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USACE / NAVFAC / AFCEC **UFGS-23 76 00 (August 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-23 76 00.00 10 (April 2008)
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2025
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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 76 00

EVAPORATIVE COOLING SYSTEMS

08/21

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SECTION 23 76 00

EVAPORATIVE COOLING SYSTEMS
08/21

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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. The coolers covered in this specification are intended for use in areas where climatic conditions generally provide dry-bulb temperatures in excess of 29 degrees C 85 degrees F and concurrent wet-bulb temperatures below 21 degrees C 70 degrees F. Moderate success can be expected with wet-bulb temperatures as high as 24

degrees C 76 degrees F; however, for general practice, use of the coolers with prevailing wet-bulb temperatures above 22 degrees C 72 degrees F is not recommended. 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.

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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 MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 210	(2025) Laboratory Methods of Testing Fans for Certified 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; R 2020) Load Ratings and Fatigue Life for Roller Bearings

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A240/A240M	(2025a) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A1011/A1011M	(2023) 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 2023) Standard Specification for Coatings of Cadmium Mechanically Deposited
ASTM E2016	(2022) Standard Specification for Industrial Woven Wire Cloth

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 00001	(2024) 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	(2023) Coal Tar Epoxy-Polyamide Black (or Dark Red) Paint

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 200-1-13	(2016) Environmental Quality -- Minimizing the Risk of Legionellosis Associated with Building Water Systems on Army Installation

UL SOLUTIONS (UL)

UL 94	(2023; Reprint Jan 2024) 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 Mar 2025) UL Standard for Safety Polymeric Materials - Use in Electrical Equipment Evaluations
UL 900	(2015; Reprint Aug 2022) UL Standard for SafetyStandard 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 and Air Force 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.

****

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. Submittals not having a "G" or "S" classification are 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-01 Preconstruction Submittals

Letter Of Qualification

Manufacturer's Authorized Service Representative; G, [_____]

SD-02 Shop Drawings

Installation Drawings; G, [_____]

SD-03 Product Data

Evaporative Coolers; G, [_____]

Air Washers; G, [_____]

Water Tanks; G, [_____]

[Thermostats; G, [_____]

] Corrosion Coating; G

SD-06 Test Reports

Performance Tests; G, [_____]

SD-07 Certificates

Test Procedures; G, [_____]

Energy Efficient Products for Evaporative Cooler; S, [_____]

System Diagrams; G, [_____]

SD-08 Manufacturer's Instructions

Installation; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

Operational Training; G, [_____]

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Coordination of Trades

Furnish tank supports, piping offsets, fittings, and any other accessories as required to provide a complete and functional system in accordance with the manufacturer's published criteria for the type of system installed and to eliminate interference with other construction.

1.4 QUALITY CONTROL

1.4.1 Standard Products

Provide evaporative air-cooling equipment 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 must 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 must be supported by a Manufacturer's Authorized Service Representative.

1.4.2 Manufacturer's Representative

Perform the work specified in this section under the supervision of a manufacturer's authorized representative. Provide manufacturer-approved installation drawings, test procedures, and test results.

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

b. Submit installation 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.

1.5 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. Store equipment in shipping crates and original packaging containers until ready to install. When required to be removed for inspection; repackage to protect equipment. In the event original packaging material is no longer suitable for storing the equipment or its components, provide storage containers agreed to by the government.

PART 2 PRODUCTS

****

NOTE: For Army projects, minimize the risk of legionellosis in building water system by following

guidance in the U.S. Army Corps of Engineers Engineering Manual EM 200-1-13.
****

2.1 SYSTEM DESRIPTION

Provide water treatment and positive water bleed-off for the evaporative air-cooling equipment. The color of finished coat, lubrication, and treatment for fungus resistance must be the manufacturer's standard. Provide solenoid valves in water supply lines. Furnish starting switch separated from coolers, [as a stand-alone switch][integral with the thermostat control][as part of the DDC controls].[Provide manual reset control for motors rated greater than 3/4 kW one HP.][Provide air filters for air inlets for rotary-type evaporative coolers.][Minimize the risk of Legionellosis by following the guidance in EM 200-1-13.]

2.2 PRODUCT SUSTAINABILITY CRITERIA

For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following:

2.2.1 Energy Efficient Products for Evaporative Coolers

Provide equipment meeting the efficiency requirements as stated within this section and provide documentation in conformance with Section 01 33 29 SUSTAINABILITY REPORTING paragraph ENERGY EFFICIENT PRODUCTS.

2.3 MATERIALS AND EQUIPMENT

2.3.1 Standard Products

Provide evaporative air-cooling equipment 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 must 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 must be supported by a Manufacturer's Authorized Service Representative.

2.3.2 Asbestos Prohibition

****
NOTE: Use this paragraph for Army only.
****

Asbestos and asbestos-containing products will not be accepted.

2.3.3 Nameplates

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

2.3.4 Equipment Guards and Access

****
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 must be properly guarded or covered with insulation of a type specified.[Provide catwalks, operating platforms, ladders, and guardrails where shown and construct according to Section [05 50 13 MISCELLANEOUS METAL FABRICATIONS][05 51 33 METAL LADDERS]].

2.4 PIPING COMPONENTS

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

2.5 SYSTEM COMPONENTS

2.5.1 Air Supply, Distribution, Ventilation and Exhaust

****
NOTE: Gas-fired furnaces, which are often used in conjunction with evaporative air-cooling equipment, are specified in Section 23 54 19 BUILDING HEATING SYSTEMS, WARM AIR.
****

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

2.5.2 Electrical Components

Electrical motor-driven equipment specified must be provided complete with motor, motor starter, controls and appropriate enclosures. Unless otherwise specified, electric equipment, including wiring, must be according to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Motor controllers, contactors and overloads must comply with NEMA ICS 2. Enclosures must comply with NEMA ICS 6. Electrical characteristics and enclosure type must be as shown. Integral size motors must be the premium efficiency type in accordance with NEMA MG 00001. Each motor must be according to NEMA MG 00001 and must 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, must 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 must be utilized for 0.745 kW through 7.45 kW fractional hp through 10 hp ratings. Provide adjustable frequency drives for motors larger than 10 hp.

a. Provide pump motors with moisture-proof windings and a factory

installed three conductor rubber sheathed flexible cord with the third wire being the grounding conductor.

b. Provide [dripproof] [totally enclosed] type pump motors, suitable for the available electric service. Provide [manual] [magnetic] across-the-line type motor starter with [general purpose] [weather resistant] [watertight] enclosure. Provide thermal overload protection in the starter or integral with the motor.

2.6 MISCELLANEOUS MATERIALS

Materials must conform to the following:

2.6.1 Aluminum Sheets

ASTM B209M ASTM B209, Alloy 3003, temper H14.

2.6.2 Steel Sheets, Galvanized

ASTM A924/A924M, commercial quality.

2.6.3 Steel Sheets, Uncoated

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

2.6.4 Structural Steel

ASTM A36/A36M.

2.6.5 Stainless Steel

ASTM A240/A240M.

2.6.6 Structural Polymeric Components

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

2.6.7 Nonstructural Polymeric Components

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

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

2.7.1 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 must be the centrifugal or axial type, complete with motor, drive equipment, and vibration-isolation supports between motor and fan housing. Water distributor or rotary wheel motor must 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] [provided with a time delay in the fan circuit to allow media to be thoroughly dried before air flow terminates].[Remote manual switch with pilot indicating light must be provided where indicated.] Fan scroll and wheel must 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 must 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 must be connected to tubing and serviceable from a single accessible point. Bearing life must be L50 rated at not less than 200,000 hours as defined by ABMA 9 and ABMA 11.

2.7.1.1 Fan Rating

****

NOTE: Each fan powered by a motor of 5.6 kW 7.5 hp or larger must have the capability to operate that fan at two-thirds of full speed or less and must 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 must have air delivery ratings based on AMCA 210 tests by an AMCA approved laboratory.

2.7.1.2 Retarding Agent

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

2.7.2 Evaporative Media

2.7.2.1 Evaporative and Eliminator Media for [_____] Type Units

Media must be fabricated of [wood aspen fibers,] [refined cellulose matrix,] [bonded synthetic fiber,] [glass fiber,] [nonferrous metal]. Media must conform to UL 900 Class II. Media must be of the type specifically manufactured for use with evaporative coolers. Nonferrous metal media must be constructed of corrosion and fungus resistant material not susceptible to decomposition by fungal or bacterial action. [Eliminator media must be provided for slinger-type systems.] Media-pad face velocities must not exceed [1.27 m/s 250 fpm for wood aspen fiber]. Media must be securely mounted in a galvanized steel, stainless steel, or polymeric material frame. Louvers must be positioned in such manner that the water will not run on the outside surface. Nonrigid filter media must be held in frame by a rigid retainer grid, a 6 mm 1/4 inch wire mesh or fabric netting.

2.7.2.2 Evaporative Media for Rotary-Type Units

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

2.7.3 Water Handling Equipment

2.7.3.1 Water Handling Equipment for Drip Coolers

Water handling equipment must thoroughly wet and continuously flush evaporative surfaces of the media material. The water distribution system must be designed, to provide equal flow of water directly to the pads or to each trough. Troughs, if used, must 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 must be adjustable for leveling or sectionalized and each section supplied with water by means of an individual tube. The water pump must be a centrifugal type with capacity and head characteristics for the specified operation of the unit and must be provided with a low water safety shut-off. The motor shaft must be constructed of stainless steel, hot-dip galvanized steel or cadmium coated steel. The impeller must be constructed of stainless steel or polymeric material conforming to UL 746C. Pump housing must be constructed of [painted] [hot-dip zinc coated] steel, brass, or polymeric material conforming to UL 746C. Pump housing bottom must be removable for impeller cleaning and must not permit galvanic action with cooler bottom. Water pump must be provided with a filter screen constructed of plastic or bronze which must project 25 mm 1 inch above the high water level of the water tank.

2.7.3.2 Water Handling Equipment for Slinger Coolers

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

2.7.3.3 Water Blowdown Equipment

Water must be periodically dumped (approximately every six to twelve hours). This must 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.

2.7.4 Indirect Cooler Section

The indirect cooler must 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.

2.7.4.1 Heat Exchanger

The unit must 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 must 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 must 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 must be plugged at the return bins.

2.7.4.2 Water Distribution Header

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

2.7.4.3 Scavenger Fan

The fan must be the centrifugal or axial type and must be complete with motor, drive equipment, and vibration-isolation supports between motor and fan housing on single-phase motors. The fan motor must be [synchronized to start and stop with the indoor fan unit] [controlled by the HVAC system controls]. Water distributor motor must be synchronized to start and stop with the scavenger fan unit. Manual or automatic reset type thermal overload protection must be provided in the starter or must be integral with the motor. Motor starters must be [manual] [magnetic] across-the-line type with [general purpose] [weather resistant] enclosure.[Remote manual switch with pilot indicating light must be provided where indicated.] Fan scroll and wheel must 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 must have an air delivery rating based on AMCA 210 tests by an AMCA approved laboratory.

2.7.4.4 Water Pump

The water pump must be a self-priming centrifugal type with capacity and head characteristics for the specified operation of the unit. The motor shaft must be constructed of stainless steel, cadmium coated steel or hot-dip zinc galvanized steel. The impeller must be constructed of stainless steel or polymeric material conforming to UL 746C. Pump housing must be constructed of factory [painted] [hot-dip zinc coated] steel or

polymeric material conforming to UL 746C. Pump housing bottom must be removable for impeller cleaning and must not permit galvanic action with cooler bottom. Water pump must be provided with a filter screen constructed of plastic which must project 25 mm 1 inch above the high water level of the water tank.

2.7.5 Cooling Coil

Supplemental water cooling coil must be located [upstream from the direct stage] [between stages] [downstream from the second stage]. The coil must be fin-and-tube type constructed of seamless copper tubes and copper or aluminum fins mechanically bonded or soldered to tubes. Headers must be constructed of cast iron, welded steel or copper. Casing and tube support sheets must be 1.6 mm 16 gauge galvanized steel, formed to provide structural strength. Tubes must be correctly circuited for proper water velocity without excessive pressure drop and be drainable where required or indicated. Factory test each coil at not less than 1720 kPa 250 psi air pressure and must be suitable for 1380 kPa 200 psi working pressure. Install drainable coils 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 must conform to the provisions of AHRI 410.]

2.8 AIR WASHERS

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

2.8.1 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.

****

Provide a centrifugal type fan unit complete with motor, drive equipment, and vibration-isolation supports between motor and fan housing. Spray pump must 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.[Remote manual switch with pilot indicating light must be provided where indicated.] Provide fans and motors with vibration isolation supports or mountings. Construct fan scroll and wheel 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 must have air delivery ratings based on tests by an AMCA approved laboratory to the AMCA 210.

2.8.2 Water-Handling Equipment

One or more banks of spray nozzles, flooding nozzles, water piping, spray

pump, and strainers constitute water handling equipment. Provide the number of banks of spray nozzles required to produce the specified efficiency. Provide self-cleaning, centrifugal type spray nozzles, constructed of brass, and provided with removable caps for cleaning. Construct flooding nozzles of machined brass or low pressure PVC nozzles. Provide centrifugal type spray pumps with capacity and static pressure required for the spray equipment provided. Unless otherwise indicated, all piping materials and installations must be in conformance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.8.3 Evaporative Cells

Cells must consist of galvanized steel, stainless steel or polymeric material frames packed with [glass fiber] [bonded synthetic fiber] [nonferrous metal] screens, arranged in tiers. Media must be of the type specifically manufactured for the use with air washers. Construct non-ferrous metal media of corrosion and fungus resistant material not susceptible to decomposition by fungal or bacterial action. Each tier must be independent of the others and include separate spray headers, drain sheets and drain conduits to the tank below.

2.8.4 Eliminator

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

Eliminators must 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. Construct eliminator plates of galvanized steel or polymeric material, positioned at both top and bottom and designed to prevent water carryover.

2.9 WATER TANKS

Construct water tanks of stainless steel, polymeric material, or minimum G90 galvanized steel with welds coated with zinc-rich paint. Provide the tank 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 must be capable of a water working pressure of 862 kPa 125 psi. Both valve stems and seat disks must be constructed of brass or other approved corrosion resisting material. Provide continuous bleed-off assembly or automatic flush system, adjustable to limit the concentrations from three to ten times the incoming water concentration. Where practicable install water storage tanks with access hatches in order to facilitate annual cleaning and inspections.

2.10 CABINETS

Provide cabinets constructed of galvanized steel sheets, stainless steel or polymeric material. Protect outside air inlets 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. Provide access to all moving parts including fans, pumps, and float valves.

2.10.1 Metal Cabinets

Where possible, provide factory-assembled cabinets with either welded or bolted and screwed construction. Cabinets must be braced and reinforced. Bolts, screws, hinges, trim, and other metal appurtenances must 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 must be designed for assembly with cadmium plated or galvanized bolts. [Clean and chemically treat the interior and exterior of the galvanized steel cabinet, including hinges, handles, and other trim, to assure paint adhesion.] [Factory][Field]coat the interior bottom of cabinet with coal tar based enamel or epoxy meeting the requirements of SSPC PS 10.01 or SSPC Paint 16.[Galvanized surfaces damaged during fabrication or handling must be given a coat of zinc-rich paint. Provide finish as specified in paragraph FIELD PAINTING AND FINISHING.] Gauge of cabinet components must 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	*
Bottom pan	0.8522	1.020	*
Top pan	0.8522	1.020	*

* In accordance with manufacturer's standards.

2.10.2 Polymeric Material Cabinets

Construct unit cabinets of polymeric materials, such as fiberglass or polypropylene which meet the requirements of UL 746C, Figure 12.1. Polymeric cabinets are not acceptable for outdoor installations or where the unit cabinet is exposed to sunlight.

2.11 PREVENTION OF GALVANIC CORROSION

Materials that will be exposed to water during operation of the unit must be such that galvanic action will not occur in the normal operation of the equipment. Finish the interior of water tank and cabinet and the exterior of the fan housing with an enamel paint coat or epoxy coating. There will be no evidence of holidays particularly at 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.

2.12 CONTROLS

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

Specify controls in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC AND Section [23 09 23.01, LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][23 09 23.02, BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS].

[2.13 THERMOSTATS

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

Thermostats must be the low-voltage type or line voltage heavy duty type 115 volt ac with an electrical rating greater than the cooler being controlled. Provide thermostats with 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 must be UL listed and with an indicator[and a transparent cover with lock].

]2.14 FACTORY COATING

Equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish except that all components inside and outside of the evaporative cooling section must have weather resistant finishes as described in paragraph "Corrosion Coating."

[2.14.1 Corrosion Coating

****
NOTE: For all outdoor applications and in Environmental Severity Classification (ESC) locations C3 thru C5 and all humid locations, as well as all indoor applications in a harsh environment, see UFC 1-200-01 for determination of ESC for a project location; humid locations are

those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C, and 5C (as identified in ASHRAE 90.1).

****

For equipment located within five miles of a body of salt water and either installed outdoors or handles outside air, provide a uniformly applied [epoxy electrodeposited] [phenolic] [vinyl] type coating to all exposed surface areas. Submit product data on the type coating selected, the coating thickness, the application process used, and verification of conformance with ASTM B117 for a duration of 3,000 hours. Apply coatings at either the unit manufacturer's or coating manufacturer's factory.

]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

****

During construction, cover and seal all openings to ductwork, plenums and control equipment. Uncover ductwork, plenums and control equipment prior to start-up of unit. Install all equipment as shown and in accordance with the manufacturer's approved diagrams and recommendations, in order to provide a complete and functioning system, except where otherwise indicated. Provide manufacturers data on proper maintenance schedules to avoid "scale", "micro biological infestation", and "corrosion" resistance.Connect units to the building's water supply system. Install piping as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

a. Submit installation 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 and showing equipment relationship to other parts of the work, including clearances required for operation and maintenance.

b. Install a ball valve and union in the water supply line adjacent to each unit. Do not install valves with stems below the horizontal. Slope all supply piping to drain to the indicated stop and waste valve.

c. Submit proposed system diagrams, at least 2 weeks prior to start of related testing. System diagrams that show the layout of equipment, piping, controls, 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 must be framed under glass or laminated plastic. After approval, post diagrams where directed.

3.2.1 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][23 54 19 BUILDING HEATING SYSTEMS, WARM AIR].

3.3 FIELD QUALITY CONTROL

3.3.1 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.

3.3.2 Testing, Adjusting, And Balancing

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

3.3.3 Performance Tests

****
NOTE: The evaporative air-cooling equipment may require coordination with Section 01 91 00.15 BUILDING COMMISSIONING.
****

Conduct the test with entering air at 35 degrees C, dry-bulb, plus or minus 2.78 degrees C and a spread between wet-bulb and dry-bulb temperature of minus 4 degrees C plus or minus 3 degrees C. Show the capacity in liter per second (L/s) and efficiency. Meet the following requirements:

Evaporative Cooler	Minimum Efficiency, Percent
Single Stage	80
Two Stage	Indirect Section, 60; Direct Section, 90

$$\text{Efficiency} = \frac{T1-T2}{T1-Tw} \times 100 \text{ percent}$$

where: T1 is the entering dry-bulb temperature in degrees C.
T2 is the leaving dry-bulb temperature in degrees C.
Tw is the entering wet-bulb temperature in degrees C.

Conduct the test with entering air at 95 degrees F, dry-bulb, plus or minus 5 degrees F and a spread between wet-bulb and dry-bulb temperature of 25 degrees F plus or minus 5 degrees F. Show the capacity in cubic feet per minute (cfm) and efficiency. Meet the following requirements:

Evaporative Cooler	Minimum Efficiency, Percent
Single Stage	80
Two Stage	Indirect Section, 60; Direct Section, 90

$$\text{Efficiency} = \frac{T1-T2}{T1-Tw} \times 100 \text{ percent}$$

where: T1 is the entering dry-bulb temperature in degrees F.
T2 is the leaving dry-bulb temperature in degrees F.
Tw is the entering wet-bulb temperature in degrees F.

After testing, adjusting, and balancing has been completed as specified, test the system 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 must be conducted by the Manufacturer's Representative. Tests must cover a period of not less than [_____] days and must demonstrate that the entire system is functioning according to the specifications. Record ambient air temperature and supply air temperature and quantity readings at hourly intervals for the duration of the test 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.

3.3.4 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. Wipe equipment 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. Properly lubricate bearings with oil or grease as recommended by the manufacturer.

3.4 OPERATIONAL TRAINING

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

a. Conduct operational training 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, must start after the system is functionally completed but prior to final acceptance tests.

b. The field instructions must 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 - especially to reduce legionella, 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 Manufacturer's Authorized Service Representative (including address and telephone number) for each item of equipment.

-- End of Section --