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USACE / NAVFAC / AFCEC / NASA	**UFGS-23 64 00 (November 2016)** **Change 2 - 08/18**
Preparing Activity: NAVFAC	**Superseding** **UFGS-23 64 00 (August 2009)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021

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SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 64 00

PACKAGED WATER CHILLERS, ABSORPTION TYPE

11/16, CHG 2: 08/18

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 SAFETY REQUIREMENTS
1.4 DELIVERY, STORAGE, AND HANDLING
1.5 PROJECT REQUIREMENTS
1.5.1 Verification of Dimensions
1.5.2 Drawings

PART 2 PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS
2.2 NAMEPLATES
2.3 ELECTRICAL WORK
2.4 CHILLER COMPONENTS
2.4.1 Tools
2.5 ABSORPTION WATER CHILLER
2.5.1 General
2.5.2 Assembly
2.5.3 Operation
2.5.4 Components
2.5.4.1 Absorber, Evaporator, Condenser & Generator
2.5.4.2 Tube Bundles
2.5.4.3 Heads
2.5.4.4 Purge System
2.5.4.5 Crystallization
2.5.4.6 Refrigerant and Absorber
2.5.5 Combustion Burner Assembly
2.5.6 Controls Package
2.5.6.1 Operating Controls
2.5.6.2 Monitoring Capabilities
2.5.6.3 Programmable Setpoints
2.5.6.4 Safety Controls with Manual Reset

2.5.6.5 Remote Alarm
2.5.6.6 Utility Monitoring and Control System
2.6 ACCESSORIES
2.6.1 Cleaning Brushes
2.6.2 Gaskets
2.6.3 Bolts and Nuts
2.7 FABRICATION
2.7.1 Factory Coating
2.7.2 Factory Applied Insulation
2.8 SUPPLEMENTAL COMPONENTS/SERVICES
2.8.1 Charging and Testing
2.8.2 Chilled and Condenser Water Piping and Accessories
2.8.3 Cooling Tower
2.8.4 Temperature Controls

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Installation Instructions
3.1.2 Vibration Isolation
3.1.3 Posted Instructions
3.1.4 Verification of Dimensions
3.1.5 System Performance Test Schedules
3.1.6 Demonstrations
3.1.7 Certificates
3.1.8 Operation and Maintenance Manuals
3.1.9 Connections to Existing Systems
3.1.10 Mechanical Room Ventilation
3.1.11 Field Applied Insulation
3.1.12 Field Painting
3.2 MANUFACTURER'S FIELD SERVICE
3.3 CLEANING AND ADJUSTING
3.4 FIELD ACCEPTANCE TESTING
3.4.1 Test Plans
3.4.2 Testing
3.5 SYSTEM PERFORMANCE TESTS
3.5.1 General Requirements
3.5.2 Test Report
3.6 DEMONSTRATIONS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC / NASA | **UFGS-23 64 00 (November 2016)**
Change 2 - 08/18

Preparing Activity: NAVFAC | **Superseding**
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SECTION 23 64 00

PACKAGED WATER CHILLERS, ABSORPTION TYPE
11/16, CHG 2: 08/18

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NOTE: This guide specification covers the requirements for packaged water chillers, absorption type equipment.

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).

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CAMP LEJEUNE NOTE: Do not specify packaged water chiller absorption type for Camp Lejeune projects without specific approval from the base

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PART 1 GENERAL

1.1 REFERENCES

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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)

ANSI/AHRI 560	(2000) Absorption Water Chilling and Water Heating Packages

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

ANSI/ASHRAE 15 & 34	(2013) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1	(2012) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM B395/B395M	(2018) Standard Specification for U-Bend Seamless Copper and Copper Alloy Heat Exchanger and Condenser Tubes
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F104	(2011; R 2020) Standard Classification System for Nonmetallic Gasket Materials

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2018) Motors and Generators
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2021) National Fuel Gas Code

1.2 SUBMITTALS

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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.

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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[, [_____]]

SD-03 Product Data

Absorption Water Chiller; G[, [_____]]

Posted Instructions; G[, [_____]]

Verification of Dimensions; G[, [_____]]

System Performance Tests; G[, [_____]]

Demonstrations

[Absorption Water Chiller - Field Acceptance Test Plan

] SD-06 Test Reports

Field Acceptance Testing; G[, [_____]]

[Absorption Water Chiller - Field Acceptance Test Report; G[, [_____]]

] System Performance Tests; G[, [_____]]

SD-07 Certificates

Absorption Water Chiller; G[, [_____]]

SD-08 Manufacturer's Instructions

[Water Chiller - Installation Instructions; G[, [_____]]

] SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

SD-11 Closeout Submittals

Indoor Air Quality During Construction; S

1.3 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices must be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements must be in accordance with AWS Z49.1. Fuel-fired equipment must be in accordance with NFPA 54.

1.4 DELIVERY, STORAGE, AND HANDLING

Stored items must be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged must be replaced at the Contractor's expense. During installation, piping and similar openings must be capped to keep out dirt and other foreign matter.

1.5 PROJECT REQUIREMENTS

1.5.1 Verification of Dimensions

The Contractor must become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.5.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor must carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and must arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions. The Contractor must submit detailed drawings consisting of:

a. Equipment layouts which identify assembly and installation details.

b. Plans and elevations which identify clearances required for maintenance and operation.

c. Wiring diagrams which identify each component individually and all interconnected or interlocked relationships between components.

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

e. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

PART 2 PRODUCTS

****

Minimum chiller efficiencies will either be presented in this specification or on the design drawings. Delete chiller efficiencies in the specification if efficiencies are shown on the drawings. If the efficiencies are shown on the drawings, reference the applicable ARI standard.

The following is a list of terms which are commonly used in regard to efficiency ratings of equipment defined within this specification.

COP - Coefficient of Performance (dimensionless)
EER - Energy Efficiency Ratio (kW/kW) (Btuh/Watt)
IPLV - Integrated Part Load Value (dimensionless or kW/kW kW/ton)
NPLV - Non-Standard Part Load Value (dimensionless or kW/kW kW/ton)

Note that the IPLV ratings presented by manufacturers are based upon standard rating conditions established by ARI. NPLV ratings on the

other hand are based upon site specific rating conditions. NPLV ratings should be specified in most applications. NPLV ratings will be coordinated with ARI and with the chiller manufacturers.

Minimum efficiency ratings for absorption chillers are defined under paragraph ABSORPTION LIQUID CHILLER.

****

2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment must be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products must have been in satisfactory commercial or industrial use for two years prior to bid opening. The two year use must include applications of equipment and materials under similar circumstances and of similar size. The two years experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a two 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. System components must be environmentally suitable for the indicated locations.

2.2 NAMEPLATES

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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.

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Major equipment including chillers, water coolers, heat exchanges, and motors must have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates must be durable and legible throughout equipment life and made of [anodized aluminum][stainless steel][_____]. Plates must be fixed in prominent locations with nonferrous screws or bolts.

2.3 ELECTRICAL WORK

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NOTE: Where motor starters for mechanical equipment are provided in motor-control centers, the references to motor starters will be deleted.

Show the electrical characteristics, motor starter type(s), enclosure type, and maximum rpm on the drawings in the equipment schedules.

Where reduced-voltage motor starters are recommended by the manufacturer or required otherwise, specify and coordinate the type(s) required in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Reduced

voltage starting is required when full voltage starting will interfere with other electrical equipment and circuits and when recommended by the manufacturer. Where adjustable speed drives (ASD) are specified, reference Section 26 29 23ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS. The methods for calculating the economy of using an adjustable speed drive is described in UFC 3-520-01, "Interior Electrical Systems".
****

a. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown, must be provided. For packaged equipment, the manufacturer must provide controllers including the required monitors and timed restart.

b. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11.

c. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system, and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1.

****
NOTE: Bracketed sentence "Motor bearings..." to be used for Army projects only.
****

d. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Motors must be rated for continuous duty with the enclosure specified. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. 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. Provide motor starters complete with thermal overload protection and other necessary appurtenances. [Motor bearings must be fitted with grease supply fittings and grease relief to outside of the enclosure.] Motor enclosure type may be either TEAO or TEFC.

e. [Where two-speed motors are indicated, variable-speed controllers may be provided to accomplish the same function.][Use adjustable frequency drives for all variable-speed motor applications.] Provide variable frequency drives for motors as specified in Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS.

f. Provide inverter duty premium efficiency motors for use with variable frequency drives.

2.4 CHILLER COMPONENTS

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NOTE: Coordinate the type of chiller components required with the type of chiller specified in the previous paragraphs. Components define under this paragraph do not apply to absorption type chillers. Delete this paragraph if only absorption type chillers are specified.
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NOTE: Paragraph TOOLS to be used in Army projects only.
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[2.4.1 Tools

One complete set of special tools, as recommended by the manufacturer for field maintenance of the system, must be provided. Tools must be mounted on a tool board in the equipment room or contained in a toolbox as directed by the Contracting Officer.

]2.5 ABSORPTION WATER CHILLER

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NOTE: Minimum efficiency ratings for absorption chillers must meet the requirements of ASHRAE 90.1 Table 6.8.1.C.
****

2.5.1 General

Chiller must be tested and rated in accordance with ANSI/AHRI 560, ANSI/ASHRAE 15 & 34 and must bear the appropriate underwriter's laboratories (UL) label. [Integrated Part Load Value (IPLV)] [Application Part Load Value (APLV)] of [_____] COP in accordance with ANSI/AHRI 560. Chiller must have a minimum cooling COP of [_____] at part load conditions in accordance with ANSI/AHRI 560. Chiller must be the [single-stage] [two-stage] hermetic, water-cooled type design. Chiller must be [indirectly-fired with [steam] [hot water]] [directly-fired with a [single] [dual] fuel burner]. [For direct-fired units, ratings for cooling capacity, fuel consumption, and COP must be based on the higher heating value (HHV) or the specific type of fuel utilized.] Chiller exterior surfaces must be factory painted, finished, and insulated as applicable.

2.5.2 Assembly

Unless necessary for delivery purposes, chiller must be assembled, leak-tested, charged, and adjusted at the factory. In lieu of delivery constraints, a chiller may be assembled, leak-tested, charged, and adjusted at the job site by a factory representative. Unit components delivered separately must be sealed and charged with a nitrogen holding charge. Unit assembly must be completed in strict accordance with manufacturer's recommendations.

2.5.3 Operation

Chiller must operate within capacity range and speed recommended by the manufacturer. Parts weighing 23 kg 50 pounds or more which must be removed for inspection, cleaning, or repair must have lifting eyes or lugs. Chiller must be provided with insulation on surfaces subject to sweating including the water cooler and water boxes. Chiller must be provided from the factory with a single point wiring connection for incoming power supply. Magnetic across-the-line motor starters with overload protection must be provided for each factory supplied pump. Chiller must include all customary auxiliaries deemed necessary by the manufacturer for safe, controlled, automatic operation of the equipment. Unit shall be capable of operating automatically and continuously between 10 percent and 100 percent of full load.

2.5.4 Components

Chiller shall include the following as a minimum:

a. Absorber, evaporator, and condenser

b. [Generator][First and second stage generators]

c. Refrigerant, absorber, and inhibitor solutions

d. [Low][Low and high] temperature heat exchanger(s)

e. Self-contained, hermetically sealed, self lubricating, water cooled, refrigerant and solution pumps. Pumps shall be direct coupled with the motor and shall include isolation valves.

f. Anticrystallization or automatic decrystallization system

[g. Factory-installed combustion burner assembly and pre-piped fuel train

][h. Cooling/heating switch valve

][i. Exhaust gas economizer

] j. [Automatic][Manual] purge system

k. Chiller controls package

l. Interconnecting piping and wiring

m. [Grooved mechanical][Flanged][Welded] connections for water boxes

n. Refrigerant spray nozzles

o. Factory-mounted structural steel base (welded or bolted) or support legs

p. Thermometers and sight glasses to allow visual inspection of unit operation. Mercury shall not be used in thermometers.

2.5.4.1 Absorber, Evaporator, Condenser & Generator

The absorption unit shall be of the shell-and-tube type construction which shall be designed, constructed, tested, and certified in accordance with

ASME BPVC SEC VIII D1. The absorber, evaporator, and condenser shall be suitable for not less than [1,000][1,750] kPa [150][250] psig working pressure. The generator shall have a heating medium of [steam] [hot water]. The absorption unit may be enclosed in one or two shells with removable water boxes or heads. Condenser tubes shall be seamless copper or copper-nickel. Generator tubes shall be seamless copper-nickel. Absorber and evaporator tubes shall be either seamless copper or seamless copper-nickel. Tube ends shall be rolled into or silver brazed to tube sheets. All copper or copper-nickel tubes shall be seamless and be in accordance with ASTM B395/B395M. [For double effect absorption chiller[/heaters], first stage concentrator tubes shall be titanium and the steam circuit shall comply with ASME BPVC SEC VIII D1. Double effect absorption chillers[/heaters] shall be equipped with capacity modulation to control solution flow entering and leaving the first stage concentrator.]

2.5.4.2 Tube Bundles

Provide sufficient clearance between tubes and an adequate number of support sheets, with tubes fitted in the sheets, to prevent chafing of tubes or crevice corrosion due to uneven tube expansion, vibration, or pulsation. Holes in the tube sheets shall not have sharp corners. Each tube shall be removable, in one piece, through holes individually provided for it in tube and support sheets. Water velocities through cooler, condenser and absorber tubes shall range from less than 0.9 to 3.7 m/s 3 to 12 fps. Condenser shall be [single][double]-tube bundle type.

2.5.4.3 Heads

Provide removable, welded-steel or cast-iron heads for external steam and water connections to permit access to tubes for inspection and cleaning. Design and test water spaces for a working pressure of not less than 150 psig. Water spaces that are not subject to the ASME Code, due to the size or other limitations, shall be tested at a pressure of not less than 1.5 times the working pressure.

2.5.4.4 Purge System

Provide chiller with an automatically controlled purge system consisting of a motor driven, jet type, or viscosity type, high vacuum pump with separators, pipe connections, and controls. Provide positive protection against return air to unit when evacuator is not in operation.

2.5.4.5 Crystallization

Provide for automatic decrystallization or anti-crystallization, in accordance with manufacturer's standard. If decrystallization is used, provide and arrange for supplemental heating elements if required for automatic operation.

2.5.4.6 Refrigerant and Absorber

Refrigerants shall be distilled or deionized water. Absorbent shall be lithium bromide.

Absorber unit shall be fully charged with water and a nontoxic absorber after installation. Refrigerant and inhibitors shall not generate films that would reduce machine efficiency by coating tubes. The corrosion inhibitor shall not cause the solution to be classified as hazardous waste

under the Resource Conservation and Recovery Act.

2.5.5 Combustion Burner Assembly

Chiller shall be provided with a forced draft, flame retention type burner and fuel train assembly. Burner shall be the [single] [dual] fuel type capable of burning [natural gas] [propane] [and] [number 1 fuel oil] [number 2 fuel oil] [diesel]. Burner and fuel train shall be listed by the underwriters laboratories (UL). Burner assembly shall be provided with all pressure regulators, switches, controls, ignition system, blower fans, and other devices required for proper and safe operation of the burner. Burner assembly shall be equipped with an external primary-secondary air ratio adjustment that allows adjustment without dismantling the burner. Burner controls shall allow either manual or automatic burner operation. Fuel changeover shall be accomplished [by a manual fuel changeover switch] [automatically as indicated].

2.5.6 Controls Package

Chiller shall be provided with a complete factory mounted and prewired electric or microprocessor based control system. Controls package shall be [unit-mounted] [floor-mounted where indicated] which contains as a minimum a digital display or acceptable gauges, an on-auto-off switch, motor starters, power wiring, control wiring, and disconnect switches. Controls package shall provide operating controls, monitoring capabilities, programmable setpoints, safety controls, and UMCS interfaces as defined below.

2.5.6.1 Operating Controls

Chiller shall be provided with the following adjustable operating controls as a minimum.

a. Leaving chilled water temperature control

b. System capacity control to adjust the unit capacity in accordance with the system load and the programmable setpoints. Controls shall automatically re-cycle the chiller on power interruption.

2.5.6.2 Monitoring Capabilities

During normal operations, the control system shall be capable of monitoring and displaying the following operating parameters. Access and operation of display shall not require opening or removing any panels or doors.

a. Entering and leaving chilled water temperatures

b. Entering and leaving condenser water temperatures

c. Refrigerant and solution temperatures

d. Generator pressures and temperatures

e. Self diagnostic

f. Operation status

g. Operating hours

h. Number of starts

i. Number of purge cycles over the last 7 days

2.5.6.3 Programmable Setpoints

The control system shall be capable of being reprogrammed directly at the unit. No parameters shall be capable of being changed without first entering a security access code. The programmable setpoints shall include the following as a minimum.

a. Leaving Chilled Water Temperature

b. Leaving Condenser Water Temperature

c. Time Clock/Calendar Date

2.5.6.4 Safety Controls with Manual Reset

Chiller shall be provided with the following safety controls which automatically shutdown the chiller and which require manual reset.

a. Refrigerant or solution pump thermal or current overload

b. Low refrigerant temperature

c. Loss of chilled water

d. Loss of condenser water

e. High or low condenser water temperatures

f. Power failure

g. Generator high temperature or pressure

h. Low solution level

[i. Burner or related combustion malfunction
]

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NOTE: Safeties shall be per UL Standards 795 Oil for Heating Equipment and 726 Oil for Direct-Fired Water Chilling-Heating Units.
****

[j. Burner controls and [gas][oil] train.

]2.5.6.5 Remote Alarm

During the initiation of a safety shutdown, the control system shall be capable of activating a remote alarm bell. In coordination with the chiller, the Contractor shall provide an alarm circuit (including transformer if applicable) and a minimum 100 mm 4 inch diameter alarm bell. Alarm circuit shall activate bell in the event of machine shutdown due to the chiller's monitoring of safety controls. The alarm bell shall not sound for a chiller that uses low-pressure cutout as an operating control.

2.5.6.6 Utility Monitoring and Control System

The control system shall be capable of communicating all data to a remote integrated DDC processor through a single shielded cable. The data shall include as a minimum all system operating conditions, capacity controls, and safety shutdown conditions. The control system shall also be capable of receiving at a minimum the following operating commands.

a. Remote Unit Start/Stop

b. Remote Chilled Water Reset

c. Remote Condenser Water Reset

2.6 ACCESSORIES

2.6.1 Cleaning Brushes

Furnish chiller with two brushes, having jointed rods, suitable for cleaning evaporator and condenser tubes.

2.6.2 Gaskets

Gaskets shall conform to ASTM F104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 300 degrees C 700 degrees F service.

2.6.3 Bolts and Nuts

Bolts and nuts, except as required for piping applications, shall be in accordance with ASTM A307. The bolt head shall be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A307.

2.7 FABRICATION

2.7.1 Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish.

2.7.2 Factory Applied Insulation

Chiller shall be provided with factory installed insulation on surfaces subject to sweating including the water cooler, suction line piping, economizer, and cooling lines. Insulation on heads of coolers may be field applied, however it shall be installed to provide easy removal and replacement of heads without damage to the insulation. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material.

Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

2.8 SUPPLEMENTAL COMPONENTS/SERVICES

2.8.1 Charging and Testing

Unless fully assembled, tested, evacuated, and charged at factory, components shall be dried and sealed to prevent corrosion of internal surfaces prior to field assembly. Assemble, test, evacuate, and charge units under supervision of manufacturer's representative. Periodic tests shall be readily made on the concentration of the inhibitor and lithium bromide solution with a field test kit furnished by the manufacturer, or as recommended by the manufacturer.

2.8.2 Chilled and Condenser Water Piping and Accessories

Chilled and condenser water piping and accessories shall be provided and installed in accordance with Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.

2.8.3 Cooling Tower

Cooling towers shall be provided and installed in accordance with Section 23 65 00 COOLING TOWERS AND REMOTE EVAPORATIVELY-COOLED CONDENSERS.

2.8.4 Temperature Controls

****

NOTE: Modify this paragraph as required to coordinate the central equipment controls with the air-side system controls. In projects where this section of the specifications is intended to produce control equipment for existing air-side systems, this paragraph will be rewritten to secure controls to match existing controls and to properly integrate the specified controls into the existing temperature control system.

A sequence of control, a schematic of controls, and a ladder diagram should be included on the drawings for each major system component such as cooling tower fan, chilled water pump, condenser water pump, in order to define the overall system operation.

****

Chiller control packages shall be fully coordinated with and integrated [into the temperature control system indicated in Section 23 30 00 HVAC AIR DISTRIBUTION, [Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC] [Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] [or] [Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS]][into the existing air-conditioning system].

PART 3 EXECUTION

3.1 INSTALLATION

Installation of absorption chiller systems including materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with the manufacturer's written installation instructions, including the following:

[(1) Water chiller - installation instructions

]3.1.1 Installation Instructions

Provide manufacturer's standard catalog data, at least [5] [_____] weeks prior to the purchase or installation of a particular component, highlighted to show features such as materials of construction, dimensions, options, performance and efficiency. Data must include manufacturer's recommended installation instructions and procedures. Data must be adequate to demonstrate compliance with contract requirements

3.1.2 Vibration Isolation

If vibration isolation is specified for a unit, vibration isolator literature must be included containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations.

3.1.3 Posted Instructions

Provide posted instructions including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions must include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions must be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

3.1.4 Verification of Dimensions

Provide a letter including the date the site was visited, conformation of existing conditions, and any discrepancies found.

3.1.5 System Performance Test Schedules

Provide a schedule, at least [2][_____] weeks prior to the start of related testing, for the system performance tests. The schedules must identify the proposed date, time, and location for each test.

3.1.6 Demonstrations

Provide a schedule, at least [2][_____] weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

3.1.7 Certificates

Where the system, components, or equipment are specified to comply with requirements of AGA, NFPA, ARI, ASHRAE, ASME, or UL, proof of such compliance must be provided. The label or listing of the specified agency

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

3.1.8 Operation and Maintenance Manuals

Provide [Six][_____] complete copies of an operation manual in bound 216 by 279 mm 8 1/2 by 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least [4][_____] weeks prior to the first training course. The booklets must include the manufacturer's name, model number, and parts list. The manuals must include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features. [Six][_____] complete copies of maintenance manual in bound 216 by 279 8 1/2 by 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals must include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

3.1.9 Connections to Existing Systems

Notify the Contracting Officer in writing at least 15 calendar days prior to the date the connections are required. Obtain approval before interrupting service. Furnish materials required to make connections into existing systems and perform excavating, backfilling, compacting , and other incidental labor as required. Furnish labor and tools for making actual connections to existing systems.

3.1.10 Mechanical Room Ventilation

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

3.1.11 Field Applied Insulation

Field installed insulation shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.1.12 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.

3.2 MANUFACTURER'S FIELD SERVICE

The services of a factory-trained representative shall be provided for [_____] days. The representative shall advise on the following:

Absorption Units:

(1) Testing and evacuation.

(2) Charging the machine with lithium bromide solution and refrigerant water (distilled or deionized water).

(3) Starting the machine.

3.3 CLEANING AND ADJUSTING

Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Provide temporary filters for all fans that are operated during construction. Perform and document that proper Indoor Air Quality During Construction procedures have been followed; this includes providing documentation showing that after construction ends, and prior to occupancy, new filters were provided and installed. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions. Testing, adjusting, and balancing shall be as specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC.

3.4 FIELD ACCEPTANCE TESTING

3.4.1 Test Plans

a. Manufacturer's Test Plans: Within [120] [_____] calendar days after contract award, submit the following plans:

[Absorption water chiller - field acceptance test plan

] Field acceptance test plans shall be developed by the absorption chiller manufacturer detailing recommended field test procedures for that particular type and size of equipment. Field acceptance test plans developed by the installing Contractor, or the equipment sales agency furnishing the equipment, will not be acceptable.

The Contracting Officer will review and approve the field acceptance test plan for each of the listed equipment prior to commencement of field testing of the equipment. The approved field acceptance tests of the absorption chiller and subsequent test reporting.

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NOTE: In the paragraph below, specification Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS are for Navy projects only.

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b. Coordinated testing: Indicate in each field acceptance test plan when work required by this section requires coordination with test work required by other specification sections. Furnish test procedures for the simultaneous or integrated testing of tower system controls which

interlock and interface with controls for the equipment provided under [Section 23 09 53.00 20, SPACE TEMPERATURE CONTROL SYSTEMS] [Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC][Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] [or] [Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS].

c. Prerequisite testing: Absorption chillers for which performance testing is dependent upon the completion of the work covered by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC must have that work completed as a prerequisite to testing work under this section. Indicate in each field acceptance test plan when such prerequisite work is required.

d. Test procedure: Indicate in each field acceptance test plan each equipment manufacturers published installation, start-up, and field acceptance test procedures. Include in each test plan a detailed step-by-step procedure for testing automatic controls provided by the manufacturer.

    Each test plan shall include the required test reporting forms to be completed by the Contractor's testing representatives. Procedures shall be structured to test the controls through all modes of control to confirm that the controls are performing with the intended sequence of control.

    Controller shall be verified to be properly calibrated and have the proper set point to provide stable control of their respective equipment.

e. Performance variables: Each test plan shall list performance variables that are required to be measured or tested as part of the field test.

    Include in the listed variables performance requirements indicated on the equipment schedules on the design drawings. Chiller manufacturer shall furnish with each test procedure a description of acceptable results that have been verified.

    Chiller manufacturer shall identify the acceptable limits or tolerance within which each tested performance variable shall acceptably operate.

f. Job specific: Each test plan shall be job specific and shall address the particular cooling towers and particular conditions which exist in this contract. Generic or general preprinted test procedures are not acceptable.

g. Specialized components: Each test plan shall include procedures for field testing and field adjusting specialized components, such as pressure valves.

3.4.2 Testing

a. Each absorption chiller system shall be field acceptance tested in compliance with its approved field acceptance test plan and the resulting following field acceptance test report submitted for approval:

[Absorption water chiller - field acceptance test report

] b. Manufacturer's recommended testing: Conduct the manufacturer's recommended field testing in compliance with the approved test plan. Furnish a factory trained field representative authorized by and to represent the equipment manufacturer at the complete execution of the field acceptance testing.

c. Operational test: Conduct a continuous 24 hour operational test for each item of equipment. Equipment shutdown before the test period is completed shall result in the test period being started again and run for the required duration. For the duration of the test period, compile an operational log of each item of equipment. Log required entries every two hours. Use the test report forms for logging the operational variables.

d. Notice of tests: Conduct the manufacturer's recommended tests and the operational tests; record the required data using the approved reporting forms. Notify the Contracting Officer in writing at least 15 calendar days prior to the testing. Within 30 calendar days after acceptable completion of testing, submit each test report for review and approval.

e. Report forms: Type data entries and writing on the test report forms. Completed test report forms for each item of equipment shall be reviewed, approved, and signed by the Contractor's test director. The manufacturer's field test representative shall review, approve, and sign the report of the manufacturer's recommended test. Signatures shall be accompanied by the person's name typed.

f. Deficiency resolution: The test requirements acceptably met; deficiencies identified during the tests shall be corrected in compliance with the manufacturer's recommendations and corrections retested in order to verify compliance.

3.5 SYSTEM PERFORMANCE TESTS

[Six][_____] copies of the report must be provided in bound 216 by 279 mm 8 1/2 by 11 inch booklets.

3.5.1 General Requirements

Before each refrigeration system is accepted, tests to demonstrate the general operating characteristics of all equipment shall be conducted by a registered professional engineer or an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed. Tests shall cover a period of not less than [48] [_____] hours for each system and shall demonstrate that the entire system is functioning in accordance with the drawings and specifications. Corrections and adjustments shall be made as necessary and tests shall be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, service valve seal caps and blanks over gauge points shall be installed and tightened. Any refrigerant lost during the system startup shall be replaced. If tests do not demonstrate satisfactory system performance, deficiencies shall be corrected and the system shall be retested. Tests shall be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor.

Field tests shall be coordinated with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

3.5.2 Test Report

The report shall document compliance with the specified performance criteria upon completion and testing of the system. The report shall indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. The report shall also include the following information and shall 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) For absorption units, the cooling water pressures and temperatures entering and exiting the absorber and condenser. Also the refrigerant solution pressures, concentrations, and temperatures at each measurable point within the system.

(2) Running current, voltage and proper phase sequence for each phase of all motors.

(3) The actual on-site setting of all operating and safety controls.

(4) Chilled water pressure, flow and temperature in and out of the chiller.

(5) The position of the [capacity-reduction gear] [gas supply control valve] [fuel oil supply valve] at machine off, one-third loaded, one-half loaded, two-thirds loaded, and fully loaded.

3.6 DEMONSTRATIONS

Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total [_____] hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The training course must cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations.

-- End of Section --