MANUALS – CORPS OF ENGINEERS
U.S. ARMY

EM 1110-345-163
20 JUN 61

ENGINEERING AND DESIGN

MECHANICAL REFRIGERATION AND VENTILATION IN COLD-STORAGE FACILITIES

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1. PURPOSE AND SCOPE. This manual covers the design of major mechanical equipment for cold-storage and meat-cutting facilities. The manual will be used by Division and District engineers.

2. REFERENCE. EM 1110-345-209, ENGINEERING AND DESIGN, COLD-STORAGE FACILITIES.

3. RESCISSION. Engineering Manual for Military Construction, Part V, Chapter 2, REFRIGERATION, Mechanical Design, July 1956 (EM 1110-345-163) (AFM 88-8, Chap. 2).

4. CRITERIA FOR COLD-STORAGE AND MEAT-CUTTING STRUCTURES. It is essential that EM 1110-345-209 be used in conjunction with this manual. EM 1110-345-209 covers basic siting considerations, layouts, structural and architectural design, building materials, and temperature and humidity requirements for cold-storage facilities.

5. GENERAL INSTRUCTIONS. Unusual and special conditions not covered by this manual will be referred to the Office of the Chief of Engineers, ATTN: ENGMC-EU. Refrigeration equipment will be fabricated, installed, and guaranteed in accordance with Guide Specification CE-302.01. Ventilating equipment will be fabricated, installed, and guaranteed in accordance with Guide Specification CE-301.08. All equipment will be simple to install and operate. The controls will be as simple as possible consistent with requirements and will conform to the standards of the Underwriters' Laboratories, Inc.

6. SELECTION OF EQUIPMENT.

a. Unit-Cooler and Compressor Size. In selecting unit coolers and compressors to balance the load and to insure a

defrosting cycle, sizing will be based on 16 hours of operating time.

b. Frozen-Food Storage Rooms. Unit coolers, with or without ducts, and steel-plate evaporators are the preferred types of cooling surfaces. Refrigerant evaporative temperatures will be held between -10 degrees and -12 degrees F., and air velocities will be kept as low as practicable, preferably 100 feet per minute or less. For defrosting of unit coolers, provision will be made for water spray or electric defrosting. Plate evaporators will be defrosted by manual scraping when required. The frozen-food product load will be based on the periodic delivery of 1,175 pounds of frozen food per 100 men at a mean temperature of 15 degrees F., and its subsequent cooling within 24 hours to 0 degrees F. For Air Force construction, unit coolers only will be used.

c. Cold-Storage Rooms Above Freezing. Ceiling-type unit coolers are recommended as evaporators for storage rooms to be held at temperatures from 32 degrees F. to 50 degrees F. Air velocities will be kept as low as practicable.

d. Meat-Cutting Plants.

(1) Refrigeration. Ceiling-type unit coolers will be used in all rooms requiring refrigeration. In rooms used for temporary storage of processed meat, evaporator coils will have sufficient capacity to lower the temperature of the meat from 45 degrees to 28 degrees F. within 10 hours.

(2) Ventilation. In the fat-rendering room, ventilation will be provided by a fan unit that will exhaust air from a hood over the kettles at a rate of approximately 12 air changes per hour. In meat-cutting rooms fresh air will be supplied at the rate of not less than 15 cubic feet per man per minute.

e. For Machinery Rooms. Ventilation will be provided in accordance with code requirements.

7. TECHNICAL CRITERIA FOR REFRIGERATION AND VENTILATION EQUIPMENT.

a. Design Computations. The constants, coefficients, and methods used in computing cooling loads will be obtained from the latest editions

of the American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc., Data Book on Air Conditioning and Refrigeration. Load computations will be prepared on any standard printed form employed by the refrigeration industry.

b. Equipment and Installation Codes and Standards. Machinery, material, equipment, and installation thereof will conform to the following codes and standards:

(1) Air Conditioning and Refrigeration Institute Standards.

(2) American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., Codes and Standards.

(3) American Standard ASA B9.1

(4) Air Moving and Air Conditioning Association, Inc., Standard 110.

c. Compressors. A maximum of three compressors will be provided except that in large depot-type facilities an additional compressor may be used if fully justified. Duplicate standby refrigeration compressors for the chill and freezer refrigeration systems will not be provided. However, one standby compressor may be provided for interchangeable use in either the chill or the freezer refrigeration system. Compressor auxiliary devices such as thermometers, gages, sight-glasses, dryers, bypass and other valves, and controls will be kept to the minimum essential number. Special care will be given to the standby compressor to avoid unnecessary duplication of such auxiliary devices. Central control boards and duplicate control or indication stations are not authorized. A wattmeter or other device for measuring power input will be provided so that plant efficiency may be determined. Piston speed of compressors will be limited to 875 feet per minute.

d. Air-Cooled Condensers. The use of complete factory-assembled air-cooled condensing units suitable for either exterior or interior installation will be considered for possible savings in machine-room space and installation costs. Air-cooled condensers will be

given full consideration in all climatic zones. In cold climates where outside cooling towers or evaporative condensers require auxiliary heating to prevent freezing, the use of air-cooled condensers will be studied carefully.

e. Evaporative Condensers and Water-Cooling Towers. Cooling towers or evaporative condensers will not be located within the building except in areas having such low winter temperatures that the indoor location is the most economical method of maintaining proper head pressures. In low-temperature climate, consideration will be given to outdoor evaporative condensers or water towers with sump tank located in machinery room. Water will drain from evaporative condensers or water tower to sump by gravity. Machinery room will not be enlarged to provide for sump tank, and the use of heating devices for outdoor installations is not authorized. Evaporative condensers and cooling towers will be provided with an adjustable water bleeder on discharge side of pump to minimize the deposit of salts and scale. Chemical treatment of the water to prevent fouling will be provided when necessary. Use of facilities of a company familiar with water treatment or consultation with a chemist on this problem is advisable for this aspect of operation.

f. Unit Coolers. Unless otherwise indicated on standard drawings, unit coolers will be installed near the ceiling, and whenever possible will be located above aisles in order to facilitate maintenance without disturbing the stored products. Air velocities will be kept as low as practicable. Where unit coolers are to be operated in rooms of 45 to 50 degrees F. and are connected to refrigerating systems of lower temperature, the unit-cooler temperature will be maintained in conjunction with the lower temperatures required for the other cooler rooms by means of a back-pressure regulating valve in the suction line leaving the coil.

g. Oil Separators. Oil separators will be provided in all cases where capacity modulation is required, and suitable provision will be made to insure that approximately the same temperatures are maintained in the receiver and oil separator. In no case will the oil-separator temperature be lower than that of the receiver.

h. Receivers. A refrigerant receiver used with an evaporative condenser will be installed as near to the evaporative condenser as practicable. The liquid lines connecting the condenser to the receiver generally will be at least as large as the receiver outlet and preferably one or two pipe sizes larger, but not larger than the hot gas line. The drain lines from the evaporative-condenser coils to the receiver will be sized for a velocity not in excess of 200 feet per minute at capacity operation, and will pitch down toward the receiver with a grade of not less than 1/4 inch per foot. Where the evaporative condenser is installed out of doors, the receiver will be adequately protected from solar radiation and, if necessary, the receiver will be properly insulated.

8. DEFROSTING.

a. Selection of Method. It is recommended that unit-cooler coils operating below 35 degrees F. be defrosted by means of water spray or electric defrosting. Glycol defrosting systems may be used on larger facilities provided their use can be fully justified. For unit-cooler coils operating at temperatures of 35 degrees F. or higher, automatic air defrosting is recommended. Air defrosting can be accomplished during the periods when refrigerant solenoid valves are shut and fans continue to operate.

b. Water Defrosting. Water supply and drain lines will be run to and from each unit cooler requiring water defrosting. Supply and drain lines within the refrigerated spaces will be adequately pitched to facilitate draining and to minimize fouling. Wherever possible, control valves for water defrosting will be located in spaces where the ambient temperature is 50 degrees F. or more. Drain lines from pan of unit cooler will be protected from freezing and will be properly trapped to prevent air backflow. Where the cold-water supply temperature is below 50 degrees F., suitable water-heating equipment will be provided for maintaining a supply temperature not less than 50 degrees F. In no case will either water supply or drain lines be installed in spaces where the temperature is below freezing.

c. Electric Defrosting. Electric defrosting systems may be used. Such a system will consist of an electric heater cable, electric timer, drain-pan heater when necessary, heating safety thermostat,

and electrical controls assembled as a unit compatible with the unit cooler. The liquid solenoid valve will be so installed as to be controlled automatically by the timer during defrosting period and to be controlled thermostatically by the refrigerated area during normal operation. Drain lines will be run from each unit-cooler pan requiring defrosting. Drain lines within the refrigerated spaces will be adequately pitched to facilitate draining and to minimize fouling. Electric drain-line heaters will be installed when required. Drain lines will be properly trapped to prevent air backflow.

9. WATER-SUPPLY CONSIDERATIONS. A study will be made of the water supply, taking into consideration cost, hardness, availability, and local regulations relative to its use, in order to determine whether or not evaporative condensers or cooling towers and water-softening equipment are required. When necessary in order to remove acidity or hardness and thereby prevent corrosion or scale, specifications will provide for a simple, economical water-treatment system, integrated with the cooling tower, evaporative condenser, or air washer. Suitable provisions may also be required to prevent the formation of algae and the accumulation of solids. Unless otherwise approved by the Chief of Engineers, or Headquarters, U. S. Air Force, condenser water will be conserved through the use of evaporative condensers or cooling towers. Where water is extremely critical, consideration will be given to the use of air-cooled condensing equipment.

FOR THE CHIEF OF ENGINEERS:

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