SECTION 236423.13 - AIR-COOLED, SCROLL WATER CHILLERS

Revise this Section by deleting and inserting text to meet Project-specific requirements.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

1. GENERAL
   * + 1. RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

* + - * 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
      1. SUMMARY
         1. Section includes packaged, air-cooled, electric-motor-driven, scroll water chillers.
      2. DEFINITIONS

Retain terms that remain after this Section has been edited for a project.

* + - * 1. BAS: Building automation system.
        2. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
        3. DDC: Direct digital control.
        4. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in Btu/h to the total power input given in watts at any given set of rating conditions.
        5. GFI: Ground fault interrupt.
        6. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.
        7. I/O: Input/output.
        8. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.
        9. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and intended for operating conditions other than the AHRI standard rating conditions.
        10. SCCR: Short-circuit current rating.
        11. TEAO: Totally enclosed air over.
        12. TENV: Totally enclosed nonventilating.
      1. ACTION SUBMITTALS
         1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
         2. Manufacturer's installation instructions shall be provided along with product data.
         3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
         4. Product Data: For each type of product.

Include refrigerant, rated capacities, operating characteristics, and furnished specialties and accessories.

Performance at AHRI standard conditions and at conditions indicated.

Performance at AHRI standard unloading conditions.

Minimum evaporator flow rate.

Refrigerant capacity of water chiller.

Oil capacity of water chiller.

Fluid capacity of evaporator.

Characteristics of safety relief valves.

Force and moment capacity of each piping connection.

* + - * 1. Shop Drawings: Complete set of manufacturer's prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:

Assembled unit dimensions.

Weight and load distribution.

Required clearances for maintenance and operation.

Size and location of piping and wiring connections.

Diagrams for power, signal, and control wiring.

* + - 1. INFORMATIONAL SUBMITTALS

Retain "Coordination Drawings" Paragraph below for situations where limited space necessitates maximum utilization for efficient installation of different components or if coordination is required for installation of products and materials by separate installers. Coordinate paragraph with other Sections specifying products listed below. Preparation of coordination drawings requires the participation of each trade involved in installations within the limited space.

* + - * 1. Coordination Drawings:

Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

Structural supports.

Piping roughing-in requirements.

Wiring roughing-in requirements, including spaces reserved for electrical equipment.

Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

Coordination drawings showing plan, section and elevation views, drawn to <**Insert scale**>.

Each view to show screened background with the following:

Column grids, beams, columns, and concrete housekeeping pads.

Layout with walls, floors, and roofs, including each room name and number.

Equipment and products of other trades that are located in vicinity of chillers and part of final installation, such as plumbing systems.

Retain "Certificates" Paragraph below if retaining "AHRI Certification" Paragraph in "Quality Assurance" Article.

* + - * 1. Certificates: For certification required in "Quality Assurance" Article.

Retain "Seismic Qualification Data" Paragraph below if required by seismic criteria applicable to Project. Coordinate below with Section 230548 "Vibration and Seismic Controls for HVAC." See ASCE/SEI 7 for certification requirements for equipment and components.

* + - * 1. Seismic Qualification Data: Certificates, for water chillers, accessories, and components, from manufacturers.

Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

* + - * 1. Installation instructions.
        2. Source quality-control reports.
        3. Startup service reports.
        4. Sample Warranty: For special warranty.
      1. CLOSEOUT SUBMITTALS
         1. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.
         2. Spare Parts List: Recommended spare parts list with quantity for each.
         3. Touchup Paint Description: Detailed description of paint used in application of finish coat to allow for procurement of a matching paint.
         4. Instructional Videos: Including those that are prerecorded and those that are recorded during training.
      2. MAINTENANCE MATERIAL SUBMITTALS

Retain this article to require tool kit and touchup paint.

Consult Director’s Representative about chiller service and need for tool kit. Servicing of chiller by unqualified personnel is not recommended by chiller manufacturers and may void chiller warranty.

* + - * 1. Tool kit to include the following:

A tool kit specially designed by chiller manufacturer for use in servicing chiller(s) furnished.

Special tools required to service chiller components not readily available to Director’s Representative service personnel in performing routine maintenance.

Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Chiller Tool Kit." Text size shall be at least 1 inch high.

A list of each tool furnished. Permanently attach the list to underside of case cover. Text size shall be at least 1/2 inch high.

* + - * 1. Touchup Paint: [**32 oz.**] <**Insert volume**> container of paint used for finish coat. Label outside of container with detailed description of paint to allow for procurement of a matching paint in the future.
      1. QUALITY ASSURANCE

Retain "AHRI Certification" Paragraph below if AHRI certification is required and Project requirements fall within limits of AHRI 590 certification program. AHRI 550/590 is broken into two certification programs; AHRI 590 certification program is applicable to scroll water chillers. Review the latest version to confirm requirements.

* + - * 1. AHRI Certification: Certify chiller according to AHRI 590 certification program.
      1. DELIVERY, STORAGE, AND HANDLING
         1. Ship water chillers from the factory fully charged with refrigerant and filled with oil.

Retain paragraph below only for projects with special shipping requirements. Export shipping adds cost.

* + - * 1. Package water chiller for export shipping.
      1. WARRANTY

When warranties are required, verify with Director’s Representative's counsel that special warranties stated in this article are not less than remedies available to Director’s Representative under prevailing local laws.

* + - * 1. Special Warranty: Manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within specified warranty period.

Verify available warranties with manufacturers listed in Part 2 articles.

Extended warranties include, but are not limited to, the following:

Retain one of first three subparagraphs below.

Complete chiller including refrigerant and oil charge.

Complete compressor and drive assembly including refrigerant and oil charge.

Refrigerant [**and oil**]charge.

Loss of refrigerant charge for any reason due to manufacturer's product defect and product installation.

Parts [**only**] [**and labor**].

Verify available warranties and warranty periods with manufacturers listed in Part 2 articles. A common manufacturer's warranty offering will start 18 months from date of shipment or 12 months from date of startup because "Substantial Completion" is more difficult for manufacturer to estimate.

Warranty Period: [**Five**] <**Insert number**> years from date of Substantial Completion.

1. PRODUCTS

Manufacturers and products listed in SpecAgent and MasterWorks Paragraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications. For definitions of terms and requirements for Contractor's product selection, see Section 016000 "Product Requirements."

* + - 1. PERFORMANCE REQUIREMENTS

Retain "Seismic Performance" Paragraph below with "Seismic Qualification Data" Paragraph in "Informational Submittals" Article for projects requiring seismic design. Delete paragraph if performance requirements are indicated on Drawings. Model building codes and ASCE/SEI 7 establish criteria for buildings subject to earthquake motions. Coordinate requirements with structural engineer.

* + - * 1. Seismic Performance: Scroll water chillers shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] <**Insert requirement**>.

Retain first subparagraph below to define the term "withstand" as it applies to this Project. Definition varies with type of building and occupancy and is critical to valid certification. Option is used for essential facilities where equipment must operate immediately after an earthquake.

The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

For life-safety components required to function after an earthquake (such as fire-sprinkler systems, components that contain hazardous content, and storage racks in structures open to the public), the Component Importance Factor is 1.5. For other components, the Component Importance Factor is 1.0 unless the structure is in Seismic Use Group III and component is necessary for continued operation of facility or failure of component could impair continued operation of facility, in which case the Component Importance Factor is 1.5.

Component Importance Factor: [**1.5**] [**1.0**].

See ASCE/SEI 7, Coefficients for Architectural Component Table and Seismic Coefficients for Mechanical and Electrical Components Table for requirements to be inserted in subparagraph below.

<**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

* + - * 1. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

Retain "Performance Tolerance" Paragraph below if Project requires more stringent tolerances than allowed by AHRI 550/590.

* + - * 1. Performance Tolerance: Comply with the following in lieu of AHRI 550/590:

Allowable Capacity Tolerance: [**Zero**] <**Insert number**> percent.

Allowable Full-Load Energy Efficiency Tolerance: [**Zero**] <**Insert number**> percent.

Allowable Part-Load Energy Efficiency Tolerance: [**Zero**] <**Insert number**> percent.

* + - * 1. AHRI Rating: Rate water chiller performance according to requirements in AHRI 550/590.
        2. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.

Retain "ASHRAE/IES 90.1 Compliance" Paragraph below to require compliance with ASHRAE/IES 90.1.

* + - * 1. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
        2. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.
        3. Comply with NFPA 70.
        4. Comply with requirements of UL 1995, "Heating and Cooling Equipment," and include label by a qualified testing agency showing compliance.

Retain "Operation Following Loss of Normal Power" Paragraph below if uninterrupted chiller operation is required without operator intervention.

* + - * 1. Operation Following Loss of Normal Power:

Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought on-line.

See drawings for equipment served by backup power systems.

Provide means and methods required to satisfy requirement even if not explicitly indicated.

Retain "Outdoor Installations" Paragraph below for chillers installed outdoors.

* + - * 1. Outdoor Installations:

Chiller shall be suitable for outdoor installation indicated. Provide adequate weather protection to ensure reliable service life over a [**25**] <**Insert time**>-year period with minimal degradation due to exposure to outdoor ambient conditions.

Chillers equipped to provide safe and stable operation while achieving performance indicated when operating at extreme outdoor temperatures encountered by the installation. Review historical weather database and provide equipment that can operate at extreme outdoor temperatures recorded over past [**30**] <**Insert time**>-year period.

* + - 1. MANUFACTURERS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=12115) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Carrier Global Corporation](http://www.specagent.com/Lookup?uid=123457139286).

[Daikin Applied](http://www.specagent.com/Lookup?uid=123457139287).

[Trane](http://www.specagent.com/Lookup?uid=123457139288).

[YORK; brand of Johnson Controls International plc, Building Solutions North America](http://www.specagent.com/Lookup?uid=123457139289).

* + - 1. MANUFACTURED UNITS
         1. Description: Factory-assembled and run-tested water chiller complete with compressor(s), compressor motors and motor controllers, evaporator, condenser with fans, electrical power, controls, and indicated accessories.

Retain first paragraph below for projects in seismic areas.

* + - * 1. Fabricate water chiller mounting base with reinforcement strong enough to resist water chiller movement during a seismic event when water chiller is anchored to field support structure.

Retain "Sound-Reduction Package" Paragraph below for projects with stringent acoustical requirements. Sound-reduction packages are typically an optional feature.

* + - * 1. Sound-reduction package shall have the following:

Acoustic enclosure around compressors.

Reduced-speed fans with acoustic treatment.

Designed to reduce sound level without affecting performance.

Retain "Security Package" Paragraph below for projects with security requirements and where restricted access is not provided. Security packages are typically an optional feature and can conflict with other available optional packages such as the sound-reduction package. Consult manufacturer.

* + - * 1. Security Package: Security grilles with fasteners for additional protection of compressors, evaporator, and condenser coils. Grilles shall be coated for corrosion resistance and shall be removable for service access.
      1. CABINET
         1. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
         2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
         3. Casing: Galvanized steel.
         4. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a [**500**] <**Insert time**>-hour salt-spray test according to ASTM B117.
      2. COMPRESSOR-DRIVE ASSEMBLIES
         1. Compressors:

Description: Positive-displacement direct drive with hermetically sealed casing.

Requirements in first subparagraph below are not offered by Carrier.

Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.

For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.

Operating Speed: Nominal 3600 rpm for 60-Hz applications.

Retain option in "Capacity Control" Subparagraph below if capacity control below the smallest chiller step is required. See the Evaluations.

Capacity Control: On-off compressor cycling[**, plus hot-gas bypass**].

Digital compressor unloading is an acceptable alternative to achieve capacity control.

Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug or removable magnet in sump, and initial oil charge.

Manufacturer's other standard methods of providing positive lubrication are acceptable in lieu of an automatic pump.

Retain "Vibration Isolation" Subparagraph below for factory-installed vibration isolation.

Vibration Isolation: Mount individual compressors on vibration isolators.

For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.

* + - * 1. Compressor Motors:

Hermetically sealed and cooled by refrigerant suction gas.

High-torque, two-pole induction type with inherent thermal-overload protection on each phase.

* + - * 1. Compressor Motor Controllers:

Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.

* + - 1. REFRIGERATION

LEED 2009 NC and CS, and LEED 2009 for Schools Credit EA 4 require that new HVAC&R systems be HCFC free. See the Evaluations.

* + - * 1. Refrigerant: R-410A. Classified as Safety Group A1 according to ASHRAE 34.
        2. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
        3. Refrigerant Circuit: Each circuit shall include [**an electronic**] [**or**] [**a thermal**]-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.

Retain "Refrigerant Isolation" Paragraph to isolate refrigerant during compressor servicing and replacement. Requirement below is not applicable to all chiller types and sizes. Consult manufacturers.

* + - * 1. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.

For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in each circuit in lieu of each compressor.

* + - * 1. Pressure Relief Device:

Comply with requirements in ASHRAE 15, ASHRAE 147, and applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

Select and configure pressure relief devices to protect against corrosion and inadvertent release of refrigerant.

ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger.

* + - 1. EVAPORATOR

Retain first paragraph below if more than one evaporator type is used on Project. See the Evaluations for discussion of evaporator types.

* + - * 1. Brazed-plate or shell-and-tube design, as indicated.

Retain "Shell and Tube" Paragraph below for water chillers with shell-and-tube evaporators. Carrier and Daikin offer shell-and-tube evaporators on some larger chiller sizes. Trane and York do not offer shell-and-tube evaporators.

* + - * 1. Shell and Tube:

Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.

Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.

Shell Material: Carbon steel.

Shell Heads: Removable carbon-steel heads with multipass baffles designed to ensure positive oil return and located at each end of the tube bundle.

Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with mechanical-coupling end connections for connection to field piping.[**Furnish flange adapters to mate to flanged piping.**]

Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.

Retain "Brazed Plate" Paragraph below for water chillers with brazed-plate evaporators. Trane and York offer only brazed-plate evaporators. Carrier and Daikin offer brazed-plate evaporators on some smaller chiller sizes.

* + - * 1. Brazed Plate:

Direct-expansion, single-pass, brazed-plate design.

Type [**304**] [**or**] [**316**] stainless-steel construction.

Code Compliance: Tested according to ASME Boiler and Pressure Vessel Code.

Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.[**Furnish flange adapters to mate to flanged piping.**]

Inlet Strainer: Factory-furnished, [**20**] [**or**] [**40**] <**Insert value**>-mesh strainer for field installation in supply piping to evaporator. Manufacturer has option to factory install strainer.

Retain "Flow Switch" Paragraph below for factory-furnished flow switch. Some manufacturers do not offer factory-installed flow switches on some models. Consult listed manufacturers.

* + - * 1. Flow Switch: Factory-furnished [**and -installed,**] [**thermal-type**] flow switch wired to chiller operating controls.

Retain "Heater" Paragraph below if water chiller is exposed to ambient temperatures capable of freezing the fluid in the evaporator. See the Evaluations for discussion of evaporator freeze protection.

* + - * 1. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to [**minus 20 deg F**] <**Insert temperature**>.

Retain "Remote-Mounting Kit" Paragraph below for applications that require evaporator to be remotely mounted. Trane does offer a remote-mounted evaporator option. York offers a remote-mounted evaporator option only on some models.

* + - * 1. Remote-Mounting Kit: Designed for remote field mounting where indicated. Provide kit for field installation.
      1. AIR-COOLED CONDENSER
         1. Coil(s) with integral subcooling on each circuit.
         2. Copper Tube with Plate Fin Coils:

Construct coils of copper tubes mechanically bonded to [**aluminum**] [**copper**] fins.

Coating: [**None**] [**Corrosion resistant**].

"Aluminum Microchannel Coils" Paragraph below has limited availability. Consult manufacturers.

* + - * 1. Aluminum Microchannel Coils:

Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.

Single- or multiple-pass arrangement.

Construct fins, tubes, and header manifolds of aluminum alloy treated with a corrosion-resistant coating.

Retain "Hail Protection" Paragraph below if additional protection is required. Hail protection is typically an optional feature. Consult manufacturer.

* + - * 1. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
        2. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
        3. Fan Motors: TENV or TEAO enclosure, with sealed and permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.

Overcurrent- and thermal-overload protection not integral to motor is acceptable if provided with chiller electrical power package.

* + - * 1. Fan Guards: Removable steel safety guards with corrosion-resistant [**PVC**]coating.
      1. HEAT RECOVERY CONDENSER

Retain this article for applications that use heat rejected from chillers to provide a heating source for other applications requiring heat. See the Evaluations.

Daikin does not offer a heat recovery option. Carrier and York offer heat recovery option only on some models, with limitations. Carrier is only manufacturer to offer "full" heat recovery.

* + - * 1. Brazed plate, or shell and tube; as indicated, capable of [**full**] [**partial**] heat recovery.

Retain "Shell and Tube" Paragraph below for water chillers with shell-and-tube heat recovery condensers. Carrier offers shell-and-tube heat recovery condensers.

* + - * 1. Shell and Tube:

Description: Shell-and-tube design with refrigerant flowing through the shell and fluid flowing through the tubes within the shell.

Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.

Shell Material: Carbon steel.

Water Boxes: Removable, of carbon-steel construction, located at each end of the tube bundle with fluid nozzles terminated with mechanical-coupling end connections for connection to field piping.

Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.

Provide each condenser circuit with a pressure relief device, purge cock, and liquid-line shutoff valve.

Provide each condenser with vent and drain.

Retain "Brazed Plate" Paragraph below for water chillers with brazed-plate condensers. Trane offers brazed-plate heat recovery condensers.

* + - * 1. Brazed Plate:

Type 316 stainless-steel construction.

Code Compliance: Tested according to ASME Boiler and Pressure Vessel Code.

Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.

Inlet Strainer: Factory-furnished, [**20**] [**or**] [**40**] <**Insert value**>-mesh strainer for field installation in supply piping to condenser. Manufacturer has option to factory install strainer.

Retain "Heater" Paragraph below if water chiller is exposed to ambient temperatures capable of freezing the fluid in the heat recovery condenser.

* + - * 1. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the heat recovery condenser to [**minus 20 deg F**] <**Insert temperature**>.
        2. Insulation: Insulation on heat recovery condenser shall match evaporator.
        3. Controls: Integral to chiller control package.
      1. CHILLED-WATER HYDRONIC PACKAGE

Retain this article to include hydronic system components indicated as part of chiller package. See the Evaluations.

* + - * 1. Factory-furnished [**and -installed**]hydronic package consisting of the following:

Pumps: Single or dual pumps with capacity, as indicated.

[**Vertical in-line**] <**Insert type**> type, single-stage design, serviceable without disturbing piping connections.

Cast-iron, ductile-iron, bronze, or stainless-steel body.

Bronze or stainless-steel impeller keyed to shaft and secured with screw.

Premium efficient motor with TEFC motor enclosure.

Dual pump packages to provide for servicing and replacement of failed pump with other pump operating.

Variable-speed pumps with variable-frequency controllers integral to pump motor or provided with chiller electrical package.

Expansion Tank: [**Replaceable**]bladder type.

Retain "Storage Tank" Subparagraph below to expand overall system volume. See the Evaluations. Carrier and Daikin offer storage tanks; Trane and York do not.

Storage Tank: Insulated carbon-steel tank with [**internal baffles,**]drain and vent connections; with capacity indicated.

Piping: [**Copper tube**] [**or**] [**carbon-steel pipe**].

Strainers: Y-type at suction side of each pump.

Valves:

Ball- or butterfly-style valves for isolation and balancing.

Check valve on each pump discharge for dual pump packages.

Drain valves to be positioned to drain isolated sections of pipe and equipment.

Option to use combination valves.

Hydronic Specialties:

Air Vents: [**Automatic**] [**or**] [**manual**] air vents located and arranged to vent air from high points and locations capable of trapping air.

Test Plugs: Located to measure pressure difference across each pump and strainer.

* + - * 1. Hydronic package rated for same pressure as evaporator.
        2. Pressure and leak tested before apply insulation.
        3. Insulation on hydronic package shall match evaporator.
        4. Controls:

Lead/lag operation for dual pump packages.

Controlled to automatically equalize run time.

Control of variable-speed pumps.

Retain one of first two subparagraphs below.

Integral to chiller control package.

Remotely controlled through field interface with building controls.

Retain "Heater" Paragraph below if water chiller is exposed to ambient temperatures capable of freezing the fluid in the heat recovery condenser.

* + - * 1. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the heat recovery condenser to [**minus 20 deg F**] <**Insert temperature**>.
      1. INSULATION
         1. Closed-cell, flexible, elastomeric thermal insulation complying with ASTM C534/C534M, Type I for tubular materials and Type II for sheet materials.

Second option in "Thickness" Subparagraph below may not be available from all manufacturers as a standard factory option. Consult listed manufacturers.

Thickness: [**3/4 inch**] [**1-1/2 inches**] <**Insert dimension**>.

* + - * 1. Adhesive: As recommended by insulation manufacturer.
        2. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.

Apply adhesive to 100 percent of insulation contact surface.

Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.

Seal seams and joints to provide a vapor barrier.

After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.

Manufacturer has option to factory or field insulate chiller components to reduce potential for damage during installation.

Field-Applied Insulation:

Components that are not factory insulated shall be field insulated to comply with requirements indicated.

Manufacturer shall be responsible for chiller insulation whether factory or field installed to ensure that manufacturer is the single point of responsibility for chillers.

Manufacturer's Company Service Advisor shall instruct and supervise installation of field-applied insulation.

After field-applied insulation is complete, paint insulation to match factory-applied finish.

* + - 1. ELECTRICAL
         1. Factory installed and wired, and functionally tested at factory before shipment.

Not all manufacturers provide all features indicated in remaining paragraphs below. Verify availability with manufacturers.

* + - * 1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
        2. House in a unit-mounted, NEMA 250, [**Type 3R**] <**Insert type**> enclosure with hinged access door with lock and key or padlock and key.
        3. Wiring shall be numbered and color-coded to match wiring diagram.

Retain first paragraph below to enclose wiring if required by special application, such as a corrosive or humid environment, or outdoor application. Requirement will add cost and is unnecessary for many indoor applications. Chiller manufacturers do not usually enclose all wiring. Consult listed manufacturers for availability.

* + - * 1. Factory wiring shall be located outside of an enclosure in a [**metal**]raceway. Terminal connections shall be made with not more than a 24-inch length of [**liquidtight**] [**or**] [**flexible metallic**] conduit.
        2. Field power interface shall be to [**wire lugs**] [**NEMA KS 1, heavy-duty, nonfused disconnect switch**] [**circuit breaker**]. Minimum SCCR according to UL 508 shall be as required by electrical power distribution system, but not less than [**42,000**] [**65,000**] [**100,000**] <**Insert value**> A.
        3. Each motor shall have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:

Retain any of three subparagraphs below, or all. Consult listed manufacturers for availability of different branch circuit disconnecting means indicated.

NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.

NEMA KS 1, heavy-duty, nonfusible switch.

UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

* + - * 1. Each motor shall have overcurrent protection.
        2. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
        3. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.

Retain first paragraph below for power factor correction. York is only manufacturer indicating this option in its product data. Consult other manufacturers for availability if required by application.

* + - * 1. Power Factor Correction: Capacitors to correct power factor to [**0.90**] [**0.95**] <**Insert value**> at full load.
        2. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
        3. Control Relays: Auxiliary and adjustable time-delay relays, or an integral to water chiller microprocessor.

Retain "Service Receptacle" Paragraph below if unit-mounted convenience power receptacle is required.

* + - * 1. Service Receptacle:

Unit-mounted, 120-V GFI duplex receptacle.

Power receptacle from chiller internal electrical power wiring.

* + - * 1. Indicate the following for water chiller electrical power supply:

Verify availability of items listed in eight subparagraphs below with listed manufacturers. Not all items listed are available from all manufacturers.

Current, phase to phase, for all three phases.

Voltage, phase to phase and phase to neutral for all three phases.

Three-phase real power (kilowatts).

Three-phase reactive power (kilovolt amperes reactive).

Power factor.

Running log of total power versus time (kilowatt hours).

Fault log, with time and date of each.

<**Insert features**>.

* + - 1. CONTROLS
         1. Factory installed and wired, and functionally tested at factory before shipment.
         2. Standalone, microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.
         3. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
         4. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, digital display. Display the following:

Verify availability of items listed in 18 subparagraphs below with listed manufacturers. Not all items listed are available from all manufacturers.

Date and time.

Operating or alarm status.

Operating hours.

Outside-air temperature if required for chilled-water reset.

Temperature and pressure of operating set points.

Chilled-water entering and leaving temperatures.

Refrigerant pressures in evaporator and condenser.

Saturation temperature in evaporator and condenser.

No cooling load condition.

Elapsed time meter (compressor run status).

Pump status.

Antirecycling timer status.

Percent of maximum motor amperage.

Current-limit set point.

Number of compressor starts.

Alarm history with retention of operational data before unit shutdown.

Superheat.

<**Insert items**>.

* + - * 1. Control Functions:

Verify availability of items listed in 11 subparagraphs below with listed manufacturers. Not all items listed are available from all manufacturers.

Manual or automatic startup and shutdown time schedule.

Capacity control based on evaporator leaving-fluid temperature.

Capacity control compensated by rate of change of evaporator entering-fluid temperature.

Chilled-water entering and leaving temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on [**return-water**] [**outside-air**] [**space**] <**Insert variable**> temperature.

Current limit and demand limit.

Condenser-water temperature.

External water chiller emergency stop.

Antirecycling timer.

Automatic lead-lag switching.

Ice-building mode.

<**Insert functions**>.

* + - * 1. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:

Verify availability of items listed in nine subparagraphs below with listed manufacturers. Not all items listed are available from all manufacturers.

Low evaporator pressure or high condenser pressure.

Low chilled-water temperature.

Refrigerant high pressure.

High or low oil pressure.

High oil temperature.

Loss of chilled-water flow.

Loss of condenser-water flow.

Control device failure.

<**Insert items**>.

Retain first paragraph below if chiller controls interface with a BAS or DDC system.

* + - * 1. [**BAS**] [**DDC**] System Interface: Factory-install hardware and software to enable system to monitor, control, and display chiller status and alarms.

Retain "Hardwired I/O Points" Subparagraph below if interface with control system is through hardwired points and minimal interface is required. If extensive interface is required, delete below and retain "Communication Interface" Subparagraph, or retain both subparagraphs if requiring both hardwired and communication interface. Contact manufacturer to verify that options retained are available.

Hardwired I/O Points:

Monitoring: On/off status, [**common trouble alarm**] [**electrical power demand (kilowatts)**] [**electrical power consumption (kilowatt hours)**] <**Insert monitoring point**>.

Control: On/off operation, [**chilled-water discharge temperature set-point adjustment**] [**electrical power demand limit**] <**Insert control point**>.

Retain "Communication Interface" Subparagraph below if extensive interface is required and is beyond that than can be provided by hardwired I/O points alone. Coordinate communication protocol option retained with control system requirements. Contact manufacturer to verify that communication interface is available.

Communication Interface: [**ASHRAE 135 (BACnet)**] [**LonTalk**] [**Modbus**] [**Industry-accepted open-protocol**] <**Insert type of interface**> communication interface shall enable control system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through DDC system for HVAC.

Retain paragraph below to enclose wiring if required by special application, such as a corrosive or humid environment, or outdoor application. Requirement will add cost and is unnecessary for many indoor applications. Chiller manufacturers do not normally enclose all wiring. Consult listed manufacturers for availability.

* + - * 1. Factory-installed wiring outside of enclosures shall be in NFPA 70-complaint raceway.[**Make terminal connections with liquidtight or flexible metallic conduit.**]
      1. ACCESSORIES

Consult listed manufacturers for availability of accessories listed.

* + - * 1. Factory-furnished [**neoprene**] [**or**] [**spring**] isolators [**with seismic restraints**]for field installation.

Retain "Spring Deflection" Subparagraph below if retain "spring" option in paragraph above.

Spring Deflection: [**1 inch**] [**2 inches**] <**Insert inches**>.

* + - 1. CAPACITIES AND CHARACTERISTICS

If Project has more than one type or configuration of water chiller, delete this article and schedule water chillers on Drawings.

* + - * 1. Capacity: <**Insert tons**>.

LEED Prerequisite EA 2 requires compliance with ASHRAE/IES 90.1. LEED Credit EA 1 requires efficiency in excess of minimum efficiency required by ASHRAE/IES 90.1. Coordinate efficiency requirements with "Quality Assurance" Article.

* + - * 1. Full-Load Efficiency:

Retain one of first three subparagraphs below. First subparagraph is used in ASHRAE/IES 90.1.

COP: <**Insert number**>.

EER: <**Insert number**>.

Power Input/Cooling Output, kW/Ton: <**Insert value**>.

* + - * 1. Part-Load Efficiency:

Retain one of first two subparagraphs below. Retain first subparagraph if operating conditions reference AHRI standard conditions; retain second subparagraph if operating conditions are other than AHRI standard rating conditions.

IPLV: <**Insert number**>.

NPLV: <**Insert number**>.

Retain "Low Ambient Operation" Paragraph below if low ambient operation is required. Daikin, Trane, and York can operate to 0 deg F (minus 18 deg C) with optional accessories. Carrier can operate to minus 20 deg F (minus 29 deg C).

* + - * 1. Low Ambient Operation: Chiller designed for operation to [**0 deg F**] [**minus 20 deg F**] <**Insert temperature**>.

Retain "High Ambient Operation" Paragraph below if high ambient operation is required. Daikin, Trane, and York can operate to 115 deg F and above with optional accessories. Carrier can operate to 120 deg F.

* + - * 1. High Ambient Operation: Chiller designed for operation to [**115 deg F**] [**120 deg F**] <**Insert temperature**>.
        2. Evaporator:

Type: [**Brazed plate**] [**or**] [**shell and tube**].

Pressure Rating: <**Insert psig**>.

Fluid Type: [**Water**] <**Insert fluid type**>.

Design Fluid Flow Rate: <**Insert gpm**>.

Minimum Fluid Flow Rate: <**Insert gpm**>.

Entering-Fluid Temperature: <**Insert deg F**>.

Leaving-Fluid Temperature: <**Insert deg F**>.

Fluid Pressure Drop: <**Insert feet of head**>.

Fouling factor units in subparagraph below are consistent with AHRI 550/590; first option is based on AHRI 550/590 standard rating.

Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu**] [**0.00025 sq. ft. x h x deg F/Btu**] [**0.0005 sq. ft. x h x deg F/Btu**] <**Insert value**>.

* + - * 1. Condenser Entering-Air Temperature: <**Insert deg F**>.
        2. Site Altitude: <**Insert feet**>.

Retain "Heat Recovery Condenser" Paragraph below if retaining "Heat Recovery Condenser" Article.

* + - * 1. Heat Recovery Condenser:

Type: [**Brazed plate**] [**or**] [**shell and tube**].

Capacity: <**Insert MBH**>.

Pressure Rating: <**Insert psig**>.

Fluid Type: [**Water**] <**Insert fluid type**>.

Design Fluid Flow Rate: <**Insert gpm**>.

Minimum Fluid Flow Rate: <**Insert gpm**>.

Entering-Fluid Temperature: <**Insert deg F**>.

Leaving-Fluid Temperature: <**Insert deg F**>.

Fluid Pressure Drop: <**Insert feet of head**>.

Fouling factor units in subparagraph below are consistent with AHRI 550/590; first option is based on AHRI 550/590 rating.

Fouling Factor: [**0.00025 sq. ft. x h x deg F/Btu**] [**0.0005 sq. ft. x h x deg F/Btu**] [**0.001 sq. ft. x h x deg F/Btu**] <**Insert factor**>.

Second option in "Number of Refrigeration Circuits" Paragraph below is not available in all chiller sizes. Consult listed manufacturers.

* + - * 1. Number of Refrigeration Circuits: [**One**] [**Two**].

Retain "Hydronic Package" Paragraph below if retaining "Chilled-Water Hydronic Package" Article.

* + - * 1. Hydronic Package:

Number of Pumps: [**One**] [**Two**].

Pump Control: [**Constant**] [**Variable**] speed.

Pump Design Fluid Flow Rate: <**Insert gpm**>.

Pump Dynamic Head: <**Insert feet of head**>.

Pump Speed: <**Insert rpm**>.

Pump Motor Horsepower: <**Insert horsepower**>.

Storage Tank: <**Insert storage capacity**>.

Copy "Compressor Rated Load Amperes" and "Compressor Locked-Rotor Amperes" paragraphs below and insert values for each compressor of multiple compressor units.

* + - * 1. Compressor Rated Load Amperes: <**Insert value**>.
        2. Compressor Locked-Rotor Amperes: <**Insert value**>.
        3. Controls Power Connection: Fed through integral transformer.
        4. Chiller Power Input: <**Insert kilowatts**>.
        5. Chiller Minimum Circuit Ampacity: <**Insert value**>.
        6. Chiller Maximum Overcurrent Protection Device: <**Insert amperage**>.
        7. Chiller Electrical Characteristics: [**208**] [**240**] [**480**] [**600**] <**Insert value**>-V ac, three phase, 60 Hz.
        8. Noise Rating: <**Insert dBA**> at <**Insert distance in feet**> when measured according to AHRI 370.
      1. MATERIALS
         1. Steel:

ASTM A36/A36M for carbon structural steel.

ASTM A568/A568M for steel sheet.

* + - * 1. Stainless Steel:

Manufacturer's standard grade for casing.

Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

* + - * 1. Galvanized Steel: ASTM A653/A653M.
        2. Aluminum: ASTM B209.

Retain first paragraph below if corrosion-resistant coating is specified in Section 230546 "Coatings for HVAC." Retain "Corrosion-Resistant Coating" Paragraph if corrosion-resistant coating options are cited in "Air-Cooled Condenser" Article and if corrosion-resistant coating is specified in this Section. Determine availability with water chiller manufacturers.

* + - * 1. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.
        2. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a [**3000**] <**Insert time**>-hour salt-spray test according to ASTM B117.

Standards:

ASTM B117 for salt spray.

ASTM D2794 for minimum impact resistance of 100 in-lb.

ASTM B3359 for cross hatch adhesion of 5B.

Application: [**Immersion**] [**Spray**].

Thickness: [**1 mil**] <**Insert value**>.

Gloss: Minimum gloss of 60 on a 60-degree meter.

* + - 1. SOURCE QUALITY CONTROL
         1. Perform functional test of water chillers before shipping.

Factory performance tests are an added cost option and may not be available from some manufacturers. Consult availability of testing with listed manufacturers. Verify need for requirement with Director’s Representative.

* + - * 1. Factory performance test water chillers, before shipping, according to AHRI 550/590.

Test the following conditions:

Design conditions indicated.

Retain one of first two subparagraphs below for part-load performance testing. Limit testing to only test conditions required to validate chiller performance. Each test point adds cost and requires time to stabilize operation on test stand. Excessive testing provides little benefit and value to Director’s Representative.

AHRI 550/590 part-load points.

<**Insert test points**>.

Retain subparagraph below to witness testing.

Allow [**Director’s Representative**] <**Insert entity**> access to place where water chillers are being tested. Notify [**Director’s Representative**] <**Insert entity**> [**14**] [**30**] <**Insert number**> days in advance of testing.

* + - * 1. Factory test and inspect evaporator [**and water-cooled condenser**]according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
        2. For water chillers located outdoors, rate sound power level according to AHRI 370 procedure.

1. EXECUTION
   * + 1. EXAMINATION
          1. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.

Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.

* + - * 1. Proceed with installation only after unsatisfactory conditions have been corrected.
      1. WATER CHILLER INSTALLATION

Retain first paragraph below for mounting chillers on concrete bases.

* + - * 1. Coordinate sizes and locations of bases with actual equipment provided. Cast anchor-bolt inserts into concrete bases.

Retain first paragraph below for mounting chillers on a structural-steel support structure.

* + - * 1. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures with actual equipment provided.

Retain first paragraph below if water chillers are installed on a support structure other than a concrete base. Indicate design of support structure on Drawings.

* + - * 1. Install water chillers on support structure indicated.
        2. Equipment Mounting:

Retain first subparagraph below to require equipment to be installed on cast-in-place concrete equipment bases.

Install water chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

Retain one of two subparagraphs below if vibration isolation and seismic-control devices are not furnished with chillers. Retain first for projects in seismic areas; retain second for projects not in seismic areas. Indicate vibration isolation and seismic-control device type and minimum deflection in supported equipment schedule on Drawings.

Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

* + - * 1. Maintain manufacturer's recommended clearances for service and maintenance.
        2. Maintain clearances required by governing code.
        3. Chiller manufacturer's factory-trained service personnel shall charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.
        4. Install separate devices furnished by manufacturer and not factory installed.

Chillers shipped in multiple major assemblies shall be field assembled by chiller manufacturer's factory-trained service personnel.

* + - 1. PIPING CONNECTIONS

Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

* + - * 1. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

Retain first paragraph below for chillers with remote evaporator or condenser.

* + - * 1. Comply with requirements in Section 232300 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
        2. Where installing piping adjacent to chillers, allow space for service and maintenance.

Revise requirements in "Evaporator Fluid Connections" Paragraph below if retaining "Chilled-Water Hydronic Package" Article.

* + - * 1. Evaporator Fluid Connections:

Connect to evaporator inlet with shutoff valve,[**strainer,**] [**flexible connector,**] thermometer, and plugged tee with pressure gage.

Connect to evaporator outlet with shutoff valve, balancing valve,[**flexible connector,**] flow switch, thermometer, plugged tee with pressure gage,[**flow meter,**] and drain connection with valve.

Make connections to water chiller with a [**union**] [**flange**] [**or**] [**mechanical coupling**].

Retain "Heat Recovery Condenser Fluid Connections" Paragraph below if retaining "Heat Recovery Condenser" Article.

* + - * 1. Heat Recovery Condenser Fluid Connections:

Connect to condenser inlet with shutoff valve,[**strainer,**] [**flexible connector,**] thermometer, and plugged tee with pressure gage.

Connect to condenser outlet with shutoff valve, balancing valve,[**flexible connector,**] flow switch, thermometer, plugged tee with pressure gage,[**flow meter,**] and drain connection with valve.

Make connections to water chiller with a [**union**] [**flange**] [**or**] [**mechanical coupling**].

* + - * 1. Connect each drain connection with a drain valve, full size of drain connection.[**Connect drain pipe to drain valve with union and extend drain pipe to terminate over floor drain.**]
        2. Connect each chiller vent connection with [**an automatic**] [**or**] [**a manual**] vent, full size of vent connection.
      1. ELECTRICAL POWER CONNECTIONS
         1. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
         2. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
         3. Provide nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high. Locate nameplate where easily visible.
      2. CONTROLS CONNECTIONS
         1. Install control and electrical power wiring to field-mounted control devices.
         2. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.

Retain first paragraph below to connect chillers to control system for remote monitoring and control.

* + - * 1. Connect control wiring between chiller control interface and [**DDC system**] <**Insert system description**> for remote monitoring and control of chillers. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."
        2. Provide nameplate on face of chiller control panel indicating control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high.
      1. STARTUP SERVICE
         1. [**Engage a Company Field Advisor per OGS Spec Section 014216 to perform**] [**Perform**] startup service.
         2. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
         3. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

Verify that refrigerant charge is sufficient and water chiller has been leak tested.

Verify that pumps are installed and functional.

Verify that thermometers and gages are installed.

Operate water chiller for run-in period.

Check bearing lubrication and oil levels.

Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.

Verify proper motor rotation.

Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.

Retain option in first subparagraph below if retaining "Heat Recovery Condenser" Article.

Verify and record performance of chilled-[**and heat recovery condenser-**]water flow and low-temperature interlocks.

Verify and record performance of water chiller protection devices.

Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

* + - * 1. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.
        2. Prepare a written startup report that records results of tests and inspections.
      1. DEMONSTRATION
         1. Engage a Company Field Advisor per OGS Spec Section 014216 to train Facility’s maintenance personnel to adjust, operate, and maintain water chillers.[**Video record the training sessions and provide electronic copy to Director’s Representative.**]

Instructor shall be factory trained and certified.

Provide not less than [**eight**] <**Insert time**> hours of training.

Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.

Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.

Obtain Director’s Representative sign-off that training is complete.

Facility Maintenance Personnel training shall be held at Project site.

END OF SECTION 236423.13