IIAR Code Advocacy Update

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Understanding NFPA 704 Placards and Their Use at Ammonia Refrigeration Facilities

Put yourself in the position of a firefighter. You've been dispatched to a reported structure fire in an industrial area. It's 3:00 a.m. Your engine rolls out the door, and in the distance, you see a glow in the sky. Experience has taught you that you're headed to a "working fire."

As you respond to the scene, a lot of thoughts are going through your mind…Are there people in the building that will need to be rescued? Where is the nearest fire hydrant? Will the structure be at risk of collapse as firefighting and rescue operations get underway? Are their hazardous chemicals in the building? These are just a few of the many questions that will need to be answered, and need to be answered quickly, as operations unfold at the scene. Good information about the facility will be essential in helping to ensure that responders are kept safe and can go home at the end of their shift without injury.

In progressive jurisdictions with adequate resources, industrial facilities may get "pre-planned" through on-site inspections and exercises that provide answers to questions about the building, its use and emergency response tactics before an incident occurs. Nevertheless, pre-plans, even when they have been performed, cannot be exclusively relied upon to ensure the safety of responders. Sometimes, responders come from neighboring districts or jurisdictions or they may be volunteer or part-time personnel who have not had an opportunity to see a facility before an incident occurs.

When it comes to hazardous materials, it is essential that responders be provided with a posted warning about the types of materials that are present in buildings and outdoor areas so that appropriate precautions can be taken, and for more than 50 years, the recognized means of providing this notification has been placards that comply with National Fire Protection Standard NFPA 704.

NFPA 704 – What's It All About?

NFPA 704 originated in 1957, but development work on the document, which was initially oriented towards flammable liquids, goes back to the early-1950s. The purpose of the document is to:

> *"…provide a simple, readily recognized, and easily understood system of markings that provides a general idea of the hazards of a material and the severity of these hazards as they relate to emergency response."*

The purpose statement is enhanced by several stated objectives, two of which are:

(1) To provide an appropriate signal or alert and on-the-spot information to safeguard the lives of both public and private emergency response personnel, and

(2) To assist in planning for effective fire and emergency control operations, including cleanup.

It's pretty clear from reading these extracts that NFPA 704 is not intended to serve as a basis of regulation with respect to how buildings or facilities are built, and for the most part, codes and standards recognize this by limiting application of NFPA 704 to prescribing requirements for warning placards. Notable exceptions are the International Fire Code and the NFPA Uniform Fire Code, which base a limited number of hazardous materials regulations on NFPA 704 ratings. However, none of these regulations affects ammonia refrigeration.

Compliance with NFPA 704 results in the placement of one or more placards that contain four quadrants, each having a different color, and most containing a number that indicates a relative level of hazard. Hazards are ranked numerically from 0 to 4, with 0 indicating no hazard and 4 indicating the greatest hazard (See Figure 1).

The convention provides for the following:

- BLUE quadrant to reflect health hazards
- RED quadrant to reflect flammability hazards
- YELLOW quadrant to reflect instability hazards
- WHITE quadrant to reflect special hazards, such as water reactivity and oxidizing potential, when applicable.

Figure 1. NFPA 704 Hazard Classification System

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The white box will occasionally be found with "COR" or an image representing corrosivity to indicate the presence of corrosive chemicals, but this is not currently specified by or consistent with NFPA 704. NFPA 704 factors in corrosivity as part of the health rating. "SA" may also appear in this quadrant to indicate the presence of a simple asphyxiant gas (specifically limited to nitrogen, helium, neon, argon, krypton, and xenon).

The rating system used by NFPA 704 is not an exact science. On the contrary, the Section 4.2 acknowledges that subjective, but informed, decisions are needed to apply the standard. Section 4.2 also advises that proper ranking of hazardous materials considers not only the properties of a material, but also the conditions associated with its storage or use.

> *4.2.1 The hazard evaluation required to determine the correct hazard ratings for a specific material shall be performed by persons who are technically competent and experienced in the interpretation of the hazard criteria set forth in this standard.*
>
> *4.2.2 Assignment of ratings shall be based on factors that encompass a knowledge of the inherent hazards of the material, including the extent of change in behavior to be anticipated under conditions of exposure to fire or fire control procedures.*
>
> *4.2.3 The system shall be based on relative rather than absolute values, requiring considerable judgment be exercised.*

NFPA 704 and Ammonia Refrigeration

Assessment of the hazard ranking for anhydrous ammonia is generally straightforward.

Health Classification: Anhydrous ammonia is corrosive to human tissue. NFPA 704 assigns corrosive chemicals a health hazard rating of "3."

Instability Classification: With respect to instability, NFPA's classification system focuses primarily on whether a material is inherently reactive or is reactive when subjected to changes in temperature, pressure or shock. As a general rule, the instability rating is not concerned with reactions between incompatible materials because it is assumed that incompatible materials will be appropriately segregated to prevent unintended mixing. The exceptions to this rule are materials classified as "oxidizer" or "water reactive," but those classifications are handled in the white "special hazards" quadrant of the placard.

As a stable chemical that is neither self reactive nor dangerously reactive to changes in pressure, shock or temperature, anhydrous ammonia is assigned a "0" for instability under NFPA 704.

Special Hazard Classification: Anhydrous ammonia is not classified as an oxidizer, is not a simple asphyxiant gas and is not typically regarded as water reactive under NFPA 704. Although liquid anhydrous ammonia can produce a vigorous exothermic reaction when mixed with water, the water-reactive warning under NFPA 704 is typically associated only with solid and liquid materials (not including liquefied compressed gases).

While application of water may not be the best approach to controlling some incidents in ammonia refrigeration facilities, the NFPA 704 "W" (avoid the use of water) warning would suggest that use of water as a fire suppression agent should be broadly avoided. In my experience, it's unusual for ammonia refrigeration facilities to be viewed in this manner, which is why the "W" isn't ordinarily found on placards at such facilities.

Flammability Classification: One aspect of the NFPA 704 classification for anhydrous ammonia that has been the subject of extensive debate for more than 15 years is the flammability classification. The debate is based on a lack of clear guidance in NFPA 704, which has resulted in varied opinions on the appropriate classification.

The debate originated in 1993, when a pair of code change proposals was submitted to the Uniform Fire Code by Dillon Consulting Engineers (Item 54-1994) and the Air Conditioning and Refrigeration Institute (Item 55-94). The Dillon proposal recommended that ammonia refrigerants be assigned a "3" for flammability. The ARI proposal recommended a "1" for flammability as a base requirement, with a footnote that increased the rating to "3" for indoor use conditions.

Having attended the meeting, I can recall an energetic discussion about whether it was appropriate for ammonia to have different classifications for indoor versus outdoor conditions, and in the end, the Uniform Fire Code Committee took a conservative approach, assigning a flammability rating of "3" for all cases (unfortunately, the official committee report for this meeting provided no specific justification for this decision). At the subsequent final-action hearing for the 1994 code development cycle, IIAR submitted a public comment recommending that a flammability designation of "1" be reinstated for outdoor conditions, but that recommendation was not accepted.

Figure 2. NFPA 704 Warning for Indoor Ammonia Refrigeration Equipment

Figure 3. NFPA 704 Warning for Outdoor Ammonia Refrigeration Equipment

The following year, IIAR and ARI jointly sponsored Item 44-95 as a second attempt to reinstate the flammability "1" designation for outdoor areas, and this time, the recommendation was approved. The amended requirement was then published in the 1997 edition of the Uniform Fire Code, and it has remained essentially unchanged ever since, except for having been relocated to Table 1103.1 of the International Mechanical Code (IMC).

Code history aside, it is understandable why the fire service supported the flammability "3" designation for ammonia refrigeration. The "3" reflects a reduction from the "4" classification assigned to typical flammable gases such as propane and hydrogen, and it puts indoor ammonia refrigeration on a par with storage and use of flammable liquids, which like ammonia, can be difficult to ignite where enough ventilation is provided. If the "1" classification were applied to indoor ammonia refrigeration, emergency responders would be led to believe that the fire risk is on a par with ordinary combustible materials and high-flashpoint liquids such as refrigerant oil. While that may be appropriate if adequate ventilation is provided, the "3" designation for indoor ammonia fosters a conservative approach to emergency incident management and tactics until the risk has been fully assessed and appropriately controlled.

ANSI/IIAR-2, Appendix L

When the 2008 edition of ANSI/IIAR-2 (with Addendum A), was published, Appendix L was included to provide guidance on signage to be applied to machinery room doors. In the initial printing, Appendix L illustrated the NFPA 704 warning placard with a "1" in the flammability hazard quadrant, which, as stated above, is inconsistent with the designation mandated by the IMC. Even though Appendix L is only an informational appendix and even though the designation is legally permitted to be other than "3" in jurisdictions that don't adopt the IMC, IIAR has chosen to issue an erratum and correct future printings so that illustration will be consistent with the IMC requirements. This will avoid misleading users of the standard who are working in jurisdictions that have adopted the IMC, which is the predominant mechanical code in the United States.

Conclusion

In most cases, NFPA 704 classifications are assigned based on the subjective judgment of persons knowledgeable in hazardous materials. However, in the case of ammonia refrigeration systems, IMC Table 1103.1 has codified the classifications by formally assigning health, fire and instability ratings of 3-3-0 (Figure 2) for indoor installations and 3-1-0 (Figure 3) for outdoor installations.

It's important to note that the flammability "3" designation currently has no regulatory impact on machinery room design, building construction or equipment installation. Nevertheless, IIAR has been made aware of some negative consequences, such as occasional reports that fire departments won't participate in drills at ammonia refrigeration facilities. Education would appear to be the best tool in overcoming such situations, and IIAR provides regular training seminars for the fire service and others to help responders better understand the risks associated with ammonia refrigeration systems.

It is possible that IIAR will seek to change the IMC's flammability classification for ammonia in a future edition, but because the 2012 IMC is already finalized, the next opportunity for such a change will be the 2015 edition. In the meantime, owners have the option of submitting an appeal to the local code officials if there is a belief that the "3" flammability designation is believed to overstate the hazard at a particular facility.

Recognizing that the latest editions of IIAR-2 and model codes now provide significantly greater ventilation rates than those that were previously required and that detection, alarm and shutdown system requirements have been enhanced, all of which mitigate much of the risk of ammonia ignition in the event of a leak, there is certainly a basis for a discussion to take place on the appropriateness of the "3" flammability rating.