems, which have led to many questions and confusion regarding intended application.

Development of model codes and standards is an ongoing activity that involves many dedicated IIAR member volunteers serving on the IIAR Code Committee and IIAR Standards Committee. Individuals who serve on these committees as representatives of the membership help to identify and respond to issues of concern to the industry and play a key role in directing future changes, such as those described above, many or all of which can be expected to appear in the 2015 International and Uniform codes. ■

IIAR Issues 2014 Call for Technical Papers

The International Institute for Ammonia Refrigeration issued its annual "call for papers," in preparation for the 2014 IIAR Industrial Refrigeration Conference & Exhibition, Heavy Equipment Show in Nashville, Tennessee, March 23 – 26.

IIAR is currently requesting proposals for technical papers, including Spanish-language technical papers. Abstracts that address any topic related to ammonia refrigeration are invited. However, papers that address specific topics will receive preferential consideration.

SPECIFIC TOPICS OF INTEREST TO IIAR INCLUDE:

- **energy efficiency case studies;**
- **energy management for utility demand response;**
- **mechanical integrity – specific practices;**
- **comparison of secondary systems with direct systems in various applications;**
- **operator training;**
- **troubleshooting case studies;**
- **low charge and DX design;**
- **packaged system design and application or options to replace "freon" systems;**
- **OSHA citations and response;**
- **equipment design for improved efficiencies;**
- **charge reduction case studies;**
- **and, food production room considerations such as operations, cleanliness, effects on refrigeration, air distribution and USDA design considerations**

For a technical paper to be considered by IIAR, a paper proposal must be submitted and should include a 150 to 200 word abstract as well as a 50 to 75 word description of the practical applications of the paper's proposed contents. IIAR's proposal submission deadline for the 2014 conference is June 1, 2013.

Technical paper abstracts will be chosen for development by June 15, and authors will be asked to commit to a development timeframe that will begin with the submission of a first draft on September 1, and will undergo all peer reviews and subsequent edits by November 30.

Contact information such as name, address, phone and fax number should be submitted with each author's proposal.

Once a paper is chosen, IIAR offers each primary author a complimentary conference registration. Every year, the Andy Ammonia award is presented to the author of the English and Spanish technical papers that have received the highest ratings. The primary author of each award winning paper receives a complementary registration for the following year's IIAR conference.

Papers should be submitted to the IIAR Technical Director, Eric Smith, at eric.smith@iiar.org.

Ongoing Reviews of Procedures Now Can Prevent Confusion Later

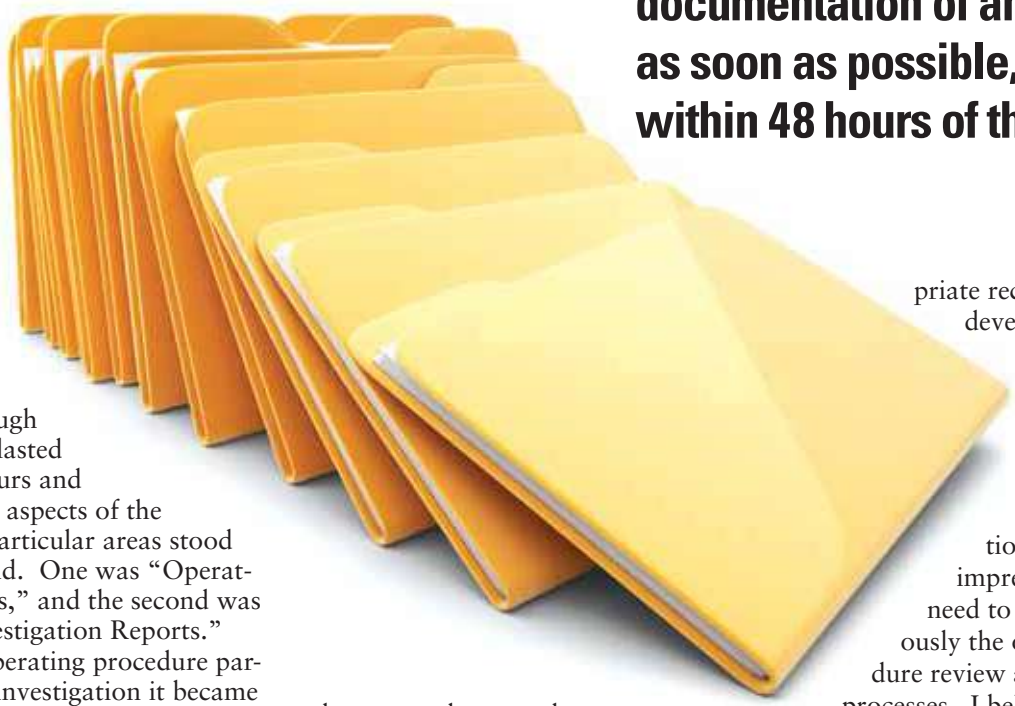
BY: KEM RUSSELL

We learn, hopefully, by our experience – in a classroom, in the field, or in our personal study. When operating an ammonia refrigeration system, we depend on education combined with experience. That education and experience can take the form of well thought-out and written operating procedures. And it's worth asking: Are those operating procedures reviewed at least annually with the intent to correct or improve them from experience? In addition, if an incident occurs, whether it is an actual release or a close call, is it well investigated?

A few months ago, I had the opportunity to be interviewed by two criminal investigators regarding a release of ammonia. The goal of the investigators was to better understand what happened, and why it might have happened. Although the interview lasted for several hours and covered many aspects of the release, two particular areas stood out in my mind. One was "Operating Procedures," and the second was "Incident Investigation Reports."

From the operating procedure particular to the investigation it became clear that there could be confusion regarding what really was meant by some of the procedural steps. The criminal investigators – in the process of attempting to understand the procedure, and answer in their minds why what happened didn't seem to match with the procedure – opened my eyes to the possible confusion of some procedural steps and statements.

Although I have been involved in procedure development and review for many years, it occurred to me that not only is it important to review procedures carefully and in detail, but also to solicit the input from other knowledgeable persons that can bring to light steps in a procedure that may be unclear or confusing. The annual review of operating procedures can sometimes become a tedious task, and one that we might quickly gloss over since the same procedures have been reviewed and certified possibly year after year. However, when something goes wrong, those procedures can be critical to the investigation of what happened and why.



This leads to the second part of my experience with this investigation, the written "Incident Investigation." The clear and complete documentation of an incident can be extremely important. In this particular case, some of the facts were questionable and difficult to explain or justify based on the documented information.

The correct time to start the documentation of an incident is as soon as possible, and at least within 48 hours of the event. As with operating procedures, the investigation and documentation of an incident must be carefully and thoroughly done. And as appropriate recommendations develop, they must be addressed to reduce the chance of a similar event occurring in the future.

The correct time to start the documentation of an incident is as soon as possible, and at least within 48 hours of the event.

The investigation of this incident impressed upon me the need to take very seriously the operating procedure review and investigation processes. I believe that many of us do work hard at our reviews and investigations, but from this particular incident I realized there is always room for improvement. A more dedicated effort at improvement of operating procedures and investigations can both help and protect employees, as well as non-employees, the public and the environment. ■

IIAR Shatters Attendance Records, Sets New Goals at Conference

BY ANDREA FISCHER

The International Institute of Ammonia Refrigeration hit record attendance numbers, signed agreements with international organizations and introduced a new president at its 2013 Industrial Refrigeration Conference & Exhibition, an event that marked a variety of transitions and new initiatives for the association this year.

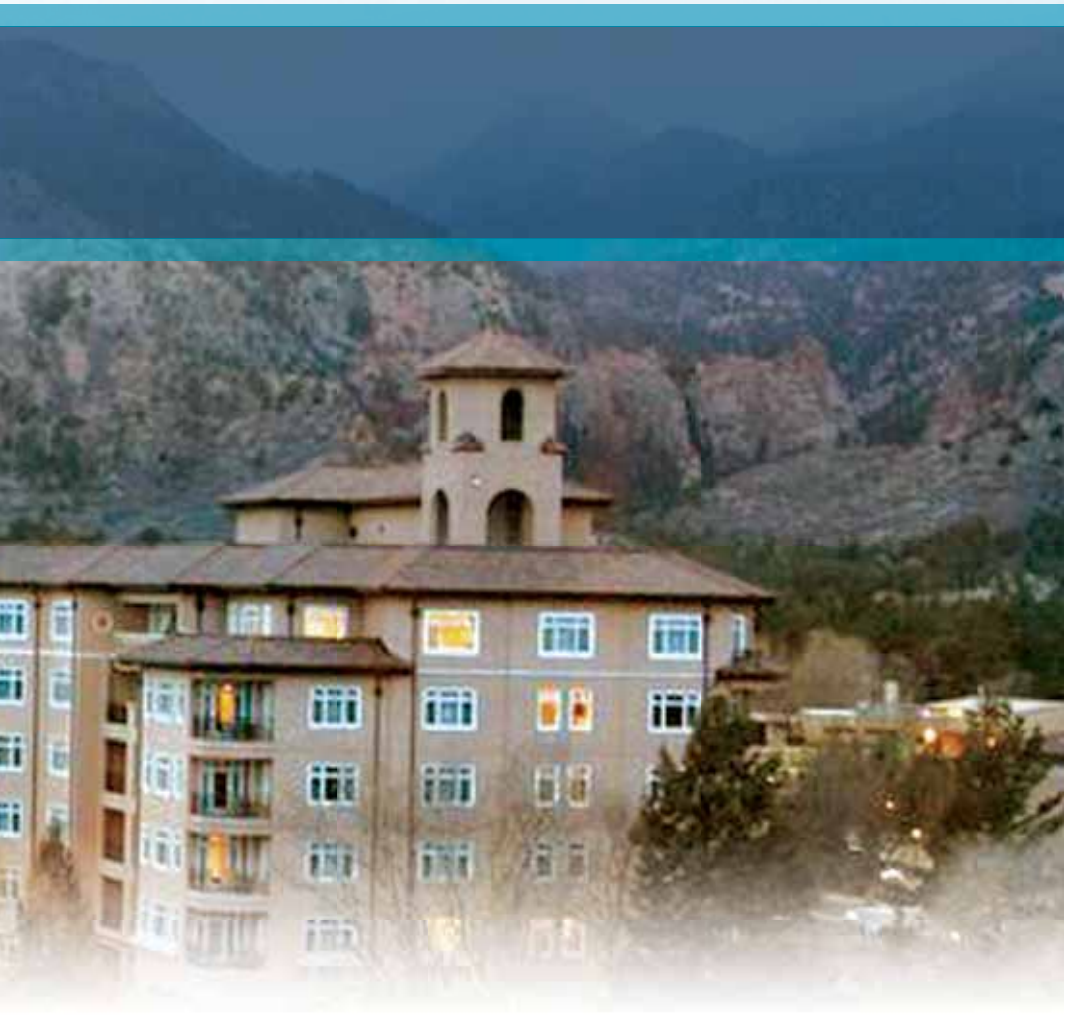
The four days of networking at industry sponsored events was an opportunity for IIAR conference goers to meet other professionals in the industry while taking advantage of the technical knowledge and resources available on the exhibition floor and at technical program presentations. At the same time, attendees were introduced to Dave Rule, who began his tenure as IIAR's new president at the event.

"This was such an energetic conference, and it ended on a high note, as the most successful event yet for IIAR in terms of attendance," said 2013 Conference Chair Marcos Braz. "Between the record turnout and all the other new things we had going on this year, I'd say it was really a conference of firsts."

The conference, which was held at the Broadmoor Hotel, March 17 – 20, drew over 1,200 attendees, many of whom were new to the event.

"We had a record number of first-timer attendees," said Braz. "That's exciting because new attendees are the pulse of our organization. It's good to bring in new people with fresh ideas to add to the collective knowledge our members represent."

The new conference attendees represented a cross-section of the industry,



said Braz, with many of them coming from the end-user environment, a sector IIAR has worked hard to support.

"This just shows how much the organization is growing," said Braz. "And that's due to the hard work that has been done over the last few years to make sure we're meeting the unique needs of our members."

The IIAR convention is the most tangible way for industrial refrigeration professionals to interact with their own industry, by networking and making use of the available technical resources, said Braz, an effort that is only possible with the support of IIAR sponsors and exhibitors.

> "IIAR is working hard to carry the momentum and energy of our sponsors, exhibitors and members to the upcoming conference and heavy equipment show in Nashville next year."
>
> **– 2013 Conference Chair Marcos Braz**

This year, the conference boasted more exhibitors than any other year and also garnered a record-breaking number of sponsorships at the event. "These sponsorships are so important because they help us sustain the conference financially, and they allow us to provide the things, like coffee breaks, lunches and social functions, that make it nice for everyone," said Braz.

As for exhibitors, one of the many ways they support the event is by introducing new information and creating a culture of communication that showcases the knowledge and technology of the industry.

"The participation of the exhibitors and sponsors was vital to the record success of this show," said Braz.

"Their work demonstrates how active and helpful our industry is."

Nevertheless, it wasn't just the sponsors and exhibitors that made the conference a success, said Braz, who pointed out that IIAR members took up new initiatives at the committee level.

"All of the IIAR committees were very active at this conference," said Braz.

He added that the work of the committees was especially important this year because they supported the work of IIAR's international committee, which orchestrated the signing of new agreements with delegations representing the ammonia refrigeration industry in India, Colombia, Chile, Australia and Europe.

The memorandums of understanding, signed at the conference, highlighted IIAR's focus on international relationships, calling for the exchange of publications, technical knowledge and resources as well as plans to pursue new joint initiatives.

"This was an important moment for IIAR because we were able to expand our reach as a true international organization," said Braz. "That wouldn't have been possible without the hard work of all of our committees. They produce and refine the accumulated knowledge and resources that come with over 40 years of experience in this industry."

"Because of them, we are able to expand the knowledge of our industry to other countries with the know-how that only IIAR can provide."

IIAR views the partnerships that were formalized at this year's conference as a way to support the growth of the industry around the world, said Braz. "These agreements, combined with the work of our committees, represent a pool of knowledge that is being made available to countries that might otherwise have a hard time accessing the experience of our industry. It's an opportunity for the future growth of our organization's members and the global exchange of information."

While international agreements were being formalized, IIAR's conference attendees were participating in the conference technical program, which included eight workshops, eight technical paper presentations, five technical paper presentations in Spanish and eight technomercials.

More "firsts" on display at this year's conference were two Spanish-

"We're thankful for the talents and resources that our members bring to this organization, especially the effort of all of our staff in making such a large event a great success." – 2013 Conference Chair Marcos Braz

language workshops and one Portuguese-language workshop. In addition, a conference guide was available to members for the first time as a mobile application.

"This year there was broad involvement of our members," said Braz. "We got several comments that this was one of the most interesting conferences from a content perspective."

Braz said the technical program, as well as a special CO2 technical presentation, gave IIAR "the opportunity to extend the conversation to other natural refrigerants," this year. Two technical papers in particular focused on the use of natural refrigerants in applications that extend beyond traditional settings.

These papers, in addition to the other ideas presented at this year's meeting underscore the importance of always looking ahead as an industry, said Braz. "As an organization, we're always ready to hear about developments in our own field, and this year, there were plenty of opportunities to do that."

Beyond the technical program, another factor that drew attendees to the 2013 conference was the chance to socialize and enjoy the Broadmoor hotel. "The Broadmoor was a great place to relax and enjoy catching up with friends and colleagues in the industry," said Braz.

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

Now, IIAR is working to prepare for 2014, a year that is even more important for the association because it will feature IIAR's heavy equipment show, said Braz, adding that the event only happens once every three years. "IIAR is working hard to carry the momentum and energy of our sponsors, exhibitors and members to the upcoming conference and heavy equipment show in Nashville next year."

IIAR's 2014 Industrial Refrigeration Conference & Exhibition, Heavy Equipment Show, will be held March 23 – 26 in Nashville, Tennessee. ■

Board of Directors

First Row (seated): Joe Mandato, Marcos Braz, Bob Port, Thomas Leighty, Mark Stencel, Dave Rule

Second Row (seated): Bob Czarnecki, Jim Adler, Gary Webster, John Gay, Bent Wiencke

Third Row: Bruce Badger, Paul Bishop, Martin Timm, David Blackhurst, Linda McDaniel, Mike Lynch, Kem Russell, Harold Streicher

Back Row: John Collins, Brian Marriott, Tim Facius, Doug Reindl, Don Hamilton, Bruce Nelson, Walter Teeter

IIAR Names Members of the Year, Honorary Life Member

MEMBERS OF THE YEAR

IIAR recognized two of its board members, Paul Bishop and John Collins, by naming them both Members of the Year in 2013. The Member of the Year award is usually given to only one recipient a year, but, said IIAR chairman Bob Port, "These two enthusiastic and dedicated volunteers have contributed so much to the success and growth of our organization that we wanted to recognize them both this year."

John Collins (left) and Paul Bishop (right) are presented with the IIAR Member of the Year award.

As Chairman of the International Committee and Chairman of the Code Committee, both Bishop and Collins went "above and beyond" to complete projects and lead initiatives important to the industry, said Port. "John has worked tirelessly with the code committee, and has really driven its efforts this year, and Paul has done the same thing with the International Committee."

"They have skillfully executed one of the most demanding volunteer positions in this organization, the role of committee chair," he said. The Member of the Year award is given to individuals who make outstanding contributions to the ammonia refrigeration industry through their service to the association over the preceding year. However, said Port, "Both of these men have given so much time to IIAR, we're really recognizing them for their efforts over the past five years."

HONORARY LIFE MEMBER

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

"Brian has contributed so much to our organization over the years, it was a joy and an honor to be able to nominate him for lifetime membership," said IIAR chairman Bob Port. "He's served for many years on the standards review committee and over the years he has put in so many hours reviewing those documents. When he wasn't working, he was always finishing up some IIAR standard or responding to questions on behalf of our organization."

Brian Marriott (center) is named an IIAR Honorary Life Member.

Marriott's leadership of IIAR includes a year-long term as chairman of the IIAR Board of Directors from 2008 to 2009, as well as his current role as chairman of the CO2 Committee. Marriott retired last year, but Port said he doubts that will slow Marriott down. "He's still working hard for our industry. Like any dedicated ammonia guy, Brian has managed to fail at retirement." ■

Andy Ammonia Award Winners Recognized for Technical Paper Contributions

The Andy Ammonia awards for the 2013 IIAR Industrial Refrigeration Conference & Exhibition were presented this year to Dave Malinauskas of CIMCO Refrigeration and David Sánchez Rojas of Parker Hannifin. The Andy Ammonia awards are determined based on the results of the technical paper evaluation forms completed by those who attend technical paper sessions. Malinauskas won the award for his paper, *Ice Rink Case Study: Comparing a Transcritical CO_2 Direct System against an Ammonia Heat Recovery System*. The paper presented the results of a case study which compared the energy consumption of three types of refrigeration systems; a basic ammonia refrigeration system with no heat recovery, an ammonia heat-recovery system, and a carbon dioxide transcritical heat recovery system. Meanwhile, David Sánchez Rojas won the award for his Spanish language paper, *Estudio de un caso real de golpe hidráulico en tuberías de refrigeración con amoniaco (Case Study of Hydraulic Shock in Ammonia Refrigeration Piping)*. The paper examined a recent occurrence of this phenomenon in a vegetable processing facility and presented design recommendations for piping and valve arrangements to minimize the risks associated with hydraulic shock while improving system safety and efficiency. ■

Dave Malinauskas and David Sanchez Rojas are presented with the Andy Ammonia award

Held every three years, the ***IIAR Industrial Refrigeration Conference & Exhibition, Heavy Equipment Show***, showcases the latest equipment, products, services and technologies available in industrial refrigeration. This popular trade show gives attendees the unique opportunity to network with hundreds of industry professionals, and reconnect with clients, representing all aspects of the industrial refrigeration community, from around the world.

This year the ***IIAR Industrial Refrigeration Conference & Exhibition, Heavy Equipment Show***, will be held in Nashville, TN on Sunday March 23 – Wednesday March 26, 2014.

Save the date and make plans to see the latest equipment and innovations in industrial refrigeration all together in one place. Go to **www.iiar.org** for the latest updates and information regarding this event.

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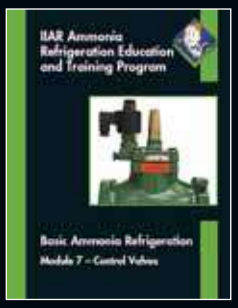

Part of the IIAR Ammonia Refrigeration Education and *Training Program Series I,* Module 7 focuses on the characteristics of control valves in ammonia refrigeration systems.

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Series I Modules 1-7 Complete set now available

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UPDATE

ANSI/IIAR 2-2008 with Addendum B

This update to the American National Standard for Equipment, Design, and Installation of Closed-Circuit Ammonia Mechanical Refrigerating Systems directly addresses issues related to valve and flange installation.

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As always, digital copies of IIAR standards are ***free*** to IIAR members to view online.

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International Committee Meets for Second Time as Official IIAR Working Committee

BY CHRIS COMBS, IIAR INTERNATIONAL PROGRAMS DIRECTOR

The IIAR International Committee's second meeting since becoming a formal IIAR working committee in 2012 was attended by 54 people. After a review of the committee's mission, purpose, scope and regional structure, Paul Bishop introduced the committee's vice chairmen appointed since the last International Committee meeting was held in Milwaukee. John Flynn of Emerson Vilter was selected as the committee's Senior Vice Chair. As mentioned previously in the Condenser, Samir Shah is the International Committee's Regional Vice Chair for India and South Asia and Stefan Jensen is the Regional Vice Chair for Australia and Oceania. Bishop also introduced the recently appointed International Committee voting members.

Much of the meeting was dedicated to presentations by IIAR's alliance partners around the globe. On behalf of the Australian Refrigeration Association, Steffen Jensen discussed Australia's new Carbon Equivalent HFC levy and its impact on the HVAC&R industry in Australia (see last issues Global View Column for more details).

Anne Xu of Parker Hannifin China indicated that the current plans of China's government call for an increase in cold storage capacity from 12.76 million cubic meters to 23 million cubic meters by 2015. The government's focus on food safety, energy savings, environmental friendliness and safe operation of refrigeration systems will create new opportunities for ammonia refrigeration in China.

Eurammon Chair, Monica Witt, highlighted Eurammon activities promoting the use of natural refrigerants including the upcoming symposium in Schaffhausen, Switzerland on June 27 and 28, an annual gathering of members and clients consisting of lectures as well as awards promoting innovations in natural refrigerant applications. Monica noted the growing popularity of CO_2 refrigeration applications in Europe.

Andy Pearson, representing the U.K.'s Institute of Refrigeration, suggested that IIAR's allied associations should identify IIAR publications useful to their members and that they negotiate arrangements with IIAR so they can adapt the language and format to suit their regions.

Much of the meeting was dedicated to presentations by IIAR's alliance partners around the globe.

Speaking on behalf of the Association of Ammonia Refrigeration in India, Samir Shah indicated that most industrial refrigeration installations in India (up to 85 percent) are in rural locations where design standards tend to be very low. Ammonia installations in areas previously considered rural face stricter regulations as a consequence of increasing urbanization. Despite recent developments affecting the industry including new technical standards for industrial refrigeration from April 2010, Shah pointed out that there will be a great deal of regulatory uncertainty at least until after the Indian elections in 2014. In the meantime, strengthening education and awareness is their main focus.

Raul Perea spoke on behalf of ACAIRE (the Colombian Association of Air Conditioning and Refrigeration). He highlighted ACAIRE's initiative to create an industrial refrigeration course delivered via the internet. The next CIAR (Iberoamerican Congress of Air Conditioning and Refrigeration) will be organized and hosted by ACAIRE in Cartagena, Colombia from July 22 - 24, 2013.

Patrick Fossey presented for the Chilean Chamber of Refrigeration and Air Conditioning. In 2012 the chamber created an ammonia committee and began working with the Chilean Government to create a good practice manual (discussed in a previous Global View column). A final draft for review is expected soon.

One of the IC's main initiatives is the series of Industrial Refrigeration Seminars in Latin America. A special meeting for Latin America an hour before the main IC meeting was attended by 36 people. At the beginning of the meeting Federico Alarcon, IIAR's Marketing Coordinator for Latin America based in Mexico City, presented an overview IIAR's various investments and initiatives relating to Latin America including the ongoing development of Spanish language content. This was followed by an open discussion about factors for the continued success of the seminars including a spirit of collaboration among the various members involved, financial balance and the academic level. Several IIAR member companies' joint efforts to handle the local organization of the 2012 Seminar in Santiago, Chile was cited as an example of the spirit of collaboration needed to run a successful regional seminar. Attendees stressed the importance of focusing on the educational mission of

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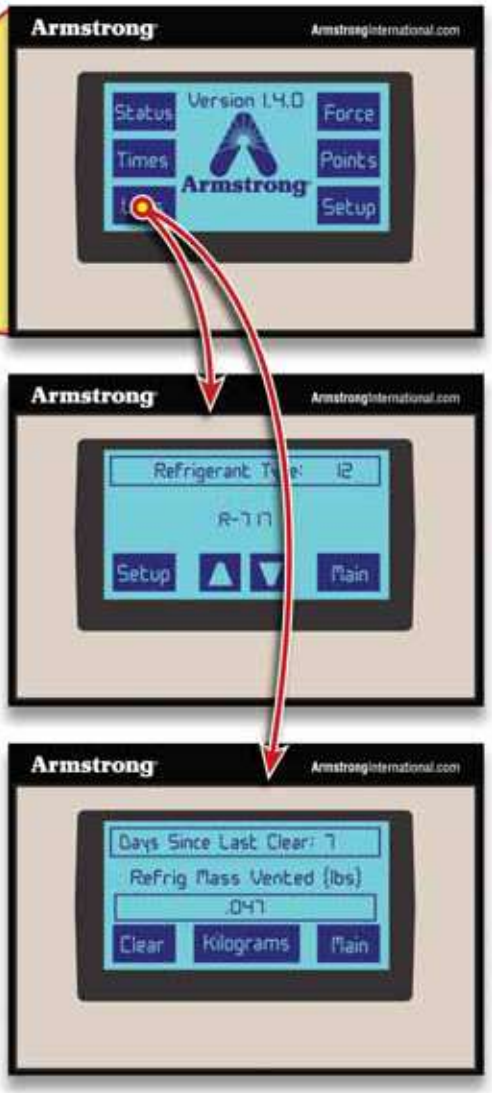

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the seminars (many countries in the region lack specialized programs in refrigeration studies) and promoting and bringing IIAR to Latin America (where many can't afford to participate in IIAR's U.S. based events) rather than focusing on particular commercial interests. Another suggestion was to have more presentations based on content previously published by IIAR.

A group of IIAR members in Costa Rica indicated they were ready to begin preparing for a seminar there. Another IIAR member proposed hosting a future IIAR seminar in Panama. IIAR International Programs Director, Chris Combs, noted that a three-year cycle would be more realistic than a two-year cycle for covering all the potential seminar host countries in Latin America and presented a regional approach in which there would be no more than one meeting in each sub region (first, Central America and the Caribbean, second, Andean Countries and third, the Southern Cone) in any given membership year. The discussion also focused on whether IIAR would include Mexico and Venezuela as seminar locations.

Following the discussion on Latin America, John Flynn made a presentation on the activities of other IIAR committees including possible tie-ins to International Committee activities.

Combs reminded the committee about the International Affiliate membership program which makes IIAR membership available to individuals in the BRIC countries and countries listed in article five of the Montreal Protocol for only US$100. He noted that the number of international affiliates grew from 15 to 59 since March 2012 and that IIAR had a total of 261 members outside the U.S. at the time of the meeting.

Combs announced that he had begun working from a home office in South Africa in order to be with his wife who is working on a project based in Pretoria scheduled to end in June 2015.

The IC meeting ended with a discussion of new business and Paul Bishop's inquiry regarding opportunities for the International Committee to make a difference. Guy Cloutier suggested that a French language task force might address the needs of a group of members in Quebec who proposed forming a French speaking chapter. Responding to Paul Bishop's inquiry, John Mott asked if there are any IIAR initiatives planned for hydrocarbons. ■

IIAR Welcomes Associations from Around the World, Signs Four Agreements in Colorado Springs

BY CHRIS COMBS, IIAR INTERNATIONAL PROGRAMS DIRECTOR

IIAR hosted delegations from numerous associations at the Industrial Refrigeration Conference in Colorado Springs including Jin Jaiwei, Yin Congxu and others from the Chinese Association of Refrigeration; Nikhil Raj, Samir Shah and others from the Association of Ammonia Refrigeration in India; Dr. Karin Jahn and Monica Witt of Eurammon; and Andy Pearson of the Institute of Refrigeration in the United Kingdom. Three additional associations were welcomed for the first time at IIAR's 2013 annual meeting: ACAIRE (or the Colombian Association of Air Conditioning and Refrigeration), Australian Association of Refrigeration (AAR) which was discussed in the last issue of the Condenser, and the Chilean Chamber of Refrigeration and Air Conditioning.

In a ceremony held in the afternoon of Tuesday, March 19, IIAR entered into 4 separate agreements with some of the organizations just mentioned. The current senior officers of IIAR, Bob Port, and Eurammon, Monica Witt, signed a modified IIAR-Eurammon Memorandum of Understanding (MOU) strengthening the commitment of both organizations to participate in each other's meetings. Silvio Toro, the president of ACAIRE's refrigeration chapter, joined Port in signing the first IIAR-ACAIRE MOU. Stefan Jensen signed the initial IIAR-AAR MOU and the delegates of the Chilean Chamber of Refrigeration, Patrick Fossey and Raul Bunster, delivered the first MOU between IIAR and the Chilean Chamber which had previously been signed by the Chamber's President Heinrich Stauffer both of which were signed by Port at the Ceremony. Each of these associations are now allied associations of IIAR. Nikhil Raj, the President of the Association of Ammonia Refrigeration in India (AAR), also participated in a ceremonial signing of the MOU previously executed by IIAR and AAR. Also present at the signing ceremony were Dave Rule, Samir Shah of AAR, Klaas Visser of ARA, Raul Perea of ACAIRE and Dr. Karin Jahn of Eurammon.

Each of these associations are now allied associations of IIAR.

The relationship described in the MOUs signed that day includes the exchange of news publications, sending representatives to the main conference or meeting of the other association, transferring technical knowledge and holding meetings to plan joint initiatives which benefit both parties. Each allied association is able to nominate a voting member to the International Committee. Furthermore, the MOUs signed with the associations from Colombia and Chile establish a potential role for the allied associations as the main local organizers for the IIAR Industrial Refrigeration Seminars in their respective countries or regions. The intention of these alliance relationships is to more effectively promote the safe and efficient use of ammonia and other natural refrigerants in refrigeration applications worldwide. ■

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Editor's Note:

The technical paper "Personal Protective Equipment for NH3 Releases Less Than 15,000 PPM of Vapor," was presented at the 2013 IIAR Industrial Refrigeration Conference and Exhibition, recently held in Colorado Springs, Colorado, March 17-20, 2013. The purpose of this paper is to build upon the background used in 1991 that established the 5,000 PPM regulatory interpretation to limit the use of Level B personal protective equipment.

According to ASTI, the organization has gathered new information, identified new technology, and has additional experience available today to provide an alternative to using the Level A personal protective equipment option in levels of ammonia less than 15,000 PPM. The Institute said it is recommending that OSHA approve a performance-based PPE ensemble created with a combination of protective clothing options to address identified hazards rather than relying exclusively on one of the four EPA created levels of personal protective equipment.

Gary Smith, the author of this technical paper, has spent 42 years in the emergency management business. Thirty-three of those years were in the fire service, with 20 years as a fire chief. For the last ten years, Smith has worked as president of the Ammonia Safety and Training Institute, or ASTI, a non-profit organization founded in 1987. ASTI said its team is dedicated to making ammonia the most safely managed hazardous material in the world. In addition, ASTI said its ongoing goal is to continue to work on ways to accurately portray the hazards, risks, and threats of ammonia and to educate public safety and end-user emergency responders on how to properly manage an emergency event.

Personal Protective Equipment (PPE) for NH3 Releases Less Than 15,000 PPM of Vapor

INTRODUCTION AND BACKGROUND

BY GARY W. SMITH, AMMONIA SAFETY AND TRAINING INSTITUTE, PRESIDENT

The federal Occupational Safety and Health Administration sets the safe work practice guidelines that employers must comply with as minimum standards. Many states have assumed administering authority and have the right to define a higher standard of safety, when local hazards and special conditions exist.

The information used to produce the recommendations in this document was gathered from federal OSHA requirements, ASTI-related experiences in handling anhydrous ammonia releases, and from related technical information about personal protective equipment, or PPE, standards.

Levels of response into environments containing ammonia vapor were defined in October of 1991 in an OSHA Standard Interpretation Letter written by Patricia K. Clark, Regional Director of Compliance Programs for OSHA. She was answering a question from a firefighter who wanted clarification on the most appropriate level of PPE to wear within ammonia vapor during an emergency event. Following is the key summary that Director Clark provided in her Interpretation Letter:

"Generally, we would expect emergency responders to respond in Level A suits to unknown concentration levels and levels at or above one-half the Immediate Dangerous to Life and Health, or IDLH, level. The IDLH for ammonia is 500 parts per million, or PPM, (now 300 PPM) and one half that level is 250 PPM (now 150 PPM). However, ammonia is an inhalation hazard at 1,000 PPM and not a skin absorption hazard. Ammonia begins to affect moist skin at exposures greater than 10,000 PPM (1 percent) (mild irritation) and at concentrations great than 30,000 PPM (3 percent) a stinging sensation is observed. Therefore, the general procedure of using Level A equipment at half the IDLH may be unduly conservative for ammonia exposures. For ammonia it may be more appropriate to respond in Level A gear to exposures of half the threshold for skin irritation, or 5,000 PPM."

The International Institute of Ammonia Refrigeration, or IIAR, Ammonia Safety Data Book adopted the 5,000 PPM standard for setting the maximum limit for using Level B ensembles in ammonia vapor.

PURPOSE AND SUMMARY RECOMMENDATION:

The purpose of this paper is to build upon the background used in 1991 that established the 5,000 PPM regulatory interpretation to limit the use of Level B PPE. ASTI has gathered new information, identified new technology, and has additional experience available today to provide an alternative to using the Level A option in levels of ammonia less than 15,000 PPM. We are recommending that OSHA approve a performance-based PPE ensemble created with a combination of protective clothing options to address identified hazards rather than relying exclusively on one of the four EPA created levels of PPE (Level A, B, C, or D).

The hazard analysis on 15,000 PPM of anhydrous ammonia vapor reveals that the inhalation hazard is high, requiring a self-contained breathing apparatus, and the skin damage hazard is low.

The following is a quote from the Industrial Hygiene and Toxicology Volume II, also known as the Patty Handbook, (Frank Patty, Editor, published in 1963, Library of Congress number 58-9220). We believe that OSHA Regional Director Patricia Clark used this information when defining skin damage threat.

"During the approval testing of respiratory protective devices, the author has observed that atmospheres of one percent ammonia are mildly irritant to the moist skin, those of two percent have a more pronounced action, and concentrations of three percent or greater cause a stinging sensation and may produce chemical burns with blistering after a few minutes of exposure."

The range of concern for ammonia vapor begins with mild irritation at 10,000 PPM and increases to a stinging sensation felt at 30,000 PPM. The decontamination procedure for dealing with a vapor irritation is to aerate the skin and PPE clothing with fresh air from a portable fan.

The following is a summary of the findings that support ASTI's desire to define a safer PPE alternative to using Level A PPE for working in atmospheres less than 15,000 PPM of anhydrous ammonia vapor.

- Reducing the time and stress associated with PPE suit-up to enter low-level vapor (under 15,000 PPM of ammonia) will help achieve the response objectives set for engagement in the first 30 minutes of an emergency event. The need for rapid entry rescue, defensive mitigation of the emergency event, and ability to perform reconnaissance to secure the information needed to plan a longer-term response strategy occurs during the first 30 minutes. The overall risks and threats that materialize in the first 30 minutes can be quickly and effectively mitigated to contain and control an emergency event that might otherwise increase to higher concentrations and a greater level of risk and threat to responders and downwind receptors.
- Level A PPE takes longer to put on than Level B protection. The stresses and medical oversight needed to wear a fully encapsulated suit present life safety challenges for the responder that can be more of a concern than the potential of minor skin irritation from exposure to ammonia vapor under 15,000 PPM.
- The assumption that most employers use a Level A response team is incorrect. The trend for employers who work with ammonia has been to drop all emergency response that requires an offensive strategy and, instead, count on public safety to engage hazmat response teams to contain and control an emergency event. Many public agency responders do not have a level A technician-trained response team immediately available. They may count on a regional response team that takes more than an hour to become operationally available.
- The life threat and damage from an unattended ammonia emergency can be mitigated if employers are given a more realistic PPE emergency response plan option to engage offensively to contain and control an ammonia release during the first thirty minutes.
- The use of protective clothing can itself create significant wearer hazards, such as heat stress, physical and psychological stress, and impaired vision, mobility, and communication. The greater the level of chemical protective clothing, the greater the associated risks. For any given situation, equipment and clothing should be selected to provide an adequate level of protection. Overprotection, as well as under-protection, can be hazardous and should be avoided (quoted from the OSHA, Section 7, Chapter #1, Chemical Protective Clothing).

For any given situation, equipment and clothing should be selected to provide an adequate level of protection.

CASE HISTORY — NYC FIRE DEPARTMENT FOUND AN ALTERNATIVE TO LEVEL A ENTRY FOR ALL HAZARDOUS VAPOR-RELATED EMERGENCY THREATS:

The risk to the responder using Level A ensemble is high, especially when the responder is not comfortable or experienced in emergency circumstances. An article published in Fire Chief magazine (September 2011), revealed that the New York Fire Department made the decision to reduce the level of risk to the responder by creating an optional PPE clothing ensemble rather than mandating Level A fully encapsulated suits to handle all vapor releases of toxic inhalation hazardous vapor. The following is a quote from that article:

"While all of the units are trained for life-safety operations (assessment, packaging and removal) in the Hot Zone, only the Hazmat Technician II units and Hazmat Company 1 are trained for the mitigation of incidents that require vapor protection. Prior to upgrading its chemical protective clothing, or CPC, program, the FDNY issued Level A suits to these units.

New options: the department discovered that for hot-zone responses, fully encapsulated gastight garments, i.e., Level A suits, pose several challenges for the first responder. For instance, such suits trap heat and put the responder at risk for heat injury. Also, vision is obscured when moisture (sweat and respiration) condenses on the inside of the visor. If that wasn't problem enough, the bulkiness of the suit material required the wearing of oversized boots, and the glove system compromised dexterity. The combination of obscured vision, ill-fitting footwear and decreased dexterity, increased the potential for injury. The packaging and removal of exposed victims are physically demanding tasks that underscore the limitations of using fully encapsulated CPC for hazmat rescues.

It should be noted that the levels of protection (A, B, C and D) outlined in CFR 1910.120 are design standards, not performance standards. In contrast, NFPA standards are performance-based, and they influenced the FDNY's decision to upgrade its CPC program.

NFPA standards that are applicable to this discussion include the following:

NFPA 1971: Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting

NFPA 1991: Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies

In 2007, NFPA 1994, Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents, was released. This standard parallels the rescue mission of FDNY's tiered-response system. Because of this standard, as well as innovations that were occurring at the time, the department further evaluated its hazmat equipment and tactics, with

the following objectives: increase department response capabilities with mission-specific protection; improve responder safety; and, decrease physical impact on responders.

As a result, two garments were selected for inclusion in the department's CPC program.

The Trelleborg Trellchem VPS Flash Suit was selected as an upgraded and improved Level A suit for mitigation missions performed by Hazmat Company 1 and Hazmat Technician II units.

Performance improvements include the following:

- It meets the optional flash-fire standard in NFPA 1991;
- No over-garment yields a 7.3-pound weight savings, which decreases physical strain;
- Anti-fog hard-impact visor increases safety by improving vision;
- Improved dexterity;
- Streamlined suit material does not require the use of oversized boots.

The VPS Flash Suit improves safety and decreases the demands placed on hazmat technicians. Mitigation missions often require fine motor skills to make repairs; consequently, improvements in vision and dexterity increase the chance of a successful response using one entry team.

In addition, the Lion MT-94 was selected for rescue missions within the hot zone. Performance improvements compared with the legacy Level A suits include the following: A 3- to 4-minute donning time, which improves the time-to-victim contact; visibility is not an issue due to the non-encapsulating design; a glove system that provides superior dexterity and protection; a substantial reduction in heat stress and physical demand on the first responder; and enhanced garment durability.

The MT-94 is a non-encapsulated, gas/vapor-tight garment that is 13 pounds lighter than the previous Level A suit. The substantial improvements in decreasing heat stress are due in large measure to the garment's unique material, W.L Gore's Chempak fabric, that was developed in response to military and first responder requests for a lightweight, highly mobile and durable garment for use in chemical and biological incident response. The fabric sandwiches a protective barrier between two layers of Nomex fabric.

Reduced heat generation was achieved primarily through the dramatically decreased weight of the garment, but also by increasing its flexibility compared with the Level A suit. Heat stress can be reduced further by wetting the garment with water. A combination of conductive and evaporative cooling occurs when the garment is wetted, which decreases the thermal load on the responder. In turn, reducing heat stress and physical exertion decreases air consumption. So, the responder can remain safely in the Hot Zone for longer periods. In training exercises, the department has seen a marked increase in the number of extractions a CPC team can complete before members deplete their air supplies. Moreover, the garment's

improved durability has allowed an expansion of tactical areas of operations to include incidents that were considered too damaging to the Level A suit, e.g., collapsed debris areas. Finally, the MT-94 also can be utilized by a rapid-intervention team to respond to injured members of a mitigation team."

ASTI RECOMMENDATION ON A STANDARD OPERATING PROCEDURE FOR ENGAGING IN LEVELS OF AMMONIA VAPOR OF LESS THAN 15,000 PPM WITH NO EVIDENCE OF DENSE GAS CLOUD GREATER THAN 3 CUBIC FEET

PPE Parameters: The PPE recommendations made herein are designed to protect the responder (person wearing the gear) within the specifications of the outer protective suit plus a buffer protection provided by clothing worn under the outer suit in case the responder experiences a sudden and unforeseen exposure to threats beyond what was evident when entering the hot zone, e.g., a small aerosol release suddenly becomes a large aerosol release (greater than 3 cubic feet) or suit damage results in a vapor leak through the outer suit.

The Incident Commander and responders must be trained technicians to engage any offensive operation within the hot zone. They must have a full understanding of the hazards, risks, and threats, and they must be equipped with proper monitoring equipment to determine that entry into the hot zone is safe within the scope of the adopted PPE emergency response SOP(s). The hot zone hazards, risks, and threats may be pre-defined in a Hazard Zone Checklist that is included in the emergency plan, or within an ICS 215A form and/or an ICS 208 form that defines hazards and mitigations for the hazards within the hot zone before entry is allowed by the responders.

Hazard Zone Disclaimer: The PPE recommendations defined within this document are not intended to cover a circumstance in which the responder is entering a hot zone that involves an out-of-control aerosol release that is developing into a dense gas cloud (greater than three cubic feet) and is moving towards a source of ignition, or spreading at a rate that will place responder(s) at an uncertain level of risk. An out-of-control aerosol stream may have the potential to transition into a highly flammable and extremely cold environment within several minutes. This would require the highest level of PPE with a fully encapsulated entry suit, flash-fire protection, and thermal insulated clothing and gloves that resist damage at temperatures as low as -80°F. Entry into an atmosphere that threatens to transition to this type of circumstance is not within the scope of the PPE recommendations provided herein.

Identification of the hazards or suspected hazards: ASTI recommends that a Pre-Emergency Readiness Checklist and a Hazard Zone Checklist (provided as an appendix to this document) be created for every facility using anhydrous ammonia. This information helps define the level of PPE engagement using a faster and more accurate hazard analysis. The pre-arranged hazard analysis provided within the Pre-Emergency and Hazard Zone checklists defines the hazards, risks, and threats, as well as the defensive measures used to reduce the impact of the ammonia release. The Hazard Zone details are put into place by a Command Team made up of an Incident Commander, Lead Responder, Evacuation Group Supervisor, and Notification Unit Leader. An Incident Commander may appoint a Plans Section Chief or a Safety Officer to develop a Situation Status Report and advanced hazard analysis for engagement beyond the first thirty minutes of emergency response engagement.

There are seven hazard scenarios that the SOP for entering any atmosphere above PEL (Permissible Exposure Level), Isolation Zone, or Hot Zone must address:

- **Defensive action in atmospheres less than IDLH and greater than PEL:** Evaluate and prepare for the hazards, risks, and threats associated with entry into the hazard zone by reviewing the Pre-Emergency Readiness checklist and/or the Hazard Zone checklist provided in the emergency plan, or develop an ICS 215A hazard analysis.
- **Engaging in command and support functions:** Those conducting command assignments on the outer perimeter of the Isolation Zone or Protective Action Zone may experience an occasional shift of vapor and may need an escape hood or APR. Levels of ammonia may exceed the IDLH temporarily. The same is true for

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1. Dr. Steve Curry, MD, FACMT, FAACT, is the Director of the Department of Medical Toxicology, Banner Good Samaritan Medical Center, and is an experienced lecturer about the toxic effects of ammonia. He is the medical advisor for the Phoenix Fire Department.

Timothy Brady, Ph.D., FACHE, FHFMA, is the Regional Inspector General at the US Department of Health and Human Services in San Francisco, California, and is a 20-year supporter of ASTI training. Dr. Brady has repeatedly presented on the health risks associated with ammonia at Safety Day presentations for many thousands of end-users, public safety personnel, and regulators of anhydrous ammonia.

Dr. Paul Nony, Senior Toxicologist from the Center for Toxicological and Environmental Health, is an experienced emergency responder to major events involving toxic inhalation gases. Dr. Nony is a respected speaker at hazmat conferences and has worked with ASTI for the last five years.

Richard A. Nickle, Agency for Toxic Substances and Disease Registry (ATSDR), performed a data search for medical reports on injury related to exposure to anhydrous ammonia vapor. This search revealed no technical data that would clarify the levels of exposures to ammonia vapor.

Dr. Shelley DuTeaux, Emergency Services Coordinator for the Office of Emergency Response, California Air Resources Board. Dr. DuTeaux provides toxicological and health-based technical support to incident command, local air districts, and state agencies during major toxic air releases and other emergencies with air quality impacts. She has been a featured speaker at Ammonia Safety Day training in Salinas, CA, and Phoenix, AZ

those performing decontamination on a person who has aerosol or liquid burns.

- **Those trapped in an ammonia contaminated environment** may also use an escape hood to move through ammonia vapor that exceeds the IDLH limits. ASTI recommends that a person should not escape through a dense gas cloud of ammonia without the highest level of respiratory protection.
- **Incidental control of an emergency event as defined by OSHA limits:** The definition of Incidental control is provided in the Definitions section of this document.
- **Entry into the hot zone for levels of risk above the IDLH**: The Incident Commander and entry team must be technician trained. They will conduct a pre-entry briefing to assure that the Incident Action Plan (IAP) and Safety Plan address the acknowledged hazards and risks. The Hazard Zone Checklist, ICS 215A, and/or ICS 208 may be used to support the IAP. The entry team must be supported by back-up, decontamination set-up, and rehab support. On-air time must be monitored by the IC or Safety Officer.
- **Entry to perform reconnaissance and hazard assessment**: Responders may not have all the evidence needed to properly judge the hot zone and will need to enter to assess the conditions before initiating containment and control measures, other than incidental control on the way to and from the Hot Zone. Entry into IDLH conditions requires the same level of oversight as described in the previous bullet statement.
- **Entry for rapid extrication "grab and go" rescue:** Rescuing a person who is down within the hot zone is the most challenging response protocol for the employer to create. The first steps of the rescue will require a hazard assessment. Those participating in rapid extrication rescue must be trained on how to perform the rescue evolution. The options for rescue include: defensive measures (reduce risk by managing the release using mitigations), placement of a portable fan to move the ammonia vapor away from the rescue victim, entry to supply the victim with PPE to survive the exposure, and entry to move the victim from the hot zone.

The Incident Commander and entry team must be technician trained. They will conduct a pre-entry briefing to assure that the Incident Action Plan (IAP) and Safety Plan address the acknowledged hazards and risks.

POTENTIAL EXPOSURE, E.G., INHALATION, INGESTION, AND SKIN ABSORPTION: Ammonia presents a high level of respiratory threat and a reduced level of concern for skin damage, especially at exposure levels of 10,000 PPM or less (based upon the conditions defined in PPE Parameters and limitations prescribed by ASTI and described within this document). The OSHA standard is clear that the transition from APR (Air Purifying Respiratory) to SCBA occurs at the IDLH of 300 PPM.

Inhalation Hazard: The hazards of vapor exposure of 15,000 PPM or less represent a respiratory threat that can be mitigated with an APR at levels below 300 PPM. A Self-Contained Breathing Apparatus is required at levels above the IDLH.

Ingestion Hazard: The full-face mask APR or SCBA will provide adequate protection from the threat of ingesting ammonia. There will be no other details provided to address ingestion of ammonia because the PPE SOP begins with the mandatory use of an APR or SCBA to mitigate this threat.

Skin Absorption: Exposure to ammonia vapor has been characterized by OSHA Region II Director Patricia Clark as being "mild irritation" at 10,000 PPM and a "stinging sensation" at 30,000 PPM. ASTI has conducted live ammonia PPE testing that confirms that assessment.

ASTI conducted a data search for medical reports and specific medical findings regarding skin tissue burns associated with exposure to anhydrous ammonia vapor.

The conclusions of the medical advisors[1] who were consulted reveal that there are little or no medical findings in recent history that provide medical evidence of serious injury due to exposure to ammonia vapor in atmospheres less than 15,000 PPM. There is plenty of medical evidence of inhalation injury and thermal, chemical burns associated with exposure to aerosol stream and liquid ammonia exposure.

The alkaline burns associated with ammonia occur when anhydrous ammonia mixes with water, as in contact with body fluids (eyes and respiratory track). When significant amounts of vapor mix with body fluids irritation begins to develop starting with itching eyes and a tickling sensation at 150 to 700 PPM, progressing to airway closure due to the irritation created in the esophageal airway at 1500 to 2700 PPM.

The pH of ammonia becomes a factor for skin irritation when anhydrous ammonia mixes with water. A weak alkaline is developed (maximum of 11.2 pH). Direct exposure to skin moisture, usually body sweat in the armpits or groin, produces mild skin irritation at 1 percent (10,000 PPM). Skin irritation at 3

percent (30,000 PPM) creates a cold, stinging sensation. Skin exposure can be decontaminated by an air-driven portable fan. When exposed to aerosol dense gas or liquid ammonia, the victim should be showered with water for at least 15 minutes.

CASE HISTORY EXPERIENCES BY VICTIMS CAUGHT IN DENSE GAS CLOUD LEVELS OF AMMONIA VAPOR THAT SIGNIFICANTLY EXCEEDED 10,000 PPM

- 1975 survival of Mickey Johnson and her son who were caught in an ammonia cloud on a Houston freeway: Mickey experienced no skin injury but did experience significant respiratory damage. Her 2-year-old son experienced no significant long-term injury because Mickey covered him with a coat that shielded him from dense gas exposure.
- 2010 Minot, North Dakota, train derailment: Approximately 1 million pounds of ammonia traveled through Minot. Exposures within some of the homes exceeded 1,000 PPM. There was no evidence of ammonia skin burns.
- 2012 survival of Jose Mata in Yuma, Arizona: He was thrown to the ground when a condenser failed due to over-pressure that instantaneously released a large volume of ammonia. The concussion of the mechanical explosion threw Jose on his back and he was completely covered in an aerosol dense gas cloud. He held his breath, closed his eyes, and ran out of the ammonia cloud. He suffered thermal burns and chemical burns to his lower torso because his clothing (pants and boots) were left on during and after initial decontamination. The high pH of the aqua-ammonia solution caused serious chemical burns. Jose's face and upper torso did not show any evidence of vapor burn.
- In February of 2012 the fire department in Yuma, Arizona, worked with ASTI to test the protection of firefighter turnout gear while performing a tarp and cover evolution over a high-pressure/high-volume aerosol ammonia release (150 psi through a 3/4" outlet). Two firefighters got too close to the aerosol release and were caught in a visible dense gas cloud. The ammonia vapor (at about 30,000 PPM) entered the legs of their turnout pants. They immediately went to the decontamination fan for decontamination. The vapor burning sensation was mitigated within several minutes and there was no evidence of skin irritation. The firefighters were wearing knee-length shorts under their turnouts, so the irritation factor was more significant than if they had been wearing long underwear or cotton pants.

The increased vision, mobility, and physical comfort afforded by the ASTI-recommended levels of PPE will result in a safer overall response.

ASTI-RECOMMENDED CHANGES TO SKIN PROTECTION STANDARDS

On three different occasions, ASTI has tested exposure levels when wearing overalls, CBRN first responder overalls, fire turnouts, Level B (un-taped), and Level B (taped). The tests were conducted inside training buildings at the Military Operations on Urban Terrain (MOUT) training facility at Fort Ord in California. OSHA and EPA officials witnessed the tests. ASTI team members, the Salinas Fire Department Hazmat Team, and the 95th Civil Support Team from Hayward, California, participated in the ammonia vapor PPE evaluations. The results of the testing consistently showed that exposure within the 1 percent to 3 percent mixture is consistent with Ms. Clark's letter regarding skin exposure.

The test procedure was conducted within an enclosed 20' x 30' room with an 8' ceiling. Small amounts of liquid ammonia (approximately 2 cups per spill) were dropped on the cement floor. The ammonia vapor evaporated into a small cloud and then dispersed into the room, slowly building up the ammonia vapor concentrations. Four entry team responders were dressed in different levels of PPE: 1) CBRN protective overalls with charcoal-filtering protective layer; the entry person wore shorts; 2) Nomex overalls with cotton blend pants and shirt under the overall; 3) Fire turnouts meeting NFPA standards for fire protection; 4) Level B over-suit with no taping of the arms, legs, and face mask; 5) Level B oversuit taped at the arms, legs, and zipper flap (upper torso). The face mask seal was a built-in gasket connection (available with some suits) and/or a Nomex hood that overlaps the face mask.

The room was monitored by two handheld ammonia monitors and Honeywell ammonia sensors strategically located within the room. The concentration of ammonia vapor was monitored as those who were exposed walked about the room to simulate working in ammonia vapor conditions.

The ASTI findings are categorized for the various levels of skin protection as follows:

- CBRN Overalls (under clothing - shorts with unprotected legs from the knees down): Those who wore overalls with no second layer of clothing (long-legged pants) and open cuffs were the first to experience skin irritation on the legs and crotch area at approximately 8,000 to 10,000 PPM.
- Overalls with cotton pants and shirt under the overalls: skin irritation began with a sense of cold and slight stinging sensation at approximately 17,000 PPM.

- Fire Turnouts: at 20,000 PPM minor skin irritation in moist areas of the body was felt.
- Level B Un-Taped: resulted in minor irritation at approximately 25,000 PPM.
- Level B Taped: experienced no discomfort at levels above 25,000 PPM.

In all cases, skin irritation was mitigated by decontamination with a portable fan.

Responders must comply with OSHA requirements for PPE response and be properly equipped with appropriate respirators. The hot zone environment, where entry takes place, must be monitored with handheld or fixed system monitoring that reads the constant exposure levels. Decontamination, medical readiness, safety oversight, and other applicable OSHA requirements must be in place as per the emergency response plan SOP. ASTI recommends that OSHA approve the following criteria for working within atmospheres of ammonia vapor:

- Maximum of 5,000 PPM exposure within a Hot Zone while wearing cotton or fire-resistant overalls over long underwear or clothing (long-sleeved shirt and full-length pants);
- Maximum of 10,000 PPM exposure with Level B over-suit un-taped;
- Maximum of 10,000 PPM exposure with fire turnouts meeting NFPA specification;
- Maximum of 15,000 PPM exposure with Level B over-suit with chemical resistant tape-seal at all suit openings.

Justification for the exposure limits: Exposure to levels above 30,000 PPM for any of the PPE ensembles described above is unlikely. The entry team is prohibited from entering if an aerosol/dense gas cloud is forming. The emergency responder will be backed up with a buddy who can assist the entry team in reaching decontamination AND the undergarments used for the PPE ensemble (should a tear or other failure allow ammonia vapor to enter the suit) will be adequate to protect the responder to the point of decontamination with little or no skin irritation beyond slight discomfort. The 15,000 PPM limit does not present as big a concern for skin irritation as it does for breathing (SCBA). The increased vision, mobility, and physical comfort afforded by the ASTI-recommended levels of PPE will result in a safer overall response than if responders wear Level A ensembles (with the potential of heat, tripping, and stress-related problems).

OSHA COMPLIANCE CONSISTENCY

The future of creating a more appropriate level of PPE for defined entry into hazard zones involving less than 15,000 PPM of ammonia vapor will require clarification of the various code interpretations and verbiage by OSHA.

The following OSHA information must be clarified by code enforcement leadership within OSHA to assure that an employer-developed SOP using the logic presented in the document is appropriately designed.

There is inconsistency in the parameters associated for Level B PPE protection written in Section VII, Chapter 1 of the OSHA Technical Manual and the 1910.120 Appendix B definition of Level B protection.

Section VII states “no protection against chemical vapors or gases,” and then later states that “primary hazards associated with site entry are from liquid and not vapor contact.”

OSHA 1910.120 Appendix B regarding Level B states “The highest level of respiratory protection is necessary but a lesser level of skin protection is needed.”

Both quotes are cited below:

OSHA TECHNICAL MANUAL, SECTION VII, CHAPTER 1 — DEFINITION OF LEVEL B PROTECTION:

LEVEL B: Liquid splash-protective suit (meets NFPA 1992); pressure-demand, full-face piece SCBA, inner chemical-resistant gloves, chemical-resistant safety boots, two-way radio communications

Hard hat. OPTIONAL: Cooling system, outer gloves

Protection Provided: Provides same level of respiratory protection as Level A, but less skin protection. Liquid splash protection, but no protection against chemical vapors or gases.

Used When: The chemical(s) have been identified but do not require a high level of skin protection. Initial site surveys are required until higher levels of hazards are identified. The primary hazards associated with site entry are from liquid and not vapor contact.

Limitations: Protective clothing items must resist penetration by the chemicals or mixtures present. Ensemble items must allow integration without loss of performance.

OSHA 1910.120 APPENDIX B — DEFINITION OF LEVEL B

II. Level B - The highest level of respiratory protection is necessary but a lesser level of skin protection is needed.

The following constitute Level B equipment; it may be used as appropriate.

1. Positive pressure, full-face piece self-contained breathing apparatus (SCBA), or positive pressure supplied air respirator with escape SCBA (NIOSH approved).
2. Hooded chemical-resistant clothing (overalls and long-sleeved jacket; coveralls; one or two-piece chemical-splash suit; disposable chemical-resistant overalls).
3. Coveralls. (1)
4. Gloves, outer, chemical-resistant.
5. Gloves, inner, chemical-resistant.
6. Boots, outer, chemical-resistant steel toe and shank.
7. Boot-covers, outer, chemical-resistant (disposable). (1)
8. Hard hat. (1)
9. [Reserved]
10. Face shield. (1)

Footnote (1) Optional, as applicable

There is no doubt that Level B PPE protection offers some protection from ammonia vapor. OSHA Regional Director Patricia Clark made this fact clear in her Letter of Interpretation for Level B use on ammonia emergencies.

The threats associated with an ammonia vapor release (under 15,000 PPM) are predominantly an inhalation threat rather than a skin damage concern. The utilization of Level B PPE and, to a lesser degree, fire turnouts or overalls and self-contained breathing apparatus is a reasonable alternative to Level A fully encapsulated suits when working exclusively in ammonia vapor for short durations of time (under 10 to 15 minutes).

The appropriate resolution to this code-related conflict is to use the most specific regulatory requirement, which would be the 1910.120 Appendix B wording.

Further code-related support that is used to focus the use of Level A and B protection is provided with the following Federal OSHA 29 CFR code citations:

1910.120(g)(3)(iv): Totally-encapsulating chemical protective suits (protection equivalent to Level A protection as recommended in Appendix B) shall be used in conditions where skin absorption of a hazardous substance may result in a substantial possibility of immediate death, immediate serious illness or injury, or impair the ability to escape.

1910.120(g)(3)(v): The level of protection provided by PPE selection shall be increased when additional information or site conditions show that increased protection is necessary to reduce employee exposures below permissible exposure limits and published exposure levels for hazardous substances and health hazards (see Appendix B for guidance on selecting PPE ensembles).

NOTE TO PARAGRAPH (g)(3): The level of employee protection provided may be decreased when additional information or site conditions show that decreased protection will not result in hazardous exposures to employees.

1910.120 Appendix B: As an aid in selecting suitable chemical protective clothing, it should be noted that the National Fire Protection Association (NFPA) has developed standards on chemical protective clothing. The standards that have been adopted include:

NFPA 1991 - Standard on Vapor-Protective Suits for Hazardous Chemical Emergencies (EPA Level A Protective Clothing)

NFPA 1992 - Standard on Liquid Splash-Protective Suits for Hazardous Chemical Emergencies (EPA Level B Protective Clothing)

NFPA 1993 - Standard on Liquid Splash-Protective Suits for Non-emergency, Non-flammable Hazardous Chemical Situations (EPA Level B Protective Clothing)

These standards apply documentation and performance requirements to the manufacture of chemical protective suits. Chemical protective suits meeting these requirements are labeled as compliant with the appropriate standard. It is recommended that chemical protective suits that meet these standards be used.

THE PERFORMANCE OF PPE MATERIALS AND SEAMS IN PROVIDING A BARRIER TO HAZARDS

PPE Protection:
The amount of protection offered by a particular type of PPE is material and hazard specific. Certain types of PPE will protect well against some hazards and poorly, or not at all, against others. Other factors in the selection process include matching the PPE to the employer's work requirements and task-specific conditions. The durability of the PPE materials, as well as its performance in extreme heat or cold, must also be considered when:

Climbing ladders or entering confined space.

Jumping, reaching, or extending beyond routine walking and arm motions. Permeation data should include the following:

- Chemical name;
- Breakthrough time (shows how soon the chemical permeates);
- Permeation rate (shows the rate that the chemical comes through);
- System sensitivity (allows comparison of test results from different laboratories);
- A citation that the data was obtained in accordance with ASTM Standard Test Method F739-85. If no data are provided or if the data lack any one of the above items, the manufacturer should be asked to supply the missing data. Manufacturers that provide only numerical or qualitative ratings must support their recommendations with complete test data.

Liquid penetration data should include a pass or fail determination for each chemical listed, and a citation that testing was conducted in accordance with ASTM Standard Test Method F903-86. Protective suits that are certified to NFPA 1991 or NFPA 1992 will meet all of the above requirements.

Particulate penetration data should show some measure of material efficiency in preventing particulate penetration in terms of particulate type or size and percentage held out. Unfortunately, no standard tests are available in this area and end users may have little basis for company products.

Suit materials which show no breakthrough or no penetration to a large number of chemicals are likely to have a broad range of chemical resistance. Breakthrough times greater than one hour are usually considered to be an indication of acceptable performance. Manufacturers should provide data on the ASTM Standard Guide F1001-86 chemicals. Manufacturers should also provide test data on other chemicals as well. If there are specific chemicals within your operating area that have not been tested, ask the manufacturer for test data on these chemicals.

THE ELEMENTS OF THE PPE PROGRAM

PPE selection based upon site hazards: Pre-Entry Hazard Analysis to enter an atmosphere above the PEL and for entry into a hot zone.

Selection of the proper PPE ensemble to meet the hazards, risks, and threats existing in the hot zone

Buddy system and PPE readiness review of entry Incident Action Plan objectives, safety plan, and a review of emergency communica-

tions. The physical and mental readiness, as well as hydration, of the entry team to enter the hot zone are also priorities.

IC approval to enter the hot zone with an Incident Action Plan describing the entry objective(s) designed to be accomplished within 10 minutes of entry time (or in a timeframe consistent with air bottle time and personnel readiness training limits); and IC or Safety Officer monitoring of on-air time while in the hot zone, and clarification of the Safety Plan to include a review of the hand signals and other means of communications prior to entry

WHILE IN THE HOT ZONE

Visual, verbal, and/or tag line communications between entry team, back-up, and the Incident Commander,

Decon, medical evaluation, and rehab (hydration) upon leaving the Hot Zone.

Pre- and post-entry briefing: Prior to entry into the Hot Zone, the Incident Commander must be assured that the Entry Team is briefed as defined in the PPE standard of operation.

Work mission duration: The work mission will be defined within an Incident Action Plan approved for implementation by the Incident Commander. The entry time will be monitored, especially for on-air time (SCBA). The maximum working time within the Hot Zone must be 15 minutes or less. The work mission will be described, assuring that the dexterity and construction of the PPE entry suit is within safe standards to minimize damage to the suit.

PPE Procedures not discussed in this document: The code requirements that govern the use of PPE during a hazmat emergency are clearly defined within the 29 CFR 1910.120 requirements, and within the state-adopted safety requirements that fulfill the OSHA requirements in 1910.120. The following is a list of the subject matter NOT specifically covered within this document:

- PPE maintenance and storage
- PPE decontamination and disposal
- PPE training and proper fitting
- PPE donning and doffing procedures
- PPE inspection procedures
- Evaluation of program effectiveness
- Limitation due to external or medical conditions
- 1910.134 Respiratory program requirements

CONCLUDING RECOMMENDATIONS:

The evidence provided within this document clearly supports the ASTI recommendation to provide more alternatives for PPE choice when working in lower than 15,000 PPM of ammonia vapor (with no aerosol cloud greater than 3 cubic feet within the entry hot zone). The criteria described within this document define the conditions by which the PPE judgment can be made by the Incident Commander to vary from the existing standard of wearing Level A fully encapsulated entry suits for ANY release that exceeds 5,000 PPM.

ASTI has provided evidence and related experiences that show that alternative levels of PPE (other than Level A) provide protection to the responder and an overall improvement of the health and safety concerns, especially when the risks and threats of wearing Level A ensembles are considered.

The improved timeframe and availability of alternative PPE choices described within this document will provide first responders with the ability to engage rapid entry rescue, a defensive mitigation strategy, and control small releases before they have time to develop into major life threatening events.

TECHNICAL ADVISORS AND TRAINING EXPERIENCES USED TO CREATE THE SUBSTANCE OF THIS DOCUMENT:

ASTI conducts a 32-hour course on advanced subject matter related to managing ammonia emergencies. In October 2010 and November 2011, the subject of personal protective equipment was evaluated by testimony from experts from OSHA, Department of Homeland Security, Center for Toxicology and Environmental Health, and EPA. Kent Anderson, Vice Chair of the ASTI Board of Directors and President Emeritus of the International Institute of Ammonia Refrigeration (M_Kent_Anderson@att.net), played a big role in bringing these players together and has made connections to pave the way for ASTI to make the recommendations within this document. The following is a list of those who participated in the PPE evaluation conducted at the 32-Hour course. They suggested that ASTI create a technical document that would be peer reviewed to define the PPE recommendations contained herein. This document begins that process. ■

The documentation and planning forms originally presented with this technical paper and referenced in this issue of the Condenser are not reprinted here in the interest of space. To obtain these forms and learn more about the information discussed in this Technical Paper, contact Gary Smith at asti@ammonia-safety.com.

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AMMONIA REFRIGERATION FOUNDATION

ARF Targets $3 Million Funding Goal Amid Leadership Transitions

BY ANDREA FISCHER

The Ammonia Refrigeration Foundation (ARF), the research and education foundation organized by IIAR, said it was on track to complete new research projects, award scholarships and raise existing funding levels this year.

"ARF projects allow us as an industry to go after the issues that are faced by a broad cross-section of our market, issues that we all have interest in resolving, but may not individually have the resources to address," said ARF Executive Director Tim Facius. "The research we sponsor answers some of the big questions in our industry, and the scholarships we award will become an investment in the future of the industrial refrigeration industry."

Currently, ARF is focusing on finding new ways to bolster its funding efforts so that it can continue to support those two initiatives, research and education, said Facius. The foundation, which has already successfully collected over $1.25 million dollars in contributions, announced that its next funding goal is to reach the $3 million level.

"This is a significant goal because it really will allow us to fund research at the level we want to reach. We always have a greater list of research projects that need to be done than can be accomplished with the funding we have," said Facius. "On an immediate basis, we prioritize the most urgent needs of the industry, but the greater the funds at our disposal in the future, the more projects we can complete."

Projects that have been recently completed by ARF include: a study that was co-funded with ASME on low temperature piping criteria; development of a bench test procedure for post-mortem testing of safety relief valves; a statistical analysis method for predictive valve replacement frequency; as well as a quantitative risk analysis for various ammonia release technologies. These research projects have each been the topic of workshop sessions at past IIAR Annual Conferences, and published papers on these topics are available in the IIAR e-Library. The Research Committee is in the process of working on software and other vehicles to enhance the availability of this work to the industry.

Meanwhile, additional projects as recommended by the IIAR research committee are under review.

In a regulated environment, ARF's research goals make a lot of sense, because they allow the industry to structure operational parameters around proven concepts, said Facius.

"As an industry, we must take our practices beyond the 'this has worked in the past' mentality. Regulation is going to be based on standards, and documented proof of concept makes the best foundation for standards," he said. "We have to have a definitive understanding for why something works."

As ARF focuses on funding its new research goals, the organization is also going through several transitions, said Facius, including a complete leadership transition. Joe Mandato has just assumed the role of ARF Chairman, and Peter Spellar has assumed the role of Chairman, ARF Board of Trustees.

We are getting some excellent traction," he said, adding that past ARF leaders Adolfo Blasquez and those before him have set the organization up to grow in the next several years.

"We've got several excellent research projects lined up, we're working with targeted schools on our scholarship initiative, and we've formed a finance committee to focus on finding ways to expand the funding of our industry research goals."

"ARF is about thinking on a bigger scale," said Facius, who urged all IIAR members to find a way to contribute to the organization or get involved in its work. "By supporting ARF, you as a member help this organization make the advancements that benefit everyone." ■

To learn more, visit the ARF website at www.nh3foundation.org.

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

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Understanding the Importance of Passivation

from the technical DIRECTOR

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

In recent years, the quality of the circulated water in evaporative condensers and cooling towers has declined as air and water pollution has increased. As regulations limit the use of many corrosion inhibitors for the hot dip galvanizing process, such as chromates, the passivation process for protection has become even more critical.

Passivation is a treatment process that forms a very thin protective layer that reduces chemical activity with air and water or other material that comes into contact with a surface. The passivation process varies depending on the type of material to be protected and the substances with which they contact. The most common circumstance in industrial refrigeration is passivation for coils and casings for evaporative condensers and cooling towers. Passivation provides maximum protection from corrosion on newly installed evaporative condensers and cooling towers that have hot dipped galvanized steel tube coil surfaces. Hot dip galvanizing produces a coating of zinc-iron intermetallic alloy layers on steel with the outer layer being purely zinc. The zinc provides cathodic (sacrificial) protection and a physical barrier protection. Passivation helps prevent the development of corrosion that could result in rapid penetration through the zinc coating to the steel. If the corrosion makes it entirely through the protective coating to the carbon steel condenser tubes, they will rapidly corrode. Note that fouling material, such as scale or white rust on the tubes can hide corrosion on the surface of the tubes. Corrosion control of galvanized steel depends on forming and maintaining a stable and passive oxide layer on the surface of the galvanized steel during the installation of the equipment.

Passivation is a chemical process that forms a metal oxide bond that enhances the original corrosion resistant, hot dipped galvanized surface by forming a thin transparent oxide coating. It dissolves any embedded or slightly rubbed-in iron pick-up on the surface, and reduces the transport of corrosive elements to the underlying metal surfaces.

It is important that proper precautions are planned and taken for passivation when a new condenser or tower with hot dip galvanized tubes is installed. The passivation must take place prior to start up with a full heat load. The heat load should be avoided since water evaporation can concentrate corrosive ions and increase the pH and fouling potential.

Water quality varies by location, so passivation must be performed on site and cannot be done at the factory. Many contractors will not accept responsibility for passivation because water treatment is an ongoing process that is the responsibility of the owner. It is important to develop a schedule, early in the startup process, that includes time to involve a qualified water treatment provider to minimize problems and optimize the investment. The passivation process can take weeks or months (typically 6 to 8 weeks or even more in some locations). For a quality assurance check on your water treatment service provider, have the company provide references for which equipment they have successfully passivated and have them provide and explain the passivation process they will use to service your equipment. Hold the company accountable as the expert to provide the passivation process, even if they have to get the process details from the manufacturer. Make sure they have enough insurance in case an unfortunate situation occurs while your equipment is in their hands. Passivation must extend the life of the galvanized protective coating on the tubes and not damage it in anyway. If an onsite water treatment provider is currently servicing existing similar equipment at your facility, it is best if they provide a proven passivation process for your new equipment.

It is also important to have a good preventive maintenance program for existing equipment that checks the conditions of the tubes early enough to consider enhanced water treatment, re-passivation, or the scheduling of equipment replacement before it becomes a risk for a refrigerant release. Typically, condenser or cooling tower replacement projects need to start at least six months in advance to insure the involvement of a qualified water treatment company. If the project schedule gets too crunched, the passivation process is at risk of elimination because the new unit will need to be on line as quickly as possible. A sign that the passivation process is successful and completed is when the new shiny zinc coating on the tube surfaces turns to a dull gray color.

The target life expectancy of a newly installed condenser should be a minimum of fifteen years with a stretch target of up to twenty-five years. It is noteworthy that some condensers are still in operation after more than forty years. When originally purchased, these condensers likely had chromate corrosion inhibitors applied as part of the hot dipped galvanizing process and the galvanizing itself was likely thicker. If a new condenser is installed without passivation, the tubes may only last from five to fifteen years. This quickly identifies passivation as a great investment to optimize your equipment's life expectancy. ■

The IIAR acknowledges Tony Lundell, IIAR Associate Technical Director, for the content of this article.

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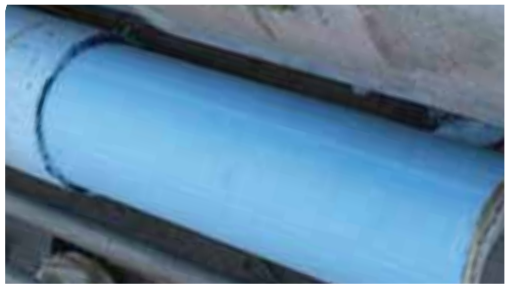

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