
USACE / NAVFAC / AFCEA UFGS-15721N (September 1999)

Preparing Activity: NAVFAC Replacing without revision
NFGS of same number and date

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 23 June 2005

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15721N

EVAPORATIVE COOLING SYSTEM

09/99

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 GENERAL REQUIREMENTS
- 1.3 SUBMITTALS
- 1.4 CORROSION PROTECTION TESTS
 - 1.4.1 Corrosion Criteria
 - 1.4.2 Thickness of Coating
- 1.5 LABORATORY TEST

PART 2 PRODUCTS

- 2.1 SINGLE-STAGE EVAPORATIVE COOLERS
 - 2.1.1 Evaporative Media (Limited specie of wood)
 - 2.1.2 Water Reservoirs
 - 2.1.3 Automatic Flush (Electric Dump) Valves and Timers
- 2.2 TWO-STAGE (COMPOUND) EVAPORATIVE COOLERS
 - 2.2.1 Indirect Section
 - 2.2.1.1 Heat Exchanger
 - 2.2.1.2 Evaporative Media
 - 2.2.1.3 Recirculating Pump
 - 2.2.1.4 Secondary Air Exhaust Fan
 - 2.2.1.5 Filter Rack
 - 2.2.1.6 Component Casing
 - 2.2.2 Direct Section
 - 2.2.2.1 Evaporative Media
 - 2.2.2.2 Water Reservoirs
 - 2.2.2.3 Automatic Flush (Electric Dump) Valves and Timers
- 2.3 FAN PLENUMS
- 2.4 BIRD SCREENS, FRESH-AIR INTAKE HOODS, AND DUCTWORK
- 2.5 THERMOSTATS, AUTOMATIC DAMPERS, AND DAMPER ACTUATORS
- 2.6 ROOF CURBS
- 2.7 VIBRATION ISOLATORS
- 2.8 PLUMBING
- 2.9 MOTORS AND MOTOR STARTERS
- 2.10 WATER TREATMENT UNIT FOR THE EVAPORATIVE COOLING SYSTEM

2.11 REFINED CELLULOSE FIBERS' REQUIREMENTS FOR EVAPORATIVE MEDIA

PART 3 EXECUTION

3.1 INSTALLATION

3.2 FIELD TESTING AND BALANCING

3.2.1 Evaporative Coolers Tests

3.2.2 Control Sequences

3.3 SCHEDULE

-- End of Section Table of Contents --

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SECTION 15721N

EVAPORATIVE COOLING SYSTEM 09/99

NOTE: This guide specification covers the requirements for evaporative coolers including roof curbs on which they are mounted.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

NOTE: 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. Conform to DOD 4270.1-M for the selection of evaporative coolers.

NOTE: The following information shall be shown on the project drawings:

1. Dry-bulb temperature entering and leaving the evaporator coolers.

2. Wet-bulb temperature entering the evaporator cooler.

3. Air quantity and static pressure.

4. Motor rpm, volts, and amperes.

5. Air outlet velocity in m/s or fpm.

PART 1 GENERAL

1.1 REFERENCES

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.

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.

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 653/A 653M	(2004a) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 117	(2002) Operating Salt Spray (Fog) Apparatus
ASTM D 1654	(1992; R 2000) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 202	(1997; R 2002e1) Sampling and Testing Untreated Paper Used for Electrical Insulation
ASTM D 374	(1999) Thickness of Solid Electrical Insulation
ASTM D 374M	(1999) Thickness of Solid Electrical Insulation (Metric)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2004) Industrial Controls and Systems: Controllers, Contactors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC
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NEMA ICS 6 (1993; R 2001) Industrial Control and Systems: Enclosures

NEMA MG 1 (2003; R 2004) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2005) National Electrical Code

NFPA 90A (2002) Installation of Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA HVAC Duct Const Stds (1995, 2nd Ed) HVAC Duct Construction Standards - Metal and Flexible

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY (TAPPI)

TAPPI T403 OM (2002) Bursting Strength of Paper

TAPPI T404 CM (1992) Tensile Breaking Strength and Elongation of Paper and Paperboard (Using Pendulum-Type Tester)

TAPPI T410 OM (2002) Grammage of Paper and Paperboard (Weight Per Unit Area)

TAPPI T456 OM (2003) Wet Tensile Breaking Strength of Paper and Paperboard ("Wet Tensile Strength")

TAPPI T487 PM (1999) Fungus Resistance of Paper and Paperboard

1.2 GENERAL REQUIREMENTS

Section 15050N BASIC MECHANICAL MATERIALS AND METHODS, with the following additions and modifications. Provide water treatment and positive water bleed-off for the evaporative cooling system. The color of finished coat, lubrication, and treatment for fungus resistance shall be the manufacturer's standard. Provide solenoid valves in water supply lines. Furnish starting switch separated from coolers, integral with the thermostat control. [Provide manual reset control for motors rated greater than 3/4 kW one hp.] [Provide air filters for air inlets for rotary-type evaporator coolers.]

1.3 SUBMITTALS

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

A "G" following a submittal item indicates that the

submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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 projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Evaporative cooling system

SD-03 Product Data

Evaporative coolers

Roof curbs

Vibration isolators

SD-06 Test Reports

Corrosion protection tests

Cooler efficiency tests

Evaporative coolers tests

SD-10 Operation and Maintenance Data

Evaporative coolers, Data Package 2

Water treatment unit, Data Package 3

Submit in accordance with Section 01781 OPERATION AND
MAINTENANCE DATA.

1.4 CORROSION PROTECTION TESTS

Comply with [ASTM A 123/A 123M] [ASTM A 653/A 653M] or protect the equipment with a corrosion-inhibiting coating or paint system that has proved capable of satisfactorily withstanding corrosion in accordance with ASTM B 117. Test 125 hours for equipment installed indoors and 500 hours for equipment installed outdoors or subjected to marine atmosphere. Each specimen shall have a standard scratch as defined in ASTM D 1654.

1.4.1 Corrosion Criteria

Upon completion of exposure, coating or paint shall show no indication of deterioration or loss of adhesion, indication of rust, or corrosion extending further than 3 mm 1/8 inch on either side of original scratch.

1.4.2 Thickness of Coating

Thickness of coating or paint system on the equipment shall be identical to that on the test specimens with respect to materials, conditions of application, and dry film thickness.

1.5 LABORATORY TEST

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:

<u>Evaporative Cooler</u>	<u>Minimum Efficiency, Percent</u>
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:

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

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

Evaporative Cooler Minimum Efficiency, 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.

PART 2 PRODUCTS

2.1 SINGLE-STAGE EVAPORATIVE COOLERS

[Drip-type with stationary wetted pad] [Rotary-type] with revolving drum or disk. [Washer (eliminator) type.]

2.1.1 Evaporative Media (Limited specie of wood)

Refined cellulose fibers. [Impregnate fibers with copper 8-quino-linolate or other equivalent fungicides.] [Rotary filters with maximum 3 m/s 600 FPM and 2 1/2 percent by-pass water flow through the rotary assemblies and minimum 127 mm 5 inch depth of rotary sections.] [Washer media consisting of self-cleaning centrifugal brass spray nozzles, brass flooding nozzles, [copper] [or] [galvanized steel] water piping, centrifugal water pump, strainers, and a minimum 24 gage [galvanized steel] [or] [aluminum] eliminator with minimum four surfaces and three bends in the airflow direction.]

2.1.2 Water Reservoirs

Fabricate tank from minimum 20 gage zinc-coated steel, bronze, or stainless steel, with a capacity of 19 liters 5 gallons water for each 472 L/s of air 1,000 cubic feet of air per minute passing through the cooler section. Coat the entire water reservoir surfaces with minimum 0.254 mm 10 mils bituminous coating after the fabrication.

2.1.3 Automatic Flush (Electric Dump) Valves and Timers

Provide cast bronze valves with neoprene-diaphragm solenoid and timer.

2.2 TWO-STAGE (COMPOUND) EVAPORATIVE COOLERS

NOTE: An indirect-section evaporative cooler is the first stage of cooling, which lowers both dry-bulb and wet-bulb temperatures of the incoming supply air. This supply air is then passed through a direct-section evaporative cooler which provides the second stage of cooling. The first stage of cooling is at constant humidity ratio, while the second stage is at constant wet-bulb temperature.

Self-contained, packaged, pre-wired, and factory-fabricated evaporative coolers with indirect and direct sections for two-stage cooling.

2.2.1 Indirect Section

Indirect sensible cooler with a complete secondary evaporative cooling system. Include components of heat exchanger, evaporative media, recirculating pump with suction strainer, sump drain, overflow, automatic fill and level control, secondary air exhaust fan, and distribution head

and internal piping. House all components in a common casing.

2.2.1.1 Heat Exchanger

NOTE: Shell-and-tube design generally achieves 55 to 60 percent efficiency; and the flat-plate, cross flow air-to-air design generally achieves 65 to 85 percent efficiency. Cooling tower coil design may be the most efficient method of all three choices, generally used in industrial areas where the outdoor wet bulb temperature is 7 degrees C 45 degrees F or below. This third design can maintain space conditions similar to those achieved with mechanical refrigeration.

- a. Shell-And-Tube Design: Fabricate tubes and tube sheets from [galvanized steel] [stainless steel] [aluminum] [polystyrene] [or] [copper]. Tube interiors shall be bonded with an epoxy coated crystalline surface or equivalent. Protect tube sheets with a bituminous coating applied after fabrication. Provide the interior of heat exchanger enclosure with 25 mm one inch thick neoprene-coated fiberglass or equivalent insulation.
- b. Flat Plate, Cross-Flow Air-To-Air, Design: Fabricate the heat exchanger of [aluminum] [stainless steel] [galvanized steel] [or] [copper] with a water absorbent coating applied to the secondary or wet air surface.
- c. Cooling Tower Coil Design: Transport chilled water from the direct evaporative cooler, and circulate this chilled water through a cooling coil fabricated of copper tubing expanded into aluminum fins.

2.2.1.2 Evaporative Media

Self-cleaning evaporative media capable of withstanding a maximum air face velocity of 3.56 m/s 700 fpm without moisture carryover. Construct media of refined cellulose fibers impregnated with insoluble anti-rot salts and rigidifying saturants.

2.2.1.3 Recirculating Pump

Submersible pump with epoxy-coated cast-iron housing, corrosive resistant base and cover, non-clog impeller, screened intake, and permanently lubricated motor with thermal overload protection.

2.2.1.4 Secondary Air Exhaust Fan

NOTE: Propeller fan wheels usually have two or more single thickness blades in a single ring enclosure. Forward curved centrifugal fan wheels have small and curved forward blades in the direction of the wheel's rotation. The wheel type of such centrifugal fans is often called "squirrel cage wheel." Both fans run at a relatively low speed to move a given amount of air. Use propeller fans

without attached ductwork; use centrifugal fans with
attached ductwork.

- a. Propeller Fan: Direct-drive propeller fan with all welded frame and statically-dynamically balanced aluminum blades. The exterior and interior of the fan shall be epoxy primed prior to the application of a baked enamel finish. The fan motor shall be totally enclosed with permanently lubricated ball bearings.
- b. Centrifugal Fan: Belt-drive or direct-drive centrifugal fan with forward curved blades. Construct scrolls, wheels, and inlet cones of [steel] [or] [aluminum] with corrosion resistant finish. Attach the fan to a welded steel frame designed to support the entire fan and motor assembly. Select V-belt sheaves based on a minimum of 1.3 times the motor nameplate power. Provide these sheaves to have critical speed at least 20 percent higher than the maximum operating speed.

2.2.1.5 Filter Rack

Water resistant permanent frame with 50 mm 2 inch thick disposable fiberglass or equivalent medium.

2.2.1.6 Component Casing

Construct casing of minimum 14 gage galvanized steel panels secured to a welded steel angle frame. Exterior panels shall be removable to permit access to any interior component. Coat with epoxy on frame members, sump drains, entire casing bottom and interior wet surfaces. Exterior steel surfaces shall be primed with epoxy and finished with baked enamel. Terminate all exterior wiring in a weathertight junction box located outside of the casing. Provide hoisting lug for installation.

2.2.2 Direct Section

**NOTE: For two-stage evaporative cooling systems,
major manufacturers often use direct evaporative
coolers.**

Except as modified, direct evaporative cooler [Drip-type with stationary wetted pad] [Rotary-type] with revolving drum or disk. [Washer (eliminator type)].

2.2.2.1 Evaporative Media

Refined cellulose fibers. [Impregnate fibers with copper 8-quinolinate.] [Rotary filters with maximum 3 m/s 600 fpm and 2 1/2 percent by-pass water flow through the rotary assemblies and minimum 127 mm 5 inch depth of rotary sections.] [Washer media consisting of self-cleaning, centrifugal brass spray nozzles, brass flooding nozzles, [copper] [or] [galvanized steel] water piping, centrifugal water pump, strainers, and a minimum 24 gage [galvanized steel] [or] [aluminum] eliminator with minimum four surfaces and three bends in the airflow direction.]

2.2.2.2 Water Reservoirs

Fabricate tank from minimum 20 gage zinc-coated steel, bronze, or stainless steel, with a capacity of 19 liters 5 gallons water for each 472 L/s of air 1,000 cubic feet of air per minute passing through the cooler section. Coat the entire reservoir surfaces with minimum 0.254 mm 10 mils bituminous coating applied after fabrication.

2.2.2.3 Automatic Flush (Electric Dump) Valves and Timers

Provide cast bronze valves with neoprene-diaphragm solenoid and timer.

2.3 FAN PLENUMS

Provide gaskets for plenum covers on all edges which contact sides of sheet-metal plenum with continuous 3 mm 1/8 inch thick butyl-rubber gasket with pressure sensitive backing. Insulate plenum interior, including covers with duct liner. Provide fresh-air intake hoods with bird screens. Install automatic dampers in the fresh-air intake hoods.

2.4 BIRD SCREENS, FRESH-AIR INTAKE HOODS, AND DUCTWORK

Section 15810N DUCTWORK AND DUCTWORK ACCESSORIES.

2.5 THERMOSTATS, AUTOMATIC DAMPERS, AND DAMPER ACTUATORS

Section 15901N SPACE TEMPERATURE CONTROL SYSTEMS.

2.6 ROOF CURBS

Provide factory-fabricated sheet-steel structural members. The curbs shall have high load-bearing capacities attained by a system of internal bulkheads, welded into position at logical intervals along the length of rails. Provide minimum 100 mm 4 inch cants, 50 by 150 mm 2 by 6 inch factory-installed wood nailers, and fully mitered end sections. Use welded 18 gage galvanized steel shell, base plate, and counterflashing.

2.7 VIBRATION ISOLATORS

[Factory-fabricated, high static and double deflection type. Mold metal parts in oil-resistant neoprene, with color codes by type and size for identification of capacity. Provide bottom steel plates with bolt holes for bolting to equipment bases to prevent movement of equipment.] [Section 15070N MECHANICAL SOUND VIBRATION AND SEISMIC CONTROL.]

2.8 PLUMBING

Section 15400 PLUMBING SYSTEMS.

2.9 MOTORS AND MOTOR STARTERS

NOTE: The motor control requirements should be coordinated with the Electrical Section and will depend on field conditions. The following types of motor starters should be used as a guide only. When electrical equipment is connected to heavily loaded, power circuits the starting current may cause excessive voltage drop.

<u>Motor kW</u>	<u>Voltage</u>	<u>Type Starter</u>
Up to 1/4	120	Manual or automatic
1/4 to 5 1/2	208-230	Across-the-line magnetic
5 1/2 to 11	208-230	Across-the-line magnetic, part winding or wye-delta
11 to 22	460	Across-the-line magnetic, part winding or wye-delta
Above 11	208-230	Part winding or wye-delta
Above 22	460	Part winding or wye-delta
<u>Motor hp</u>	<u>Voltage</u>	<u>Type Starter</u>
Up to 1/4	120	Manual or automatic
1/3 to 7 1/2	208-230	Across-the-line magnetic
7 1/2 to 15	208-230	Across-the-line magnetic, part winding or wye-delta
15 to 30	460	Across-the-line magnetic, part winding or wye-delta
Above 15	208-230	Part winding or wye-delta
Above 30	460	Part winding or wye-delta

NEMA MG 1 and NEMA ICS 2 and NEMA ICS 6 with electrical characteristics as indicated. Motor shall be [open] [dripproof] [totally-enclosed, [non-ventilated] [or] [fan-cooled]] [explosion-proof]. Motor starters shall be [[manual] [magnetic-across-the-line] [reduced-voltage] [part-winding] [wye-delta] type with [general-purpose] [weather resistant] [watertight] [explosion-proof] enclosure] [manufacturer's standard]. Motor efficiencies shall be high efficiency in accordance with Section 16402 INTERIOR DISTRIBUTION SYSTEM.

2.10 WATER TREATMENT UNIT FOR THE EVAPORATIVE COOLING SYSTEM

Provide complete and ready for operation, factory packaged water treatment unit for chemical treatment of water, as recommended by the manufacturer of evaporative coolers.

2.11 REFINED CELLULOSE FIBERS' REQUIREMENTS FOR EVAPORATIVE MEDIA

<u>Test</u>	<u>Requirements</u>	<u>Test Method</u>
Basis weight 24 by 36, 500 sheets	21.34 kg plus or minus 0.5 kg	TAPPI T410 OM
Mullen	42 minutes	TAPPI T403 OM

<u>Test</u>	<u>Requirements</u>	<u>Test Method</u>
Caliper	0.14 to 0.15 mm	ASTM D 374M, Method A
Tensile, dry	18 minutes	TAPPI T404 CM
Tensile, wet	25 percent of dry after 1 minute age at 110 degrees C	TAPPI T456 OM
Absorption	19 mm to 28 mm	ASTM D 202
Fungus resistance	Satisfactory at 2 weeks incubation	TAPPI T487 PM

<u>Test</u>	<u>Requirements</u>	<u>Test Method</u>
Basis weight 24 by 36, 500 sheets	47 lb. plus or minus 1 lb.	TAPPI T410 OM
Mullen	42 minutes	TAPPI T403 OM
Caliper	0.0054 to 0.0058-inch	ASTM D 374, Method A
Tensile, dry	18 minutes	TAPPI T404 CM
Tensile, wet	25 percent of dry after 1 minute age at 230 degrees F	TAPPI T456 OM
Absorption	12/16 inch to 18/16 inch	ASTM D 202
Fungus resistance	Satisfactory at 2 weeks incubation	TAPPI T487 PM

PART 3 EXECUTION

3.1 INSTALLATION

Installation of evaporative coolers shall conform with NFPA 90A, SMACNA HVAC Duct Const Stds, recommendations and printed instructions of the manufacturer, and details and notes indicated. Provide mounting and supporting of thermostats, ducts, piping, roof curbs, equipment, accessories, and appurtenances, including but not limited to structural supports, hangers, vibration isolators, stands, clamp and brackets, and access doors. Electric isolation shall be provided between dissimilar metals for the purpose of minimizing galvanic corrosion. Electrical work shall conform with NFPA 70 and Division 16, Electrical. Equip electric motor-driven equipment with motor starters, fused-disconnect switches, and controls. Provide manual or automatic control, protective devices, and control wiring for operations as indicated.

3.2 FIELD TESTING AND BALANCING

Adjust evaporative coolers to produce air quantities at the conditions

indicated. Use Pitot or electronic instrument to measure air quantities. Set control devices to control at the points indicated. Lubricate bearings and check the speed and direction of rotation of each fan. Check the running current of each motor. Furnish water analysis and sufficient chemicals to initially place the evaporative system in service. [Provide same chemicals used at station's cooling towers.]

3.2.1 Evaporative Coolers Tests

Perform minimum 4-hour cooler efficiency tests of each cooler. Record test data in typed tabulation form, no less than 2 days before the final tests of entire systems indicating the following:

- a. Time, date, and duration of test
- b. Dry-bulb temperature entering and leaving the evaporizer coolers
- c. Wet-bulb temperature entering the evaporizer cooler
- d. Air quantity and static pressure
- e. Motor rpm - voltmeter and ammeter readings
- f. Air outlet velocity m/s fpm
- g. Evaporative cooler-make, model and size

3.2.2 Control Sequences

[As indicated] [Section 15901N SPACE TEMPERATURE CONTROL SYSTEMS].

3.3 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurements commonly agreed on by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

<u>Products</u>	<u>Inch-Pound</u>	<u>Metric</u>
a. [_____	_____	_____]

-- End of Section --