UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

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EVAPORATIVE COOLING SYSTEMS

04/08

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC / NASA	**UFGS-23 76 00.00 10 (April 2008)**

Preparing Activity: USACE	**Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021

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SECTION 23 76 00.00 10

EVAPORATIVE COOLING SYSTEMS
04/08

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NOTE: This guide specification covers the requirements for evaporative cooling systems.

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

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NOTE: This guide specification covers evaporative cooling systems. As mentioned in the ASHRAE Handbook Applications, evaporative cooling systems provide life cycle cost savings in many areas of the U.S. Evaporative cooling may be used for total cooling or for precooling of outdoor or mixed return air. Other potential uses are also addressed in the ASHRAE Handbook Applications. Types of evaporative cooling equipment are described in the ASHRAE Handbook Systems and Equipment. Use of evaporative is further discussed in UFC 3-410-01 Heating, Ventilating, and Air Conditioning Systems.

****

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.

****

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 MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 410	(2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

ASTM A240/A240M	(2020) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A924/A924M	(2020) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A1011/A1011M	(2018a) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
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 B696	(2000; R 2015) Standard Specification for Coatings of Cadmium Mechanically Deposited
ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM E2016	(2020) Standard Specification for Industrial Woven Wire Cloth

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2018) Motors and Generators

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PS 10.01	(1982; E 2004) Hot-Applied Coal Tar Enamel Painting System
SSPC Paint 16	(2006; R 2015; E 2015) Coal Tar Epoxy-Polyamide Black (or Dark Red) Paint

UNDERWRITERS LABORATORIES (UL)

UL 94	(2013; Reprint Jun 2020) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 507	(2017; Reprint Aug 2018) UL Standard for Safety Electric Fans
UL 746C	(2018; Reprint Apr 2020) UL Standard for

	Safety Polymeric Materials - Use in Electrical Equipment Evaluations
UL 900	(2015) Standard for Air Filter Units

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

Installation Drawings; G[, [_____]]

SD-03 Product Data

Equipment; G[, [_____]]
Test Procedures; G[, [_____]]

Installation; G[, [_____]]
Manufacturer's Representative; G[, [_____]]
Service Organization; G[, [_____]]
Performance Tests; G[, [_____]]
Training Course; G[, [_____]]

SD-06 Test Reports

Testing, Adjusting, and Balancing; G[, [_____]]

SD-07 Certificates

Installation Drawings; G[, [_____]]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G[, [_____]]

1.3 QUALITY ASSURANCE

1.3.1 Coordination of Trades

Furnish tank supports, piping offsets, fittings, and any other accessories as required to provide a complete installation and to eliminate interference with other construction.

1.3.2 Manufacturer's Representative

Perform the work specified in this section under the supervision of and certified by the Manufacturer's Representative. Provide certification for installation drawings, test procedures, and test results.

a. The Manufacturer's Representative shall have no less than 3 continuous years of experience directly involved in the design and installation of evaporative cooling systems, and have served in a similar capacity on no fewer than five projects of similar size and scope during that period. Submit a letter, at least 2 weeks prior to the start of work, listing the actual experience and training of the Manufacturer's Representative.

b. Submit drawings consisting of layout of equipment including assembly and installation details and electrical connection diagrams. Include on the drawings any information required to demonstrate that the system has been coordinated and will properly function as a unit and showing equipment relationship to other parts of the work, including clearances required for operation and maintenance. Concurrent with installation drawings, submit manufacturer's certification of installation drawings.

c. Submit proposed test procedures for performance tests of systems, at least 2 weeks prior to the start of related testing.

1.3.3 Service Organization

Perform work specified in this section by a service organization certified by the System Manufacturer. The Service Organization shall have no less than 3 continuous years of experience directly involved in the installation, maintenance, and repair of evaporative cooling systems, and have served in a similar capacity on no fewer than five projects of

similar size and scope during that period. The Service Organization submitted shall be capable of performing all maintenance and field repairs and providing [4] [_____] hour onsite response to a service call on an emergency basis. Submit a letter, at least 2 weeks prior to the start of work, listing the actual experience and training of the Service Organization.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.5 EXTRA MATERIALS

Provide one set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment. In addition, furnish a two year supply of all spare parts for system operation.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide an evaporative cooling system designed and assembled by a manufacturer regularly engaged in the manufacturing of systems that are of a similar design, workmanship, capacity, and operation. Systems of similar design and capacity shall have been in satisfactory commercial or industrial use for 2 years before bid opening. The 2 years must be satisfactorily completed by a system which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Systems 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. The system shall be supported by a service organization certified by the system manufacturer.

2.1.2 Asbestos Prohibition

Asbestos and asbestos-containing products will not be accepted.

2.1.3 Nameplates

All equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.1.4 Equipment Guards and Access

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NOTE: Catwalks, ladders, and guardrails may be required. If so, select the applicable item and indicate on drawings. If not applicable, delete the entire sentence within the brackets.

****

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact according to OSHA requirements. High temperature equipment and

piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified. Catwalks, operating platforms, ladders, and guardrails shall be provided where shown and shall be constructed according to Section [08 31 00 ACCESS DOORS AND PANELS][05 51 33 METAL LADDERS].

2.2 PIPING COMPONENTS

Piping components shall be as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.3 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST

****

NOTE: Gas-fired furnaces, which are often used in conjunction with evaporative cooling systems, are specified in Section 23 82 01.00 10 WARM AIR HEATING SYSTEMS.

****

All ductwork and related accessories, including air filters and terminal units, shall be as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.4 ELECTRICAL WORK

****

NOTE: Electrical characteristics, motor starter type, enclosure type, and maximum rpm should be shown on the drawings in the equipment schedules.

****

Electrical motor-driven equipment specified shall be provided complete with motor, motor starter, and controls. Unless otherwise specified, electric equipment, including wiring, shall be according to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical characteristics and enclosure type shall be as shown. Integral size motors shall be the premium efficiency type in accordance with NEMA MG 1. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary. Each motor shall be according to NEMA MG 1 and shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, shall be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controller may be provided to accomplish the same function. Solid-state variable-speed controllers shall be utilized for 0.745 kW through 7.45 kW fractional hp through 10 hp ratings. Adjustable frequency drives shall be used for larger motors.

2.5 MISCELLANEOUS MATERIALS

Materials shall conform to the following:

2.5.1 Aluminum Sheets

ASTM B209M ASTM B209, Alloy 3003, temper H14.

2.5.2 Steel Sheets, Galvanized

ASTM A924/A924M, commercial quality.

2.5.3 Steel Sheets, Uncoated

ASTM A1011/A1011M, hot-rolled, commercial quality.

2.5.4 Structural Steel

ASTM A36/A36M.

2.5.5 Stainless Steel

ASTM A167 and ASTM A240/A240M.

2.5.6 Structural Polymeric Components

Components made of structural polymeric materials shall meet the applicable requirements of UL 746C.

2.5.7 Nonstructural Polymeric Components

Components not made of structural polymeric materials shall meet or exceed the requirements of UL 94 for Classifying Materials 94HB.

2.6 EVAPORATIVE COOLERS

****

NOTE: Drip type evaporative coolers are the most widely used; pads are uniformly and sufficiently wetted to reduce scale buildup. Indirect evaporative coolers are used when the designer wishes to add no moisture to the supply air. Two stage coolers incorporate both indirect and direct sections to provide lower supply temperatures, a degree of humidity control. In general, a blow through unit can provide discharge air that is slightly cooler than a comparable draw through units. In addition, the fan and motor in a blow through unit is not located in the saturated air stream, as is typically the case with draw through units.

****

Units shall be a self-contained [direct] [indirect] [indirect/direct] [multi-stage], weather resistant [drip,] [rotary,] [slinger] type, [blow through] [draw through] and shall conform to UL 507 and UL 746C. Unit shall be the [side] [or] [vertical downblast] discharge type as indicated. A guillotine type manual winterizing damper complete with holding rack shall be provided on the discharge side of each unit. Holding rack shall retain damper during operating season.

2.6.1 Fan Unit

****

NOTE: Inapplicable motor enclosures, motor starters, and starter enclosures will be deleted. In areas where severe sand and dust conditions

exist, totally enclosed motors will be considered.
****

The unit shall be the centrifugal type and shall be complete with motor, drive equipment, and vibration-isolation supports between motor and fan housing. Water distributor or rotary wheel motor shall be [synchronized to start and stop with the fan unit] [separately controlled] [provided with a time delay in the fan circuit to allow media to be thoroughly wetted before air flow starts]. Manual or automatic reset type thermal overload protection shall be provided in the starter or shall be integral with the motor. Motor starters shall be [manual] [magnetic] across-the-line type with [general purpose] [weather resistant] enclosure. [Remote manual switch with pilot indicating light shall be provided where indicated.] Fan scroll and wheel shall be constructed of galvanized steel, aluminum, stainless steel, or polymeric material with stainless steel, hot-dip zinc coated steel or cadmium coated steel shaft. Fan scroll may be made of a different material than the wheel. Bearings shall be sleeve type, self-aligning and self-oiling with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Grease fittings shall be connected to tubing and serviceable from a single accessible point. Bearing life shall be L50 rated at not less than 200,000 hours as defined by ABMA 9 and ABMA 11.

2.6.1.1 Fan Rating

****
NOTE: Each fan powered by a motor of 5.6 kW 7.5 hp or larger shall have the capability to operate that fan at two-thirds of full speed or less and shall have controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of the heat rejection device per ASHRAE 90.1.
****

Evaporative cooler fans shall have air delivery ratings based on AMCA 210 tests by an AMCA approved laboratory.

2.6.1.2 Retarding Agent

An ultraviolet retarding agent such as additives, gel coatings or other manufacturer approved equivalents shall be part of or applied on exterior nonmetallic components susceptible to ultraviolet degradation from sun rays and shall conform to UL 746C.

2.6.2 Evaporative Media

2.6.2.1 Evaporative and Eliminator Media for [_____] Type Units

Media shall be fabricated of [wood aspen fibers,] [refined cellulose matrix,] [bonded synthetic fiber,] [glass fiber,] [nonferrous metal]. Media shall conform to UL 900 Class II. Media shall be of the type specifically manufactured for use with evaporative coolers. Nonferrous metal media shall be constructed of corrosion and fungus resistant material not susceptible to decomposition by fungal or bacterial action. [Eliminator media shall be provided for slinger-type systems.] Media-pad face velocities shall not exceed [1.27 m/s 250 fpm for wood aspen fiber]. Media shall be securely mounted in a galvanized steel, stainless steel, or

polymeric material frame. Louvers shall be positioned in such manner that the water will not run on the outside surface. Nonrigid filter media shall be held in frame by a rigid retainer grid, a 6 mm 1/4 inch wire mesh or fabric netting.

2.6.2.2 Evaporative Media for Rotary-Type Units

The evaporative filter unit shall be either drum or disk type. Media shall be fabricated of copper, bronze, or polymer material. No moisture entrainment shall occur. Where necessary to prevent such entrainment, eliminator media constructed of copper, copper alloy, or polymer material shall be provided. Face velocities shall be limited to those recommended by media manufacturer.

2.6.3 Water Handling Equipment

2.6.3.1 Water Handling Equipment for Drip Coolers

Water handling equipment shall thoroughly wet and continuously flush evaporative surfaces of the media material. The water distribution system shall be designed, to provide equal flow of water directly to the pads or to each trough. Troughs, if used, shall be adjustable hot-dip galvanized steel, stainless steel, or polymeric and suitably designed in a manner that will effectively regulate the flow of water to the media pad to obtain even and complete saturation. Troughs shall be adjustable for leveling or sectionalized and each section supplied with water by means of an individual tube. The water pump shall be a centrifugal type with capacity and head characteristics for the specified operation of the unit and shall be provided with a low water safety shut-off. The motor shaft shall be constructed of stainless steel, hot-dip galvanized steel or cadmium coated steel. The impeller shall be constructed of stainless steel or polymeric material conforming to UL 746C. Pump housing shall be constructed of [painted] [hot-dip zinc coated] steel, brass, or polymeric material conforming to UL 746C. Pump housing bottom shall be removable for impeller cleaning and shall not permit galvanic action with cooler bottom. Pump shall have permanently sealed and lubricated bearings and fan cooled motor with moisture proof winding. Pump motor shall be provided with a factory installed three conductor rubber sheathed flexible cord with the third wire being the grounding conductor. Water pump shall be provided with a filter screen constructed of plastic or bronze which shall project 25 mm 1 inch above the high water level of the water tank.

2.6.3.2 Water Handling Equipment for Slinger Coolers

Water distribution to the evaporative pad shall be accomplished by a motor driven water slinger to uniformly distribute water to the pad.

2.6.3.3 Water Blowdown Equipment

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NOTE: Water shall be discharged as specified in the National Standard Plumbing Code.

****

Water shall be periodically dumped (approximately every six to twelve hours). This shall be done by either the use of a mechanical timer or by measuring the conductivity and dumping the water when the conductivity reaches 1500-2000 micro mhos.

2.6.4 Indirect Cooler Section

The indirect cooler shall consist of a [frame and plate counter flow] [finned tube water-to-air] heat exchanger, [evaporative media] water distribution header, scavenger fan and motor, and recirculating water pump, [cooling coil,] drain, overflow and makeup water.

2.6.4.1 Heat Exchanger

The unit shall be constructed of stainless steel, polymeric material, or aluminum with the surface exposed to water being fully protected against corrosion by an epoxy coating. The plates shall be constructed in such a way as to withstand a 250 Pa 1 inch water gauge differential pressure without collapsing the plates. Units having horizontal air discharge shall be provided with discharge baffle to direct air upward, constructed of the same material and thickness as the casing. The unit must be at least 80 percent efficient. For cleaning purposes coils on finned tube water-to-air heat exchangers shall be plugged at the return bins.

2.6.4.2 Water Distribution Header

The water distribution header shall be a nonwettable, nondrip type. Water shall be distributed by means of copper spray headers with brass nozzles, or PVC header and nozzles, which shall impart a fine water mist into the scavenger air side of the heat exchanger.

2.6.4.3 Scavenger Fan

The fan shall be the centrifugal or axial type and shall be complete with motor, drive equipment, and vibration-isolation supports between motor and fan housing on single-phase motors. The fan motor shall be [synchronized to start and stop with the indoor fan unit] [controlled by the HVAC system controls]. Water distributor motor shall be synchronized to start and stop with the scavenger fan unit. Manual or automatic reset type thermal overload protection shall be provided in the starter or shall be integral with the motor. Motor starters shall be [manual] [magnetic] across-the-line type with [general purpose] [weather resistant] enclosure. [Remote manual switch with pilot indicating light shall be provided where indicated.] Fan scroll and wheel shall be constructed of galvanized steel, aluminum, stainless steel or polymeric material with stainless steel, hot-dip zinc coated steel or cadmium coated steel shaft. Fan scroll may be made of a different material than the wheel. Fans shall have an air delivery rating based on AMCA 210 tests by an AMCA approved laboratory.

2.6.4.4 Water Pump

The water pump shall be a self-priming centrifugal type with capacity and head characteristics for the specified operation of the unit. The motor shaft shall be constructed of stainless steel, cadmium coated steel or hot-dip zinc galvanized steel. The impeller shall be constructed of stainless steel or polymeric material conforming to UL 746C. Pump housing shall be constructed of factory [painted] [hot-dip zinc coated] steel or polymeric material conforming to UL 746C. Pump housing bottom shall be removable for impeller cleaning and shall not permit galvanic action with cooler bottom. Pump shall have permanently sealed and lubricated bearings and fan cooled motor with moisture proof winding. Pump motor shall be provided with a factory installed three conductor rubber sheathed flexible cord with the third wire being the grounding conductor. Water pump shall

be provided with a filter screen constructed of plastic which shall project 25 mm 1 inch above the high water level of the water tank.

2.6.5 Cooling Coil

Supplemental water cooling coil shall be located [upstream from the direct stage] [between stages] [downstream from the second stage]. The coil shall be fin-and-tube type constructed of seamless copper tubes and copper or aluminum fins mechanically bonded or soldered to tubes. Headers shall be constructed of cast iron, welded steel or copper. Casing and tube support sheets shall be 1.6 mm 16 gauge galvanized steel, formed to provide structural strength. Tubes shall be correctly circuited for proper water velocity without excessive pressure drop and they shall be drainable where required or indicated. Each coil shall be factory tested at not less than 1720 kPa 250 psi air pressure and shall be suitable for 1380 kPa 200 psi working pressure. Drainable coils shall be installed in the units with a pitch of not less than 10 mm per m 1/8 inch per foot of tube length toward the drain end. [Coils shall conform to the provisions of AHRI 410.]

2.7 AIR WASHERS

Air washers shall be furnished as a factory package unit, complete with fan unit, spray pump, nozzles, piping, evaporative cells, washdown cycle and eliminators. Air washers shall be spray type [or sprayed cell type]. A guillotine type manual winterizing damper complete with holding rack shall be provided on the discharge side of each unit. Holding rack shall retain damper during operating season.

2.7.1 Fan Unit

****

NOTE: Each fan powered by a motor of 5.6 kW 7.5 hp or larger shall have the capability to operate that fan at two-thirds of full speed or less and shall have controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of the heat rejection device per ASHRAE 90.1.

****

The unit shall be the centrifugal type and shall be complete with motor, drive equipment, and vibration-isolation supports between motor and fan housing. Spray pump shall be synchronized to start and stop with fan unit or on a timed cycle which allows the evaporative cells to be wetted prior to fan start. Manual reset type thermal overload protection shall be provided in the starter or shall be integral with the motor. The motor enclosure shall be [dripproof] [totally enclosed] type. Motor starters shall be [manual] [magnetic] across-the-line type with [general purpose] [weather resistant] [watertight] enclosure. [Remote manual switch with pilot indicating light shall be provided where indicated.] Fans and motors shall be provided with vibration isolation supports or mountings. Fan scroll and wheel shall be constructed of galvanized steel, aluminum, stainless steel or polymeric material with a stainless steel, hot-dip zinc coated steel, or cadmium coated steel shaft. Fan scroll may be made of a different material than the wheel. Fans shall have air delivery ratings based on tests by an AMCA approved laboratory to the AMCA 210.

2.7.2 Water-Handling Equipment

One or more banks of spray nozzles, flooding nozzles, water piping, spray pump, and strainers constitute water handling equipment. The number of banks of spray nozzles shall be as required to produce the specified efficiency. Spray nozzles shall be self-cleaning, centrifugal type, constructed of brass, and provided with removable caps for cleaning. Flooding nozzles shall be constructed of machined brass or low pressure PVC nozzles. The spray pumps shall be centrifugal type with capacity and static pressure required for the spray equipment provided. Pump motor shall be a [dripproof] [totally enclosed] type suitable for the available electric service and provided with the thermal overload protection. Motor starter shall be [manual] [magnetic] across-the-line type with [general purpose] [weather resistant] [watertight] enclosure. Unless otherwise indicated, all piping materials and installations shall be in conformance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.7.3 Evaporative Cells

Cells shall consist of galvanized steel, stainless steel or polymeric material frames packed with [glass fiber] [bonded synthetic fiber] [nonferrous metal] screens, arranged in tiers. Media shall be of the type specifically manufactured for the use with air washers. Nonferrous metal media shall be constructed of corrosion and fungus resistant material not susceptible to decomposition by fungal or bacterial action. Each tier shall be independent of the others and shall have a separate spray header, drain sheet and drain conduit to the tank below.

2.7.4 Eliminator

****
NOTE: If the velocity over the media is less than 2.5 m/s 500 fpm, this paragraph may be deleted.
****

Eliminators shall consist of vertical plates having a series of bends presenting a large surface area against which the water drops impinge and return down to the tank. Eliminator plates shall be constructed of galvanized steel or polymeric material and shall be positioned at both top and bottom. The eliminators shall be designed to prevent water carryover.

2.8 WATER TANKS

Water tanks shall be constructed of stainless steel, polymeric material, or minimum G90 galvanized steel and welds shall be coated with zinc-rich paint. The tank shall be provided with a means for drainage, a makeup connection, a float-operated valve, an overflow connection and, when required, a recirculating pump suction connection. The float valve shall be designed for a water working pressure of 862 kPa 125 psi and both valve stems and seat disks shall be constructed of brass or other approved corrosion resisting material. Continuous bleed-off assembly or automatic flush system shall be provided. This system shall be adjustable to limit the concentrations from three to ten times the incoming water concentration.

2.9 CABINETS

Galvanized steel sheets, stainless steel or polymeric material shall be used in the construction of cabinets. Outside air inlets shall be

protected with bird screens that conform to ASTM E2016, Type I, Class 1, 2 by 2 mesh, 1.6 mm 0.063 inch diameter aluminum wire or 0.8 mm 0.031 inch diameter stainless steel wire. Cabinets shall provide access to all moving parts including fans, pumps, and float valves.

2.9.1 Metal Cabinets

Where possible, cabinets shall be factory assembled by either welded or bolted and screwed construction. Cabinets shall be braced and reinforced. Bolts, screws, hinges, trim, and other metal appurtenances shall be cadmium plated or galvanized in accordance with ASTM B696 or ASTM A123/A123M. When it is necessary to ship the unit disassembled, the cabinet sections shall be designed for assembly with cadmium plated or galvanized bolts. [The interior and exterior of the galvanized steel cabinet, including hinges, handles, and other trim, shall be cleaned and chemically treated to assure paint adhesion.] The interior bottom of cabinet shall be [factory] [field] coated with coal tar based enamel or epoxy and shall meet the requirements of SSPC PS 10.01 or SSPC Paint 16. [Galvanized surfaces damaged during fabrication or handling shall be given a coat of zinc-rich paint. Finish shall be as specified in paragraph PAINTING AND FINISHING.] Gauge of cabinet components shall be as indicated in TABLES I and II.

TABLE I. STEEL CABINET (MINIMUM THICKNESS mm gauge)				
Nominal Size of Industry Standard Air Rating				
Component part of cooler	0/1650 L/s 0-3500 cfm	1651/2600 L/s 3501/5500 cfm	2601-3300 L/s 5501/7000 cfm	3301/7500 L/s 7001/16000 cfm
Water tank	0.8522	0.8522	1.020	1.318
Corner posts	0.7523	0.7523	0.7523	1.020
Sides	0.8522	0.8522	0.8522	0.8522
Louver pad holder	0.527	0.527	0.527	0.527
Blower scroll	0.7523	0.8522	1.020	1.020
Blower wheel	0.8522	0.8522	0.8522	1.020
Drip trough	0.527	0.5526	0.5526	0.5526
Top	0.8522	0.8522	1.020	1.020

TABLE II. STAINLESS STEEL CABINET (MINIMUM THICKNESS mm gauge)			
Nominal Size of Industry Standard Air Rating			
Component part	0/2100 l/s4500 cfm	2101/3050 L/s 4501/6500 cfm	Beyond 3050 L/s 6500 cfm
Corner posts	0.6524	0.6524	*

TABLE II. STAINLESS STEEL CABINET (MINIMUM THICKNESS mm gauge)			
Nominal Size of Industry Standard Air Rating			
Component part	0/2100 l/s4500 cfm	2101/3050 L/s 4501/6500 cfm	Beyond 3050 L/s 6500 cfm
Bottom pan	0.8522	1.020	*
Top pan	0.8522	1.020	*
* In accordance with manufacturer's standards.			

2.9.2 Polymeric Material Cabinets

Unit cabinets shall be constructed of polymeric materials, such as fiberglass or polypropylene and shall meet the requirements of UL 746C, Figure 12.1.

2.10 PREVENTION OF GALVANIC CORROSION

Materials that will be exposed to water during operation of the unit shall be such that galvanic action will not occur in the normal operation of the equipment. The interior of water tank and cabinet and the exterior of the fan housing shall be finished with an enamel paint coat or epoxy coating. There will be no evidence of holidays and particular attention will be given to sealing joints. Media retainer will not be coated. This paragraph does not apply to nonmetallic materials or the interior water tank and cabinet of stainless steel materials.

2.11 CONTROLS

****
NOTE: This section may be omitted for less complex systems.
****

Controls shall be as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

2.12 THERMOSTATS

****
NOTE: Show thermostats on the drawings.
****

Thermostats shall be line voltage heavy duty type 115 volt ac and shall have an electrical rating greater than the cooler being controlled or shall be low voltage type. Thermostats shall have a range of 7 to 29 degrees C 45 to 85 degrees F with [an adjustable] [1 degree C 2 degree F] differential range. Thermostats shall be UL listed and shall have an indicator [and a transparent cover with lock].

2.13 FACTORY COATING

Equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish except that

all components inside and outside of the evaporative cooling unit shall have weather resistant finishes that will withstand 500 hours of exposure to the salt spray test specified in ASTM B117 and ASTM D1654 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen shall 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. Upon request of the Contracting Officer, results of the test will be submitted by the manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

****

NOTE: Indicate supply line stop and waste valves on the drawings. Where required, show backflow preventers on the drawings

****

Install all equipment as shown and in accordance with the manufacturer's diagrams and recommendations except where otherwise indicated. Connect units to the building's water supply system. Piping installation shall be as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

a. Install a globe or gate valve and union in the water supply line adjacent to each unit. Valves shall not be installed with stems below the horizontal. Slope all supply piping to drain to the indicated stop and waste valve.

b. Submit manufacturer's catalog data included with the detail drawings. Highlight the data to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with contract requirements for the following:

   (1) Evaporative coolers
   (2) Air washers
   (3) Water tanks
   (4) Thermostats

c. Submit proposed diagrams, at least 2 weeks prior to start of related testing. System diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system shall be framed under glass or laminated plastic. After approval, these items shall be posted where directed.

3.3 AIR-SUPPLY AND DISTRIBUTION SYSTEM

Install equipment, sheet metal work, air filters, and terminal units as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

3.4 FIELD PAINTING AND FINISHING

Painting of surfaces not otherwise specified, including nonferrous metals, finish painting of items only primed at the factory, and field repair of factory finish, is specified in Section 09 90 00 PAINTING, GENERAL.

3.5 TRAINING COURSE

****

NOTE: Provide training when justified and approved in programming documents, otherwise delete this paragraph.

****

a. Conduct a training course for operating staff as designated by the Contracting Officer. Submit proposed schedule for field training at least 2 weeks prior to the start of related training. The training period, for a total of [_____] hours of normal working time, shall start after the system is functionally completed but prior to final acceptance tests.

b. The field instructions shall cover all of the items contained in the approved operation and maintenance manuals. Submit [6] [_____] manuals listing step-by-step procedures required for system startup, operation, shutdown, cleaning, and routine maintenance, at least 2 weeks prior to field training. Include in the manuals the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and Service Organization (including address and telephone number) for each item of equipment.

3.6 TESTING, ADJUSTING, AND BALANCING

Perform testing, adjusting, and balancing as specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.7 PERFORMANCE TESTS

****

NOTE: The evaporative cooling system may require coordination with Section 01 91 00.15 10 TOTAL BUILDING COMMISSIONING. The designer is responsible for determining if pre-commissioning and functional checklists are necessary.

****

After testing, adjusting, and balancing has been completed as specified, the system shall be tested as a whole to see that all items perform as integral parts of the system and that operation is as specified. Submit proposed test schedules for performance tests, at least 2 weeks prior to the start of related testing. Make corrections and adjustments as necessary to produce the conditions indicated or specified. Capacity tests and general operating tests shall be conducted by the Manufacturer's Representative. Tests shall cover a period of not less than [_____] days and shall demonstrate that the entire system is functioning according to the specifications. Ambient air temperature and supply air temperature and quantity readings shall be made at hourly intervals for the duration of the time period. Submit test reports for the performance tests in

booklet form, upon completion of testing. Document in the reports all phases of tests performed including initial test summary, all repairs/adjustments made, and final test results.

3.8 CLEANING

Thoroughly clean ducts, plenums, and casings of all debris; blow them free of all small particles of rubbish and dust before installing outlet faces. 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; and after all construction dirt has been removed from the building, install new filters. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer.

-- End of Section --