

Safety and Hazards in the Refrigeration Industry

Robert D Heap MBE, F Inst R

President, Cambridge Refrigeration Technology

President, IIR Science and Technology Council

The scope of the refrigeration industry is outlined. It reaches into a huge range of fields we all encounter in our daily lives, particularly relating to food, health and comfort. It is unfortunately impossible for an industry as vast and various as the refrigeration industry to operate without accidents and fatalities, but it is important to place them in context. The refrigeration industry is relatively safe, and most of the hazards are common to many work situations, rather than specific to refrigeration. Statistical details of UK workplace accidents are summarised. Refrigeration is widespread and is generally not lethal, and with common sense and proper care, it should never be lethal.

THE REFRIGERATION INDUSTRY

The scope of the refrigeration industry is vast. It reaches into a huge range of fields we all encounter in our daily lives, particularly relating to food, health and comfort.

In this paper, the term “refrigeration” refers to all applications including air conditioning and heat pumps. Its scope was summarised in the IIR report to the Johannesburg world summit (1) as follows. Refrigeration:

- reduces post-harvest losses, preserves foods and makes it possible to provide the safe, wholesome food all consumers have the right to expect;
- plays a key role in the healthcare sector; safe vaccine storage, cryosurgery, and cryotherapy have been made possible by the advent of advanced refrigeration technology;
- promotes economic and social development in hot countries thanks to air-conditioning;
- is used in many industrial processes in the food, chemical, plastics and many other industries;
- can be used for heating; heat pumps provide energy-efficient heating using renewable heat sources and waste heat;
- enables liquid natural gas to be transported and stored;
- enables superconductivity to be applied in the medical field and other important applications.

The report estimated the annual investment in refrigerating equipment world wide at about USD 200 billion, with the value of refrigerated foodstuffs at least USD 1200 billion.

Refrigeration is responsible for the use of 15% to 25% of all electricity generated in developed countries. It provides a wide range of essential services to every modern community.

At home, the domestic refrigerator and freezer are obvious applications. Travelling to work, increasingly we use air conditioned vehicles. At work, offices may be air

conditioned, computer installations may need cooling, and drinks dispensers may be refrigerated. Refrigeration is also an integral part of many industrial processes.

We shop in air conditioned stores with refrigerated display cabinets containing perishable goods, many of which are brought from other continents in a chain of refrigerated transportation and storage. At leisure, pubs, clubs and restaurants need cooling for comfort, for drinks, and for safe storage of food. Swimming pools need dehumidification and ice rinks need freezing.

In sickness we need hospitals with air conditioned operating theatres and refrigerated blood banks, and even at death, refrigeration is to be found as an essential service to mortuaries. Refrigeration is a part of all aspects of our lives.

Domestic.

The domestic refrigerator has become an essential part of household equipment, especially for the storage of dairy products and prepared meals. The home freezer, either combined with the refrigerator or as a separate appliance, has made a considerable difference to shopping patterns. In total these appliances number about 36 million in the UK. The world market is for a further 64 million every year.

Commercial systems.

There are many applications within the group known as "small commercial units". This important sector includes commercial refrigerators and freezers in food outlets in pubs, hotels and restaurants, non-supermarket retail display cabinets, drinks coolers in shops and offices, various medical applications, small dehumidifiers and integral "through the wall" air conditioning units. There are about 4 million of these integral units in the UK. There are also some 300,000 distributed or "split" systems, including cellar coolers, small cold stores and bulk milk tanks.

Supermarkets generally have integrated systems and there are around 8,300 supermarkets in the UK, representing 7.2% of the world total. Frozen and chilled food cabinets, store air conditioning and "behind the scenes" cold stores are essential to enable the provision of the range of foodstuffs we have come to expect. The world's annual consumption of frozen and chilled foods is estimated at 350 million tonnes. There is also a large quantity of fresh produce, which needs refrigeration to maintain it in good condition.

Industry.

Many industrial sites use refrigeration as part of their processing, notably food and drink manufacturers and chemical and pharmaceutical works. In addition there are numerous cold storage facilities. There are about 2,000 UK sites representing large enterprises, and a further 13,000 in small to medium sized companies (SMEs). Many processes could not be carried out successfully without air conditioning of process areas.

Within this category there are specialist defence applications in warships and tanks, etc., details of which are seldom discussed for obvious reasons. Nevertheless it is clear that a modern defence system is as dependent on refrigeration as are many industrial processes.

Air conditioning.

There are about 400,000 UK installations of direct air conditioning systems and a further 20,000 indirect or secondary systems. These maintain comfort conditions and improve

productivity in offices, keep computers running more reliably, and generally make high rise development of city centres possible. Financial institutions and government departments are dependent on such systems. The scale of air conditioning is such that the worldwide capacity is around 1.7×10^{12} watts, or some 300 watts per person on the planet.

The same technology is used for heating-only heat pumps. These are devices which cool an external heat source such as water or air, and transfer the extracted heat to where it is needed. Although heat pumps are not strictly refrigeration, they should be included here. There are 1.5 million such units world wide, relatively few of which are in the UK.

Transport.

The local distribution of perishable foodstuffs requires refrigerated vehicles, and long distance transport of perishables is an international business in which UK companies have an appreciable stake. UNEP estimates suggest there are over a million refrigerated road vehicles, 400,000 refrigerated intermodal containers and 1,000 refrigerated ships in the world. This does not include large numbers of fishing vessels with refrigeration, or the many installations of air conditioning in cruise ships and crew quarters in cargo ships.

Mobile air conditioning.

Air conditioning is used in trains, coaches and aircraft. It is also being used increasingly in the UK in cars. Numbers are particularly difficult to obtain, but there are probably around 5 million air-conditioned cars on Britain's roads at present. Thought of as an unnecessary luxury until a few years ago, this is increasingly a standard item nowadays.

SAFETY AND HAZARDS

It is unfortunately impossible for an industry as vast and various as the refrigeration industry to operate without accidents and fatalities. The following papers today will discuss these in some detail, but it is important to place them in context. The refrigeration industry is relatively safe, and most of the hazards are common to many work situations, rather than specific to refrigeration. To justify this statement, it is necessary to look at some statistics. Unless stated otherwise, the statistics quoted below relate to the UK alone, and to reported data from all industries. More data is available from HSC (2).

Figures for 2001/2 show that 249 UK workers died from work related accidents, and 384 members of the public were killed due to industry related causes. (Figures for 2002/3 are lower by about 10%.) Of these 384, 295 were railway related (including trespasses and suicides) and of the remaining 89, 73 were in other service industries. There were 28383 major injuries to workers, 127989 lesser ("over-3-day") injuries to workers, and 14362 injuries to the public. This is in a population of 58.8 million. To put the deaths in context, there were about 3500 road deaths. Interestingly, the UK rate of workplace fatal injury (per 100000 workers or employees) at 1.9 is the lowest in Europe apart from Finland, and compares with an EU average of 3.6 and a USA figure of 2.7.

The types of common accident are identified in table 1. These show that the majority of injuries are a consequence of mechanical tasks which are not industry specific. Injury data is broken down by industrial classifications, including the following:

- agriculture, hunting, forestry and fishing
- extractive and utility supply industries
- manufacturing
- service industries
- education
- health and social work.

This classification includes many applications of refrigeration, but refrigeration is not identified separately.

	Fatal accidents to workers	Major injuries to employees	Over-3-day injuries to employees
Falls from a height	68	3996	-
Slips and trips, falls on the same level	-	10118	29509
Struck by moving/falling object	43	3993	16008
Injured while handling, lifting or carrying	-	2809	48000
Trapped by something collapsing/overturning	8	-	-
Struck by a moving vehicle	40	722	2085
Other	90	5839	31482
Total workers/employees	249	27477	127084

Table 1, Reported UK injuries to workers/employees, 2001/2. In this data, the term “workers” includes both employees and the self-employed.

REFRIGERATION INDUSTRY HAZARDS

A recent paper (3) has considered available data on refrigeration accidents. The authors show that specific data is sparse, and that most accidents are not due to the refrigerant itself. It gives details of accidents in Sweden, which are well documented (Figure 1). In the period 1986-2001, there were 232 injuries and no deaths. For comparison purposes, it may be noted that Sweden has a population of 8.83 million, and has 5600 certified refrigerant handlers. The study also shows details of some specific accidents, and includes a good bibliography. It concludes that the risks with working with refrigeration equipment are not primarily connected to the refrigerant, but are mostly hazards common to other branches of industry.

It is probable that most accidents in the refrigeration industry worldwide follow the Swedish pattern, and are attributable to mechanical or general causes. These include some that will be considered specifically today by the speakers who follow; accidents to eyes, electrocution, erection and dismantling of equipment and structures.

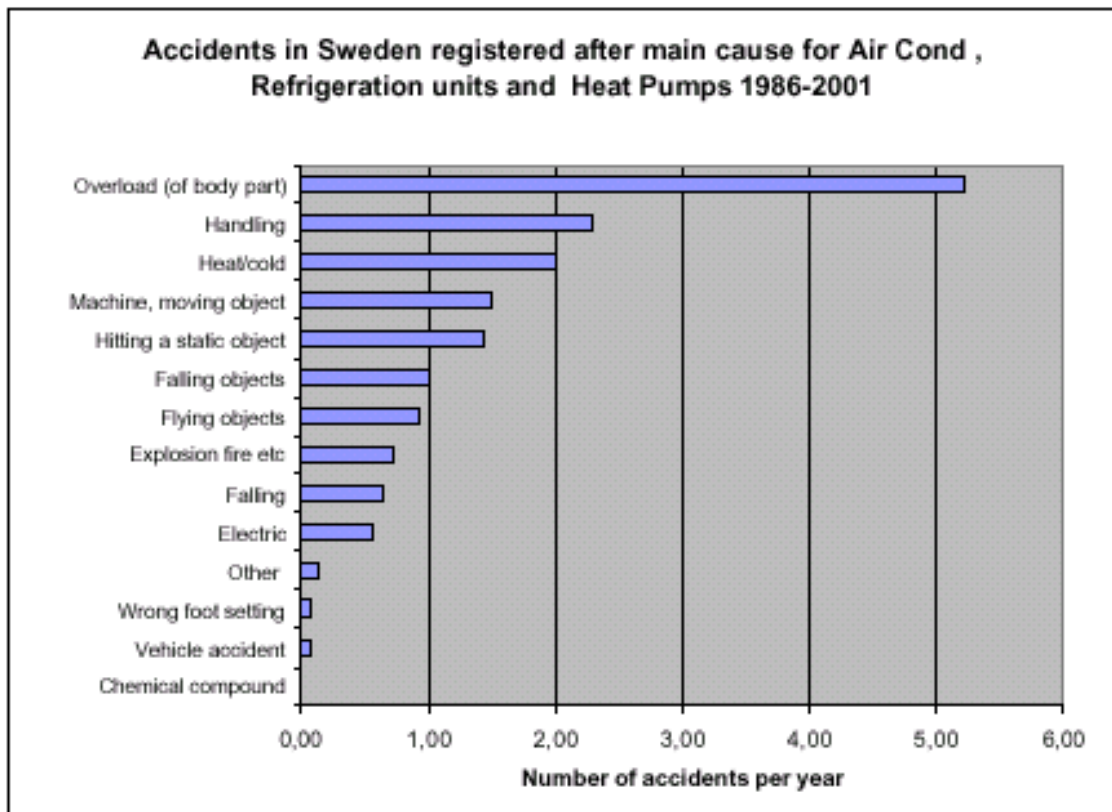


Figure 1. Causes of refrigeration accidents in Sweden 1986-2001.

There are some accidents more directly connected to refrigeration per se, which are hidden within the “other” category in Table 1. These include pressure explosions and refrigerant vapour explosions, asphyxiation risks (from virtually all refrigerants), and specific hazards of refrigerant decomposition products. There are also the microbiological consequences of inadequate maintenance leading to legionnaires disease outbreaks, and of inadequate refrigeration of chilled foods leading to food poisoning.

It is important that we consider these hazards carefully, hence the conference today. In doing so, though, we must not lose sight of the facts that refrigeration is widespread and is generally not lethal, and that, with common sense and proper care, it should never be lethal.

Proper care involves proper education and training of those who work with refrigerants and refrigeration systems, and this will be encouraged by the mandatory registration of refrigerant handlers. ACRIB has presented the UK Government with proposals (4) and awaits the outcome. Despite many delays, I am sure this or a similar scheme will be in place sometime within the next three years, and it will help to keep refrigeration related accidents at a low level. Training is not considered explicitly in this conference, but it is implicit in many of the papers and must not be ignored. Indeed, the content of today’s papers could well be the basis of a module in a fuller training course.

As was stated previously, the refrigeration industry is relatively safe, but to help keep it so it is now time to hear about the things that can go wrong on those few occasions when it really is lethal refrigeration.

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