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**Part 1            General**

**1.1                RELATED REQUIREMENTS**

- .1            Section 23 05 00 - Common Work Results for HVAC

**1.2                REFERENCES**

- .1            American Society for Testing and Materials International (ASTM)
  - .1            ASTM E202, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

**1.3                CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS**

- .1            In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

**1.4                HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)**

- .1            Perform hydronic systems performance verification after cleaning is completed and system is in full operation.
- .2            When systems are operational, perform following tests:
  - .1            Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.
  - .2            Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.
    - .1            Pump operation.
    - .2            Boiler and/or chiller operation.
    - .3            Pressure bypass open/closed.
    - .4            Control pressure failure.
    - .5            Maximum heating demand.
    - .6            Maximum cooling demand.
    - .7            Boiler and/or chiller failure.
    - .8            Cooling tower (and/or industrial fluid cooler) fan failure.
    - .9            Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

**1.5                HYDRONIC SYSTEM CAPACITY TEST**

- .1            Perform hydronic system capacity tests after:
  - .1            Testing, adjusting and balancing has been completed
  - .2            Verification of operating, limit, safety controls.

- .3 Verification of primary and secondary pump flow rates.
- .4 Verification of accuracy of temperature and pressure sensors and gauges.
- .2 Calculate system capacity at test conditions.
- .3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.
- .4 When capacity test is completed, return controls and equipment status to normal operating conditions.
- .5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.
- .6 Heating system capacity test:
  - .1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:
    - .1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or
    - .2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.
  - .2 Test procedures:
    - .1 Open fully heat exchanger, heating coil and radiation control valves.
    - .2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.
    - .3 Conduct flue gas analysis test on boilers at full load and at low fire conditions.
- .7 Chilled water system capacity test:
  - .1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:
    - .1 Adding heat from building heating system or;
    - .2 Raising space temperature by turning off cooling and air systems for sufficient period of time before starting testing and pre-heating building to summer design space temperature (occupied) or above. Set OAD and RAD for minimum outside air if OAT is near outside design temperature or to maximum recirculation if RAT is greater than OAT. RAT to be at least 23 degrees C minimum.
  - .2 Test procedures:
    - .1 Open fully cooling coil control valves.
    - .2 Set thermostats on associated AHU's for maximum cooling.
    - .3 Set AHU's for design maximum air flow rates.
    - .4 Set load or demand limiters on chillers to 100%.

- .5 After system has stabilized, record chilled water, and condenser water flow rates and supply and return temperatures simultaneously.

## **1.6 GLYCOL SYSTEMS**

- .1 Test to prove concentration will prevent freezing to minus 40 degrees C Test inhibitor strength and include in procedural report. Refer to ASTM E202.

## **1.7 FUEL OIL SYSTEMS**

- .1 Environmental protection systems:
  - .1 Test oil storage tank leakage detection system using manufacturer's recommended procedures.
  - .2 Test spill protection and over-fill protection systems using manufacturer's recommended procedures.
- .2 Operational Tests:
  - .1 Timing: perform at same time as 100% and 105% boiler PV tests.
  - .2 Charge system and verify operation.
  - .3 Verify adequacy of flow rates and pressure from storage facilities to burners.
  - .4 Verify accurate metering of fuel to burners.
  - .5 For further details refer to relevant sections of Division 23.

## **1.8 POTABLE WATER SYSTEMS**

- .1 When cleaning is completed and system filled:
  - .1 Verify performance of equipment and systems as specified elsewhere in Division 23.
  - .2 Check for proper operation of water hammer arrestors. Run [one] outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or recharge air chambers. Repeat for each outlet and flush valve.
  - .3 Confirm water quality consistent with supply standards, verifying that no residuals remain resulting from flushing and/or cleaning.

## **1.9 WET AND DRY PIPE SPRINKLER SYSTEM, STANDPIPE AND HOSE SYSTEMS**

- .1 Cleaning, testing, start-up, performance verification of equipment, systems, components, and devices is specified elsewhere in Division 23.
- .2 Verification of controls, detection devices, alarm devices is specified Division 26.
- .3 Demonstrate that fire hose will reach to most remote location regardless of partitions, and obstructions.
- .4 Verify operation of interlocks between HVAC systems and fire alarm systems.

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**1.10 SANITARY AND STORM DRAINAGE SYSTEMS**

- .1 Buried systems: perform tests prior to back-filling. Perform hydraulic tests to verify grades and freedom from obstructions.
- .2 Ensure that traps are fully and permanently primed.
- .3 Ensure that fixtures are properly anchored, connected to system.
- .4 Operate flush valves, tank and operate each fixture to verify drainage and no leakage.
- .5 Cleanouts: refer to Section 22 42 00 - Plumbing Fixtures.

**1.11 REPORTS**

- .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Reports, supplemented as specified herein.

**1.12 TRAINING**

- .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O M Personnel, supplemented as specified herein.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**