REFRIGERATION REVIEW

PREVENTING AMMONIA SPILLS BY PROPER DESIGN
DESIGNER OPTIONS THAT AFFECT SAFETY

In addition to taxes, there are two things you can count on when it comes to a refrigeration system: mechanical failure and human error. The impact of these two things can be reduced by the design of the refrigeration system. We will discuss seven designer options which greatly affect the safety of the refrigeration system.

OPTION #1 – VENTILATION

The first and foremost safety precaution, as previously mentioned, is ventilation. By code, machinery rooms need to be ventilated, and that ventilation should be placed in the proximity of where ammonia leaks will most likely occur – such as adjacent to recirculators, ammonia pumps, etc. The design of machinery rooms, particularly with high ceilings, provides the best means of dispersing the refrigerant and mixing it with fresh air. Large complex facilities should be equipped with portable fans and ventilation

hoses for moving air in and out of refrigerated rooms.

OPTION #2 – SYSTEM COMPONENT LOCATION

The refrigeration system component location is a major factor in determining where ammonia leaks occur in a refrigerated facility. When human error or mechanical failure occur, the location of the components of the system will generally determine how "bad" the leak is, or in most cases, whether an emergency will result.

The location of the machinery room itself is often a factor, and in some cases machinery rooms are operating completely surrounded by process areas or storage rooms. When this occurs, normal safety and mitigation procedures are often ineffective.

Machinery rooms should ALWAYS have at least one wall exposed to the "outside." A remote refrigeration machinery room provides the most effective way of implementing safe operating procedures. High ceilings provide an effective way for diffusion of leaks which may occur around components such as recirculating pumps. Many systems used "packaged horizontal" recirculators with hard-to-access recirculating pumps located in remote or low-ceiling areas. This makes routine maintenance very difficult.

Pipeline routing and installation techniques are a key to successful designs. The maintenance of pipe and pipe insulation are very important to an older plant, as replacement of fittings and insulation will become necessary. This

is particularly true of pipelines that fluctuate above 32°F and gradually rust, requiring maintenance. When these pipelines are placed in well-ventilated accessible places (such as on the roof), maintenance is a much easier task, and greatly reduces the risk to the spaces being refrigerated.

The same applies to air units. If they are located in a floor mounted position or ceiling mounted position, they are susceptible to human error or mechanical failure. The same space can be refrigerated by rooftop air units, and the air can then be transferred to the space being refrigerated and be evenly distributed. Rooftop units provide for easy maintenance, maintenance of valves, ease of cleaning, and enhanced safety without the need for fork trucks or catwalks for access. Processes such as freezing can be provided by air units that are located completely out of reach of materials handling equipment.

Evaporative condensers containing the "high pressure" side of the system can generally be located above a machinery room, making the diffusion of refrigerant easy, and damage from motor vehicles difficult.

In process facilities, the location of boilers, air compressors, and auxiliary equipment which could be a source of sparks or flames should be located in a separate room and not adjacent to the machinery room.

OPTION #3 – REFRIGERANT LIQUID PROTECTION

The most frequent cause of mechanical failure in both compressors and the

piping system is the conveying and handling of excess liquid refrigerant returning in suction lines. A positive means of transferring excess liquid to its proper place in a closed system is IMPERATIVE to safe operation of the refrigeration system. This is done with recirculated liquid by transfer solenoids.

We consider DX (direct expansion) systems high risk, particularly in process plants where loads fluctuate widely and maintenance of DX valves poses additional risk on cold, hard-to-access refrigerated spaces. The design of safe systems necessitates minimizing failures inside refrigerated areas. There are some designers still using high pressure "flooded" systems which pose serious safety implications by placing large quantities of refrigerant directly in closed spaces and also placing high pressure liquid lines in those same areas. The use of mechanical pumps in recirculated systems provides "low pressure" liquid in a form which can be readily turned off and contained.

OPTION #4 – OPERATOR SKILL LEVEL

The operator skill level should be considered by the designer as well as the owner's personnel. Most refrigerant accidents have occurred in old facilities. It has been our observation that failures decrease inversely with automation. Newer facilities have better safety controls, and even though they may be operating with less skilled operators, they will maintain better safety records than older facilities. Older facilities, in addition to having a high probability of mechanical failure, have less skilled operators than when

the system was originally installed. The less skilled operator quite often faces many system hazards such as "liquid slop over," valves that will not work, and corroded or broken pipe, and they are generally less prepared to handle a complicated emergency. Quite often it takes a jarring news story to increase our awareness for the need to modernize older facilities. Industry engineers and contractors alike need to "sell" new technology. We will continuously see regulatory codes and agencies such as OSHA and EPA reflect on older, unsafe systems as a benchmark for new system design.

OPTION #5 – SAFETY AWARENESS

The primary means of providing good risk management includes safety awareness in procedures and safety equipment.

Bulletins and courses are available. RETA and IIAR provide service courses, and they have proven to be very successful, and continual programs of these types are one of the best means of providing new technology and safety information.

OPTION #6 – OPERATING AND SAFETY DEVICES AND CONTROLS

This designer option includes electrically operated switches and relays actuated by pressure and float switches for maintaining safe operating conditions in the closed refrigeration system. In addition, adequate manual pressure gauges are needed to permit operators to monitor system pressures and operating conditions. Emergency shutoff stations (E-Stops) are essential to the system safety of machinery rooms.

All closed refrigeration systems are provided with safety relief valves. These are effective on occasions where discharge pressure safety devices fail to turn off compressors. Refrigerant, by its nature, will "cool" itself upon release of pressure through relief valve vent lines. Dual relief valves afford additional emergency protection, should one relief open and not reseat. An auxiliary relief can be turned on for permanent protection.

New technology in data processing and energy management have provided new frontiers which also offer many safety advantages. Refrigeration systems utilizing computer technology will afford many opportunities to provide not only efficient systems, but good, safe systems, and systems easier to operate.

OPTION #7 – SYSTEM DECONTAMINATION

Another option is the handling of system decontamination. This includes removal of air from the refrigeration system, and oil used by the compressors. Generally, these functions are performed manually, however they can be automated very effectively. Automation of oil drain system, particularly in process plants, provides effective means of eliminating potential refrigerant exposure in closed refrigerated and process areas. These can be automated to periodically drain oil from process equipment such as freezing tunnels, plate freezers, and air units. An advantage of using ammonia as the refrigerant is that oil separates easily and can generally be drained from "low points" in the system.

Cleaning of coil surfaces is necessary and can be implemented much easier if the equipment is located on the roof. Removal of water from systems can be a more involved process, however small quantities of water generally pose no problem to ammonia refrigerants, and a trace of it is desirable in most cases.