Preparing Activity: USACE Superseding
UFGS-23 63 00.00 10 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION 23 63 00.00

COLD STORAGE REFRIGERATION SYSTEMS

08/22

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COLD STORAGE REFRIGERATION SYSTEMS
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NOTE: This guide specification covers the requirements for refrigeration equipment for cold storage facilities.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 420	(2008) Performance Rating of Forced-Circulation Free-Delivery Unit Coolers for Refrigeration
AHRI 450	(2007) Water-Cooled Refrigerant Condensers, Remote Type
AHRI 490 I-P	(2011) Performance Rating of Remote Mechanical-Draft Evaporatively-Cooled Refrigerant Condensers
AHRI 700	(2016) Specifications for Fluorocarbon Refrigerants
AHRI 710 I-P	(2009) Performance Rating of Liquid-Line Driers
AHRI 711	(2009) Performance Rating of Liquid-Line Driers
AHRI 720	(2002) Refrigerant Access Valves and Hose Connectors
AHRI 750 I-P	(2016) Performance Rating of Thermostatic Refrigerant Expansion Valves
AHRI 751 SI	(2016) Performance Rating of Thermostatic Refrigerant Expansion Valves
ANSI/AHRI 460	(2005) Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers
ANSI/AHRI 495	(2005) Performance Rating of Refrigerant Liquid Receivers
ANSI/AHRI 510	(2006) Performance Rating of Positive Displacement Ammonia Compressors and Compressor Units
ANSI/AHRI 520	(2004) Performance Rating of Positive Displacement Condensing Units

ANSI/AHRI 760	(2014) Performance Rating of Solenoid Valves for Use With Volatile Refrigerants

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15 & 34	(2013) ASHRAE Standard 34-2016 Safety Standard for Refrigeration Systems/ASHRAE Standard 34-2016 Designation and Safety Classification of Refrigerants-ASHRAE Standard 34-2016
ASHRAE 17	(2022) Method of Testing Capacity of Thermostatic Refrigerant Expansion Valves
ASHRAE 23.1	(2019) Methods for Performance Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Temperatures of the Refrigerant
ASHRAE 64	(2020) Methods of Testing Remote Mechanical-Draft Evaporative Refrigerant Condensers

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2020) Scheme for the Identification of Piping Systems
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B31.1	(2022) Power Piping
ASME B31.5	(2022) Refrigeration Piping and Heat Transfer Components
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS BRH	(2007; 5th Ed) Brazing Handbook
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105/A105M	(2021) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A126	(2004; R 2019) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A181/A181M	(2014; R 2020) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A197/A197M	(2000; R 2019) Standard Specification for Cupola Malleable Iron
ASTM A234/A234M	(2023a) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A278/A278M	(2001; R 2020) Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 degrees F (350 degrees C)

ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A334/A334M	(2004a; R 2021) Standard Specification for Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B280	(2020) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM C534/C534M	(2023) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM D5864	(2011) Standard Test Method for Determining Aerobic Aquatic Biodegradation of Lubricants or Their Components
ASTM D6081	(1998; R 2014) Aquatic Toxicity Testing of Lubricants: Sample Preparation and Results Interpretation
ASTM F104	(2011; R 2020) Standard Classification System for Nonmetallic Gasket Materials

COOLING TECHNOLOGY INSTITUTE (CTI)

CTI ATC-105	(2000) Acceptance Test Code

INTERNATIONAL INSTITUTE OF AMMONIA REFRIGERATION (IIAR)

IIAR 2	(2021) Standard for Design of Safe Closed-Circuit Ammonia Refrigeration Systems

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA MG 2	(2014) Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-2-1424	(2016) Engineering and Design -- Lubricants and Hydraulic Fluids

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023) Structural Engineering

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82	Protection of Stratospheric Ozone

UNDERWRITERS LABORATORIES (UL)

UL 207	(2022) UL Standard for Safety Refrigerant-Containing Components and Accessories, Nonelectrical

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals

required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; G[, [_____]]

Refrigeration Equipment; G[, [_____]]

SD-03 Product Data

Refrigeration System; G[, [_____]]

Spare Parts

Framed Instructions

Qualifying Procedures

Verification of Dimensions

Coil Corrosion Protection

Tests

Training; G[, [_____]]

Energy Star Label for Air-Cooled Condenser Product; S

Energy Star Label for Water-Cooled Condenser Product; S

Energy Star Label for Unit Cooler Product; S

SD-06 Test Reports

Tests

Pressure Vessels; G[, [_____]]

Aquatic Toxicity

SD-07 Certificates

Refrigeration System

Service Organizations

Ozone Depleting Substances Technician Certification

SD-08 Manufacturer's Instructions

Refrigeration Equipment; G

1.3 QUALITY ASSURANCE

1.3.1 Qualifications

****
NOTE: If the need exists for more stringent requirements for weldments, delete the first bracketed statement; otherwise delete the second.
****

[Submit a letter listing the qualifying procedures for each welder including supporting data and a list of the names of qualified welders. Weld piping in accordance with the qualified procedures using performance qualified welders and welding operators. Procedures and welders must be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests and perform at the work site if practical. Apply the personally assigned symbol near each weld made by the welder or welding operator as a permanent record.] [Use welding and nondestructive testing procedures as specified in Section 40 05 13.96 WELDING PROCESS PIPING.] Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.

1.3.2 Drawings

Investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and

accessories to meet such conditions. Fit equipment, ductwork, and piping arrangements into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance. Submit drawings providing adequate detail to demonstrate compliance with contract requirements and consisting of:

(1) Equipment layouts identifying assembly and installation details.

(2) Piping layouts which identify valves, fittings, pipe sizes, and pipe slopes. Clearly identify and explain any changes to the design.

(3) Plans and elevations which identify clearances required for maintenance and operation.

(4) Wiring diagrams which identify each component individually and interconnected or interlocked relationships between components.

(5) Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for equipment indicated or required to have concrete foundations.

(6) Details of supports, if other than those indicated, including loadings and type of frames, brackets, stanchions, or others.

(7) Automatic temperature control diagrams and control sequences.

(8) Installation details which include the amount of factory set superheat and corresponding refrigerant pressure/temperature.

1.3.3 Service Organizations

Submit a certified list of qualified permanent service organizations for the specified equipment, as specified. Include their addresses and qualifications, for support of the specified equipment. The service organizations must be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.3.4 Modifications of References

Accomplish work in accordance with the referenced publications, except as modified by this section. Consider the advisory or recommended provisions to be mandatory, as though the word "must" had been substituted for the words "should" or "could" or "may," wherever they appear. Interpret reference to "the Authority having jurisdiction," "the Administrative Authority," "the Owner," or "the Design Engineer" to mean the Contracting Officer.

1.3.5 Safety

Design, manufacture, and installat refrigeration equipment conforming to ASHRAE 15 & 34, UL 207, and NFPA 70. Provide personnel protection from moving parts including fans, pulleys chains gears and couplings. Guard or cover with insulation high temperature machinery and piping.

1.3.6 Pressure Vessels

The design, fabrication, inspection, and testing of pressure vessels

including the waterside and refrigerant side of condensers and evaporators must be in accordance with ASME BPVC SEC VIII D1, and ASHRAE 15 & 34. The presence of the ASME official Code U-Symbol or Code UM-Symbol stamped or marked on the vessels, and the submitting of the applicable ASME required manufacturer's data report will be accepted as evidence that the pressure vessels comply to the ASME rules for construction. Where referenced publications do not apply, test pressure components tested at 1-1/2 times design working pressure. Refrigerant wetted carbon steel surfaces must be pickled or abrasive blasted free of mill scale, cleaned, dried, charged, and sealed. [Where service temperatures below minus 7 degrees C 20 degrees F are encountered, materials of construction must be low temperature alloy carbon steel.] Nozzle length must be approximately 1/3 greater than insulation thickness. Fit insulated vessels with rings and other insulation supports as required for installation of insulation. Exterior surfaces of vessels which are insulated and vapor barrier sealed must be abrasive blasted and primed with 0.076 mm 3 mil dry film thickness of inorganic zinc rich coating.

1.3.7 Refrigeration Equipment

Include layout drawings and control diagrams of the refrigeration equipment.

1.3.8 Ozone Depleting Substances Technician Certification

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NOTE: The following paragraph requires a certification for technicians who work on equipment that could release ozone depleting refrigerants, such as R-123, into the atmosphere. This is required as of January 1, 2018 to meet the requirements of 40 CFR 82, Subpart F.

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All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

1.4 ENVIRONMENTAL REQUIREMENTS

Assess potential effects of all lubricants on aquatic organisms in accordance with ASTM D6081 and submit aquatic toxicity reports. Assess biodegradation in accordance with ASTM D5864. In accordance with EM 1110-2-1424 Chapter 8, aquatic toxicity must exceed 1,000 ppm at LL50 and biodegradation must exceed 60 percent conversion of carbon to carbon dioxide in 28 days.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather and contamination. Proper protection and care of material before, during, and after installation is the Contractor's responsibility. Replace any materials found to be damaged at the Contractor's expense. Cap piping and similar openings during installation to keep out dirt and other foreign matter.

1.6 MAINTENANCE

1.6.1 Operation Manual

Provide an operation manual in PDF format listing step-by-step procedures required for system startup, operation, and shutdown. The manual must include the manufacturer's name, model number, parts list, and a brief description of all equipment and their basic operating features.

1.6.2 Maintenance Manual

Provide a maintenance manual in PDF format listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manual must include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

1.6.3 Extra Materials

Submit spare parts data for each different item of equipment specified, after approval of detail drawings and not later than [_____] months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis

PART 2 PRODUCTS

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NOTE: Projects which include vapor-compression type refrigeration systems will comply with the safety standards defined in ASHRAE 15 & 34. Designers will be responsible for thoroughly researching and implementing the ASHRAE 15 & 34 safety requirements. For refrigerant-containing parts (excluding piping) located within an indoor space, a designer can use the following 6-step synopsis as a guide in determining "System Application Requirements" from ASHRAE 15 & 34.

Step 1. Identify the safety group classification of the refrigerant anticipated to be used in the new refrigeration equipment. Refrigerants R-22 and R-134a are considered Group A1 refrigerants. Refrigerant R-123 is considered a Group B1 refrigerant. Ammonia is considered a Group B2 refrigerant. Do not use ammonia for Navy and Marine Corps projects.

Step 2. Identify the occupancy classification of the facility which will house the new refrigerant equipment. Occupancies include institutional, public assembly, residential, commercial, large mercantile, industrial, and mixed types.

Step 3. Determine the system probability (high or low) of the new refrigeration equipment. Split system applications are typically considered high-probability systems according to ASHRAE 15 & 34.

Step 4. Estimate the quantity of refrigerant (grams or pounds) in the largest single refrigerant circuit of the new equipment. The designer will research catalog data from a minimum of 2 different manufacturers in order to get an approximation.

Step 5. Determine the volume (cubic meters or cubic feet) of the indoor space which is planned to house the new refrigeration equipment.

Step 6. Identify the "System Application Requirements" from the applicable table in ASHRAE 15 & 34 based upon the information identified in the previous steps (e.g., safety group, occupancy, system probability, refrigerant quantity, and indoor space volume). The "System Application Requirements" will dictate applicable refrigerant limitations as well as occupied space or mechanical room requirements.

ASHRAE 15 & 34 refers to a mechanical room as a machinery room, however, the terms are synonymous. On mechanical room design, ASHRAE 15 & 34 touches on criteria concerning equipment placement, ventilation design, door and passageway restrictions, refrigerant monitoring, open-flame devices, pressure-relief and purge piping. In addition to mechanical room design, ASHRAE 15 & 34 also touches on criteria concerning refrigerant piping, signs, self-contained breathing apparatus (SCBA), and miscellaneous installation restrictions. (SCBAs cannot be considered MCA funded items and are therefore not included in this specification.)

****

2.1 STANDARD PRODUCTS

Provide materials and equipment which are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship and that have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use includes applications of equipment and materials under similar circumstances and of similar size. The 2 years experience includes products which have been sold or are offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products must be supported by a service organization. System components must be environmentally suitable for the indicated locations.

2.2 NAMEPLATES

****

NOTE: In a salt water environment substitute acceptable non-corroding metal such as but not limited to nickel-copper, 304 stainless steel, or monel. Aluminum is unacceptable. Nomenclature (or

system identification) should be established by the designer.
****

Secure a plate on major equipment including compressors, condensers, unit coolers, receivers, heat exchanges, fans, and motors with manufacturer's name, address, type or style, model or serial number, and catalog number. Provide plates that are durable and legible to last throughout equipment life and made of [anodized aluminum] [stainless steel] [_____]. Fix plates in prominent locations with nonferrous screws or bolts.

2.3 ELECTRICAL WORK

****
NOTE: Delete references to motor starters where motor starters for mechanical equipment are provided in motor-control centers.
****

Electrical equipment, motors, motor efficiencies, and wiring must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide specified electrical motor driven equipment complete with motors, motor starters, and controls. Electrical characteristics and enclosure type must be as shown, and unless otherwise indicated, motors of 746 W 1 horsepower and above with open, dripproof, or totally enclosed fan cooled enclosures, must be high efficiency type. Field wiring must be in accordance with manufacturer's instructions. Each motor must conform to NEMA MG 1 and NEMA MG 2 and must be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Provide continuous duty motors with the enclosure specified. Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Furnish motors with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Size motors for the applicable loads. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Fit motor bearings with grease supply fittings and grease relief to outside of enclosure. Provide manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown. Mount unit control panels and electrical components in a NEMA ICS 6, Type 1 or 3A enclosure.

2.4 MISCELLANEOUS MATERIALS

2.4.1 Refrigerant and Oil

****
NOTE: References to ammonia and IIAR are made throughout this section. If ammonia is inapplicable, then delete these references. Do not use ammonia for Navy and Marine Corps projects
****

Use the number designations and safety classifications in accordance with ASHRAE 15 & 34 for refrigerants. Refrigerants must meet the requirements

of AHRI 700 as a minimum. Ammonia to be in accordance with IIAR 2 and as defined herein. Charge refrigerant systems in accordance with manufacturer's recommendations, including types and quantities of refrigerant and lubricating oil. Except for factory sealed units, furnish two complete charges of lubricating oil for each compressor. Use one charge during the system performance testing period. Following the satisfactory completion of the performance testing, drain the oil and replace the second charge.

2.4.2 Gaskets

Provide gaskets that conform to ASTM F104 classification for compressed sheet with nitrile binder and acrylic fibers for temperature ranges of minus 40 to 370 degrees C minus 40 to 700 degrees F service.

2.4.3 Bolts and Nuts

Bolts and nuts, except as required for piping applications, must conform to ASTM A307. Mark the bolt head to identify the manufacturer and the standard with which the bolt complies, in accordance with ASTM A307.

2.4.4 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports must conform to MSS SP-58.

2.4.5 Escutcheons

Escutcheons must be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screws.

2.4.6 Pressure and Vacuum Gauge

Gauge must conform to ASME B40.100, Class 1, 2, or 3, Style X, Type I or III as required, 115 mm 4-1/2 inches in diameter with phenolic or metal case. Select each gauge range so that at normal operating pressure, the needle is within the middle third of the range.

2.4.7 Temperature Gauges

Provide industrial duty thermometers for the required temperature range. Thermometers must have a Fahrenheit scale on a white face. The pointer must be adjustable.

2.4.7.1 Stem Cased-Glass

Stem cased-glass case must be polished stainless steel or cast aluminum, 229 mm 9 inches long, with clear acrylic lens, and non-mercury filled glass tube.

2.4.7.2 Bimetallic Dial

Bimetallic dial type case must be not less than 89 mm 3-1/2 inches, stainless steel, and must be hermetically sealed with clear acrylic lens. Dampen bimetallic element with silicone and fit unit with external calibrator adjustment. Accuracy must be one percent of dial range.

2.4.7.3 Liquid-, Solid-, and Vapor-Filled Dial

Liquid-, solid-, and vapor-filled dial type cases must be not less than 89 mm 3-1/2 inches, stainless steel or cast aluminum with clear acrylic lens. Fill must be nonmercury, suitable for encountered cross-ambients, and connecting capillary tubing must be double-braided bronze.

2.4.7.4 Thermal Well

Thermal well must be identical size, 13 or 19 mm 1/2 or 3/4 inch NPT connection, brass or stainless steel. Where test wells are indicated, provide captive plug-fitted type 13 mm 1/2 inch NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Extended neck thermal wells must be of sufficient length to clear insulation thickness by 25 mm 1 inch.

2.4.8 Unicellular Plastic Foam

Provide unicellular plastic foam in accordance with ASTM C534/C534M, Type I. Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

2.4.9 Bird Screen

Provide screen consisting of square mesh, plain weave, 2 by 2 mesh, 1.6 mm 0.063 inch diameter aluminum wire or 0.79 mm 0.031 inch diameter stainless steel wire.

2.4.10 Galvanized Steel Sheet

ASTM A653/A653M, Coating Class G-90, lockforming quality.

2.4.11 Galvanized Steel Shapes

ASTM A36/A36M to commercial weight of not less than 0.70 kg/square meter 2.3 ounces/square foot of single side surface.

2.4.12 Aluminum Sheets and Plates

ASTM B209M ASTM B209, Alloy 3003, H-14. Sheets must be lockforming quality.

2.4.13 Aluminum Shapes

ASTM B221M ASTM B221, Alloy 6061, T-5 and T-6.

2.5 COMPRESSOR/CONDENSING UNITS

****

NOTE: Delete the last sentence if an ammonia system is not specified. Do not use ammonia for Navy and Marine Corps projects.

****

[Compressor] [Condensing] unit must be factory fabricated, assembled, tested, packaged, and ready for full capacity operation after terminal point connection and field charging with operating fluids. Unit must conform to ANSI/AHRI 520, ASHRAE 23.1, and ASHRAE 15 & 34. Ammonia systems must also conform to IIAR 2 and ANSI/AHRI 510.

2.5.1 Capacity Criteria

****

NOTE: Show the capacity and saturated suction temperature, saturated condensing temperature, superheat, and subcooling on the drawings.

****

Application capacity rating shown must include suction superheat and liquid subcooling. Do not exceed compressor design saturated condensing temperature and saturated suction temperature limits.

2.5.2 Compressor

Select compressors for good operating reliability. Rotating parts must be statically and dynamically balanced at the factory to eliminate vibration at both partial and full load conditions. [Provide compressor system above 5 H.P. with variable speed capability.]

2.5.2.1 Construction

****

NOTE: Delete the second to last sentence if an ammonia system is not specified. Do not use ammonia for Navy and Marine Corps projects.

****

Compressors must be the [reciprocating] [or] [scroll] type of either the open or hermetic design. Reciprocating compressors must have integrally cast housings of close-grained iron with an oil-level bull's eye, cast cylinder heads, cast aluminum or forged steel connecting rods, and cast iron or forged steel crankshafts with sleeve-insert type main bearings. Fit ammonia service compressor cylinder blocks and heads with self-draining water- or refrigerant-cooled jackets where recommended by the manufacturer. Freeze protect water jackets.

2.5.2.2 Lubrication System

The lubrication system on compressors 2.2 kW 3 hp or larger must be the forced-feed, positive-displacement type with oil strainer. The oil pump must be reversible. Provide lube oil pressure gauge and failure switch for forced-feed lubrication type compressors. Provide compressor with an adjustable oil level regulator with a shutoff valve on each inlet to allow removal of individual compressors without shutting down the entire system.

2.5.2.3 Motor

Compressor motors must be of the [constant-speed, squirrel-cage, induction, hermetically sealed, low-starting-current, high-torque type] [permanent magnet type with an inverter type drive].[Furnish motors with magnetic NEMA across-the-line motor starters in general purpose enclosures.]

2.5.2.4 Compressor Components

Compressor systems must include, as a minimum, the following:

a. Provide compressors 1.1 kW 1-1/2 hp and larger with double seated

suction and discharge service valves each with gauge ports.

b. Compressors 3.7 kW 5 hp or larger must have a solid state oil pressure safety switch with a manual reset with auxiliary alarm contacts. Time delay duration must be as recommended by compressor manufacturer.

c. Each compressor must have a single low-pressure control with automatic reset and adjustable cut-in and cut-out range. Use braided steel lines.

d. Each compressor must have a single high-pressure control with manual reset, adjustable set-point, and auxiliary alarm contact. Use braided steel lines.

e. Provide a compressor cooling fan for each compressor which operates below minus 18 degrees C 0 degrees F saturated suction temperature.

f. Each compressor must have a crankcase oil heater. Control of the heaters must be as recommended by the compressor manufacturer.

g. When required by the compressor manufacturer, provide compressors with a hot-gas muffler to reduce vibration and noise from pulsations.

2.5.3 Base Mounting

****

NOTE: Where condensing units or compressors are located on top of walk-in boxes, mount on spring vibration isolators. Mass of inertia block must be an engineered solution accommodating site conditions.

****

Factory mount compressor and accommodating components on a rigid, steel [base,][rack,] where indicated. Mount the compressor assembly [with spring type vibration isolation mountings[. Place elastomer pads between the assembly base and the floor.][selected to limit transmissibility of imbalanced forces at lowest equipment rpm to 5 percent.]][on a concrete inertia block, fitted with spring type vibration isolation mountings. Mass of the concrete inertia block must be [2.0][_____] times mass of supported assembly. Select spring mountings to limit transmissibility of imbalanced forces at lowest equipment rpm to 3 percent.]

2.5.4 Unit Accessories

[Integral] [Remote] condensers must be in accordance with paragraph CONDENSER, [_____]. Provide accessories to be used in combination with each unit as indicated and in accordance with paragraph REFRIGERANT ACCESSORIES. Provide outdoor condensing units with weather hoods.

2.5.5 Electrical Controls

****

NOTE: Verify that reverse-phase, and phase-imbalance protection provisions are available in sizes under 70 kW 20 tons. Check with manufacturers before specifying other than across-the-line starting. If the transmissibility of equipment vibration is critical, indicate the use of service-rated flexible connectors on all pipe,

tubing, and conduit to the equipment.
****

Provide electrical controls for the unit in accordance with paragraph ELECTRICAL WORK and include at a minimum main and branch circuit overload protective devices compensated for ambient temperatures as recommended by the manufacturer; status pilot lights; compressor safety, operating and capacity controls; defrost controls; local and remote audible and visual alarms with provisions to silence; short cycling control with lock-out timer; time delay for sequenced compressor starts; and remote component interface.

2.6 CONDENSER, AIR-COOLED

Unit must be factory fabricated and tested, packaged, self-contained and ready for full capacity operation after terminal point connections. Provide unit conforming to ANSI/AHRI 460. Split systems must be manufacturer matched units. Fans must be propeller or centrifugal type as specified in paragraph Fans. Provide fan motors that have [open][dripproof][totally enclosed][explosion proof] enclosures. Provide electrical controls for the unit in accordance with paragraph ELECTRICAL WORK, include a control transformer, and are capable of interfacing with local and remote components.

2.6.1 Capacity Rating

Size the condenser for the capacity and conditions indicated. Do not oversize.

2.6.2 Energy Performance

Equipment efficiency must meet the requirements of Energy Star designated efficiency. Provide proof of Energy Star label for air-cooled condenser product.

2.6.3 Unit Casing

Casing must be weatherproof and enclose all unit components. Construct structural members and sheet metal for the unit casing of galvanized steel or aluminum. Fit casing with lifting provisions, access panels, removable legs, and fan and heat rejection coil guards and screens.

2.6.4 Finishes

Equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish, except that items located outside of buildings and subject to a salt atmosphere must have weather resistant finishes that will withstand 240 hours exposure to the salt spray test conducted in accordance with ASTM B117, using a 20 percent sodium chloride solution. Immediately after completion of the test, the specimen must show no sign of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3.18 mm 1/8 inch on either side of the scratch mark.

2.6.5 Condenser Coil

****
NOTE: When coils are located in a corrosive or salt-laden environment, require both the copper or

aluminum tubes and the protective coating.
****

Coil must have [nonferrous][copper or aluminum] tubes of 10 mm 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. [Protect coil in accordance with paragraph COIL CORROSION PROTECTION.] Casing must be galvanized steel or aluminum. Avoid contact of dissimilar metals. Coils must be tested in accordance with ASHRAE 15 & 34 at the factory and must be suitable for the working pressure of the installed system. Condenser may be used for refrigerant storage in lieu of separate receiver, provided that storage capacity is 20 percent in excess of fully charged system. Coil must be dehydrated and sealed after testing and prior to evaluation and charging. Provide unit with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge must be field charged. Provide separate expansion devices for each compressor circuit.

2.7 CONDENSER, WATER-COOLED

Condenser must be [remote mounted, tested and rated to AHRI 450][an integral component of a water-cooled condensing unit, be tested and rated to ANSI/AHRI 520]. Condensers must have safety provisions conforming to ASHRAE 15 & 34. Coils must conform to ASME BPVC SEC VIII D1 or UL 207, as applicable for maximum and minimum pressure or temperature encountered. Condenser heads must be removable and have flanged side inlet pipe connections which permit access to or removal of the tubes. Provide a separate condenser for each compressor circuit. Fans must be propeller or centrifugal type as specified in paragraph Fans. Fan motors must have [open][dripproof][totally enclosed][explosion proof] enclosures.

2.7.1 Unit Casing

Casing must be weatherproof and enclose all unit components. Construct structural members and sheet metal for the unit casing of galvanized steel or aluminum. Fit casing with lifting provisions, access panels, removable legs, and fan and heat rejection coil guards and screens.

2.7.2 Condenser Coil

****
NOTE: Normally 70/30 copper nickel performance is superior to 90/10 copper nickel in brackish water and salt water. Where conditions are not detrimental to 90/10 copper nickel, incorporate same as an alternative acceptable material. Use the higher fouling factor for open systems.
****

Condensers must be of the shell-and-tube type with the coolant in the tubes. Water-wetted metals must be [copper][or][[90/10][or][70/30] copper-nickel], except that heads may be ferrous metal in systems with chemically treated recirculating water. Unit must be rated for not less than 2758 kPa 400 psig refrigerant side and 860 kPa 125 psig water side pressure service at operating temperatures. Water supply, return and control system wetted parts must be copper, bronze or stainless steel. Water supply, return connections and piping internal to unit must be copper with brazed or threaded copper or bronze fittings, terminating in a threaded connection. Include valved access for recirculation of acidic scale removal chemicals and isolation pressure taps to determine pressure

drop and water flow in piping arrangement. Base performance on an allowable water velocity not less than 0.9 m/s 3 fps nor more than 3 m/s 10 fps with a fouling factor of [0.0005][0.001]. The design pressure drop must govern the number of passes. Control valve on the water supply line must be [the automatic, self-contained type, controlled by condensing pressure which close bubble-tight when compressor is not operating.] [the modulating three-way type, controlled by pressure controller.]

2.7.3 Energy Performance

****

NOTE: UFC 1-200-02 requires new buildings to use 30 percent less energy than the ASHRAE 90.1 - SI ASHRAE 90.1 - IP baseline level.

****

Equipment efficiency must meet the requirements of Energy Star designated efficiency. Provide proof of Energy Star label for water-cooled condenser product.

2.8 CONDENSER, EVAPORATIVE

Each unit must be the counter-flow blow-through design, with single-side air entry. The unit must have fan assemblies built into the unit base, with all moving parts factory mounted and aligned. Primary construction of items such as the pan section, the cabinet, must be not lighter than 1.6 mm (16 gauge) 16 gauge steel, protected against corrosion by a zinc coating. The zinc coating must conform to ASTM A153/A153M and ASTM A123/A123M, as applicable and have an extra heavy coating of not less than 0.76 kg/square m 2-1/2 ounces per square foot of surface. Give cut edges a protective coating of zinc-rich compound. After assembly, apply the manufacturer's standard zinc chromatized aluminum or epoxy paint finish to the exterior of the unit. Rate unit in accordance with AHRI 490 I-P and tested in accordance with ASHRAE 64.

2.8.1 Design and Performance Requirements

****

NOTE: When 53 m/s 10,500 fpm velocity is exceeded, noise may become a significant factor. Low tip speeds may or may not increase size of cooling tower. Consider probability of chemically-treated high-dissolved-solids drift loss causing damage to adjacent structures and environment (such as trees, shrubs).

****

The requirements of CTI ATC-105 must be the basis of establishing unit capacity and performance. Unit capacity must include a site recirculation factor. Performance wind velocity must be 8 km 5 miles per hour. Drift loss must not exceed 0.1 percent of unit circulation rate. Minimum unit design wind load must be [146 kg per square meter] [30 pounds per square foot] [_____]. [Minimum design fan deck live load must be [195 kg per square meter] [40 pounds per square foot] [_____].] Fan tip speed must not exceed [53 mps] [10,500 feet per minute][_____]. Design and construction of steel members must conform to AISC 360 and AISI SG03-3.

2.8.2 Access and Safety Provisions

Fit unit with access provisions as indicated to facilitate inspection, maintenance and replacement of components. Provide guard screens at unducted fan inlets and far discharge. Provide guards for moving power transmission components.

2.8.3 Pan Section

Provide watertight pan with drain, overflow, and make-up water connections. Standard pan accessories include access doors, a lift-out strainer of anti-vortexing design and a brass make-up valve with float ball.

2.8.4 Fan Section

Furnish [centrifugal][propeller] type fan in accordance with paragraph Fans. Do not locate fan and fan motor in the discharge airstream of the unit. Provide motors that have [open][dripproof][totally enclosed][explosion proof] enclosure and are suitable for the indicated service. The condensing unit design must prevent water from entering into the fan section.

2.8.5 Condensing Coil

****
NOTE: Delete the copper or aluminum tubes and the protective coating except in corrosive environments.
****

Provide coils that have [nonferrous][copper or aluminum] tubes of 10 mm 3/8 inch minimum diameter without fins.[Protect coil in accordance with paragraph COIL CORROSION PROTECTION.] Casing must be galvanized steel or aluminum. Avoid contact of dissimilar metals. Coils must be tested in accordance with ASHRAE 15 & 34 at the factory and suitable for the working pressure of the installed system. Each coil must be dehydrated and sealed after testing and prior to evaluation and charging. Provide each unit with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge must be field charged.

2.8.6 Water Distribution System

Distribute water uniformly over the condensing coil to ensure complete wetting of the coil at all times. Provide brass, stainless steel, or high-impact plastic spray nozzles. Nozzles must be the cleanable, nonclogging, removable type. Design nozzles to permit easy disassembly and arrange for easy access.

2.8.7 Water Pump

The water pump must be the bronze-fitted centrifugal or turbine type, and may be mounted as an integral part of the evaporative condenser or remotely on a separate mounting pad. Pumps must have cast iron casings. Impellers must be bronze, and shafts must be stainless steel with bronze casing wearing rings. Shaft seals must be the mechanical type. Pump casing must be factory coated with epoxy paint. Pump motors must have [open][dripproof][totally enclosed][explosion proof] enclosures. Provide a bleed line with a flow valve or fixed orifice in the pump discharge line and extend to the nearest drain for continuous discharge. Fully submerge

pump suction and provide with a galvanized steel or monel screened inlet.

2.8.8 Drift Eliminator

Provide eliminators to limit drift loss to not over 0.005 percent of the specified water flow. Construct eliminators of zinc-coated steel or polyvinyl chloride (PVC). Eliminators must prevent carry over into the unit's fan section.

2.9 UNIT COOLERS

****

NOTE: If it is more economical to use one big air handling unit instead of several unit coolers, use Section 23 30 00 HVAC AIR DISTRIBUTION to develop the requirements and delete the unit coolers. Use Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC to develop the control requirements for the air handling unit.

Delete the second to last sentence if an ammonia system is not specified. Do not use ammonia for Navy and Marine Corps projects.

****

Unit must be [forced circulation][free delivery] type, factory fabricated, assembled and tested, and packaged in accordance with AHRI 420. Ammonia systems must conform to IIAR 2. Fan must be the [centrifugal][propeller] type in accordance with paragraph Fans. Motors must be ECM type or rated for variable frequency drives and have [open][dripproof][totally enclosed][explosion proof] enclosures.

2.9.1 Construction

****

NOTE: Coils for fluorocarbon systems will have copper tubes and aluminum fins. Coils for ammonia systems will be hot-dip galvanized steel or aluminum. Do not use ammonia for Navy and Marine Corps projects

****

Casing must be Type 300 stainless steel, aluminum, mill galvanized or hot-dip galvanized steel after fabrication. Protectzinc-coated carbon steel in accordance with paragraph COIL CORROSION PROTECTION.. Coils must [be hot-dip galvanized steel or aluminum.][have copper tubes and aluminum fins.] Provide watertight, corrosion resistant drain pan. Insulate drainage piping for units in spaces maintained at less than 2 degrees C 35 degrees F.

2.9.2 Energy Performance

Size equipment based on Design Manual CS from the Air Conditioning Contractors of America; do not oversize. Equipment efficiency must meet the requirements of Energy Star. Provide proof of Energy Star label for unit cooler product.

2.9.3 Defrosting

****
NOTE: Spaces maintained at 2 degrees C 35 degrees F will be defrosted with ambient air. Spaces below 2 degrees C 35 degrees F will use either a hot gas or electric heat defrosting system. For a defrosting system choose between a timer defrost controller or a demand defrost controller.
****

Unit must be [defrosted with ambient space air.][fitted with a [hot gas][electric heat] defrosting system.][Control defrost system by timer defrost controller adjustable for up to 6 defrost cycles per 24 hours, each of 5 to 120 minutes duration. Include an adjustable timer to control frequency of cycles; defrost initiating thermostat; adjustable program timer to control sequence of defrost cycle; defrost terminating thermostat; manual override switch; selector switch; and status pilot light.][Control defrost system by demand defrost controller. Include an automatic, solid-state circuitry to initiate defrost cycle based on sensing adjustable temperature difference of air moving across coil in direct proportion to frost build-up; thermostat to terminate defrost; adjustable lockout to prevent initiation of defrost during pull-down after defrost cycle; manual override switch; and status pilot light.]

2.10 CONTROLS AND INSTRUMENTS

Refrigeration system controls, instruments and devices must be industrial quality, and must conform to applicable requirements of ASHRAE 15 & 34. Submit manufacturer's standard catalog data, prior to the purchase or installation of a particular component, highlighted to show items such as brand name, model number, size, options, performance charts and curves, in sufficient detail to demonstrate compliance with contract requirements.

a. Provide data for each specified component including manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, include vibration isolator literature containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations.

b. Rate fluid containing surfaces for the service and construct of materials suitable for the fluid. Component electrical rating must be 120 volt ac, unless otherwise indicated and must be suitable for imposed loads.

****
NOTE: Delete item c. if an ammonia system is not specified. Do not use ammonia for Navy and Marine Corps projects.
****

c. Ammonia systems must conform to IIAR 2. Do not use copper, copper alloy and white metals, except aluminum, for ammonia service.

d. Submit proof of compliance where the system, components, or equipment are specified to comply with requirements of AHRI, ASHRAE, ASME, or UL. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, a written certificate from

an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency may be submitted.

e. When performance requirements of this project's drawings and specifications vary from standard AHRI rating conditions, include computer printouts, catalog, or other application data certified by AHRI or a nationally recognized laboratory as described above. If AHRI does not have a current certification program that encompasses such application data, the manufacturer may self certify that its application data complies with project performance requirements in accordance with the specified test standards.

2.10.1 Refrigeration System Alarms

2.10.1.1 Audible Alarm

Provide surface-mounted audible alarm, 100 mm 4 inch vibrating bell type suitable for indoor or outdoor service.

2.10.1.2 Visual Alarm

Visual alarm must be pilot light type. Alarm must be 100 watt, incandescent, vapor-tight fixture with cast metal guard and [red][green][amber] lens.

2.10.2 Controllers

2.10.2.1 Differential Pressure Controller

Provide differential pressure controller with high and low pressure sensing ports that is direct or reverse acting with calibrated proportional band and set point adjustments. Controller output must be [low voltage electric][pneumatic][4-20 mA dc], proportional to the pressure differential sensed. Include local and remote set point adjustments. Range must meet system requirements.

2.10.2.2 Differential Temperature Controller

Provide differential temperature controller with two filled, remote sensing bulbs connected to the controller by [capillary][armored capillary] tubing. Controller must be direct or reverse acting with calibrated proportional band and set point adjustments. Controller output must be [low voltage electric][pneumatic][4-20 mA dc], proportional to the temperature differential sensed. Include provisions for local and remote set point adjustments. Range must be as required to meet system requirements. For immersion service, provide thermal wells.

2.10.3 Pilot Lights

Panel-mounted pilot lights must be NEMA Class 12 oil-tight, push-to-test transformer for 6-8 Vac lamps. Lamps must be replaceable by removal of color cap. Cap color must be as indicated.

2.10.4 Programmer, Demand Control/Load

****

NOTE: Before application of energy management

systems/load shedders to refrigeration systems, and related fans and pumps, the designer must ascertain that application will be neither conducive to equipment damage nor counterproductive. Safety trips, compressor slugging, freeze-ups and reloading of circuits may occur.
****

Programmer must be fully automatic, fail safe, field programmable, solid-state, demand control and load programmable for [_____][16] loads. Demand control portion must monitor power consumption by[watt][or][current] transducers. Set point must be field adjustable with adjustable dead band. Load shedding sequence time and differential time between load shedding must be adjustable. Contacts must store alarm condition. Meter readout must indicate demand deviation from set point. Load profile recorder must be strip-chart type with readily discernable event record. Load programmer must permit programming of on/off time of each load for any time element within a week and must equalize power demand over a preset time cycle. Include input override and time cycle accelerator for checkout. Visually indicate and record alarm condition, status of all loads and time period. Include a H-O-A toggle switch for each load. Alarm provisions must include relay contacts for external, remote alarm functions and test provisions. Provide override [thermostat][pressure switch][timer] to restore shedded loads indicated. Control panel enclosure must be NEMA ICS 6, Type 1, surface mounted type with key lock. Load profile recorder must be [surface][flush panel] mounted type. Load relays must be plug-in type with critical load failure in "on" mode and contacts rated for pilot duty at 120 volt ac. Load shedding position switches must shed loads on a first shed/last restore basis and remove loads from system logic for shedding cycle. Fit time clock with spring motor to maintain time in event of power failure.

2.10.5 Switches, Fluid Service

Switches must be field adjustable SPDT type and must have NEMA ICS 6, Type 1 enclosure with operating range specified or indicated. Provide circuits as required for the applicable functions.

2.10.5.1 Air Flow Switch

Provide air flow switch that has a service pressure range of 31 to 2542 Pa 0.12 to 10 inches wg.

2.10.5.2 Water-Flow Switch

Water flow switch must have a body rating suitable for the service, field-adjustable activating flow rate, and a pressure drop not in excess of 13.8 kPa 2 psi at maximum flow rate.

2.10.5.3 Pressure Switch

Provide factory set pressure switch, one or two stage as indicated, with adjustable operating and differential pressure. Fit bourdon tube inlet with damper screw adjustment.

2.10.5.4 Differential Pressure Switch

Provide factory set differential pressure switch with high and low sensing ports, one or two stages and adjustable differential range and pressure.

2.10.5.5 Temperature Switch

Provide factory set temperature switch with [capillary][armored capillary] tubing and filled sensing system, one or two stages as indicated, and operating adjustable differential range. For immersion service, provide thermal wells.

2.10.5.6 Differential Temperature Switch

Provide factory set differential temperature switch with two [separate][separate armored] capillary systems, one or two stages, and adjustable differential range and temperature. For immersion service, provide thermal wells.

2.10.6 Push-Button Stations

Stations must be NEMA Class 12 oil-tight, momentary or maintained-contact type, as indicated. Start push-buttons must have a fully guarded or flush black operator button. Stop push-buttons must have an unguarded or extended red operator button.

2.10.7 Selector

Switches must be NEMA Class 12 oil-tight, momentary or maintained contact type, as indicated, with standard operator.

2.11 HEAT RECOVERY DEVICES

2.11.1 Heat Recovery Coil, Air

****

NOTE: When coils are located in a corrosive or salt-laden environment, require both the copper or aluminum tubes and the protective coating.

****

Coil must be compatible with the type of refrigerant used in the system. Coil must have [nonferrous][copper or aluminum] tubes of 10 mm 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes.[Protect coil in accordance with paragraph COIL CORROSION PROTECTION.] Provide galvanized steel or aluminum casing. Avoid contact of dissimilar metals. Coils must be tested in accordance with ASHRAE 15 & 34 at the factory and must be suitable for the working pressure of the installed system. Coil must be dehydrated and sealed after testing and prior to evaluation and charging. Provide unit with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge must be field charged. Mount coil within a heat recovery, factory-fabricated, draw-through, central station type air conditioner in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.11.2 Hot Water Reclaim

****

NOTE: Indicate on the drawings the size of the exchanger either as a percent of the total rated condenser load or as a percent of the superheated portion of the total rated condenser load. The refrigerant compressor head pressure control and the

circulating pump can be deleted if inapplicable.
****

Unit must be a double-wall, tube-within-tube heat exchanger type, complete with thermostatic control. Unit must be constructed and refrigerant pressure/temperature rated in accordance with ASHRAE 15 & 34. Heat exchanger coil must consist of an external refrigerant containing carbon steel tube and an internal, double-wall-in-metallic contact, convoluted, potable water containing copper tube. Fabricate cabinet of zinc-protected steel and insulate internally in coil space. Provide recovery device with a refrigerant compressor head pressure control and an interlocked, potable water circulating pump. Pump and motor assembly must be close-coupled, manufacturer's standard type with indicated head and capacity characteristics, and with brass, bronze, copper or stainless steel wetted parts. Mount pump [remotely][integral] to the exchanger and rate for [115][208][230] volt ac power supply.

2.12 REFRIGERANT LEAK DETECTOR

****

NOTE: Refrigerant leak detectors will be provided as required by the "System Application Requirements" in ASHRAE 15 & 34.

When a detector is required, the location will be indicated on the drawings. Detectors are best located between the refrigeration system and the room exhaust. Sampling points from a detector will be located a maximum of 450 mm 18 inches above the finished floor since all commonly-used refrigerants are heavier than air.

As a rule of thumb, the distance between any refrigeration system and a refrigerant sampling point shouldn't exceed 15 m 50 feet. In order to meet the recommended 15 m 50 feet distance, a mechanical room can be provided with either multiple detectors each with single sampling points or with one detector that has the capability of monitoring at multiple sampling points. If multiple sampling points are required, enter the number in the appropriate blank below.

In accordance with ASHRAE 15 & 34, when a detector senses refrigerant it must activate an alarm and initiate the room ventilation system. In regards to alarms, as a minimum indicate that the detector will energize a light on or near the detector as well as a second light installed on the outside wall next to the mechanical room entrance. The exterior light will be provided with a sign that warns personnel entering the mechanical room of a refrigerant release and that a SCBA is required to enter. If applicable to the installation, include an audible alarm on the exterior of the mechanical room. Include the electrical design for the alarm system on the drawings.

As an additional item, ASHRAE 15 & 34 states that

open-flame devices (i.e., boilers) cannot be installed in the same area as a refrigeration system, unless either combustion air for the open-flame device is ducted straight from outside to the device; or the alarm relay from the detector is used to automatically shutdown the combustion process in the event of refrigerant leakage. Indicate all applicable alarm controls on the drawings.

Delete the information in the last bracketed sentence if an EMCS is not applicable to the design.
****

Provide continuously-operating, halogen-specific type detector that is appropriate for the refrigerant in use. Design detector specifically for area monitoring and include [a single sampling point][[_____] sampling points] install where indicated. Detector design and construction must be compatible with the temperature, humidity, barometric pressure and voltage fluctuations of the operating area. Detector must have an adjustable sensitivity such that it can detect refrigerant at or above 3 parts per million (ppm). Supply factory-calibrated detector for the appropriate refrigerant. Provide an alarm relay output which energizes when the detector detects a refrigerant level at or above the TLV-TWA (or toxicity measurement consistent therewith) for the refrigerant in use. The detector's relay should be capable of initiating corresponding alarms and ventilation systems as indicated on the drawings. Provide a failure relay output that energizes when the monitor detects a fault in its operation.[Detector must be compatible with the facility's energy management and control system (EMCS). The EMCS must be capable of generating an electronic log of the refrigerant level in the operating area, monitoring for detector malfunctions, and monitoring for any refrigerant alarm conditions.]

2.13 REFRIGERANT RELIEF VALVE/RUPTURE DISC ASSEMBLY

****

NOTE: ASHRAE 15 & 34 requires refrigeration systems to be protected with a pressure-relief device that will safely relieve pressure due to fire or other abnormal conditions. A relief valve/rupture disc assembly is the optimum solution. The rupture disc will provide visual indication of a release while also providing immediate shutoff once a safe pressure is achieved.

Designer will indicate on the drawings the location of each new relief valve/rupture disc assembly as well as the routing and size of corresponding pressure-relief piping. The routing and size of new pressure-relief piping will be in accordance with ASHRAE 15 & 34.
****

The assembly must be a combination pressure relief valve and rupture disc designed for refrigerant usage. Provide assembly in accordance with ASME BPVC SEC IX and ASHRAE 15 & 34. Provide assembly with a pressure gauge assembly which will provide local indication if a rupture disc is broken. Provide rupture disc of the non-fragmenting type.

2.14 REFRIGERANT SIGNS

Provide refrigerant signs that are a medium-weight aluminum type with a baked enamel finish. Signs must be suitable for indoor or outdoor service. Signs must have a white background with red letters not less than 13 mm 0.5 inches in height.

2.14.1 Installation Identification

Provide each new refrigerating system with a refrigerant sign which indicates the following as a minimum:

a. Contractor's name
b. Refrigerant number and amount of refrigerant.
c. The lubricant identity and amount.
d. Field test pressure applied.

2.14.2 Controls and Piping Identification

Provide refrigerant systems containing more than 50 kg 110 lb of refrigerant with refrigerant signs which designate the following as a minimum:

a. Valves or switches for controlling the refrigerant flow [, the ventilation system,] and the refrigerant compressor.

b. Pressure limiting device.

2.15 CONDENSER WATER SYSTEMS

****
NOTE: Delete this paragraph if inapplicable. Use Section 23 65 00 COOLING TOWERS AND REMOTE EVAPORATIVELY-COOLED CONDENSERS and 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS to develop the requirements for a condenser water system.
****

Cooling towers, condenser water pumps, condenser water treatment systems, condenser water piping, fittings, valves and accessories must be in accordance with Sections 23 65 00 COOLING TOWERS AND REMOTE EVAPORATIVELY-COOLED CONDENSERS and 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.

2.16 DRAIN AND MISCELLANEOUS PIPING

Piping, fittings, valves and accessories for drain and miscellaneous services must be in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.17 PIPING AND FITTINGS, FLUOROCARBONS

Piping, valves, fittings, and accessories must conform to the requirements of ASHRAE 15 & 34and ASME B31.5, except as specified.

2.17.1 Steel Pipe

Steel pipe for fluorocarbon service must conform to ASTM A53/A53M, Schedule 40, Type E or S, Grades A or B. Do not use Type F pipe.

2.17.2 Steel Pipe Joints and Fittings

Joints and fittings must be steel butt-welding, socket-welding, or malleable iron threaded type. Weld pipe except that joints on lines 50 mm 2 inches and smaller may be threaded. Threads must be tapered type conforming to ASME B1.20.2MASME B1.20.1. The malleable iron threaded type fitting must be of a weight corresponding to adjacent pipe. Flanges and flange faces of fittings must be tongue-and-groove type with gaskets suitable for the refrigerant used; size 25 mm 1 inch and smaller must be oval, two-bolt type; size above 25 mm 1 inch, up to and including 100 mm 4 inch, must be square four-bolt type; and sizes over 100 mm 4 inch must be round.

2.17.3 Steel Tubing

Steel tubing for refrigeration service must be in accordance with ASTM A334/A334M, Grade 1. Tubing with a nominal diameter of 10 mm 3/8 inch or 13 mm 1/2 inch must have a wall thickness of 1.22 mm 0.049 inches. Tubing with a nominal diameter of 19 mm 3/4 inch through 50 mm 2 inches must have a wall thickness of 1.62 mm 0.065 inches. Tubing with a nominal diameter of 65 through 100 mm 2-1/2 through 4 inches must have a wall thickness of 2.4 mm 0.095 inches. Steel tubing must be cold-rolled, electric-forged, welded-steel. Provide one end of the tubing with a socket. Clean, dehydrate, and cap steel tubing.

2.17.4 Steel Tubing Joints and Fittings

Provide socket type joints and fittings by the steel tubing manufacturer.

2.17.5 Copper Tubing

Copper tubing must conform to ASTM B280 annealed or hard drawn as required. Copper tubing must be soft annealed where bending is required and hard drawn where no bending is required. Do not use soft annealed copper tubing in sizes larger than 35 mm 1-3/8 inches. Braze joints except that joints on lines 22 mm 7/8 inch and smaller may be flared.

2.17.6 Copper Tube Joints and Fittings

Copper tube joints and fittings must be flare joint type with short-shank flare, or solder-joint pressure type. Joints and fittings for brazed joint must be wrought-copper or forged-brass sweat fittings. Cast sweat-type joints and fittings will not be allowed for brazed joints.

2.18 PIPING AND FITTINGS, AMMONIA

****

NOTE: Delete this paragraph and subparagraphs if an ammonia system is not specified. Do not use ammonia for Navy and Marine Corps projects.

****

At system application conditions to minus 6.7 degrees C 20 degrees F piping system components including but not limited to piping, flanges,

fittings, valves, and all accessories including flange bolts, nuts, and bolt patterns must conform to ASME B31.5. Do not use unions in this piping system. Other requirements are as follows:

2.18.1 Pipe, Black Carbon Steel

ASTM A53/A53M, Type E or S, Grade A or B, Schedule 40, standard weight, or Schedule 80, or extra strong as required.

2.18.2 Fittings, Threaded

ASTM A105/A105M or ASTM A181/A181M and ASME B16.11, 2.07 MPa 3000 psig WOG, forged steel.

2.18.3 Fittings, Welding

In sizes 25 mm 1 inch and under, ASTM A105/A105M or ASTM A181/A181M, and ASME B16.11, 2.07 MPa 3000 psig WOG, forged steel, socket weld, bored to match pipe wall thickness. Sizes exceeding 25 mm 1 inch must be wrought carbon steel, long radius, butt-weld, to match pipe wall thickness, conforming to ASTM A234/A234M and ASME B16.9.

2.18.4 Fittings, Flanged

High strength gray cast iron conforming to ASTM A126, Class B, or ASTM A278/A278M, Class 40, or malleable iron conforming to ASTM A197/A197M, manufacturer's standard long radius. Provide flange configuration as specified for flanges.

2.18.5 Flanges

Forged carbon steel conforming to ASTM A181/A181M, with industry standard tongue and groove face finish, 2-bolt oval shape in sizes 19 mm 3/4 inch and under; 4-bolt square shape in sizes 25 mm 1 inch through 100 mm 4 inches; round shape in sizes 127 mm 5 inches and larger; weld neck, except in sizes 50 mm 2 inches and under socket weld is acceptable. Threaded connection flanges are not acceptable. Flange template dimensional and shape criteria must be identical and/or interchangeable with valve flanges specified in paragraph VALVES, AMMONIA AND FLUOROCARBON.

2.19 VALVES, AMMONIA AND FLUOROCARBON

****

NOTE: Construction of valves for ammonia service should be stainless steel or ferrous based only. Do not use ammonia for Navy and Marine Corps projects.

****

Provide pressure and temperature rated valves for contained refrigerant service and comply with ASME B31.1. Metals of construction must be of Type 300 stainless steel, or [ferrous or copper][ferrous] based. Atmosphere exposed valve stems must be stainless steel or corrosion resistant metal plated carbon steel. Valve body connections must be brazed or welded socket, flanged or combination thereof. Do not use threaded connections, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Valves must be suitable for or fitted with extended copper ends for brazing in-place without disassembly. Fit ferrous body valves with factory fabricated and brazed copper transitions. To minimize system

pressure drops, where practicable, globe valves must be angle body type, and straight line valves must be full port ball type. Fit control valve inlets with integral or adapted strainer or filter where recommended or required by manufacturer. Clean valves and seal moisture-tight.

2.19.1 Refrigerant-Stop Valves

Design stop valves for use with the refrigerant used and provide pressure ratings compatible with system working pressures encountered. Gate valves will not be acceptable.

2.19.1.1 Fluorocarbon Service

Valves 16 mm 5/8 inch and smaller must be handwheel operated, straight or angle, packless diaphragm globe type with back-seating stem, brazed ends, except where SAE flare or retained seal cap connections are required. Valves larger than 16 mm 5/8 inch must be globe or angle type, wrench operated with ground-finish stems, or ball valves, packed especially for refrigerant service, back seated, and provided with seal caps. Refrigerant isolation and shutoff valves must have retained or captive spindles and facilities for tightening or replacement of the gland packing under line pressure as applicable. Stop valves must have back-seating plated steel stem, bolted bonnet in sizes 25 mm 1 inch OD and larger, integral or flanged transition brazed socket. Valves, in sizes through 65 mm 2-1/2 inches must be full-port, floating ball type, with equalizing orifice fitted chrome plated ball, seats and seals of tetrafluoroethylene, chrome plated or stainless steel stem, and seal cap. In sizes 100 mm 4 inch IPS and larger, and in smaller sizes where carbon steel piping is used, valve bodies must be tongue and groove flanged and complete with mating flange, gaskets and bolting for socket or butt-weld connection. Purge, charge and receiver valves must be of manufacturer's standard configuration.

2.19.1.2 Ammonia Service

****
NOTE: Delete this paragraph and subparagraphs if an ammonia system is not specified. Do not use ammonia for Navy and Marine Corps projects.
****

Valves must be straight or angle, packed, rising stem/handwheel fitted, globe type. Stem must be back-seating type, fitted with non-rotating, self-aligning, retained lead alloy seat disc. In sizes 19 mm 3/4 inch IPS and larger, bolt bonnets and buttweld or tongue and groove flange body end connections and furnish with mating flange, gaskets, and fasteners. Provide mating flange that is socket or buttweld connection type. In sizes under 19 mm 3/4 inch IPS, threaded ends will be acceptable. Ball valves constructed specifically for ammonia refrigeration service are acceptable.

2.19.2 Check Valve

Design valve for service application, spring-loaded type where required, with resilient seat and with flanged body in sizes 13 mm 1/2 inch and larger. Provide positive shutoff at [10.3][13.8][20.7] kPa [1-1/2][2][3] psi differential pressure.

2.19.3 Liquid Solenoid Valves

Provide valves in compliance with ANSI/AHRI 760 and suitable for continuous duty with applied voltages 15 percent under and 5 percent over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions. Valves must be direct-acting or pilot-operating type, packless, except that packed stem, seal capped; furnish manual lifting provisions. Solenoid coils must be moistureproof, UL approved, totally encapsulated or encapsulated and metal jacketed as required. Valves must have safe working pressure of 2758 kPa 400 psi and a maximum operating pressure differential of at least 1380 kPa 200 psi at 85 percent rated voltage. Valves must have an operating pressure differential suitable for the refrigerant used.

2.19.4 Expansion Valves

****

NOTE: Choose AHRI 751 SI AHRI 750 I-P for fluorocarbon service and ASHRAE 17 for ammonia service. Do not use ammonia for Navy and Marine Corps projects.

****

Provide expansion valves conforming to the requirements of [AHRI 751 SI AHRI 750 I-P][ASHRAE 17]. Valve must be of the diaphragm and spring type with internal or external equalizers, and bulb and capillary tubing. Provide valve with an external superheat adjustment along with a seal cap. Internal equalizers may be utilized where flowing refrigerant pressure drop between outlet of the valve and inlet to the evaporator coil is negligible and pressure drop across the evaporator is less than the pressure difference corresponding to 1 degree C 2 degrees F of saturated suction temperature at evaporator conditions. Bulb charge must be determined by the manufacturer for the application and liquid must remain in the bulb at all operating conditions. Do not use gas limited liquid charged valves and other valve devices for limiting evaporator pressure without a distributor or discharge tube or effective means to prevent loss of control when bulb becomes warmer than valve body. Pilot-operated valves must have a characterized plug to provide required modulating control. A de-energized solenoid valve may be used in the pilot line to close the main valve in lieu of a solenoid valve in the main liquid line. Provide an isolatable pressure gauge in the pilot line, at the main valve. Automatic pressure reducing or constant pressure regulating expansion valves may be used only where indicated or for constant evaporator loads. In direct-expansion unit cooler applications, thermostatic expansion valve discharge must be through distributor and distributing tubes or through a single tube outlet leading to an orificed header provided by the unit cooler manufacturer, supplying an evaporator coil with not more than four circuits. Size distributor orifices for application conditions and provide distributor by the thermostatic expansion valve manufacturer as a matched combination to suit evaporator coil circuitry. Where indicated, fit distributor tube with side inlet for hot gas bypass or defrosting. In single compressor/evaporator combinations, where compressor capacity control is only by on-off cycling, and if recommended by the compressor manufacturer, furnish thermostatic expansion valve with a small bleed passage between inlet and outlet to facilitate equalization of high and low side during off cycle. Electronic expansion valves suited for the application by the manufacture are acceptable.

2.19.5 Safety Relief Valve

****
NOTE: Three way valves should be used on ammonia vessels and equipment. Do not use ammonia for Navy and Marine Corps projects.
****

Valve must be the [two-way][three-way] type. Use single type valves only where indicated. Valve must bear the ASME code symbol. Valve capacity must be certified by the National Board of Boiler and Pressure Vessel Inspectors. Valve must be of an automatically reseating design after activation.

2.19.6 Evaporator Pressure Regulators, Direct-Acting

Valve must include a diaphragm/spring power assembly, external pressure adjustment with seal cap, and pressure gauge port. Maintain a constant inlet pressure by balancing inlet pressure on diaphragm against an adjustable spring load. Pressure drop at system design load must not exceed the pressure difference corresponding to a 1 degree C 2 degrees F change in saturated refrigerant temperature at evaporator operating suction temperature. Select spring for indicated maximum allowable suction pressure range. Electronic valves suited for the application by the manufacture are acceptable.

2.19.7 Refrigerant Access Valves

Provide refrigerant access valves and hose connections conforming to AHRI 720.

2.19.8 Service Gauge Fittings

Design fittings for connecting a pressure gauge with a hose fitting. Provide these fittings in the suction pipe at each unit cooler.

2.20 REFRIGERANT ACCESSORIES

2.20.1 Fans

Support fan wheel shafts by either maintenance-accessible lubricated anti-friction block-type bearings, or permanently lubricated ball bearings. Select unit fans to produce the air flow required at the fan total pressure. Thermal overload protection must be of the manual or automatic-reset type. Construct fan wheels or propellers of aluminum or galvanized steel. Provide galvanized steel centrifugal fan wheel housings, and construct both centrifugal and propeller fan casings of aluminum or galvanized steel. Hot-dip galvanize steel elements of fans, except fan shafts, after fabrication or fabricate of mill galvanized steel. Recoat mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting with an approved zinc-rich compound. Fan wheels or propellers must be statically and dynamically balanced. Limit forward curved fan wheels to [_____] mm inches. Direct-drive fan motors must be of the ECM variety. Provide centrifugal scroll-type fans with streamlined orifice inlet and V-belt drive. Each drive must be independent of any other drive. Propeller fans must be [direct-drive][V-belt] drive type with [adjustable][fixed] pitch blades. Mount v-belt driven fans on a corrosion protected drive shaft supported by either maintenance-accessible

lubricated anti-friction block-type bearings, or permanently lubricated ball bearings.

2.20.2 Pressure Vessels

Provide pressure vessels conforming to ASME BPVC SEC VIII D1 or UL 207, as applicable for maximum and minimum pressure or temperature encountered. Where referenced publications do not apply, test pressure components at 1-1/2 times design working pressure. Refrigerant wetted carbon steel surfaces must be pickled or abrasive blasted free of mill scale, cleaned, dried, charged, and sealed. Where service temperatures below minus 6.7 degrees C 20 degrees F are encountered, materials of construction must be low temperature alloy carbon steel.

2.20.2.1 Hot Gas Muffler

Unit must be selected by the manufacturer for maximum noise attenuation. Units rated for 105.5 kW 30 tons capacity and under may be field tunable type.

2.20.2.2 Liquid Receiver

****

NOTE: Delete the last sentence if inapplicable. Insulation may be required if the room where the receiver is located can reach a higher temperature than the saturation temperature of the refrigerant. Insulation is generally not needed in most applications.

****

Design, fill, and rate receiver in accordance with the recommendations of ANSI/AHRI 495, except as modified herein. Size receiver so that it is never filled beyond 80 percent of its total capacity. The remaining 20 percent must allow for liquid expansion. Provide receiver with a relief valve of capacity and setting in accordance with ASHRAE 15 & 34. Fit receiver to include an inlet pipe; an outlet drop pipe with oil seal and oil drain where necessary; two bulls-eye liquid level sight glass in same vertical plane, 90 degrees apart and perpendicular to axis of receiver or external gauge glass with metal guard and automatic stop valves;[a thermal well for thermostat;][a float switch column;][external float switches;] purge, charge, equalizing, pressurizing, plugged drain and service valves on the inlet and outlet connections. Receiver must be factory insulated with not less than 25 mm 1 inch thick, 100 percent adhesive bonded, vaportight, flexible, closed-cell elastomer and finished with two coats of solvent base PVC protective coating or 0.41 mm 0.016 inch thick aluminum jacket.

2.20.2.3 Oil Separator

****

NOTE: An oil separator may be required if a system has very low evaporator temperatures (minus 18 degrees C 0 degrees F or less), or very long runs of piping, or multiple compressors. Use ASHRAE Handbook, Refrigeration Systems and Applications for further guidance. Note that the inclusion of oil separators will not decrease the need for using proper pipe sizing and layout/sloping techniques to

ensure oil return.
****

Separator must be the high efficiency type, provided with removable flanged head for ease in removing float assembly and removable screen cartridge assembly. Do not exceed [69 kPa 10 psi][_____] pressure drop through a separator during the removal of hot gas entrained oil. Connections to compressor are as recommended by the compressor manufacturer. Provide separator with an oil float valve assembly or needle valve and orifice assembly, drain line shutoff valve, sight glass,[filter for removal of all particulate sized 0.01 mm and larger,][thermometer and low temperature thermostat fitted to thermal well,][immersion heater,][external float valve fitted with three-valve bypass,] and strainer.

2.20.2.4 Oil Reservoir

Reservoir capacity must equal one charge of all connected compressors. Provide reservoir with an external liquid gauge glass, plugged drain, and isolation valves. Provide vent piping between the reservoir and the suction header with a 34.5 kPa 5 psi pressure differential relief valve. Provide reservoir with the manufacturer's standard filter on the oil return line to the oil level regulators.

2.20.3 Condenser and Head Pressure Control

Unit must be capable of automatically operating without daily or seasonal adjustments in ambient temperature of [_____] degrees C degrees F. Set control for refrigerant condensing temperature of [_____] degrees C degrees F. Permit proper operation of system with proper differential pressure across the thermostatic expansion valve. Base control system on sensing of actual condensing pressure in conjunction with manufacturer's standard method of subcooling the saturated refrigerant. Set controls to produce a minimum [_____] degrees C degrees F subcooling. Liquid seal subcooling circuit. Air volume control will not be acceptable for ambient conditions below 2 degrees C 35 degrees F. Provide necessary accessories to maintain safe compressor discharge temperatures for low temperature systems.

2.20.4 Filter Driers

Driers must conform to AHRI 711AHRI 710 I-P. Sizes 16 mm 5/8 inch and larger must be the full flow, replaceable core type. Sizes 13 mm 1/2 inch and smaller must be the sealed type. Furnish cores of suitable desiccant that will not plug, cake, dust, channel, or break down, and that remove water, acid, and foreign material from the refrigerant. Construct filter driers so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure must be 10 MPa 1,500 psig.

2.20.5 Sight Glass and Liquid Level Indicator

2.20.5.1 Assembly and Components

Assembly must be pressure- and temperature-rated and constructed of materials suitable for the service. Glass must be borosilicate type. Ferrous components subject to condensation must be electro-galvanized.

2.20.5.2 Gauge Glass

Include top and bottom isolation valves fitted with automatic checks, and packing followers; red-line or green-line gauge glass; elastomer or polymer packing to suit the service; and gauge glass guard.

2.20.5.3 Bulls-Eye and Inline Sight Glass Reflex Lens

Provide bulls-eye and inline sight glass reflex lens for dead-end liquid service. For pipe line mounting, provide two plain lenses in one body suitable for backlighted viewing.

2.20.5.4 Moisture Indicator

Indicator must be a self-reversible action, moisture reactive, color changing media. Furnish indicator with full-color-printing tag containing color, moisture and temperature criteria. Unless otherwise indicated, the moisture indicator must be an integral part of each corresponding sight glass.

2.20.6 Flexible Pipe Connectors

Connector must be pressure and temperature rated for the service in accordance with ASHRAE 15 & 34 and ASME B31.5. Connector must be a composite of interior corrugated phosphor bronze or Type 300 series stainless steel, as required for fluid service, with exterior reinforcement of bronze, stainless steel or monel wire braid. Construct assembly with a safety factor of not less than 4 at 150 degrees C 300 degrees F. Unless otherwise indicated, the length of a flexible connector must be as recommended by the manufacturer for the service intended.

2.20.7 Strainers

Strainers used in refrigerant service must have brass or cast iron body, Y or angle pattern, cleanable, not less than 60-mesh noncorroding screen of an area to provide net free area not less than 10 times the pipe diameter with pressure rating compatible with the refrigerant service. Screens must be stainless steel or monel and reinforced spring-loaded where necessary for bypass-proof construction.

2.20.8 Brazing Materials

Furnish brazing materials for refrigerant piping in accordance with AWS A5.8/A5.8M, Classification BCuP-5.

2.20.9 Liquid and Suction Headers

Provide liquid and suction headers on each multi-compressor system. Size headers according to manufacturer's recommendations. Provide each header with service valves to permit servicing each unit cooler and forced circulation air coil. Each service valve must have a gauge port which can be closed by back-seating the valve and a front seat which can close off the line connected to the manifold. Provide each service valve with a removable, protective valve stem cap or cover.

2.20.10 Suction Accumulators

****

NOTE: Delete this paragraph if other means are

taken to prevent liquid carry-over and to assure oil return to the compressors.
****

Design and install accumulator within each suction header to provide a positive trap for liquid carry-over and to assure oil return to the compressors. An accumulator's internal liquid holding volume must be at least [_____] cubic meters feet. Ensure that oil is not trapped in the accumulator.

2.21 FACTORY FINISHES

2.21.1 Coil Corrosion Protection

****
NOTE: Research local conditions to determine the corrosiveness of the environment. Where condenser or evaporator coils are to be installed in highly corrosive atmospheres, carefully consider the coil and fin combinations specified. Standard coil construction is typically copper tubes with aluminum fins. For excessively corrosive atmospheres, either copper tubes with copper fins or aluminum tubes with aluminum fins should be considered.

For maximum coil protection, include the requirements of this paragraph. This paragraph addresses phenolic, vinyl, and epoxy type coatings. For coils with relatively close fin spacing the phenolic or epoxy coating are the preferred types as these have less tendency to bridge across the fins than vinyl. In addition, the phenolic and epoxy type coatings can typically provide better thermal conductivity than vinyl.

If coatings are specified, note that a coil's heat transfer capacity can be reduced anywhere between 1 to 5 percent; total unit capacity may have to be increased as a result.
****

Provide coil with a uniformly applied [epoxy electrodeposition] [phenolic] [vinyl] [epoxy electrodeposition, phenolic, or vinyl] type coating to all coil surface areas without material bridging between fins. Submit product data on the type coating selected, the coating thickness, the application process used, the estimated heat transfer loss of the coil, and verification of conformance with the salt spray test requirement. Apply coating at either the coil or coating manufacturer's factory. Ensure complete coil encapsulation. Provide coating capable of withstanding a minimum 1,000 hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.21.2 Equipment and Components

****
NOTE: A salt fog test should be required for all outdoor equipment. Specify a 125-hour test in noncorrosive environments and a 500-hour test in corrosive environments.

****

Unless otherwise specified, factory finish equipment and component items, when fabricated from ferrous metal, with the manufacturer's standard finish, except that items located outside of buildings must have weather resistant finishes that will withstand [125] [500] hours exposure to the salt spray test specified in ASTM B117 using a 25 percent sodium chloride solution. Immediately after completion of the test, the specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3 mm 1/8 inch on either side of the scratch mark. Coat cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used with a zinc-rich coating conforming to ASTM D520, Type I.

2.21.3 Color Coding

****

NOTE: Color coding for piping identification required by the using agency will be developed and inserted in the "Color Code Schedule" in Section 09 90 00 PAINTS AND COATINGS. For Air Force Installations, piping will be color-coded in accordance with Attachment 4 of AFM 88-15.

****

Color coding for piping identification is specified in Section 09 90 00 PAINTS AND COATINGS.

2.21.4 Color Coding Scheme

****

NOTE: Color Coding Scheme may be deleted in accordance with Notes in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

****

A color coding scheme for locating hidden piping must be in accordance with [Section 22 00 00 PLUMBING, GENERAL PURPOSE][Section 22 00 70 PLUMBING, HEALTHCARE FACILITIES].

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, perform verification of dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work. Submit a letter, at least 2 weeks prior to beginning construction, including the date the site was visited, confirmation of existing conditions, and any discrepancies found.

3.2 INSTALLATION

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NOTE: Delete the last sentence if an ammonia system is not specified. Do not use ammonia for Navy and Marine Corps projects.

****

Perform the work in accordance with the manufacturer's published diagrams,

recommendations, and equipment warranty requirements. Design, fabricate, and install system conforming to ASME BPVC SEC VIII D1 and ASME BPVC SEC IX as applicable. Where applicable, perform work in accordance with ASHRAE 15 & 34 and IIAR 2 for ammonia systems.

3.2.1 Equipment

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NOTE: Determine in the initial stages of design the approximate distances required for maintenance clearances of all new equipment. The maintenance clearances will be used in determining the final layout of the equipment.

****

Properly level, align, and secure equipment in place in accordance with manufacturer's instructions. Provide necessary supports for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps and similar items. Isolate compressors from the building structure. Select and size isolators based on load-bearing requirements and the lowest frequency of vibration to be isolated. Furnish foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for equipment indicated or required to have concrete foundations. Provide concrete for foundations as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.2 Mechanical Room Ventilation

****

NOTE: For mechanical rooms which are intended to house refrigeration equipment, designers will use ASHRAE 15 & 34 to determine applicable design criteria. Delete this paragraph if a mechanical room is not applicable to the design.

In summary, ASHRAE 15 & 34 allows the use of either natural or mechanical ventilation systems, however natural ventilation is allowed only in certain limited applications. Natural ventilation is allowed only when "a refrigerant system is located outdoors more than 6 m 20 feet from building openings and is enclosed by a penthouse, lean-to or other open structure", otherwise mechanical ventilation is required.

The amount of ventilation air required for a mechanical room will be determined based upon the ventilation equations in ASHRAE 15 & 34. In order to use these equations, a designer must approximate the mass of refrigerant (kgs or lbs) expected in the largest system located in the mechanical room. Refrigerant quantities will be determined based upon a minimum of 2 different system manufacturers.

a. For a natural ventilation system, ASHRAE 15 & 34 provides an equation for sizing the amount of free opening area required.

b. For a mechanical ventilation system, ASHRAE

15 & 34 requires both normal and alarm ventilation. Normal ventilation will be sized to cover personnel ventilation requirements (2.5 1/s/m2 or 0.5 cfm/ft2) and heat buildup requirements if applicable. Alarm ventilation will be sized based upon the equations in ASHRAE 15 & 34. Both the normal and alarm ventilation rates can be achieved using the same ventilation system (e.g., multi-speed exhaust fans), however, individual systems are preferred. For the alarm ventilation, exhaust intakes will be located near the equipment and close to the finished floor. Most commonly used refrigerants are heavier-than-air and subsequently sink to the floor. Also as prescribed in ASHRAE 15 & 34, air supply and exhaust ducts to the mechanical room will serve no other area within a facility. Discharge air from a mechanical ventilation system will be to the outdoors.

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Mechanical ventilation systems must be in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

3.2.3 Building Surface Penetrations

Provide sleeves in nonload bearing surfaces consisting of galvanized sheet metal, conforming to ASTM A653/A653M, Coating Class G-90, 1 mm (20 gauge) 20 gauge. Provide sleeves in load bearing surfaces consisting of uncoated carbon steel pipe, conforming to ASTM A53/A53M, [Schedule 30][Schedule 20][Standard weight]. Apply sealants to moisture and oil-free surfaces and elastomers to not less than 13 mm 1/2 inch depth. Do not install sleeves in structural members.

3.2.3.1 Refrigerated Space

Fit refrigerated space building surface penetrations with sleeves fabricated from hand-lay-up or helically wound, fibrous glass reinforced polyester or epoxy resin with a minimum thickness equal to equivalent size Schedule 40 steel pipe. Construct sleeves with integral collar or fit cold side with a bonded slip-on flange or extended collar. In the case of masonry penetrations where sleeve is not cast-in, fill voids with latex mixed mortar cast to shape of sleeve, and assemble flange/external collar type sleeve with butyl elastomer vapor barrier sealant through penetration to cold side surface vapor barrier overlap and fasten to surface with masonry anchors. Integral cast-in collar type sleeve must be flashed [as indicated.] [with not less than 100 mm 4 inches of cold side vapor barrier overlap of sleeve surface.] Seal normally noninsulated penetrating round surfaces to sleeve bore with mechanically expandable seals in vapor tight manner and insulate remaining warm and cold side sleeve depth with not less than [100][_____] mm [4][_____] inches of foamed-in-place rigid polyurethane or foamed-in-place silicone elastomer. Apply vapor barrier sealant to finish warm side insulation surface. Warm side of penetrating surface must be insulated beyond vapor barrier sealed sleeve insulation for a distance which prevents condensation. Seal wires in refrigerated space surface penetrating conduit with vapor barrier plugs or compound to prevent moisture migration through conduit and condensation therein.

3.2.3.2 General Service Areas

Extend each sleeve through its respective wall, floor, or roof, and cut flush with each surface. Provide pipes passing through concrete or masonry wall or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Provide a minimum of 6 mm 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, seal the annular space between pipe and sleeve or between jacket over-insulation and sleeve in accordance with Section 07 92 00 JOINT SEALANTS.

3.2.3.3 Waterproof Penetrations

Install pipes passing through roof or floor waterproofing membrane through a 0.48 kg 17 ounce copper sleeve or a 0.81 mm 0.032 inch thick aluminum sleeve, each within an integral skirt or flange. Suitably form flasing sleeve, and extend skirt or flange no less than 200 mm 8 inches from the pipe and set over the roof or floor membrane in a troweled coating of bituminous cement. Extend the flashing sleeve up the pipe a minimum of 50 mm 2 inches above the roof or floor penetration. Seal the annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation as indicated. Seal penetrations by either one of the following methods.

3.2.3.3.1 Waterproof Clamping Flange

Pipes up to and including 250 mm 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Clamp waterproofing membrane into place and place sealant in the caulking recess.

3.2.3.3.2 Modular Mechanical Type Sealing Assembly

In lieu of a waterproof clamping flange, a modular mechanical type sealing assembly may be installed. Seals must consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Loosely assemble links with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tighten the bolt to cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Size each seal assembly as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals must provide sleeves of the proper diameter.

3.2.3.4 Fire-Rated Penetrations

Seal penetration of fire-rated walls, partitions, and floors as specified in Section 07 84 00 FIRESTOPPING.

3.2.3.5 Escutcheons

Provide escutcheons for finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Where sleeves project slightly from floors, use special deep-type escutcheons. Secure escutcheon to pipe or pipe

covering.

3.2.4 Access Panels

Provide access panels for concealed valves, vents, controls, and items requiring inspection or maintenance. Provide access panels of sufficient size and locate so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels must be as specified in Section 08 31 00 ACCESS DOORS AND PANELS.

3.2.5 Refrigeration Piping

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NOTE: For the design of a refrigerant piping system a designer has basically two options:

1) 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.

2) 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.

3) Due to the possibility of stress fractures resulting from repeated temperature related expansion and contraction, the designer of record is responsible for determining whether to allow the use of 45 degree elbow fittings on each project.

****

Unless otherwise specified, perform pipe and fittings installation conforming to the requirements of ASME B31.5. Cut pipe accurately to the measurements established at the jobsite and work into place without springing or forcing. Cutting or otherwise weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipes must be cut square, must have burrs removed by reaming, and be installed in a manner to permit free expansion and contraction without damage to joints or hangers. Wipe filings, dust, or dirt from interior of pipe before connections are made.

3.2.5.1 Directional Changes

Make changes in direction with fittings, except that bending of pipe 100 mm 4 inches and smaller will be permitted, provided a pipe bender is used and wide-sweep bends are formed. The centerline radius of bends must not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, or other malformations will not be accepted.

3.2.5.2 Functional Requirements

Slope piping 13 mm/3 m 1/2 inch/10 feet of pipe in the direction of flow to ensure adequate oil drainage. Properly cap or plug ends of refrigerant lines or equipment during installation to keep moisture, dirt, or other foreign material out of the system. Keep piping capped until installation. Equipment piping must be in accordance with the equipment manufacturer's recommendations and the contract drawings.

3.2.5.3 Brazed Joints

Perform brazing in accordance with AWS BRH, except as modified herein. During brazing, the pipe and fittings must be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting must be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Do not use brazing flux. Surplus brazing material must be removed at all joints. Steel tubing joints must be made in accordance with the manufacturer's recommendations. Protect tubing against oxidation during brazing by continuous purging of the inside of the piping using nitrogen. Piping must be supported prior to brazing and must not be sprung or forced.

3.2.5.4 Threaded Joints

Make threaded joints with tapered threads and make tight with PTFE tape complying with ASTM D3308 or equivalent thread-joint compound applied to the male threads only. Do not show more than three threads after the joint is made.

3.2.5.5 Welded Joints

Welded joints in steel refrigerant piping must be fusion welded. Make changes in direction of piping with welded fittings only; mitering or notching pipe or other similar construction to form elbows or tees will not be permitted. Make branch connections with welding tees or forged welding branch outlets. Thoroughly clean steel pipe of all scale and foreign matter before the piping is assembled. During welding, fill the pipe and fittings with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Perform beveling, alignment, heat treatment, and inspection of weld conforming to ASME B31.1. Remove weld defects and reweld at no additional cost to the Government. Store and dry electrodes in accordance with AWS D1.1/D1.1M or as recommended by the manufacturer. Do not use electrodes that have been wetted or that have lost any of their coating.

3.2.5.6 Flanged Joints

Assemble flanged joints square and tight with matched flanges, gaskets, and bolts. Provide gaskets that are suitable for use with the refrigerants to be handled. When steel refrigerant piping is used, provide union or flange joints in each line immediately preceding the connection to each piece of equipment requiring maintenance, such as compressors, coils, refrigeration equipment, control valves, and other similar items.

3.2.5.7 Flared Connections

When flared connections are used, use a suitable lubricant between the

back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

3.2.6 Piping Supports

Refrigerant pipe supports must conform to ASME B31.5. Fabricate hangers used to support piping 50 mm 2 inches and larger to permit adequate adjustment after erection while still supporting the load. Install pipe guides and anchors to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Support piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, by variable spring hangers and supports or by constant support hangers.

3.2.6.1 Seismic Requirements

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NOTE: Provide seismic requirements for piping and related equipment supports , if a Government designer is the Engineer of Record, and show on the drawings. Delete the inappropriate bracketed phrase. Sections 13 48 73, 22 05 48.00 20, and 23 05 48.19, properly edited, must be included in the contract documents.

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Support and brace piping and attached valves to resist seismic loads [as specified in UFC 3-301-01 and Sections 13 48 73SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT[, 22 05 48.00 20 MECHANICAL SOUND, VIBRATION, AND SEISMIC CONTROL,][and 23 05 48.19 [SEISMIC] BRACING FOR HVAC]] [as indicated]. Provide structural steel, required for reinforcement, to properly support piping, headers, and equipment but not shown. Material used for support must be as specified in Section 05 12 00 STRUCTURAL STEEL.

3.2.6.2 Structural Attachments

Attachment to building structure concrete and masonry must be by cast-in-concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors must be applied with a safety factor not less than 5. Do not attach supports to metal decking. Construct masonry anchors for overhead applications of ferrous materials only. Material used for support must be as specified in Section 05 12 00 STRUCTURAL STEEL.

3.2.7 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports must conform to MSS SP-58, except as modified herein. Pipe hanger types 5, 12, and 26 must not be used.

3.2.7.1 Hangers

Do not use type 3 on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.2.7.2 Inserts

Secure type 18 inserts to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

3.2.7.3 C-Clamps

Torque type 19 and 23 C-clamps in accordance with MSS SP-58 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3.2.7.4 Angle Attachments

Furnish type 20 attachments used on angles and channels with an added malleable-iron heel plate or adapter.

3.2.7.5 Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, use the Type 39 saddle, connected to the pipe, on all pipe 100 mm 4 inches and larger when the temperature of the medium is 16 degrees C 60 degrees F or higher. Use type 40 shields on all piping less than 100 mm 4 inches and all piping 100 mm 4 inches and larger carrying medium less than 16 degrees C 60 degrees F. Use a high density insulation insert of cellular glass under the Type 40 shield for piping 50 mm 2 inches and larger.

3.2.7.6 Horizontal Pipe Supports

Space horizontal pipe supports as specified in MSS SP-58. Install a support not over 300 mm 12 inches from the pipe fitting joint at each change in direction of the piping. Space pipe supports not over 1525 mm 5 feet apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 23 kg 50 pounds must have the excess hanger loads suspended from panel points.

3.2.7.7 Vertical Pipe Supports

Support vertical pipe at each floor, except at slab-on-grade, and at intervals of no more than 4570 mm 15 feet, no more than 2440 mm 8 feet from end of risers, and at vent terminations.

3.2.7.8 Pipe Guides

Provide type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides where required to allow longitudinal pipe movement. Provide lateral restraints as required. Slide materials must be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

3.2.7.9 Steel Slides

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm 4 inches and larger, use a Type 39 saddle. On piping under 100 mm 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.2.7.10 High Temperature Guides with Cradles

Where there are high system temperatures and welding to piping is not desirable, include a pipe cradle, with the Type 35 guide, welded to the guide structure and strapped securely to the pipe. Separate the pipe from the slide material by at least 100 mm 4 inches, or by an amount adequate

for the insulation, whichever is greater.

3.2.7.11 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Spacing of the base support members must not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.2.8 Pipe Alignment Guides

Provide pipe alignment guides where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 1525 mm 5 feet on each side of each expansion joint, and in lines 100 mm 4 inches or smaller not more than 610 mm 2 feet on each side of the joint.

3.2.9 Pipe Anchors

Provide anchors wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors must consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Install anchor braces in the most effective manner to secure the desired results using turnbuckles where required. Do not attach supports, anchors, or stays where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, anchor these items immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal. Submit detailed drawings of pipe anchors for approval before installation.

3.2.10 Piping Identification

Identiy each piping system and direction of fluid flow in accordance with applicable provisions of ASME A13.1 with color coded, water, moisture and broad-spectrum temperature resistant, plastic labels.

3.2.11 Manual Valves

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NOTE: Delete the last sentence if an ammonia system is not specified. Do not use ammonia for Navy and Marine Corps projects.

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Install stop valves on each side of each piece of equipment such as compressors, condensers, evaporators, receivers, and other similar items in multiple-unit installation, to provide partial system isolation as required for maintenance or repair. Install angle and globe valves with stems horizontal unless otherwise indicated. Install ball valves with stems positioned to facilitate operation and maintenance. Provide isolating valves for pressure gauges and switches external to thermal insulation. Do not fit safety switches with isolation valves. Extend thermal wells for insertion thermometers and thermostats beyond thermal insulation surface no less than 25 mm 1 inch. Filter dryers having access ports may be considered a point of isolation. Provide purge valves at all points of systems where accumulated noncondensable gases would prevent proper system operation. Furnish valves to match line size, unless

otherwise indicated or approved. Provide drain valves in bottom of risers and low points of ammonia piping.

3.2.12 Expansion Valves

Install expansion valves with the thermostatic expansion valve bulb located on top of the suction line when the suction line is less than 50 mm 2 inches in diameter and at the 4 o'clock or 8 o'clock position on lines larger than 50 mm 2 inches. Securely fasten the bulb with two clamps. Insulate the bulb. Install the bulb in a horizontal portion of the suction line, if possible, with the pigtail on the bottom. If the bulb is installed in a vertical line, the bulb tubing must be facing up.

3.2.13 Valve Identification

Tag each system valve, including those which are part of a factory assembly. Tags must be in alphanumeric sequence, progressing in direction of fluid flow. Tags must be embossed, engraved, or stamped plastic or nonferrous metal of various shapes, sized approximately 35 mm 1-3/8 inch diameter, or equivalent dimension, substantially attached to a component or immediately adjacent thereto. Attach tags with nonferrous, heavy duty, bead or link chain, 14 gauge 14 gauge annealed wire, nylon cable bands or as approved. Reference tag numbers in Operation and Maintenance Manuals and system diagrams.

3.2.14 Strainers

Provide strainers immediately ahead of solenoid valves and expansion devices and where indicated. Strainers may be an integral part of the expansion valve.

3.2.15 Filter Dryer

Provide a liquid line filter dryer on each refrigerant circuit located so that all liquid refrigerant passes through a filter dryer. Size dryers in accordance with the manufacturer's recommendations. Install dryer so that it can be isolated from the system, evacuate the isolated portion of the system, replace and the filter dryer. Install dryers in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

3.2.16 Sight Glass

Install a moisture indicating sight glass in refrigerant circuits down stream of filter dryers and where indicated. Sight glass must be full line size.

3.2.17 Thermometers

Fit thermometers with thermal well. Do not use Mercury in thermometers. Where test thermometer locations are indicated, only provide plugged thermal well. Thermometers located within 1525 mm 5 feet of floor may be rigid stem type. Where thermal well is located above 1525 mm 5 feetabove floor, thermometer must be universal adjustable angle type or remote element type to 2135 mm 7 feet above floor and remote element type where thermal well is 2135 mm 7 feet or more above floor. Locate thermometers in coolant supply and return or waste lines at each heat exchanger, at each automatic temperature control device without an integral thermometer, refrigerant liquid line leaving receiver, refrigerant suction line at each

unit cooler, and where indicated or required for proper operation of equipment.

3.2.18 Flexible Connectors

Install flexible metallic connectors perpendicular to line of motion being isolated. Fit piping for equipment with bidirectional motion with two flexible connectors, in perpendicular planes. Install reinforced elastomer flexible connectors in accordance with manufacturer's instructions. Provide piping guides and restraints related to flexible connectors as required. Provide connectors in the suction and discharge lines on spring mounted compressors. Anchor connectors firmly at the upstream end on the suction line and the downstream end in the discharge line.

3.2.19 Power Transmission Components Adjustment

V-belts and sheaves must be properly aligned and tensioned preliminary to operation and after 72 hours of operation at final speed. Belts on drive side must be uniformly loaded, not bouncing. Alignment of direct-drive couplings must be to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.2.20 Unit Cooler Drainage

Drain lines from product storage spaces maintained at 2 degrees C 35 degrees F or lower must be fitted with NSF approved connections and cleanout tee; must be short as possible; must not be trapped; and must not be combined, unless all combined units are defrosted simultaneously and are controlled by a single timer. Drain lines may be combined in spaces maintained at nonfreezing temperatures after individual trapping. Heat trace and insulate drain lines starting with drain pan fitting through the surface penetration into a nonfreezing space, a distance sufficient to ensure freedom from ice during defrost cycle. Drain line size must be not less than drain pan outlet size. Drain line must be pitched as shown on the project design documents, and not less than 6 mm/300 mm 1/4 inch/foot where not shown. Drain line heat tracing must be[electric][and][hot gas] as indicated.[Route hot gas supply line to the unit cooler in contact with the drain line by banding with all stainless steel worm drive hose clamps on no more than 300 mm 12 inch centers and increase heat transfer area by continuous tangential fillets of heat conducting paste.][Electrically heat traced drain lines must utilize external or internal to drain line heating elements, applied to produce watt-density and temperature recommended by the manufacturer. Where metallic sheathed heat tracer is used in contact with metallic drain line or internal thereto, sheath material must be stainless steel. Install external metallic sheathing by banding on no more than 300 mm 12 inch centers with all stainless steel worm drive hose clamps and increase heat transfer area by continuous tangential fillets of heat conducting paste. Electric heat tracing power supply must be as indicated.]

3.2.21 Field Applied Insulation

Field applied insulation must be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.2.22 Factory Applied Insulation

****

NOTE: Include or delete items requiring factory applied insulation as applicable.
****

Insulate suction headers, liquid receivers, oil separators, and oil reservoirs with no less than 19 mm 3/4 inch thick unicellular plastic foam as a standard manufacturer's process.

3.2.23 Framed Instructions

Submit framed instructions for posting, at least 2 weeks prior to construction completion. Frame under glass or laminated plastic and post where directed. Include equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. Include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system in the condensed operation instructions. Post the instructions before acceptance testing of the system.

3.3 LOCATIONS AND CLEARANCES

Locate equipment so that working space is available for necessary servicing such as shaft removal, disassembling compressor cylinders and pistons, replacing or adjusting drives, motors, or shaft seals, access to water heads and valves of shell and tube equipment, tube cleaning or replacement, access to automatic controls, refrigerant charging, lubrication, oil draining and working clearance under overhead lines.

3.4 TESTS

Submit a letter, at least [10] [_____] working days in advance of each test, advising the Contracting Officer of the test. Submit individual letters for the refrigerant system, the system performance, and the acceptance tests. Identify the date, time, and location for each test. Conduct tests in the presence of the Contracting Officer. Provide utilities for testing as specified in the SPECIAL CONTRACT REQUIREMENTS. Water and electricity required for the tests will be furnished by the Government. Provide material, equipment, instruments, and personnel required for the test.

a. Coordinate field tests with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

b. Submit [6] [_____] copies of each test containing the information described below in bound 216 by 279 mm 8-1/2 by 11 inch booklets. Submit individual reports for the refrigerant system, the system performance, and the acceptance tests.

   (1) The dates the tests were started and completed.
   (2) A list of equipment used, with calibration certifications.
   (3) Initial test summaries.
   (4) Repairs/adjustments performed.
   (5) Final test results and comments.

3.4.1 Refrigerant System

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NOTE: Where applicable condensing temperature is

over 55 degrees C 130 degrees F, equipment and piping will be capable of withstanding leak pressure tests at not less than the design pressure corresponding to the condensing pressure during the higher ambient conditions. (Refer to ASHRAE 15 & 34.)

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After all components of the refrigerant system have been installed and connected, subject the entire refrigeration system to a pneumatic test as specified.

3.4.1.1 Preliminary Procedures

Prior to pneumatic testing, isolate equipment which has been factory tested and refrigerant charged as well as equipment which could be damaged or cause personnel injury by imposed test pressure, positive or negative, from the test pressure or remove from the system. Remove safety relief valves and rupture discs, where not part of factory sealed systems, and cap or plug openings.

3.4.1.2 Pneumatic Test

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NOTE: Delete the last sentence if an ammonia system is not specified. Do not use ammonia for Navy and Marine Corps projects.

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Provide pressure control and excess pressure protection at the source of test pressure. Valves must be wide open, except those leading to the atmosphere. Test gas must be dry nitrogen, with minus 56.7 degrees C minus 70 degree F dewpoint and less than 5 ppm oil. Apply test pressure in two stages before any refrigerant pipe is insulated or covered. First stage test is at 69 kPa 10 psig with every joint being tested with a thick soap or color indicating solution. During second stage tests raise the system to the minimum refrigerant leakage test pressure specified in ASHRAE 15 & 34 or IIAR 2 with a maximum test pressure of 25 percent greater than specified. Test ammonia unloading lines at 2415 kPa 350 psig. Pressure above 690 kPa 100 psigmust be raised in 10 percent increments with a pressure acclimatizing period between increments. Record the initial test pressure along with the ambient temperature to which the system is exposed. Maintain final test pressures of the second stage on the system for a minimum of 24 hours. At the end of the 24 hour period, record the system pressure along with the ambient temperature to which the system is exposed. A correction factor of 2 kPa 0.3 psi will be allowed for each degree change between test space initial and final ambient temperature, plus for increase and minus for a decrease. If the corrected system pressure is not exactly equal to the initial system test pressure, investigate the system for leaking joints. To repair leaks, take the joint apart, thoroughly clean, and reconstruct as a new joint. Joints repaired by caulking, remelting, or back-welding/brazing will not be acceptable. Following repair, retest the entire system using the pneumatic tests described above. Reassemble the entire system once the pneumatic tests are satisfactorily completed.

3.4.1.3 Evacuation Test

Following satisfactory completion of the pneumatic tests, relieve the

pressure and evacuate the entire system to an absolute pressure of 300 microns. During evacuation of the system, the ambient temperature must be higher than 2 degrees C 35 degrees F. Do not evacuate more than one system at one time by one vacuum pump. Once the desired vacuum has been reached, close the vacuum line and allow the system to stand for 1 hour. If the pressure rises over 500 microns after the 1 hour period, evacuate the system again down to 300 microns and let set for another 1 hour period. Do not charge the system until a vacuum of at least 500 microns is maintained for a period of 1 hour without the assistance of a vacuum line. If, during the testing, the pressure continues to rise, check the system for leaks, repair as required, and repeat the evacuation procedure repeated. During evacuation, record pressures by a thermocouple type, electronic type, or a calibrated-micron type gauge.

3.4.1.4 System Charging and Startup Test

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NOTE: Delete the last sentence if an ammonia system is not specified. Do not use ammonia for Navy and Marine Corps projects.
****

Following satisfactory completion of the evacuation tests, charge the system with the required amount of refrigerant by raising pressure to normal operating pressure, and in accordance with manufacturer's procedures. Following charging, operate the system with high-side and low-side pressures and corresponding refrigerant temperatures, at design or improved values. Test the entire system for leaks. Test fluorocarbon systems with halide torch or electronic leak detectors. Test ammonia systems with sulphur tapers. When charging and testing with ammonia under pressure, provide gas masks.

3.4.1.5 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, immediately isolate the leaking portion of the system from the remainder of the system and pump the refrigerant into the system receiver or other suitable container. Do not discharge the refrigerant into the atmosphere.

3.4.1.6 Contractor's Responsibility

Take steps to prevent the release of refrigerants into the atmosphere at all times during the installation and testing of the refrigeration system. The steps include, but are not limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. Do not release more than 85 grams 3 ounces of refrigerant to the atmosphere in any one occurrence. Repair system leaks within the first year in accordance with the requirements herein at no cost to the Government, including material, labor, and refrigerant, if the leak is the result of defective equipment, material, or installation.

3.4.2 System Performance

After the foregoing tests have been completed and before each refrigeration system is accepted, conduct tests to demonstrate the general operating characteristics of all equipment by a registered professional engineer or an approved manufacturer's startup representative experienced

in system startup and testing, at such times as directed. Tests must cover a period of not less than [_____] days for each system and demonstrate that the entire system is functioning in accordance with the drawings and specifications. Make corrections and adjustments as necessary and re-conduct tests to demonstrate that the entire system is functioning as specified. Replace any refrigerant lost during the system startup. During the system performance tests, maintain a report to document compliance with the specified performance criteria upon completion and testing of the system. Include the following information at a minimum and must be taken at least three different times at outside dry-bulb temperatures that are at least 3 degrees C 5 degrees F apart:

a. Date and outside weather conditions.

b. The load on the system based on the following:
   (1) The refrigerant used in the system.
   (2) Condensing temperature and pressure.
   (3) Suction temperature and pressure.
   (4) Ambient, condensing and coolant temperatures.
   (5) Running current, voltage and proper phase sequence for each phase of all motors.

c. The actual onsite setting of operating and safety controls.

d. Thermostatic expansion valve superheat-value as determined by field test.

e. Subcooling.

f. High and low refrigerant temperature switch set-points.

g. Low oil pressure switch set-point.

h. Defrost system timer and thermostat set-points.

i. Moisture content.

j. Capacity control set-points.

k. Field data and adjustments which affect unit performance and energy consumption.

l. Field adjustments and settings which were not permanently marked as an integral part of a device.

3.5 TRAINING

Conduct training for the operating staff as designated by the Contracting Officer. Submit a letter, at least 14 working days prior to the date of the proposed training, identifying the date, time, and location for the training which must start after the system is functionally completed but prior to final acceptance tests. Training must be under the direction of a registered professional engineer who must attest to installed systems and equipment compliance with the requirements of the contract documents. Training includes operation of systems equipment and controls through normal ranges and sequences and simulation of abnormal conditions. Each device must be caused to function manually and automatically in accordance with its purpose. The field instructions must cover the items contained in the Operation and Maintenance Manuals as well as demonstrations of

routine maintenance operations.

3.6 ACCEPTANCE TESTS

Upon completion and prior to acceptance of the work, perform pre-operational checkout, calibration and adjustment of system components to ensure and demonstrate stable, accurate, reproducible, energy efficient operation and optimum performance. Operate systems for [48][_____] hours after all major corrections have been made. If tests do not demonstrate satisfactory system performance, correct deficiencies and retest system. Prior to acceptance, install and tightenservice valve seal caps and blanks over gauge points.

3.7 FIELD PAINTING

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09 90 00 PAINTS AND COATINGS.

3.8 CLEANING AND ADJUSTING

Wipe equipment clean, with all traces of oil, dust, dirt, or paint spots removed. Maintain system in this clean condition until final acceptance. Properly lubricate bearings with oil or grease as recommended by the manufacturer. Tighten belts to proper tension. Adjust control valves and other miscellaneous equipment requiring adjustment to setting indicated or directed.

-- End of Section --