Response to Refrigerant Leaks Case Study: Queens Library, Langston Hughes Branch

By Lieutenant John C. Berna

It is hard to imagine a summer in New York City without air conditioning or a kitchen without a refrigerator to keep food and drinks cold. Thanks to modern refrigeration, air-conditioning and refrigeration units of all shapes, sizes and capacities, they have many commercial and residential uses today. When people think of refrigerants, they often think of the negative impact they can pose to the environment. They also may think about the newer, environmentally friendly alternatives or replacement refrigerants.

For the Firefighter and other first responders, all refrigerants present their own set of hazards. Today, due to changes in environmental laws and regulations, Firefighters must be aware of many different types of refrigerants. Using a case study of a recent and successful FDNY response and mitigation of a refrigeration leak, this article will provide those responding to a refrigeration leak or fire involving refrigerants a better understanding of the hazards, along with tactical considerations for use at these incidents.

Incident: Queens Library

On the afternoon of July 27, 2018, FDNY units were dispatched for a report of a refrigerant leak in the basement of 100-01 Northern Boulevard, the Langston Hughes branch of the Queens Library. Due to the extremely hot weather New York City was experiencing, the location had been serving as a designated "cooling center" for the communities of Corona and East Elmhurst.

On arrival, Engine 289, commanded by Captain Carmine Calderaro, and Ladder 138, led by Lieutenant Daniel Schweiger, preformed a size-up and were informed by library personnel and an air-conditioning repair technician that a refrigerant leak had occurred in the basement. The air-conditioning worker informed Ladder 138 that he believed he had the leak controlled. After ensuring all occupants were out of the structure, Ladder 138 entered the building to conduct a search of the basement and isolate and secure the air-conditioning unit by shutting power to the unit.

While responding, then-Battalion Chief Frank Leeb, Battalion 46, requested a Haz-Mat response and the assignment was upgraded to include Haz-Mat 1, Engine 274 and the Haz-Mat Battalion. When Chief Leeb arrived, Ladder 138 provided a progress report and began to vent the structure with the assistance of Ladder 154, commanded by Captain John Bradley. After speaking to the air-conditioning worker again, it was revealed that 20 or more pounds of R-407C were released into the basement with a system capacity of 125 pounds of refrigerant. Members on-scene researched Refrigerant R-407C and determined that this product was heavier than air. Based on this new information, Chief Leeb requested the response of a Ventilation Unit with Ladder 115 assigned.

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On the arrival of Haz-Mat 1 and Engine 274 (operating as the Haz-Mat Tech Engine), both units reported to Command and were provided an update of actions taken prior to their arrival. Haz-Mat 1 already had acquired the type of refrigerant (R-407C) prior to arriving. This prepared them to quickly make entry while metering for the specific product. On-scene members also had secured a container of the R-407C from the basement for analysis by Haz-Mat 1. This also provided confirmation of the released material. Members of Haz-Mat 1, commanded by Lieutenant John Berna, and Engine 274, led by Lieutenant Carlos Ruiz, entered the basement to confirm leak containment and meter for elevated levels of refrigerant. Within the basement, readings as high as 1,200 parts per million (PPM) were present, with varying readings found throughout.

With the building evacuated and the leak controlled, the final step was venting the structure to bring readings down to acceptable levels. Battalion Chief Michael Maiz, Haz-Mat Battalion, arrived and was provided an update. He then took over supervision of the Haz-Mat-trained units and the venting of the structure. Venting the basement presented some difficulties due to its size, configuration and lack of ventilation openings. Haz-Mat 1 members placed their large fan into operation, along with two large fans from Ladder 115, led by Lieutenant Arthur Markarian. Within an hour, readings were back to normal and the incident successfully concluded.

Response Considerations

Responses to air-conditioning and refrigeration leaks are not new to the FDNY. Refrigerant leaks often mistakenly are reported as a sprinkler activation or steam leak. This is especially true in areas of Manhattan where a large amount of steam is used. Members encountering a refrigerant leak unknowingly can walk through what they think is steam or water vapor and then realize it's the atomized carrier oil from a refrigeration leak. Members quickly can become dizzy, lightheaded and confused. If this takes place, the facepiece should be donned immediately and notification to the Officer must be made, with consideration of leaving the area.

Any responses for refrigeration and air-conditioning leaks or halon activations must begin with full bunker gear and the use of SCBA. First-due units should attempt to secure as much information as possible from a reliable source and ascertain: What type of refrigerant is leaking? What is the location of the leak (basement, upper floors, rooftop)? Has anyone been working on the system and, if so, is he/she accounted for? If possible, get a general description of what happened. Once entry is made, a quick primary search should be conducted of the area.

Depending on the meters available to your unit, instrumentation that detects oxygen levels is essential, as are meters that measure for flammables. The Altair, XAM 8000, TIF Freon detector and Bacharach refrigerant meter are all must-use instruments. While metering, the technique of placing the meter or probe low (at your feet), medium (about four feet from the ground) and high (over your heat at ceiling level) should be used. However, remember that almost all refrigerants are heavier than air, so concentrate on metering at floor level. Also, be cognizant of any oily surfaces on the floor or walls around the unit. Most likely, this is the fine mist that may be encountered by first-due units; namely, the atomized carrier oil, a telltale sign of a refrigeration leak.

History

Refrigeration is the simple process of drawing heat from a substance (a refrigerant) to lower its temperature. Before modern refrigeration, people stored food in cellars, wells, cold springs and underground caves. They also would cut blocks of ice and store them in insulated icehouses. These icehouses were very common until the advent of modern refrigeration in the 1920s.

Early forms of air conditioning were based on water flow. The Romans diverted the water from its aqueducts to flow through the walls of their homes. The ancient Chinese used hand fans as early as 3,000 years ago. Later on, buildings were designed to face windows away from the sun and toward prevailing winds, producing wind tunnels or wind towers as they once were called. Once electricity became readily available, fans became the choice for cooling, many times with a block of ice placed in front of the fan. Finally, in 1902, the first modern air conditioner was developed by American engineer Willis Carrier from New York.

Early refrigerants included ammonia (NH_3), sulfur dioxide (SO_2), carbon dioxide (CO_2), methyl chloride (CH_3Cl) and propane (C_3H_8). These refrigerants possess their own unique dangers, such as toxicity, flammability, asphyxiation and corrosiveness. Several fatal accidents occurred in the 1920s because of methyl chloride leakage from refrigerators. People began to leave their refrigerators outside the home. These dangers prompted companies such as Frigidaire, General Motors and DuPont to search for a less dangerous method of refrigeration.

In the 1930s, DuPont developed Freon, which is a registered trade name. It is colorless, odorless, non-flammable and non-corrosive. They are chlorofluorocarbon (CFC) and hydrochlorofluorocarbon (HCFC) refrigerants, meaning they consist of a carbon and/or hydrogen bond, with the addition of one or more halogens (chlorine, fluorine and bromine). Upon their development, these halogenated hydrocarbons as they are called, were and still are used in air-conditioning, refrigeration and some fire extinguishing systems such as halon.

Photo 1–Container taken from basement to confirm refrigerant.

In the early 1970s, it was discovered that halogenated hydrocarbons (Freons) when released into the air, destroyed the earth's ozone layer. It was time to develop a more environmentally friendly replacement. The other option was to revisit the use of the original refrigerants--ammonia, sulfur dioxide, carbon dioxide, propane etc. Both of these ideas have grabbed the attention of refrigerant producers.

Storage

Refrigerants usually are stored in cylinders/tanks; the cylinder is dependent on the specific refrigerant. The most common cylinder used by those in the refrigeration industry is the 20- or 30-lb., one-time use, low-pressure tank. These cylinders are similar in looks to a propane barbeque tank. They are short, with a rounded top and provided with a handhold. They have a rounded bottom and usually contain three protruding dimples to keep the rounded tank level when sitting in the ground (Photo 1). Freons and SUVAs (a DuPont trademarked chemical of hydrofluorocarbons) are stored in these tanks and used on smaller refrigeration units. An advantage to this type of cylinder is that there is abundant information printed on the cylinder itself. On the roadways, you will find refrigerants shipped by tractor trailers, intermodals and via rail. Small amounts used to recharge automobile air-conditioning units are found in 13-oz. cans.

Tactical Considerations

- Upon any indication of a refrigerant leak, immediately evacuate the building or area.
- Request a Haz-Mat response to ensure the response of Tech units with advanced metering capability.
- It is important to remember that neither engines nor ladders are equipped with meters that have the capability to detect most refrigerants.

Photo 2–Large air-conditioning system located in the basement of the library.

- Many chemicals are deadly at levels that would not result in a drop in oxygen on our meters.
- SCBA must be used prior to entry into the building or area of a reported leak.
- Frequently, the highest concentrations of refrigerants can be found in a remote location and not at the source of the leak once ventilation has been applied.
- Prior to re-occupying the building, all areas in and around the leak must be monitored.
- Ensure the response of EMS resources upon confirmation of a refrigerant leak.
- Consider the response of a RAC unit during extreme weather or long-duration incidents.
- Consider the response of a FAST unit.
- Consider the response of a Ventilation Support unit, especially for use in below-grade areas and when a chemical is heavier than air.

Most Widely Used Refrigerants and Their Associated Hazards

Freon—A family of refrigerants (R-12, R-22, R-502) developed by DuPont that are either chlorofluorocarbons (CFCs) or hydrochlorofluorocarbons (HCFCs), which are stable, moderately toxic and non-flammable gases or liquids. The major hazard lies in their ability to displace oxygen. Heating to approximately 400 degrees Fahrenheit, they break down, producing highly toxic phosgene gas. These refrigerants have been phased out due to their damaging effects on the earth's ozone layer.

SUVAs—Another DuPont trademarked chemical, hydrofluorocarbons (R-134A, SUVA-123), is a more environmentally friendly replacement to Freon. Used to replace R-12 in automobile air conditioners, it is mildly toxic and non-flammable. However, when mixed with air at high pressures, it can ignite. When heated to 482 degrees Fahrenheit, it produces deadly phosgene gas. SUVAs may cause blindness if it contacts the eyes and most importantly—similar to its predecessor--displaces oxygen. It is found at Madison Square Garden and the World Trade Center complex.

Propane—(R-290) has the advantage of reducing ozone depletion. It is non-toxic and extremely flammable and Firefighters should be aware that it is un-odorized when used as a refrigerant. It is found in some camper and RV air-conditioning units and is the refrigerant currently used in Coca-Cola vending machines. Its use is gaining popularity in large industrial refrigeration units.

Ammonia—This is the most widely used and oldest refrigerant in industry. It is making a comeback due to its environmentally friendly status. Ammonia is a colorless gas with a pungent odor, toxic by inhalation and though it does not meet the DOT standard of being a flammable gas, it should be treated as one. It also has the ability to penetrate bunker gear and burn the skin at higher concentrations. It is found throughout the City in cold storage units and ice-skating rinks.

Carbon Dioxide—(R-744) is a colorless, odorless gas that displaces oxygen. It is quickly becoming a popular choice for industrial refrigeration due to its limited effects on the environment. It operates under very high pressure and is more expensive to run the system than conventional refrigerants. It is used more in Europe and Asia than in the United States.

Conclusion

With the amount of research being done to find a more environmentally friendly, safe, economical and efficient refrigerant, coupled with the numerous types in use today, it must be mentioned that the dangers of refrigerants vary greatly. Recognizing the type is critical and should be noted in the Critical Information Dispatch System (CIDS). With older types of refrigerants being outlawed, systems are being retrofitted; hence, the dangers change. Preparing oneself with the proper protective clothing and wearing respiratory protection are mandatory at all refrigeration leaks and fires. Information gained at the scene should be transmitted to a Hazardous Materials Technician Unit or Haz-Mat 1, so that the associated dangers can be fully researched and tactical information can be transmitted to the Incident Commander (IC), bringing the incident to a safe and successful conclusion. ■

About the Author

Lieutenant John C. Berna has served the FDNY since 1989. He is assigned to Haz-Mat 1. Prior assignments include Ladder 142 and Squad 288 as a Firefighter and the Special Operations Command, Haz-Mat Operations and NYC Emergency Management (NYCEM) as a Lieutenant. He holds a BA degree from Dowling College. This is his second article for *WNYF*.