PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The requirements of the General Conditions, Supplementary Conditions and all Division 22 Specification sections apply to all Work herein.

1.2 SUMMARY

A. Provide all Pre-functional Testing, Functional Testing and Integrated Systems Testing to demonstrate proper operation as required by these Specifications, the City of San Francisco, and the authorities having jurisdiction of the Plumbing System, equipment and components as indicated on the Drawings and as specified herein. Tests shall include, but not be limited to the items specified in this section and in other Division 22 Specification sections.

B. The Division 22 Subcontractor shall take the lead responsibility for inspecting, completing and documenting the Pre-Functional Testing for the Plumbing Systems to ensure the systems are fully operational and ready for Functional Testing.

C. The Division 22 Subcontractor shall take the lead responsibility for demonstrating the operations of the Plumbing systems for the Functional Tests.

D. Testing shall in no way relieve the Subcontractor of the warranty requirements.

E. The Subcontractor shall furnish all fuel, water and electricity required in performing the testing, balancing and adjusting of mechanical systems.

1.3 REFERENCE STANDARDS

A. All testing, balancing, and adjusting shall be performed in accordance with the latest applicable industry standards, those standards referenced in the applicable Divisions 22 specifications, including the following:
1. NEBB “Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems”.
2. AABC National Standards.

B. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed, in accordance with the requirements of the authorities having jurisdiction and suitable for its intended use on this Project.

1.4 SUBMITTALS

A. The following submittal data shall be furnished according to the General Conditions, Section 22 00 10, and in accordance with the Subcontractor Scheduling Procedures in Section 22 00 20 titled “Plumbing Scope of Work” and shall include, but not be limited to:
1. Proposed test procedures, recording forms, test equipment, and list of personnel and qualifications for all tests proposed. Refer to Section 26 08 13 titled “Testing” for additional requirements.
2. Water and Air Balance Procedures, Recording Forms and Test Equipment.
3. Water and Air Balance Test Reports.
4. Vibration and Alignment Readings.
5. Sound Level Reading Test Equipment and Reporting Forms.
6. Pump Test Data.
7. Hydrostatic Test Logs.
8. Final Air and Water Balance Readings.

B. All items or equipment listed above with asterisks (*) shall be certified by the manufacturer using Manufacturer Certification “MCA” as set forth in Section 22 00 10. See Section 22 00 10 for certification requirements.

1.5 WARRANTY

A. Comply with the requirements of the General Conditions and Section 22 00 10.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 FACTORY TESTING

A. All factory testing shall be performed in accordance with the latest applicable industry standards, with the manufacturer's recommendations and as specified in the applicable Division 22 specifications.

3.2 FIELD TESTING - GENERAL

A. During the progress of the Work, tests shall be made as specified herein and as required by authorities having jurisdiction, including local inspectors, Owner, Owner's Insuring Agency, Architect or Engineer. Tests shall be conducted by the Plumbing Subcontractor as part of the Work of this Division and shall include all qualified personnel, equipment apparatus and services required to perform the tests.

B. The Subcontractor shall submit proposed test procedures, recording forms and test equipment for review in accordance with the Subcontractor Scheduling Procedures in Section 22 00 20 titled "Plumbing Scope of Work".

C. Leaks, damage, or defects discovered or resulting from tests shall be repaired or replaced to a like new condition. Leaky pipe joints, ductwork, etc., shall be removed and replaced with acceptable materials.

D. All equipment and instruments required for tests as well as additional thermometer wells, gauge and instrument connections shall be installed at no additional cost to the Owner.

E. All instruments used for testing and balancing must have been calibrated within a period of three (3) months prior to balancing. Instrument calibration shall be certified as specified in Section 22 00 10.

F. Submit six (6) copies of each complete testing and balancing report to the Engineer for review and send two (2) copies of the report to the Owner. The Subcontractor shall submit individual testing and balance reports for each individual floor air distribution system and each ventilation system in accordance with the Subcontractor Scheduling Procedures in Section 22 00 20 titled "Plumbing Scope of Work".

3.3 TESTING, BALANCING AND ADJUSTING OF PLUMBING SYSTEMS

A. Field vibration and alignment measurements shall be taken on every piece of the following listed equipment driven by a motor over 20 HP, water pumps, which appear in the judgment of the Engineer to have vibration, which exceeds the maximum vibration specified hereinafter; and fans. Readings shall include shaft alignment, equipment vibration, bearing housing vibration, foundation vibration, building structure vibration and other tests as directed by the Engineer. Readings will be made using portable IRD (or approved equal) equipment capable of filtering out various unwanted frequencies and standard reporting forms. Maximum vibration at any point listed above or specified shall not exceed 2 mils on pumps unless otherwise specified. Equipment manufacturers shall certify in writing that the field readings, which do not exceed the maximum specified, are acceptable to them. Vibration and alignment readings shall be taken by an independent testing agency. Submit qualifications of the independent testing agency to the Engineer for review.

B. Sound level readings shall be taken at twelve (12) locations in the building as selected by the Acoustical Consultant. The readings shall be taken on an Octave Band Analyzer in a manner acceptable to the Acoustical Consultant. The Subcontractor shall submit test equipment data and reporting forms to the Engineer and the Acoustical Consultant for review in accordance with the Subcontractor Scheduling Procedures in Section 22 00 20 titled "Plumbing Scope of Work". In order to reduce the ambient noise level, the readings shall be taken at night. All tests shall be performed in the presence of the Owner, Project Acoustical Consultant and/or the Engineer, if they so desire.

C. Hydrostatic Pressure Testing: Before piping of various systems is insulated, furred in or otherwise covered, hydrostatic leak tests shall be conducted as specified below:
   1. Vents shall be provided at all high points of the piping system in the position, in which the test is to be conducted to purge air pockets while the component or systems is filling. Venting during the filling of the system may be provided by the loosening of flanges having a minimum of four bolts or by the use of equipment vents.
   2. Liquid for hydrostatic testing of domestic water systems shall be clean domestic water.
   3. The test equipment shall be examined before pressure is applied to ensure that it is tightly connected. Pressure gauges shall be calibrated before the testing. Gauges shall read in not more than 2 psig increments. All low pressure filling lines and all other items not subject to the test pressure shall be disconnected or isolated by valves or other suitable means.
   4. The hydrostatic test pressure shall be 1-1/2 times the system working pressures listed in Section 22 05 07 titled “Design Conditions” except that the maximum test pressure shall be 500 psig. Note: Equipment must be valved off or removed during the test if the pressure rating is lower than the test pressure. Equipment and piping shall be drained and protected anytime the ambient temperature is below freezing.
   5. The hydrostatic test pressure shall be continuously maintained for a minimum of two (2) hours after which each joint, connection, etc., shall be visually examined to verify there is no evidence of weeping or leakage. The test may be witnessed by the Engineer if he so desires and pronounced satisfactory before pressure is removed or any water is drained off.
   6. The Subcontractor shall maintain a hydrostatic test log listing the system tested, portion tested, date of test, start time and pressure, finish time, pressure and test supervisor for each hydrostatic test. The hydrostatic test log shall be submitted to the Engineer and Owner for record prior to substantial completion of the Project.

D. After soils, wastes, storm lines, etc., have been installed, all pipes in groups of four or five floors shall be temporarily plugged up and the pipe shall be filled with water full to the top or air under pressure and allowed to remain so filled for twenty-four (24) hours.
   1. A final test shall be made after vertical and horizontal pipes have been run and rough in is complete before sewer or fixture connection is made. In this case, as before, all pipes in groups of four (4) or five (5) floors shall be filled with water to the top of vertical lines and allowed to remain so filled for twenty-four (24) hours. Retesting after leaks are repaired shall be at no additional cost.
   2. The Subcontractor shall maintain a log listing the system tested, group of floors tested, start date and time, finish date and time and test supervisor for each test. The test log shall be submitted to the Engineer for record at the completion of the Project.
   3. In addition to the water test, all pipes shall be tested by the peppermint or smoke test, if required by the Engineer or City Plumbing Department.

E. Pumps shall be tested to check impeller trim and operating characteristics. The following data shall be recorded and submitted to the Engineer for review. See Section 22 00 10 for requirements.
   1. Flow at operating conditions where flow venturi or turbine type flow meters are installed in the system.
   2. Shutoff pressure required to check impeller trim.
   3. Discharge pressure at operating conditions.
   4. Suction pressure at operating conditions.
   5. Motor amperage and voltage on each phase at operating conditions.
   6. Record coupling alignment data, both face and radial, to verify alignment is within coupling tolerances.

F. The domestic water piping and equipment shall be cleaned and flushed until the systems are clean as specified in Section 22 10 00 titled “Domestic Water Systems”. Inline basket type strainers and high efficiency strainers with filter cartridges shall be removed and cleaned as often as required under the supervision of the chemical manufacturer’s representative.

G. The Subcontractor shall demonstrate operating controls, control sequences and safety devices on the domestic water pumping systems. The demonstration shall be conducted by a factory trained engineer from the manufacturer’s plant.

H. The Subcontractor shall prove the capacity and performance and/or demonstrate operating controls and safety devices of each piece of equipment by field tests as requested and/or specified in various sections of these Specifications. All equipment and instruments required for tests as well as additional thermowells or gauge connections shall be installed at no additional cost to the Owner. A qualified representative of the equipment manufacturer shall be present at the test. The Engineer may witness tests, if he so desires. The

Subcontractor shall notify the Engineer and Owner in writing, at least two (2) weeks prior to the day of the test. See Section 22 00 10 for additional requirements.

I. The Subcontractor shall submit detailed balancing and performance testing procedures, recording forms and test equipment for all testing specified herein for the Engineer's review in accordance with the Subcontractor Scheduling Procedures in Section 22 00 20 titled "Plumbing Scope of Work".

J. Submit six (6) copies of complete reports to the Engineer for review and comment, and send two (2) copies of the reports to the Owner.

K. Water Balancing and Adjusting:
1. After piping systems have been installed complete with all pumps, piping, valves, coils and other items as herein specified, the Subcontractor shall make adjustments as required to deliver the water volumes at each coil and piece of equipment to within five (5%) percent of design flow as shown on the Drawings or as indicated in the "Schedule of Capacities" in the Contract Documents or as required to properly balance the cooling load throughout the conditioned areas.
2. The Subcontractor shall submit detailed balancing procedure and recording forms for the Engineer's review in accordance with the Subcontractor Scheduling Procedures in Section 22 00 20 titled "Plumbing Scope of Work".
3. Water systems shall be balanced with clean strainers and cartridge filtering elements in the bypass filters.
4. The balanced position of all valves shall be permanently marked on the pipe or insulation and recorded on the balancing forms.
5. Submit six (6) copies of complete comprehensive bound reports of the performance testing of the systems to the Engineer for review and comments in accordance with the Subcontractor Scheduling Procedures in Section 22 00 20 titled "Plumbing Scope of Work". Identify all data completely. Identify the manufacturer, size, type, location, room number and zone of each piece of equipment reported. Give design and actual water flow. Give complete nameplate data for each piece of equipment reported. The plumbing systems will not be accepted until the required reports are received, reviewed and accepted.

L. The Subcontractor shall demonstrate to the Engineer and the Owner, prior to acceptance by the Owner, that all systems and/or equipment has been balanced and adjusted properly and that the system and/or equipment is in compliance with the Contract Documents.

END OF SECTION