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UNIFIED FACILITIES CRITERIA (UFC)

DESIGN: REFRIGERATION SYSTEMS FOR COLD STORAGE

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UNIFIED FACILITIES CRITERIA (UFC)

DESIGN: REFRIGERATION SYSTEMS FOR COLD STORAGE

U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING COMMAND (Preparing Activity)

AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

Record of Changes (changes are indicated by **1**\ ... /**1**/)

Change No.	**Date**	**Location**

This UFC supersedes NAVFAC Design Manual 3.04 Refrigerated Systems for Cold Storage dated 1 Aug 1986.

FOREWORD

The Unified Facilities Criteria (UFC) system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with USD(AT&L) Memorandum dated 29 May 2002. UFC will be used for all DoD projects and work for other customers where appropriate. All construction outside of the United States is also governed by Status of forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA.) Therefore, the acquisition team must ensure compliance with the more stringent of the UFC, the SOFA, the HNFA, and the BIA, as applicable.

UFC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing technical criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Command (NAVFAC), and Air Force Civil Engineer Support Agency (AFCESA) are responsible for administration of the UFC system. Defense agencies should contact the preparing service for document interpretation and improvements. Technical content of UFC is the responsibility of the cognizant DoD working group. Recommended changes with supporting rationale should be sent to the respective service proponent office by the following electronic form: Criteria Change Request (CCR). The form is also accessible from the Internet sites listed below.

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- Whole Building Design Guide web site http://dod.wbdg.org/.

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CHAPTER 1

INTRODUCTION

1-1 **PURPOSE AND SCOPE**. This UFC provides general criteria for the design of new refrigeration systems for cold storage. This document, and all references contained herein, provides guidance to the DOD. They may also be useful to commercial firms engaged in the design and construction of refrigeration systems for cold storage for DOD facilities.

Note that this document does not constitute a detailed technical design, maintenance or operations manual. Rather, its purpose is to identify and utilize the most appropriate Non-Governmental Standards (NGS) by specifying the refrigeration industry codes and standards that best apply, and to include the Tri-service's specific requirements.

1-2 **BACKGROUND**. The purpose of refrigerated systems for cold storage is to maintain or extend product life. Refrigeration systems for cold storage are applied to processing, manufacturing, and warehousing food, biomedical materials, ice manufacture, and other uses; but the largest application is for the refrigeration and freezing of foods. Refrigerated systems provide much lower temperatures than comfort air conditioning systems. The design, selection, and construction of a refrigeration system is different and can be more intensive than that for a comfort air conditioning system. For this reason, the refrigeration industry has evolved into a separate and distinct industry.

1-3 **PRIMARY VOLUNTARY CONSENSUS STANDARD REFERENCE**. This UFC adopts the latest edition of American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc. (ASHRAE) Publications listed below as the primary voluntary consensus standard for the Tri-services refrigeration systems for cold storage.

- *ASHRAE Handbook Refrigeration*

1-4 **SECONDARY VOLUNTARY CONSENSUS STANDARD REFERENCES**. This UFC adopts the latest edition of the standards listed below as the secondary voluntary consensus standard for the Tri-services refrigeration systems for cold storage. ASHRAE Standards encompass halocarbon and ammonia refrigeration systems. International Institute of Ammonia Refrigeration (IIAR) refers to ammonia systems exclusively.

- *ASHRAE 15*
- *ASHRAE Handbook Applications*
- *ASHRAE Handbook Fundamentals*
- *ASHRAE Handbook HVAC Equipment and Systems*
- *ANSI/IIAR STANDARD 2*

- *IIAR Ammonia Refrigeration Piping Handbook*

1-5 **CONFLICTS IN CRITERIA**. If any conflicts arise between the service's safety criteria and *ASHRAE 15,* the most stringent requirement shall prevail. If a facility is located off of military owned sites, where local jurisdictional authority has control and code requirements that are more stringent than those herein, the local jurisdictional authority will prevail.

1-6 **SUSTAINABLE DESIGN**. It is the policy of the tri-services to incorporate sustainability concepts in the design of all facilities and infrastructure projects to the fullest extent possible, consistent with budget constraints and customer requirements. This policy applies to renovations and alteration projects as well as new construction; applies to projects regardless of funding source or amount; applies to projects for all customers; and applies to design associated with all procurement methods, including design/build. For further information, see NAVFAC Planning and Design policy Statements PDP 98-01, 98-02, 98-03 on the Construction Criteria Base (CCB) at http://www.ccb.org, and *Sustainable Design* at http://www.efdlant.navfac.navy.mil/lantops_04/designguides.htm. Also see Corps of Engineers ETL 1110-3-491, *Sustainable design for military facilities, at* http://www.ccb.org/.

1-7 **REFERENCES**. Refer to Appendix A for references applicable to this document.

1-8 **DEFINITIONS**

Azeotropic – A precise refrigerant mixture or blend of substances that has properties differing from either of the two constituents.

Design-Build – Contractor furnishes a designed and constructed facility, usually from a performance specification.

Direct Expansion System –- A refrigerant system that has the refrigerant entering an expansion valve and only vapor leaves the evaporator.

Glide – The absolute value of the difference between the starting and ending temperatures of a phase change process by a refrigerant.

Halocarbon – Refrigerant that is a hydrocarbon derivative that contain one or more of the halogens bromine, chlorine, fluorine, or iodine; hydrogen may also be present.

Liquid Recycle System – A refrigerant system that has liquid refrigerant in the evaporator in amounts larger than can be evaporated and obtains higher efficiencies due to higher heat transfer of wetted surfaces.

Plan and Specify – Engineering firm furnishes a design, then the design is competitively bid.

Owner – Tri-service arm having the responsibility of operating and maintaining the subject facility.

CHAPTER 2

REFRIGERATION SYSTEM DESIGN REQUIREMENTS

2-1 **GENERAL**. Design refrigerated systems for cold storage to provide safety, economy, and reliability. Refrigeration design is a specialized field. The design of cold storage refrigerated systems should be performed by an experienced refrigeration design engineer. A "plan and specify" or a "design-build" arrangement can perform the refrigeration design. Design-build has been the trend of the refrigeration industry.

In many cases, equipment manufacturers have significantly supported the refrigeration design.

2-2 **SAFETY**. Safety is paramount. Safety is critical in the design, construction and operation of refrigeration systems for cold storage, especially with ammonia systems. Refrigeration system's safety standards must meet *ASHRAE 15*. *ASHRAE 15* specifies safe design, construction, installation, and operation of refrigeration systems by establishing safeguards for life, limb, heath and property and prescribing safety standards. This includes, but is not limited to, occupancy classification, restriction on refrigeration use, installation restrictions, design and construction of equipment and systems, and operation and testing.

Consider equipment selection and its placement for safe accessible maintenance. A safety review of the engineered design and equipment layout is recommended with participation from the owner's site operations and maintenance (O&M) entities.

The designer is required to perform a system safety plan and hazard analysis. Personnel safety measures are required as part of the facility design. Refer to http://www.efdlant.navfac.navy.mil/lantops_04/designguides.htm. Hazardous substances requiring consideration may include, but are not limited, to the following:

- Ozone depleting gases
- Greenhouse gases
- Ammonia
- Pressurized gases
- Flammable gases
- Hazardous gases
- Hot gases and equipment
- Electrical power

2-3 **OPERATION AND MAINTENANCE**. Tri-service facilities do not perform the maintenance typical of commercial and industrial facilities. Participation of the site operations and maintenance entities in the design process is critical to a safely operated and maintained facility, plus helps to ensure a successful project. O&M entities will be interviewed up front in the "Charrette" stage of a refrigeration design project. Design charrettes are a key component in the initial stages of any project and should be required. The mechanical designers (specifically the lead mechanical engineer) involved in the refrigeration design should participate in the design charrette.

2-4 **ECONOMY**. Design systems to provide the lowest life-cycle cost with maximum energy efficiency and give special consideration to safety and low maintenance. As noted in Section 2-3, the maintaining of Tri-services facilities is not indicative of commercial and industrial facilities. Actual maintenance costs can be hidden and high. Therefore, a simple, high reliability design can be weighed greater than efficiency. Consider this in the life cycle analysis. Also, consider the impact of refrigerant phase-out and replacement costs, and OSHA Regulations (refer to Section 2-6.3.2) to the life cycle analysis of the refrigeration system.

2-5 **REFRIGERANT PHASE-OUT AND REPLACEMENT.** The phase-out schedule of refrigerants is briefly defined in the refrigerants chapter of the *ASHRAE Handbook Fundamentals.* This information can also be found at the United States Environmental Protection Agency's web site http://www.epa.gov/spdpublc/title6/phaseout/. Summarizing, the international treaty, Montreal Protocol, and its subsequent revisions control the ozone depleting substances including refrigerants. This treaty dictated complete cessation of the production of chlorofluorocarbons (CFC) in 1996 and halons in 1994. The treaty also dictated the phase-out of hydrochlorofluorocarbons (HCFC), including R-22, by reducing production of HCFC over the next 30 years, with production reduced to 10% by 2015 of 1996 reference production level, and complete cessation of HCFC production by 2030. HFC (including R-134a) are not regulated by the Montreal Protocol. Below are some of the primary phased out refrigerants that have replacements.

- R-12 (CFC) has been phased out and the designated replacement is 134a
- R-502 (contains CFC-115) has been phased out and the designated replacement is R-404a
- R-22 (HCFC) does not have a replacement at this writing and competes with ammonia (R-717). But with a 90% production decrease by the year 2015, R-22 can become cost prohibitive during its phase-out, similar to R-12.

2-6 **SYSTEM DESIGN AND SELECTION**. This section addresses the general requirements for the design and selection of a refrigerated system for cold storage. ASHRAE Standards are the basis for refrigeration system design, selection, installation, testing, and operating. For ammonia systems, the standards of the International Institute of Ammonia Refrigerators (IIAR) will apply, and if more stringent than ASHRAE Standards, IIAR will prevail.

2-6.1 **Facility Design**. Design new refrigerated facilities to meet the considerations for building design that are provided in the refrigerated facility design chapter of *ASHRAE Handbook Refrigeration.* Cold storage facilities held below freezing can cause under floor ice formation, resulting in floor upheaval. Design sub-floor freeze protection for facilities that are held below freezing, such as air duct systems, electrical heating systems, or heated pipe grids. These systems are detailed in the above-mentioned chapter. Comply with *ASHRAE 15* criteria, including equipment placement, ventilation design, door and passageway restrictions, refrigerant monitoring, open flame devices, pressure relief and purge piping, refrigerant piping, signs, self contained breathing apparatus (SCBA), and miscellaneous installation restrictions.

2-6.2 **Refrigeration Load**. Determine the refrigeration loads by the calculations in the Refrigeration Load chapter of *ASHRAE Handbook Refrigeration.*

2-6.3 **Refrigeration System Selection**. The primary selection of a refrigeration system, such as halocarbon or ammonia refrigerant, direct expansion or liquid recirculation, should be determined by life cycle cost analysis. Should a system be selected for a design because of other issues, such as safety, reliability, simplicity, the preference of the owner, and the recommendations of the design engineer, then the designer must clearly justify their selection in the project's design analysis, and include concurrence from the user and the funding agency.

Perform the design of the entire system, including pipe sizes and layout/slopes, based on guidance from ASHRAE. On the drawings, indicate that it will be the Contractor's responsibility to coordinate the pipe sizes and layout/slopes with the equipment and piping configurations to be provided. For small systems (systems with 1 or 2 compressors and 1 or 2 coolers; 1 compressor for each cooler), the designer may elect to show only the individual components and their relative layout or schematic with no pipe sizes or slopes. For these types of systems, it will be the Contractor's responsibility to submit shop drawings and calculations to completely define the entire system based on the equipment to be provided.

Refer to the *ASHRAE Handbook Refrigeration,* in the following chapters:

- Liquid Overfeed Systems
- System Practices of Halocarbon Refrigerants
- System Practices for Ammonia Refrigerant
- Secondary Coolants in Refrigeration Systems

2-6.3.1 **Refrigerants**. The selection of a refrigerant impacts the project economics and safety. The selection, design, construction, and operation of a refrigeration system must meet *ASHRAE 15*. Occupancy, and restrictions on refrigerant quantity and usage are also detailed on the drawings. Product, occupancy, or other criteria might require a "low-probability system" for the refrigeration system. Low-probability systems are designed so that if a leak occurred, the refrigerant cannot enter the occupied space. Most indirect systems are considered "low-probability systems".

An indirect system has a secondary coolant, such as brine, that is cooled or heated by the refrigeration system.

A comprehensive list of refrigerants and refrigerant blends are listed in Table 1 and Table 2 respectively of *ASHRAE 34.* The most common commercially available refrigerants for use in cold storage are ammonia (R-717) and the halocarbons (R-22, R-134a, R-404a, and R-507). R-404a is not recommended because it is a nonazeotropic mixture. A leak in a refrigeration system with a nonazeotropic mixture would change the composition resulting in a glide that would become unpredictable. A system leak could cause off performance that ultimately would require a complete refrigerant replacement. R-134a is not recommended for large capacity systems because the density is low and would require larger volume equipment. Ammonia is corrosive, hazardous, and can damage product when released in large quantities. But ammonia is considerably cheaper, much more efficient as a refrigerant, and has easier oil separation capabilities. Halocarbons have a lower toxicity limit than ammonia. All refrigerants can be injurious or even fatal in high enough concentrations and should be handled carefully. If ammonia is not ruled out as a refrigerant, the life cycle analysis will most likely suggest an ammonia system for large (typically above 464.5 square meters (5000 square feet)) cold storage refrigeration applications.

Selecting a refrigerant for cold storage design is a function of the refrigeration design temperature and the equipment available. Lubrication oil management becomes critical at lower temperatures, especially when the oil is lighter than the refrigerant. The application temperatures of refrigerants overlap, but the current trends are the following:

- Ammonia (R-717) and R-22 have similar temperature applications for approximately –34.4 degrees C (-30 degrees F) and above.

- R-507and R-404a have similar temperature applications for approximately – 60 degrees C to 0 degrees C (-76 degrees F to 32 degrees F)

- R-134a has temperature applications for approximately –17.8 degrees C (0 degrees F) and above.

2-6.3.1.1 **Ammonia**. Ammonia is a self-alarming substance that is distinguished by its pungent odor. Persons exposed to ammonia vapors well below the permanently damaging levels will not voluntarily stay in such areas. Flammability limits of ammonia at atmospheric pressure are at least 100 times greater than the amount willingly tolerated. An ammonia-air mixture in an iron flask does not ignite below 651.1degrees C (1204 degrees F). The US Department of Transportation classifies ammonia as a nonflammable compressed gas for the purpose of transportation. Ammonia is rated a Group B-2 in *ASHRAE 34;* that classifies ammonia as more toxic than most other refrigerants. Safety requirements are heightened for ammonia, thus the need for special care and attention to safety details in ammonia systems. Since ammonia is lighter than air, adequate ventilation is the best means of preventing accumulation. The challenge with ammonia is to control the magnitude of and promptly correct a leak, in order to avoid injury to people and damage to property and product. It is important that personnel understand the properties of ammonia and be thoroughly trained in its use and application.

2-6.3.1.2 **Halocarbons**. Halocarbons are halogenated hydrocarbons that contain one or more of the halides: chlorine, bromine, fluorine, or iodine. Halocarbons are typically rated a Group A-1 in *ASHRAE 34;* that is a lower toxicity and flammability than ammonia. Halocarbons are widely used because they are considered a safe approach to refrigeration. Economically, halocarbons are significantly more expensive and not as efficient as ammonia.

2-6.3.2 **Designed Mechanical Refrigeration Systems**. The selection and design of a mechanical refrigeration system should be economical, safe, reliable, and simple. A design should be indicative of the refrigeration industry's trends, with emphasis on simplicity and low maintenance. There are essentially two refrigerant system designs utilized in the cold storage refrigeration market, i.e., direct expansion and liquid recirculation. The dominant design is a field constructed ammonia liquid recirculation system utilizing screw compressors and evaporative condensers.

Large systems can have thousands of kilograms of refrigerant. If an ammonia refrigerant system exceeds 4536 kg (10,000 pounds) of ammonia, *OSHA 29 CFR 1910* requires implementing a Process Safety Management program (PSM) and a Risk Management Plan (RMP). This entails written procedures, environmental impact plan, etc. This would require staff and other operating requirements that can be very expensive to implement and maintain. There is an O&M savings incentive for ammonia refrigeration systems to contain less than 4536 kg (10,000 pounds) of ammonia. The owners of the larger refrigeration systems that have PSM programs try to mitigate safety incidences and their respective magnitude. There is a safety preference for refrigeration systems that contain the least amount of refrigerant to minimize the potential of a possible release. For these reasons, direct expansion systems are sometimes preferred rather than the more economical recirculation systems.

2-6.3.2.1 **Liquid Recirculation**. Liquid recirculation is the mechanical pumping, or gas pressure pumping arrangement, that forces liquid refrigerant into evaporators. More liquid is introduced into the evaporator than can be evaporated, usually by a factor of 3. This system requires additional pumping equipment, liquid-gas separation equipment, and significantly more refrigerant. The advantages of this system are realized during O&M. A liquid recirculation to direct expansion general comparison is as follows:

- higher initial capital investment
- contains a significantly larger amount of refrigerant (can be cost prohibitive with halocarbons)
- lower operating costs
- greater operating flexibility to control multiple temperate zones
- easier maintenance

- Halocarbon recirculation requires large oil separation systems due to much lower separation velocity than ammonia

2-6.3.2.2 **Direct Expansion**. Direct expansion is the introduction of refrigerant through an expansion device prior to the evaporator and only vapor leaves the evaporator. It is limited in low temperature applications. Ammonia direct expansion cannot perform much below –17.8 degrees C (0 degrees F) so is not applicable with freezers. A direct expansion to liquid recirculation general comparison is as follows:

- lower initial capital investment
- contain significantly less refrigerant
- high operating cost
- little operating flexibility
- difficult to balance
- compressor must be sized for the lowest temperature zone
- limited low temperature applications with ammonia

Direct expansion with ammonia has two notable maintaining concerns i.e., ammonia is abrasive for a refrigerant, and lubricating oil is not as miscible in ammonia as it is with halocarbons, leading to difficulties in maintaining oil recirculation in ammonia systems.

2-6.3.2.3 **Unitary System**. Unitary system is a packaged unit that is designed and built by a manufacturer; that includes retail display cases, walk-in storage coolers, household refrigerators and freezers, and commercial icemakers. Small refrigeration systems may have their design needs met with unitary systems. Unitary units are recommended for small applications due to the typical benefits over field-assembled units. These benefits are lower capital investment, higher reliability of factory assembled equipment, and comprehensive warranties.

2-6.4 **Equipment Selection**. The refrigeration industry relies heavily on equipment manufacturers. Refrigeration equipment manufacturers provide expertise and information regarding equipment and design. Finalizing the selection of equipment should be compatible with the equipment manufacturer's recommendations. Installing new technological advances in equipment is encouraged, but installing prototypes or new unproven technology is not recommended.

2-6.4.1 **Materials of Construction**. Most common ferrous and copper base metals can be used with halocarbons. Not recommended are magnesium, zinc, and aluminum alloys containing more than 2% magnesium in contact with the refrigerant. Most common ferrous metals can be used with ammonia. Copper and alloys containing copper, brass, or alloys containing copper in contact with the ammonia refrigerant should not be used.

Contractors often install halocarbon refrigerant systems with the more stringent ammonia specifications for construction efficiencies. Ammonia components are typically more expensive but some halocarbon systems can be competitive with the ammonia specified components by utilizing experienced ammonia installation technicians.

2-6.4.2 **Compressors**. Compressors are typically of two types: reciprocating and rotary (screw or scroll). Scroll compressors are limited to lower capacity halocarbon systems. Rotary screw and scroll are increasingly popular due to lower maintenance costs. Screw compressors dominate the refrigeration market. This is mainly due to their high reliability, usually capable of operating over 50,000 hours between overhauls, and the selection of capacities of commercially available equipment. Commercially available motor driven capacities range from 20 kilowatts (25 horsepower) to over 1250 kilowatts (1675 horsepower). The recommended compressor for refrigeration service is a screw type compressor that comes as a package unit. The screw compressor package units consist of screw compressor, motor, coupling, oil separator, local logic controller, oil pump and filter. Refer to *ASHRAE Handbook HVAC Systems and Equipment.*

2-6.4.3 **Condensers**. Condensers are air or water-cooled. Halocarbon systems are usually air cooled, but water-cooled units are available. Ammonia systems are more often water-cooled. Properly sized water-cooled condensers result in greater efficiency and lower compressor energy consumption. This is offset by considerably higher maintenance costs, water consumption, and more complex systems than air-cooled. Water-cooled condensers are normally used for larger systems. Refer to *ASHRAE Handbook HVAC Systems and Equipment.*

2-6.4.4 **Cooling Towers**. Cooling towers used for condensing refrigerants are typically the closed circuit evaporative type. Refer to *ASHRAE Handbook HVAC Systems and Equipment.*

2-6.4.5 **Liquid Coolers**. Liquid coolers are heat exchangers that are normally used as liquid chilling systems for secondary coolants. Refer to *ASHRAE Handbook HVAC Systems and Equipment.*

2-6.4.6 **Evaporators**. Evaporators are most commonly fan-coil assemblies of the blow through type using propeller direct drive fans. Coil material must be compatible with refrigerant used and the environment. Proper air distribution, location and quantity of evaporators depend on the load, size and layout of the refrigerated zone. Refer to *ASHRAE Handbook Refrigeration.*

2-6.4.7 **Piping Systems**. Refer to Pipes, Tubes, and Fittings, *ASHRAE Handbook HVAC Equipment and Systems.* Separate codes or standards as listed below govern specific systems.

- Refrigeration Piping: *ASME B31.5 Refrigerant Piping, ASHRAE 15, ASHRAE Handbook Refrigeration, ASHRAE Handbook HVAC Equipment and Systems,* and *IIAR Ammonia Refrigeration Piping Handbook.*

2-6.4.8 **Piping Insulation**. Refer to *ASHRAE Handbook Refrigeration* and *IIAR Ammonia Refrigeration Piping Handbook.*

2-6.5 **Control Systems**. Design control systems, including control software applications, with safety interlocks, alarms, and shutdowns. Provide programmable logic controller (PLC) based systems with ladder logic documentation. Alarms with automatic notification must be integrated. Automatic alarm notification should be first to the area supervisor onsite location. If no response, automatic alarm notification must notify the 24-hour watch. This can be accomplished via a dedicated telephone line.

Control systems, having communication and data logging, permit systems to operate at optimum conditions under transient load conditions. This should include staggered startup of multiple compressors and other refrigeration loads. Due to this, and stored product requirements, refrigerated control systems can become complicated. Recommend simple installations if at all possible. Basic control systems for an ammonia liquid recirculation system have approximately 100 input and output (I/O) signals. These include evaporator pressure regulation, backpressure regulation, capacity control, hot gas bypass, room temperature, and concrete slab temperature. Control system designs should be reviewed and approved by the local O&M entities.

Before application of energy management systems/load shedders to refrigeration systems, and related fans and pumps, the designer will ascertain that application will be neither conducive to equipment damage nor counterproductive. Safety trips, compressor slugging, freeze-ups, and loading of circuits may become more likely to occur.

2-6.6 **Defrosting**. Spaces maintained at 2 degrees C (35 degrees F) will be defrosted with ambient air. Spaces maintained below 2 degrees C (35 degrees F) will use either a hot-gas or electric-heat defrost system. For safety reasons, electric defrost should be avoided on ammonia systems. For a defrosting system, choose between a timer defrost controller or a demand defrost controller.

Timer defrosting is a time initiated and time terminated control method that has an adjustable defrost duration and number of cycles in a 24 hour period. The timer defrosting is the most common method of defrosting control. Winter and summer conditions require different defrost duration and cycles. Demand defrost is a defrosting control method initiated by measuring the air pressure drop across the coils. Demand defrost is a more efficient defrost control method.

2-6.7 **Seismic Zone Requirements**. The geographical location of a facility determines its seismic zone. The seismic zone locations have requirements for building design and restraint of equipment. Refrigeration facilities for cold storage must meet seismic design requirements. Refer to *TI-809-04 Seismic Design for Buildings* at http://www.ccb.org and the seismic and wind restraint design chapter of the *ASHRAE Handbook Applications.*

2-6.8 **Refrigerant Management.** The Air Force document *AF Refrigerant Management Handbook* may be of assistance during the preparation of a facility refrigerant conservation and replacement program. The handbook is available on CCB.

APPENDIX A

REFERENCES

GOVERNMENT PUBLICATIONS:

1. U.S. Government Printing Office

Superintendent of Documents
U.S Government Printing Office
P.O. Box 371954
Pittsburgh, PA 15250-7954

Environmental Protection Agency, AP-42, The Compilation of Air Pollutant Emission Factors

Code of Federal Regulations, Title 40, Protection of the Environment

2 U.S. Department of Defense (DOD)

U.S. Department of Defense

Department Of Defense
Plumbing MIL-HDBK-1003/1 (YD)

Corps of Engineers ETL 1110-3-491, Sustainable design for military facilities

Sustainable Design, NAVFAC Criteria Office

NAVFAC Planning and Design policy Statements PDP 98-01, 98-02, 98-03

Professional Services Guide, Naval Facilities Engineering Command, Atlantic Division

TI 809-04 Seismic Design for Buildings

UFGS 15652A Cold Storage Refrigeration Systems

Military Handbook 1008, Fire Protection for Facilities Engineering, Design, and Construction

AFCESA Refrigerant Management Handbook

3. Occupational Safety and Health Administration (OSHA)

U.S. Department of Labor Occupational Health and Safety Administration Office of Public Affairs (Room N3647) 200 Constitution Avenue Washington, D.C. 20210	OSHA Regulations Standard 29 CFR-1910

NON-GOVERNMENT PUBLICATIONS:

4. American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc. 1791 Tullie Circle, N.E. Atlanta, GA 30329	ASHRAE Handbook 2001 Fundamentals
	ASHRAE Handbook 2000 HVAC Equipment and Systems
	ASHRAE Handbook 1998 Refrigeration
	ASHRAE Handbook 1999 Applications
	ASHRAE STANDARD ANSI/ASHRAE 15-2001 Safety Code for Mechanical Refrigeration
	ASHRAE STANDARD ANSI/ASHRAE 34-92 Designation and Safety Classification of Refrigerants

5. American Society of Mechanical Engineers (ASME)

American Society of Mechanical Engineers 11 West 42nd Street New York, NY 10036	ASME Boiler and Pressure Vessel Code
	ASME B16.5, Pipe Flanges and Flanged Fittings
	ASME B31.1, ASME Code for Pressure Piping, Power Piping
	ASME B-31.5, Refrigeration Piping

6. American Society for Testing Materials (ASTM)

American Society for Testing Materials	ASTM B280, Copper for Refrigeration and Air Conditioning

7. International Institute of Ammonia Refrigeration (IIAR)

International Institute of Ammonia Refrigeration 1110 North Glebe Road, Suite 250 Arlington, VA 22201	ANSI/IIAR STANDARD 2-1999 Equipment, Design, and Installation of Ammonia Mechanical Refrigerated Systems IIAR Ammonia Refrigeration Piping Handbook

8. National Fire Protection Association (NFPA)

National Fire Protection Association Batterymarch Park Boston, MA 02110	NFPA-70, National Electrical Code