

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The BIDDING REQUIREMENTS, CONTRACT FORMS, AND CONDITIONS OF THE CONTRACT and applicable parts of DIVISION 1 - GENERAL REQUIREMENTS, as listed in the Table of Contents, shall be included in and made a part of this Section.

1.02 SUMMARY OF WORK *(for general guidance-not all inclusive)*

A. Introduction

Furnish all labor, materials, equipment and services necessary to construct the following: (1) a recreation pool, and (2) a spa. This work shall include the structure(s) and installation of pool finish(es) as well as all products listed in Part 2 of Section 13150.

B. Work included in this Section:

It is the intent of this Section to place the entire responsibility for the construction of the pool(s) (including the construction of the pool shell(s)) under one vested CONTRACTOR. Under this Section the Swimming Pool Contractor will provide but is not necessarily limited to the following:

1. Provide all equipment and services required for erection and delivery onto the premises of any equipment or apparatus furnished. Remove equipment from premises when no longer required.
2. Layout, excavate, remove from the construction site, replace and grade materials as required beyond the limits of excavation of the pool shell(s) to complete the work described in this section. Reference Division 2 - Site Work.
3. Grade and replace load bearing or high plasticity index soil, pump and dewater as necessary to keep excavations free from water during construction, and provide sub-surface drainage beneath the pump pit and backwash pit. Reference Division 2 - Site Work.
4. Provide and maintain proper shoring and bracing for existing utilities, sewers and building foundations where required for related excavations. Reference Division 2 - Site Work.
5. Provide all electrical conduit, wiring, junction boxes etc. to all low voltage pool equipment within pool filter/chemical rooms per Division 16 - Electrical. (Low voltage is considered less than 110 V.)
6. Furnish and install all necessary piping and valving as shown on the drawings and specified herein.
7. Furnish and install the main drain hydrostatic relief system and a sight sump as shown on the drawings. Reference Division 2 - Site Work.
8. Construct the cast in place or pneumatically applied concrete pool shell(s) as described in these specifications and detailed on the Drawings, including reinforcement steel, inserts, fittings, main drain sumps and all embedded items (piping, anchors, etc.) for the pool(s) and spa. Reference Division 3 - Concrete and Structural. Before commencing the placement of concrete, verify electrical bonding of pool(s) and spa embedded items and reinforcing steel. Also, coordinate and arrange any required electrical, plumbing and or building inspections. Provide any structure drainage around the pool as shown on the Drawings. Backfill and compact fill around the pool structure, piping trenches and excavations required by this work. Reference Division 2 - Site Work.

9. Furnish and install a Diamond Brite/Pebble Tec finish in the pool(s) with a slip resistant surface with a vertical tile band. Furnish and install specialty tile for the perimeter tile deck band, recessed steps, wall targets, floor lane markings, depth markings and warning signs, construction joint installation bands and all other tile installation within the pool structures. Reference Section 13154 - Swimming Pool Tile - including the tolerance requirements for the concrete substrate.
10. Assemble and install the cleaning and maintenance equipment for the pool(s) as specified herein.
11. Provide for the storage of all pool related equipment, materials and systems. All items are the responsibility of the CONTRACTOR until accepted by owner.
12. Obtain final acceptance by jurisdictional health department(s).
13. Start, test, calibrate and adjust all mechanical equipment, electrical equipment, recirculation, chemical, and other supplied systems including deck, loose, maintenance, and safety equipment. Instruct the Owner's representative in the systems operation and maintenance as described herein.

C. Related work specified in other sections:

Work related to the swimming pools to be completed by other contractors.

1. Provide, erect and maintain all necessary barricades, signs, lights and flares for pool construction to protect workers and the public.
2. Provide and maintain proper shoring and bracing for existing utilities, sewers and building foundations where required for swimming pool related excavations. Reference Division 2 - Site Work.
3. Furnish and install the under drain system beneath the pool(s).
4. Construct pump pit and backwash pit including reinforcement, pump housekeeping, support pads, inserts, wall sleeves, anchors, access hatches, and fittings. Reference Division 3 - Concrete.
5. Layout, excavate, remove from the construction site, replace and grade materials as required beyond the limits of excavation of the pool shell(s) to complete the work described in this section. Reference Division 2 - Site Work.
6. Prior to concrete pours, verify electrical bonding of pool embedded items. Coordinate and arrange any required electrical, plumbing and or building inspections to be performed on embedded items. Reference Division 16 - Electrical.
7. Furnish and install sanitary sewer and storm drain connections. Reference Division 15 - Mechanical.
8. Layout and install all deck mounted anchors, sockets, and inserts for the pool(s).
9. Furnish and install deck finish beyond perimeter tile band. Reference Division 9 - Finishes.
10. Provide rules and regulations signage as required by code. Reference Division 1 - General Requirements.

11. Provide chlorine resistant caulking (sealant) and backer rod on pool decks. Reference Division 7 - Thermal and Moisture Protection.
- D. Related work specified in Plumbing section. Reference Division 15 - Mechanical. Work to be completed by other contractors.
1. Furnish and install trench drains and area drains on pool deck.
 2. Furnish and install sanitary sewer piping from the filter room including floor drains.
 3. Furnish and install water service to all hose bibs, flush hydrant boxes and auto-fill by-pass to air gap above fill funnel(s). Install slow closing solenoid valve in by-pass auto-fill piping.
- E. Related work specified in Mechanical section. Reference Division 15 – Mechanical. Work to be completed by other contractors.
1. Furnish and install the heating system for the pool(s). Work to include all piping from the installed pool heating loop tees, heaters, booster pumps, controls, gauges, thermostats, control valves and wiring required to draw water from the recirculation line, heat the water and return it back to the recirculation line and interlock with pool recirculation pumps.
 2. Furnish and install air recirculation systems for pool related spaces.
- F. Related work specified in Electrical sections. Reference Division 16 – Electrical. Work to be completed by other contractors.
1. Furnish and install power to exhaust fan for chemical room(s).
 2. Furnish and install motor starters, auxiliary contacts, magnetic relays and other electrical control devices necessary for the complete operation of the pool systems.
 3. Ground pool structures and all equipment in accordance with Article 680 of the N.E.C.
 4. Obtain permits, inspections, and approvals of all wiring including grounding and bonding of all metal components associated with the pool in accordance with local, State and National Electrical Codes.
 5. Confirm all electrical conduit that penetrates the pool shell is watertight and installed per N.E.C. Article 680.

1.03 QUALITY ASSURANCE

- A. The specifications and drawings illustrate and detail two (2) swimming pool systems that shall be utilized for recreational use. Certain technical aspects of the design are common only to pool systems planned for public use. Understanding these aspects, their functions and interaction through experience is vital to completing a successful operating system. It is a mandatory requirement that all bidders will have achieved such experience as a prerequisite for bidding this project.
1. The GENERAL CONTRACTOR must include a written bid bond from an approved surety company registered in the State of New Mexico certifying that the CONTRACTOR will provide 100% Performance and Labor - Materials Bond on this Project.

2. The CONTRACTOR shall show evidence of having adequate experience in constructing public pools. In order to be considered for this project, the CONTRACTOR must have completed at least five (5) public use, recreation pool(s) with individual water surface areas in excess of 4500 square feet and a depth of 11'-6" ft. or more within the last 10 years. The pools must be complete and currently in operation. Submit a list of such projects with the name, address and current telephone number of the Owner's Operator and Architect of Record to the Architect with the bid.
3. The Owner reserves the right to reject any bid if the evidence submitted by, or investigation of, such bidder fails to satisfy the Owner that such bidder is properly qualified to carry out the obligation of the contract and to complete the work described or if the bidder does not have the qualifications stated herein. Subject to compliance with item 2 above on this specification.
4. The following bidders have been pre-approved. All bidders shall meet the requirements listed above.

Wescon, Inc. Steve Kraft P.O. Box 1483 7301 Jefferson St., NE Albuquerque, NM 87109 Phone: 505-345-2511 Fax: 505-345-2512	California Commercial Pools David Jackson, Lee Jackson 2255 E Auto Center Dr. Glendora, CA 91713 Phone: 909-394-1280 Fax: 909-394-4579
Shasta Industries Karyn Smith 7220 N. 16th St., #C-200 Phoenix, AZ 85020 Phone: 602-997-7896 Fax: 602-943-8692	

1.04 REGULATORY AGENCY REQUIREMENTS AND ENGINEERING SERVICES

- A. The entire system shall be designed and installed to meet all National and local codes and be in compliance with applicable sections of the American National Standards Institute / National Spa and Pool Institute (ANSI /NSPI-2 1999).
- B. The system shall comply with all necessary approvals obtained by the Architect from local regulatory agencies governing the design and construction of public swimming pools.
- C. The Contractor shall give all necessary notices, obtain all permits and pay all government fees, and other costs in connection with his work; file all necessary drawings, prepare all documents and obtain all necessary approvals of governmental departments having jurisdiction; obtain all required certificates of inspection for his work and deliver same to the Architect before request for acceptance and final payment for the work.
- D. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus or drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether or not shown on drawings and/or specified.

1.05 COORDINATION AND CLARIFICATION

- A. Coordinate with other contractors or subcontractors all work relating to this section.

- B. The Contractor must establish with other contractors or subcontractors, having related work in this Section, that all work necessary to complete the pool(s) as shown on the drawings and in the specifications is included in the base bid and alternates to the Owner.
- C. If in doubt regarding the responsibility for work covered in this Section and/or discovery of errors or omissions in the bidding documents, the Contractor shall notify the Architect through channels established by the specifications and request a clarification ten (10) days prior to the bid date.

1.06 ALTERNATES

- A. Review the description of Alternates in Division 1 and on the drawings for possible effect upon work in this Section. Alternates related to the Work in this section are described in this division and on the Bid Proposal Form.
- B. Pool Alternates:
 - Alternate #1: Provide the train slide.
 - Alternate #2: Provide the climbing wall.
 - Alternate #4: Provide the spa. Piping and Electrical to the spa is base bid.

1.07 CONTRACTOR'S ALTERNATE PROPOSAL

- A. Contractor shall submit his bid to the owner based on materials, equipment and methods as specified in this Section. No substitutions of material will be allowed.
- B. It is the intent of the Contract Documents to encourage competition. The base proposal must be on furnishing the construction methods and equipment as specified and detailed. Any proposed system substitution must have prior written approval by the Architect.
- C. All proposed substitutions of specified construction methods and equipment shall include a complete submittal as required by these specifications and drawings of appropriate scale incorporating all required changes. The Contractor shall provide a list of at least ten (10) satisfactory installations comparable to this project that have been manufactured and installed under the manufacturer's current legal name. Submit a list of such projects with the name, address and current telephone number of the Owner's Operator and Architect of Record to the Architect on the bid date.
- D. Any changes or modifications to the Contract Documents that are not authorized by the architect shall be the sole responsibility of the Contractor.

1.08 SUBMITTALS

- A. All submittals shall be made in accordance with the requirements of Division 1 - General Requirements and in strict compliance with the following procedures and guidelines.
- B. Six (6) sets of shop drawings and engineering data shall be tabbed, indexed, referenced to the specifications, bound in 3 ring binders and submitted in two stages. Provide 8 ½" x 11" cover sheet for each item submitted identifying item and product number. The first stage will be all embedded items for the pool shells (including piping diagrams) and the second stage all other items. Only complete sets will be reviewed.

1. Engineering data covering all systems, equipment, structures and fabricated materials, which will become a permanent part of the Work under this Contract shall be submitted for review. This data shall include drawings and descriptive information in sufficient detail and scale to show the kind, size, arrangement, and operation of component materials and devices; the external connections, anchorage's and supports required; performance characteristics; fabrication and dimensions needed for installation and correlation with other materials and equipment. A certification, in writing, shall be provided indicating that all equipment will fit in the space allotted and as shown in the Drawings.
2. All submittals regardless of origin shall be stamped with the approval of the CONTRACTOR and identified with the name and number of this Contract, CONTRACTOR'S name, and references to applicable specification paragraphs and Contract Drawings. Each submittal shall indicate the intended use of the item in the Work. When catalog pages are submitted, applicable items shall be clearly identified. The current revision, issue number, and date shall be indicated on all Drawings and other descriptive data.
3. Submittals will not be accepted from anyone but the CONTRACTOR. Submittals shall be consecutively numbered in direct sequence of submittal and without division by subcontracts or trades.
4. CONTRACTOR'S stamp of approval is a representation that the CONTRACTOR accepts full responsibility for determining and verifying all quantities, dimensions, field construction criteria, materials, catalog numbers and similar data, and that he has reviewed or coordinated each submittal with the requirements of the Work and the Contract Documents.
5. Each submittal shall include a statement prepared by the originator of the Drawings and data, certifying compliance with the Contract Documents except for deviations, which are specifically identified.
6. All deviations from the Contract Documents shall be identified on each submittal and shall be tabulated in the CONTRACTOR'S letter of transmittal. Such submittals shall, as pertinent to the deviation, indicate essential details of all changes proposed by the CONTRACTOR (including modifications to other facilities that may be a result of the deviation) and all required piping and wiring diagrams.
7. CONTRACTOR shall accept full responsibility for the completeness of each submission, and, in the case of a resubmission, shall verify that all exceptions previously noted have been taken into account. In the event that more than one resubmission is required because of failure of CONTRACTOR to respond to exceptions and rejections previously noted, CONTRACTOR shall make all further resubmissions in person at the consultant's office.
8. Any need for more than one resubmission, or any other delay in obtaining review of submittals, will not entitle the CONTRACTOR to an extension of the Contract Time unless delay of the Work is directly caused by a change in the Work authorized by a Change Order.
9. Review of drawings and data submitted by CONTRACTOR will cover only general conformity to the Drawings and Specifications, external connections and dimensions that affect the layout. Review does not indicate a thorough review of all dimensions, quantities, and details of the material, equipment, device or item shown. Review of submittals shall not relieve CONTRACTOR from responsibility for errors, omissions, or deviations, or responsibility for compliance with the Contract Documents.
10. When the drawings and data are returned marked REJECTED, REVISE AND RESUBMIT or SUBMIT SPECIFIED ITEM, the corrections shall be made as noted thereon and as instructed and six corrected copies (or one copy and one corrected reproducible copy) resubmitted.

11. Resubmittals shall bear the number of the first submittal followed by a letter (A, B, etc.) to indicate the sequence of the resubmittal. All resubmittals shall be indexed, tabbed, referenced to the specifications and bound in a three-ring binder and submitted at one time.
 12. When corrected copies are resubmitted, CONTRACTOR shall in writing direct specific attention to all revisions and shall list separately any revisions made other than those called for on previous submissions.
 13. When the drawings and data are returned marked NO EXCEPTIONS TAKEN or MAKE CORRECTIONS NOTED, no additional copies need to be furnished unless specifically requested to do so for record.
- C. Permits, Receipts and Test Reports:
1. Furnish the Architect with copies of all permits and receipts for fee payments.
 2. Submit a sample format for each test report intended for use. Submit test reports required herein only on approved forms.
- D. Include complete product data indexed, tabbed, and referenced to specifications with 8 ½" x 11" cover sheet covering:
1. Paragraph 2.01 - Overflow System
 2. Paragraph 2.02 - Pumping Equipment
 3. Paragraph 2.03 - Filtration Equipment
 4. Paragraph 2.04 - Recirculation Fittings
 5. Paragraph 2.05 - Piping Systems
 6. Paragraph 2.06 - Chemical Treatment Systems
 7. Paragraph 2.07 - Chemistry Monitoring and Control Systems
 8. Paragraph 2.08 - Flow Meter and Water Meter
 9. Paragraph 2.09 - Water Level Controllers
 10. Paragraph 2.10 - Inserts and Anchor Sockets
 11. Paragraph 2.11 - Deck Equipment
 12. Paragraph 2.12 - Loose Equipment
 13. Paragraph 2.13 - Maintenance Equipment
 14. Paragraph 2.14 - Safety Equipment
 15. Paragraph 2.15 - Thermometers
 16. Paragraph 2.16 - Finishes

- 17. Paragraph 2.17 - Waterproofing
- 18. Paragraph 2.18 - Sealants
- 19. Paragraph 2.19 - Water Features and Support Equipment
- 20. Paragraph 2.20 - Pool Concrete Coping
- E. Include engineering/construction drawings for the pool structure.
 - 1. Reference Division 3 - Concrete.
- F. Include engineering construction drawings for all pool piping.
- G. Reference Section 13154 - Pool Tile
- H. Reference Section 13155 - Waterslide

1.09 OPERATION AND MAINTENANCE MANUALS AND CLOSE-OUT SUBMITTALS

- A. Detailed operation and maintenance information shall be supplied for all equipment requiring maintenance or other attention. The equipment supplier and/or CONTRACTOR shall prepare an operation and maintenance manual for all equipment. Parts lists and operating and maintenance instructions shall be furnished.
- B. Each operation and maintenance manual shall include the following:
 - 1. Equipment function and calibration, normal operating characteristics, and limiting conditions.
 - 2. Assembly, installation, alignment, adjustment and checking instructions.
 - 3. Operating instructions for startup, routing and normal operation, regulation and control, shutdown and emergency conditions.
 - 4. One (1) copy of all video taped training sessions.
 - 5. Operating cycles shall be specifically described in outline format and in referenced detail. A wall-mounted color-coded piping flow diagram shall be provided in equipment room. Diagram to be engraved on laminated plastic with color-coded piping to match color of coding on piping, and including valves identified with number on tags. Minimum size to be 11 inch x 17 inch.
 - 6. Include manufacturer recommended maintenance schedule, parts lists, piping diagram (to agree with wall mounted diagram) and trouble shooting information for all pool mechanical equipment.
 - 7. Using reference to keyed valves and wall diagram, include specific written instructions for procedures to be followed for a) emptying and refilling the pool(s) including de-watering during the period that the pool will be empty; b) water level control adjustment and chemical control operation c) filter operation and backwashing; and d) super chlorination.
 - 8. Lubrication and maintenance instructions.
 - 9. Guide to “troubleshooting”.

10. Parts list and predicted life of parts subject to wear.
11. Outline, cross section, and assembly drawings; engineering data and wiring diagrams.
12. Test data and performance curves, where applicable.
13. Specific written instructions for procedure for emptying and refilling the pools including dewatering during any period that the pool will be empty. Include furnishing and installing a "Yellow" warning sign 8-1/2 in. x 11 in., to be mounted in the filter room, that reads:

WARNING
Prior to emptying Pool
Consult O & M Manuals for Procedures

Add another sign to read:

Keep all Caps, Plugs and Tops Tight Fitting to Prevent Escape of Fumes.

14. One set of applicable submittals shall be included in each manual.
- C. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered, or which may be required by the CONTRACTOR.
 - D. Manuals and other data shall be printed on heavy, first quality paper, 8-1/2 x 11 inch size with standard 3-hole punching and inserted in plastic covers. Drawings and diagrams shall be reduced to 8-1/2 x 11 inches or 11 x 17 inches. Where reduction is not practical, larger drawings shall be folded separately and placed in envelopes that are bound into the manuals. Each envelope shall bear suitable identification on the outside.
 - E. Six (6) bound volumes of each manual shall be submitted. All parts lists and information shall be assembled in substantial manuals and permanent, three-ring or three-post binders. Material shall be assembled and bound in the same order as specified, and each volume shall have a table of contents and suitable index tabs.
 - F. All material shall be marked with Project identification. Non-applicable information shall be marked out or deleted.
 - G. Shipment of equipment will not be considered complete until all required manuals and data have been received.

1.10 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver material in manufacturer's original, unopened containers and crates with all labels intact and legible.
- B. Deliver materials in sufficient time and quantity to allow continuity of work and compliance with approved construction schedule.
- C. Handle materials in a manner to prevent damage.
- D. Store all materials on clean raised platforms with weather protective covering. Provide continuous protection of materials against damage or deterioration.
- E. Remove damaged materials from site.

1.11 WARRANTIES

- A. The CONTRACTOR warrants to the Owner and Architect that materials and equipment furnished under the contract will be of good quality and new unless otherwise required or permitted by the Contract Documents, that the work will be free from defects not inherent in the quality required or permitted, and that the work will conform with the requirements of the Contract Documents. Work not conforming to these requirements, including substitutions not properly approved and authorized may be considered defective. The CONTRACTOR's warranty may exclude remedies for damage or defect caused by abuse, improper or insufficient maintenance, improper operations, modifications not executed by the CONTRACTOR or improper wear and tear under normal use. If required by the Architect, the CONTRACTOR shall furnish satisfactory evidence as to the kind and quality of materials and equipment. All warranties shall be for a period of one year from the date of substantial completion or the owner begins using the pool unless otherwise specified.
- B. The CONTRACTOR shall agree to repair or replace any defective or non-complying work at no cost to the Owner upon written notification from the Owner within the warranty period. Pro-rated warranties are not acceptable.
- C. Submit all warranties covering, but not limited to the following:
1. All pool deck equipment and accessories against defects in material, manufacturer and installation for a period of one (1) year.
 2. Defects in material, manufacture or installation of the recirculating overflow system for a period of one (1) year.
 3. Defects in material, manufacture and installation of the filtration, backwash, chlorination, pH adjustments and cleaning systems, including controls for a period of one (1) year.
 4. Defects in material or workmanship of the pool structure causing a loss of water for a period of three (3) years.
 5. Defects in material, workmanship, and installation of the pool piping system for a period of three (3) years.
 6. Defects in material, workmanship, and installation of the pool pumps for a period of one (1) year.
 7. Manufacturer's minimum fifteen (15) year warranty on the filter tank and lining against defective materials or workmanship of the tank and components. (Additional warranty time may be purchased from the manufacturer).
 8. Manufacturer's minimum one (1) year warranty against defective materials, components and workmanship in the sanitizing feed system.
 9. Manufacturer's minimum one (1) year warranty against defective materials, components and workmanship in the ph buffer feed system.

1.12 SYSTEM TRAINING

- A. A qualified representative of the CONTRACTOR performing work under this Section shall put the equipment into operation and instruct the Owner's representatives in the operation of this equipment to the Owner's satisfaction immediately after project substantial completion.

- B. Training periods shall be 32 hours on-site training scheduled as follows:
 1. 16 hours initial training on the complete swimming pool system.
 2. 16 hours after Owner's staff has had experience operating the system. This time may be requested any time after the pool has been placed in operation within a period of one (1) year from the time the pool was accepted by the owner.
 3. CONTRACTOR shall video tape all training sessions and/or arrange taping sessions with major suppliers such as filtration system, water chemical feeders and controller and water level controller.
 4. CONTRACTOR shall include (1) one copy of all video taped training sessions in each Operations and Maintenance Manual.

1.13 POOL FILL WATER QUALITY

- A. The Owner shall bear the cost of the water required for two (2) complete fillings of the pool (the initial leak test and the final filling). Removal of iron or copper (if in excess of .3 ppm) may be required for the final fill to avoid staining of the pool finish. Any subsequent fillings or partial fillings (more than 25%) of the pool shall be by the CONTRACTOR, at its own expense.
- B. CONTRACTOR shall provide the necessary plant equipment so that the temperature of fill water will be within plus or minus 10 degrees of the ambient air and/or the pool structure at the time of filling. Extreme caution is urged if the temperature is greater than 10 degree F.
- C. CONTRACTOR to provide the necessary chemicals and to adjust and balance the water chemistry in the pools to the following levels:

pH	7.4 - 7.6
Calcium Hardness	200 - 400 PPM
Total Alkalinity (Calcium Hypochlorite)	60 - 80 PPM
Langelier saturation index	-0.3 - +0.3

1.14 START-UP CHEMICALS

- A. CONTRACTOR shall maintain the chemical balance of the pool water (including the cost of all chemicals required) until the pool and mechanical system is fully operational and accepted by the architect and the owner.
- B. Provide the owner with sufficient quantities of the necessary chemicals to maintain the pool operation for a minimum of thirty (30) days from substantial completion or the owner begins using the pool.
- C. Chemicals to be provided to the owner shall include those required by the chemical feed systems installed.

1.15 RECORD DRAWINGS

- A. Provide a complete set of record drawings of the entire pool system including all sub-systems. All record drawings shall be prepared in accordance with the requirements of Section 01720 and shall be a complete, stand alone set. The CONTRACTOR shall be permitted to obtain original documents and copy them for this purpose only. Furnish the record set on 30 inch x 42 inch mylar, 3-1/2 inch computer diskettes, or compact disk (AutoCAD Release 12, 13, 14, 2000 or compatible software).

PART 2 - PRODUCTS

2.01 OVERFLOW SYSTEM

It is the intent of the specifications that the perimeter overflow system and surface cleaning be maintained under all conditions of normal operation and that no water be discharged to waste except when cleaning the filters or emptying the pool.

A. Skimmer Overflow System

1. Provide skimming system consisting of units as shown on the drawings. Skimmers shall be so located as to insure maximum skimming action.
2. The piping and other pertinent components of skimming equipment shall be designed for a total capacity of the required filter flow of the recirculation system, and no skimmer shall be designed for a flow-through rate of less than 30 gallons per minute or 5 gallons per minute per lineal inch of weirs.
3. The skimmer weirs shall be automatically adjustable and shall operate freely with continuous action to variations in water level over a range of at least 4 inches. The weirs shall operate at all flow variations. The weir shall be of such buoyancy and design so as to develop an effective velocity.
4. An easily removable and cleanable basket or screen through which all overflow water must pass shall be provided to trap large solids.
5. The skimmer shall be provided with a device to prevent air lock in the suction line. An equalizer pipe shall be used and shall provide an adequate amount of water for pump suction should the water of the swimming pool drop below the weir level.
6. The equalizer shall be sized to meet the capacity requirements of the filter and pump and shall be in no case less than 2 inches in diameter. The pipe shall be located at least 1 foot below the lowest overflow level of the skimmer. It shall be provided with a valve or equivalent device that will remain tightly closed under normal operating conditions but will automatically open when the water level drops below the lowest weir operating level.
7. The equalizer fitting shall be a design to reduce the possibility of hair entrapment in the fitting.
8. The skimmer shall be of sturdy, corrosion-resistant materials.
9. Each skimmer shall be equipped with a variable orifice trimming device to allow balancing of flow.
10. Skimmers shall be NSF approved.
11. Pool skimmers shall be Sta-Rite #08650-1403, Recreonics No. 34-204, or equal. Equalizer/suction fittings shall be Sta-Rite #08011-0000, Recreonics No. 34-215, or equal. Hayward Model SP1082-1 skimmer and SP1080-kit equalizer fitting are acceptable.
12. Spa Skimmers shall be Admiral S20 by American Products.

2.02 PUMPING EQUIPMENT

- A. It is not the intention of the specifications to limit competition. The base proposal must be on furnishing the equipment as specified; however, any bidder may, at his option, offer a substitution for consideration. In proposing a substitution, the project bidder must refer to Section 13150, Part 1.07 (Contractors Alternative Proposal).
- B. Any proposed substitutions shall include a mechanical drawing incorporating all required changes in layout, piping and valves. The cost of such changes shall be included in the price of the substitute. CONTRACTOR to confirm voltage prior to ordering pump. All motors shall be capable of continuously running without overloading at any point on the characteristic curve of the pump without overload or harm. CONTRACTOR shall confirm by 1/4 inch scale shop drawing that the pumps and filters to be furnished will fit in the available space and can be removed for servicing.
1. Pumps shall be certified by the National Sanitation Foundation (NSF) and bear the certification mark.
 2. Pump casing shall be cast iron fitted with a replaceable bronze case wear ring. Mechanical seals shall be provided specific for a clear, mildly chlorinated water application. Pump impeller shall be enclosed type of cast bronze, statically and dynamically balanced, and trimmed for the specified design conditions. All bronze materials shall be suitable for use in a chlorinated environment. Suction and discharge flanges shall be provided and tapped for gauge connections. Provide steel or cast iron bases.
 3. Motor shall be Totally Enclosed, Fan Cooled (TEFC) and premium efficiency of the horsepower and speed specified. A pump requiring larger horsepower shall not be acceptable.
 4. Provide a hair and lint strainer, for each pump, of fiberglass or epoxy coated stainless steel construction with a clear observation top, as manufactured by MerMade Filter Inc., Neptune/Benson Inc., Fluidtrol, or US Filter in the sizes (or pipe sizes) indicated on the drawings. Verify and coordinate pipe and pump suction sizes in the field. Strainer to be of a low pressure drop full-open or a tapered eccentric reducing type. Straight reducing type strainers will not be acceptable without the addition of an approved tapered eccentric reducer between the strainer and the pump (in which case, sufficient space in the pump pit must be verified). Furnish a stainless steel basket with at least 4 times the free open area as the inlet pipe, and one spare basket with each strainer.
 5. Provide an Emergency Shutoff Switch for the Spa. System shall include a clearly labeled Emergency Shutoff Switch for all Spa pumps per Article 680-38 of the NEC. The Architect shall approve the location of the switch. The wiring shall be done per division 16 and coordinated with the pool wiring.
 6. Provide a 15-minute Spa Timer for the hydrotherapy pump(s). The Architect shall approve the location of the timer. The wiring shall be done per division 16 and coordinated with the pool wiring.

Timer shall be a pneumatically actuated on-switch, each with an integrated time delay off, for each of the Spa hydrotherapy pumps. Switch is to be on/off control with integral 15 minute time-off feature. Unit to be Len Gordon AS-STD-10MM, with #10 "Power Touch" or #15 "Classic Touch" air button, in smooth finish and bone beige color (or as noted), suitable for use with up to 150' control tubing distance. Mount button(s) at spa edge, adjacent wall, bollard or at E-Stop switch location, as indicated and required. Provide PVC conduit with long sweep 90's to switch location. Coordinate for button and switch location with Architect and for actual connection by Electrical.
 7. Provide a coating to protect all non-bronze pump(s) from corrosion. Coating shall be fusion bonded epoxy coating on all wetted parts. Preparation: Sandblast to bare, white metal. Thickness: 8 to 12 mils (heavy film). Testing: Verify thickness by non-destructive testing.

Coat parts as recommended by manufacturer, including preheating parts to 400 degrees and electrostatic deposition or fluidized bed technique. Provide primers if required to resist chlorinated water <10 ppm. Coating shall be Scotchkote 134 manufactured by Fusecote or equal, 9658 Alpaca St., South El Monte, CA 9733, 818-443-6760, 213-886-2258, or fax 818-443-9142, or equal.

8. Entire pumping unit shall be mounted on a base using cap screws to preserve the back pull out feature of the pump. Pumps shall not be secured with floor studs. The pump base shall be coated with the same epoxy coating as the pump.
9. Recirculation Pumps and Motors:
 - a. Recreation Pool: Furnish and install one (1) horizontally mounted centrifugal pump, as shown on the Drawings and described in these specifications. Each pump is to be of a straight centrifugal, end suction, bronze fitted, close coupled type, capable of pumping 1,000 GPM against 75 ft. TDH with an efficiency of no less than 80% and a required Net Positive Suction Head (NPSHr) no greater than 10 ft. It shall be provided with a 25 HP, 1750 RPM, 460 VAC, 3 phase, 60 cycle electrically driven motor meeting these specifications. System design based upon Paco. Pumps manufactured by ITT Marlow, Griswold, or Aurora shall all be considered provided they meet the requirements.
 - b. Spa: Furnish and install one (1) horizontally mounted centrifugal pump, as shown on the Drawings and described in these specifications. Each pump is to be of a straight centrifugal, end suction, bronze fitted, close coupled type, capable of pumping 265 GPM against 65 ft. TDH with an efficiency of no less than 75% and a required Net Positive Suction Head (NPSHr) no greater than 5 ft. It shall be provided with a 7.5 HP, 1750 RPM, 460 VAC, 3 phase, 60 cycle electrically driven motor meeting these specifications. System design based upon Paco. Pumps manufactured by ITT Marlow, Griswold, or Aurora shall all be considered provided they meet the requirements.
 - c. All recirculation pumps shall be provided by the same manufacturer. Confirm voltages prior to ordering pumps.
10. Other System Pumps and Motors
 - a. Provide one (1) submersible sump pump, one for each pump pit. The pump shall be a 1/2 HP, 1750 RPM, 115 volt, 1 phase, 60 cycle unit capable of 60 GPM at 25 ft. TDH. The pump body shall be bronze and the motor shall be sealed with a stainless steel shaft. Supply with an automatic mercury level control switch. Pump to be a PACO or equal.
 - b. Provide one (1) self-priming pump for pool draining as shown on the drawings. Pump to draw water from the deep main drain and deposit water into the backwash pit. The pump shall be 1 HP, 3450 RPM, 208/230/460 volt, 3 phase, 60 cycle unit capable of 100 GPM at 25 ft. TDH. Pump to be a Pentair Whisperflo WFE 2/4/6/8 or approved equal.
11. Feature Pumps and Motors
 - a. Feature: Furnish and install one (1) horizontally mounted centrifugal pump, as shown on the Drawings and described in these specifications. Each pump is to be of a straight centrifugal, end suction, bronze fitted, close coupled type, capable of pumping 350 GPM against 35 ft. TDH with an efficiency of no less than 75% and a required Net Positive Suction Head (NPSHr) no greater than 4 ft. It shall be provided with a 5 HP, 1750 RPM, 460 VAC, 3 phase, 60 cycle electrically driven motor meeting these specifications. System design based upon Paco. Pumps

manufactured by ITT Marlow, Griswold, or Aurora shall all be considered provided they meet the requirements.

- b. Waterslide: Furnish and install one (1) horizontally mounted centrifugal pump, as shown on the Drawings and described in these specifications. Each pump is to be of a straight centrifugal, end suction, bronze fitted, close coupled type, capable of pumping 800 GPM against 45 ft. TDH with an efficiency of no less than 76% and a required Net Positive Suction Head (NPSHr) no greater than 9 ft. It shall be provided with a 15 HP, 1750 RPM, 460 VAC, 3 phase, 60 cycle electrically driven motor meeting these specifications. System design based upon Paco. Pumps manufactured by ITT Marlow, Griswold, or Aurora shall all be considered provided they meet the requirements.
- c. Vortex: Furnish and install one (1) horizontally mounted centrifugal pump, as shown on the Drawings and described in these specifications. Each pump is to be of a straight centrifugal, end suction, bronze fitted, close coupled type, capable of pumping 600 GPM against 30 ft. TDH with an efficiency of no less than 75% and a required Net Positive Suction Head (NPSHr) no greater than 7 ft. It shall be provided with a 7.5 HP, 1750 RPM, 460 VAC, 3 phase, 60 cycle electrically driven motor meeting these specifications. System design based upon Paco. Pumps manufactured by ITT Marlow, Griswold, or Aurora shall all be considered provided they meet the requirements.
- d. Recreation Pool Hydrotherapy: Furnish and install one (1) horizontally mounted centrifugal pump, as shown on the Drawings and described in these specifications. Each pump is to be of a straight centrifugal, end suction, bronze fitted, close coupled type, capable of pumping 300 GPM against 35 ft. TDH with an efficiency of no less than 83% and a required Net Positive Suction Head (NPSHr) no greater than 4 ft. It shall be provided with a 5 HP, 1750 RPM, 460 VAC, 3 phase, 60 cycle electrically driven motor meeting these specifications. System design based upon Paco. Pumps manufactured by ITT Marlow, Griswold, or Aurora shall all be considered provided they meet the requirements.
- e. Spa Hydrotherapy: Furnish and install one (1) horizontally mounted centrifugal pump, as shown on the Drawings and described in these specifications. Each pump is to be of a straight centrifugal, end suction, bronze fitted, close coupled type, capable of pumping 360 GPM against 45 ft. TDH with an efficiency of no less than 76% and a required Net Positive Suction Head (NPSHr) no greater than 4 ft. It shall be provided with a 7.5 HP, 1750 RPM, 460 VAC, 3 phase, 60 cycle electrically driven motor meeting these specifications. System design based upon Paco. Pumps manufactured by ITT Marlow, Griswold, or Aurora shall all be considered provided they meet the requirements.
- f. Air Blower: Furnish and install one (1) regenerative air blower in the pool mechanical room as shown on the Drawings. The blower shall be capable of 65 SCFM at 120 inch of H₂O and include an internal muffler for noise dampening. Construction to be of cast aluminum housing, impeller and cover. Unit to be a 5 Hp, 3 phase, 60 cycle, 460 volt as manufactured by Rotron, Inc. Model DR656D72X (330-673-3452) or equal. Provide pressure relief valve (515093), pressure gauge (271949) and a gate valve, which can adjust excess air bleed off.

C. Pressure Gauges shall be installed on the discharge of the pump(s).

Compound Gauges shall be provided at the intake port of the pump(s), after the hair and lint strainer.

Gauges shall be liquid filled, 316L stainless steel bourdon tube type with a minimum 2-1/2 inch diameter dial, high impact polypropylene or stainless steel case, corrosion resistant white scale with black divisions

and numerals, 300 Series stainless steel heavy duty rotary bushed movement, , black enameled balanced Micrometer pointer.

Scale ranges shall be selected to indicate the normal system operating pressure of each system or location within the system. Pressure ranges shall be calibrated in psig and vacuum ranges shall be calibrated in inches of mercury.

A stainless steel filter type pressure snubber shall be provided for each pressure gauge installed consisting of a 3/8 inch diameter by 1/8 inch thick Micro Metallic stainless steel filter and placed in the line just before the pressure gauge. Provide isolation brass valves or brass gauge cocks at each gauge for easy replacement and maintenance.

Gauges shall be as manufactured by Weksler Instrument Corporation or equal.

- D. Provide "Link-Seals" for all pipe penetration as indicated on the Drawings. Locations may include the Pump Pit and other locations as noted. Link Seals shall be provided in the sizes and quantities shown on the Drawings and installed to provide a flexible watertight penetration. Metal parts shall be made of 316L stainless steel. Links shall form a continuous rubber seal that is tightened with a series of stainless steel bolts to form a watertight seal. Link Seals shall be manufactured by Thunderline Corporation, Calpico Inc. or approved equal. CONTRACTOR is to provide factory plastic wall sleeves of the appropriate sizes designed for the specific application and seal size and type. Each sleeve is to have an integrated water stop.

2.03 FILTRATION EQUIPMENT

The filter system shall consist of high rate pressure sand filter tank(s) as shown on the drawings. Every aspect and component of the filter system must be certified by the National Sanitation Foundation (NSF) and bear the certification mark. The filter must have an engraved metal data plate permanently affixed on the face of the system that describes operational data and instructions and indicates start up date.

It is the intent of these specifications to describe a filtration system complete in every respect with all accessory items and supplied and warranted by one manufacturer.

- A. Horizontally Oriented Fiberglass Tanks: The filter tanks shall be horizontally oriented single cell fiberglass tanks, minimum 42 inch diameter. The filter system must be listed as approved by National Sanitation Foundation prior to bid date.
1. Filter tanks must incorporate all components and feature as described in this section.
 2. Saddle style bases (2) shall be provided for tank support. Systems that incorporate stacked tanks shall include similar bases and mounting saddles for the upper vessel. Tank supports and connections shall be seismic rated to support the filter tank(s) for the appropriate seismic zone where the project is located. Access to the tank shall be provided by a 14" x 18" manhole with two (2) curved yokes. Manhole seal shall be complete with a one piece 1/4" neoprene gasket and positioned so that internal pressure from the filter will augment the seal. No additional hardware or through bolts will be allowed.
 3. Each filter tank shall be equipped with the necessary flanges and connections for the internal and external piping. Connections shall be comprised of fiberglass flanges and schedule 80 PVC flanges.
 4. All tank connections 2 inches and smaller shall be 150 lb. Type 316L stainless steel threaded full couplings. All tank connections 3 inches and larger shall be heavy steel bosses drilled and

tapped both sides to receive standard flanged fittings or Sch. 40 Type 316L stainless steel nipples.

5. The discharge from the automatic air release valve shall be hard piped to waste. Each filter tank shall have a means of releasing air. Each coupling or orifice is to be provided with a slotted PVC sand retainer or stainless steel strainer. An automatic air release system shall be provided for each tank.
6. The drain system shall consist of a 3/4 inch 316L stainless steel coupling mounted at the lowest point in the bottom head. This drain shall be valved and piped to the nearest floor drain or backwash pit.

B. Filter Piping - Internal

1. The lower internal distribution system shall be a horizontal header/lateral arrangement. The header shall be Schedule 80 PVC construction, capped on one end and flanged or threaded at the other end for field connection. Lateral connections shall be spaced no more than 6 inches on centers, and shall be 1-1/2 inch FPT connections. All attachments to header shall be solvent welded and thermo-welded to insure integrity of connection.
2. Underdrain system shall be factory installed and constructed of extra heavy Schedule 80 high impact PVC. Multiple PVC main headers to be tapped and threaded to receive laterals.
3. Laterals shall consist of 1-1/2 inch Schedule 80 PVC pipe with openings as required. Each lateral shall be fabricated complete with socket cap on one end and male adapter on the other end. Both fittings to be solvent welded to the slotted pipe. Laterals shall be designed and sized at the factory so as to be installed in the field and over the entire cross sections area of the filter.
4. The upper distributor shall consist of PVC piping Schedule 80 and/or deflector plate per manufacturer standard design.
5. Each filter shall be supplied with a pressure equalizing upper internal distribution system consisting of a horizontal header/lateral arrangement. The header piping shall be constructed of Schedule 80 PVC. The header/lateral piping and all connections shall be designed and sized to provide uniform distribution and unrestricted flow during the filtration and backwash cycles.
6. Upper laterals shall be constructed of Schedule 80 PVC pipe with machine slotted openings or orifices. All machined slots or orifices shall be clean, deburred and free of any obstructions that would not permit the free flow of water through the opening. Details of the lateral attachment to the header shall be submitted for review and approval.
7. The lower and upper distribution systems shall be properly supported and anchored. All hardware in wetted areas shall be Type 316L stainless steel or non-metallic. Tank interiors must be inspected prior to the media being placed in the filters.

C. Filter Piping - External (Face)

1. External face piping shall be Schedule 80 PVC pipe and fittings. Flanges shall be located so as to allow for easy dismantling of face piping. All fittings shall be solvent cemented.
2. Piping shall be drilled and tapped where necessary to accommodate gauge tubing connectors.
3. All valves 3" and larger shall be constructed with cast aluminum S12A alloy (as defined by ASTM B275) housing and fully coated with Rilsan on all interior and exterior surfaces.

Internal components include EPDM resilient lining, Rilsan coated ductile iron disc and 316L stainless steel shaft. Valves shall be rated for 150 psi bubble tight shutoff. Unless otherwise specified, all nuts and bolts shall be stainless steel with stainless steel washers to be used when secured to PVC flanges. Systems incorporating solenoid, pneumatic, pressure amplified, hydraulic or multi-directional valves shall not be acceptable.

4. Standard accessory items shall include sight glass rated for 50 psi with polycarbonate glass, remote mounted gauge panel with two 4½" diameter pressure gauges, ¼" petcocks, ¼" poly vent tubing with PVC compression adapters.

D. Backwash Control

1. The filter manifold face piping shall be designed to allow for one (1) filter tank to be backwashed at a time while the recirculation system is operating. A semi-automatic backwashing system shall be provided with the filter system.
2. Semi-Automatic Backwashing System: The semi-automatic backwash system shall be capable of operating the entire backwash filter sequence for its respective pool with one push of the button.
3. Water connection to backwash system and booster pump system.
 - a. A 3/8" minimum protected water connection shall be provided to the backwash controller. Coordinate with manufacturer.
 - b. A booster pump system (BPS) shall be provided by the filter system manufacturer for the purpose of maintaining a consistent, adjustable water pressure for hydraulic actuation of the backwash control valves. The BPS shall include a centrifugal pump, pressure sustaining tank, adjustable pressure switch, valves, required tubing / connectors and all fittings and appurtenances for a complete and operable system.

E. Automatic Air Relief Valve

A 1" valve shall be provided to automatically and continuously release air in the filter. The valve shall be fabricated of plastic with Buna-N seals. A plumbing kit shall be provided with two (2) PVC ball valves to allow manual air relief and isolation of the automatic valve. Valves fabricated of cast iron, bronze or stainless steel will not be accepted.

F. Filter Media

1. Filter media shall be a carefully selected grade of hard uniformly graded silica material. Media shall be milled angular shaped particles of silica quartz. The filter sand shall have a particle size between .45 mm and .55 mm and have a uniformity coefficient not to exceed 1.53. Specific gravity shall not be less than 2.5 with a pH of 7.0.
2. All media (sand) shall be cleaned and free from any clay or limestone deposits. Bottom layer of support media shall be placed by hand to avoid damage to the underdrain system and leveled before the addition of the upper layer of filter media.
3. All media shall be delivered after approval by the manufacturer of the filter and stored in 100 pound bags for ease of handling and elimination of possible contamination.
4. Media to be supplied by the filter manufacturer and approved by the filter manufacturer prior to shipping.

G. Filter Size

Fiberglass filters shall be the product of Paragon Aquatics / Stark, U.S. Filter, Neptune Benson, Nemato, or Astral (USA) provided they meet the specifications and layout. System design based upon Paragon Aquatics / Stark. Valves must be provided to backwash one filter at a time.

Filters have been sized based on a maximum allowable filtration rate of 15 gpm/sq ft:

Pool	Recreation	Spa
Volume (gal)	176,600	3,165
Flow Rate (gpm)	1,000	265
Filter Model	(2) NB SHFFG 42-108	(1) NB SHFFG 42-60
Filter Size (sq ft)	69.2	20.4
Turnover Rate	2.9 hours	12 minutes
Filtration Rate (gpm/sq ft)	15.0	15.0

H. Warranty

The filter manufacturer shall guarantee the filter will maintain water clarity in the pool to the standards of the local and state health regulations under all maximum allowable conditions of pool use, if the filter is installed and operated in accordance with the manufacturer's printed instructions.

The manufacturer must also provide the Owner with a separate, written fifteen (15) year warranty against structural failure due to manufacturing defects. (Additional warranty time may be purchased from the manufacturer). Said warranty must describe in detail inclusions and exclusions. Provide the Architect with a sample copy of said warranty, prior to bid date, from all manufacturers' submitting a bid on this Section of the specifications. Prorated warranties are not acceptable.

2.04 RECIRCULATION FITTINGS

- A. Main outlets (Main Drains) shall be concrete sumps with 12 gauge 316L stainless steel frame and PVC grating and sized as shown on the plan. Grate openings shall not exceed 11/32 inch in width, providing an open flow area to allow water velocity not to exceed 1.0 fps. The grate shall be PVC and fit closely and flush with top surface of frame, and secured to frame with vandal proof fasteners. Square outlets shown on the drawings shall be similar to the rectangular outlets. Provide additional stainless steel flanged pipe connections where required by the drawings for equalizer lines. Provide no-leak seal flange at midpoint of box. All exposed edges of main outlets shall be rounded and smooth, free of burrs and sharp edges.
- B. Furnish and install hydrostatic relief valves consisting of a 2" cyclac relief valve connected to a FPT commercial style Schedule 80 PVC collector tube. The collection tube shall have seepage holes, 3/8 inch in diameter, and shall be screwed securely to the valve body. The hydrostatic relief valve shall be designed to seal with minimum pressure and shall have a non-plugging, self-cleaning raised valve seat. Hydrostatic relief valve to be Recreonics model #34-601 with collector tube model #34-605, or approved equal.
- C. Wall inlet fittings shall be Hayward Model SP-1421-E (3/4 inch opening) Cyclac directional inlet mounted in Hayward Model SP-1022S or equal from Paddock, Sta-Rite, or Swimtime.
- D. Static water line inlet fitting for the automatic water level controller shall be provided consisting of a Cyclac body, grate and construction shield. The body shall have a 1-1/2 inch solvent weld connection and provided with an integral molded "knock-out" membrane to facilitate line pressure

testing. The static water line inlet fitting shall be a Hayward SP-1026 mounted in a Hayward Model SP-1022S or equal.

- E. The outlet fitting grate from the fill funnel piping to the pool shall be a 9" x 9" cyclac frame and grate.
- F. Adjustable floor inlet fittings shall be provided each consisting of an ABS plastic body and adjusting top plate with a positive locking device. A spanner wrench shall be provided to facilitate flow adjustment. The inlet body shall be provided with a 2-inch cyclac solvent weld connection and internal NPT threads to facilitate line pressure testing. Floor inlet fittings shall be Sta-Rite No. 8417-0000-White/Sta-Rite No. 8417-0100-Gray/Sta-Rite No. 8417-0200-Black or equal.
- G. Valve box covers and frames that are not specified on the drawings or specifically identified as another size or material shall be Zurn Model# ZANB-1461-14-VP, nickel bronze with polished scored top, vandal proof screws or approved equal. Valve box covers and frames for the sight sump shall be Strongwell Quazite 24" X 24" PG Style gasketed heavy duty precast polymer concrete cover with two vandal-proof bolts, Part number PG2424HG00 and open bottom box, part number PG2424BA24, or approved equal. Quazite box and cover color by Architect – standard color is concrete gray.
- H. Hydrotherapy inlet fitting(s) shall be provided consisting of a cast bronze or Cyclac venturi body with 1-1/2 inch water inlet pipe connections and 1/2 inch air intake connection. A 1/8-inch IPS thread shall be provided in the inlet throat to permit hydrostatic pressure testing of piping system. The inlet shall be designed to operate at 25 GPM at a working pressure of 15 PSI and installed as shown on the drawings. Fittings to be Hayward Model SP-1419-D, SP-1430 and SP-1022, or equal.

2.05 PIPING SYSTEMS

A. General

1. Provide all recirculating piping between the pool and filter room, fill receptor and all interconnecting piping to and from the chemical feed systems and chemical controller.
2. Provide all necessary pipe supports and support systems required to support all associated piping and valves.
3. Provide all other tubing, conduit, or piping associated with equipment specified herein. Coordinate with other trades.

B. Pipes

Pipe routing as shown and detailed on the Contract Drawings is diagrammatic only and is not intended to show minor details or exact locations of piping systems. Installation is required to be adjusted to accommodate interference and adjustments anticipated and encountered. Pipe sizes on plans refer to nominal inside diameter of the pipe.

1. Swimming pool piping above the floor or deck in the filter room shall be NSF approved, PVC, Schedule 80. All PVC pipe shall conform to ASTM D-1785. Both pipes and fittings shall be the product of one manufacturer. Approved manufacturers of PVC piping are Eslon, Harvel, and Chemtrol or engineer approved equal.
2. Swimming pool piping below the filter room floor or deck shall be NSF approved, PVC, Schedule 80.

3. All swimming pool piping under the pool floor shall be NSF approved, Schedule 40 PVC and concrete encased. All transitions between Schedule 40 and Schedule 80 shall be encased in concrete.
4. All other pipes and fittings shall be Schedule 80 PVC except for the influent and effluent lines to the heat exchanger unit shall be CPVC. Connections between metallic piping and/or equipment and PVC shall be flanged. Molded fittings shall be as manufactured by Asahi, Eslon, Chemtrol, Spears, or acceptable substitute. Fabricated fittings shall be as manufactured by Harrison Machine, Plastinetics, or acceptable substitute.
5. Vertical sight sump piping shall be NSF approved, Schedule 40 PVC. Horizontal sight sump piping shall be NSF approved, Schedule 40 PVC that is perforated and wrapped with fabric and have 3/8" diameter holes located top and bottom on 4 ft centers. Horizontal sight sump piping shall extend 1 ft minimum beyond the main drain.
6. Tubing used for chemical feed lines from chemical feeders to recirculation lines shall be enclosed in Schedule 40 PVC piping. Piping shall have long radius 90 degree "L" and piping shall not be glued. All Piping shall be vented and pitched back toward the chemical feed pump or to an immediate drain location.
7. All flanged plumbing connections at pumps, valves, strainers, and filters shall be stainless steel.
8. All materials shall be installed by workmen thoroughly skilled in their trades and all work shall present a neat and mechanical appearance when complete. The CONTRACTOR, at no additional expense to the owner, shall replace or correct any work not judged acceptable by the architect, owner's testing agency, or their consultants.
9. All support hardware, brackets, fasteners, hangers, etc. installed in the surge tank shall be stainless steel.
10. No installation shall be made that will provide a cross-connection or inter-connection between a distributing supply for drinking purposes and the swimming pool, or between the pool and a sanitary or storm water sewer system that will permit a backflow of water into the pool water system.
11. All piping shall be hydrostatically (water) pressure tested for leaks before and after backfilling to guarantee water tightness. Pneumatic (air) pressure test not allowed.
12. The CONTRACTOR shall furnish and install 1/4" PVC water stops for this work for watertight penetration of concrete walls. Water stops shall be round and the O.D. shall be sized to 150% of the O.D. of the pipe. The water stops shall be thermo-welded to the pipe from both sides and shall be located at the centerline of the wall being penetrated prior to placing the concrete to assure a watertight seal.
13. CONTRACTOR must adhere to all the applicable provisions in Division 15 - Mechanical, "General Provisions" and "Basic Materials and Methods" for installation of piping system.
14. All mechanical equipment to be connected into the recirculation piping system shall be done so using flanged or union connections.
15. Provisions shall be made to purge all pipes in the system.
16. Concentric reducers shall be fiberglass by MerMade Filter, Inc., 316 L (low carbon) stainless steel or cast iron with Scotchkote applied lining.

C. Pipe Hangers and Supports

1. Manufacturer: Subject to compliance with these specifications, pipe hanger and support systems shall be manufactured by Cooper B-line (Basis of Design), Inc, TOLCO, and Anvil International or approved equal.
2. Hangers
 - a. Pipes 2 inch and smaller:
 1. Adjustable steel clevis hanger, B-Line Models B3100 or B3104.
 2. Adjustable steel swivel ring (band type) hanger, B-Line Model B3170
 - b. Pipes 2-1/2 and larger:
 1. Adjustable steel clevis hanger, B-Line Model B3100.
 2. Adjustable steel yoke pipe roll, B-Line Model B3114.
3. Multiple or Trapeze Hanger
 - a. Trapeze hangers shall be constructed from 12 gauge roll formed ASTM A1011 SS, Grade 33 structural steel channel, 1-5/8 by 1-5/8 inch minimum, B-line B22 strut or stronger as required.
 - b. Mount pipes to trapeze with 2 piece pipe straps sized for outside diameter of pipe, B-line B-2000 Series.
4. Wall Supports
 - a. Pipes 2-1/2 inch and smaller:
 1. Steel Offset J-Hook hanger, B-Line Model B3600
 - b. Pipes 3 inch and larger:
 1. Welded strut bracket and pipe straps, B-line Models B3064 and B2000 Series.
 2. Welded steel bracket B-Line Model B3066 or B3067 with roller chair or adjustable steel yoke pipe roll. B-Line Model B3120 or B3110.
5. Floor Supports
 - a. Electro plated carbon steel adjustable pipe saddle and nipple attached to steel base stand sized for pipe elevation. B-Line Model B3093 and B3088T or B3090 and B8088. Pipe saddle shall be screwed or welded to appropriate base stand.
6. Vertical Supports
 - a. Steel riser clamp sized to outside diameter of pipe, B-Line Model B3373.
7. Plastic Pipe Supports

- a. V-Bottom clevis hangers with galvanized 18-gauge continuous support channel, B-Line Models B3106 and B3106V, to form a continuous support system for all plastic pipes smaller than 1 inch or flexible tubing.
 - b. A vented and sloped continuous PVC SCH 40 pipe no smaller than 1-1/2 inch outside diameter may be used to route flexible tubing with the appropriate pipe supports.
8. Supplementary Structural Supports - Design and fabricate supports using structural quality steel bolted framing materials. Channels shall be roll formed, 12 gauge ASTM A1011 SS Grade 33 steel, 1-5/8 inch or greater as required by loading conditions. Submit design for pipe tunnels, pipe galleries etc. to engineer for approval. Use clamps and fittings designed for use with the strut system.
- D. Hanger Attachments
1. Upper Attachments
 - a. Beam Clamps
 1. Beam clamps shall be used where piping is to be suspended from building steel. Clamp type shall be selected on the basis of load to be supported, and load configuration.
 2. C-Clamps shall be locknuts and cup point set screws similar to B-Line Model B351L or B3036L. Top flange c-clamps shall be used when attaching a hanger rod to the flange of structural steel, B-Line Model B3034 or B3033 or equal. Refer to manufacturers recommendations for setscrew torque. Retaining straps shall be used to maintain the clamp position on the beam where required.
 3. Center load beam clamps shall be used where specified. Steel clamps shall be B-Line Models B3050 or B3055. Forged steel beam clamps with cross bolt shall be B-Line B3291-B3297 Series or equal as required to fit beams.
 - b. Concrete Inserts
 1. Cast in place spot concrete inserts shall be used applicable, either steel or malleable iron body, B-line B2500 or B3014 or equal. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Select inserts to suit threaded hanger rods sizes, B-line Models N2500 or B3014N Series.
 2. Continuous concrete inserts shall be used where applicable. Channels shall be 12 gauge, ASTM A1011 Grade 33 structural quality carbon steel, complete with Styrofoam inserts and end caps with nail holes for attachment to forms. The continuous concrete insert shall have a load rating of 2,000 lbs/ft. in concrete, B-Line Models B22I, 32I, or 52I or equal. Select channel nuts suitable for strut and rod sizes.
- E. Hanger Accessories
1. Hanger Rods shall be threaded both ends or continuous threaded rod of circular cross section. Use adjustable locknuts at upper attachments and hangers. No wire, chain, or perforated straps are allowed.
- F. Hanger Finish

1. Indoor Finishes
 - a. Hangers shall be zinc plated in accordance with ASTM B633 OR shall have an electro-deposited green epoxy finish.
 - b. Strut channels shall be pre-galvanized in accordance with ASTM A653 SS Grade 33 G90 OR shall have an electro-deposited green epoxy finish.
 - c. Zinc Plated hardware is not acceptable for use in chemical rooms.
2. Outdoor Finishes:
 - a. Hanger and strut subject to weathered conditions shall be hot dipped galvanized after fabrication in accordance with ASTM A123. All hanger hardware shall be hot dipped galvanized or stainless steel. Zinc plated hardware is not acceptable for outdoor or corrosive use.
 - b. Hangers and strut located in corrosive areas shall be type 316L stainless steel with stainless steel hardware.

G. Valves

1. Valves 3 inch and larger shall be butterfly type valves, with PVC body, 175# SWP with stainless steel shaft, polypropylene disc and replaceable resilient seat bonded to a rigid shaft and guaranteed for bubble tight shutoff from 27 inch vacuum to 150 PSI. Extended neck 2 inch beyond flanges for any insulated piping shall be provided with handle for manual operation. Valves to be Asahi/America, Chemtrol, George Fisher (G.F.), Bray or Dominion or acceptable substitute.
2. Valves smaller than 3" shall be PVC true union ball valves, full port, three-piece construction, blowout-proof stem, Viton seal with socket end connectors.
3. Check valves shall be a quick closing non-slam type, either self aligning wafer or flanged type, of corrosion resistant materials suitable for use in a swimming pool environment. Install check valves in accordance with the manufacturer's recommendations. Locate Check valves at least 5 pipe diameters from pumps and fittings. Check valves shall be either by Technocheck Corp., elastomer hinge design, Style 5005 series, with PVC body and disks, stainless steel bolts, connectors and fittings, or bronze/stainless steel body with 316L stainless internals; or shall be by Centerline/Crane, series 800, elastomeric lined, with bronze/stainless disks and 316L stainless fittings, or approved equal, for installation between 150 lb flanges.
4. Submerged valves up to 3 inch shall be PVC true union ball valves. Submerged valves over 3 inch to be PVC bodied, wafer type, butterfly valves with stainless steel handle extensions as required. Valves shall be by approved manufacturers listed above. Submerged valves must be provided with all stainless steel connectors. The stem housing extensions shall be properly supported and braced.
5. All butterfly type valves 8 inch and larger shall be fitted with a watertight gear operator.
6. All valves located 7 ft. or greater off the floor shall be fitted with a chain operator.
7. All submerged valves, valves buried below grade or valves not readily accessible, shall be furnished with a stainless steel reach rod and handle.

H. Pipe and valve identification

All exposed pool piping shall be equipped with color coded flow directional arrows at thirty (30) inch intervals. The following table shall be used to indicate the pool pipe color selection. The Contractor shall verify that all pool piping identification is in accordance with all local and state health regulations.

Pipe Service Application	Color
Pool Heat Exchanger Lines	RED
Fresh or Make-Up Water Lines	DARK BLUE
Backwash Waste Water Lines	DARK BROWN
Main Drain Lines	BLACK
Filter Water Lines	AQUA
Chlorine Feed Lines	YELLOW
Acid Feed Lines	PINK
Gutter Lines	OLIVE GREEN
Compressed Air Lines	DARK GREEN

All valves shall be identified with minimum 1-1/2 inch diameter brass tags stamped with minimum 1/2-inch high numbers and attached to valves with #16 brass jack chain. (Plastic laminate engraved tags with nylon attachment acceptable.) Valves shall be described as to their function and referenced in the operating instruction manual and wall mounted piping diagram to be prepared by the CONTRACTOR.

I. Testing

All piping installation and pressure testing shall be reviewed by the Owner’s testing agency before commencement of backfilling. A minimum of one weeks notice is required prior to review. Results of review shall be documented.

1. All pool related piping, shall be hydraulically pressure tested (with water, not air) to a pressure of not less than 50 PSI for a period of no less than two (2) hours.
2. Contractor is responsible for the maintenance of a sustained 20 PSI pressure on all pool related piping throughout the course of construction.
3. Contractor shall adhere to the applicable provisions of Division 15 - Mechanical, "General Provisions" and "Basic Materials and Methods" for installation of piping system.

2.06 CHEMICAL TREATMENT SYSTEMS

A. Calcium Hypochlorite (Chlorinator Briquettes)

Shop drawings complete with a piping diagram depicting the location in which the Dry Chlorination Feeder is to be connected to the system shall be provided and approved prior to installation. Installation of the system shall be as specified in the manufacture’s directions and no exceptions shall be taken. CONTRACTOR shall furnish and install either of the calcium hypochlorite systems specified below.

A factory-authorized representative shall provide training to the owner and the training shall be video taped per 13150, Section 1.12 of the project contract documents.

1. Pulsar III System
 - a. The Sanitization System shall operate in a non pressurized manner to ensure optimum safety and ease of operation.
 - b. A post filter recirculation loop will be added to the main pool recirculation system as part of the Pulsar III System. The recirculation loop will provide the inlet water supply to the chlorinator as well as the vacuum to evacuate the chlorinated solution.
 - c. The Sanitization System shall be N.S.F. ® listed.
 - d. The Sanitization System shall incorporate the principle of spray technology. Water shall spray on to the grids of Briquette Tank making contact with Pulsar® Plus Dry Chlorinator Briquettes. The briquettes shall be in contact with the water for a short time creating a chlorinated solution which will fall into the discharge tank. The chlorinated solution shall be drawn by the vacuum from the discharge tank and introduced into the recirculation system. The output shall operate with a vacuum range between 5" and 29" Hg.
 - e. The vacuum is created by a Mazzei venturi, model 1585X, which is installed in the post filter recirculation loop driven by a ¾ hp Pulsar pump. The venturi is installed on the discharge side of the Pulsar pump creating a flow through the venturi, which provides the suction on the discharge valve evacuating the discharge tank. An emergency shutoff valve shall ensure that water flow to the spray manifold is shut off in the unlikely event that the discharge tank has not emptied properly.
 - f. The System will operate with an inlet water pressure of 25 – 45 psig. The inlet water is supplied from the ¾ hp Pulsar pump.
 - g. The Briquette Tank shall have a capacity of sixty-two (62) pounds of Pulsar® Plus Dry Chlorinator Briquettes.
 - h. The chlorine output shall be controlled by a timer or an ORP controller. The timer has twenty-one settings. One knob controls the off time which ranges from 19 seconds to 53 minutes and is called out from A (19 seconds) to G (53 minutes). The on time is controlled by a second knob, which has 3 settings, ranging from 10 to 30 seconds, low being 22 seconds, normal being 11 seconds and high being 30 seconds. The timer will allow a minimum available chlorine (AvCl) output of 1 lb/day and will allow a maximum available chlorine (AvCi) output of 120 lbs./day.
 - i. The Sanitization System shall be capable of functioning in temperature between 40°F. and 130°F.
 - j. The Sanitization System shall operate with Pulsar Plus Dry Chlorinator Briquettes having 65% minimum available chlorine with at 0.4 to 0.6% scale inhibitor (by weight).
 - k. The Sanitization System shall be provided with a spare screen.
 - l. The Sanitization System shall be capable of satisfactory performance if installed as per the Manufacturer's recommendations (Reference Pulsar III Installation Manual). An Authorized Representative of the Manufacturer shall be located within a reasonable distance of the facility and shall be available to install and service the system as required.

- m. Manufacturer warrants parts of the Sanitization System to be free of defects in workmanship and material for 2 years from date of installation.
 - n. The unit shall be provided with an illustrated installation, operating and maintenance manual with drawings and detailed written descriptions of all phases of controller function.
 - o. Final installation, start-up calibration, and instruction of operating personnel shall be performed on-site by an authorized representative of the manufacturer.
 - p. Training sessions shall be video taped and included with the final O&M manuals.
2. PPG PowerBase
- a. The system shall be designed to feed low concentrations of calcium hypochlorite in solution intermittently or continuously as required for pool and spa applications. The system shall be a single pre-assembled, package unit with a welded aluminum frame consisting of chlorinator, electrical box, centrifugal pump, and balance tank for ease of installation and operation. The system shall be the PowerBase Model by PPG Industries, Inc. Only Accu-Tab® Blue calcium hypochlorite tablets by PPG Industries, Inc shall be used.
 - b. The system shall use an NSF Standard 50 listed erosion feeder and tablet combination, and shall be capable of meeting all requirements of the Health Department having jurisdiction over the installation.
 - c. A maximum chlorine solution level of 0.05% (500 ppm) shall be maintained to prevent calcification in system components. Systems producing chlorine concentrations higher than 0.05% shall not be acceptable.
 - d. Delivery shall be by erosion feed technology to control accurate and consistent concentration limits in the chlorine treatment solution. Soaking type, spray and/or vortex technology systems shall not be acceptable.
 - e. The chlorinator shall automatically and continuously feed a limited quantity of chlorine in solution as needed; when the system is not running, no more chlorine than that amount which can be fed in one minute or less shall be left in the tank to prevent dilution. Batch systems preparing excess quantities of solution for delivery over an extended period shall not be acceptable.
 - f. A centrifugal pump wired to the system electrical box shall feed freshly mixed chlorine treatment solution only as required for maximum efficiency. Batch systems requiring the use of a metering pump or pumps to feed pre-prepared standing solution shall not be acceptable.
 - g. All piping in the chlorinator unit shall be Schedule 40 PVC. Systems with flexible tubing shall not be acceptable.
 - h. Tablet Chlorinator - Accu-Tab® chlorinators by PPG Industries, Inc are designed exclusively for Accu-Tab® Blue calcium hypochlorite tablets by PPG Industries, Inc. Tablets are placed on a sieve plate inside the chlorinator; as water flows across the sieve plate, the tablets erode at a rate proportional to the flow rate.
 - i. Inlet Water Supply Connection with Filter.

Model 3012 1-1/2" FNPT (water supply of 20 GPM required)

Model 3075	1-1/2" FNPT	(water supply of 30 GPM required)
Model 3150	1-1/2" FNPT	(water supply of 60 GPM required)
Model 3500	1-1/2" FNPT	(water supply of 60 GPM required)

- j. Inlet Solenoid Valve - Opens and closes on command when the system receives a signal. 110 VAC required.
- k. Flow Meter - A rotameter (flow-through) flow meter, measuring the flow of the water-dissolving stream to the chlorinator.
- l. Flow Control Valve - PVC gate valve mounted in line with the flow meter allows operator to adjust flow of water-dissolving stream.
- m. Solution Tank - PowerBase units made of high-density polyethylene. Capacities:
- | | |
|------------|------------|
| Model 3012 | 22 gallons |
| Model 3075 | 22 gallons |
| Model 3150 | 30 gallons |
| Model 3500 | 30 gallons |
- n. Primary Solution Tank Level Control - Made from Schedule 80 PVC and 316L stainless steel, this float valve meters the tablet by-pass flow. The by-pass stream balances the variation in the water-dissolving stream. The float valve opens or closes to maintain the pump rate as it is manually throttled.
- o. Secondary High Level Solution Tank Control - Prevents the solution tank from overflowing. High level: when activated, a switch opens the circuit to the solenoid valve, causing the valve to close.
- p. Solution Delivery Pump - Delivers chlorinated solution to the return line. A single-stage centrifugal pump is provided for systems with pressures up to 20 PSIG. (For systems requiring a discharge pressures greater than 20 PSIG, a custom selected pump shall be utilized.)

B. pH Buffering System (Muriatic Acid)

1. Chemical feeders for muriatic acid shall be peristaltic type pumps. Chemical feed pumps shall be furnished and connected to the filtered water return lines to the pool(s) as shown on the pool plans. The pumps shall be capable of feeding a solution to the pool(s) to maintain pH level against the back pressure involved and shall be fully adjustable while in operation.
2. The pumps shall be furnished complete with fractional horsepower motor for 110V 60 hz current, plastic feed lines, and fitting necessary for connections to pool system piping.
3. All chemical pumps shall be electrically connected to, and operated by the water chemical controllers.
4. All acid pumps shall be affixed with a metallic stamped label indicating the chemical being pumped and the pool to which it is connected.
5. Provide non-metallic wall mounted shelf support for all chemical feeders.
6. Provide two (2) fifteen (15) gallon acid drums or one (1) 55 gallon acid tank by LMI.

- c. An automatic, adjustable, electric motor-driven quartz sleeve cleaning system.
 - d. Operational and power controls.
 - e. The ability to do automatic dose control of the UV delivered to the pool water.
 - f. The system shall be sized to match the swimming pool recirculation rate and turnover rate of each pool.
2. UV Chamber: The UV chamber shall be pressure rated for continuous operation at 150psi tested to 225psi and constructed of type 316L stainless steel. It shall be designed for an internal pressure drop not to exceed 2 psi at maximum flow. The chamber shall incorporate:
- a. A temperature sensor to shut off the UV arc tube when there is inadequate flow in the chamber.
 - b. An UV intensity monitor which alarms when the UV arc tube output drops below the dosing level required for proper operation. The monitor shall be of the wet probe type wavelength specific to 240nm – 280nm with a 4-20mA output. It shall display actual lamp intensity (nW/cm²) on the control cabinet door display. (NOTE: *Relative* type UV monitors shall not be acceptable). Dry probe monitors shall not be acceptable, as this type cannot be wiped during the automatic wiping action. Direct line of site monitors (ie those types that have the sensor directly exposed to UV light) shall not be permitted. The monitor shall use offset filters to extend monitor life and to ensure only a limited band of wavelengths is measured.
 - c. A stainless steel terminal cover fastened to the chamber end plate, to which is affixed the electrical conduit, to protect the lamps and electrical leads. (NOTE: plastic terminal covers/caps shall not be permitted).
 - d. A design for laminar flow to provide maximum efficiency in the transfer of UV to the water. (NOTE: baffle plates or similar devices create turbulent flow and dead spots which reduce the efficiency of UV transfer into the water and are therefore not permitted).
 - e. Limit switches shall be located to position the wiper, and to prevent the wiper parking over the active arc tube. The switches shall be magnetic type, and shall include visual indication of the wiper position. The wiper mechanism shall be fail safe, and shall shut the system down in the event of failure, as described below.
 - f. The chamber shall contain a quartz sleeve, which is sealed at both ends by a UV shrouded O ring. The quartz must be annealed for durability and against breakage. Systems that contain a quartz thimble shall not be permitted. The thimble is inherently buoyant and poses a safety risk to operators during annual maintenance.
 - g. The wetted surfaces shall be chemically passivated and all welds ground to eliminate any potential corrosion mechanisms. Crevices (as found behind a quartz thimble) shall not be permitted under any circumstance.
3. Automatic Wiper System: For periodic cleaning of the quartz sleeves and the UV monitor probe, the chamber shall be fitted with an automatic cleaning mechanism. It shall consist of a single SS yoke with Teflon bosses and replaceable molded viton wiper rings that travel the full length of the quartz sleeve twice per cleaning cycle. The frequency of the wiper cycle shall be adjustable from 15 to 720 minutes and set for job conditions. The mechanism shall be driven by a two-pole bi-directional electric motor and acme lead screw. Reed type limit switches shall

control the length of travel. The wiper mechanism wiper rings in the “parked” position shall not be over the lamp, blocking the transfer of UV light, or creating a “hot” spot on the arc tube.

4. Ultra Violet Lamp: The UV lamp shall be high intensity, *medium-pressure* UV arc tube modified to emit a continuous UV spectrum from 220nm to 400nm into the water. The lamp shall be designed to have a spectral output at 245nm (Monochloramine), 297nm (Dichloramine) and both 260nm and 336nm for Trichloramine. Full output must be available from 0 to 200 degrees. The lamp shall be UL approved with one electrical lead at each end.

Lamps with metal frames to permit a single electrical connection diminish operational life and shall not be permitted, as the frame can obscure the UV and metal from the frame can be transferred onto the inside of the quartz sleeve, thus inhibiting the UV action.

A spectral certificate shall be provided with each lamp to demonstrate spectral accuracy. Each lamp shall be individually numbered and the manufacturing process shall permit full audit and traceability of assembly. In addition to an individual serial number, the part number shall be displayed on the lamp.

5. UV System Control: The system control cabinet shall be epoxy-coated steel, NEMA 12 fan cooled with louvers and replaceable filters. The control system shall be de-energized when the cabinet door(s) are open. All wiring shall be harnessed in DIN channels. The power supply to the UV arc tubes shall be from a constant wattage transformer. High frequency ballast systems shall not be used. The entire system shall be UL listed and there shall be a UL decal clearly showing this listing displayed in the cabinet. The control cabinet shall display via a back lit liquid-plasma display the following information:

- a. Power on
- b. UV intensity (% and nW/cm²)
- c. UV dose (mJ/cm²)
- d. Flow rate in GPM
- e. Arc tube ready indicator
- f. Any alarm condition
- g. Wiper status and alarm
- h. Consumable spare parts list with part numbers
- i. Local/remote operation switch, door mounted
- j. Data Logging of UV Dose, lamp hours, lamp intensity for regulatory audit.

The control panel shall contain an Earth Leakage detector, which shall provide fail-safe protection for bathers and those working on the equipment within the pool environment. This requirement is mandatory, as the voltages used within UV systems can pose risk of death. The control panel will require a dedicated 50 amp circuit for the recreation pool system and a 25 amp circuit for the spa system.

The control panel shall be UL LISTED, and in addition shall conform to EN 50081 and EN 61000. The panel and all UV components shall be manufactured to ISO 9001-2000.

6. Instructions: The manufacturer (supplier) shall prepare complete drawings for the installation and printed instructions for the operation of the UV system herein specified and shown on the drawings. A qualified factory trained representative of the manufacturer shall install this equipment, put it into operation and instruct the owner's representative in the operation and maintenance of all such equipment.
7. Warranty: The equipment shall be warranted in writing that when operated and maintained according to the manufacturers operating instructions provided and accepted, it will perform in complete accord with these specifications. All components (excluding the UV arc tube) shall have a limited warranty to be free from defects in workmanship and materials for a period of 12 months from date of start-up. UV arc tubes are warranted to operate for 4000 hours when operated continuously. A continuously operated UV arc tube that fails prior to 4000 hours of operation shall be replaced free of charge. Intermittently operated UV arc tubes (>1 on/off cycle per day) will be replaced free of charge should failure occur prior to 2000 hours and prorated between 2000 and 4000 hours. All warranty replacements are FOB point of shipment. Any claims under this warranty must be made on a timely basis, in writing, to PurAqua Products Inc, P.O.Box 11723, Rock Hill, South Carolina, 29730.

2.07

WATER CHEMISTRY MONITORING AND CONTROL SYSTEMS

A programmable chemical automation system shall be furnished for the recreation pool and spa for continuous monitoring of water chemistry (ORP/HRR, PPM, pH and Temperature), Langelier Saturation Index, and for automatic control of the chemical feeders, heater, and water level. Installation of the system shall be as specified by the manufacturer and no exceptions shall be taken.

Contractor shall furnish and install the water chemistry monitoring and control system as specified below. A factory-authorized representative shall provide training to the owner and the training shall be video taped per 13150, Section 1.12 of the project contract documents.

1. Water Chemistry Controller – Specification based upon a Chemtrol PC3000.
 - a. The controller shall automatically activate the appropriate chemical feeders in order to maintain the sanitizer level within +/-0.1 parts per million (PPM) or +/- 10 mV (millivolts) of Oxidation-Reduction Potential (ORP) and the pH within +/- 0.1 pH unit of the setpoints selected by the operator. ORP and Sanitizer functions shall include seven-day, level-based chemical saver programs. All setpoint and calibration levels shall be adjustable with a numeric keypad mounted on the front panel of the unit. Controllers with internal switches or calibration adjustments will not be considered equal.
 - b. The controller shall be capable of actuating all outputs in the following operator-selectable modes: off, manual, automatic and timer cycle. In the automatic mode, the operator shall be able to choose between on/off control with adjustable deadband or proportional feed control with adjustable deadband and progressive control zones.
 - c. The controller shall include a programmable seven-day clock program with operator selectable ON and OFF times for each day of the week and optional separate chemical feeder relay control.
 - d. The controller shall include a temperature sensor and automatic control of the heater with a seven-day energy saver program.
 - e. The controller shall continuously calculate and display the Langelier Saturation Index using either sensor data and/or manual input for pH, temperature, total alkalinity and calcium

hardness. The resulting calculated water condition shall be displayed on the main screen as either "Scaling", "Corrosive" or "OK".

- f. The controller shall be contained in a NEMA Type 4X (rain and splash proof) lockable fiberglass cabinet with an LCD graphic display screen of eight (8) lines of twenty two (22) alphanumeric characters. The main screen shall display current readings, control modes and operational status for ORP, PPM, pH, temperature (flow rate, influent and effluent pressure displays available with optional installation.) A 16-key touch pad shall be provided for direct access to all the menus and submenus and for entering numerical data. Controllers with smaller displays or displays that require scrolling through menus will not be considered equal. All screens shall have the capability of being displayed at any time in unabbreviated English, French or Spanish and in US or metric units.
 - g. The sensor bypass line shall include an in-line filter, a flowmeter, a safety flow switch, a sampling spigot and two flow control valves, or shall include a flow cell assembly with a safety flow switch.
 - h. The controller shall be factory set to water treatment industry standards. The operator shall be able at any time to adjust all programmable functions to preferred settings. The controller shall have a reset mode to reset all or selected functions to the original factory standards.
 - i. The controller shall have the capability to calibrate all sensor inputs, depending on the accuracy needed, using 1-, 2-, or 3-point calibration to determine respectively the origin, slope and curvature of the calibration curve.
 - j. The controller shall include programmable high and low alarm levels for all control functions with operator-selectable feed lockout and alarm buzzer options. A Remote Alarm relay shall be included in parallel with alarm buzzer for operator-selectable voltage or dry contact output.
 - k. The controller shall continuously monitor and alert for failure of ORP and pH probes using dynamic probe testing before the water chemistry gets out of range. Failure alarms based on safety timers or out-of-range alarms will not be considered equal.
 - l. The controller shall record and display the elapsed run time for each activation event and a cumulative run time resettable at any time by the operator. The controller shall provide for operator-adjustable event run time limits and total run time alarms for all control functions.
 - m. The controller shall include a memory storage battery with minimum reserve power for six (6) months.
 - n. The controller shall include an on-board memory chip for storing of test data on operator-selectable schedules. RS-232 serial communications port shall be included for on-site downloading of the test data. Test data storage must consist of the following sensor inputs: ORP, PPM, pH, Temperature (Conductivity or TDS, Pressure influent of filter, Main flow rate available with optional sensors). The controller shall insert a test data every time power is turned on to indicate power failures. Controllers failing to data log all listed parameters will not be considered equal.
2. The following options shall be provided as part of the base bid:
 - a. OPTION SCA: The ORP and pH sensors shall be mounted in a see-through flow cell with a clear cover located inside a lockable fiberglass enclosure with a window. Optional Temperature and TDS sensors will be mounted on corner Tee inline with flow cell.

- b. OPTION REM3: The controller shall include a modem for remote operation by PC-compatible computer. A Windows software program shall be supplied with true duplex operation capability representing the actual controller screen display with automatic downloading and visual graphics representation of test data. Controllers using simulation or virtual representation of the display screen shall not be considered equal.
 - c. OPTION TEL3: The controller shall have telephone voice communication capability including report of test data, adjustment of controller and automatic dial to six (6) telephone numbers to report alarm conditions.
3. The following available options are not required as part of the base bid. However, if these items are included with the Chemtrol PC3000, they are not required as specified elsewhere in this specification.
- a. OPTION FLOW3: The controller shall include an electronic water flow meter for monitoring and displaying the main line water flow and cumulative flow. The operator shall be able to calibrate the flow sensor by entering its K-factor. The controller shall also include a programmable low flow alarm with operator selectable pump lockout and alarm buzzer options.
 - b. OPTION LEVEL3: The controller shall include a water level sensor and automatic water level control of a water fill valve. The sensor is an electro-optical sensor which can be located in the pool or in the surge pit. The controller shall be capable of operating the fill valve in the following operator-selectable modes of operation: OFF, Manual or AUTO. A programmable seven (7) day program shall be included for AUTO mode with operator selectable ON and OFF times for each day of the week. During Fill cycles, all chemistry control is set in stand-by mode to prevent improper chemical treatment and a "LOW LEVEL" message is displayed on the Main Screen.
4. Warranty
- a. The controller shall be covered by a standard manufacturer warranty of five (5) years. Special extensions of more limited warranties shall not be considered acceptable. All sensors will be covered by a standard one (1) year warranty. Other parts shall be covered by their own manufacturer's warranty. The controller shall not require a service technician for annual calibration, seasonal start up, or whenever chemicals supplier or type are changed.
 - b. The manufacturer shall supply a complete instruction, operating and maintenance manual. Check-out of installation, start up, and instruction of operating personnel shall be performed by an authorized and properly trained manufacturer representative.
5. Water chemistry controller shall be a Chemtrol PC3000, BECSys 5, Acu-Trol AK 600, CAT 5000 or a technically equal system capable of providing equal performance for all operating functions.

2.08 FLOW METER AND WATER METER

A. Flow Meter

1. Flow meters (2 required) shall be installed in the filtered water return lines to each of the pools. Flow meter shall be GF Signet 8150 Battery Powered Flow Monitor. Paddle wheel flow sensor shall be GF Signet 515/2536. Flow sensor shall be installed in the pool return piping according to the manufacturer with the dial to be located next to the chemical controller as shown on the drawings.

Furnish and install the coaxial cable from the sensor to the flow meter or Chemtrol 3000 (if used). Flow meter accuracy shall be +/- 0.5% of reading. The flow meter shall have an LCD display with four-digit flow rate display and simultaneous eight-digit totalizer display. Flow rate and flow totalizers shall be calibrated independently. The flow meter shall be powered by an internal 3.6 V, 4.5 Amp-hour lithium battery with nominal life expectancy of four years. The flow meter shall have a low battery indicator and provisions to retain calibration settings while the battery is being changed.

2. Backwash piping flow meter (2 required) shall be a pilot, impact ball, variable area type with one piece, impact resistant machined acrylic plastic body. GPM scale to be permanently etched or imprinted on the meter. Flow rate indicator to be of stainless steel material. Scale range to be appropriate for specific flow rate. Pipe size to accommodate backwash rate. Manufacturer shall be BLUE-WHITE or equal
3. Installations are to be installed in a straight run of pipe, with a minimum 10 pipe diameters upstream and minimum 5 pipe diameters downstream of any pipe fitting.

B. Water Meter

1. Water meter (2 required) shall be provided by the Contractor. The water meter shall be installed on the fresh water supply line prior to the manual fill valve and the slow closing solenoid valve as shown on the swimming pool drawings.
2. The register for the water meter shall be hermetically sealed, and include a straight reading, odometer-type totalization display, 360° test circle with a center sweep hand and a low flow (leak) detector. Gears to be self lubricating molded plastic. The automatic meter reading system shall be an intelligent communications encoder (ICE) manufactured by Sensus Technologies, model ECR for use with the specified water meter.
3. The remote readout system shall have a liquid crystal display that provides the reading from the meter's absolute encoder. Meter reading data should be automatically updated every 15 minutes. The remote readout system should be wall mounted at eye level. The remote readout system shall be the meter display unit (MDU), manufactured by Sensus Technologies.
4. The spa water meter shall have a non-corrodible epoxy coated bronze main case. The water meter shall be the Turbo, model W-120 DR by Sensus Technologies, Bailey & Gallatin Avenues, Uniontown, PA 15401, ph# 412-430-4054.
5. The pool water meter shall have a non-corrodible epoxy coated bronze main case. The water meter shall be the Turbo, model W-350 DR by Sensus Technologies, Bailey & Gallatin Avenues, Uniontown, PA 15401, ph# 412-430-4054.

C. Refill Flow Meter

Refill flow meter (2 required) shall be installed on dilution piping to backwash tank. Flow meter shall be one piece meter body of injected molded polysulfone adapters, viton o-ring seals, and 316L stainless steel floats and float guide, impact resistant machined acrylic plastic body. GPM scale to be permanently etched or imprinted on the meter. Flow rate indicator to be of stainless steel material. Scale range to be appropriate for specific flow rate. Manufacturer shall be BLUE-WHITE or equal Model F-45750LHN-12, 3/4" M/NPT @ 0.4 to 10.0 gpm.

2.09 WATER LEVEL CONTROLLERS

A. In-Deck Probe Water Level Controller

1. Provide an in-deck probe type make up water controller system for the Recreation Pool and Spa which shall consist of a PVC chamber to house stainless steel probes, control panel housing, a liquid level relay, a delay timer and a 110 volt, 24 hour transformer and timer. All controller components and housing shall be UL listed. Unit shall be Neptune-Benson model WLC-100 water level controller or approved equal.
2. Water level shall be controlled by the use of a three-probe electrode system; high level, low level, and ground. A mechanical linkage or float operated system will not be considered equal.
3. Probes and holder shall be housed in a PVC chamber consisting of an 8 inch schedule 80 PVC pipe. Chamber shall be sized to accommodate desired range of water level variation and shall be complete with a removable cover and adjusted collar suitable for deck level installation. A 1-½ to 2 inch equalizing line shall be connected to the bottom of the probe chamber from the pool.
4. Probes shall be mounted on a readily removable transparent lexan disc within the probe chamber. Probe connectors shall be protected with 90 deg. molded plastic holders. Set probe length / height to indicated or required water level.
5. Wiring from the probes to the Controller shall be provided by the CONTRACTOR and shall be connected to the terminal points mounted within a corrosion-resistant, nonmetallic NEMA 4X enclosure. All wiring connections shall be made through the bottom of the enclosure. The enclosure size shall be no less than 8 inches wide x 10 inches high x 5 inches deep. The access door shall be the entire front face of the enclosure with a vertically mounted stainless steel hinge equal to the full height of the door. Stainless steel hasp with locking loop latch shall be permanently secured to the enclosure.
6. Mounted within the enclosure shall be a liquid level relay, adjustable delay timer, 24 hour clock/timer and terminal board. Major components shall be plugged-in type for ease of replacement without re-wiring. Unit shall be designed to activate a 110 volt solenoid valve.
7. Provide a make-up water solenoid valve, normally closed, stainless steel fitted, bronze body, 115 VAC slow closing type. Size to pipe. Interlock with automatic water level control system. Refer to the Drawings for additional information. Such as Asco, OAE.
8. Discharge of makeup water shall be into a fill standpipe and piping to the Recreation pool / Spa. Refer to the Drawings for additional information.

2.10 INSERTS AND ANCHOR SOCKETS

Sockets and Anchors shall be provided as stainless steel or cast bronze for swimming pool accessories and set prior to placing any concrete. CONTRACTOR shall confirm compatibility of deck equipment and deck anchors with the deck equipment manufacturer. All anchors or sockets shall be furnished with flush closure caps and escutcheons with set screws where indicated.

- A. Anchor sockets for all railings and grab rails shall be of forged stainless steel, 6 inches in depth and made to receive 1.50 inch OD tubing as manufactured by Spectrum Products, part number 24093 or equal. Each anchor socket shall be machined following the forging process to ensure close tolerances and proper fit of rails. ACME threads are to be used to prevent galling and a stainless steel compression ring, designed to make full contact with 1.50 inch tubing, shall be provided. A stainless steel spanner wrench, part number 24094 as manufactured by Spectrum Products or equal, is to be provided with each set of anchors. All metallic components shall be passivated, in compliance with ASTM A967-99, incorporating organic acid passivation techniques for maximum corrosion resistance.

- B. Anchor sockets for all stanchions shall be of cast bronze, sized to receive a full 6 inches penetration of 1.900 inch OD tubing as manufactured by Paragon Aquatics Catalog No. 38201TC, Spectrum Products No. 23626, or Recreonics No. 46-041. Each anchor socket is to be furnished with a flush threaded, vandal proof closure cap Paragon Aquatics Catalog No. 38201TC or Spectrum Products No. 23628, and a grounding lug with screw. Furnish Paragon Aquatics Catalog No. 38303, Spectrum Products No. 23630, or Recreonics No. 46-043 spanner wrenches for removing the closure cap.
- C. Cup anchors for lane lines shall be incorporated into the perimeter overflow system. Cup anchors shall be (Commercial) Paragon Aquatics Catalog No. 70316, Spectrum Products No. 58316, or Recreonics No. 14-505. Cup anchor shall be a stainless steel with eye bolt having a 5/8-11N.C. threads.
- D. Anchors for the diving board stand shall be all bronze threaded castings for respective 5/8" threaded anchor bolts. The stand shall be designed for mounting with the use of Durafirm Catalog # 70-231-900 bronze deck anchors.

2.11 DECK EQUIPMENT

- A. Grab rails shall be furnished and installed as required in the quantities and to the dimensions as shown on the Drawings. Grab rails shall be fabricated of one continuous length of polished and buffed tubing. The tubing shall be ASTM-A-554 grade 316L stainless steel, 1.50 inch OD x .120 inch wall thickness, polished and buffed to 320 grit finish and shall be passivated, in compliance with ASTM A967-99, incorporating organic acid passivation techniques for maximum corrosion resistance. All bends shall be smooth and free of wrinkles. Grab rails shall be pretzel bend as manufactured by Spectrum Products, SR Smith, Paragon Aquatics similar to Spectrum Cisco, Part No. 23437, or approved equal.
- B. Entry rails shall be furnished and installed as shown on the drawings, fabricated from one continuous piece of polished and buffed ASTM-A-554 grade 316L stainless steel, 1.500 inch OD x .120 inch wall thickness, polished and buffed to 320 grit finish and shall be passivated for maximum corrosion resistance. Bends shall be smooth and wrinkle free. Custom rails shall be as manufactured by Spectrum Products, or approved equal. Custom rail submittal drawings shall be complete with details of custom fabrication and installation information.
- C. Stanchion posts for backstroke flags shall be furnished and installed as required and in the quantities shown on the drawings. The posts shall be a straight length of Type 316L stainless steel tubing, 1.900 in. OD x .145 in. wall thickness x 8 ft. 0 in. overall length, polished and buffed to 320 grit finish. Stanchions shall be capped at one end with a closure plug containing a U shaped hook and fitted with a stainless steel eyebolt attached to an adjustable nickel plated bronze sliding collar. Stanchion shall be as manufactured by Paragon Aquatics, Catalog No. 38106, Spectrum Products No. 23614, or Recreonics No. 46-025 with Paragon Aquatics Catalog No. 38301, Spectrum Products No. 23625, or Recreonics No. 46-030 sliding collar, with eyebolt or approved equal.
- D. Lifeguard Chairs (3 required) shall be portable and provided with a molded plastic seat 42 inches above the deck. The seat shall be capable of a 360-degree swivel and shall be supported on a stainless steel tube structure. Platform shall be a 38" x 36" fiberglass platform with a slip resistant surface. The framework of the chair shall be rigidly bolted Type 316L stainless steel tube (1.90 inch OD x 0.065 inch wall thickness, polished and buffed) and angle. Rear access shall be by means of 19" x 4", injection molded, UV stabilized ABS steps. Rubber bumpers shall be furnished for each leg. Chair shall have an assembly that includes (2) 4" Polyolifin diameter wheels on an axle and shall be welded to the front legs in a manner that prevents the wheels from engaging the deck when the chair is at rest. Lifeguard chairs shall be the 2-Step Lookout Guard Chair by Paragon Aquatics Catalog No. 20360 with lookout wheels Paragon Aquatics No. 20377, Recreonics No. 42-624, or approved equal.
- E. Diving Stands:

1. Durafirm by Duraflex International Corp.- Diving stands for one-meter springboards shall be installed as shown on the plans. The diving board stand shall consist of heavy aluminum castings dipped in Iridite chromic acid solution, followed by a 20 mil coat of baked epoxy. Finish must be touched up in the field if damaged in shipping or assembly. The roller tube and tracks shall be heat-treated extruded aluminum processed by Alcoa Duranodic hard anodizing process. The bearings for the roller tube and slide shall be nylon with grease fittings, adjustable and field replaceable. The diving board anchor hinges and pins shall be heat treated aluminum forgings with a design tensile strength of 35,000 psi and shall receive Alcoa Duranodic hard anodizing. Hinges shall be designed to allow 180-deg. rotation of the diving board to the rear of the stand. Hinges shall be mounted on a transverse casting machined to allow 7 leveling positions in one-inch increments. The diving board anchor bolts shall be 5/8-inch diameter by 3-1/2 inch long Silicon bronze. The diving stand shall be supplied with top and intermediate guard rails on two sides. The diving stand guard rails shall be stainless steel tubing firmly attached to the guard rail supports with stainless steel band fasteners. The rails shall extend to the edge of the swimming pool and the rail ends shall be fitted with rubber safety tips. Fulcrum shall have an adjusting wheel at one end that can be turned by hand or foot. Diving stands to be as manufactured by Duraflex International Corp.

One Meter Stand (1 required)

Durafirm Catalog #70-231-400 or Recreonics No. 42-201
(8) Bronze Deck Anchors Durafirm Catalog #70-231-900
or Recreonics No. 42-210

- F. Diving Boards (1 required) shall be an aluminum extrusion type springboard. The diving board shall be a Maxiflex diving board as manufactured by Duraflex International, Inc., Model #66-231-328 or Recreonics No. 40-328. The diving board shall be 16 ft long and 19-5/8 inches wide. The top surface shall be finished with three coats combined with a mixture of sand and white aluminum oxide to affect the non-skid surface.
- G. Pool Lift (1 required) shall be a portable, battery powered handicap lift with footrest assembly. Lift shall be capable of lifting 300 lbs. and shall include the following: Arm Rest Assembly (Recreonics #46-734), and Seat Belt Assembly (Recreonics #46-736). The following accessories shall also be provided: Lift Cover (Recreonics #46-727), Stability Vest (Recreonics #46-728), Extra Battery (Recreonics #46-729), and Spineboard Attachment (Recreonics #46-738). Lift to be a PAL Lift (Recreonics #46-755), or approved equal. Contractor to confirm pool lift fits on pool perimeter and operates correctly.
- H. Climbing Wall (Alternate #2) shall consist of modular panel system with panels that are hand sculpted; hand carved; fiberglass reinforcing, polyester resin with protective UV additives, with minimum hardness Barcol of 45. Panel must be compatible with chlorinated environments. Panel system shall be compatible with modular support system and allow for total re-configuration of topography. Support system shall be compatible with competition pool deck level gutter system. Panels shall have a negative incline and a safety panel at the top. System shall be removable in less than 1 hour. Support structure shall be welded frame made of 316 stainless steel with powder coated finish. Fasteners shall be stainless steel. System shall be designed and installed to CEN/AFNOR standards. Climbing wall shall be Aquaclimb, model number AQCL-4H4W by Pyramid USA (800) 956-6692.

2.12 LOOSE EQUIPMENT

- A. Floating lane lines shall be as shown on the drawings and described in these specifications. Floating lane lines shall be a non-turbulent type with wave quelling floats and 3/16" stainless steel coated cable. Floats shall be injection-molded polyethylene. Colors to alternate the length of the pool with a contrasting solid color for the final 15 feet (Architect/Owner to select colors). All floating lane lines shall be furnished as completely assembled and installed with take up reel, Type 316L stainless steel spring and cable lock, hooks, and wrench. Floating lane lines shall be similar to Competitor Swim Products, Competitor 4"

Lanes pre-assembled and sized to fit the length of the pool. Provide Competitor lane line extension hooks as detailed on the drawings complete with protective sleeve.

Quantities:

Recreation Pool: - Provide two (2) at 25 Yards

- B. Backstroke flags shall be equal to Paragon Aquatics, Catalog No. 40102 or Recreonics No. 92-304 with triangular pennants fabricated of heavy duty boat top vinyl 12 inch wide x 18 inch long, alternating colors (submit samples for review and approval) and butted end to end on a braided polypropylene rope tested to a one-ton pull. Additional 5 ft. of braided polypropylene rope is required at each end of the pennant line assembly for attachment to stanchions.
- C. Lane Line Storage Reel shall be fabricated from a heavy-duty aluminum reel joined together by a 1-1/2 inch aluminum axle. This unit must ride easily on four hard rubber wheels. The CONTRACTOR is responsible for assembly. The correct number of storage reels shall be provided to store all lane line markers. Lane line storage reel to be equal to Competitor Swim Products, Stor-Lane Reel, Catalog #200 350 or Recreonics No. 14-360 with Competitor Storage Reel Cover, Catalog #200 351 or Recreonics No. 14-365.
- D. Pace Clock (1 required) shall be a portable type with stand, battery powered, 31-inch octagonal face with tempered aluminum hands and rollaway stand. Pace clock to be Competitor Swim Products, 31" Pace Clock, Catalog # 200 301 or Recreonics No. 92-515.
- E. Lifeline shall be 3/4 inch blue and white polyethylene rope with floats that are 5 inch diameter by 9 inch long. Floats to be spaced on five foot centers. All metallic rope hooks shall be stainless steel. Provide lifeline at five foot break between shallow and deep water as shown on the drawings. Lifeline to be equal to Recreonics No. 14-381.BW Safety Line Rope, Recreonics No. 14-381 Locking 5" x 9" Floats, and Recreonics No. 14-456 Rope End Hooks.
- F. Triple Water Basketball Goal shall be furnished and installed at the location shown on the drawings. The feature shall be constructed of 304 stainless steel 4" tubing, with a baked on powder coat finish to withstand the environment. Provide the embed consisting of stainless steel J-bolts. The three (3) 39" x 54" fiberglass backboards shall be fan shaped to reduce contact by players, and marked with a regulation target area. The three (3) rims shall be designed for heavy institutional use (600 lb. bend strength), constructed of 5/8" cold rolled steel to make an 18" inside diameter ring. Finish shall be of durable electrostatic powder coat. Three (3) nets shall be provided. All hardware, including fasteners and mounting bolts shall be 304 or 316 stainless steel. The design shall eliminate all hard corners and utilize rounded edges to reduce contact hazards. The basketball goal shall be Stationary Triple WaterGoal Model No. P3TWG as manufactured by Play Pool Products, LLC, 2601 E. Truman Road, Kansas City, MO 64127 (800) 933-6960, www.playpoolproducts.com, or approved equal.
- G. Deck Mounted Water Volleyball shall be furnished and installed at the locations shown on the drawings. Equipment shall include: heavy duty 2 3/8" dia. powder coated aluminum stanchion posts with finishing rings, anchors with caps, heavy duty 24' net with net shortening kit, adjustable height net clamps and hot colored ball. Hardware shall be brass and stainless steel. The water volleyball shall be by Dunn Rite model Deck Volley Item No. DMV100 with brass anchored units Item No. DMV100BR or equal.

2.13 MAINTENANCE EQUIPMENT

The following items are to be supplied by the CONTRACTOR unless otherwise noted. All proprietary names are to designate performance only. Equal products will be accepted.

- A. Wall brush (1 required) - Brush backing shall be a flexible polyethylene material with five (5) rows of nylon bristles. Pool brush holder shall be permanent mold cast aluminum with hydrofoil flap. Holder shall have stainless steel screws to facilitate brush changes. Handle bracket shall be quick detachable mount to fit standard 1 ¼ or 1 ½ inch diameter handles. Brush to be Recreonics No. 10-135, or equal.
- B. Skimming Net (1 required) - Skimmer head shall consist of one-piece molded plastic frame with a reinforced, integral handle bracket suitable for quick attachment to a standard 1¼ or 1 ½ inch diameter handle using bolts and wing nut. The standard nylon net shall be attached to the frame using the groove and spline method. Net depth shall be 4 inches minimum in the center. Skimmer net shall be Recreonics No. 10-121, manufactured by Skimlife No. SS8, or equal.
- C. Telescopic Poles (2 required) - Cleaning tool handle shall be of the telescopic design and fabricated from corrosion resistant, high-quality anodized aluminum. Poles should be fully adjustable, to desired length, with a simple twist of a cyclac threaded locking device. Poles should consist of a 1 inch tube fitted inside a 1¼ inch tube and be adjustable from a range of 8 ft. to 16 ft. Handle shall be adjustable from 8 ft. to approximately 16 ft. having a threaded bushing type clamp to lock handle at desired position. Poles shall be Recreonics No. 10-323, manufactured by Pool King, or equal.
- D. Provide two (2) Test Kits – The first test kit shall feature liquid reagents, color comparator, waterproof instructions and treatment charts, chemistry guide and watergram. Test kit to have the ability to test for free and total chlorine (0.5 – 5.0 ppm), bromine (1-10 ppm), pH (7.0 – 8.0), acid and base demand, total alkalinity, calcium hardness and cyanuric acid. Test kit shall be Taylor Complete 2005 Test Kit, Recreonics No. 56-192, or equal. The second test kit shall allow accurate measurement of free and total chlorine, pH, alkalinity, and calcium hardness. The test kit shall have solid-state digital electronics and built-in filters. The test kit shall be direct-reading with automatic blank settings and automatic power cut-off. Power requirements include 9v (6x1.5v) alkaline batteries. Test kit shall be a Pooltest9 system based on the Palintest system of water analysis. Provide SP 370 Pooltest9 Photometer Kit and PT 232 Pooltest9 Check Standard.
- E. Vacuum Cleaner (Filtered water return to pool) - (1 required) to be complete with a 36 inch dual manifold head with 50 feet of 2 inch floating hose. Hose to be Recreonics, Catalog No. 10-422 or equal. 24 ft. stainless steel pole shall be available for attachment. A stainless steel pool vacuum cart shall be provided with a 155 sq. ft. single cartridge filter, lid mounted handle, separate lid-mounted bracket for electrical cord, and two rubber-tired ball bearing wheels with grease fittings. Cart and filter shall be fabricated from T-316L stainless steel with welds treated and pacified. Cartridge shall be Harmsco No. ST/155, or equal. Pump and Strainer - provide an all bronze pump with a 1½-HP, 115/230 volt, single phase motor and a 5 in. bronze trap. Pump shall be UL and NSF listed, have 2 inch suction and 1½ inch discharge fittings, and have a brass priming valve with hose bib. Entire pump assembly shall be anchored to vacuum cart with two stainless steel bolts. Provide a 100 ft. 10 AWG 3/C SJ electrical cord with ground fault interrupter (GFI) plug, or be pre-wired with GFI protection. Cord shall be wired to a double pole, 30 amp, 115/230 volt switch which shall be mounted on pump motor. Unit to be Recreonics, Catalog No. 10-840, or equal. Accessories shall include a 1½ inch x 25 ft. discharge hose with stainless steel hose clamp. Hose to be Recreonics No. 10-440, manufactured by Quaker Plastic Corporation No. QT-131, or equal.
- F. Robotic Pool Cleaner - Provide one electric motor driven automatic robot swimming pool vacuum device. Unit complete with UltraKart, 120 ft cord, 2 sets of SP3002BM rubber brushes, 2 filter bags and 110/24 volt transformer. Cleaner provided by Aqua Products. Unit to be AquaMax Cleaner (include with remote control, infrared sensor to detect walls or other obstructions, and zero depth air sensor (air sensor option must have infrared sensor)).
- G. Stainless Steel Cleaner: Provide one (1) stainless steel cleaning kit for each pool and spa. The kit shall comprise of one (1) 3M scouring pad, one (1) pair of latex gloves, one (1) 22 ounce bottle of organic passivation solution, one (1) 2 ounce bottle of wax, and three (3) twill cloths. It shall be complete

with instructions for proper maintenance of stainless steel surfaces and material safety data sheets for the passivation solution. The cleaning and passivation kit shall be #202050 as manufactured by Spectrum Products.

2.14 SAFETY EQUIPMENT

The following items are to be supplied by the CONTRACTOR unless otherwise noted. All proprietary names are to designate performance only. Equal products will be accepted.

- A. Ring Buoy and Extension Rope - (3 required) – Buoy shall be 24 inch diameter vinyl clad PVC foam with a metal ring molded inside. Buoy shall have a 3/8 inch polyethylene rope attached to it at four points and be a minimum 100 feet in length. Preserver shall be U.S.C.G. approved. Buoy and rope to be mounted at each lifeguard chair on hooks. Ring buoy to be Recreonics No. 12-252, manufactured by Cal-June No. G-24-WH or equal. Throw rope to be Recreonics No. 12-260, or equal.
- B. Life Hook and Pole - (1 required) – Life hook shall be an anodized aluminum 3/8 inch OD "Shepherd's Crook" with a 1-1/8-inch OD handle attachment suitable for a 1¼-inch 16 ft. aluminum extension pole. Hook shall be of looped construction. Each pole to be provided with a set of spring type stainless steel pole clamps for mounting on each lifeguard chair. Life hook shall be equal to Recreonics No. 12-239, Manufactured by Rainbow No. 153. Pole clamps shall be Recreonics No. 10-353, or equal.
- C. Spineboards (1 required) - Spineboard shall be 72" Long x 20" Wide, constructed of 5/8" thick marine plywood capped with head and foot bumpers. There shall be (10) handholds around the perimeter of the board and capped wood runners on the bottom of the board, which shall raise the board ½" when placed flat for access to handholds. The spineboard shall be supplied with (1) 2-piece head immobilizer, (1) head strap, (4) body straps, (4) side roll ups, (8) adhesive strips and required staples. The Spineboard shall be CJ1000 Package as manufactured by C. J. Spineboard at 1-206-824-8886 (Recreonics Catalog No. 12-325) or approved equal. The CONTRACTOR shall provide (1) set of heavy duty stainless steel utility hooks per spineboard for storing the spineboard at a convenient and readily accessible location near the pool (Recreonics Catalog No. 10-362).
- D. First Aid Kit - (1 required) - First aid kit shall be a 24 unit kit per American Red Cross standards as manufactured by Swift First Aid, or equal.
- E. Rescue tube - (6 required) - Rescue tube to be Recreonics No. 12-311, Manufactured by Bremen Corporation No. 21414-14, or equal.
- F. Safety Eye Wash Station - (1 required) - Safety eyewash station shall be a self-contained system in which eyewash bottles are securely positioned in a portable holder. Eyewash bottles shall be 32 ounces and easily removable from case, and shall contain a sterile, saline solution with the ability to neutralize a varying quantity acids or caustics. Eyewash stations shall be equipped with a double back screw and holes for easy mounting in location to be determined by the Architect. Stations shall be Recreonics 12-033, or equal.
- G. Safety Eyeglasses - Furnish and install a safety eyeglass dispenser station containing ten (10) pairs of safety glasses. Eyeglasses shall be ANSI/OSHA accepted, and be equal to Lab Safety Supply Inc. (1-800-356-0783) No. WQ-14740B.

2.15 THERMOMETERS

The following items are to be supplied by the CONTRACTOR unless otherwise noted. All proprietary names are to designate performance only. Equal products will be accepted.

- 1. Portable thermometer (2 required) shall be a molded ABS plastic tube body type with the ability to measure temperature in both degrees Fahrenheit and Celsius. A 3 ft. polyethylene cord is to be

attached to thermometer. Thermometer is to be Recreonics No. 56-112, Manufactured by Pac-Fab/Rainbow No. R141036, or equal.

2. In-Line thermometer to be near the heating loop and shall have a 9 inch adjustable angle with a minimum 6 inch stem. There shall be a minimum of two (2) thermometers per loop, and must have ability to read temperature in both degrees Fahrenheit and Celsius. Thermometers are to be Recreonics No. 32-702 or equal.
3. Digital temperature indicator (2 required) shall be a 115 volt, wall mounting case, sensor and a stainless steel immersion well. Weiss Instruments Model 20DT or equal. Digital thermometer not required if Chemtrol 3000 is used.

2.16 FINISHES

A. Diamond Brite

1. Description: Diamond Brite finish to be a blend of selected quartz aggregates and fortified white Portland Cement. Color and texture by architect.
2. Surface Preparation: Pool surface must be free of dirt, oil, grease or other foreign materials. Lightly moisten walls and floors prior to application of Diamond Brite.
3. Mixing: Thoroughly mix Diamond Brite to a homogeneous lump-free consistency using 1-1/2 to 2 gallons of potable water per 80 lb. bag.
4. Application: Diamond Brite shall be applied to a uniform thickness of 3/8" to 1/2" over the entire surface. The walls shall be scratch-coated followed by a finish coat. Material applied to the floor after the walls have been applied shall be accelerated to assure uniform setting time throughout the pool surface.
5. Coverage: Each 80 lb. bag shall cover approximately 25 square feet to a thickness of 3/8".

B. Slip-Resistant Natural Pebble Stone Finish

1. CONTRACTOR to install a slip-resistant pebble stone surface in the areas as indicated on the Drawings. Surface to consist of Pebble Tec as supplied by Pebble Technology, Inc. (480) 948-5058 or equal.
2. Installation Procedure:
 - a. The cement –pebble stone mixture is to be pneumatically applied to the pool surface.
 - b. After application of Pebble Tec material the surface is to be hand troweled for exposure of pebble material.
 - c. Spray down troweled surface with water to remove excess cement and exposure of pebbles.
 - d. Surface is allowed a minimum of a 24 hour hardening period. Upon hardening the surface is cleansed with an approved solution as provided by the manufacturer for final exposure and luster of pebble surface.
 - e. Surface is to be buffed so as to ensure all sharp edges are removed and final surface texture is per the manufacturer's recommendations.

3. Natural pebble stone surface is to be applied by a licensed applicator as approved by the manufacturer.

C. Paint

1. Scope: The interior surfaces of the backwash pit shall be coated with a high build epoxy paint or waterproofing material. The color shall be white or an approved light color.
2. General: Coating shall be a polyamide-cured epoxy suitable for chlorinated water below 3.2 ppm. CONTRACTOR shall provide on-site technical services and approval from the coating manufacturer prior to application and during the coating application. Coating shall be Tnemec Series 66 Hi-Build Epoxoline or equal. Color shall be white.
3. Surface Preparation (Cast In Place Concrete): Allow concrete to cure a minimum of 28 days at 60 deg. F. Brush-off pool interior surfaces, then blast clean to remove laitance and weak surface concrete to produce an anchor profile similar to a medium grade sandpaper. Blasting should open up surface voids, holes and irregularities. No holes or holidays in the paint membrane will be allowed. Fill with an approved grout any hole or irregularity that cannot be satisfactorily painted. Do not entirely remove the surface or completely expose underlying aggregate. After blasting, neutralize concrete with a solution of 2 cups aqua ammonia per 5 gallons of water. Flush with clean water and allow to thoroughly dry.
4. Application Procedures: Before applying any material, measure and record the temperature and relative humidity. Apply only if temperature is above 55 deg. F. and at no lower temperature than 5 deg. F. above the dew point. Do not apply when the R.H. is greater than 85%. If possible, plan the painting schedule so that all painting is done in the coolest part of the day. Provide proper ventilation so that paint fumes do not become concentrated.
5. Application of the Primer: After the pool surface has been thoroughly dried and cleaned the primer coat can be applied. Surface spreading rate should be observed as not to exceed the recommended manufacturer's rate of application. The primer may be applied at a minimum rate of 250 sq. ft. per gallon. A good heavy coat should be applied. A rough or porous concrete pool will require more paint than recommended. On particularly rough surfaces two coats are recommended in order to provide a smooth, uniform finish. Note: Any marks or irregularities that show through the primer will also be apparent when the finish coat is applied.
6. Application may be made by brush, roll, lambs wool applicator, or spray. When the finish coat is to be a color other than white the primer may be tinted.
7. Application of the Finish: After the primer is dry enough to walk on without removing or marking surface, apply the finish coat(s) in accordance with the manufacturer's instructions. Application shall be done by the use of a brush, roller, lambs wool applicator or spray methods at a rate of 150-250 sq. ft. per gallon. Allow a minimum of 6-8 hours (at 77 deg.F) drying time between coats. Two coats of finish paint are recommended to improve upon general appearance of pool shell. Allow 7 days curing (at 77 deg. F.) before filling the pool.
8. Application of pool striping, depth markings, warning signs and wall targets, shall be done after final coat of finish paint has cured for at least 24 hours.
9. Slip resistant additive shall be applied to the all outdoor areas, entry steps, ramp areas, zero entry and all deck markings.
10. Final paint coating shall be allowed to dry a minimum of 7 days at 35 degree Fahrenheit or above, before filling the pool.

- D. Pool Tile – Reference specification section 13154.

2.17 WATERPROOFING

- A. Scope: The interior surfaces of the backwash pit shall be coated with a high build epoxy paint or waterproofing material. The color shall be white or an approved light color.
1. General: Coating shall be a pre-blended, cementitious waterproofing coating/mortar consisting of hydraulic binders, selected aggregates and a synthetic polymer intended for the protection of concrete masonry surfaces.
 2. Surface Preparation: Surface shall be structurally sound and free of any foreign substances and debris that could reduce or impair adhesion. Surfaces shall be roughened by sand blasting, water jetting, shot blasting, scarifying, or grinding. Surface defects or holes shall be patched per manufacturer's recommendations.
 3. Application: Concrete substrate shall be maintained moist a few hours before application of waterproof coating. However, surface shall be free from any standing water. Apply first coat of waterproof coating with a trowel or a brush. First coating shall be worked against the concrete surface as to ensure a uniform coat. Waterproof coating shall be allowed to harden for a time period of at least 5 hours and not to exceed 24 hours before the second coat is applied. Application of the second coat of waterproofing can be done by the use of a trowel.
 4. All mixing and application procedures shall be done in accordance with the manufacturer's recommendations.
 5. Waterproofing coating shall be Xypex, Vandex, Planiseal 88, Thoroseal, Aquafin 2KM, or equal.

2.18 SEALANTS

- A. Provide sealed expansion joints as shown on the pool and pool structural drawings or noted on the Contractor's construction/expansion joint layout, and as required. Expansion joints shall be constructed and sealed as indicated and in accordance with the manufacturer's recommendation. Sealant to be Vulkem by Tremco, Inc. or approved equal, phone: 216 – 292-5000, in either of the two types:
1. Vulkem 116, one part, water cured, high performance elastomer Polyurethane sealant in the color(s) as selected.
 2. Vulkem 227 (fast cure), two part, chemical cured, high performance elastomer Polyurethane sealant in the color(s) as selected.
- B. Material storage: All materials are to be stored in the original un-opened factory containers in a cool dry location 60 to 80 degrees F. Protected from the elements and the hazards of construction. Open only as many containers as can be used in any particular period.
- C. Joint preparation:
1. Clean the joints of all deleterious material, to sound, clean and dry substrate.
 2. In mixing the slurry it is recommended that the water be added first, then the cement, and finally the bentonite. The more bentonite the faster the set. Do not get the slurry on the joint itself.
 3. Joint is to be formed or filled with an approved, resilient, non-asphaltic, closed cell, polyethylene joint filler material down to firm substrate. Allow space at the top of the joint for the installation of approved closed cell polyethylene backer rod and install same to the required depth below the surface of the slab to control the depth of the sealant bead to within manufacturer requirements.

- D. Surface Preparation:
1. Concrete surfaces to receive sealant must be fully cured, clean, dry and free of dirt, dust and any deleterious material that might compromise the adhesion and performance of the sealant. Curing aids, form release agents and joint former residue must be completely removed, if necessary by sand blasting and/or grinding. Loose dust must be brushed off.
 2. Prime all surfaces to receive sealant with Vulkem 171 primer prior to sealant application.
- E. Application:
1. Apply sealant in accordance with the manufacturer's recommendations.
 2. Tool the joint immediately after application to insure a firm, intimate contact with the joint interface.
 3. Remove excess sealant and smears from adjacent surfaces with Xylol or Toluol before sealant cures.
 4. After the sealant has fully cured (generally a minimum period of five days at 72 degrees and 50% humidity), paint the surface of the sealant with a chlorine resistant chlorinated rubber or equivalent pool paint, such as Ramuc, in a compatible color as selected by the Architect

2.19 WATER FEATURES AND SUPPORT EQUIPMENT

- A. Train Slide – The train slide shall be placed on the deck, manufactured of a fiberglass substructure, coated with a foam impact attenuating protection on all surfaces, and painted with a high gloss, vibrant colors. A single below-grade connection shall be provided to supply water to the Slide. All connection hardware shall be stainless steel. The stair module shall have an interior width of no more than 24" as measured between the inside handrails. Train Slide shall be Model No. 6172 as supplied by Play Pool Products, LLC, 2601 E. Truman Road, Kansas City, MO 64127, (800) 933-6960, www.playpoolproducts.com, or approved equal.
- B. Train Slide Non-Slip Pool Bottom Padding – Non-slip padding shall be durable, watertight, slip resistant, colorfast, UV stabilized, and algae and fungus resistant. Padding shall have dimensions as required by manufacturer and be attached to the pool floor by using stainless steel screws into nylon expanding anchors, which shall be supplied with the padding. Non-slip padding shall be Model P3-R as supplied/manufactured by Play Pool Products, LLC, 2601 E. Truman Road, Kansas City, MO 64127, (800) 933-6960, www.playpoolproducts.com, or approved equal.
- C. Floatable Raft – The floatable shall be foam lined throughout and urethane coated to eliminate hard impact surfaces. The bottom side shall have a recessed stainless steel U-bolt anchor for tethering to the pool bottom floor. The floatable shall have an EVA soft foam construction and a stainless steel inner structure construction, polyurethane coated foam on all exposed impact surfaces, recessed stainless steel U-bolt anchor with threaded removable top, and universal tethering assembly system. The installation of the anchor cup embed with stainless steel anchor for the tethering assembly must be set in concrete with the anchoring system of the embed tied into the reinforcing and electrical bonding system. Leave the winter cap in place on the anchor cup while setting in concrete. Set top of anchor cup flush with top of finished surface. Floatable shall be supplied by Play Pool Products, LLC, 2601 E. Truman Road, Kansas City, MO 64127, (800) 933-6960, www.playpoolproducts.com, or approved equal.
- D. Pipe Falls – The pipe falls shall be constructed of 304 stainless steel. The shafts shall be 4" diameter 304 stainless steel pipe and the mounting flange shall be 4" diameter stainless steel. All hardware used for the installation and erection of the pipe falls shall be stainless steel, and all stainless steel parts of the unit shall be powder coated. The pipe falls shall be capable of handling 85 gpm and shall have an overall height of 65". Pipe falls shall be WaterL Model No. P3WL-NV as manufactured by Play Pool Products, LLC, 2601 E. Truman Road, Kansas City, MO 64127, (800) 933-6960, www.playpoolproducts.com, or approved equal.

- E. Tunnel Arch – Provide one (1) tunnel arch feature as shown on the drawings with additional nozzles as required to meet the dimensions on the plans. Unit and all piping connections shall be constructed of heavy duty, high tensile strength PVC, gas welded and shall be impervious to rust and corrosion. The nozzles shall be high strength corrosion resistant machine cast brass. Unit to be Tunnel Arch by Raindrop Products, (800) 343-6063, or approved equal.
- F. Air Bubblers – Refer to swimming pool drawings for construction details.

2.20 POOL CONCRETE COPING

- A. Cast-in-Place Coping - The coping shall have the shape as shown on the Construction Drawings. All concrete shall have an equal strength and reinforcing per Division 3 – Concrete, Section 13151 Pneumatically Applied Concrete and/or Section 13152 Cast-In-Place Concrete. The concrete forms shall be by Stegmeier Corporation (1-800-382-5430).

PART 3 - EXECUTION

3.01 EXISTING CONDITIONS, INSPECTION AND PREPARATION

- A. Carefully examine all of the Contract Documents for requirements that affect the Work of this Section. Prior to starting of Work, notify the General Contractor of defects requiring correction. Do not start work until conditions are satisfactory.
- B. Verify that all Work by others, related to this Section, has been completed. This includes all earthwork, concrete work, and mechanical, electrical and plumbing connections.
- C. Protect all materials and Work completed by others from damage while completing the Work in this section.

3.02 FIELD MEASUREMENTS

- A. Verify benchmark and pool location prior to layout.
- B. If field measurements differ from the Construction Drawing dimensions, notification shall be given to the Architect prior to proceeding with Work.

3.03 EXCAVATION, REINFORCING STEEL AND PNEUMATICALLY APPLIED OR CAST-IN-PLACE CONCRETE

- A. Reference Division 2 - Site Work
Reference Division 3 - Concrete
Reference Section 13151 - Pneumatically Applied Concrete
Reference Section 13152 - Cast-In-Place Concrete

3.04 TOLERANCES FOR CONSTRUCTION OF POOL SHELL

- A. The completed structures shall be constructed level and to the dimensions, elevation, depths and thickness as shown on the plans.
- B. The elevation tolerance of the pool shell and gutter lip shall be plus or minus 1/8 inch.

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- C. The vertical wall surface tolerance of the pool shell, for the first 36 inches from the water surface shall be plus or minus 1/4 inch from plumb measured with a 6 foot straight edge.
- D. Ground wires or grade pins, if used, shall be installed in such a manner that they accurately outline the section of the pool shell as indicated on the plans. They shall be located at intervals sufficient to insure proper thickness throughout and shall be maintained tight. Grade pins or grounding wires shall not be permanently embedded in the pool shell.

3.05 WATER TIGHTNESS TEST

- A. This test applies to the Pool and Spa. The water tightness test shall be completed prior to the application of the pool finish.
- B. Water Tightness Test Procedure
 - 1. Preparation: Allow the concrete structure to set 28 days for curing purposes. Once the pool shell has gained sufficient strength to withstand the test load and after all the outlets have been securely sealed, the pool shall be filled with water.
 - 2. Fill: Fill and then isolate the pool. The water tightness test shall begin after the pool has been filled for a minimum of three (3) days. During the filling, all outlets shall be monitored for water tightness and all concrete joints shall be monitored for any visible leakage. If any visible leakage from the pool shell is observed, the condition shall be corrected prior to the start of the test.
 - a. After the initial fill, all ground water shall be removed from the pool sight sump or the pool location de-watering system. This shall be completed "prior" to the start of the watertightness test. De-watering of the pool site sump shall be maintained during the entire duration of the test.
 - 3. Evaporation Measurement Procedure: Fill a floating, restrained, partially filled, calibrated, open container with water and allow the container to float within the pool during the testing period. This will be used to measure evaporation.
 - 4. Measurement: On a separate sheet of paper draw a sketch of the pool. Measurements shall be taken at the pool(s). Multiple test points with averaging are recommended for pools which may be exposed to wind. Document the separate findings on the chart below. Repeat the measurements and document every 12 hours for a total of three (3) days. The General Contractor shall check the pool(s) for water loss with the Architect or owners representative every 12 hours.

Total Allowable Water Loss		(0.1%)			Pan Depth
Total Gallons _____		x 0.001 = _____			Allowable Loss Per 24 Hrs.
Pool Measurements	_____ Pool	Pool or Spa _____	Gutter System or _____	Surge Tank or _____	Pan Measurements
12 Hrs.					
24 Hrs.					
36 Hrs.					
48 Hrs.					
60 Hrs.					

72 Hrs.					
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Total Loss = 7.481 x Structure Surface Area (SF) x Total Water Loss per Day (FT) – Evaporation per Day (FT) + Precipitation per Day (FT)

Day #1 =

Day #2 =

Day #3 =

Repair: The allowable leakage rate for an unlined pool structure shall not exceed 0.1 percent of the total water volume in a 24-hour period. (Example: 0.001 x 200,000 gallon pool = 200 gallons per 24 hour period) This excludes the addition of evaporation loss.

Absorption: Waiting 3 days after the initial water fill will allow the concrete to absorb water and should be sufficient to minimize the effect of absorption on the test results.

Evaporation: Evaporation should not have a significant effect on natatoria that are completely enclosed with no air circulation during the water tightness test. However, evaporation will have a significant effect on the water level in natatoria that has air movement across the water surface or are still partially uncovered.

5. If leaks are detected, repair the pool shell and make it watertight.
6. With regard to this test, the curing requirements, the final fill and the cost of the water for two (2) complete fillings shall be borne by the Owner. Any subsequent fillings or partial fillings (more than 25%) of the pool shall be by the CONTRACTOR, at its own expense.

3.06 PIPING INSTALLATION

A. General:

Provide and erect, according to the best practices of the trade, all piping shown on the Drawings and required for the complete installation of these systems. The piping shown on the Drawings shall be considered as diagrammatic in indicating the general run and connections, and may or may not in all parts be shown in its true position. The piping may have to be offset, lowered or raised as required or as directed at the site. This does not relieve the CONTRACTOR from responsibility for the proper erection of the systems or piping in every respect suitable for the Work intended as described in the Specifications and approved by the Architect. In the erection of all piping, it shall be properly supported and proper provisions shall be made for expansion, contraction and anchoring of piping. All piping shall be cut accurately for fabrication to measurements established at the construction site. Pipe shall be worked into place without springing and/or forcing, properly clearing all windows, doors, and other openings and equipment. Cutting or other weakening of the building structure to facilitate installation will not be permitted. All pipes shall have burrs and/or cutting slag removed by reaming or other cleaning methods in strict accordance with the manufacturer's instructions. All changes in direction shall be made with fittings. All open ends of pipes and equipment shall be properly capped or plugged to keep dirt and other foreign materials out of the systems. Plugs of rags, wool, cotton waste or similar materials may not be used in plugging. All piping shall be arranged so as not to interfere with removal and maintenance of equipment, filters or devices, and so as not to block access to manholes, access openings, etc. Flanges or unions as applicable for the type of piping specified shall be provided in the piping at connections to all items of equipment. All piping shall be installed to ensure noiseless circulation. All valves and specialties shall be so placed to permit easy operation and access.

B. Pipe Hangers and Supports:

1. Pipe shall be adequately supported by pipe hangers and supports specified in Part 2.05 Pipe, Hangers, and Valves.
2. Horizontal PVC SCH 80 piping shall be supported in accordance with the manufacturers recommendations for fluid temperature not exceeding 120 degree F and as listed below:

Nominal Pipe Size (inch)	Hanger Support Spacing (Feet)	Minimum Rod Size for Single Rod Hanger (Inch)
1-1/4" and less	5	3/8"
1-1/2" to 3"	6	1/2"
4" to 6"	8	5/8"
8" to 12"	10	7/8"
Greater than 12"	12	1"

3. Horizontal CPVC SCH 80 piping shall be supported in accordance with the manufacturers recommendations for fluid temperature not exceeding 140 degree F and as listed below:

Nominal Pipe Size (inch)	Hanger Support Spacing (Feet)	Minimum Rod Size for Single Rod Hanger (Inch)
1/2" and less *	4	3/8"
3/4" to 2"	6	3/8"
2-1/2" to 3"	7	1/2"
4" to 8"	8	7/8"
Greater than 12"	10	1"

- C. Provide means of preventing dissimilar metal contact such as plastic coated hangers, copper colored epoxy paint, or non adhesive isolation tape.
- D. Install hangers to provide a minimum of 1 inch space between finished covering and adjacent work.
- E. Place a hanger within 12 inches of each horizontal elbow.
- F. Support vertical piping independently of connected horizontal piping. Support vertical pipes at every floor. Wherever possible, locate riser clamps directly below pipe couplings or shear lugs.
- G. Where several pipes can be installed in parallel and at the same elevation, provide trapeze hangers as specified in section 2.05.C.3. Trapeze hangers shall be spaced according to the smallest pipe size, or install intermediate supports according to the support spacing schedules.
- H. Do not support piping from other pipes, ductwork or other equipment that is not building structure. Do not modify building structure for hanger installation.
- I. Concrete Inserts
 1. Provide inserts for placement in formwork before concrete is poured.

2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Where concrete slabs form finished ceilings, provide inserts to be flush with the slab surface.
4. Provide hook rod to concrete reinforcement section for inserts carrying pipe over 4 inch.

J. Pipe Hangers and Supports:

1. All piping shall be rigidly supported from the building structure by means of hanger assemblies properly selected and sized for the application in accordance with the manufacturer's recommendations and specifications.
2. All piping in a service tunnel, if required shall be supported by a structure of the CONTRACTOR's design. The structure shall be non-corrodible and shall be of a size and configuration to rigidly support all the piping as shown in the plans at a minimum spacing as shown below.
3. Piping hangers shall be spaced per the below schedule and shall have hangers not more than one foot on each side of every change in direction. Piping system shall be installed in an approved manner and shall not overload the building structural frame. CONTRACTOR shall provide additional hangers and miscellaneous steel supports as may be required to distribute the piping system load over several structural members where required or directed. Maximum allowable spacing for piping shall be as follows:

PVC Piping	Maximum Spacing
3/4" thru 2"	5'-0"
2 1/2" thru 4"	6'-0"
6" thru 10"	9'-0"
12" thru 14"	12'-0"

4. Round rods supporting the pipe hangers shall be of the following dimensions:

1/2" to 2" pipe	-3/8" rod
2-1/2" to 3" pipe	-1/2" rod
4" to 5" pipe	-5/8" rod
6" pipe	-3/4" rod

5. Hanger rods shall be galvanized steel. Provide for controlling level and slope by turnbuckles or other approved means of adjustment and incorporate locknuts.
6. Where piping is installed side by side, the CONTRACTOR may support the piping by utilizing trapeze type hanger assemblies. Horizontal trapeze member shall be non-metallic channel. CONTRACTOR shall provide heavier members as required for the load to be supported the entire distance span. Hanger rods shall be as specified above and properly sized for the load supported, but not less than 5/8 inch diameter.
7. The use of pipe hooks, chains, or perforated iron for pipe hanger supports will not be permitted.
8. Attachment of piping hangers to the building structure shall be provided in a manner approved by the Architect. The CONTRACTOR shall provide concrete inserts to be installed by the General Contractor in the building construction at the time the concrete is poured and hangers shall be attached to these inserts.

K. Piping Installation:

Trench bottoms shall be smooth and free of rocks and debris. If the trench is dug in ledge rock, hardpan or where large boulders are not removed, place 3 inches of sand or compacted fine-grained soil below pipe. Pipe must be supported over its entire length with firm, stable material. Blocking may not be used to change pipe grade or provide intermittent support over low sections in the trench. Surround the pipe with backfill meeting the requirements of Section 02200 with a particle size of 1-1/2 inch or less. Compact in layers not to exceed 6 inches with vibratory method. Follow installation methods of ASTM D2774 "Underground Installation of Thermoplastic Pressure Piping".

L. Flushing, Draining and Cleaning Pipe Systems:

The CONTRACTOR shall flush out all water systems with water before placing them in operation. Other systems shall be cleaned by using compressed air or nitrogen. After systems are in operation and during the test period, all strainer screens shall be removed and thoroughly cleaned.

M. Expansion and Contraction:

The CONTRACTOR shall make all necessary provisions for expansion and contraction of piping with offsets, loops, flexible connections and anchors as required to prevent undue strain. CONTRACTOR shall provide shop drawings for proposed method and arrangement for control of expansion and contraction of piping.

3.07 EQUIPMENT AND SYSTEMS INSTALLATION

F. The CONTRACTOR shall assemble and install all equipment, special parts and accessories as shown on pool drawings, specifications and shop drawings of the equipment suppliers.

G. CONTRACTOR shall furnish all anchors and inserts to be imbedded in the deck including all fittings, inserts and structure sleeves and required anchorage's as shown on the plans and as indicated in this Section of specifications. Equipment shall be set true and plumb, using factory jigs where available. Removable equipment items shall be easily removable from anchors and shall fit without noticeable wobble.

H. Provide templates for all equipment anchors. Provide anchor bolts of the size and spacing as required by the equipment manufacturer. All anchor bolts shall be stainless steel Type 316L and of a length capable of adequate anchorage into rough slab-on-grade allowing for finish deck tile and setting bed. Anchors shall be set and cast into place during building concrete work. Inspect all anchor settings for horizontal and vertical alignment prior to placing concrete.

I. CONTRACTOR to install all equipment and systems in accordance with manufacturer's directions. Equipment shall all be assembled and in place for final observation.

J. All items necessary to complete this Section are shown on the plans or described in the specifications including items that may be purchased by the Owner. Items are detailed and specified as a guide for dimensional purposes. The CONTRACTOR must make provisions accordingly and submit shop drawings and submittals based on that data.

3.08 START-UP AND INSTRUCTION

The CONTRACTOR shall supply the services of an experienced swimming pool operator/instructor for a period of not less than two days (total 16 hours) after the pool has been filled and initially placed in operation. During this period, the Owner's representatives who will be operating the pool shall be thoroughly instructed in all phases of the pool's operation. CONTRACTOR shall deliver six (6) complete sets of operating and maintenance instructions for the swimming pool, structures, finishes and all

component equipment. Prior to leaving the job, he shall obtain written certification from the designated Owner's representative acknowledging that the instruction period has been completed and all necessary operating information provided. CONTRACTOR shall, in his Contract, include the cost of two (2) additional days (total 16 hours) of instruction and operational check out by the qualified representative of the CONTRACTOR during the first season of operation.

Written reports of each of these visits outlining the pool's operation, competence and performance of the pool's operation personnel, and other pertinent comments shall be submitted to the Owner and Architect/Engineer within one (1) week after each visit.

The CONTRACTOR shall provide specific written procedures to be followed for emptying and refilling the pool as mentioned previously in this Section. The procedures must be included in the bound volume of operating instructions and references in the front index with a note headed by the words: "CAUTION -- VERY IMPORTANT".

3.09 CONCLUSION

It is the intention of these specifications to provide a complete installation. All accessory construction and apparatus necessary in the operation or testing of the performance of the work shall be included. The omission of specific reference to any part of the work necessary for such complete installation shall not be interpreted as relieving the CONTRACTOR from furnishing and installing such parts. Any such omission or clarification shall be brought to the attention of the Architect prior to bidding as provided in this Section.

END OF SECTION 13150

SECTION 13151 – SWIMMING POOL SHOTCRETE (or GUNITE)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies alternate construction using shotcrete applied by dry-mix or wet-mix process, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
 - 1. Swimming Pool Walls.
- B. Related Sections include the following:
 - 1. Division 2 Section "Earthwork" for additional specification of drainage course under swimming pools.
 - a. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.
- C. Division 13 Section "Swimming Pool Cast In Place Concrete" for swimming pool base slab.

1.3 DEFINITIONS

- A. Shotcrete: Mortar or concrete pneumatically projected onto a surface at high velocity.
- B. Dry-Mix Shotcrete (Gunite): Shotcrete with most of the water added at nozzle.
- C. Wet-Mix Shotcrete: Shotcrete with ingredients, including mixing water, mixed before introduction into delivery hose.

1.4 SUBMITTALS

- A. Product Data: For manufactured materials and products including reinforcement and forming accessories, shotcrete materials, admixtures, and curing compounds.
- B. Shop Drawings: For details of fabricating, bending, and placing reinforcement. Include support and anchor details, number and location of splices, and special reinforcement required for openings through shotcrete structures.
- C. Design Mixes: For each shotcrete mix.
- D. Samples: For waterstops

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- E. Qualification Data: For Installer.
- F. Material Test Reports: For shotcrete materials.
- G. Material Certificates: For each material item, signed by manufacturers.
- H. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer employing nozzle operators who attain mean core grades not exceeding 2.5, according to ACI 506.2, on preconstruction tests.
- B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
- C. Comply with provisions of the following, unless more stringent requirements are indicated:
 - 1. ACI 301, "Specifications for Structural Concrete."
 - 2. ACI 506.2, "Specification for Shotcrete."
- D. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing and inspections indicated below:
 - 1. Produce test panels before shotcrete placement according to requirements in ACI 506.2 and ASTM C 1140 for each design mix, shooting orientation, and nozzle operator. Produce test panels with dimensions of 24 by 24 inches (600 by 600 mm) minimum and of average thickness of shotcrete, but not less than 3-1/2 inches (90 mm). From each test panel, testing agency will obtain six test specimens: one set of three specimens unreinforced and one set of three specimens reinforced. Agency will perform the following:
 - a. Test each set of unreinforced specimens for compressive strength according to ASTM C 42.
 - b. Visually inspect each set of reinforced shotcrete cores taken from test panels and determine mean core grades according to ACI 506.2.
- E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.6 PROJECT CONDITIONS

- A. Cold-Weather Shotcreting: Protect shotcrete work from physical damage or reduced strength caused by frost, freezing, or low temperatures according to ACI 306.1 and as follows:
 - 1. Discontinue shotcreting when ambient temperature is 40 deg F (4.4 deg C) and falling. Uniformly heat water and aggregates before mixing to obtain a shotcrete shooting temperature of not less than 50 deg F (10 deg C) and not more than 90 deg F (32 deg C).
 - 2. Do not use frozen materials or materials containing ice or snow.
 - 3. Do not place shotcrete on frozen surfaces or surfaces containing frozen materials.
 - 4. Do not use calcium chloride, salt, or other materials containing antifreeze agents.

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- B. Hot-Weather Shotcreting: Mix, place, and protect shotcrete according to ACI 305R when hot-weather conditions and high temperatures would seriously impair quality and strength of shotcrete, and as follows:
 - 1. Cool ingredients before mixing to maintain shotcrete temperature at time of placement below 100 deg F (38 deg C) for dry mix or 90 deg F (32 deg C) for wet mix.
 - 2. Reduce temperature of reinforcing steel and receiving surfaces below 100 deg F (38 deg C) before shotcreting.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

- A. Forms: Form-facing panels that will provide continuous, straight, smooth, concrete surfaces. Furnish panels in largest practicable sizes to minimize number of joints.

2.2 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Plain-Steel Wire: ASTM A 82, as drawn.
- C. Supports: Bolsters, chairs, spacers, ties, and other devices for spacing, supporting, and fastening reinforcing steel in place according to CRSI's "Manual of Standard Practice" and as follows:
 - 1. For uncoated reinforcement, use all-plastic or CRSI Class 1, plastic-protected bar supports.
- D. Reinforcing Anchors: ASTM A 36/A 36M, unheaded rods or ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), hex-head bolts; carbon steel; and carbon-steel nuts.
 - 1. Finish: Plain, uncoated.

2.3 SHOTCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I or III. Use only one brand and type of cement for Project.
- B. Normal-Weight Aggregates: ASTM C 33, from a single source, and as follows:
 - 1. Aggregate Gradation: ACI 506R, Gradation No. 1 with 100 percent passing 3/8-inch (10-mm) sieve.
 - 2. Coarse-Aggregate Class: 5S.
- C. Water: Potable, complying with ASTM C 94/C 94M, free from deleterious materials that may affect color stability, setting, or strength of shotcrete.
- D. Ground Wire: High-strength steel wire, 0.8 to 1 mm in diameter.

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2.4 CHEMICAL ADMIXTURES

- A. General: ASTM C 1141, Class A or B, but limited to the following admixture materials. Provide admixtures for shotcrete that contains not more than 0.1 percent chloride ions. Certify compatibility of admixtures with each other and with other cementitious materials.
1. Air-Entraining Admixture: ASTM C 260.
 2. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 4. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.
 5. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 6. Accelerating Admixture: ASTM C 494/C 494M, Type C.

2.5 WATERSTOPS

- A. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
1. Available Manufacturers:
 - a. Bometals, Inc.
 - b. Greenstreak.
 - c. Meadows, W. R., Inc.
 - d. Murphy, Paul Plastics Co.
 - e. Progress Unlimited, Inc.
 - f. Tamms Industries, Inc.
 - g. Vinylex Corp.
 2. Profile: Ribbed with center bulb.
 3. Dimensions: 6 inches by 3/8 inch thick(150 mm by 10 mm thick); nontapered

2.6 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.

2.7 RELATED MATERIALS

- A. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

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2.8 REPAIR MATERIALS

- A. Concrete Patching Mortar: Chemical treatment for waterproofing concrete.
 - 1. Xypex Concrete Waterproofing by Crystallization, Xypex Chemical Corporation.
 - a. Xypex Concentrate.

2.9 SHOTCRETE MIXTURES, GENERAL

- A. Prepare design mixes for each type and strength of shotcrete.
- B. Limit water-soluble chloride ions to maximum percentage by weight of cement or cementitious materials permitted by ACI 301.
- C. Admixtures: When included in shotcrete design mixes, use admixtures and retarding admixtures according to manufacturer's written instructions.
- D. Design-Mix Adjustments: Subject to compliance with requirements, shotcrete design-mix adjustments may be proposed when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

2.10 SHOTCRETE MIXTURES

- A. Proportion dry mixtures by field test data methods and wet mixtures according to ACI 211.1 and ACI 301, using materials to be used on Project, to provide shotcrete with the following properties:
 - 1. Compressive Strength (28 Days): 4000 psi (27.6 MPa).
 - 2. Cementitious Material Content: 600 lbs.
 - 3. Maximum Water-Cementitious Ratio: 0.40.
 - 4. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight, wet-mix shotcrete having an air content before pumping of 7 percent with a tolerance of plus or minus 1-1/2 percent.

2.11 SHOTCRETE EQUIPMENT

- A. Mixing Equipment: Capable of thoroughly mixing shotcrete materials in sufficient quantities to maintain continuous placement.
- B. Dry-Mix Delivery Equipment: Capable of discharging aggregate-cement mixture into delivery hose under close control and maintaining continuous stream of uniformly mixed materials at required velocity to discharge nozzle. Equip discharge nozzle with manually operated water-injection system for directing even distribution of water to aggregate-cement mixture.
 - 1. Provide uniform, steady supply of clean, compressed air to maintain constant nozzle velocity while simultaneously operating blow pipe for cleaning away rebound.
 - 2. Provide water supply with uniform pressure at discharge nozzle to ensure uniform mixing with aggregate-cement mix. Provide water pump to system if line water pressure is inadequate.
- C. Wet-Mix Delivery Equipment: Capable of discharging aggregate-cement-water mixture accurately, uniformly, and continuously.

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2.12 BATCHING AND MIXING

- A. Dry-Mix Process: Measure mix proportions by weight batching according to ASTM C 94/C 94M or by volume batching complying with ASTM C 685/C 685M requirements.
 - 1. In volume batching, adjust fine-aggregate volume for bulking. Test fine-aggregate moisture content at least once daily to determine extent of bulking.
 - 2. Prepackaged shotcrete materials may be used at Contractor's option. Predampen prepackaged shotcrete materials and mix before use.
- B. Wet-Mix Process: Measure, batch, mix, and deliver shotcrete according to ASTM C 94/C 94M and furnish batch ticket information.
 - 1. Comply with ASTM C 685/C 685M when shotcrete ingredients are delivered dry and proportioned and mixed on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before applying shotcrete, remove unsound or loose materials and contaminants that may inhibit shotcrete bonding. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and 1/2 inch (13 mm) deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders. Dampen surfaces before shotcreting.
 - 1. Abrasive blast or hydroblast existing surfaces that do not require chipping to remove paint, oil, grease, or other contaminants and to provide roughened surface for proper shotcrete bonding.
- B. Earth: Compact and trim to line and grade before placing shotcrete. Do not place shotcrete on frozen surfaces. Dampen surfaces before shotcreting.
- C. Rock: Clean rock surfaces of loose materials, mud, and other foreign matter that might weaken shotcrete bonding.

3.2 FORMS

- A. General: Design, erect, support, brace, and maintain forms, according to ACI 301, to support shotcrete and construction loads and to facilitate shotcreting. Construct forms so shotcrete members and structures are secured to prevent excessive vibration or deflection during shotcreting.
 - 1. Fabricate forms to be readily removable without impact, shock, or damage to shotcrete surfaces and adjacent materials.
 - 2. Construct forms to required sizes, shapes, lines, and dimensions using ground wires and depth gages to obtain accurate alignment, location, and grades in finished structures. Construct forms to prevent mortar leakage but permit escape of air and rebound during shotcreting. Provide for openings, offsets, blocking, screeds, anchorages, inserts, and other features required in the Work.

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- B. Form openings, chases, recesses, bulkheads, keyways, and screeds in formwork. Determine sizes and locations from trades providing such items. Accurately place and securely support items built into forms.

3.3 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that weaken shotcrete bonding.
- C. Securely embed reinforcing anchors into existing substrates, located as required.
- D. Accurately position, support, and rigidly secure reinforcement against displacement by formwork, construction, or shotcreting. Locate and support reinforcement by metal chairs, runners, bolsters, spacers, and hangers, as required.
- E. Place reinforcement to obtain minimum coverage for shotcrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during shotcreting. Set wire ties with ends directed into shotcrete, not toward exposed shotcrete surfaces.
- F. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.4 JOINTS

- A. Construction Joints: Locate and install construction joints tapered to a 1:1 slope where joint is not subject to compression loads and square where joint is perpendicular to main reinforcement. Continue reinforcement through construction joints, unless otherwise indicated.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated.
 - 2. Locate horizontal joints in walls at top or underside of floors and slabs.
 - 3. Vertical joints in walls shall be located at corners, and in concealed locations where possible.
 - 4. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 5. No construction joints shall be placed in pool walls or slabs unless noted on drawings or approved by Engineer.
- B. Contraction Joints: No contraction joints shall be placed on swimming pool walls or slabs.

3.5 WATERSTOPS

- A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

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3.6 ALIGNMENT CONTROL

- A. Ground Wires: Install ground wires to establish thickness and planes of shotcrete surfaces. Install ground wires at corners and offsets not established by forms. Pull ground wires taut and position adjustment devices to permit additional tightening.

3.7 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by shotcrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.8 APPLICATION

- A. Apply temporary protective coverings and protect adjacent surfaces against deposit of rebound and overspray or impact from nozzle stream.
- B. Moisten wood forms immediately before placing shotcrete where form coatings are not used.
- C. Apply shotcrete according to ACI 506.2.
- D. Apply dry-mix shotcrete materials within 45 minutes after predampening and wet-mix shotcrete materials within 90 minutes after batching.
- E. Deposit shotcrete continuously in multiple passes, to required thickness, without cold joints and laminations developing. Place shotcrete with nozzle held perpendicular to receiving surface. Begin shotcreting in corners and recesses.
 - 1. Remove and dispose of rebound and overspray materials during shotcreting to maintain clean surfaces and to prevent rebound entrapment.
- F. Maintain reinforcement in position during shotcreting. Place shotcrete to completely encase reinforcement and other embedded items. Maintain steel reinforcement free of overspray and prevent buildup against front face during shotcreting.
- G. Do not place subsequent lifts until previous lift of shotcrete is capable of supporting new shotcrete.
- H. Do not permit shotcrete to sag, slough, or dislodge.
- I. Remove hardened overspray, rebound, and laitance from shotcrete surfaces to receive additional layers of shotcrete; dampen surfaces before shotcreting.
- J. Do not disturb shotcrete surfaces before beginning finishing operations.
- K. Remove ground wires or other alignment control devices after shotcrete placement.
- L. Shotcrete Core Grade: Apply shotcrete to achieve mean core grades not exceeding 2.5 according to ACI 506.2, with no single core grade exceeding 3.0.
- M. Installation Tolerances: Place shotcrete without exceeding installation tolerances permitted by ACI 117R, increased by a factor of 2.

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3.9 SURFACE FINISHES

- A. General: Finish shotcrete according to descriptions in ACI 506R for the following finishes:
- B. Flash-Coat and Final Finish: After screeding and rodding surface, apply up to 1/4-inch (6-mm) coat of shotcrete using ACI 506R, Gradation No. 1, fine-screened sand modified with maximum aggregate size not exceeding No. 4 (4.75-mm) sieve and apply steel-trowel finish.

3.10 CURING

- A. Protect freshly placed shotcrete from premature drying and excessive cold or hot temperatures.
- B. Start initial curing as soon as free water has disappeared from shotcrete surface after placing and finishing.
- C. Curing Exposed Surfaces: Cure shotcrete by one of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for at least seven days with water, continuous water-fog spray, water-saturated absorptive covers, or moisture-retaining covers. Lap and seal sides and ends of covers.
- D. Curing Formed Surfaces: Cure formed shotcrete surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

3.11 FORM REMOVAL

- A. Forms not supporting weight of shotcrete may be removed after curing at not less than 50 deg F (10 deg C) for 24 consecutive hours after gunning, provided shotcrete is hard enough not to be damaged by form-removal operations and provided curing and protecting operations are maintained.
 - 1. Leave forms supporting weight of shotcrete in place until shotcrete has attained design compressive strength. Determine compressive strength of in-place shotcrete by testing representative field-cured specimens of shotcrete.
 - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing materials are unacceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

3.12 FIELD QUALITY CONTROL

- A. Owner will engage a qualified independent testing agency to sample materials, visually grade cores, perform tests, and submit reports during shotcreting.
- B. Air Content: ASTM C 173/C 173M, volumetric method or ASTM C 231, pressure method; 1 test for each compressive-strength test for each mix of air-entrained, wet-mix shotcrete measured before pumping.

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- C. Shotcrete Temperature: ASTM C 1064/C 1064M; 1 test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and 1 test for each set of compressive-strength specimens.
- D. In-Place Shotcrete: Take a set of 3 unreinforced cores for each mix and for each workday or for every 50 cu. yd. (38 cu. m) of shotcrete placed; whichever is less. Test cores for compressive strength according to ACI 506.2 and ASTM C 42. Do not cut steel reinforcement.
- E. Strength of shotcrete will be considered satisfactory when mean compressive strength of each set of 3 unreinforced cores equals or exceeds 85 percent of specified compressive strength, with no individual core less than 75 percent of specified compressive strength.
 - 1. Mean compressive strength of each set of 3 unreinforced cubes shall equal or exceed design compressive strength with no individual cube less than 88 percent of specified compressive strength.

3.13 REPAIRS

- A. Remove and replace shotcrete that is delaminated or exhibits laminations, voids, or sand/rock pockets exceeding limits for specified core grade of shotcrete.
 - 1. Remove unsound or loose materials and contaminants that may inhibit bond of shotcrete repairs. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and 1/2 inch (13 mm) deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders. Dampen surfaces and apply new shotcrete or patching mortar.
- B. Repair core holes from in-place testing according to repair provisions in ACI 301 and match adjacent finish, texture, and color.

3.14 CLEANING

- A. Remove and dispose of rebound and overspray materials from final shotcrete surfaces and areas not intended for shotcrete placement.

3.15 WATERTIGHTNESS TESTING

- A. Pool shall be tested for watertightness according to procedures stated in ACI350.1 / AWWA 400.
 - 1. Preliminary Test Criteria: HST-VIO.
 - 2. Quantitative Test Criteria: HST-100.

END OF SECTION 13151

SECTION 13152 – SWIMMING POOL CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
 - 1. Swimming Pools.
- B. Related Sections include the following:
 - 1. Division 2 Section "Earthwork" for drainage course under swimming pools.
 - a. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone; subject to compliance with requirements.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
- D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.
 - 1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.
- E. Samples: For waterstops.

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- F. Qualification Data: For manufacturer.
- G. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
 - 1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- H. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Form materials and form-release agents.
 - 4. Steel reinforcement and accessories.
 - 5. Waterstops.
 - 6. Curing compounds.
 - 7. Bonding agents.
 - 8. Repair materials.
- I. Field quality-control test and inspection reports.
- J. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
 - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5.

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2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
 - G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."
 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete subcontractor.
 2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, forms and form removal limitations, shoring and reshoring procedures, steel reinforcement installation, concrete repair procedures, and concrete protection.
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
 - B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.
- 1.7 ALTERNATE CONSTRUCTION
- A. Swimming Pool Walls: Walls may be cast in place concrete or shotcrete. See Section 13151 for Swimming Pool Shotcrete.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

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2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 - 1. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - a. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch(19 by 19 mm), minimum.
- D. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- E. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 1. Furnish units that will leave no corrodible metal closer than 1 inch(25 mm) to the plane of exposed concrete surface.
 - 2. Furnish ties that, when removed, will leave holes no larger than 1 inch(25 mm) in diameter in concrete surface.
 - 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60(Grade 420), deformed.
- B. Plain-Steel Wire: ASTM A 82, as drawn.

2.4 REINFORCEMENT ACCESSORIES

- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
- B. Dowel Bar Substitutes: Tapered, threaded couplers, pre-assembled to reinforcing with mounting plate for attachment to form work and a pressed in metal disc thread protector which can be easily removed. The mechanical connection shall meet building code requirements of developing in tension or compression. The mechanical connection shall be the positive locking,

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taper threaded type coupler manufactured from high quality steel. The bar ends must be taper threaded using the manufacturer's requirements.

1. Lenton Form Saver; Erico Corp.

2.5 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type I/II, gray.

- B. Normal-Weight Aggregates: ASTM C 33, Class 5S Insert class coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1 inch(25 mm) nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

- C. Water: ASTM C 94/C 94M and potable.

2.6 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.

- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.7 WATERSTOPS

- A. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Available Manufacturers:
 - a. Bometals, Inc.
 - b. Greenstreak.
 - c. Meadows, W. R., Inc.
 - d. Murphy, Paul Plastics Co.
 - e. Progress Unlimited, Inc.
 - f. Tamms Industries, Inc.
 - g. Vinylex Corp.

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2. Profile: Ribbed with center bulb.
3. Dimensions: 6 inches by 3/8 inch thick(150 mm by 10 mm thick); nontapered.

2.8 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Available Products:

- a. Axim Concrete Technologies; Cimfilm.
- b. Burke by Edoco; BurkeFilm.
- c. ChemMasters; Spray-Film.
- d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Aquafilm.
- e. Dayton Superior Corporation; Sure Film.
- f. Euclid Chemical Company (The); Eucobar.
- g. Kaufman Products, Inc.; Vapor Aid.
- h. Lambert Corporation; Lambco Skin.
- i. L&M Construction Chemicals, Inc.; E-Con.
- j. MBT Protection and Repair, Div. of ChemRex; Confilm.
- k. Meadows, W. R., Inc.; Sealtight Evapre.
- l. Metalcrete Industries; Waterhold.
- m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
- n. Sika Corporation, Inc.; SikaFilm.
- o. Symons Corporation, a Dayton Superior Company; Finishing Aid.
- p. Unitex; Pro-Film.
- q. US Mix Products Company; US Spec Monofilm ER.
- r. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.

- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd.(305 g/sq. m) when dry.

- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

- D. Water: Potable.

- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of pool coating.

1. Available Products:

- a. Burke by Edoco; Spartan Cote WB II 20 Percent.
- b. ChemMasters; Safe-Cure Clear.
- c. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; High Seal.
- d. Dayton Superior Corporation; Safe Cure and Seal (J-19).
- e. Euclid Chemical Company (The); Diamond Clear VOX.
- f. Kaufman Products, Inc.; SureCure Emulsion.
- g. Lambert Corporation; Glazecote Sealer-20.
- h. L&M Construction Chemicals, Inc.; Dress & Seal WB.
- i. MBT Protection and Repair, Div. of ChemRex; MasterKure-N-Seal VOC.
- j. Meadows, W. R., Inc.; Vocomp-20.

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- k. Metalcrete Industries; Metcure 0800.
- l. Nox-Crete Products Group, Kinsman Corporation; Cure & Seal 200E.
- m. Sonneborn, Div. of ChemRex; Kure-N-Seal.
- n. Symons Corporation, a Dayton Superior Company; Cure & Seal 18 Percent E.
- o. Tamms Industries, Inc.; Clearseal WB STD.
- p. Unitex; Hydro Seal 18.
- q. US Mix Products Company; US Spec Radiance UV-25
- r. Vexcon Chemicals, Inc.; Starseal 0800.

2.9 RELATED MATERIALS

- A. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
 - 1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.10 REPAIR MATERIALS

- A. Concrete Patching Mortar: Chemical treatment for waterproofing concrete.
 - 1. Xypex Concrete Waterproofing by Crystallization, Xypex Chemical Corporation.
 - a. Xypex Concentrate.

2.11 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- C. Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - 3. Use water-reducing admixture in pumped concrete, and concrete with a water-cementitious materials ratio below 0.50.

2.12 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. All concrete: Proportion normal-weight concrete mixture as follows:
 - 1. Minimum Compressive Strength: 4000 psi(27.6 MPa) at 28 days.

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2. Maximum Water-Cementitious Materials Ratio: 0.40.
3. Minimum Cementitious Materials Content: 600 lb/cu. yd.
4. Slump Limit: 4 inches(100 mm) or 8 inches(200 mm) for concrete with verified slump of 2 to 4 inches(50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch(25 mm).
5. Air Content: 6%.

2.13 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.14 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
 1. When air temperature is between 85 and 90 deg F(30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F(32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 1. Class A, 1/8 inch(3.2 mm) for smooth-formed finished surfaces.
 2. Class C, 1/2 inch(13 mm) for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 1. Install recesses, pipe sleeves and the like, for easy removal.
 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to

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prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

- H. Chamfer exterior corners and edges of permanently exposed concrete. See drawings for other required profiles.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F(10 deg C) for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
 - 1. Leave formwork for beam soffits, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
 - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 SHORES AND RESHORES

- A. Comply with ACI 318(ACI 318M) and ACI 301 for design, installation, and removal of shoring and reshoring.
- B. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

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3.5 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

3.6 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 - 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches(38 mm) into concrete.
 - 3. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of floor slabs.
 - 4. Space vertical joints in walls shall be located at corners, and in concealed locations where possible.
 - 5. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 6. No construction joints shall be placed in pool bottom slab. Unless noted on drawings.
- C. Contraction Joints in Pool Bottom Slab: No contraction joints shall be placed in pool bottom slab.

3.7 WATERSTOPS

- A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

3.8 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

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- C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches(150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Maintain reinforcement in position on chairs during concrete placement.
 3. Screenshot slab surfaces with a straightedge and strike off to correct elevations.
 4. Slope surfaces uniformly to drains where required.
 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F(4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- F. Hot-Weather Placement: Comply with ACI 301 and as follows:
1. Maintain concrete temperature below 90 deg F(32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.9 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

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1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, to be covered with a coating or covering material applied directly to concrete.
- C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.10 FINISHING SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighen until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 1. Apply a trowel finish to surfaces exposed to view or to be covered with ceramic tile , paint, or another thin-film-finish coating system.
 2. Finish surfaces to the following tolerances, according to ASTM E 1155(ASTM E 1155M), for a randomly trafficked floor surface:
 - a. Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15.

3.11 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
 1. All patches shall be watertight.

3.12 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h(1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch(300-mm) lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches(300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project..
 - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of tile used on Project.

3.13 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16(1.18-mm) sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch(13 mm) in any dimension in solid concrete, but not less than 1 inch(25 mm) in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 - 2. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 - 1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch(0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 - 2. After concrete has cured at least 14 days, correct high areas by grinding.
 - 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 - 4. Repair defective areas, except random cracks and single holes 1 inch(25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch(19-mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 - 5. Repair random cracks and single holes 1 inch(25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

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3.14 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
1. Steel reinforcement placement.
 2. Verification of use of required design mixture.
 3. Concrete placement, including conveying and depositing.
 4. Curing procedures and maintenance of curing temperature.
 5. Verification of concrete strength before removal of shores and forms from beams and slabs.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd.(4 cu. m), but less than 25 cu. yd.(19 cu. m), plus one set for each additional 50 cu. yd.(38 cu. m) or fraction thereof.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F(4.4 deg C) and below and when 80 deg F(27 deg C) and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
 - b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
 - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
 7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
 8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive

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- strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi(3.4 MPa).
9. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
 10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
 11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
 12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- D. Measure floor and slab flatness and levelness according to ASTM E 1155(ASTM E 1155M) within 24 hours of finishing.

3.15 WATERTIGHTNESS TESTING

- A. Pool shall be tested for watertightness according to procedures stated in ACI350.1-01 / AWWA 400.
1. Preliminary Test Criteria: HST-VIO.
 2. Quantitative Test Criteria: HST-100.

END OF SECTION 13152

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The drawings and General Provisions of the Contract, including General and Supplementary Conditions apply to work of this section.

1.02 SUMMARY

- A. A ceramic tile finish shall be furnished and installed on the zero entry, vertical tile band, stair nosing, step nosing, recessed wall steps, depth markings, targets and lane markings and behind the pool edge as shown and detailed on the Contract Drawings and in strict accordance with these specifications.
- B. A ceramic tile finish shall be furnished and installed on the entire interior surface of the spa.
- C. The CONTRACTOR shall furnish and install the work of this Section.

1.03 RELATED SECTIONS

- A. Division 7 - Joint Sealers
- B. Division 9 - Ceramic Tile
- C. Section 13150 - Swimming Pool

1.04 QUALITY ASSURANCE

- A. Reference Standards: Conform to the following standards unless otherwise required herein.
 - 1. American National Standards Institute (ANSI):
 - a. A108.1, Glazed Wall Tile, Ceramic Mosaic Tile, Quarry Tile and Paver Tile installed with Portland Cement Mortar.
 - b. A137.1 Standard Specifications for Ceramic Tile.
 - 2. American Society for Testing and Materials (ASTM):
 - a. C144-99, Aggregate for Masonry Mortar
 - b. C150-00, Portland Cement
 - c. C171-97a, Sheet Materials for Curing Concrete
 - d. C206-97, Finishing Hydrated Lime
 - e. C207-91 (R1997), Hydrated Lime for Masonry Purposes
 - 3. Tile Council of America (TCA); 2002 Edition, Handbook for Ceramic Tile Installation. See Swimming Pool Section of TCA handbook, Method 601-98.

- B. Tile installers shall have two years experience in similar pool projects which the Owner may require written proof thereof and proper tools to install tile.

1.05 MANUFACTURERS

- A. Subject to compliance with requirements provide ceramic tile, mortar and grout of the following manufacturers: American Olean Tile Co., Dal-Tile Co., KlinkerSire, Mapei Corp. (grout and admixtures), and Laticrete International Inc. or approved equal (grout and admixtures).

1.06 SUBMITTALS

- A. Submit shop drawings indicating tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, thresholds and setting details.
- B. Submit product data indicating material specifications, characteristics, and instructions for using adhesives and grouts.
- C. Samples:
 - 1. Mount tile and apply grout on 24 x 24 inch plywood panels to indicate pattern, color variation and grout joint size variations of each pattern. (One panel required for each pool.)
- D. Submit manufacturer's installation instruction.
- E. Submit maintenance data.
 - 1. Include recommended cleaning and stain removal methods, cleaning materials.

1.07 PRODUCT DELIVERY AND STORAGE

- A. Deliver tile materials to site in unopened factory containers sealed with Grade Seals bearing printed name or manufacturer and the words "Standard Grade". Keep the Grade Seals intact and containers dry until tiles are used. Keep cementitious materials dry until used.

1.08 JOB CONDITIONS

- A. Inspect and verify job conditions. Report all defects in base surfaces for correction before proceeding.
- B. Maintain a curing temperature of 50 F during installation and for 7 days after completion.
- C. Vent temporary heaters to outside to avoid carbon dioxide damage to the new tile work.

1.09 COLORS

- A. Colors to be selected by the Architect. See 2.02 Tile Materials for Price Group breakdowns.

1.10 WARRANTIES

- A. The CONTRACTOR warrants to the Owner that materials and equipment furnished under the Contract will be of good quality and new unless otherwise required or permitted by the Contract Documents, that the Work will be free from defects not inherent in the quality required or permitted and that the Work will conform with the requirements of the Contract Documents. Work not conforming to these requirements including substitutions not properly approved and authorized, may

be considered defective. The CONTRACTOR'S warranty excludes remedy for damage or defect caused by abuse, improper or insufficient maintenance, improper operation, modifications not executed by the CONTRACTOR or improper wear and tear under normal usage. If required by the Owner, the CONTRACTOR shall furnish satisfactory evidence as to the kind and quality of materials and equipment. All warranties shall be for a period of five years, unless otherwise specified.

- B. The CONTRACTOR shall agree to repair or replace any Work at no cost to the Owner upon written notification from the Owner within the warranty period. Pro-rated warranties are not acceptable.

PART 2 - PRODUCTS

2.01 BASIC MATERIALS

- A. Portland Cement: ASTM C150, Type II, low alkali.
- B. Hydrated Lime: ASTM C206 or 207 Type S.
- C. Mortar Sand: ASTM C144, at least 4% passing No. 100 sieve
- D. Joint Sand: Same as mortar sand except all passing the No. 30 sieve.
- E. Water: Clean and fresh, from domestic potable source.
- F. Color Pigments: Pure ground mineral oxides, non-fading, alkali and lime-proof, factory-weighed and packaged.

2.02 TILE MATERIALS

- A. Standard Grade conforming to ANSI A137.1. Provide trimmer units as indicated and specified, including special shapes as detailed or required. Tile patterns and colors shall be as indicated and specified, colors of approved shades. Mesh mounted or perforated paper backed tile is not allowed where the mesh of paper remains as a permanent part of the installation.
- B. Unglazed Ceramic Mosaic Tile:
 - 1. Type: Slip-resistant porcelain unglazed ceramic mosaic tile, cushion or all-purpose edges, one inch square from Price Group 2 for floor, walls, and stair treads unless otherwise noted. Where other tile (2x2, special shapes) is required they shall be selected from Price Group 3.
 - 2. Ceramic tile band below the pool gutter lip, crown detail at stairs, recessed steps and depth marker letters and numerals shall be selected by Architect from Dal-Tile, "Unglazed", 1" x 1" Price Group 4.
 - 3. Ceramic tile deck band that contains the depth marker letters and numerals shall be selected by the Architect from Dal-Tile, 1" x 1", Price Group 4.
 - 4. Contrasting ceramic tile nosings at pool stairs, recessed steps, spa steps and spa bench shall be selected by the Architect from Dal-Tile "Unglazed" Price Group 3 and 4.
 - 5. 4" wide contrasting ceramic tile stripe and 12" lane markers on the pool floor shall be selected by Architect from American Olean, "Unglazed" 1" x 1" Price Group 3. The wall targets and lane markers shall be black or midnight blue.

- C. Provide tile trim units where indicated or necessary for a complete and finished installation. Provide bullnose units for external corners and angles. Internal corners shall be squared unless detailed for cove. Provide trim units of material and finish identical to the adjoining tile. Provide SCR/L701 units where the C701 hand hold is interrupted to permit deck draining. The SCR/:701 are available through Stacey Zolman, DalTile at 314-997-6970 or 1-800-672-2086.
- D. Message Tile and Depth Markings: Deck messages shall be provided in 1 inch x 1 inch unglazed ceramic mosaic tile using "special" characters minimum five inch high as described in American Olean "Ceramic Tile for Swimming Pools" Booklet 805. Provide 4 inch high vertical depth markers on the wall just above the water line and on the deck in 1 inch x 1 inch tiles.

2.03 TILE BOND COAT

- A. Bond coat shall be Mapei Grani/Rapid, fast setting, latex hydraulic mortar system or equal. The setting mortar shall be weather, frost and shock resistant. TCA rating extra heavy duty. Follow manufacturer's instructions.

2.04 SETTING BED MORTAR

- A. Machine mix mortar after dry mixing materials. Mix mortar not less than 5 minutes after water is added. Accurately measure materials using calibrated measuring boxes; shovel measurement is not permitted. Discard mortar that is not placed and compacted before initial set. Measure materials by volume. Setting bed mortar: Factory blended Laticrete 226 thick bed mortar mix gauged with Laticrete 3701 admix as manufactured by Laticrete International. The mortar shall be weather, frost and shock resistant. TCA rating: heavy duty. Follow manufacturer's instructions.

2.05 TILE JOINT GROUT

- A. Grout shall be Mapei Ultra/Color, Fast-Curing, High Early Strength, Polymer Modified Sanded Tile Grout or equal. Mix and apply according to manufacturer's instructions and ANSI A108.10.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean substrates of dust, dirt, oil, grease and deleterious substances and mechanically roughen concrete and shotcrete for bond. Conform to applicable Reference Standards and to recommendations of manufacturers of materials used.
- B. Substrates to Receive Mortar Setting Beds: Keep cement backing damp for at least 8 hours and scrub with a neat Portland cement slurry just prior to placing setting bed mortar.
- C. Substrates to receive Thin Set tile applications shall meet normal construction tolerances of 1/4" in 10' where competition tolerances do not apply, and shall meet competition tolerances where required elsewhere in these specifications, and shall be free of bumps, dips and surface irregularities that may effect the satisfactory installation of the tile.
- D. Tile Wetting: Dampen tile according to above Reference Standards or tile manufacturer's instructions, as required.
- E. Screeds: Accurately set temporary screeds to control the finish plane of mortar-bed set tile and remove as soon as setting bed is sufficiently hardened. Fill void spaces from screeds with same mortar.

3.02 TILE INSTALLATION

- A. Arrange tile according to patterns detailed. Set tile with flush well-fitted joints, finished in true planes, plumb, square, joints or uniform size. Provide approved trimmers as shown or required. Cut tile without marring. Carefully grind and joint tile edges and cuts.
- B. Mortar Bed Set Tile: Follow Tile Council of America Installation Method to achieve total tile system thickness for Thin or Thick-Set. Apply specified setting bed mortar on fresh Portland cement slurry coat, tamp and screed to required planes. Spread no more mortar than can be covered with tile before initial set. Do not use retempered mortar. Trowel 1/32 inch to 1/16 inch thick bond coat over plastic setting bed mortar just before setting tile or apply bond coat to back of each tile placed. Set tile in position and beat firmly into the setting bed mortar. Bring tile faces to a true and correct plane. Complete all beating and leveling before mortar sets and in no case later than one hour after first placing. When ready, wet and remove paper and glue avoiding excess water. At this time adjust any out-of-line or out-of-level tile.
- C. Finished tile surface shall be level and in plane, with no sharp or protruding edges. Tiles out or plane more than 1/16" shall be removed and replaced. Sharp edges shall be stoned smooth.
- D. Joint Sizes: Unless otherwise approved, install tile with uniform 1/16 inch joint width. A maximum 1/8" joint width may be utilized to meet specific installation requirements, if required.
- E. Ceramic Tile Joint Grouting: Grout tile joints full after washing out and saturating with clean water. Mix grout with water to a thick creamy consistency and force into joints for entire thick depth, flush with surface. Clean off all excess and fill skips and gaps before grout sets. Use white grout except grout between black tiles with black grout, and grout between other colored tiles with grout matching approved submittals. Provide dampness for minimum 3-day curing and polish with clean dry cloths.
- F. Expansion joints: Provide expansion joint per TCA Method EJ171-2002 at all expansion joints, construction joints or locations recommended by manufacturers of the products. Saw cut control joints as necessary. Provide shop drawings showing backer rod and joint dimensions.

3.03 TESTING AND INSPECTION

- A. Before filling of the pool, and its subsequent provisional acceptance at substantial completion, the tile installation shall be visually inspected and sounded in the presence of the Architects and/or the Owner's representative to verify adhesion of the tile to its substrate as well as its over-all compliance with the requirements of this Section.
- B. Any and all tile work found to be loose, improperly adhered, out of plane, misaligned or otherwise non-conforming shall be removed and replaced at no additional cost to the Owner.

3.04 CLEANING

- A. Upon completion of placement and grouting, clean tile installation as recommended by TCA and manufacturers of proprietary materials. Tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer's printed instruction. Protect metal surfaces and fittings from effects of acid cleaning. After cleaning, flush with clean water.
- B. Leave finished installation clean and free of cracked, chipped, broken, unbonded or otherwise defective tile work.

SECTION 13154 – SWIMMING POOL TILE

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- C. Protect installed tile work with Kraft paper or other heavy covering during the construction period to prevent damage.

3.05 REPLACEMENT TILE

- A. Provide Owner with approximately 10% or 25 square feet (whichever is least) of each color and type tile used on the Project for Owner's repair and replacement requirements.

END OF SECTION 13154

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 - Specification Sections, apply to the work specified in this Section.

1.02 SUMMARY

- A. Furnish all labor, material, equipment and services for installation of the fiberglass water slide including all foundations, anchor bolts and support structure.
- B. The indoor enclosed drop waterslide shall have an approximate slide length of 96 lineal feet at the centerline, with a vertical drop of approximately 17.5 feet and consist of multiple turns, entry sections and straight sections as shown on the project plans.
- C. Provide minimum interior cross section, 32 inch wide x 32 inch deep. The waterslide shall be enclosed.
- D. Design, Furnish and install foundation system, structural supports and all other related work to meet specified and indicated criteria.
- E. Furnish and install fiberglass water slides as indicated on the Drawings, specified herein, and as necessary for proper completion including, but is not necessarily limited to:
 - 1. All fiberglass flume components.
 - 2. All flume structural support systems including foundations and support columns.
 - 3. All tower, platforms, stairways and related supports.
 - 4. Installation supervision, ride testing and certification.
 - 5. Labor, materials and equipment to complete the installation.
 - 6. Operations and Maintenance manuals.
 - 7. On-site startup training.
 - 8. Proper signage as required.
- F. Related Work Specified Elsewhere:
 - 1. All demolition and repairs to decks, fences and landscaping.
 - 2. Construction of concrete drilled pier or spread footer foundations, columns and flat work as required.
 - 3. All electrical works, buildings, permits and modifications if any to the pool.
 - 4. Supply and installation of mechanical equipment and pool piping as necessary for slide operation.

1.03 QUALITY ASSURANCE

- A. Supplier shall demonstrate their specific experience and competency in the manufacturing and installation of water slides.
- B. The supplier shall have completed at least five installations comparable to the system specified herein within the last 5 years. Submit a list of such projects with name, address and current telephone number of the Owner's Operator and Architect of Record to the Architect with bid on bid date.
- C. The Owner reserves the right to reject any bid if the evidence submitted by, or investigation of, such bidder fails to satisfy the Owner that such bidder is properly qualified to carry out the obligation of the contract and to complete work described or if bidder does not have the qualifications stated herein.

1.04 REGULATORY AGENCY REQUIREMENTS AND ENGINEERING SERVICES

- A. In addition to complying with all applicable codes and regulations, comply with pertinent recommendations contained in:
 - 1. Water slide flumes shall comply with "WWA Considerations for Operating Safety", 1989, as published by the World Waterpark Association.
 - 2. "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings" of the American Institute of Steel Construction.
 - 3. "Code for Welding in Building Construction" of the American Welding Society.
 - 4. "Specifications for Architecturally Exposed Structural Steel" of the American Institute of Steel Construction.
 - 5. "Manual of Standard Practice for Detailing Reinforced Concrete Structures", Publication ACI 315-92 of the American Concrete Institute.
 - 6. "Structural Concrete for Buildings", Publication ACI 301-96 of the American Concrete Institute.
 - 7. "ASTM" requirements for all steel components, of the American Society of Testing Materials.
- B. Where provisions of pertinent codes and standards conflict with this specification, the more stringent shall govern.

1.05 COORDINATION AND CLARIFICATION

- A. Coordinate with other Trades affecting and affected by work in this Section.
- B. The CONTRACTOR must establish with the selected water slide installer and with other trades having related work in this Section that all work necessary to complete the installation is included in his bid to the G.C. Further the water slide supplier in his bid to the CONTRACTOR will list specifically those items of related work not included in his proposal.
- C. When in doubt regarding the responsibility for work covered in this Section and/or discovery of errors or omissions in the bidding documents, the CONTRACTOR and/or supplier shall notify the Architect and request a clarification prior to the bid date.

1.06 CONTRACTORS ALTERNATIVE PROPOSAL

- A. Suppliers to submit their bid based on materials, equipment and methods as specified in this Section. Any substitutions of material, equipment or method must be submitted in accordance with the specified procedure described in Division 1. Any required changes to the construction documents shall be described in writing and any costs or changes must be included in the price quoted to complete the installation.

1.07 SUBMITTALS

- A. Division 1 requirements.
- B. Shop Drawings:
 - 1. Provide a complete set of checked shop drawings required to fabricate and assemble all systems that is signed and sealed by a Licensed Professional Engineer in the state of New Mexico.
 - 2. Statements: Furnish the Owner with copies of all permits and receipts for fee payments.
 - 3. Test Reports: Submit a sample form of any performance test reports that will be used by the installer following slide erection, prior to beginning slide installation.
- C. Include complete product data indexed, tabbed and referenced to specifications.
- D. Include complete shop drawings, directly from the manufacturer at appropriate scale, illustrating the fabrication and installation of the water slide and support structure.
- E. Submit engineering design calculations that are prepared and sealed by a Professional Engineer licensed in the State of New Mexico, with shop drawings for water slide layouts, structures and footings. Provide rough-in information for interfacing mechanical and electrical work. Shop Drawings shall include accurate dimensions and locations for sleeves, inserts and anchors to be cast into concrete.
- F. Specify water supply requirements and required pump characteristics to Architect, for approval, prior to preparation of fabrication drawings.
- G. Guarantee / Warranty: All work of this Section shall be warranted against all defects of material and/or application for a period of one (1) year from date of acceptance. Any failures that may occur within this warranty period, due to defective installation and/or materials, shall upon written notification of such failure be immediately repaired or replaced.

1.08 MAINTENANCE MANUALS AND CLOSE-OUT SUBMITTALS

- A. Submit six (6) bound volumes of complete Operating and Maintenance instructions covering all installed equipment. Include wiring diagrams, lubrication and user maintenance instructions.
- B. Include manufacturer's recommended maintenance schedule, parts lists, piping diagram and troubleshooting information.
- C. Include one set of approved submittals as a part of each O & M manual.

1.09 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver material in manufacturer's original, unopened containers and crates with all labels intact and legible.

- B. Deliver materials in sufficient time and quantity to allow continuity of work and compliance with approved construction schedule.
- C. Handle materials in a manner to prevent damage.
- D. Store all materials on clean raised platforms with weather protective covering when stored outdoors. Provide continuous protection of materials against damage or deterioration.

PART 2 - PRODUCTS

2.01 SLIDE CONFIGURATIONS

- A. The preliminary slide layouts have been developed utilizing a slide path design provided by Splashtacular, La Quinta, California 1-800-844-5334.
- B. Slides by WhiteWater, Columbus, OH 614-485-9500 or 800-775-4337 are acceptable provided they meet deck accessibility and support tower requirements without design changes.

2.02 FIBERGLASS FLUME SLIDE COMPONENTS

A. Fiberglass Laminate Materials

1. Gelcoat: Interior gelcoat shall be high quality isophthalic polyester with U.V. inhibitors. 18 to 20 mil thick ride surface, 20 mils exterior coating. Translucent fiberglass shall also have exterior UV protection clear coat.
2. Resins: Thixotropic promoted low profile polyester resin with alternate layers of continuous roving chop and 18 oz. woven roving.
3. Structure: Fiberglass lamination with sandwich panel centerline reinforcement. Standard flume section shall be 3/16 inch thick, minimum weight 20 oz. per square foot. Flanges shall be minimum 1/4 inch thick and extend at least 4-3/4 inch from the slide surface, "L" type.
4. No fill material to fiberglass slide other than aforementioned products shall be allowed without written approval prior to erection.

B. Joints, Connections and Seams

1. Flume to flume joints shall be fastened with 3/8 inch stainless steel bolts, washers (2 per bolt) and self-locking nuts.
2. Flume to support system connections shall be made with stainless steel hardware, and shall be connected separately from water slide section connections to the exterior flange of the flume.
3. All connections shall be external to flume interior. No connection, hardware or penetration shall be made to flume interior.
4. Fiberglass joint connections shall be made using waterproof, non-shrink caulking with suitable adhesion to fiberglass. Silicone sealants will not be permitted. The slide manufacturer shall supply caulking material.

5. Fiberglassing over seams within the riding surface is not permitted. Sanding within the slide surface should be minimized to maintain adequate gel coat thickness and gloss. Any sanded areas shall be polished to a high gloss until undetectable.
- C. Color: Shall be integral to the fiberglass. The color shall be selected by the Architect and Owner from all available colors submitted with the bid in the form of color chart or color chips. Color variations within the inside and outside of slide shall be an option to the Owner.
- D. Water slide shall be furnished with the following components:
1. Entry tray shall be pre-plumbed for water injection down stream of the rider entry point. Rider entry area shall be a non-skid surface, with no steps permitted.
 2. Water slide shall be constructed so that water loss does not occur. Risers or built-up sections are required for ride safety and to control water loss, shall be provided on all curved flume sections. Risers shall be integral to the flume, and bolt-on sections will not be acceptable.
 3. Riser ends to provide a smooth transition at the beginning and ending of each riser shall be provided integral to the flume section.
 4. Pool entry section shall provide a smooth finished end piece, which provides safe pool entry and masks any hardware or connections to the pool.
 5. Factory pre-drilling of all sections.
 6. Waterproof joint sealant
 7. Stainless steel assembly hardware

2.03 FLUME SLIDE STRUCTURAL SUPPORT SYSTEM

- A. General: The flume support towers, tower foundations and stair systems shall consist of all elements necessary to safely and securely support the fiberglass flume or tube from starting platform to the plunge pool and consist of:
1. Concrete footings and foundations, including excavation, backfill and compaction.
 2. Steel support columns.
 3. Structural steel tower and stair system.
 4. Guardrailing, balustrades and handrails shall be painted galvanized steel tubing. Stainless steel railings are acceptable.
 5. All connecting hardware.
- B. Design: Design of all slide supports and footings shall be certified by a licensed by a structural engineer in the State of New Mexico. Design shall accommodate the local soil conditions as indicated, and the stresses generated by the water flume ride during use.
- C. Concrete
1. Cast-in-place: Minimum compressive strength shall be 3,000 psi at 28 days. Maximum size aggregate shall be $\frac{3}{4}$ inch. Slump shall not be more than 3 inches. Concrete shall be vibrated but not

excessively so as to cause segregation of materials. Check all applicable drawings for locations of blockouts, anchors, inserts, etc. before concrete is placed.

2. Reinforcing Steel:
 - a. $F_y = 60,000$ psi min. for: ASTM A615 (deformed bar) or equivalent. ASTM A82 (welded wire fabric) or equivalent.
3. Unless otherwise noted, concrete cover to reinforcing shall be as follows; Footing 3 in. and walls, pedestals and columns 1 ½ in.
4. All concrete procedures to conform to latest ACI Building Code.
5. Steel reinforcing lap splices for concrete slab shall be a minimum of #6 bar diameter.

D. Structural Steel

1. Shall consist of radial arms with end yoke type fastening assembly for each support point. (NOTE: A central column support with radial arms may be used to support circular sections of 180 degrees or greater.
2. Structural steel shall be new material of sizes and shapes listed in current AISC handbooks and as indicated on drawings.
3. Shapes and plates: ASTM A36 or equivalent minimum $F_y = 36,000$ psi (248.2 MpA)
4. Square structural section: ASTM A500 minimum $F_y = 46,000$ psi (317 MpA).
5. Round steel pipes: ASTM A53 Grade B minimum $F_y = 35,000$ psi (241.3 MpA).
6. Cast steel: ASTM A27 minimum $F_y = 35,000$ psi or equivalent.
7. Tension rods, bolts and anchor bolts: ASTM A36 minimum allowable tensile stress $F_t = 19,100$ psi (131.7 MpA).
8. Structural bolts: ASTM A325, friction type or equivalent minimum allowable shear stress, $F_v = 21,000$ psi (144.8 MpA). Minimum allowable tensile stress, $F_t = 44,000$ psi (303.4 MpA).
9. Welding electrodes: E480XX electrode (E70XX). Minimum allowable shear stress, $F_v = 21,000$ psi (144.8 MpA).
10. Grout: Masterflow 713 or approved equal non-shrink, non-metallic grout. Use as recommended by manufacturer.
11. All plates, shapes and tubes in contact are to be welded with ¼ inch minimum fillet welds all around unless otherwise indicated.
12. Unless otherwise noted all steel structure shall be galvanized.
13. CONTRACTOR shall supply temporary bracing to take care of all loads on the structure during erection to ensure the safety of the structure, leave as long as it is required, remove when safety is assured.

14. All flumes and support arms shall be properly set and installed prior to installation of permanent column bracing. Additional column bracing as required by Engineer, in addition to those noted on the drawing, shall be provided upon site inspection.
 15. All hollow structural sections shall be closed airtight with end plates sealed with welds.
 16. All steel shall be thoroughly cleaned of all loose mill scale, loose rust, oil and dirt.
 17. Surface to be welded shall be free from loose scale, rust, paint or other foreign matter. Care shall be taken to minimize stresses due to heat expansion, contraction and distortion by using proper sequence in welding and by other approved methods.
 18. Fabrication and erection shall conform to the latest editions of the ASTM Specifications and Code of Practice; Welding shall be done by welders certified with AWS-D-1.1
 19. Equivalent structural steel sizes listed in current AISC or CISC Handbook may be used upon approval of the Architect/Engineer/Engineer.
 20. Definitions
 - a. ASTM – American Society of Testing Materials.
 - b. AISC – American Institute of Steel Construction
 - c. CISC – Canadian Institute of Steel Construction
- E. Column Systems
1. A single or multiple steel post system shall be used.
- F. Starting Towers/Stairways/Railings
1. The starting tower/stairway shall consist of:
 - a. A steel top deck, stair and support system supporting the starting chute for the Indoor slide. Guard railing, balustrades and handrails shall be galvanized steel tubing.
 - b. Painted galvanized steel or stainless steel handrails.
 - c. Bracing and structural support (non-corrodible).
 - d. Concrete Foundation, columns and flatwork as required by the design.
 2. Design
 - a. An Engineer licensed in the State of New Mexico shall certify the structure design. Structure shall be sized to handle the user volumes, the height required by the flume length, and the location on the existing topography.
 - b. Stair design shall follow current UBC Code per State Building Codes.
 - c. Coordinate with slide manufacturer.
 3. Concrete Footings and Piers

- a. Shall be designed and constructed to support the design loads.
 - b. All concrete shall have a minimum twenty-eight (28) day compressive strength of 4000 psi.
 - c. All footings shall be on undisturbed soil.
 - d. Vertical members shall be on concrete footings, above grade and be secured with flange plates and anchor bolts.
4. Hardware
- a. Steel Hardware, ASTM A-7 or A-36 (hot dipped galvanized)
 - b. Bolts, Federal Specification FF-B-SC1.
5. Starting Tower
- a. Starting tower structure shall be constructed of a galvanized steel support deck with a slip resistant finish surface consisting of either a broom finish concrete or vinyl tread inserts. Coordinate design with building structural engineer and slide manufacturer.
6. Stairs and Railings
- a. Prefabricated stairway sections shall include stringers constructed of hot dip galvanized steel. Stair treads and landings shall be of non-corrosive and impervious fiberglass or vinyl with appropriate non-slip surface. Colors to be chosen from water slide manufacturer color chart. Stairway systems, handrails and guardrails shall comply with all applicable codes.
 - b. Rail system shall be a minimum of 42 inch high at any point, including height above starter tub section, non-climbable and designed to prevent accidental exit. Guardrailing, balustrades and handrails shall be painted galvanized steel tubing. Stainless steel railings are acceptable. Handrails shall be provided to meet all code requirements. Color selection by Architect/Engineer/Engineer and Owner.
 - c. Railing must surround top platform on all sides (except at slide start area). Railings must be provided along stair section and continue from the top platform area, down to the bottom of the finish deck.
 - d. Stair system from finish deck to top platform shall be a minimum of 36 inches in clear width.
 - e. A chain with removable self-closing hook and sign labeled "CLOSED" shall be provided across the entry of each waterslide at the top of the waterslide platform.
 - f. A swing gate with self-closing hook and sign labeled "CLOSED" shall be provided across the stair entry point on the deck of the waterslide.
7. Finish
- a. All ferrous metal parts (All steel components of waterslide are to be factory painted with field touch-up as required.)

- 1) Surface Preparation: Blast all surfaces to be coated to the extent of an SSPC-SP6 commercial-grade level of cleanliness. Create a 1.5 – 2.0 mil profile and prime before any rust bloom forms on the surface.
 - 2) Primer: Spray apply in the shop, one full coat of Tnemec Series 90-97 Aromatic Urethane Zinc-Rich or Amercoat 68 HS primer to a DFT of 4.0 mils. Allow to cure as per data sheet (4 hours @ 75 deg. F.) before applying topcoat.
 - 3) Topcoat: Spray apply in the shop one even finish coat of Tnemec Series 74-Color Endura-Shield. Acrylic Polyurethane or Ameron PSX-700 finish to a minimum DFT of 5.0 mils. Allow to cure as per data sheet (6 hours @ 75 de. F.) before handling/loading in the shop.
 - 4) Field Touchup: If the broken area of the shop applied film is rough from scaring, disc-abrade that area smooth and then solvent clean it as per an SSPC-SP1, level of cleanliness. Brush or roller apply one coat of Tnemec Series 135 Chembuild or Ameron epoxy primer. Allow to cure as per data sheet. Brush or roller apply one coat of Tnemec Series 74 or Ameron PSX-700 shop applied color to bring the film up to specification thickness.
- b. Fiberglass handrail posts
 - 1) Finish: Tnemec Series 74 or Ameron PSX-700 shop applied at 5.0 mils DFT.
 - 2) Field Touch-Up: Tnemec Series 74 or Ameron PSX-700 shop applied at 5.0 mils DFT.
 - 3) Manufacturer: Tnemec 816/483-3400 or Amercoat 800/244-0025 or pre-approved equal.
 - c. Top deck and landing shall have a non-slip finish.
 - d. The stair system and treads shall consist of galvanized steel pans with vinyl tread inserts. The stair treads shall be concrete fill galvanized steel pans with brushed concrete finish. All stair treads and platform shall have a slip-resistant finish.
 - e. All exposed concrete vertical surfaces shall have an exposed aggregate finish.
 - f. Seal all concrete with a minimum of two (2) coats of H&C Silicone Acrylic Concrete Sealer, FLR Paints, Inc., 6104 31st St., East, Bradenton, FL.
 - g. Colors shall be as selected by the Owner and Architect/Engineer.

PART 3 - EXECUTION

3.01 SYSTEMS INSTALLATION

- A. The water slide installer shall assemble and install all equipment, special parts and accessories in accordance with these specifications and detailed layouts and shop drawings of equipment supplier.
- B. Installer shall furnish and install all anchors and inserts to be imbedded including all fittings, inserts, structure sleeves and required anchorages.
- C. Install all equipment and systems in accordance with manufacturer's directions.

- D. The water slide shall be as described in the specifications. Items are detailed and specified as a guide reference and for dimensional purposes. The CONTRACTOR must make provisions accordingly and submit shop drawings and submittals based on that data.
- E. Installer shall coordinate, supervise and approve work by other trades responsible for work related to this Section. All work in this Section shall be performed by the water slide installer except as noted.

3.02 SITE CONDITIONS

- A. Inspection
 - 1. Prior to installation of the work of this Section, carefully inspect the installed work of other trades and verify that all such work is complete to the point where this installation may properly commence.
 - 2. Verify that fiberglass slide and structural support systems may be fabricated and erected in strict accordance with the original design, the approved Shop Drawings and the referenced standards.
- B. Discrepancies
 - 1. In the event of discrepancy, immediately notify the Architect.
 - 2. Do not proceed with fabrication or installation in areas of discrepancy until all such discrepancies are fully resolved.

3.03 FABRICATION

- A. General: Fabricate the water slide and structural support systems in strict accordance with the approved Shop Drawings and referenced standards.

3.04 INSTALLATION OF FOOTINGS AND FOUNDATIONS

- A. Foundations shall be installed in strict accordance with the approved Shop Drawings prepared by professional Engineer registered in the State of New Mexico.

3.05 WELDING

- A. General
 - 1. For details of joints, comply with requirements for AWS joints accepted without qualification tests.
 - 2. Use ASTM A-233, E-70XX series electrodes.
 - 3. Follow applicable sections of AWS specifications.
- B. Types of Welds unless otherwise noted
 - 1. Make all fillet welds 1/4 inch minimum.
 - 2. Make all butt welds full penetration welds.

3.06 ERECTION

SECTION 13155 – WATER SLIDE

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- A. General: Erect the fiberglass water slides and structural support systems in strict accordance with the approved Shop Drawings and all pertinent regulations and standards.
- B. Tolerance: Align all structural steel straight, plumb and level with a tolerance of 1 in 500.
- C. Fiberglass Joints: All flange to flange connections shall be made utilizing the waterproof caulking supplied by the fiberglass manufacturer and shall be joined in such a way as to provide for a safe and matless ride. All joints shall be aligned for a completely smooth riding surface, that is, alignment must be within 1/64 inch and in no case shall the downstream side of the joint be above the upstream side of the joint.
- D. Steel Finishes: Any field welds or scarred surfaces shall be cleaned and cold galvanized with zinc rich paint.

3.07 CLEAN-UP

Upon completion of the work of this Section, immediately remove all fiberglass, debris and rubbish occasioned by this work to the approval of the Architect and at no additional cost to the Owner.

3.08 START-UP AND INSTRUCTION

Supply the services of an experienced operator/instructor after water slides have been completed and initially placed in operation. During this period, the Owner's representatives who will be operating the pool shall be thoroughly instructed in all phases of the slide operation. Prior to leaving the job, obtain written certification from the designated Owner's representative acknowledging that the instruction period has been completed and all necessary operating information provided. A minimum of one (1) 2-hour session is required.

3.09 CONCLUSION

It is the intention of these specifications to provide a complete installation of the water slides as described. All accessory construction and apparatus necessary or advantageous in the operation or testing or high performance of the work shall be included. The omission of specific reference to any part of the work necessary for such complete installation shall not be interpreted as relieving the water slide supplier or installer from furnishing and installing such parts. Any such omission or clarification shall be brought to the attention of the Architect prior to bidding.

END OF SECTION 13155

SECTION 15010 - GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of the General Conditions, Supplementary Conditions and Division 1 - General Requirements, and applicable provisions elsewhere in the Contract Documents apply to work of Division 15.
- B. In case of disagreement between Drawings and Specifications, or within either document itself, obtain written clarification from the Mechanical Engineer through the Architect. Failure to obtain clarification prior to bid will result in the better quality and greater quantity being required during the construction phase without additional reimbursement.

1.2 DESCRIPTION OF SYSTEMS

- A. The related work of Division 15 includes but is not limited to:

1. Section 15010 – General Mechanical Requirements.
2. Section 15045 – Mechanical Related Work.
3. Section 15060 – Pipe, Valves & Pipe Specialties.
4. Section 15190 – Mechanical Identification.
5. Section 15250 – Mechanical Insulation.
6. Section 15300 – Fire Protection.
7. Section 15400 – Plumbing.
8. Section 15500 – HVAC Hydronic Systems.
9. Section 15550 – Heat Generation.
10. Section 15560 – Electric Heating Terminals.
11. Section 15600 – Refrigeration
12. Section 15750 – Air Handling Units
13. Section 15770 – Pool Dehumidification Units.
14. Section 15800 – Air Distribution.
15. Section 15900 – Temperature Control Systems – DDC.
16. Section 15990 – Testing, Adjusting & Balancing.

1.3 DESCRIPTION OF WORK

- A. Work Included: Unless specified otherwise, provide all supervision, labor, materials, transportation, equipment, hauling, and services necessary for a complete and operational mechanical system. Provide all incidental items such as offsets, fittings, etc. required as part of the work even though not specifically shown on Contract Drawings or Specifications.
- B. Inspection: Inspect work proceeding or interfacing with work of Division 15 sections prior to submitting bid and report any known or observed defects that affect the Mechanical Design to the General Contractor. Do not proceed with the construction work until defects are corrected.

1.4 UTILITIES, EXTENTIONS, CONNECTIONS AND FEES FOR WATER AND SEWER

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- A. Provide all services within the building to a point ten (10) feet outside of building. Provide permanent marker at grade for other contractors' location reference for connection purposes.
- B. Connection charges, membership fees, system development charges and the like, that in principle allow the right to obtain the services from the utility, will be arranged and paid for by the property owner.
- C. In the event that the serving utility company installs their own taps, service, meters, etc., all costs imposed by this action shall be paid for by the Owner. Extensions from termination points to connection with building services and systems will be the responsibility of the Division 15 Contractor.
- D. Contractor shall be responsible for all pads, valves, service boxes, and appurtenances, all in conformance with requirements of the serving utility company.

1.5 REFERENCES

- A. General:
 - 1. For products or workmanship specified by Association, Trade or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
 - 2. The date of the standard is that which is in effect as of the date of the Contract Documents, except when a specific date is specified.

1.6 QUALITY CONTROL

- A. Materials and apparatus required for the work shall be new and of first-class quality; to be furnished, delivered, erected, connected and finished in every detail; and to be so selected and arranged so as to fit properly into the building spaces.
- B. Unless otherwise specifically indicated, equipment and materials shall be installed in accordance with the recommendations of the manufacturer. This includes the performance of tests as recommended by the manufacturer.

1.7 EXAMINATION OF CONTRACT DRAWINGS AND SPECIFICATIONS

- A. The Mechanical Drawings show the general arrangement of piping, ductwork, mechanical equipment, and appurtenances, and shall be followed as closely as actual building construction and the work of other trades will permit.
- B. The Architectural and Structural Drawings shall be considered part of the mechanical work insofar as these Drawings furnish this Division with information relating to design and construction of the building.
- C. Field verify building dimensions governing mechanical work. Do not scale the Mechanical Drawing for dimensions. If field dimensions are not available take dimensions, measurements, locations, levels, etc. from the Architectural Drawings and the approved Shop Drawings submitted on the actual equipment to be furnished.
- D. The Mechanical Contractor shall request of the Test and Balance (TAB) Contractor an early review of the Contract Documents for the purpose of identifying where proper balancing cannot be achieved. The report requirements are referred to in Section 15990, "Inspection of the Contract Documents." Forward a copy of the report to the mechanical engineer for review. The Mechanical Contractor shall modify the system as recommended by the TAB Contractor or refer unresolved issues to the Mechanical Engineer for

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resolution prior to ordering of ductwork and equipment. Unresolved balancing issues from untimely or incomplete application of these requirements will be the responsibility of the Mechanical Contractor to correct.

- E. No extra compensation shall be claimed or allowed due to differences between the actual dimensions and those indicated on the Drawings.
- F. Discrepancies: Examine Drawings and Specifications for other parts of the work, and if any discrepancies occur between the plans for the work of this Division and the plans for the work of others, report such discrepancies to the General Contractor and obtain written instructions for any changes necessary. Report any inconsistencies between the drawings and specifications and the installation requirements of equipment manufacturers.
- G. Order of Precedence: The precedence of Mechanical Construction Documents is as follows:
 - 1. Addenda and modifications to the Drawings and Specifications take precedence over the original Drawings and Specifications.
 - 2. Should there be a conflict within the Specifications or within Drawings of the same scale, the more stringent or higher quality requirements shall apply.
 - 3. In the Drawings, the precedence shall be figured dimensions over scaled dimensions and noted materials over graphic indications.
 - 4. Should a conflict arise between the Drawings and the Specifications the Specifications shall have precedence.
 - 5. Should there be a conflict in dimensions or locations between Mechanical Drawings and/or Architectural/Structural Drawings, the Architectural/Structural Drawings shall have precedence.

1.8 EXAMINATION OF PROJECT SITE

- A. Examine site carefully to determine conditions to be encountered, work to be performed, equipment, materials to be transported, stored, furnished, and other features applicable to completion of the work.
- B. Study Drawings And Specifications, report inconsistencies, errors, omissions or conflicts with codes and ordinances.
- C. Submittal of bid will indicate satisfactory examination of the Documents have been made, and applicable allowances included in the bid.

1.9 REGULATORY REQUIREMENTS

- A. Execute work per Underwriters, Public Utility, Local and State Codes, Ordinances and applicable regulations. Obtain and pay for required permits, inspections, and certificates. Notify Architect of items not meeting said requirements.
- B. Comply with latest editions of all applicable codes, standards, ordinances and regulations in effect as of the date of the Contract Documents.
- C. If discrepancies occur between the Contract Documents and any applicable codes, ordinances, acts, or standards, the most stringent requirements shall apply.
- D. Where hourly fire and smoke ratings are indicated or required, whether or not shown, provide components and assemblies meeting requirements of the American Insurance Association, Factory Mutual Insurance Association and listed by Underwriters Laboratories, Inc.

1.10 COORDINATION

- A. The Contractor shall plan all of his work in advance, and shall inform the General Contractor of the proposed construction schedule and anticipated completion date upon request. Contractor shall complete the entire installation as soon as the condition of the remaining building construction will permit.
- B. Before purchase, fabrication, or installation of items, determine if the installation will properly fit and can be installed as contemplated without interference with structural elements or the work of other trades.
- C. Locations of pipes, ducts, switches, panels, equipment, and fixtures, shall be adjusted to accommodate the work or interferences anticipated and encountered. Determine the exact route and location of each pipe and duct prior to fabrication.
- D. Right of Way: Lines which pitch shall have the right-of-way over those which do not pitch. Lines whose elevations cannot be changed shall have right-of-way over lines whose elevations can be changed.
- E. Offsets, transitions and changes in direction of pipes and ducts shall be made as required to maintain proper head room and pitch of sloping lines whether or not indicated on the Drawings.
- F. Where major conflicts occur, contractor shall rely upon the Architect/Engineer to make final decision regarding priority of right-of-way. Contractor shall request written clarification from the Architect/Engineer prior to conflict reaching critical stage requiring removal of previously installed equipment or system components either by himself or by other trades involved.
- G. When directed by the Architect/Engineer, submit Shop Drawings showing interrelationship of various portions of work and work of other trades. Failure to properly coordinate may result in removal and relocation at expense to the Contractor.
- H. Coordinate all electrical work with Electrical Contractor. Read the Electrical Specification and report any inconsistencies.
- I. Coordinate all cutting & patching with General Contractor.

1.11 PROJECT CONDITIONS

- A. Accessibility:
 - 1. Contractor shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions and hung ceilings for proper installation of work. Coordinate these requirements with the General Contractor. Such spaces and clearances shall be kept to the minimum size required.
 - 2. Locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Furnish access doors for this purpose. Minor deviations from Drawings may be allowed to provide for better accessibility. Any changes shall be approved by the Architect prior to making the change.
 - 3. Provide the General Contractor with the exact locations of access doors. Locations of these doors shall be submitted in sufficient time to be installed in the normal course of work.
- B. Fabrication: Before any ductwork is fabricated and before installing and/or fabricating any lines of piping or ductwork the Contractor shall assure himself that they can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work.

- C. Freeze Protection: Do not run pipes in outside walls, or locations where freezing may occur. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection.
- D. Scaffolding, Rigging and Hoisting: Provide scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required.

1.12 SUBMITTALS:

- A. Within thirty days after award of the Contract, submit to Architect complete catalog data and/or Shop Drawings for each item of material and for every manufactured item of equipment to be used in the work. Such data shall include specific performance data, material description, rating, capacity, dimensions, and type for each item of material, each manufactured item, and all component parts utilized in final operating mechanical system. Applicable data shall be underlined and each applicable item identified in each catalog by the same identification acronyms used on the Drawings.
- B. This Contractor shall submit to the Architect the number of copies required by the General and Special Conditions of Division 1, but in no case less than four (4) copies.
- C. Each item submitted shall bear the Contractor's stamp, be dated and signed certifying that he has reviewed and approved the Submittal.
- D. For each item scheduled on the Drawings, submit a replication of that schedule indicating actual data of the submitted equipment in the schedule.
- E. The review comments of the Architect and/or Engineer do not in any case supersede the Drawings and Specifications, and shall not relieve the Contractor from responsibility for deviations from the Drawings or Specifications unless the Contractor has called to the attention of the Architect and/or Engineer, in writing, such deviations at the time of submission, nor shall it relieve the Contractor from responsibility for errors of any sort in the items submitted.
- F. Test Reports: Submit certified test reports as required by various Sections of Division 15 showing compliance in accordance with the General Conditions of the Contract.
- G. Deviations: It is the contractors responsibility to indicate deviations from the Plans And Specifications. Approval shall not be considered acceptance of the deviation unless it has been explicitly indicated.

1.13 SITE OBSERVATION REPORTS

- A. During the construction period the Engineer may issue periodic site observation reports. The contractor shall immediately address the issues and provide a written response identifying the "Responsible Contractor," "Date," "Corrective Action Taken," and "Recommendations."
- B. The written response must be returned to the Architect no later than (5) working days after receipt of the site observation report.

1.14 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Substitutions: Comply with Division 1 & Instructions to Bidders.

- B. Contractors desiring to use alternate equipment or materials and manufacturers or suppliers desiring to furnish alternate materials or equipment in lieu of those specified, shall submit requests for approval to the Engineer not less than seven (7) calendar days prior to scheduled closing date for receipt of proposals.
- C. Materials and equipment are specified by manufacturer and catalog numbers. The manufacturers and catalog numbers are used to establish a degree of quality and style for such equipment and material.
- D. When alternate or substitute materials and equipment are used, Contractor will be responsible for space requirement, configurations, performance, changes in bases, supports, structural members and openings in structure, electrical changes and other apparatus and trades that may be affected by their use. Contractor shall provide drawings for alternate/substitute equipment in detail equal to the construction documents.

1.15 PROJECT RECORD DOCUMENTS

- A. General: Comply with Division 1.
- B. Job Site Documents: Maintain at the job site, one record copy of the following:
 - 1. Drawings
 - 2. Specifications
 - 3. Addenda
 - 4. Reviewed Shop Drawings
 - 5. Field Test Records
- C. Do not use record documents for construction purposes. Maintain documents in clean, dry legible condition, apart from documents used for construction.
- D. Record Information: Label each document "Record Document." Mark information with contrasting color using ink. Keep each record current. Do not permanently conceal any work until required information is recorded. Record the following information on drawings:
 - 1. Horizontal and vertical location of underground utilities.
 - 2. Location of internal utilities and appurtenances concealed in construction.
 - 3. Field changes of dimension and detail.
 - 4. Changes by change order or field order.
 - 5. Details not on original Contract Drawings.
- E. Contractor shall transfer all information on to CAD files. Provide electronic copy upon request.
- F. Record the following information on Specifications:
 - 1. Manufacturer, trade name, catalog number and supplier of each product and item of equipment actually installed.
 - 2. Changes by change order or field order.
 - 3. Other matters not originally specified.
- G. Shop Drawings: Maintain Shop Drawings as record documents recording changes made after review as specified for drawings above.

1.16 ELECTRIC WIRING AND SAFETY DEVICE WORK AND MATERIAL RESPONSIBILITIES

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- A. Unless otherwise indicated, all mechanical equipment motors and controls shall be furnished, set in place, and wired in accordance with the following schedule: MD = Mechanical Division, ED = Electrical Division, TD = Temperature Control Division, I = Installer of equipment requiring electrical service, FPC = Fire Protection Contractor.
- B. Note: If Temperature Control Division is a subcontract to the Mechanical Contractor, both MD and TD shall fall under the responsibility of MD. If no Temperature Control Contractor is under contract, Mechanical Division shall assume all Temperature Control responsibilities.

	Furnished Under	Set In Place or Mounted Under	Power Wired & Connected Under	Control Wired & Connected Under
1. Other Equipment Motors/Starters	I	I	ED	I
2. Mechanical Equipment Motors	MD	MD	ED	TD
3. Mechanical Magnetic Motor Starters	MD	MD	ED	TD
4. Control Wiring Regardless of Voltage	TD	TD	TD See footnote 1	TD
5. Control Components: Control Relays, Thermostats, Control Transformers	TD	TD	TD See footnote 1	TD
6. Temperature Control Panels, Time Clocks, Controllers	TD	TD	TD See footnote 1	TD
7. Valve and Damper Motors and Actuators	TD	TD	TD See footnote 1	TD
8. Control Valves, Solenoid Valves	TD	MD	--	TD
9. Control Dampers Integral with a Fan Unit	MD	MD	--	--
10. Control Dampers (duct mounted)	TD	MD	--	TD
11. Thermowells in Piping	TD	MD	--	--
12. Fire Protection (Exterior horn & light)	FPC	ED	ED	ED
13. Fire Protection (Tamper & flow switch)	FPC	FPC	ED	ED See footnote 2
14. Smoke Duct Detectors (including relays)	ED See footnote 3	MD See footnote 3	ED See footnote 4	ED See footnote 3
15. Fire and Smoke Dampers	MD	MD	ED	ED See footnote 2
16. Pilot Lights	MD	MD	--	TD See footnote 4
17. Manual Operating Switches	MD	MD	ED	-- See footnote 5
18. Fused and Unfused Disconnect Switches & Thermal Overload Switches	ED See footnote 6	ED See footnote 6	ED	--
19. Contactors	ED	ED	ED	ED
20. Temporary Heating Connection	MD	MD	ED	TD
21. Pool Heater and Water Heater Controls, Heater Burner Control Panels Internally Wired	MD	MD	TD See footnote 1	TD
22. Remote Disconnect Switches for Pool Heater and Water Heater Controls per ASME-CSD-1.	TD	TD See footnote 7	ED See footnote 8	TD

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1. Footnote 1: It is the intention of this specification for all conduit and wiring which connects to control equipment or provides controls to mechanical equipment to be provided by the Temperature Control Contractor. Other portions of the specification which may be in conflict with this concept shall be brought to the attention of the engineer for clarification prior to bidding the project. The ED shall provide line voltage wiring conduit and junction boxes for the express purpose of temperature controls. It shall be the responsibility of the Temperature Control Contractor to coordinate the location of the junction boxes (if not otherwise shown on the Electrical Drawings) and to utilize these junction boxes for temperature control wiring. The Temperature Control Contractor shall extend line and/or low voltage wiring from junction boxes to all mechanical and control components which requires control wiring.
 2. Footnote 2: Wiring from the fire alarm electrical contacts to fire alarm system control panel by ED; all mechanical equipment control function wiring by TD. ED to coordinate locations of electrical contact with MD. MD to coordinate locations of duct smoke detectors with ED.
 3. Footnote 3: MD shall assist in locating the detectors, but ED shall verify that the installation meets the manufacturer's installation guidelines, and is responsible for correctly ordering the smoke detectors. MD shall mount the detectors in a manner directed by ED according to manufacturer's recommendation. If the detector is used for operation of a smoke/fire damper, the control wiring will be by ED. If the unit is used for fan shutdown, the fire alarm functions will be by ED and the wiring to the starter for a direct shutdown will be by MD, typically by the TD. Any signal required for the sequence of operation shall be coordinated between MD and ED, with ED providing a point of connection and MD responsible for the rest of the installation.
 4. Footnote 4: For connection to auxiliary contacts if required.
 5. Footnote 5: Device is used in the power wiring circuit to the equipment. Control functions do not exist.
 6. Footnote 6: Unless furnished with equipment.
 7. Footnote 7: A manually operated remote shutdown switch(es) shall be located just outside the boiler room door and marked for easy identification. Consideration should be given to the type and location of the switch to safeguard against tampering. If the boiler room door is on the building exterior, the switch should be located just inside the door. If there is more than one door to the boiler room, there should be a switch located at each door. The emergency shutdown switch shall be wired to the boiler safety circuit relay and shall disconnect all power to the boiler safety circuit. Use explosion proof switches at indoor switch locations.
 8. Footnote 8: ED shall provide a separate 120 volt branch circuit and a junction box at each boiler room door. Junction box location shall be as indicated on Mechanical Drawings and shall be coordinated with TD prior to installation.
- C. All temperature control conduit and wiring will be furnished and installed under temperature control subcontract. In the event that temperature control is not under separate contract, Mechanical Contractor shall assume all temperature control subcontract responsibilities.
- D. Division 16 shall furnish and install all conduit and wiring required for power wiring carrying equipment full load amperage to all mechanical equipment unless shown otherwise.
- E. Provide Division 16 with a complete summary list of all mechanical equipment and line voltage control requiring electric power within 30 days after award of contract. This list shall summarize equipment power loads, line voltage control requirements, quantities, and locations of equipment and connection points. If any HVAC equipment is required to run on emergency power, the list shall note that requirement along with the requirement for the building temperature controls systems to also be under emergency power.
- F. All starters, other than those in Motor Control Centers and noted on the Drawings shall be furnished under Division 15. All starters furnished under Division 15 shall be complete with three overload heaters and shall conform to NEC and NEMA requirements. All starters shall have 65,000 AIC rating.
- G. Exhaust Fans: The Electrical Contractor under Division 16 of the work will furnish and install circuits, feeders and disconnect switches, and make all connections to motors and controls unless interlocked with

other mechanical equipment or exhaust fans in locations indicated. Where exhaust fans are interlocked with other mechanical equipment, the interlock wiring will be furnished by the Mechanical Contractor under Division 15.

1.17 DELIVERY, STORAGE AND HANDLING

- A. Deliver and store materials and equipment in manufacturer's unopened containers fully identified with manufacturer's name, trade name, type, class, grade, size and color.
- B. Protection: Make provisions for coordination with Owner and other Contractors for safe storage of materials and equipment. Store materials and equipment off the ground and under cover, protected from damage.
- C. All items subject to moisture damage, such as controls, shall be stored in a dry, heated space.
- D. Large Items: Make arrangements with other Contractors on the job for introduction into the building of equipment too large to pass through finished openings. Schedule delivery of large equipment requiring special openings as required for installation without delaying the work of other project trades.
- E. Acceptance: Check and sign for materials to be furnished by Division 15 and other trades for installation under Division 15 upon delivery. Assume responsibility for the storage and safekeeping of such materials from time of delivery until final acceptance.
- F. Inspection: Stored material shall be readily accessible for inspection by the Architect until installed.

1.18 WARRANTIES

- A. Warranty: In accordance with Division 1, provide a written warranty to the Owner covering the entire mechanical work to be free from defective materials, equipment and workmanship for a period of one year after Date of Acceptance. Purchase of manufacturers extended warranty may be required to comply with the one year requirement. During this period provide labor and materials as required to repair or replace defects at no additional cost to the Owner. Provide certificates for such items of equipment which have warranties in excess of one year. Submit to the General Contractor.
- B. This warranty will be in addition to the terms of any specific equipment warranties or warranty modifications resulting from use of equipment for temporary heat or ventilation.

1.19 SCHEDULE OF TESTING

- A. Provide testing in accordance with the General Conditions of the Contract. Make all specified tests on piping, ductwork and related systems as necessary. Demonstrate the proper operation of equipment installed under this project.
- B. Equipment shall not be tested, or operated for any purpose until fully lubricated in accordance with manufacturer's instructions and until connections to fully operative systems have been accomplished.
- C. A schedule of testing shall be drawn up by the Division 15 Contractor in such a manner that it will show areas tested, test pressure, length of test, date, time and signature of testing personnel. All testing must be performed in the presence of the General Contractor's representative; his signature for verification of the test must appear on the schedule. At completion of testing, the schedule shall then be submitted in triplicate to the Architect.

- D. Make sure operational and performance tests are made on seasonal equipment.
- E. Complete all tests required by Code Authorities, such as smoke detection, life safety, fire protection and health codes.

1.20 CERTIFICATES AND KEYS

- A. Certificates: Upon completion of the work, deliver to the General Contractor one copy of Certificate of Final Inspection.
- B. Keys: Upon completion of work, submit keys for mechanical equipment, panels, etc. to the General Contractor.

1.21 OPERATING AND MAINTENANCE DATA

- A. Submit three (3) typed and bound copies of the maintenance manual, 8-1/2" x 11" in size, to the Architect, for review and approval. These approved copies shall then be transmitted to the Owner.
- B. The manual shall be enclosed in a stiff-back, three-ring binder and shall have:
 - 1. Table of Contents, Equipment List with identification used in contract documents.
 - 2. Alphabetical list of all system components including the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year of operation.
 - 3. Operating instructions for complete system, including procedures for fire or failure of major equipment and procedures for normal starting/operating/shutdown and long-term shutdown.
 - 4. Maintenance instructions, including valves, valve tag and other identified equipment lists, proper lubricants and lubricating instructions for each piece of equipment and necessary cleaning/replacing/adjusting schedules.
 - 5. Manufacturer's data on each piece of equipment, including:
 - a. Installation instructions.
 - b. Drawings and Specifications (approved Shop Drawings).
 - c. Parts lists.
 - d. Complete wiring and temperature control diagrams. (Approved Shop Drawings).
 - e. Completed and approved TAB report.

1.22 INSTRUCTIONAL SESSIONS

- A. Be responsible for scheduling instructional meetings for maintenance personnel on the proper operation and maintenance of all mechanical systems, using the maintenance manual as a guide. These meetings must be scheduled through the Architect or General Contractor and with enough advanced notice that all personnel can be notified. Provide instructional sessions.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 15010

SECTION 15045 - MECHANICAL RELATED WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to work of this Section.

1.2 DESCRIPTION OF WORK

- A. Types of mechanical related work specified in this section include the following:
 - 1. Motors.
 - 2. Starters.
 - 3. Access Doors.
 - 4. Temporary Heat.
 - 5. Excavation.
 - 6. Cutting and Patching.

PART 2 - PRODUCTS

2.1 MOTORS

- A. Motor Characteristics: Except where more stringent requirements are indicated, comply with the following requirements for motors of mechanical work:
 - 1. Temperature Rating: Rated for 104°F (40°C) environment with maximum 122°F (50°C) temperature rise for continuous duty at full load (Class A Insulation).
 - 2. Altitude Deration: Motors to be furnished to maintain specified rated service factor at altitude of project.
 - 3. Starting Capability: Provide each motor capable of making starts as frequently as indicated by automatic control system, and not less than 5 starts per hour for manually controlled motors.
 - 4. Phases and Current Characteristics: Provide squirrel-cage induction polyphase motors for 3/4 hp and larger. Provide capacitor-start single-phase motors for 1/2 hp and smaller; except 1/6 hp and smaller may, at equipment manufacturer's option, be split-phase type. Coordinate current characteristics with power specified in Division-16 sections and with individual equipment requirements specified in other Division-15 requirements. For 2-speed motors provide 2 separate windings on polyphase motors. Do not purchase motors until power characteristics available at locations of motors have been confirmed, and until rotation directions have been confirmed.
 - 5. Power Factor: All motors rated greater than 1000 watts shall have a Power Factor of not less than 85% under rated load conditions. The 85% PF may be obtained by design of the motor or by providing a capacitor. Capacitors, if provided to obtain the 85% PF, must be switched with the motor. If the motor draws less than 1000 watts at full load, it is excluded from the 85% power factor requirement.
 - 6. Efficiency: Motor efficiency ratings shall conform to NEMA Standard MG-1-1987.
 - 7. Service Factor: 1.15 for three-phase motors and 1.35 for single-phase motors.

- B. Motor Construction: Provide general purpose, continuous duty motors, Design "B" or "C" where required for high starting torque. Provide inverter duty motors, for all variable speed motor applications:
1. Frames: NEMA No. 56.
 2. Bearings: Ball or roller bearings with inner and outer shaft seals, regreasable except permanently sealed where motor is normally inaccessible for regular maintenance. Provide double shielded ball bearings in accordance with ANSI-B 3.16-1972.
 3. Where belt drives and other drives produce lateral or axial thrust in motor, provide bearings designed to resist thrust loading. Refer to individual sections of Division 15 for fractional-hp light-duty motors where sleeve-type bearings are permitted.
 4. Enclosure Type: Except as otherwise indicated, provide open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation, and provide guarded drip-proof motors where exposed to contact by employees or building occupants. Provide weather-protected Type I for outdoor use, Type II where not housed. Refer to individual sections of Division 15 for other enclosure requirements.
 5. Overload Protection: Provide built-in thermal overload protection and, where indicated, provide internal sensing device suitable for signaling and stopping motor at starter.
 6. Noise Rating: Provide "Quiet" rating on motors. Motors shall not exceed 80 DB at full speed and power.
- C. Name Plate: Provide metal nameplate on each motor, indicating full identification of manufacturer, ratings, characteristics, construction, special features and similar information.
- D. Manufacturer: Except where item of mechanical equipment (which otherwise complies with requirements) must be integrally equipped with motor produced by another manufacturer, provide motors for mechanical equipment manufactured by one of the following:
1. Allis-Chalmers Corp.
 2. Baldor Electric Co.
 3. Century Electric Div., Inc.
 4. General Electric Co.
 5. Louis Allis Div.; Litton Industrial Products, Inc.
 6. Marathon Electric Mfg. Corp.
 7. Reliance Electric Co.
 8. Westinghouse Electric Corp.

2.2 STARTERS

- A. Motor Starter Characteristics: Comply with NEMA standards and NEC. Provide enclosures NEMA Type as required with padlock ears, and with frames and supports for mounting on wall, floor or panel as indicated. Where starter location is not within sight of motor, provide fused disconnect switch within sight of motor. Provide type and size of starter recommended by motor manufacturer and equipment manufacturer for applicable protection and start-up condition; refer to individual equipment sections for basic load requirements.
1. Manual Switches: Provide manual switch and pilot light for motors 1/2 hp and smaller, except where interlock or automatic operation is indicated. Provide extra switch positions and pilot lights for multi-speed motors.
 - a. Overload Protection: Provide melting alloy type thermal overload relays.
 2. Magnetic Starters: Provide magnetic starters for motors 3/4 hp and larger, and for smaller motors where interlock or automatic operation is indicated. Include the following:

- a. Heavyduty oiltight type hand-off-auto switch and pilot lights, properly arranged for single-speed operation as indicated.
 - b. Trip-free thermal overload relays, each phase.
 - c. Built-in 120-volt control circuit transformer, fused from line side and on secondary side.
 - d. Control circuit conductors to be protected in accordance with Article 250-5, Exception 5, of the National Electric Code.
 - e. Externally operated manual reset.
 - f. Undervoltage release or protection.
 - g. Hand-off-auto switch.
 - h. Single Phasing Protection: All starters shall include a phase protection relay mounted and wired in the starter enclosure, equal to time-mark 257 series or motor saver model 201. Starters for motors 5 hp and less may meet this requirement either by supplying the phase protection relay as above, or by providing a current differential trip mechanism in the overload relay which advances the trip setting 25% or more under single phase conditions. Submittals must include documentation of the type of single phasing protection is used.
 - i. Provide spare normally open and normally closed contacts.
 - j. With two speed starters, include an adjustable time delay device within starter enclosure to allow the motor to come to a complete stop when switching from high to low speed. Two speed starters shall have heavyduty 4 position rotary switch, "auto-off-low-high".
- B. Weather Protection: Provide weather-proof mounting of magnetic starters for equipment outside of the building.
- C. Unless furnished otherwise, provide over current protection for each motor. Coordinate with Division 16.
- D. Motor Starter Manufacturer: Provide motor starters for mechanical equipment manufactured by one of the following:
1. ABB.
 2. Allen-Bradley Co.
 3. Cutler-Hammer, Inc.
 4. General Electric Co.
 5. Sprecher & Schuh.
 6. Square D Co.
 7. Westinghouse Electric Co.

2.3 ACCESS DOORS

- A. Furnish access doors where shown on Drawings and at all locations where required for access to concealed valves, shock absorbers, dampers, cleanouts, control devices, coils, and equipment servicing. Access doors shall be 12" x 12" for hand access and 24" x 24" for head and shoulder access, or as indicated.
- B. Standard Doors:
1. Frames: 16 ga. steel.
 2. Panels: 14 ga. steel.
 3. Finish: Chemically bonded prime coat of baked enamel.
 4. Hinge: Concealed spring hinges openable to 175°; removable pins. Provide number of hinges as recommended by manufacturer for size of door.
 5. Locking Devices: Flush steel, screw driver operated, cam type locks. All access doors below 8'-0" in public areas shall be key-operated cylinder lock with two keys.
 6. Style of doors shall be appropriate for architectural finish at door location. Furnish masonry anchors where required.

C. Fire Rated Doors:

1. Frames: 16 gauge steel.
2. Panels: Sandwich type, 20 gauge steel sheets, manufacturer's standard insulated core.
3. Finish: Chemically bonded prime coat of baked enamel.
4. Hinge: Continuous type, steel with stainless steel pin.
5. Closer: Automatic closing mechanism.
6. Locking Devices: Self latching, key-operated cylinder lock with two keys; interior, latch release mechanism.
7. Style of doors shall be appropriate for architectural finish at door location.
8. Fire rated doors shall have components and assemblies meeting requirements of the American Insurance Association, Factory Mutual Insurance Association and listed by Underwriters Laboratories, Inc.

D. Acceptable Manufacturers:

1. Cesco.
2. Karp Associates, Inc.
3. Meadowcraft, Inc.
4. Milcor Div; Inryco Inc.
5. Nystrom, Inc.

PART 3 - EXECUTION

3.1 INSTALLATION OF MOTORS AND STARTERS

- A. Install motors on motor mounting systems in accordance with motor manufacturer's instructions, securely anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 hp and less may be secured with Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.
- B. Install starters and wiring devices securely supported and anchored, and in accordance with manufacturer's installation instructions. Locate for proper operational access, including visibility, and for safety.
- C. Install control connections for motors to comply with NEC and applicable provisions of Division-16 sections.

3.2 ACCESS TO MECHANICAL WORK

A. Installation:

1. Deliver access doors to General Contractor for installation and provide instructions for their location. Exact location of access doors to be as directed by Mechanical Contractor and Architect/Engineer.
2. Furnish all access doors whether shown or not.
3. Comply with manufacturer's instructions for installation of access doors.
4. Coordinate installation with work of other trades.
5. Set frames accurately in position and securely attach to supports with face panels plumb or level in relation to adjacent finish surfaces.
6. Install access doors for the following concealed equipment:

- a. Shock absorbers (bellows type only).
- b. Valves.
- c. Control devices.
- d. Fire dampers and fire/smoke dampers.
- e. Coils.
- f. Other mechanical equipment requiring service.

B. Adjust and Clean:

1. Adjust hardware and panels after installation for proper operation.
2. Remove and replace panels or frames that are warped, bowed, or otherwise damaged.

3.3 EXCAVATING FOR MECHANICAL WORK

- A. General: Do not excavate for mechanical work until work is ready to proceed without delay, so that total time lapse from excavation to completion of backfilling will be minimum.
- B. All trenches deeper than the footing of any building or structure and paralleling the same shall be at least forty-five (45) degrees therefrom, unless permission is otherwise granted by the Administrative Authority and Structural Engineer.
- C. Excavation for Trenches: Dig trenches to uniform width required for particular item to be installed, sufficiently wide to provide ample working room. Provide 6" to 9" clearance on both sides of piping:
 1. Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations. Beyond building perimeter, keep bottoms of trenches sufficiently below finish grade to avoid freeze-ups.
 2. Where rock is encountered, carry excavation 6" below required elevation and backfill with 6" layer of 3/4" gravel prior to installation of pipe.
 3. Where bedding is required, backfill with sand 6" below and 6" above pipe.
 4. For piping 5" or less in nominal size, do not excavate beyond indicated depths. Hand excavate bottom cut to accurate elevations and support piping on undisturbed soil.
 5. For piping 6" and larger in nominal size, tanks, and other mechanical work indicated to receive sub-base, excavate to sub-base depth indicated, or if not otherwise indicated, to 6" below bottom of work to be supported.
 6. Grade bottoms of trenches as indicated, notching under piping couplings to provide solid bearing for entire body of piping.
- D. Shape sub-bases and bottoms of excavations with recesses to receive pipe bells, flanged connections, valves and similar enlargements in piping systems.

3.4 BACKFILLING

- A. Do not backfill until installed mechanical work has been tested and accepted, wherever testing is indicated.
- B. All excavations shall be completely backfilled as soon after inspection as practical. Adequate precaution shall be taken to insure proper compactness (95% density) of backfill around piping without damage to such piping. Trenches shall be backfilled in thin layers to twelve (12) inches (0.3m) above the top of the piping with clean earth which shall not contain stones, boulders, cinderfill, or other materials which would damage or break the piping or cause corrosive action. Mechanical devices such as bulldozers, graders, etc., may then be used to complete backfill to grade. Fill shall be properly compacted (95%

density). Suitable precautions shall be taken to insure permanent stability for pipe laid in filled or made ground. For testing and backfill material see Division 2 - Site Work.

3.5 CUTTING AND PATCHING

- A. Openings in New Construction – Provisions for New Openings: Verify all openings required in the new construction in connection with the work under Division 15 with the Architectural and Structural Drawings. Meet with and verify same with the General Contractor/Construction Manager who will assign the work to the appropriate contractor to provide all openings in the new construction of the correct size and location in walls, floors or through roofs required for the installation of the mechanical work.
- B. Cutting in New Construction: Failure on the part of the Division 15 Contractor to make the above arrangements for required openings shall cause the cost of cutting and patching for the necessary openings or the installation of his work to be borne by him, either by having the cutting done by the appropriate contractor as assigned by the General Contractor or in the form of performing the required cutting himself. In either case, all patching shall be done by the appropriate finishing contractor as determined by the General Contractor. No cutting or drilling of holes shall be done without approval of the Architect/Engineer.
- C. Patching in New Construction:
 - 1. The appropriate finishing contractor as determined by the General Contractor shall patch all openings in the new structure. All openings made in fire-rated walls, floors, or ceilings, shall be patched and made tight to conform to the fire rating for the enclosure. All materials used in patching shall match the materials specified in the Architectural Specifications and all patched areas shall be restored to the specified finish surface to the satisfaction of the Architect.
 - 2. The Division 15 Contractor shall pay the appropriate Finishing Contractor as determined by the General Contractor for all patching resulting from cutting to accommodate mechanical work.

3.6 HEATING SYSTEM USED FOR TEMPORARY HEAT DURING CONSTRUCTION

- A. Permanent heating system shall not be used unless approved in writing.
- B. If for any reason the heating system has been placed into operation, it shall not be shut down except for moderate weather, and all heated areas shall be maintained at a minimum temperature of 50°F, 24 hours a day. Building must be totally enclosed; no temporary barriers.
- C. When any air-handling equipment is used for temporary heat, the filters shall be installed and maintained. Before building acceptance by Owner, these units shall be thoroughly cleaned and new filters shall be installed. This is over and above the set of filters to be provided the Owner as called for in the specifications. Coils shall be cleaned if necessary, as determined by the Architect or Engineer:
 - 1. Any and all systems being used for temporary heat shall become the contractor's responsibility to maintain, and be put into first class working order before acceptance by the Owner.
 - 2. Any guarantees that start with the use of equipment for temporary heat shall be personally extended by the contracting firm holding the prime contract for construction, so that the Owner will have his one-year guarantee from date of acceptance.

END OF SECTION 15045

SECTION 15060 - PIPES, VALVES AND PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

- A. Types of equipment specified in this section include the following:
 - 1. Pipes and Pipe Fittings.
 - 2. Valves.
 - 3. Pipes Specialties.
 - 4. Supports and Anchors.
 - 5. Gages.

1.3 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. Welding: Qualify welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9, as applicable, for shop and project site welding of piping work.
 - 2. Brazing: Certify brazing procedures, brazers, and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, for shop and job-site brazing of piping work.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. Shall be of material, weight, ASTM and ANSI Designation, and pressure ratings as follows unless specifically excepted otherwise.
- B. Above Ground Storm Drain, Waste, and Vent Piping:
 - 1. Pipe Size 10" and Smaller: Hubless cast-iron soil pipe; Service weight; Hubless cast-iron soil pipe fittings.
 - a. Hubless Joints:
 - 1) Standard couplings equal to CISPI 310 on all piping unless otherwise noted.
 - 2) Heavy duty couplings with 304 stainless steel band, bolts, etc. on the following piping:
 - a) Roof drain, overflow drain and storm drain piping with more than 10 of developed hydrostatic head.

- b) Drainage piping above computer related rooms.
 - 2. Pipe size 1 1/2" and Smaller: DWV copper with DWV pattern solder joints.
- C. Underground Storm Drain and Building Drain Piping to 5 Feet Beyond Building Line:
 - 1. Pipe size 8" and smaller: Schedule 40, PVC-DWV pipe with DWV drainage fitting and solvent welded joints. ASTM D-2665/ASTM D-1785.
- D. Domestic Water Service Outside of Building:
 - 1. 3" and Smaller: Type "K" hard drawn copper, all joints to be silver soldered.
- E. Domestic Hot and Cold Water Underground Inside Building: Include 10'-0" plus or minus outside of building wall.
 - 1. 2-1/2" and Under:
 - a. Pipe: Copper water tube, heavy wall thickness, annealed temper; ASTM B 88, Type K.
 - b. No fittings or joints allowed underground, below floor slabs.
 - 2. 1-1/4" and Smaller:
 - a. Pipe: PEX piping equal to Wirsbo "AquaPEX, high density polyethylene, cross linked. Must meet the following standards: ASTM F876, ASTM F877, ASTM F1807, ASTM, 1960, ASTM F2080, ANSI/NSF Standard 14 and 61.
- F. Domestic Cold Water, Hot Water, Hot Water Recirculation and Condensate Piping Above Ground Inside Building:
 - 1. 4" and Under:
 - a. Pipe: Type L, hard drawn, seamless copper tubing ASTM B 88-70.
 - b. Fittings: Wrought copper or bronze solder joint pressure type fittings per ANSI B16.22.
 - c. Joints: Canfield 100% watersafe solder. Antimony is not allowed in solder.
- G. Pool Heating Water and Pool Rooftop Unit Condensate Piping:
 - 1. Schedule 80 CPVC with solvent welded joints. Shall not be located in return air plenum.
- H. Fire Protection Piping:
 - 1. Underground:
 - a. Pipe: Cast iron, 250 psi or ductile iron Class II, 250 psi, AWWA C151.
 - b. Fittings: Cast iron and ductile iron pipe fittings shall correspond to pipe in material, Class and ASTM designation.
 - c. Joints: Mechanical joint type, complete with set screw retaining glands.
 - 2. Schedule:

<u>PIPE SIZE</u> <u>(INCHES)</u>	<u>TYPE CAST</u> <u>IRON</u>	<u>MAXIMUM BURY</u> <u>(FEET)</u>	<u>WALL THICKNESS</u> <u>(INCHES)</u>
4 thru 8	18/40	16	0.32 thru 0.44

3. Interior and Exterior Above-ground Piping:
 - a. Pipe and Joints:
 - 1) Black steel and/or galvanized steel threaded, welded or roll grooved schedule 40 conforming to ASTM A-53. Light wall conforming to ASTM A-135 equal to Dyna Thread, or replacement Schedule 10 equal to American Tube Dyna-Flow ASTM-795. All threaded piping shall meet a threaded CRR equal to 1.00 or better, 300 psi max. system pressures. All pipe shall conform to NFPA #13, Chapter 3 and shall be UL/FM approved.
 - b. Fittings:
 - 1) Threaded cast iron 175 psi minimum and in accordance with developed system pressures, conforming to ANSI B16.4. Threaded malleable iron 175 psi minimum and in accordance with developed system pressures, conforming to ANSI B16.3.
 - 2) Weld type fittings (schedule 40 pipe only): Buttweld conforming to ANSI B16.9. Flanges conforming to ANSI B16.25. Socket weld conforming to ANSI B16.11. All welds by certified welder in accordance with Section 15060.
 - 3) Grooved fittings shall conform to ASTM-A47 (malleable), ASTM 536 (ductile), or ASTM-106 GRB (forged steel), ASTM A-53 type E, F, or S GRB (nipples), ANSI B-16.5 or B16.1 cast iron and carbon steel flanges.
- I. Natural Gas and Natural Gas Relief Vent Piping, Above Ground Inside Building:
 1. Pipe: Schedule 80 for pipe sizes 1/2" and under; Schedule 40 for pipe sizes over 1/2", black seamless steel pipe per ASTM A53.
 2. Fittings:
 - a. 1/2" and Under: 300 pound malleable iron flat banded pattern screwed fittings per ANSI B16.3.
 - b. Over 1/2" thru 2": Same as above except 150 pound class, screwed or welding fittings per joints below. Welded and/or sleeved only in return air plenum.
 - c. Over 2": Schedule 40, seamless carbon steel welding fittings, long radius, 150 pound class, dimensions per ANSI B16.9-1971; ASTM A 234-73, Grade WPB.
 3. Joints:
 - a. 2" and Under: Threaded using joint compound resistant to gas-air mixture.
 - b. 2-1/2" and Above: Butt-welded.
 - c. Note: Weldolets, Threadolets, Sockolets, where permitted by authorities having jurisdiction may be used in lieu of standard fittings on natural gas piping.
- J. Sump Pump and Sewer Ejector Discharge:
 1. Pipe: Galvanized steel pipe, ASTM A53 or DWV copper tube, ASTM B306.
 2. Fittings: Malleable iron threaded fittings, ANSI B16.3, or square grooved fittings, ASTM A234, for grooved mechanical couplings; cast copper solder joint drainage fittings, ANSI B16.23 with silver soldered joints.
- K. Foundation Drainage Pipe, Fittings, and Accessories:
 1. Perforated Polyvinyl Chloride Pipe (PVC): ASTM D 2729; perforated except where standard sections of pipe are indicated. Install with perforation located on top of pipe.

2. Fittings and Accessories for Foundation Drainage Pipe: Unless otherwise indicated, provide fittings matching and of same material as pipe units; comply with same standards, where applicable, except fittings need not be perforated where pipe is required to be perforated.

2.2 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

- A. Welding Materials: Except as otherwise indicated, provide welding materials as determined by Installer to comply with installation requirements.
 1. Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.
- B. Soldering Materials: Except as otherwise indicated, provide soldering materials as determined by Installer to comply with installation requirements.
 1. Tin-Antimony Solder: ASTM B 32, Grade 95TA.
 2. Canfield 100% Water Safe. "No Antimony."
- C. Brazing Materials: Except as otherwise indicated, provide brazing materials as determined by Installer to comply with installation requirements.
 1. Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials.
- D. Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast- iron flanges; raised-face for steel flanges, unless otherwise indicated.
- E. Piping Connectors for Dissimilar Non-Pressure Pipe: Elastomeric annular ring insert, or elastomeric flexible coupling secured at each end with stainless steel clamps, sized for exact fit to pipe ends and subject to approval by plumbing code.
 1. Acceptable Manufacturers:
 - a. Fernco, Inc.
 - b. Indiana Seal

2.3 VALVES

- A. General: Provide valves of types and pressure ratings indicated; provide proper selection as determined by Installer to comply with installation requirements. Provide end connections which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option. Valves shall be manufactured in accordance with all applicable M.S.S. Standards.
- B. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.
- C. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves, 6" and smaller, other than plug valves. Provide one wrench for every 10 plug valves.
- D. Acceptable Manufacturer's
 1. Gate Valves, Globe Valves and Swing Check Valves:
 - a. Crane/Stockham.

- b. Hammond/Milwaukee Valve Corp.
 - c. Kitz Corp.
 - d. Nibco, Inc.
 - e. Watts.
2. Drain Valves:
- a. Apollo.
 - b. Hammond/Milwaukee Valve Corp.
 - c. Kitz Corp.
 - d. Nibco, Inc.
3. Gas Plug Valves:
- a. DeZurik Co.
 - b. Walworth Co.
4. Gas Cocks:
- a. Conbraco/Apollo.
 - b. DeZurik Corp.
 - c. Kitz Corp.
 - d. Nibco.
5. Ball Valves:
- a. Apollo.
 - b. Hammond/Milwaukee Valve Corp.
 - c. Kitz Corp.
 - d. Nibco, Inc.
 - e. Watts Co.
6. Wafer Check Valves:
- a. Centerline.
 - b. Mission.
 - c. Techno.
7. Lift Check Valves:
- a. Hammond/Milwaukee Co.
 - b. Nibco.
 - c. Stockham/Crane.
8. Balance Valve (2" and smaller Venturi Type):
- a. Flowset-Flow Design Inc.
 - b. Gerand.
 - c. Preso.
 - d. Griswold
9. Balance Valve (2" and smaller variable CV orifice type):
- a. Armstrong.
 - b. Bell & Gossett.

- c. Tour – Anderson.
- 10. Balance Valve (2 1/2" and larger eccentric ball design):
 - a. Milliken.
- 11. Balance Valve (2 1/2" and larger plug valve type):
 - a. Dezurik.
 - b. Rockwell.
- 12. Reduced Pressure Backflow Preventer:
 - a. Conbraco.
 - b. Febco Sales, Inc.
 - c. Watts.
 - d. Zurn/Wilkins.
- 13. Double Check Backflow Preventer:
 - a. Conbraco.
 - b. Febco Sales, Inc.
 - c. Watts.
 - d. Zurn/Wilkins.
- E. Valve Features:
 - 1. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features as determined by Installer for installation requirements. Comply with ASME B31.9 for building services piping, and ASME B31.1 for power piping.
 - 2. Flanged: Valve flanges complying with ANSI B16.1 (cast iron), ANSI B16.5, (steel), or ANSI B16.24 (bronze).
 - 3. Threaded: Valve ends complying with ANSI B2.1.
 - 4. Butt-Welding: Valve ends complying with ANSI B16.25.
 - 5. Solder-Joint: Valve ends complying with ANSI B16.18.
 - 6. Flangeless: Valve bodies manufactured to fit between flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).
- F. Valve Schedule:
 - 1. General: Provide the following valves for various valve types referenced in Division-15 sections.
 - 2. Gate Valves (Fire Protection Only):
 - a. 2" and Smaller: 125 lb. SWP, bronze, screw-in bonnet, rising stem, solid wedge. Conform to MSS SP-80.
 - 1) Hammond/Milwaukee – Threaded Ends: 148.
 - 2) Hammond/Milwaukee – Solder Ends: 149.
 - b. 2" and Smaller: 125 lb. SWP, bronze screw-in bonnet, non-rising stem, solid wedge. Conform to MSS SP-80.
 - 1) Hammond/Milwaukee – Threaded Ends: 105.
 - 2) Hammond/Milwaukee – Solder Ends: 115.

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- c. 2-1/2" and Larger: Flanged ends, 125 lb. SWP, iron body, bolted bonnet, solid wedge, bronze mounted. Conform to MSS SP-70.
 - 1) Hammond/Milwaukee – OS & Y: F-2885.
- d. Threaded End; 2" and Smaller: FM, UL-listed, 175 psi, bronze body solid wedge, outside screw and yoke, rising stem.
 - 1) Nibco: T-104-0.
- e. Flanged End; 2-1/2" and Larger: FM, UL-listed, 175 psi, iron body bronze mounted, solid wedge, outside screw and yoke, rising stem.
 - 1) Nibco: F-607-0.
- 3. Globe Valves:
 - a. 2" and Smaller: 125 lb. SWP, bronze body, screw-in bonnet, integral seat, renewable disc. Conform to MSS SP-80.
 - 1) Hammond/Milwaukee – Threaded Ends: 502.
 - 2) Hammond/Milwaukee – Solder Ends: 1502.
- 4. Drain Valves:
 - a. 125 lb. SWP: Bronze body, screw-in bonnet, rising stem, composition disc, 3/4" hose outlet, provide cap and chain. Conform to ASSE 1005.
 - 1) Nibco – Threaded End: 73.
 - 2) Nibco – Solder Ends: 72.
- 5. Ball Valves:
 - a. 2" and Smaller: 600 WOG/150 SWP, bronze body, full port, bronze trim, 2-piece construction, TFE seats and seals.
 - 1) Apollo – Threaded Ends: 77C-100.
 - 2) Apollo – Solder Ends: 77C-200.
 - b. 2-1/2" thru 4": 400 WOG/150 SWP, bronze body, full port, 2- or 3-piece body, PTFE seats with bronze trim.
 - 1) Apollo – Threaded Ends: 82-100.
 - 2) Apollo – Solder Ends: 82-200.
- 6. Swing Check Valves:
 - a. 3" and Smaller: 125 lb. SWP, bronze body, horizontal swing, straight pattern flow renewable disc. Conform to MSS SP-80.
 - 1) Nibco – Threaded Ends: T-433.
 - 2) Nibco – Solder Ends: S-433.
 - b. 2-1/2" and Larger FM: 175 psi, iron body, teflon disc, bronze mounted, renewable composition disc and bronze seat ring, bolted cover, flanged ends.

- 1) Crane/ Stockham: G-940.
7. Wafer Check Valves:
- a. All Sizes: 125 psi, cast-iron body, aluminum bronze or plated iron plates, stainless steel stem, Buna-N seat, stainless steel springs.
 - 1) Center Line: CLC.
 - 2) Mission: 12HMP.
 - 3) Crane/Jenkins/Stockham: WG970.
 - 4) Techno 5050.
 - 5) Grooved Ends: Victaulic Series 711.
8. Lift Check Valves:
- a. 2" and Smaller: 125 psi, bronze body, lift type, spring loaded, renewable disc, threaded ends. Conform to FCI74-1 for design, rating and testing.
 - 1) Crane/Jenkins/Stockham – Horizontal: 655-A.
 - 2) Crane/Jenkins/Stockham – Angle: 118-A.
9. Gas Plug Valve:
- a. 2" and Smaller: 150 psi, cast-iron body, straightaway pattern, square bronze head, threaded ends.
 - 1) DeZurik: 425.
 - b. 2-1/2" and Larger: 175 psi, lubricated or permanently lubricated plug type, semi-steel body, single gland, wrench operated, flanged ends.
 - 1) DeZurik: 118.
 - 2) Nordstrom: 143.
 - 3) Powell: 2201.
10. Gas Cocks:
- a. Gas Cocks 3" and Smaller: 250 psi non-shock WOG, bronze ball valve with chrome plated ball, threaded ends, UL listed.
 - 1) Nibco: T-580-70-UL-842.
 - 2) Apollo: 80-100
 - b. Gas Cocks 4" and Larger: 175 psi non-shock WOG, iron body nickel plated, corrosion resistant plug, flanged ends, lever handle.
 - 1) Dezurik: 425
11. Balance Valves:
- a. 2" Size and Smaller: Provide balance valves equipped with readout valves to facilitate connecting of differential pressure meter to balance valves. Equip each readout valve with integral EPT check valve designed to minimize system fluid loss during monitoring process. Provide calibrated nameplate to indicated degree of closure of precision machined orifice. Construct balancing valve with internal EPT o-ring seals to prevent leakage around

rotating element. Provide balance valves with preformed polyurethane insulation suitable for use on heating and cooling systems, and to protect balance valves during shipment.

- 1) Acceptable Manufacturers:
 - a) Armstrong.
 - b) Bell & Gossett, ITT; Fluid Handling Div.
 - c) Tour-Anderson.

b. 2" and Smaller: One piece, non-ferrous, bronze/brass flow measuring and balancing/shutoff valve combination. The flow element shall be a low loss/high signal Venturi type (\pm 2% accuracy) of one to ten rangeability, equipped with dual Schrader Type pressure test posts and caps. Balancing/shutoff valves shall be Ball type with large diameter plated ball, teflon seats, blow out proof stem with teflon packing and packing nut. Full size handle, grip and memory stop. Entire assembly rated to 400 WOG and tested to 100% after assembly.

- 1) Provide one gauge kit consisting of Bellows Type meter capable of reading flow directly in GPM using magnetically attached transparent faces. Meter equipped with 6 ft. hoses, Schrader Type end connectors, bleed and equalizing manifold and rugged plastic case with instructions.
- 2) Acceptable Manufacturers:
 - a) Gerand Co.
 - b) Flow Design-Flowset.
 - c) Preso.
 - d) Griswold (manually adjusted valves only).

c. 2 1/2" and Larger: Provide cast-iron body with ball centric or plug valve design. Locate downstream of all flow measuring stations or as recommended by manufacturer.

- 1) Acceptable Manufacturers:
 - a) Milliken - Ball Centric.
 - b) Dezurik - 400 Series (to 4").

12. Reduced Pressure Backflow Preventer:

a. Provide reduced pressure principle backflow preventers consisting of assembly including shutoff valves on inlet and outlet, and strainer on inlet. Backflow preventers shall include test cocks, and pressure-differential relief valve located between 2 positive seating check valves. Provide funnel drain assembly and airgap drain to floor drain. Construct in accordance with ASSE Standard 1013, and is USC approved.

- 1) FEBCO Co. #880, #880V or #860.

13. Double Check Backflow Preventer:

a. Provide double check assembly consisting of a "Y" pattern design incorporating two spring loaded check valve assemblies, inlet and outlet shutoff valves. Construct in accordance with USC, ASSE 1015, AWWA C-510, and CSA B645. Shall be U.L. and FM approved.

- 1) FEBCO Co. #870, #870V and #850.

2.4 PIPING SPECIALTIES

- A. General: Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service, or if not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option.
- B. Pipe Escutcheons:
1. General: Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.
 2. Acceptable Manufacturers:
 - a. Chicago Specialty Mfg. Co.
 - b. Producers Specialty & Mfg. Corp.
 - c. Sanitary-Dash Mfg. Co.
- C. Strainers:
1. General: Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125 psi working pressure, with Type 304 stainless steel screens, with 3/64" perforations @ 233 per sq. in. as a minimum.
 - a. Threaded or Sweat Ends, 4" and Smaller in Copper Systems: Cast bronze body, screwed screen retainer with full size centered blowdown fitted with blowdown piped to nearest drain with valve.
 - b. Acceptable Manufacturers:
 - 1) Hoffman Specialty ITT; Fluid Handling Div.
 - 2) McAlear Co.
 - 3) Metraflex Co.
 - 4) Mueller Co.
 - 5) R.P. & C Co.
 - 6) Watts Regulator Co.
- D. Dielectric Fittings:
1. General: Provide standard products recommended by manufacturer for use in service indicated, which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.
 - a. Dielectric unions and flanges shall conform to ANSI and have no flow restriction when assembled. Flanges shall be rated at 175 psi and unions at 250 psi.
 - 1) Acceptable Manufacturers:
 - a) Capital MFG.
 - b) Epco Sales, Inc.
 - c) Mueller Company.
 - d) Watts Regulator.

- b. Clearflow dielectric waterway nipple, steel nipple with inert thermoplastic liner. Shall meet ASTM F-492-77.

- 1) Acceptable Manufacturers:

- a) Perfection Corporation – Victaulic.

E. Fire Barrier Penetration Seals:

- 1. Provide seals for any opening through fire-rated walls, floors, or ceilings used as passage for mechanical components such as piping or ductwork.

- a. Cracks, Voids, or Holes Up to 4" Diameter: Use putty or caulking, one-piece intumescent elastomer, non-corrosive to metal, compatible with synthetic cable jackets, and capable of expanding 10 times when exposed to flame or heat, UL-listed.

- b. Openings 4" or Greater: Use sealing system capable of passing 3-hour fire test in accordance with ASTM E-814, consisting of wall wrap or liner, partitions, and end caps capable of expanding when exposed to temperatures of 250 to 350°F (121 to 177°C), UL-listed.

- c. Acceptable Manufacturers:

- 1) Electro Products Div./3M. (Fire Barrier Systems)
- 2) Manville Products Corp.
- 3) Nelson; Unit of General Signal. (Flameseal)
- 4) Pipe Shield Incorporated.
- 5) STI.

F. Water Hammer Arresters:

- 1. General: Provide bellows or piston type water hammer arresters, pressure rated for 250 psi, tested and certified in accordance with ASSE #1010. Piston type shall have lifetime warranty and replacement without the use of an access panel.

- 2. Acceptable Manufacturers:

- a. Josam Co.
- b. PPP, Inc.
- c. Sioux Chief.
- d. Smith (Jay R.) Mfg. Co.
- e. Tyler-Wade.
- f. Watts.
- g. Zum Industries, Inc.; Hydromechanics Div.

2.5 FABRICATED PIPING SPECIALTIES

A. Drip Pans: Provide drip pans fabricated from corrosion-resistant sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top, either by structural angles or by rolling top over 1/4" steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1" drain line connection.

B. Pipe Sleeves: Provide pipe sleeves of one of the following:

- 1. Sheet-Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gages: 3" and smaller, 20 gage; 4" to 6" 16 gage; over 6", 14 gage.
- 2. Steel-Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.

3. Iron-Pipe: Fabricate from cast-iron or ductile-iron pipe; remove burrs.
4. Plastic-Pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.

C. Sleeve Seals: Provide sleeve seals in sleeve as follows:

1. Below grade in foundation wall or exterior walls above grade.
 - a. Link seal.
 - b. Innerlynx
2. Penetration below grade thru floor.
 - a. Provide elastomeric joint sealant to maintain watertight and airtight continuous seal.
3. Penetrations thru walls, floors, or ceilings above grade.
 - a. Intumescent fire stop.

2.6 HANGERS AND SUPPORTS

A. References:

1. ASTM B633 – Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
2. ASTM A123 – Specification for Zinc (Hot Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
3. ASTM A653 G90 – Specification for Steel Sheet, Zinc Coated by the Hot-Dip Process.
4. MSS SP58 – Manufacturers Standardization Society: Pipe Hangers and Supports – Materials, Design and Manufacture.
5. MSS SP69 – Manufacturers Standardization Society: Pipe Hangers and Supports – Selection and Application.
6. NFPA 13 – Standard for the Installation of Sprinkler Systems.

B. Quality Assurance:

1. Hangers and supports used in fire protection piping systems shall be listed and labeled by Underwriters Laboratories.
2. Steel pipe hangers and supports shall have the manufacturer's name, part number, and applicable size stamped in the part itself for identification.
3. Hangers and supports shall be designed and manufactured in conformance with MSS SP58.
4. Supports for sprinkler piping shall be in conformance with NFPA 13.

C. Horizontal-Piping Hangers and Supports:

1. General: Except as otherwise indicated, provide factory- fabricated horizontal-piping hangers and supports selected by Installer to suit horizontal-piping systems. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide baked on epoxy paint hangers and supports for copper piping systems.

D. Vertical-Piping Clamps:

1. General: Except as otherwise indicated, provide factory- fabricated vertical-piping clamps complying with MSS SP-58 selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping

clamps to exactly fit pipe size of bare pipe. Provide baked on epoxy paint clamps for copper-piping systems.

E. Hanger-Rod Attachments:

1. General: Except as otherwise indicated, provide factory- fabricated hanger-rod attachments complying with MSS SP-58 selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.

F. Building Attachments:

1. General: Except as otherwise indicated, provide factory- fabricated building attachments complying with MSS SP-58 selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods.

G. Finishes:

1. Indoor Finishes:

- a. Hangers and clamps for support of bare copper piping shall be coated with copper colored epoxy paint. Additional PVC coating of the epoxy painted hanger shall be used where necessary.
- b. Hangers for other than bare copper pipe shall be zinc plated in accordance with ASTM B633 or shall have an electrodeposited epoxy finish.
- c. Strut channels shall be pre-galvanized in accordance with ASTM A653 G90 or have an electrodeposited epoxy finish.

2. Outdoor and Corrosive Area Finishes:

- a. Hangers and strut located outdoors shall be hot dip galvanized after fabrication in accordance with ASTM A123. All hanger hardware shall be stainless steel. Zinc plated hardware is not acceptable for outdoor or corrosive use.
- b. Hangers and strut located in corrosive areas shall be electrodeposit epoxy finish with stainless steel hardware.

H. Manufacturers of Hangers and Supports (Acceptable Manufacturers):

1. B-Line Systems Inc.
2. Grinnel Corp.
3. Superstrut.

I. Saddles and Shields:

1. General: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
2. Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation or manufacturers pre-insulated type.
3. Protection Shields: MSS Type 40; of length per schedule below to prevent crushing of insulation. Provide coated projection shields on cold/ chilled water piping.

a. Schedule:

<u>Nominal Pipe or Tubing Size</u>	<u>Shield Length</u>	<u>Shield Gauge Thickness</u>	<u>Material</u>
½" thru 3"	12"	18	Galvanized
4"	12"	16	Galvanized

4. Thermal Hanger Shields: MSS Type 40 Constructed of an insert of high density, 100 psi, water-proofed calcium silicate, encased in a sheet metal shield. Provide assembly of same thickness as adjoining insulation. The style of thermal hanger shield assembly shall be determined by shield manufacturer based on hanger type.

5. Acceptable Manufacturers:

- a. Pipe Shields, Inc.
- b. Value Engineering Products, Inc.

2.7 MISCELLANEOUS MATERIALS

A. Metal Framing:

- 1. Supplementary Structural Supports: Design and fabricate supports using structural quality steel bolted framing materials as manufactured by B-Line Systems. Channels shall be roll formed, 12 gauge ASTM A570 Grade 33 steel, 1 5/8" x 1 5/8" or greater as required by loading conditions. Submit designs for pipe tunnels, pipe galleries, etc., to Engineer for approval. Use clamps and fittings designed for use with the strut system.

B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.

- C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

D. Trapeze Hangers:

- 1. Trapeze hangers shall be constructed from 12 gauge roll formed ASTM A570 Gr. 33 structural steel channel, 1 5/8" x 1 5/8" minimum. B-Line B22 strut or stronger as required.
- 2. Mount pipes to trapeze with 2 piece pipe straps sized for outside diameter of pipe, B-Line B2000 Series.
- 3. For pipes subjected to axial movement:
 - a. Strut mounted roller support, B-Line B3126. Use pipe protection shield or saddles on insulated lines.
 - b. Strut mounted pipe guide, B-Line B2417.

- E. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

- F. Pipe Guides: Provide factory-fabricated guides, of cast semi- steel or heavy fabricated steel, consisting of bolted two- section outer cylinder and base with two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

2.8 GLASS THERMOMETERS

- A. General: Provide glass thermometers of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
- B. Case: Die cast aluminum finished in baked epoxy enamel, glass front, spring secured, 9" long.
- C. Adjustable Joint: Die cast aluminum, finished to match case, 180°F adjustment in vertical plane, 360 degrees adjustment in horizontal plane, with locking device.
- D. Tube and Capillary: Organic filled "red" color, magnifying lens, 1% scale range accuracy, shock mounted.
- E. Scale: Satin faced, non-reflective aluminum, permanently etched markings.
- F. Stem: Copper-plated steel, or brass, for separable socket, length to suit installation.
- G. Range: Conform to the following:
 - 1. Hot Water: 30° - 240°F with 2°F scale divisions.
- H. Acceptable Manufacturers:
 - 1. Ernst Gage Co.
 - 2. Marshalltown Instruments, Inc.
 - 3. Taylor.
 - 4. Trerice (H.O.) Co.
 - 5. Weiss Instruments, Inc.
 - 6. Winters Thermogauge.

2.9 THERMOMETER WELLS

- A. General: Provide thermometer wells constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2" extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.
- B. Manufacturer: Same as thermometers.

2.10 PRESSURE AND TEMPERATURE GAGE CONNECTOR PLUGS

- A. General: Provide temperature and pressure gage connector plugs pressure rated for 500 psi and 275°F. Construct of brass and finish in nickel-plate, equip with 1/2" NPT fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8" O.D. probe assembly from dial type insertion thermometer or pressure gauge. Equip orifice with gasketed screw cap and retaining strap. Provide extension, length equal to insulation thickness, for insulated piping.
- B. Acceptable Manufacturers:
 - 1. Peterson Equipment Co.

2.11 PRESSURE GAGES

- A. General: Provide pressure gages of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
- B. Type: General use, 1% accuracy, ANSI B40.1 grade A, phosphor bronze bourdon type, bottom connection.
- C. Case: Drawn steel or brass, glass lens, 4 1/2" diameter.
- D. Connector: Brass with 1/4" male NPT. Provide protective syphon when used for steam service.
- E. Scale: White coated aluminum, with permanently etched markings.
- F. Range: Conform to the following:
 - 1. Water: 0 - 100 psi.
- G. Acceptable Manufacturers:
 - 1. Ametek/U.S. Gauge.
 - 2. Marsh Instrument Co.; Unit of General Signal.
 - 3. Marshalltown Instruments, Inc.
 - 4. Trelice (H.O.) Co.
 - 5. Weiss Instruments, Inc.
 - 6. Winters Thermogauge.

2.12 PRESSURE GAGE COCKS

- A. General: Provide pressure gage cocks between pressure gages and gage tees on piping systems. Construct gage cock of brass with 1/4" female NPT on each end, and "T" handle brass plug.
- B. Snubber: 1/4" brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.
- C. Manufacturer: Same as for pressure gages.

2.13 FLOW MEASURING STATIONS (VENTURI)

- A. Furnish and install where shown on drawings or indicated elsewhere, complete Venturi Flow Measuring System. This shall be a coordinated system, including individual Venturi Flow Stations and Portable Master Meter, supplied by one manufacturer.
- B. Each primary flow element shall be a Venturi selected from a manufacturer's engineering data to permit prescribed flow at a minimum of head loss. For maximum accuracy and minimal turbulence in recovery area and thus, low pressure loss, Venturis shall have minimum length of 1.6 x pipe diameter. The beta ratio shall be selected to allow for a differential pressure compatible with the meter as specified herein and insure a properly calibrated system accuracy within 1% throughout the entire range. This accuracy must be obtained with as little as five (5) pipe diameters of straight pipe upstream and two (2) diameters downstream from the Venturi. Each Venturi shall be furnished with two (2) accurately located built-in sensing taps, nipples, shut-off valves, and quick connect couplings. Venturis shall be complete with identification tag on chain, giving pipe size, Venturi series, station identification and meter reading at specified flow rate, flow vs. differential curves and installation instructions.

- C. Sizes 2-1/2" through 8" shall consist of one-piece cadmium-plated cast steel Venturi with weld neck or flanged ends with balance valve downstream per this specification.
- D. Venturi sizes and beta ratios shall be selected so that design flow rates shall read between 20% and 80% of the full scale range on a linear meter with permanent pressure loss of not more than 25% of indicated flow rate differential pressure.
- E. The indicating meter shall be portable type with 6" round dial, 270° indication. It shall be the dual rupture-proof liquid-filled bellows type with integral temperature compensation. The meter shall have over-range protection in either direction equal to the working pressure equivalent of the instrument housing (250 psig at 250°F). The accuracy of the meter shall be no less than 0.5% full scale. The meters case shall be waterproof and coated with appropriate paint. It shall have external zero and range-adjusting screws and life-long lubrication. Scale shall be calibrated uniformly either in differential pressure, percent of flow, or directly in gpm.
 - 1. Portable Master Meters shall be mounted in a durable metal reinforced plastic carrying case with the following accessories:
 - a. Two 10" lengths of connecting hose, each with color coded quick connect couplings compatible with the Venturi couplings.
 - b. Two brass blow-down valves with Buna-N seals.
 - c. Blow-down hoses.
 - d. Instruction book with flow vs. differential curves.
- F. Acceptable Manufacturers:
 - 1. Barco.
 - 2. Flow Design
 - 3. Gerand.
 - 4. Griswold.
 - 5. Preso.

PART 3 - EXECUTION

3.1 PIPE AND PIPE FITTING INSTALLATION

- A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16" misalignment tolerance.
- B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, columns and other structural and permanent-enclosure elements of building; limit clearance to 1/2" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1" clearance outside insulation. Wherever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.

- C. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures unless unavoidable. Install drip pan under piping that must be run through electrical spaces.
- D. Painting of Pipe: Paint all exterior steel piping (gas, condenser, chilled water, etc.) with a rust inhibitor paint. Coordinate color with architect prior to painting.

3.2 PIPING SYSTEM JOINTS

- A. General: Provide joints of type indicated in each piping system.
- B. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
- C. Braze copper tube-and-fitting joints where indicated, in accordance with ASME B31.
- D. Solder copper tube-and-fitting joints where indicated, in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Use only flux with no lead content. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.
- E. Weld pipe joints in accordance with recognized industry practice and as follows:
 - 1. Weld pipe joints only when ambient temperature is above 0°F (-18°C) where possible.
 - 2. Bevel pipe ends at a 37.5 degree angle where possible, smooth rough cuts, and clean to remove slag, metal particles and dirt.
 - 3. Use pipe clamps or tack-weld joints with 1" long welds; 4 welds for pipe sizes to 10", 8 welds for pipe sizes 12" to 20".
 - 4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes and non-metallic inclusions.
 - 5. Do not weld-out piping system imperfections by tack-welding procedures; re-fabricate to comply with requirements.
 - 6. At Installer's option, install forged branch-connection fittings wherever branch pipe is indicated; or install regular "T" fitting.
 - 7. Clean all welded joints and apply prime coat rust inhibitor.
- F. Weld pipe joints of steel water pipe in accordance with AWWA C206.
- G. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.
- H. Hubless Hub & Spigot, Cast-Iron Joints: Comply with coupling manufacturer's installation instructions.
- I. Plastic Pipe/Tube Joints: Comply with manufacturer's instructions and recommendations, and with applicable industry standards.

3.3 INSTALLATION OF FLOW MEASURING STATIONS

A. Install at the following locations:

1. Upstream of all balancing valves 2½" and larger (except in balancing valve(s) located in the bypass line of a 3-way control valve).
2. Discharge of each pump prior to discharge balancing valve.
3. Discharge of each chiller (one on evaporator side and one on condenser side.)

3.4 INSTALLATION OF VALVES

A. General: Except as otherwise indicated, comply with the following requirements:

1. Install valves where required for proper operation of piping and equipment, including valves in all branch lines to isolate sections of piping whether shown or not. Branch lines will be considered any line connecting to the main piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.

B. Shutoff Valves: Install on inlet and outlet of each mechanical equipment item, and elsewhere as indicated.

C. Drain Valves: Install on each mechanical equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere where indicated or required to completely drain hydronic piping system.

D. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

E. Mechanical Actuators: Install mechanical actuators with chain operators where indicated. Extend chains to about 5' above floor and hook to clips to clear aisle passage.

F. Valve System: Select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.

G. Non-Metallic Disc: Limit selection and installation of valves with non-metallic discs to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.

H. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

I. Fluid Control: Except as otherwise indicated, install ball, globe, and butterfly valves to comply with ANSI B31.9. Where throttling is indicated or recognized as principal reason for valve, install globe or butterfly valves.

J. Installation of Check Valves:

1. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.
2. Wafer Check Valves: Install between 2 flanges in horizontal or vertical position, position for proper direction of flow.
3. Lift Check Valve: Install in piping line with stem vertically upward, position for proper direction of flow.

3.5 INSTALLATION OF PIPING SPECIALTIES

- A. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration thru floors, walls, partitions, and ceilings where penetration is exposed to view; and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surface.
- B. Y-Type Strainers: Install Y-type strainers full size of pipeline, in accordance with manufacturer's installation instructions. Install pipe nipple and shutoff valve in strainer blow down connection, full size of connection, except for strainers 2" and smaller installed ahead of control valves feeding individual terminals. Where indicated, provide drain line from shutoff valve to plumbing drain, full size of blow down connection.
 - 1. Locate Y-type strainers in supply line ahead of the following equipment, and elsewhere as indicated, if integral strainer is not included in equipment:
 - a. Pumps.
 - b. Pressure reducing valves.
 - c. Main domestic water entry prior to backflow.
- C. Dielectric Unions:
 - 1. Provide dielectric pipe fittings and isolators at all connections between dissimilar metals in the domestic water, pool water, and fire protection systems to control corrosion potential caused by galvanic or electrolytic action.
 - 2. Typical locations for dielectric isolation are: water heaters, storage and pressure tanks, water conditioning equipment, pumps, changes in service piping materials, make-up connections to boiler systems, valves, flexible connectors and the like where materials of different electrode potential are joined.
 - 3. Storage tanks shall be isolated from piping and tank stands by use of anti-electrolytic and galvanic isolators.
- D. Fire Barrier Penetration Seals: Fill entire opening with sealing compound. Adhere to manufacturer's installation instructions.
- E. Water Hammer Arresters: Install in upright position, in locations and of sizes in accordance with ASSE #1010, and elsewhere as indicated.

3.6 INSTALLATION OF FABRICATED PIPING SPECIALTIES

- A. Drip Pans: Locate drip pans under piping passing over or within 3' horizontally of electrical equipment, and elsewhere as indicated. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1" drain line to drain connection, and run to nearest plumbing drain or elsewhere as indicated.
- B. Pipe Sleeves: Install pipe sleeves of types indicated where piping passes through walls, floors, ceilings, and roofs. Do not install sleeves through structural members of work, except as detailed on drawings, or as reviewed by Architect/Engineer. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion; but not less than 2 pipe sizes larger than piping run. Where insulation includes vapor-barrier jacket, provide sleeve with sufficient clearance for installation. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves. Extend floor sleeves 1/4" above level floor finish, and 3/4" above floor finish sloped to drain. Provide temporary support of sleeves during placement of concrete and other work around sleeves, and provide temporary closure to prevent concrete and other materials from entering sleeves.

1. Install sheet-metal sleeves at interior partitions and ceilings other than suspended ceilings.
2. Install iron-pipe sleeves at exterior penetrations; both above and below grade.
3. Install steel-pipe sleeves except as otherwise indicated.

C. Sleeve Seals: Install in accordance with the manufacturer's requirements.

3.7 EXPANSION LOOP INSTALLATION

A. General: Fabricate expansion loops as indicated, in locations indicated, and elsewhere as determined by Installer for adequate expansion of installed piping system. Subject loop to cold spring which will absorb 50% of total expansion between hot and cold conditions. Provide pipe anchors and pipe alignment guides as indicated, and elsewhere as determined by Installer to properly anchor piping in relationship to expansion loops.

3.8 INSTALLATION OF HANGERS AND SUPPORTS

A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings per local code. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

B. Installation of Building Attachments:

1. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69 Table 3 or local code, whichever is more stringent. Install additional hangers at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.

C. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

D. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods, or by plastic coated hangers.

E. Provisions for Movement:

1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
3. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 Pressure Piping Codes are not exceeded.

F. Insulated Piping: Comply with the following installation requirements.

1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.
2. Saddles and Shield Installation:
 - a. 3" and smaller piping: Contractor option; protection shields or thermal hanger shields. Provide on cold/chilled water a vapor barrier.
 - b. 4" and Larger: Contractors option; thermal hanger shields or protection saddles.

3.9 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31, and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.
- C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
- D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.10 EQUIPMENT SUPPORTS

- A. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.

3.11 INSTALLATION OF TEMPERATURE GAGES

- A. General: Install temperature gages in vertical upright position, and tilted so as to be easily read by observer standing on floor.
- B. Locations: Install in the following locations, and elsewhere as indicated:
 1. At inlet and outlet of each hydronic pool boiler.
 2. At outlet of each domestic hot water storage tank and temperature mixing valve.
 3. Downstream of hot water recirculation pump.
- C. Thermometer Wells: Install in piping tee where indicated, in vertical upright position. Fill well with oil or graphite, secure cap.
- D. Temperature Gage Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.

3.12 INSTALLATION OF PRESSURE AND TEMPERATURE TEST PLUGS

- A. General: Install in piping where indicated, located on pipe at the most readable position. Secure cap.

- B. For horizontal pipe, install in top half of pipe line.

3.13 INSTALLATION OF PRESSURE GAGES

- A. General: Install pressure gages in piping tee with pressure gage cock, located on pipe at most readable position.
- B. Locations: Install in the following locations, and elsewhere as indicated:
 - 1. At suction and discharge of each pump.
 - 2. At discharge of each pressure reducing valve.
 - 3. At water service and fire service entry. Prior to backflow preventer.
- C. Pressure Gage Cocks: Install in piping tee with snubber.
- D. Pressure Gage Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.

3.14 CLEANING, FLUSHING, INSPECTING

- A. General: Clean exterior surfaces of superfluous materials, and prepare for application of specified coatings (if any). Flush out systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.
 - 1. Inspect pressure piping in accordance with procedures of ASME B31.
- B. Disinfection of Domestic Water Piping System
 - 1. Disinfect water mains and water service including all new and existing inside building domestic HW, CW and HWC piping.
 - 2. Disinfection of piping and testing shall be completed a minimum of one week prior to occupancy.
 - 3. Prior to starting work, verify system is complete, flushed and clean.
 - 4. Ensure Ph of water to be treated in between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
 - 5. Inject disinfectant, free chloride in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/K residual.
 - 6. Bleed water from outlets to ensure distribution and test for disinfectant residual at a minimum 15 percent of outlets.
 - 7. Maintain disinfectant in system for 24 hours.
 - 8. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
 - 9. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
 - 10. Take samples no sooner than 24 hours after flushing, from 5 percent of outlets and from water entry, and analyze in accordance with AWWA C651.
- C. Disinfect water mains and water service including all new and existing inside building domestic HW, CW and HWC piping in accordance with the authority having jurisdiction or, if methods are not prescribed, in accordance with AWWA C651. Disinfection of piping and testing shall be completed a minimum of one week prior to occupancy.
- D. Provide a pre-start up liquid alkaline dispersant cleaner for all the flushing and cleaning of all HVAC water systems.

3.15 PIPING TESTS

- A. Test pressure piping in accordance with ASME B31.
- B. General: Provide temporary equipment for testing, including pump and gages. Test piping system before insulation is installed wherever feasible, and remove control devices before testing. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.
 - 1. Required test period is 2 hours.
 - 2. Test long runs of Schedule 40 pipe at 150 psi, except where fittings are lower Class or pressure rating.
 - 3. Test each piping system at 150% of operating pressure indicated, but not less than 25 psi test pressure.
 - 4. Test drainage piping systems at a nominal pressure of 10 ft. hydrostatic head.
 - 5. Test force drainage (pumped) piping at 50 psi.
 - 6. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.
- C. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.
- D. Drain test water from piping systems after testing and repair work has been completed.

END OF SECTION 15060

SECTION 15190 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Types of identification devices specified in this section include the following:
 - 1. Plastic Pipe Markers.
 - 2. Plastic Tape.
 - 3. Underground-Type Plastic Line Marker.
 - 4. Valve Tags.
 - 5. Valve Schedule Frames.
 - 6. Engraved Plastic-Laminate Signs.
 - 7. Plastic Tags.

PART 2 - PRODUCTS

2.1 MECHANICAL IDENTIFICATION MATERIALS

- A. General: Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.2 PLASTIC PIPE MARKERS

- A. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1.
- B. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F (52°C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
- C. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - 1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 - 2. Adhesive lap joint in pipe marker overlap.
 - 3. Laminated or bonded application of pipe marker to pipe (or insulation).
 - 4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".

- D. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
1. Laminated or bonded application of pipe marker to pipe (or insulation).
 2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2" wide, full circle at both ends of pipe marker, tape lapped 3".
 3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.
- E. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.
1. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.3 PLASTIC TAPE

- A. General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
- B. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6". Provide 2 1/2" wide tape for larger pipes.
- C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

2.4 UNDERGROUND-TYPE PLASTIC LINE MARKERS

- A. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.
1. Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape.

2.5 VALVE TAGS

- A. Brass Valve Tags: Provide 19-gage polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve number 1/2" high, and with 5/32" hole for fastener.
1. Provide 1-1/2" diameter tags.
- B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain wire link or beaded type, or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- C. Access Panel Markers: Provide manufacturer's standard 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.

2.6 VALVE SCHEDULE FRAMES

- A. General: For each page of valve schedule, providing glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

2.7 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
- B. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.8 PLASTIC TAGS

- A. General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matte finish suitable for writing, approximately 3-1/4" x 5-5/8", with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 PIPING SYSTEM IDENTIFICATION

- A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow.
 - 1. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.
- B. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
 - 1. Near each valve and control device.
 - 2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - 3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
 - 4. At access doors, manholes and similar access points which permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.

6. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

3.3 UNDERGROUND PIPING IDENTIFICATION

- A. General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.4 VALVE IDENTIFICATION

- A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.
- B. Mount valve schedule frames and schedules in boiler rooms where indicated or, if not otherwise indicated, where directed by Architect/Engineer.

3.5 MECHANICAL EQUIPMENT IDENTIFICATION

- A. General: Install engraved plastic laminate sign on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. When more than one HVAC unit is present, it shall be permanently identified as to the area or space served by the equipment. Provide signs for the following general categories of equipment and operational devices:
 1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 2. Gages, thermometers and similar units.
 3. Fuel-burning units including pool heater and water heaters.
 4. Pumps and similar motor-driven units.
 5. Coils and similar equipment.
 6. Fans, blowers, primary balancing dampers and mixing boxes.
 7. Packaged HVAC central-station and zone-type units.
 8. Tanks and pressure vessels.
 9. Strainers, filters, water treatment systems and similar equipment.
- B. Optional Sign Types: Where lettering larger than 1" height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, at Installer's option.
- C. Lettering Size: Minimum 1" high lettering for name of unit.
- D. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions and warn of hazards and improper operations.

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- E. Fire and Smoke Damper Identification: Access points, i.e. access doors, access panels, lay-in ceiling tile, etc., shall be permanently identified on the exterior of the access point by a label having letters not less than 0.5" in height reading: "SMOKE DAMPER" or "FIRE DAMPER" or "FIRE/SMOKE DAMPER".

END OF SECTION 15190

SECTION 15250 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

- A. Types of mechanical insulation specified in this section include the following:
 - 1. Piping System Insulation:
 - a. Fiberglass.
 - 2. Ductwork System Insulation:
 - a. Fiberglass.
 - b. Calcium Silicate.

1.3 QUALITY ASSURANCE

- A. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

PART 2 - PRODUCTS

2.1 PIPING INSULATION MATERIALS

- A. Fiberglass Piping Insulation: ASTM C 547, Type I unless otherwise indicated.
- B. Jackets for Piping Insulation:
 - 1. Factory applied jackets shall comply with the requirements of ASTM C 1136.
 - 2. Field applied jackets shall comply with the requirements of ASTM C 921, Type 1 unless otherwise specified.
- C. Encase pipe fittings insulation with flame and smoke rated one-piece premolded PVC fitting covers, fastened as per manufacturer's recommendations.
- D. Encase exterior piping and pipe insulation with aluminum jacket with weather-proof construction.
- E. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

- F. Acceptable Manufacturers:
1. Armacell.
 2. Knauf Fiber Glass.
 3. Johns Manville Corporation.
 4. Owens-Corning Fiberglass Corp.
 5. Pittsburgh Corning Corp.
 6. Rubatex Corp.

2.2 DUCTWORK INSULATION MATERIALS

- A. Rigid Fiberglass Ductwork Insulation: ASTM C612, Class 1.
- B. Flexible Fiberglass Ductwork Insulation: ASTM C 553, Type I, Class B-4.
- C. Jackets for Ductwork Insulation: ASTM C 921, Type I for ductwork with temperatures below ambient; Type II for ductwork with temperatures above ambient.
- D. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.
- E. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.
- F. Acceptable Manufacturers:
1. Knauf Fiber Glass.
 2. Johns Manville Corporation.
 3. Owens-Corning Fiberglass Corp.
 4. Pittsburgh Corning Corp.
 5. Rubatex Corp.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PLUMBING PIPING SYSTEM INSULATION

- A. Cold Piping systems:
1. Application Requirements: Insulate the following plumbing piping systems:
 - a. Cold water piping.
 - b. Interior horizontal and vertical above-ground storm and overflow storm water piping including roof drain bodies.
 2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:

- a. Fiberglass: 1" thick for all pipe sizes.
3. Insulation Omitted: Omit insulation on chrome-plated exposed piping (except for handicapped fixtures), air chambers, unions, strainers, check valves, balance cocks, flow regulators, drain lines from water coolers, drainage piping located in crawl spaces or tunnels, buried piping, fire protection piping, and pre-insulated equipment.

B. Hot Piping Systems (up to 140°F):

1. Application Requirements: Insulate the following plumbing piping systems:
 - a. Hot water piping.
 - b. Hot water recirculating piping.
2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:
 - a. Fiberglass: 1" thick for pipe sizes through and including 2", 1-1/2" thick for pipe sizes over 2".
3. Insulation Omitted: Omit insulation on chrome-plated exposed piping (except for handicapped fixtures), air chambers, unions, strainers, check valves, balance cocks, flow regulators, drain lines from water coolers, drainage piping located in crawl spaces or tunnels, buried piping, fire protection piping, and pre-insulated equipment.

3.3 HVAC PIPING SYSTEM INSULATION

A. Cold Piping (35°F to ambient):

1. Application Requirements: Insulate the following cold HVAC piping systems:
 - a. Air conditioner condensate drain piping.
2. Insulate each piping system specified above with the following type and thicknesses of insulation:
 - a. Fiberglass: 1" thick for pipe sizes up to and including 1-1/2", 1-1/2" thick for pipe sizes over 1-1/2".

B. Hot Low Pressure Piping (to 250°F):

1. Application Requirements: Insulate the following hot low pressure HVAC piping systems water piping up to 250°F:
 - a. Pool heating water.
2. Insulate each piping system specified above with the following type and thicknesses of insulation:
 - a. Fiberglass: 1" thick for pipe sizes up to and including 1-1/2", 2" thick for pipe over 1-1/2".

3.4 DUCTWORK SYSTEM INSULATION

- A. Insulation Omitted: Do not insulate fibrous glass ductwork, or lined ductwork. Refer to Section 15800 for Lined Ductwork requirements.

B. Dual Temperature Ductwork:

1. Application Requirements: Insulate the following dual temperature ductwork:
 - a. Hot/cold supply and return ductwork between fan discharge or HVAC unit discharge and room terminal outlets; except omit insulation on return air ductwork located in return air ceiling plenums.
2. Insulate each ductwork system specified above with one of the following types and thicknesses of insulation:
 - a. Rigid Fiberglass: 2" thick.
 - b. Flexible Fiberglass: 2" thick, application limited to concealed locations.

3.5 INSTALLATION OF PIPING AND DUCTWORK INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Maintain integrity of vapor-barrier jackets on insulation, and protect to prevent puncture or other damage.
- F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.
- G. Extend insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
- H. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band.
- I. Install insulation and vapor barrier jackets continuous over piping at trapeze hangers.
- J. Piping and Ductwork Exposed to Outdoor/Ambient Conditions: Increase specified insulation thickness by 1" minimum. Protect outdoor insulation from weather by installing outdoor protective jacketing as recommended by manufacturer.

3.6 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

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- B. Replace and repair insulation disturbed by testing and balancing procedures required under Section 15990.
- C. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION 15250

SECTION 15300 - FIRE PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

- A. Furnish and install a complete automatic fire sprinkler system for the entire building. The work shall include but not be limited to the following items:

1. System Design Requirements.
2. Sprinkler System.
3. Fire Department Connections.
4. Inspectors Test And Drain Assembly.

- B. Related work specified elsewhere:

1. Finish painting, including pipe stenciling.
2. Electrical wiring, except as noted.
3. Excavation and backfilling.
4. Concrete and reinforcing for foundations.
5. Fire extinguishers.
6. Freezing protection heating cable.
7. Access ladders to control valves.
8. Access doors.
9. Bonding Requirements. Refer to Division 1.

1.3 QUALITY ASSURANCE

- A. Contractor's Qualifications: Firms regularly engaged in the design and installation of fire protection systems, of types, materials, and sizes required, which have been in satisfactory use in similar service for not less than 5 years.

1. The design of the fire protection systems including hydraulic calculations shall be stamped and signed by a registered New Mexico fire protection engineer. Said professionals shall be experienced in fire protection, thoroughly familiar with and experienced in this type of installation.
2. The owner's representative, Engineer, and AHJ reserve the right to request proof of qualifications.
3. No design related work shall be subcontracted or performed by persons other than bona fide employees working solely for the contractor. Any exception shall be pre-approved by the owner, in writing.
4. The entire fire protection system project including design, calculation, installation and testing, excluding prefabrication, shall be bid by a single firm which has the capabilities to perform all of the work required under this standard. No installation work shall be subcontracted without prior permission in writing from the Owner/Architect/Engineer.
5. Shall have an emergency service capability for response to emergency conditions.

6. Shall have an established office within one hundred (100) miles of the project which maintains a full complement of spare parts, tools and equipment for the specific project and type of system.
7. Welders shall comply with the requirements of AWS D10.9, "Specifications of Qualifications of Welding Procedures and Welders for Piping and Tubing, Level AR-3."
8. Job foremen shall be trained for the installation and operation of each type of system and possess documentation of qualifications and training. Foremen shall have a minimum of three (3) years of successful installation experience on projects with fire protection systems similar in scope and nature to that required for the project.

B. Codes and Standards:

1. NFPA Compliance: Install fire protection systems in accordance with NFPA as applicable.
2. UL Compliance: Provide fire protection products in accordance with UL standards; provide UL label on each product.
3. Fire Department/Marshal Compliance: Install fire protection systems in accordance with local regulations of fire department or fire marshal.
4. Screw Thread Connections: Comply with local Fire Department/Marshal regulations for sizes, threading and arrangement of connections for fire department equipment to standpipe system.

1.4 SYSTEM DESIGN REQUIREMENTS

- A. Verify requirements with Jurisdictional authorities, i.e.: Insurance Co. or Underwriter, Fire Department or Marshal, or Building Departments. Provide system complete, functional and acceptable to Jurisdictions without penalty of any type to the insurance premium rate.
- B. System shall be installed hydraulically calculated per NFPA #13.
- C. System shall be designed to provide sprinkler heads at ¼ points in 2'x4' lay-in ceiling tiles in a uniform pattern, centered in 2' direction, ¼ points in 4' direction. All heads shall be centered in 2'x2' lay in ceiling tiles. Provide fire sprinkler heads below ceiling clouds in lobby 021 per NFPA requirements.
- D. All calculations shall include flow test results. Flow tests shall be performed by this Contractor and verified by the Fire Department, Architect, and Engineer. Prior flow tests on file with jurisdictional agencies may be used in lieu of new flow tests only when previous test has been made within 3 months of project start date.
- E. Contractor shall use 90% of flow test pressure data as the base in performance of the Project Calculations.
- F. Six Copies of Hydraulic Calculations and Drawings shall be submitted for review. Drawings shall show hydraulic reference points, hydraulically most remote areas clearly shown, and proof by example that area shown is in fact the hydraulically most remote.
- G. Area and densities shall conform to NFPA #13 or jurisdictional authorities requirements.
- H. Include all lines as center to center of fittings, not cut lengths, include all fittings.
- I. Sprinkler system shall be calculated from the flow test elevation to the highest sprinkler head.
- J. Provide all trim and accessories, inlets, alarms, switches, and valves required.
- K. Provide bracing, restraining, thrust blocks, rods, anchors, cathodic protection, and plastic pipe wrap as required.
- L. Water supply flow test(s) shall be conducted in strict accordance with NFPA #13 and NFPA #291.

- M. Hydraulic calculation submittals shall clearly define and annotate all devices which will cause friction loss with equivalent lengths of pipe. This includes vane type electric water flow switches (assume 10 feet of equivalent length of pipe).

1.5 SUBMITTALS

- A. Product Data: Submit product data for the following items:

1. Pipe, fittings, hangers, attachments devices, and valves.
2. Sprinkler heads and escutcheons.
3. Specialty valves and devices.
4. Alarms and connecting devices.
5. Flow switches.
6. Siamese fire department connections.
7. Inspections Test And Drain Assembly.
8. Fire Flow Test Results.

- B. Shop Drawings: Submit shop drawings for the following items:

1. Engineered fabrication drawings showing main and line elevations, sizes, and routing.
2. Drawings showing lights, registers, grilles, diffusers, heat detection devices, ceiling grids, beams, joists, trusses and other items of possible interference with proper function or routing of the system and component devices such as access panels, clerestories, display structures, skylights, atriums, etc.
3. Hydronic calculations prepared in a form with appropriate information as required and acceptable to all reviewing and jurisdictional agencies. Include certified flow test data with calculations.
4. All drawings and calculations shall be reviewed and accepted by the jurisdictional fire department, building department, fire marshal, and the insurance carrier or insurance reviewing authority prior to submitting to the Architect. Indication of review and acceptance by all agencies, as appropriate, shall be certified by name of reviewer, agency, and date affixed to the plans or reproducible submitted to the Architect.
5. Alarms, devices, monitors and all electrical wiring diagrams
6. Partial submittals shall not be acceptable.
7. Equipment submittals shall contain annotated descriptive data to show the specific model, type and size of each item the Contractor proposes to furnish. Catalog cut sheets shall be submitted in a suitable folder or binder and indexed referencing the applicable specification sections. Unclear or partial reproductions of manufacturer's original catalog cuts or descriptive data shall not be accepted. Each item supplied shall be clearly identified on each sheet. Where the submittal material describes items, in addition to the items being submitted, the additional items shall be crossed out and the submittal item shall be identified. Submit proof of compatibility for equipment components required to be approved as a system.
8. Review by the Engineer shall not relieve the Contractor from full compliance with requirements of the contract documents, codes, and standards.
9. Submit detailed shop drawings including a riser diagram, stamped and signed hydraulic calculations, equipment data sheet submittals and employee certification in accordance with NFPA #13.

- C. Certificate of Installation: Submit certificate upon completion of fire protection piping work which indicates that work has been tested in accordance with NFPA 13 and that system is operational, complete, and has no defects.

- D. Record Drawings: At project closeout, submit record drawings of installed fire protection piping and products in accordance with requirements of Division 1.

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- E. Maintenance Data: Submit maintenance data and parts lists for fire protection materials and products. Include this data, product data, shop drawings, approval drawings, approval calculations, certificate of installation, and record drawings in maintenance manual in accordance with requirements of Division 1.

1.6 PROJECT CONDITIONS

- A. Contractor shall not fabricate or install any piping until they have assured themselves that the piping can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work.

1.7 WARRANTY

- A. Provide original copies of all warranties and extended warranties for specific equipment where specified and in accordance with Section 15010.

PART 2 - PRODUCTS

2.1 MATERIALS AND PRODUCTS

- A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in fire protection systems. Where more than one type of materials or products are indicated, selection is Installer's option.

2.2 BASIC IDENTIFICATION

- A. General: Provide identification complying with Division-15 Basic Mechanical Materials and Methods section "Mechanical Identification" in accordance with the following listing:
 - 1. Fire Protection Piping: Pipe markers.
 - 2. Fire Protection Valves: Valve tags.
 - 3. Fire Protection Signs: Provide the following signs:
 - a. At each sprinkler valve, sign indicating what portion of system valve controls.
 - b. At each outside alarm device, sign indicating what authority to call if device is activated.

2.3 BASIC PIPES AND PIPE FITTINGS

- A. General: Provide pipes and pipe fittings in accordance with the following:
- B. Underground Piping:
 - 1. General: Provide pipes and pipe fittings complying with Division 15 Section 15060.
 - 2. Rotatable Fittings:
 - a. Provide for all service risers and valves, MJ x PE or rotatable MJ gland tees and connecting pieces to provide plumb and true valve and service riser settings.

3. Thrust Blocks - Tie Rods:
 - a. Provide 3000 lb. type II concrete thrust blocks with soil contact area based on not more than 2000 psf horizontal soil bearing quality, and enveloping 1/2 of pipe, fitting, or valve. Provide saddle reinforcing as required.
 - b. Provide 1/2" minimum machine thread rods and clamps on all service entries from last joint underground to riser elbow or wall entry and to first joint in the building. All rods, clamps, and bolts double coated with "ZRC" brand cold galvanizing coating after installation and draw up. Provide 1 coat of coal tar coating over galvanizing. NOTE: Clamps and rods do not preclude the requirements for thrust blocks.
 - c. Provide 8 mil thick minimum polyethylene pipe encasement sleeve, overlap at joints and seal joint with 2" wide minimum polyethylene tape triple wrapped and extending at least 6" both ways beyond joint seam or provide machine wrapped Scotchwrap #51 PVC tape with 50% overlap wrap on pipe primed with Scotchwrap primer. Double wrap all fittings to 6" beyond fitting onto pipe. Provide primer on fittings, bolts, and nuts prior to wrapping.

C. Interior Piping:

1. General: Provide pipes and pipe fittings complying with Division 15 Section 15060.

D. Valves:

1. All valves are to be indicating type.
2. All valves U.L. listed, F.M. approved.
3. Refer to Section 15060 for valve specifications.

E. Hangers:

1. All hangers, attachments and components U.L. listed, F.M. approved.
2. Refer to Section 15060 for specifications and restrictions for hanger systems. Where specification is more stringent, these requirements will apply.
3. Permission to use anchoring system utilizing powder driven studs must be obtained from the Structural Engineer prior to submitting pricing or bids.

F. Backflow Preventers:

1. Provide backflow preventer assemblies in fire service as required by local water department.
2. Backflow preventers shall be as required and shall be U.L. and F.M. listed for fire protection service. O.S.& Y. gate valves shall be furnished as part of each assembly.

2.4 FIRE PROTECTION SPECIALTIES

- A. General: Provide fire protection specialties, UL-listed, in accordance with the following listing. Provide sizes and types which mate and match piping and equipment connections.

B. Water Flow and Pressure Switches:

1. Paddle Type Flow Switch, for pipe sizes 2" thru 8", retard adjustment from 0 to 70 seconds instantly recycling.
 - a. Manufacturer: Notifier
 - b. Model: WFDT with dual contacts
2. Paddle Type Flow Switch for pipe sizes 1", 1-1/4" and 1-1/2", 10 second delay.

- a. Manufacturer: McDonnell
 - b. Model: FS4-3F with dual contacts
3. Coordinate voltage with Fire Alarm Contractor.
- C. Supervisory Switches:
1. Gate, OS&Y, and other exposed rising stem type valves:
 - a. Manufacturer: Notifier
 - b. Model: NGV or SGV
 2. Coordinate voltage with Fire Alarm Contractor.
- D. Alarms:
1. Exterior Audible and Visual Alarm:
 - a. Manufacturer: Notifier Wheelock
 - b. Model: Surface
 - c. Unit: 7004T
 - d. Box: WBB
 2. Provide with flasher, surface mounting in weather proof enclosure.
 3. Coordinate voltage with Fire Alarm Contractor.
- E. Acceptable Manufacturers:
1. Guardian Inc.
 2. Notifier Co.
 3. Potter Signal, Inc.
 4. Simplex Co.

2.5 AUTOMATIC SPRINKLERS

- A. General: Provide automatic sprinklers in accordance with the following listing.
1. Provide off-white finished plate for concealed heads in all finished ceilings. (Alt. Price)
 2. Provide white finish semi recessed and sidewall heads in all finished ceilings.
 3. Provide brass upright/pendant and sidewall heads in all exposed ceiling areas and unfinished areas.
 4. Provide epoxy coated brass upright/pendant and sidewall heads in all pool areas.
 5. Provide fire sprinkler protection cages on sprinkler heads installed less than 7'-6" above the finished floor.
 6. Wax coated dry pendant heads in chemical rooms.
- B. Sprinkler Heads: Provide quick response type throughout project. A contractor option will be to provide either standard or extended coverage heads.
- C. Sprinkler Head Cabinets:
1. Provide cabinet complete with appropriate heads, wrench and mounting per NFPA.
 2. Acceptable Manufacturer: Subject to compliance with requirements, provide automatic sprinklers of one of the following:

- a. Globe Inc.
- b. Grinnell Fire Protection Systems Co. Inc.
- c. Grunau Corp.
- d. Reliable Corp.
- e. Star Corp.
- f. Viking Inc.

2.6 FIRE DEPARTMENT INLET (SUPPLY) CONNECTION

- A. Provide chrome 5" storz connections per local fire district requirements.
 1. Provide index plates. Index plates shall read "Auto Spkr".
- B. Acceptable Manufacturer:
 1. Croker-Standard Div.
 2. Elkhart Brass Mfg. Co.
 3. Guardian Inc.
 4. Potter-Roemer, Inc.

2.7 INSPECTOR'S TEST AND DRAIN ASSEMBLY

- A. Provide AGF #1000, test and drain assembly, U.L. and F.M. approved, 300 PSI rated, lockable.

PART 3 - EXECUTION

3.1 PREPARATION AND INSPECTION

- A. Field Measurements: Verify all dimensions before proceeding with the work. Obtain field measurements for work required to be accurately fitted to other construction. Be responsible for the accuracy of such measurements and precise fitting and assembly of finished work. Prefabrication of systems is done at this Contractor's own risk.
- B. Coordination: Coordinate all work and placement of components with other trades, be responsible for complete coordination of design and field installation, (remedial field work will be required to eliminate conflicts) and provide an acceptable finished product. Removal of piping and heads will be required at contractor's expense if field coordination does not take place.

3.2 INSTALLATION

- A. General: Provide a complete operable system designed and installed in accordance with applicable local, state, federal and jurisdictional codes, enforcement agencies and insurance rating or underwriting agencies.
- B. All systems shall be drainable with proper drainage devices, and drain terminations either to exterior of building or to properly sized receptacles within building. The fire protection contractor shall route drainage per NFPA.
- C. All systems shall be supported and braced for conformance to proper and applicable standards.

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- D. Care shall be taken with chrome plated or other polished finish components so that marring does not occur to the finish, and installation provides for a uniform pattern and true installation.
- E. Install Sprinkler heads on a true axis line in both directions a maximum deviation of 1/2 inch plus or minus. Any heads exceeding the maximum tolerance are to be removed and re-installed by the contractor at no additional cost.
- F. Where piping passes thru masonry units or concrete walls or floors or other building construction, sleeves must be used. Where exposed piping passes thru finished work, chrome, plated or other finish acceptable to architect, split wall plates or escutcheons shall be installed to fit snugly around piping. Where rated walls are penetrated, approved safing shall be provided at each hole to assure effectiveness of construction as a fire stop.
- G. All openings for piping should be anticipated and coordinated with General Contractor. Indicate such openings on the shop drawings. Any additional cutting of openings must have the written approval of the Architect.
- H. Contractor shall complete the automatic fire sprinkler ready for operation, in all respects, as soon as possible. When system is complete and ready for continuous operation, activate the system for its intended use. After system has been activated for continuous use, water charges, if any will be paid for by the Owner.
- I. Provide identification sign of the standard design adopted by the Automatic Sprinkler Industry, attaching same to all valves, drains, test connections, etc., with chain around body of valve in such a way that the sign cannot be removed without opening link.
- J. Provide hydraulic placard indicating the location of calculated system, the discharge density over designed area of discharge, including gallons per minute and residual pressure demand at the base of riser. Place this sign at the system control valve.
- K. Use no face bushings.
- L. Furnish wiring requirements to Division 16 Contractor for interior alarm items furnished in this Section.

3.3 FIELD QUALITY CONTROL

- A. Sprinkler Piping Flushing: Prior to connecting sprinkler risers, flush water feed mains, lead-in connections and control portions of sprinkler piping. After fire sprinkler piping installation has been completed and before piping is placed in service, flush entire sprinkler system, as required to remove foreign substances, under pressure as specified in NFPA 13. Continue flushing until water is clear.
- B. Hydrostatic Testing: After flushing system, test fire sprinkler piping hydrostatically, for period of 2 hours, at not less than 200 psi or at 50 psi in excess of maximum static pressure when maximum static pressure is in excess of 150 psi. Check system for leakage of joints. Measure hydrostatic pressure at low point of each system or zone being tested.
- C. Repair or replace piping system as required to eliminate leakage in accordance with NFPA standards for "little or no leakage" and retest as specified to demonstrate compliance.

3.4 ADJUSTING AND CLEANING

- A. Cleaning and Inspecting: Clean and inspect fire protection systems in accordance with requirements of Division-15 Basic Mechanical Materials and Methods Section 15060 "Pipes and Pipe Fittings".

3.5 EXTRA STOCK

- A. Heads: For each style and temperature range required, furnish additional sprinkler heads, amounting to one unit for every 100 installed units, but not less than 5 units of each.
- B. Wrenches: Furnish 2 spanner wrenches for each type and size of valve connection and fire hose coupling.
 - 1. Obtain receipt from Owner that extra stock has been received.

3.6 CERTIFICATE OF COMPLETION

- A. Obtain certificate of compliance and completion for jurisdictional agencies, as applicable and present to Owner.

END OF SECTION 15300

SECTION 15400 - PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

- A. Systems and equipment specified in this section include the following:
 - 1. Potable Water System.
 - 2. Storm Water, Waste and Vent System.
 - 3. Natural Gas System.
 - 4. Plumbing Fixtures.
 - 5. Plumbing Pumps.
 - 6. Water Heaters.

PART 2 - PRODUCTS

2.1 MATERIALS AND PRODUCTS

- A. General: Provide piping materials and factory-fabricated piping products, and specified equipment of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Provide sizes and types matching piping and equipment connections and provide fittings of materials which match pipe materials. Where more than one type of materials or products are indicated, selection is Installer's option.

2.2 PIPES, PIPE FITTINGS AND ACCESSORIES

- A. General: Provide pipes and pipe fittings complying with Division 15, Section 15060.
 - 1. Basic Valves: Refer to Section 15060 for valve and manufacturer specification.
 - a. Sectional and Shutoff Valves:
 - 1) 2" and Smaller: Ball valves.
 - 2) 2-1/2" and Larger: Ball valves.
 - b. Drain Valves:
 - 1) 2" and Smaller: Ball valves.
 - 2) 2-1/2" and Larger: Ball valves.
 - c. Check Valves:
 - 1) All Sizes: Swing check valves.

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- d. Balancing Valves:
 - 1) All sizes: Calibrated type only; positive shut-off.
- 2. Potable Water Specialties:
 - a. Hose Bibbs:
 - 1) HB-1: Chicago Faucet Co. No. 952; Threaded end, chrome plated, bronze body, renewable composition disc, tee handle, 3/4" NPT inlet, 3/4" hose outlet, integral vacuum breaker.
 - 2) HB-2: Zurn Z-1350, stainless steel cabinet with door and wall flange, loose key handle, vacuum breaker, coordinate, water proofing.
 - 3) Floor Box (FB-1): J.R. Smith #5810-VB-NB nickel bronze box and cover, vacuum breaker. Coordinate location with chair lift.
 - 4) Acceptable Manufacturers:
 - a) Acorn.
 - b) Chicago Faucet Co.
 - c) Mifab, Inc.
 - d) T & S Brass and Bronze Co.
 - e) Zurn.
 - b. Wall Hydrants:
 - 1) WH-1: Woodford Model B65 or B67; non-freeze cast-bronze box hydrant, chrome plated face, tee handle key, bronze casing, length to suit wall thickness, integral vacuum breaker, self-draining, hinged locking cover, 3/4" inlet, hose outlet.
 - 2) Acceptable Manufacturers:
 - a) Josam Mfg. Co.
 - b) Mifab, Inc.
 - c) Smith, (Jay R.) Mfg. Co.
 - d) Woodford Mfg. Co.
 - e) Watts Co.
 - f) Zurn Industries Inc., Hydromechanics Div.
 - c. Backflow Preventers: Per Section 15060.
 - d. Relief Valves: Provide relief valves as indicated, of size and capacity as selected by Installer for proper relieving capacity, in accordance with ASME Boiler and Pressure Vessel Code.
 - 1) Acceptable Manufacturers:
 - a) Cash (A. W.) Valve Mfg. Corp.
 - b) Conbraco Industries, Inc.
 - c) Proset Systems.
 - d) Watts Regulator Co.
 - e) Zurn Industries, Inc.; Wilkins-Regulator Div.
 - e. Water Hammer Arresters:
 - 1) Refer to Section 15060 for specification.

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- f. Trap Primers: Provide bronze trap primer valve with automatic vacuum breaker, complying with ASSE 1018, with ½" connections matching mating piping system.
- 1) Acceptable Manufacturers:
 - a) Josam Mfg. Co.
 - b) Precision Plumbing Products, Inc.
 - c) Smith (Jay R.) Mfg. Co.
 - d) Tyler Pipe; Subs. of Tyler Corp.
 - e) Watts Regulator Co.
 - f) Zurn Industries, Inc.; Hydromechanics Div.
- g. Pressure Regulating Valves: Provide pressure regulating valves, single seated, direct operated type, bronze body, integral strainer, complying with requirements of ASSE Standard 1003. Size for maximum flow rate and inlet and outlet pressures indicated on drawings.
- 1) Acceptable Manufacturers:
 - a) Cash (A. W.) Valve Mfr. Corp.
 - b) Mueller Mfg. Co.
 - c) Watts Regulator Co.
 - d) Zurn/Wilkins.
- h. Water Heater Mixing Valve:
- 1) General: Provide thermostatic mixing valve assembly to include thermostatic three way mixing valve(s), if required, pressure reducing valve, pressure gages, union inlet strainer checkstops, dial thermometer, shut-off ball valves and all interconnecting piping. Valve(s) shall provide protection against hot or cold supply line failure and thermostatic failure. Valve(s) shall meet drawing scheduled requirements.
 - 2) Acceptable Manufacturers:
 - a) Lawler.
 - b) Leonard Valve Company.
 - c) MCC Powers Process Controls.
 - d) Symmons.
- i. Diaphragm-Type Expansion Tanks:
- 1) General: Provide diaphragm expansion tanks of size and number as indicated. Construct tank of welded steel, constructed, tested, and stamped in accordance with Section VIII of ASME Boiler and Pressure Vessel Code for working pressure of 125 psi. Furnish National Board Form U-1 denoting compliance. Provide specially compounded heavyduty butyl flexible diaphragm securely sealed into tank to permanently separate air charge from system water, and to maintain design expansion capacity. Provide pressure gage and air-charging fitting, and drain fitting.
 - 2) Acceptable Manufacturers:
 - a) Amtrol, Inc.
 - b) Armstrong Pumps, Inc.
 - c) Bell & Gossett ITT.
 - d) John Wood Company.

B. Storm Drain, Waste and Vent System:

1. General: Provide pipes and pipe fittings complying with Division 15, Section 15060.
2. Floor Drain, Floor Sinks, Roof Drain, and Vent Flashing: Flashing (safe pan) shall consist of one of the following:
 - a. 4 lb./ft² sheet lead with appropriate under support.
 - b. No. 24 B & S gauge (.02) sheet copper with 15 lb. asphalt felt sub pans (silver soldered seams only).
 - c. .04 thickness non plasticized chlorinated polyethylene and asphalted saturated felt flashing as approved and acceptable with jurisdictional code.
3. Drainage Piping Products: Provide factory-fabricated drainage piping products of size and type indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements and governing regulations.
 - a. Cleanout Plugs: Cast-bronze or brass, threads complying with ANSI B2.1, countersunk head.
 - b. Floor Cleanouts: Cast-iron body and frame; cleanout plug; adjustable round top as follows:
 - 1) Nickel-Bronze Top: Manufacturers standard cast unit of the pattern indicated:
 - a) Pattern: Exposed flush type, standard non-slip scored or abrasive finish.
 - c. Grade Cleanouts: Cast-iron body and frame; cleanout plug; adjustable round top as follows:
 - 1) Cast-iron Top: Manufacturers standard cast unit of the pattern indicated:
 - a) Pattern: Exposed flush type, standard non-slip scored or abrasive finish.
 - d. Wall Cleanouts: Cast-iron body adaptable to pipe with cast-bronze or brass cleanout plug; stainless steel cover including screws.
 - e. Acceptable Manufacturers:
 - 1) Josam Mfg. Co.
 - 2) Mifab, Inc.
 - 3) Smith (Jay R.) Co.
 - 4) Tyler-Wade.
 - 5) Watts Co.
 - 6) Zurn Industries Inc.
4. Drains:
 - a. General: Provide factory-fabricated drains of size and type indicated. Where not indicated, provide proper selection as determined by Architect/Engineer to comply with installation requirements and governing regulations.
 - b. Floor Drains and Floor Sinks:
 - 1) Floor Drain (FD-1): Josam No. 30000-A, cast-iron body, flashing collar, weepholes, satin Nikaloy strainer.
 - 2) Floor Drain (FD-2): Josam No. 32100-TG, cast-iron body, flashing collar, weepholes, 9" diameter ductile iron tractor grate (grate to bear directly on body of drain).

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- 3) Floor Drain (FD-3): Josam Co. No. 32200, cast iron body, 12-5/8" top, cast iron grate, bottom outlet, weepholes, flashing flange.
- 4) Floor Sink (FS-1): Josam No. 49320A-NB-AS, cast iron body, flashing flange acid resisting interior, weepholes, aluminum dome strainer, 12-1/2" square top, 6" deep, 1/2" grate.
- 5) Floor Drain (FD-4): Josam #28600-2, 6" size drain with calibrated vanes set from the factory to discharge 150 GPM at 6'-0" of head. Cast on dome with calibrated vanes. Bottom outlet.

c. Roof Drains:

- 1) Roof Drain (RD-1) Josam No. 21500-3-22-VP, cast iron body, clamp ring w/gravel stop, bottom outlet, deck clamp, sump receiver, cast iron locking dome.
- 2) Overflow Roof Drain (OD-1): Josam No. 21500-3-16-22-VP, cast iron drain body, clamp ring w/gravel stop, bottom outlet, deck clamp, sump receiver, cast iron locking dome, 2" water collar.
- 3) Acceptable Manufacturers:
 - a) Josam Mfg. Co.
 - b) Mifab, Inc.
 - c) Smith (Jay R.) Mfg. Co.
 - d) Tyler Pipe; Subs. of Tyler Corp.
 - e) Zurn Industries, Inc.; Hydromechanics Div.

d. Non-Metallic Trench Drains: Polymer concrete, fiberglass, or polyethylene, interlocking design with pre-sloped bottom radius.

- 1) Material: Load pressure of 14,500 psi, frost proof, salt proof, inert under dilute acid and alkali conditions, and less than 1.0% water absorption rate.
- 2) Grates: As indicated in detail on drawings. Color of trench and grate shall be approved by Architect at no additional cost.
- 3) Accessories:
 - a) Provide as indicated in detail on drawings and/or as needed for proper installation.
 - b) Provide drain support devices as suggested by manufacturer.
 - c) Provide layout drawings for Engineer/Architect approval. Drawings should show locations, lengths, etc.
- 4) Acceptable Manufacturers:
 - a) ACO.
 - b) Jay R. Smith.
 - c) Mifab, Inc.
 - d) Poly Drain.
 - e) Zurn Industries.

C. Natural Gas System:

1. General: Provide pipes and pipe fittings complying with Division 15, Section 15060.

2.3 PLUMBING FIXTURES

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- A. General: Provide factory-fabricated fixtures of type, style and material indicated. Where more than one type is indicated, selection is Installer's option; but, all fixtures of same type must be furnished by single manufacturer.
- B. Materials:
 - 1. General: Unless otherwise specified, comply with applicable Federal Specification WW-P-541/-Series sections pertaining to plumbing fixtures, fittings, trim, metals and finishes. Comply with requirements of WW-P-541/-specification relative to quality of ware, glazing, enamel, composition and finish of metals, air gaps, and vacuum breakers, even though some plumbing fixtures specified in this section are not described in WW-P-541.
 - 2. Provide materials which have been selected for their surface flatness and smoothness. Exposed surfaces which exhibit pitting seam marks, roller marks, foundry sand holes, stains, discoloration, or other surface imperfections on finished units are not acceptable.
 - 3. Where fittings, trim and accessories are exposed or semi-exposed provide bright chrome-plated or polished stainless steel units. Provide copper or brass where not exposed.
 - 4. Stainless Steel Sheets: ASTM A 167, Type 302/304, hardest workable temper.
 - a. Finish: No. 4, bright, directional polish on exposed surfaces.
 - 5. Vitreous China: High quality, free from fire cracks, spots, blisters, pinholes and specks; glaze exposed surfaces, and test for crazing resistance in accordance with ASTM C 554.
 - 6. Synthetic Stone: High quality, free from defects, glaze on exposed surfaces, stain resistant.

2.4 PLUMBING FITTINGS, TRIM AND ACCESSORIES

- A. Water Outlets: At locations where water is supplied by manual, automatic or remote control, provide commercial quality faucets, valves, or dispensing devices, of type and size indicated, and as required to operate as indicated. Include manual shutoff valves and connecting stem pipes to permit outlet servicing without shut-down of water supply piping systems.
 - 1. Vacuum Breakers: Provide with flush valves where required by governing regulations, including locations where water outlets are equipped for hose attachment.
- B. P-Traps: Include removable, 17 gauge, chrome plated P-traps with brass nuts, where drains are indicated for direct connection to drainage system.
- C. Carriers: Provide cast-iron supports for fixtures of either graphitic gray iron, ductile iron, or malleable iron.
- D. Fixture Bolt Caps: Provide manufacturer's standard exposed fixture bolt caps finished to match fixture finish.
- E. Escutcheons: Where fixture supplies and drains penetrate walls in exposed locations, provide chrome-plated cast-brass escutcheons with set screw.
- F. Aerators: Provide aerators of types approved by Health Departments having jurisdiction.
- G. Comply with additional fixture requirements contained in fixture schedule.
- H. Faucet/trim shall meet ANSI 117.1 Section 4.20.4.
- I. Acceptable Manufacturers:

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1. Plumbing Fixtures (Vitreous China):
 - a. American Standard; U.S. Plumbing Products.
 - b. Crane Co.
 - c. Eljer Co.
 - d. Kohler Co.
 - e. Toto.
 - f. Zurn.

2. Lavatory Trim:
 - a. American Standard; U.S. Plumbing Products.
 - b. Delta.
 - c. Kohler Co.
 - d. Moen – Commercial.
 - e. Zurn Co.

3. Sink Trim:
 - a. American Standard.
 - b. Delta.
 - c. Kohler.
 - d. Moen.
 - e. Zurn Co.

4. Flush Valves:
 - a. Sloan Valve Co.
 - b. Zurn Co.

5. Fixture Seats:
 - a. Bemis Mfg. Co.
 - b. Beneke Corp.
 - c. Church Products.
 - d. Kohler Co.
 - e. Olsonite Corp.; Olsonite Seats.

6. Electric Water Coolers:
 - a. Acorn-Aqua.
 - b. Elkay Mfg. Co.
 - c. Halsey Taylor Div.
 - d. Haws Drinking Faucet Co.

7. Mop Basin/Shower Base (Molded Stone):
 - a. Fiat Co.
 - b. Florestone.
 - c. Zurn.

8. Stainless Steel Sinks:
 - a. Elkay Mfg. Co.
 - b. Just Mfg. Co.

- c. Kohler.
- 9. Shower Trim:
 - a. Bradley Corp.
 - b. Leonard Co.
 - c. MCC Powers Process Controls.
 - d. Symmons.
- 10. Fixture Carriers:
 - a. Josam Mfg. Co.
 - b. Mifab, Inc.
 - c. Smith Co.
 - d. Tyler-Wade.
 - e. Watts Co.
 - f. Zurn Industries, Inc.; Hydromechanics Div.
- 11. Emergency Showers/Eyewashes:
 - a. Bradley Co.
 - b. Guardian Brass Co.
 - c. Haws Co.
 - d. Speakman Co.

2.5 PUMPS

- A. General: Provide factory-tested pumps, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. Type, size, and capacity of each pump is listed in pump schedule. Provide pumps of same type by same manufacturer.
- B. In-line Recirculation Pumps:
 - 1. General: Provide in-line recirculation pumps where indicated, and of capacities as scheduled.
 - 2. Type: Horizontal, oil-lubricated, designed for 125 psi working pressure, 225°F (107°C) continuous water temperature, and specifically designed for quiet operation.
 - 3. Body: Bronze construction.
 - 4. Shaft: Steel, ground and polished, integral thrust collar.
 - 5. Bearings: Two horizontal sleeve bearings designed to circulate oil.
 - 6. Seal: Mechanical, with carbon seal face rotating against ceramic seat.
 - 7. Motor: Non-overloading at any point on pump curve, open, drip-proof, sleeve bearings, quiet operating, rubber mounted construction, built-in thermal overload protection.
 - 8. Coupling: Self-aligning, flexible coupling.
 - 9. Acceptable Manufacturers:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett ITT; Fluid Handling Div.
 - c. Paco Inc.
 - d. Taco, Inc.

2.6 SUBMERSIBLE SEWAGE EJECTORS

- A. General: Provide submersible sewage ejectors as indicated, of size and capacity as scheduled.

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- B. Pump: Cast-iron shell, cast iron impeller, stainless steel shaft, factory-sealed grease lubricated ball bearings and double mechanical seals.
- C. Motor: Hermetically sealed, air filled or oil filled design with built-in overload protection, electrical characteristics as scheduled.
- D. Controls: Mercury float switches with galvanized rod and switch mounting plate or wall support bracket as indicated on the plans.
- E. Control Panel: Duplex panel in NEMA 1 enclosure. Panel to have hinged door and shall include:
 - 1. Fused disconnect switches with lock-out handles through cover.
 - 2. Magnetic starters with OL and LV protection.
 - 3. Test-off-automatic selector switches.
 - 4. Electric Alternator.
 - 5. Control circuit transformers.
 - 6. Green pump running lights.
 - 7. OL reset buttons.
 - 8. Alarm silencing switch.
 - 9. Terminal Switch.
- F. Provide remote alarm panel for high water condition with alarm bell and alarm light with flasher.
- G. Provide submersible sewage ejectors with quick remove system including floor discharge elbow, stainless steel lifting rope and upper guide pipe bracket.
- H. Acceptable Manufacturers:
 - 1. E. Myers.
 - 2. Hydro-Matic Co.
 - 3. Paco Pump Co.
 - 4. Peabody Barnes.
 - 5. Weil Pump Co.
 - 6. Zoeller Co.

2.7 DOMESTIC WATER HEATER

- A. Commercial Gas-Fired Water Heaters:
 - 1. The water-containing section shall be of the "fintube", 2-pass design, with straight solid copper tubes having extruded integral fins spaced 7 fins per inch. Tubes shall be terminate into a one piece cast iron headers. The entire heat exchanger shall carry a five-year limited warranty against failure caused by defective workmanship or material. The combustion chamber shall be completely enclosed with refractory fiberboard insulation. The burner shall be constructed of stainless steel and fire on a horizontal plane. The boiler shall be a direct vented appliance.
 - 2. The water heater shall bear the ASME No. 8 stamp and shall be National Board listed for 160 psi working pressure. Water heater shall be constructed with a 16 gauge jacket, galvanized inside and outside, and protected with an acrylic finish.
 - 3. The water heater shall be equipped with a factory installed and wired circulating pump of sufficient capacity to insure scale-free heater performance. Pump shall be bronze fitted and shall be 120/60/1.
 - 4. Standard operating controls and equipment shall include: Copper Fin-Tubes, stainless steel burners, CSD-1 controls, 100% safety pilot, operating aquastat, manual reset hi-limit, main gas shutdown automatic main redundant gas valve, manual gas cock, main and pilot gas pressure

- regulators, master switch, ASME temperature and pressure relief valve, flow sensing device, and temperature gauges. System shall meet the latest edition of the ASHRAE energy efficient standards.
5. The storage tank shall be glass, poly, epoxy, or cement lined with capacity as specified on drawings. Shall be ASME rated for a 125 psi working pressure. The storage tank shall be fully insulated from the factory. The storage tank shall have a 5 year non-prorated warranty.
 6. Acceptable Manufacturers:
 - a. Lochinvar Corp.
 - b. RBI.
 - c. Smith Corp. (A.O.); Consumer Products Div.
 - d. Teledyne-Laars.

PART 3 - EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which piping systems are to be installed. Verify actual locations of equipment, fixtures and/or piping connections prior to installation. Also examine floors and substrates, and conditions under which work is to be accomplished. Correct any incorrect locations of piping, and other unsatisfactory conditions. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF INTERIOR WATER PIPING

- A. Install piping level with no pitch.
- B. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- C. Refer to Section 15060 for hanger and support requirements.

3.3 INSTALLATION OF EXTERIOR WATER PIPING

- A. General: Install water service piping system in compliance with local governing regulations.
- B. Water Service Piping: Extend water service piping of size and in location indicated to water service entrance at building. Provide sleeve in foundation wall for water service entry; make entry watertight. Provide shutoff valve at water service entry inside building; strainer, pressure gage, test tee with valve.

3.4 INSTALLATION OF BACKFLOW PREVENTERS

- A. Install backflow preventers where indicated, and where required by governing authority having jurisdiction. Locate in same room as equipment being protected. Pipe relief outlet to nearest floor drain.

3.5 INSTALLATION OF PRESSURE REGULATING VALVES

- A. Install pressure regulating valves where indicated. Provide inlet and outlet shutoff valves, and throttling valve bypass. Provide pressure gage on valve outlet. Refer to details on drawings.

3.6 INSTALLATION OF UNDERGROUND STORM AND SANITARY DRAIN PIPING WITHIN BUILDING

- A. General: Install underground building drains as indicated and in accordance with International Plumbing Code. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Clean interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed. Place plugs in ends of uncompleted piping at end of day or whenever work stops.
- B. All soil and waste piping: Shall be run at a slope of not less 1/4" per foot (2.08%) for piping up to 4" in size. All piping 4" and over shall be run at a slope of not less than 1/8" (1.04%) per foot. All storm drain piping shall be run at slopes indicated on the drawings.
- C. Cast-iron Pipe: Install in accordance with applicable provisions of CISPI "Cast Iron Soil Pipe & Fittings Handbook".
- D. Polyvinyl Chloride (PVC) Pipe: Install in accordance with manufacturer's installation recommendations, and in accordance with ASTM D2321.

3.7 INSTALLATION OF ABOVE GROUND STORM AND SANITARY DRAIN, WASTE AND VENT PIPING WITHIN BUILDING

- A. General: Install all piping, as indicated and in accordance with the International Plumbing Code.
- B. Provide restraints and hangers as appropriate and in accordance with manufacturers recommendations based upon type of pipe, fittings, joints. Refer to Section 15060.
- C. Piping shall be run true, plumb, and straight, with all restraints and hangers adjusted to carry their proportional load and locked to prevent pipe "wag", misalignment, movement or shear.
- D. Provide anchors for piping risers on every floor using riser clamps, wall brackets, knee brackets, and foot blocks for all vertical piping over 20 feet straight height.
- E. All soil and waste piping shall be run at a slope of not less than 1/4" per foot (2.08%) for piping up to 4" in size. All piping 4" and over shall be run at a slope of not less than 1/8" (1.04%) per foot. All storm drain piping shall be run at slopes indicated on the drawings.
- F. Bushings in soil waste or vent piping shall be prohibited. Tapped spigots or tees shall be used when changing from cast iron pipe to steel waste or vent piping, and for appropriate cleanout plugs.
- G. All horizontal storm soil, waste and vent piping shall be supported from the building structure at not more than five (5) foot intervals. Cast iron no-hub pipe and fittings shall be supported within one foot of each side of couplings. All vertical storm soil and vent stacks shall be supported with riser clamps at each floor slab.
- H. The waste connections between fixtures and their respective collection and venting systems shall consist of DWV nipples and cast iron drainage fittings.
- I. All interior waste and vent piping up to 1 1/2" shall consist of DWV with copper drainage fittings. All piping 2" and over shall consist of service weight cast iron soil pipe and fittings.
- J. All cast iron pipe and fittings shall have affixed thereon the CISPI grade mark of identification.

- K. All vents protruding through the roof shall be not less than 3" size and extended to not less than 12" above the finished roof, and flashed with 24" x 24" x 4 lb. sheet lead. The flashing shall extend not less than 6" above the roof and the edges turned down into a hub type cast iron vent pipe, caulked in place and finished with hot poured lead.
- L. All vents shall be located in accordance with jurisdictional code and in no case less than two (2) feet from roof edge or parapet, or wall line of an "on the roof structure".
- M. Provide all expansion joints, braces, earthquake restraints as required by the contract documents and jurisdictional authority.
- N. Provide heavy duty couplings on cast-iron no-hub drainage piping above computer rooms.

3.8 INSTALLATION OF DRAINAGE PIPING PRODUCTS

- A. Cleanouts: Install in above ground piping and building drain piping as indicated, as required by Local Code; and at each change in direction of piping greater than 45 degrees; at minimum intervals of 50' for piping 3" and smaller and 100' for larger piping; and at base of each vertical soil or waste stack. Install floor and wall cleanout covers for concealed piping. Wall cleanouts shall be installed at a maximum height of 1'-6" above finished floor unless otherwise indicated or directed on the plans.

3.9 INSTALLATION OF FLOOR DRAINS AND FLOOR SINKS

- A. General: Install floor drains and floor sinks in accordance with manufacturer's written instructions and in locations indicated.
- B. Coordinate flashing work with work of waterproofing and adjoining substrate work.
- C. Cover all drain strainers during building construction with heavy duty tape similar to duct tape.
- D. Install drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.
- E. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.
- F. Provide flashing (safepan) for each floor drain above grade, 24"x24" in size.

3.10 INSTALLATION OF TRAP PRIMERS

- A. General: Install trap primers in accordance with manufacturer's installation instructions. Pitch piping towards drain trap, minimum of 1/8" per floor (1%), adjust trap primer for proper flow. Provide trap primers as required by local code authorities and at all floor drains where loss of trap seal due to evaporation exists.

3.11 EQUIPMENT CONNECTIONS

- A. Piping Runouts to Fixtures: Provide soil and waste piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by International Plumbing Code.
- B. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

- C. Upon completion of installations, flush all traps and fill with water.

3.12 INSTALLATION OF ROOF DRAINS

- A. General: Install roof drains in accordance with manufacturer's written instructions and in locations indicated.
- B. Coordinate flashing work with work of roofing, water-proofing and adjoining substrate work.
- C. Provide flashing (safe pan) for each roof drain, 36" x 36" in size.
- D. Coordinate with roofing as necessary to interface roof drains with roofing work.
- E. Install roof drains at low points of surface areas to be drained, or as indicated.
- F. Install drain flashing collar or flange so that no leakage occurs between roof drain and adjoining roofing. Maintain integrity of waterproof membranes, where penetrated.
- G. Position roof drains so that they are accessible and easy to maintain.
- H. During application of roofing, plug all roof drains with test plugs, remove plugs after roofing has cured.
- I. Securely lock roof drain domes in place upon completion of construction.

3.13 INSTALLATION OF PLUMBING FIXTURES

- A. General: Install plumbing fixtures of types indicated where shown and at indicated heights; in accordance with fixture manufacturer's written instructions, roughing-in drawings, and with recognized industry practices. Ensure that plumbing fixtures comply with requirements and serve intended purposes. Comply with applicable requirements of governing authority having jurisdiction pertaining to installation of plumbing fixtures.
- B. Fasten plumbing fixtures securely to indicated supports or building structure; and ensure that fixtures are level and plumb. Secure plumbing supplies behind or within wall construction so as to be rigid, and not subject to pull or push movement.
- C. Protect installed fixtures from damage during remainder of construction period.

3.14 FIELD QUALITY CONTROL FOR FIXTURES

- A. Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.
- B. Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit. Feasibility and match to be judged by Architect/Engineer. Remove cracked or dented units and replace with new units.

3.15 ADJUSTING AND CLEANING OF FIXTURES

- A. Clean plumbing fixtures, trim, and strainers of dirt and debris upon completion of installation.
- B. Adjust water pressure at drinking fountains, faucets, shower valves, and flush valves to provide proper flow stream and specified gpm.
- C. Adjust or replace washers to prevent leaks at faucets and stops.

3.16 INSTALLATION OF NATURAL GAS PIPING

- A. Use sealants on metal gas piping threads which are chemically resistant to natural gas. Use sealants sparingly, and apply to only male threads of metal joints.
- B. Remove cutting and threading burrs before assembling piping.
- C. Do not install defective piping or fittings. Do not use pipe with threads which are chipped, stripped or damaged.
- D. Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping, or equipment connections are completed.
- E. Ground gas piping electrically and continuously within project, and bond tightly to grounding connection.
- F. Install drip-legs in gas piping where indicated, and where required by code or regulation.
- G. Install "Tee" fitting with bottom outlet plugged or capped, at bottom of pipe risers.
- H. Use dielectric unions where dissimilar metals are joined together.
- I. Install piping with 1/64" per foot (1/8%) downward slope in direction of flow.
- J. Install piping parallel to other piping, but maintain minimum of 12" clearance between gas piping and/or hydronic piping above 200°F (93°C).
- K. For piping running through ducts or air plenums shall be welded.
- L. Refer to Section 15060 for hanger and support requirements.

3.17 GAS SERVICE

- A. General: Arrange with Utility Company to provide gas service to building including gas meter, regulator, service shut-off valve, and gas load within 30 days after award of contract. Consult with Utility as to extent of it's work, costs, fees and permits involved. Pay such costs and fees; obtain permits. Costs for actual installation of service and setting of meter by the utility company shall be paid by the owner. Coordinate size of concrete pad or wall brackets for utility company to set meter.
- B. Extend building service line from gas meter into building. Provide full size plug valve on downstream side of meter. Enter building at a minimum of 12" above grade.

3.18 INSTALLATION OF VALVES

- A. Gas Cocks: Provide at connection to gas train for each gas-fired equipment item; and on risers and branches where indicated.

- B. Locate gas cocks where easily accessible, and where they will be protected from possible injury.
- C. Pressure Regulating Valves: Install as indicated; comply with Utility requirements. Pipe atmospheric vent to outdoors, full size of outlet. Install gas shutoff valve upstream of each pressure regulating valve.
- D. Verify venting requirements for pressure regulating valves in factory installed or factory supplied valve trains. Extend atmospheric vent to outdoors, full size of vent outlet when equipment is controlled by spark ignition. When equipment has standing pilot, pipe regulator vent(s) to combustion chamber. Verify regulator venting requirements with local authority prior to installation.

3.19 INSTALLATION OF PUMPS

- A. General: Install plumbing pumps where indicated, in accordance with manufacturer's published installation instructions, complying with recognized industry practices to ensure that plumbing pumps comply with requirements and serve intended purposes.
- B. Access: Provide access space around plumbing pumps for service as indicated, but in no case less than that recommended by manufacturer.
- C. Install in-line pumps, supported from piping system.

3.20 SUMP PUMPS AND SEWAGE EJECTORS

- A. Coordinate electrical power and control wiring, panel mounting and remote and local alarm systems wiring with Division 16 Contractor.
- B. All openings through basin or cover to be gas tight, provide unions, valves and checks as appropriate. Note: pump discharge check valves to be non slam type, tilting disc or pilot operated 45 degree swing design. Lift type or spring operated types will not be allowed.
- C. Operating floats shall be tied to vertical float rod and shall not swing free in basin.
- D. Provide pump power cords of sufficient length to exit basin and connect to power source above floor outside of basin area.
- E. Mount control panel and alarm panel, on walls secured tightly and permanently.
- F. Basins: Install sump pump basins in indicated locations and connect to sewer lines. Brace interior of basin in accordance with manufacturer's instructions, to prevent distortion or collapse during concrete placement. Refer to Division 3 for concrete work; not work of this section. Set cover over basin, fasten to top flange of basin. Install so cover is flush with finished floor.
- G. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

3.21 ADJUSTING AND CLEANING OF PUMPS

- A. Alignment: Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer.
- B. Start-Up: Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.

3.22 INSTALLATION OF WATER HEATERS

- A. General: Install water heaters in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Support: Place units on concrete pads, orient so controls and devices needing service and maintenance have adequate access.
 - 1. Flue: Connect flue to draft hood with gas-tight connection. Provide flue of minimum size as flue outlet on heater. Comply with gas utility requirements.

3.23 EXPANSION TANK

- A. Install expansion tank in accordance with manufacturer's recommendations.
- B. Provide unions and ball valves for complete isolation of the tank from the system.
- C. Charge tank with proper air charge as recommended by manufacturer.
- D. Tank tapings shall be provided as detailed or appropriate, ASME welded tank flanges or nipples.
- E. Suspend tank from building structure.

END OF SECTION 15400

SECTION 15500 - HVAC HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

- A. Types of equipment specified in this section include the following:
 - 1. Hydronic Piping and Specialties.
 - 2. HVAC Pumps.

PART 2 - PRODUCTS

2.1 BASIC PIPES AND PIPE FITTINGS

- A. General: Provide piping materials and factory-fabricated piping specialties of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Provide materials and products complying with ASME B31.9 Code for Building Services Piping where applicable, base pressure rating on hydronic piping systems maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in hydronic piping systems. Provide pipes and pipe fittings complying with Division 15, Section 15060.

2.2 BASIC VALVES

- A. General: Provide valves complying with Section 15060 and in accordance with the following listing:
- B. Shutoff Valves:
 - 1. 3" and smaller: Ball valves.
 - 2. 4" and larger: Butterfly valves only.

2.3 PRESSURE RELIEF VALVES

- A. General: Provide pressure relief valves as indicated, of size and capacity as selected by Installer for proper relieving capacity, in accordance with ASME Boiler and Pressure Vessel Code.
- B. Combined Pressure-Temperature Relief Valves: Bronze body, test lever, thermostat, complying with ANSI Z21.22 listing requirements for temperature discharge capacity. Provide temperature relief at 210°F (99°C), and pressure relief at 125 psi.
- C. Pressure Relief Valves: Bronze body, test lever, ASME rated. Provide pressure relief as stated on drawings.

D. Acceptable Manufacturers:

1. Amtrol, Inc.
2. Bell & Gossett ITT.
3. Spirax Sarco.
4. Watts Regulator Co.

2.4 PUMPS

A. General: Provide factory-tested pumps, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. Type, size, and capacity of each pump is listed in pump schedule. Provide pumps of same type by same manufacturer.

B. In-line Pool Heater Booster Pumps:

1. General: Provide chlorine resistant in-line booster pumps where indicated, and of capacities as scheduled.
2. Type: Horizontal, oil-lubricated, designed for 125 psi working pressure, 225°F continuous water temperature, and specifically designed for quiet operation.
3. Body: Bronze.
4. Shaft: Steel, ground and polished, integral thrust collar.
5. Bearings: Two horizontal sleeve bearings designed to circulate oil.
6. Seal: Mechanical, with carbon seal face rotating against ceramic seat.
7. Motor: Non-overloading at any point on pump curve, open, drip- proof, sleeve bearings, quiet operating, rubber mounted construction, built-in thermal overload protection.
8. Coupling: Self-aligning, flexible coupling.
9. Acceptable Manufacturers:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett ITT.
 - c. Dunham-Bush, Inc.
 - d. Marrow Pumps, Inc.
 - e. Paco Pumps, Inc.
 - f. Taco, Inc.
 - g. Thrush Co., Inc.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Examine areas and conditions under which hydronic systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable Installer.

3.2 ELECTRICAL WIRING

A. General: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-16 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.3 INSTALLATION OF HYDRONIC PIPING

- A. Install eccentric reducers where pipe is reduced in size in direction of flow, with tops of both pipes and reducer flush.
- B. Install piping level with no pitch.
- C. Connect branch-feed piping to mains at horizontal center line of mains, connect run-out piping to branches at horizontal center line of branches.
- D. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- E. Refer to Section 15060 for hanger and support requirements.

3.4 INSTALLATION OF VALVES

- A. Shutoff Valves: Install on inlet and outlet of each mechanical equipment item, and elsewhere as indicated.

3.5 INSTALLATION OF PUMPS

- A. General: Install HVAC pumps where indicated, in accordance with manufacturer's published installation instructions, complying with recognized industry practices to ensure that HVAC pumps comply with requirements and serve intended purposes.
- B. Access: Provide access space around HVAC pumps for service as indicated, but in no case less than that recommended by manufacturer.
- C. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-16 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- D. Alignment: Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer, and in presence of manufacturer's service representative.
- E. Start-Up: Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.

END OF SECTION 15500

SECTION 15550 - HEAT GENERATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

- A. Types of boilers and accessories specified in this section include the following:
 - 1. Copper fin tube pool heaters.
 - 2. High efficiency pool heaters.
- B. Electrical Work: Provide the following wiring as work of this section, in accordance with requirements of Division 16:
 - 1. Mechanical contractor to verify Division 16 contractor is aware of ASME-CSD requirement for remote disconnect switches for boiler burner power. Refer to Electrical Wiring and Safety Device Work and Materials Responsibilities in Specification Section 15010.
 - 2. Provide control wiring between boiler control panel and thermostats, aquastats, pressurestats, or any other control device.
 - 3. Provide factory-mounted and wired controls and electrical devices as specified in this section.
- C. CSD-1 COMPLIANCE:
 - 1. As a minimum, all automatically fired boilers shall be provided with controls and safety devices in accordance with ANSI/ASME CSD-1. Other more stringent condition may be required by the individual boiler specifications and information provided on the Drawings. Contractor shall meet all requirements.

PART 2 - PRODUCTS

2.1 COPPER FIN TUBE POOL HEATER

- A. General: Provide, as indicated, a factory-assembled and tested gas fired, single stage, fin tube boiler of the capacity as scheduled. Provide design certified by A.G.A., net ratings approved by I=B=R, heating capacities based on standard test procedures prescribed by DOE, and constructed in accordance with requirements of the ASME Boiler and Pressure Vessel Code.
- B. Boiler: Shall be of "fin tube" design, with straight solid copper tubes having extruded integral fins. The tubes shall terminate into a one-piece, lined, cast iron header. The combustion chamber shall be sealed and shall utilize an integral blower to control air/fuel mixture. The boiler shall be listed and approved by the American Gas Association under the ANSIZ2110.3 test standard. The boiler shall bear the AMSE "H" stamp and shall be National Board listed for 160 psi working pressure. The boiler shall operate at a minimum of 85% thermal efficiency. The boiler shall be warranted against damage due to low temperature return consistent with usage in a pool heating system.

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- C. The heater shall be furnished with a factory supplied pumped by-pass assembly to ensure proper operation without condensation. The by-pass assembly shall include a sealed all bronze pump suitable for outdoor installation. The by-pass assembly shall be constructed with all copper piping and an automatic three-way valve. Instructions for proper setup and operation of the by-pass will be supplied with the heater.
- D. Standard operating controls shall include a digital temperature controller with an LCD display to control pool water temperatures, a pool safety high limit, manual reset high limit control and auxiliary heater high limit control. The temperature controls shall be factory installed within the weather proof enclosure. The digital temperature control shall display pool water temperature and heater inlet temperature as well as set point and differential. The digital controller shall have a +/- 1° F accuracy. The control panel shall have a master switch with an indicating light and sequential and diagnostic indicator lights.
- E. The microprocessor based adjustable digital control shall provide ON/OFF operation.
1. The temperature control shall turn on and off based upon the temperature sensed by the pool return sensor. The sensor shall be factory installed in a bulbwell located in the inlet piping to the pool heater, upstream of the three-way automatic bypass valve.
 2. The temperature control shall turn off if the temperature measured by the pool heater output sensor exceeds 160 degrees.
 3. The temperature control shall operate a factory installed three-way automatic bypass valve to maintain a minimum temperature of 135 degrees at the inlet to the pool heater.
 - a. If the temperature is not satisfied with in 15 minuets the system will shut down.
 - b. To restart the system a manual reset shall be required.
- F. The standard operating control system shall include redundant proven pilot Hot Surface Ignition systems with full flame monitoring capability. Each Ignition system shall be able to function independently in the event of a failure in one system. Multiple main gas valves with redundant valve seats and built in low gas pressure regulators shall be supplied as standard. Additional standard controls shall include a water pressure switch, blocked flue pressure switch, low air pressure switch for each fan, low voltage transformer for the control circuit, 7 amp circuit breaker for 24 VAC control circuit, ASME temperature and pressure relief valve and flow switch. The manufacturer shall verify proper operation of the burners, all controls and the heat exchanger by connection to water and venting for a factory fire test prior to shipping. A quality test report shall be shipped with each unit.
- G. A 24 VAC control circuit and components shall be used. All components shall be easily accessed and serviceable. All components shall have multi-pin plug in type connectors to ease service, troubleshooting and lower removal and replacement cost.
- H. The units control panel shall contain the controllers LCD display and Diagnostic Information Center containing 6 individual indicators of current unit status.
- I. The heater shall be approved for indoor or outdoor installation. The heater shall be approved for, DirectAire Vertical w/ Sidewall Inlet (See drawings). Venting shall be classified Category I, negative draft, non-condensing, to use type "B" double wall venting materials. Direct Vent installations (Category IV) require the use of AL29-4C vent materials.
- J. Accessories:
1. Hot surface ignition.
 2. Inlet/outlet thermometer.
 3. Stainless steel burners.
 4. Redundant gas valve.
 5. NOx rating of 9.9 ppm or less.

6. ASME temperature and pressure relief valve set at 15 psi.
7. 5 year warranty.
8. Outdoor weather vent cap.
9. Alarm contacts for low water condition (24V).
10. Flow switch.
11. Low water cutoff.

K. Standard Gas Controls:

1. All electrical safety gas controls shall be of accepted quality manufacturer and shall be U.L. listed and/or A.G.A. design certified.
2. The inlet natural gas pressure to the boiler manual main shut-off valve should be no less than five inches water column or no more than 14 inches water column.

L. Acceptable Manufacturers:

1. Lochinvar Corporation.
2. Raypak, Inc.
3. Teledyne Laars.

2.2 HIGH EFFICIENCY POOL HEATER

- A. The water containing section shall be of a "Fin Tube" design, with straight copper tubes having extruded integral fins spaced seven (7) fins per inch. The tubes shall terminate into a one piece rear header and a two piece front header with an integral by-pass assembly. The front header configuration shall allow access to the heat exchanger for the purposes of inspection, cleaning or repair. The heat exchanger shall have a drain for proper draining and winterization. The front header shall provide a 3/4" NPT connection for a field installed relief valve when required. Connection may be made directly to the front header with PVC or CPVC pipe. The heat exchanger shall be mounted in a stress free jacket assembly in order to provide a "free floating design" able to withstand the effects of thermal shock. The polymer front header shall have water connections for 2" pipe. The heat exchanger assembly shall carry a three (3) year limited warranty against failure caused by defective workmanship or material.
- B. The combustion chamber shall be sealed and completely enclosed with Loch-Heat[®] ceramic fiberboard insulation. The Loch-Heat material shall provide a high efficiency insulation barrier while providing low weight. The burners shall be constructed of high temperature stainless steel and fire on a horizontal plane. The pool heater shall have an integral combustion air blower to precisely control the fuel/air mixture for maximum efficiency. Operation of the combustion air blower and venting system shall be monitored by an air proving switch.
- C. The pool heater shall be constructed with a heavy gauge pre-painted galvanized steel exterior jacket assembly. All steel jacket components must be galvanized on both sides.
- D. The pool heater shall be certified and listed by CSA International under the latest edition of the appropriate ANSI test standard. The pool heater shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard. The pool heater shall operate at a thermal efficiency of up to 87%.
- E. The pool heater shall be furnished with an integral by-pass assembly to ensure proper operation without condensation. The by-pass assembly shall be internally mounted inside the polymer front header. The by-pass assembly shall be constructed with all corrosion resistant materials for long life. The by-pass shall automatically control water flow rates through the heat exchanger to maximize efficiency and prevent sweat and condensate problems.

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- F. Standard operating controls shall include a digital electronic thermostat located on the boiler inlet. The electronic temperature control shall ensure accurate temperature control to 61°F. A pool water safety high limit control shall be provided. The temperature controls shall be factory installed and weather proof. Adjustment of the temperature control shall be made without tools or the removal of any jacket panels. The pool heater shall have a master on/off switch inside the jacket enclosure.
- G. The electronic control module shall provide ON/OFF operation.
1. The temperature control shall turn on and off based upon the temperature sensed by the pool return sensor. The sensor shall be located in the inlet piping to the pool heater.
 2. The temperature control shall turn off if the temperature measured by the pool heater output sensor exceeds 160 degrees.
 3. A secondary high limit sensor shall turn off the temperature control if the temperature sensed exceeds 104 degrees. The sensor shall be located on the pool supply piping, downstream of the pool heater outlet.
- H. The pool heater shall be field convertible to operate on either 120 VAC or 240 VAC. The standard control system shall include a direct-spark ignition system. The ignition system shall provide flame supervision for 100% safety shutdown. The pool heater shall be equipped with a 2-line, 16-character digital display to provide the status of operation and trouble shooting assistance on a control sensed malfunction. The control shall consist of the ignition control and a main gas valve with redundant valve seats and a low gas pressure regulator. Additional standard controls shall include a combination low air and blocked flue pressure switch to monitor fan operation, low voltage transformer for the control circuit and a convenient 24 volt terminal strip for easy connection of remote controls. The pool heater shall be provided with a built-in low water pressure switch to monitor water flow.
- I. A 24 VAC control circuit and components shall be used. All components shall be easily accessed and serviceable.
- J. The pool heater shall have an independent laboratory rating for Oxides of Nitrogen (NOx) of less than 30 ppm corrected to 3% O₂.
- K. The pool heater shall be provided with the following venting system
- L. DirectAire Vertical with Sidewall Air Inlet: Installed indoors with an optional venting kit to allow use of a vertical negative draft Type "B" vent to the rooftop and an additional air inlet pipe to draw combustion air from the sidewall. Air inlet pipe not to exceed 50 equivalent feet in length.
- M. The entire pool heater shall be furnished with a 3 Year Limited Warranty. This warranty shall provide three years of protection on the heat exchanger and two full years on all other components.
- N. Acceptable Manufacturers:
1. Lochinvar Corporation.
 2. Raypak, Inc.
 3. Teledyne Laars.

2.3 SAFETY AND RELIEF VALVES

- A. Water Relief Valves: Provide water relief valves as indicated, of size and capacity as selected by Installer for proper relieving capacity, constructed in accordance with ASME Boiler and Pressure Vessel Code:
1. Pressure Relief Valves: Construct of bronze body, metallic disc, metal seat, with nonmechanically guided stem. Set valve to relieve at 10 PSI above operating pressure.

2. Acceptable Manufacturers:
 - a. Amtrol, Inc.
 - b. Bell & Gossett ITT.
 - c. Spirax Sarco Co.
 - d. Watts Regulator Co.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which boilers are to be installed, and substrate which will support boilers. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF BOILERS

- A. General: Install boilers in accordance with manufacturer's installation instructions, in accordance with State and local code requirements, and in accordance with requirements of local Utility Company. Install units plumb and level, to tolerance of 1/8" in 10' - 0" in both directions. Maintain manufacturer's recommended clearances around and over boilers.
- B. Support: Install boilers on 4" thick concrete pad, 4" larger on each side than base of unit.
- C. Erection: Assemble boiler sections in proper sequence and with sealing between each section. Assemble boiler trim shipped loose, or unassembled for shipment purposes. Follow manufacturer's installation instructions.
- D. Electrical Work: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
 1. Verify that electrical work installation is in accordance with manufacturer's submittal and installation requirements of Division-16 sections. Do not proceed with equipment start-up until electrical work is acceptable to equipment Installer.
- E. Venting: Verify venting requirements for pressure regulating valves in factory installed or factory supplied valve trains. Extend atmospheric vent to outdoors, full size of vent outlet when equipment is controlled by spark ignition. When equipment has standing pilot, pipe regulator vent(s) to combustion chamber. Verify regulator venting requirements with local authority prior to installation.

3.3 BOILER START-UP AND TEST REQUIREMENTS

- A. At a time requested by the Installing Contractor, the boiler representative shall adjust and start boiler. Copies of the starting report shall be sent to the Architect/Engineer prior to final inspection and shall include the following information for each boiler:
 1. Temperature and pressure settings of the boiler.
 2. Heating system water pressures, cold and hot.
 3. Gas pressure setting.
 4. Gas volume being burned.
 5. Percent CO(2) and CO.

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- B. A component and integrated check shall be made of all controls. Factory tests do not substitute for this test. A foreman or superintendent of the Installing Division-15 Contractor familiar with the system shall also be present and witness this test.
- C. Thermal efficiency shall be 80% minimum with CO(2) at a 9% minimum. Presence of CO in flue gas or high stack temperature will require corrective action by the Contractor.
- D. Contractor shall request and obtain inspection and written approval of the installation by the State Division of Labor prior to building occupancy.

3.4 SAFETY AND RELIEF VALVES

- A. Water Relief Valves: Install as indicated on top of boilers. Pipe discharge to floor drain.

END OF SECTION 15550

SECTION 15560 - ELECTRIC HEATING TERMINALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.
- B. Division-16 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK

- A. Types of electrical heating terminals in this section include the following:
 - 1. Propeller unit heaters.
 - 2. Corrosion resistant propeller unit heaters.
 - 3. Cabinet heaters.

PART 2 - PRODUCTS

2.1 PROPELLER UNIT HEATERS

- A. Materials and Equipment: Except as otherwise indicated, provide manufacturer's standard electric propeller unit heater materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.
- B. Heating Elements:
 - 1. General: Except as otherwise indicated, provide manufacturer's standard elements of indicated duty and rated for indicated capacity, consisting of resistance elements in steel sheath with extended fins, or in spiral sheath.
 - 2. Casings: Provide casings braced and reinforced to provide required stiffness, and containing heating element supports. Provide rounded corners. Phosphatize and paint casings inside and out with single coat of baked-on enamel; zinc plate hardware. Include fan orifice (venturi) in casing, as well as threaded hanger connections (weld nuts). Fabricate from 18-gage steel.
- C. Air Deflectors: Provide manufacturer's standard air deflectors.
- D. Motors:
 - 1. Motors: Provide totally enclosed shaded-pole, or permanent-split capacitor motors, class "B" insulation, resiliently mounted, tap wound with built-in thermal overload protection, sleeve bearings, or permanently lubricated ball bearings. Electrical characteristics: 120-volt, 60 Hz, single phase.
 - 2. Internal Wiring: Provide high temperature, heat-resistant wiring enclosed in flexible metal conduit extending from terminal junction box to electrical devices. Provide fuses in motor and control circuit wiring.

- E. Fans:
 - 1. General: Provide aluminum propeller fans, balanced statically and dynamically of indicated capacity. Provide fans suitable for standard or sparkproof application.
 - 2. Vibration Isolation: Refer to Division-15 sections.

- F. Acceptable Manufacturers:
 - 1. Berko Electric.
 - 2. Erircraft Mfg Co, Inc.
 - 3. Markel Electric Heating.
 - 4. Q'Mark.
 - 5. Trane Co.

2.2 CORROSION RESISTANT PROPELLER UNIT HEATERS

- A. Materials and Equipment: Provide manufacturer's corrosion resistant electric propeller unit heater materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.

- B. Heating Elements:
 - 1. General: Provide manufacturer's corrosion resistant elements of indicated duty and rated for indicated capacity, consisting of resistance elements composed of 316 stainless steel finned tubular elements.
 - 2. Casings: Provide casings braced and reinforced to provide required stiffness, and containing heating element supports. Provide rounded corners. Fabricate from 304 stainless steel.

- C. Air Deflectors: Provide manufacturer's corrosion resistant air deflectors.

- D. Motors:
 - 1. Motors: Provide totally enclosed, epoxy painted, shaded-pole, or permanent-split capacitor motors, class "B" insulation, resiliently mounted, tap wound with built-in thermal overload protection, permanently lubricated ball bearings. Electrical characteristics: 120-volt, 60 Hz, single phase.
 - 2. Internal Wiring: Provide high temperature, heat-resistant wiring enclosed in flexible metal conduit extending from terminal junction box to electrical devices. Provide fuses in motor and control circuit wiring.

- E. Temperature Controls:
 - 1. Provide epoxy sealed over temperature cut out, internal thermostat, and pilot light.

- F. Fans:
 - 1. General: Provide epoxy coated, aluminum propeller fans, balanced statically and dynamically of indicated capacity. Provide fans suitable for sparkproof application.

- G. Acceptable Manufacturers:
 - 1. Berko Electric.
 - 2. Markel Electric Heating.
 - 3. Q'Mark.

4. Trane Co.

2.3 CABINET HEATERS

- A. Materials and Equipment: Except as otherwise indicated, provide electric cabinet heater manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.

- B. Heating Elements:

1. General: Except as otherwise indicated, provide manufacturer's standard elements of indicated duty and rated for indicated capacity, consisting of resistance elements in steel sheath with extended fins, or in spirally finned sheath.
2. Cabinets: Provide cabinets braced and reinforced to provide required stiffness, and containing adjustable heating element supports. Provide 1/2" thick, 2-lb density, glass fiber insulation on interior of front panel. Phosphatize and paint cabinets inside and out with single coat of baked-on primer. Include discharge air grilles in cabinet, die formed with fixed directional louvers. Provide cabinets with removable front panels secured by slide bolt, camlock or Phillips head screws. Fabricate from 16-gage galvanized steel.

- C. Motors:

1. General: Provide shaded-pole or permanent-split capacitor motors, resiliently mounted, tap wound with built-in thermal overload protection, and of permanently lubricated type. Electrical characteristics: 120-volt, 60 Hz, single phase.
2. Motor Controls: Provide multi-speed motor control switch with OFF position, mounted behind access door.
3. Motor Controls: Provide remote wall mounted, multi-speed motor control switch with OFF position.
4. Internal Wiring: Provide high temperature, heat-resistant wiring in flexible metal conduit from terminal junction box to electrical devices. Provide fuses in motor and control circuit wiring.

- D. Fans:

1. General: Provide double width, double inlet centrifugal fans, balanced statically and dynamically, of indicated capacity. Connect fan to a single or double extended motor shaft, with fan, housing and motor mounted as an integral assembly on motorboard.
2. Construction:
 - a. Wheels: Talc-filled polypropylene or aluminum.
 - b. Housing: Galvanized steel.
 - c. Motorboard: Galvanized steel.
3. Vibration Isolation: Provide devices of types and sizes recommended by manufacturer, except as otherwise indicated.

- E. Acceptable Manufacturers:

1. Berko Electric.
2. Erincraft Mfg. Co.
3. Markel Electric Heating.
4. Q'Mark.
5. Trane Co.

PART 3 - EXECUTION

3.1 INSTALLATION OF HEATING TERMINALS

- A. Install heating terminal units as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices; complying with applicable installation requirements of NEC and NECA's "Standard of Installation".
- B. Coordinate with other electrical work, including wiring/cabbling work, as necessary to properly interface installation of heating terminal units with other work.
- C. Clean dust and debris from each heating terminal as it is installed to ensure cleanliness.
- D. Comb out damaged fins where bent or crushed before covering elements with enclosures.
- E. Touch-up scratched or marred heating terminal enclosure surfaces to match original finishes.
- F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A.

3.2 GROUNDING

- A. Provide equipment grounding connections as indicated. Tighten connections to comply with tightening torque values specified in UL Std 486A to assure permanent and effective grounds.

3.3 TESTING

- A. Upon completion of installation of heating terminals and after building circuitry has been energized, test heating terminals to demonstrate capability and compliance with requirements. Where possible, field correct malfunctioning units, then retest to demonstrate compliance.

END OF SECTION 15560

SECTION 15600 - REFRIGERATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

- A. Types of equipment specified in this section include the following:
 - 1. Condensing Units.

1.3 SUBMITTALS

- A. Provide refrigerant piping diagrams to the Engineer for review prior to installation. Diagram shall include schematic routing showing distances, offsets, pipe sizes, traps, pipe slopes, and all components. Installing contractor shall have the condenser or condensing unit manufacturer review and approve the installation diagram prior to submittal to the Engineer.

1.4 REGULATIONS

- A. Refrigeration systems or appliances shall:
 - 1. Be equipped with a fully protected and isolatable receiver or condenser of sufficient capacity to hold the complete refrigerant charge during servicing or repairs. This requirement shall apply only to systems and appliances with 50 pounds or greater of the manufacturer's recommended/estimated charge. However, refrigeration systems with less than 50 pounds capacity shall be equipped with suitable access valve(s) in order to provide for recovery of refrigerant charge if necessary.
 - 2. Be equipped with a system of relief valves, including reseatable relief valve and non-fragmenting disk, designed to automatically reseal after activation, to minimize refrigerant losses in the case of equipment breakdown or failure.
 - 3. Be installed meeting, at a minimum, the applicable requirements set forth in the ASHRAE Guideline 3-1990.

PART 2 - PRODUCTS

2.1 RESIDENTIAL AIR-COOLED CONDENSING UNITS

- A. General: Provide factory-assembled and tested air-cooled condensing units as indicated, consisting of compressor, condenser coil, fan, motor, refrigerant reservoir, and operating controls. Provide capacity and electrical characteristics as scheduled.

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- B. Casing: Provide 18 gauge galvanized steel casing finished with baked enamel. Provide removable panel for access to controls, and weep holes for water drainage. Provide base with mounting holes. Provide brass service valves, fittings, and gage ports on exterior of casing.
- C. Compressor: Provide welded hermetic with built-in overloads and vibration isolation. Provide for compressor motor, thermal and current-sensitive overload device, internal high-pressure protection, high and low pressure cutout switches, start capacitor and relay, 2-pole contactor, crankcase heater, and temperature actuated switch and timer to prevent compressor rapid cycle.
- D. Condenser: Construct coil of copper tubes and aluminum fins, provided with liquid accumulator and liquid subcooler. Provide aluminum propeller fan, direct driven, with permanently lubricated fan motor with thermal overload protection.
- E. Accessories: Provide the following accessories:
 - 1. Low-voltage thermostat and subbase to control condensing unit and evaporator fan.
 - 2. Precharged and insulated suction and liquid tubing of length indicated.
 - 3. Head pressure control to modulate condenser fan motor speed for low ambient conditions.
 - 4. Heat reclaim device providing preheating of domestic hot water with hot gas from condensing unit.
 - 5. Low voltage control transformer.
 - 6. Hail Guards: Provide manufacturer's coil guards for condenser coil protection.
 - 7. Low ambient controls.
- F. Acceptable Manufacturers:
 - 1. Carrier A/C Group, Carrier Corp.
 - 2. Mcquay International
 - 3. Trane Co., The.
 - 4. York International

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF CONDENSING UNITS

- A. General: Install condensing units in accordance with manufacturers installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Support: Install ground-mounted units on 4" thick reinforced concrete pad, 4" larger on each side than condensing unit. Anchor unit to pad using inserts or anchor bolts. Install roof-mounted units on mechanical equipment stand, constructed in accordance with NRCA Handbook. Anchor unit to structural frame with removable fasteners. Install roof-mounted units on 4" high concrete pad, 4" larger on each side than condensing unit. Cast anchor bolt inserts in pad.
- C. Electrical: Furnish electrical field-wiring diagrams to Electrical Installer for power wiring to condensing units, and control wiring for field-mounted controls. Wiring; not work of this section.

- D. Residential Units: Connect pre-charged refrigerant tubing to unit's quick-connect fittings. Run tubing so as not to interfere with access to unit.
- E. Start-up condensing units, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.3 ADJUSTING AND CLEANING

- A. Cleaning: Clean units thoroughly before filling for start-up. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
- B. Start-up: Comply with manufacturer's instructions for filling and start-up of operation, but not less than the following:
 - 1. Verify lubrication of rotating parts; lubricate as needed.
 - 2. Verify fan rotation direction.
 - 3. Verify that motor amperage is in accordance with manufacturer's data.
 - 4. Balance water flow.
- C. Operation Test: Test each unit to show that it will operate in accordance with indicated requirements.

3.4 CLOSEOUT PROCEDURES

- A. Provide services of manufacturer's technical representative for one 8-hour day to instruct Owner's personnel in operation and maintenance of refrigeration equipment.

END OF SECTION 15600

SECTION 15750 - AIR HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

- A. Types of air handling units specified in this section include the following:
 - 1. Blower Coil AHU.

PART 2 - PRODUCTS

2.1 BLOWER COIL AIR HANDLING UNIT

- A. General: Provide factory fabricated, factory tested air handlers as indicated herein.
- B. Casing:
 - 1. Casings shall be constructed of 18-gauge galvanized steel, insulated with one-inch, 1-1/2 lb. density fiberglass fire resistant and odorless glass fiber material to provide thermal and acoustical insulation.
 - 2. Fan housing sides shall be directly attached to the air handler top and bottom panels. Coil access panels shall be located on both sides of the air handler to allow easy removal of the internal coils and drain pan. Main access panels provide access to the fan, motor and drive from both sides of the air handler.
- C. Water Coils:
 - 1. Cooling coils shall be two, four or six-row, chilled water. Heating coils shall be one, two, four or six-row hot water. They shall be factory installed in the preheat or reheat position.
 - 2. All water coils shall be 12 fins per inch. All water coils shall use aluminum fins, mechanically bonded to seamless copper tubes.
 - 3. All coils shall be specifically designed and circuited for water use.
 - 4. All coils shall be factory tested with 450 psi air under water. Maximum standard operating conditions shall be 300 psig, 200° F.
 - 5. Sweat type connections shall be standard.
- D. Direct Expansion Coils:
 - 1. DX coils shall use refrigerant 22 and have 1/2" OD x 0.016" W round seamless copper tubes expanded into full fin collars for permanent fin-tube bond. DX coils shall use aluminum fins, mechanically bonded to seamless copper tubes. The coil casing shall be 16-gauge galvanized steel.

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2. Suction headers shall have bottom connections to aid drainage of any oil that may collect in the coil. Liquid line and suction connections to be outside the unit casing (on the same side of the unit) to facilitate field piping.
3. Coils shall have a single venturi type distributor assembly designed with a vertical downflow feed for low pressure drops.
4. Coils shall be proof tested at 450 psig and leak tested at 300 psig air-under-water. Coils shall be dehydrated and sealed with a dry nitrogen charge. Coils shall be designed and tested per ARI 410.

E. Electric Coils:

1. The electric coil shall be made of ceramic, have a NEMA 1 rating, and shall be factory mounted. Provide a UL recognized resistance open-wire heater with a disc-type automatic thermal primary safety device. One or two stages of control to be available. A single-point power connection to the unit to be provided.

F. Fans:

1. Fans shall be centrifugal blower type equipped with heavy-duty adjustable speed V-belt drive. The fan shaft shall be supported by heavy duty, permanently sealed ball bearings. All fans to be dynamically balanced.

G. Drain Pan:

1. The drain pan shall be noncorrosive and double-sloped to allow condensate drainage. The drainpan construction shall be polymer or optional stainless steel.
2. Coils to mount above the drain pan, not in the drain pan to allow the drain pan to be fully inspected and cleaned. The drain pan shall also be removable for cleaning.
3. The polymer drain pan connections shall be unthreaded ¾" schedule 40 PVC for solvent bonding. The stainless steel drain pan connection shall be ¾" NPT schedule 40 stainless steel pipe. An auxiliary drain connection shall be provided on the same side as the main connection.

H. Filters:

1. One-inch standard efficiency throwaway and two-inch pleated standard efficiency (30%) shall be available on all blower coil units.
2. Units shall have a standard flat filter rack that is sized for less than 500 feet per minute at nominal airflow. An optional angle filter rack shall be sized for less than 300 feet per minute at nominal airflow.
3. All units and filter racks shall use standard filter sizes.

I. Motors:

1. Single-phase motors:
 - a. Three phase motors for 460 voltage operation.
 - b. All motors shall have a plus or minus 10% voltage utilization range.
 - c. All standard motors to be open drip proof with permanently sealed ball bearings, internal current and thermal overload protection, a minimum 1.15 service factor and 56 frame resilient bases.
 - d. Motors shall be factory installed and wired to the air handler junction box.

J. Mixing Box:

1. Mixing boxes shall be constructed of heavy-gauge galvanized steel, complete with two low-leak parallel blade dampers that are factory linked together.

2. A ½" extendible drive rod shall be provided that can be used for actuator connection, either internally or externally.
3. Damper blades to be extruded aluminum having interlocked PVC extruded edge seals.
4. Damper frame seals to be PVC extruded forms interlocked to the damper frame and provided with a continuous edge seal to the blades. Damper seals shall be stable in the temperature range of -50° F to 230° F.
5. Mixing boxes shall also include two side access panels to provide access to the unit's internal components.

K. Acceptable Manufacturers

1. Trane
2. York
3. Carrier
4. McQuay

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which air handling units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF AIR HANDLING UNITS

- A. General: Install air handling units where indicated, in accordance with equipment manufacturer's published installation instructions, and with recognized industry practices, to ensure that units comply with requirements and serve intended purposes.
- B. Support: Install indoor mounted air handling as indicated on drawings. Coordinate type of support with General Contractor prior to installation.
- C. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-16 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.3 INSTALLATION OF FILTERS

- A. General: Comply with installation requirements as specified elsewhere in these specifications pertaining to air filters housing/casings, and associated supporting devices.
- B. Install air filters and holding devices of types indicated, and where shown; in accordance with air filter manufacturer's written instructions and with recognized industry practices; to ensure that filters comply with requirements and serve intended purposes.
- C. Locate each filter unit accurately in position indicated, in relation to other work. Position unit with sufficient clearance for normal service and maintenance. Anchor filter holding frames securely to substrate.

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- D. Coordinate with other work including ductwork and air handling unit work, as necessary to interface installation of filters properly with other work.

3.4 FIELD QUALITY CONTROL

- A. Testing: Upon completion of installation of air handling units, start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning units, then retest to demonstrate compliance.

3.5 EXTRA STOCK

- A. Provide one complete extra set of filters for each air handling unit. Install new filters at completion of air handling system work, and prior to testing, adjusting, and balancing work. Obtain receipt from Owner that new filters have been installed.
- B. Provide one spare set of belts for each belt-driven air handling unit, obtain receipt from Owner that belts have been received.

END OF SECTION 15750

SECTION 15770 - DEHUMIDIFICATION UNIT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

- A. Types of equipment specified in this section include the following:
 - 1. Natatorium Dehumidification/Heat Recovery Unit.

1.3 QUALITY ASSURANCE

- A. The unit shall be specifically designed, manufactured and tested for special dehumidification duty. Field assembled or modified standard commercial grade equipment is not acceptable. Complete unit shall be weatherproofed for outdoor installation and also suitable for indoor mounting.
- B. Manufacturer shall have five years prior experience making similar equipment as described in this specification.

PART 2 - PRODUCTS

2.1 NATATORIUM DEHUMIDIFICATION/HEAT RECOVERY UNIT

- A. Design Intent
 - 1. Provide pool dehumidification air handler with energy recovery. System is designed to use outside air for dehumidification. Systems using only refrigerant- based dehumidification are not acceptable. Provide air volumes as scheduled and provision for all modes of operation including 100% OA purge mode.
- B. Casing:
 - 1. General. Construct unit as specified herein. Single wall and 1" double wall casing are unacceptable. Fans and coils must be removable without dismantling the structural framing of the unit. Unit shall be suitable for outdoor installation.
 - 2. Base: Construct base of welded structural steel channel with integral lifting lugs. Bolted bases are unacceptable. Coat base with 2 part epoxy primer and urethane modified enamel top coat.
 - 3. Casing: Unit shall have 2" double-wall steel casing. For construction where casing is not load bearing exterior shall be minimum 18 ga. and interior shall be minimum 20 ga. If casing is load bearing exterior shall be minimum 16 ga. and interior shall be minimum 18 ga.
 - 4. Coatings: Exterior casing shall be galvanized G90. Galvanized exterior is unacceptable if unit casing or framework is welded. Interior casing shall be coated with baked polyvinyl corrosion resistant coating. All steel parts exposed to the pool airstream coated with Heresite VR500.

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5. Insulation: Insulate unit with 2" thick 1½ lb/ft³ fiberglass insulation. No insulation shall be exposed to the air stream. All interior walls, floor, and roof shall be double wall and insulated.
6. Casing insertion loss. The insertion loss, per octave band, for the casing shall not be less than the following:

Frequency:	63	125	250	500	1000	2000	4000	8000
Insertion loss, dB:	24.8	24.1	22.3	24.7	26.1	29.0	31.2	33.1

Provide verifying test results from lab accredited by the US Dept. of Commerce and the National Institute of Standards and Technology (NIST). Insertion loss verification shall be in accordance with ISO 3746: 1975 Acoustics-survey (comparison) method.

7. Access Doors: Access doors shall be insulated double wall with stainless steel piano hinges, minimum two compression latches, and minimum 24" clear opening width. Supply and exhaust air streams shall not be covered by a single door. Provide doors for access to filters, fans, heat exchangers and any area requiring access for routine maintenance. Access panels in lieu of access door are unacceptable. Provide gutters over all doors on outdoor units.
8. Weather hoods (for outdoor units): Provide weather hoods and bird screens over all exposed inlets and outlets. Ship hoods loose for installation in the field.
9. Roof (for outdoor units): Provide roof with standing seam construction. Pitch roof to ensure water drainage.

C. Flat Plate Heat Exchanger

1. Provide cross flow flat plate heat exchanger banks with performance as scheduled. Counter flow heat exchangers and dimpled plate heat exchangers are unacceptable due to high pressure drop and fouling concerns.
2. Maximum operating differential pressure of no less than 10" wc at 70°F. Maximum operating temperature no less than 400°F.
3. Construct heat exchanger with aluminum framing and MINIMUM 0.008" thick, 99.5% pure aluminum plates. Steel framing unacceptable due to corrosion concerns.
4. Entire heat transfer surface shall be visible for inspection and cleaning without disassembling the heat exchanger.
5. Provide separate drain pans under supply and exhaust sides of heat exchanger. Terminate drain pan connections through the bottom of the unit. Drain lines must be properly trapped and freeze protected by the installing contractor.

D. Blower/Motor

1. General: Fans shall be provided with performance rated according to AMCA 210. All fans shall have pillow block bearings with minimum L-50 200,000 hour rating. Entire fan shall be coated with air dried epoxy or phenolic.
2. Blowers: Supply blower shall be Class II plenum type with AF wheel. Exhaust blowers shall be Class II plenum type with AF wheel.
3. Motors: Motors shall be 3 phase TEFC with NEMA frame and 1.15 service factor. Motor base shall be adjustable. Motor brake horsepower shall not exceed scheduled values. Fan brake horsepower shall not exceed 85% of motor horsepower. All motors shall comply with EPACK efficiency requirements. Provide exhaust motor VFD with manual bypass.
4. Drives: Drives shall be adjustable for 10hp motors and smaller, fixed for 15 hp motors and larger. All drives shall be minimum 2-groove with 2 belts and minimum 1.2 service factor.
5. Isolation: Blower and motor shall be mounted on a unitary base with 1" housed seismic rated spring isolators.
6. Accessories:
 - a. Lube Lines: Provide extended lube lines for fans/motors. Terminate lube lines inside nearest access door.

E. Dampers

1. General: Provide low leakage type motorized dampers with galvanized steel or aluminum frame as specified below, vinyl edge seals, metal jamb seals, and stainless steel bearings. Provide gravity dampers with aluminum frame, aluminum blades, extruded vinyl edge seals, and synthetic bearings.
2. The following dampers shall be provided:
 - a. Outside air dampers for modulating OA and purge mode. Parallel blade type. Actuators by manufacturer.
 - b. Outside air face/bypass dampers (heat exchangers), parallel blade type. Actuator by Manufacturer.
 - c. Exhaust air bypass dampers (heat exchanger), parallel blade type. Actuator by manufacturer. Aluminum construction.
 - d. Aluminum return damper, parallel blade type. Actuator by manufacturer.
 - e. Aluminum exhaust gravity damper.

F. Filters

1. Outside air filter: Provide 2" Farr 30/30 (or equal) filter bank at the outside air inlet of the heat exchanger. Mount in side access slide rack and size for 500 fpm maximum face velocity.
2. Aluminum filter. Provide 2" washable aluminum filter bank in the location shown on unit drawing. Mount in side access rack and size for 650 fpm maximum face velocity.

G. Heating Water Coil

1. Coil shall be factory mounted and constructed of copper tubes and copper fins.
 - a. Copper fins with copper end sheets, frame and intermediate supports. Coil construction of dissimilar metals such as copper/aluminum/galvanized steel/stainless steel or plastic/vinyl coated coils shall not be acceptable. (Standard)
 - b. 0.006 inch thick polyester precoated aluminum fins with galvanized steel and sheets, frame and intermediate supports.
2. All nuts and bolts and lock washers shall be Cadmium plated. All sheet metal screws shall be Empigard coated Cadmium plated sheet.
3. All tubes shall be expanded into fin collars. All joints shall be brazed. The coil shall be tested to 320 PSIG while submerged in water. The coil shall be dried and sealed. Its inside shall be commercially free of oxides and foreign matter. Coil assembly shall be 1600 PSIG ultimate strength.
4. Hot water flow through or by-passing this coil shall be controlled by a factory installed three way flow valve. This valve shall be controlled by the unit's control system.

H. Heating

1. Indirect fired gas heater. Provide gas heat section with stainless steel primary and secondary heat exchangers, modulating gas valve with 10:1 turndown, and FM rated gas train. Enclose heater in unit double wall casing for uniform appearance and equipment life (no exceptions). Heater capacities shall be as scheduled for purge mode. Multiple AGA rated duct heaters are not allowed.

I. Cooling

1. DX cooling coil: Provide ARI rated coil with 0.02" thick seamless copper tubes and 0.0075" thick aluminum fins, pressure tested and guaranteed for 250 psi working pressure. Provide bitumastic

coated IAQ drain pan under the coil extending past the coil to ensure condensate retention. Coil shall be coated with baked phenolic.

2. Integral condensing section: Provide integral air cooled condensing system factory piped, wired, charged, and tested. Provide TXV's, sight glasses, filter driers, and liquid line solenoids and other valves and specialties as required. Provide two stages of control.
 - a. Provide hermetic scroll type compressors with suction and discharge service valves, reverse rotation protection, sight glass, oil level adjustment, oil filter, rotary dirt trap, non-short cycling control, and high and low pressure limits.
 - b. Provide condenser coils with galvanized casing, seamless copper tubes, and aluminum fins.
 - c. Condenser fans shall be direct drive with fan guards.
 - d. Independent circuits shall be provided completely tested, dehydrated, and fully charged with R-22 and oil.

J. Electrical

1. Wire units according to NEC and ETL list the entire unit. ETL listing of electrical panel only is unacceptable. All major electrical components shall be UL listed. Factory wire unit for single point power connection. Enclose all power wiring in liquid tight conduit.
2. Provide fused disconnect, fan motor starters/protectors, contactors, control transformer, control circuit fusing, service switch, and terminal block.
3. Provide NEMA 3R electrical/control panel.
4. Factory test wiring and controls before shipment.

K. Controls/Sequence of Operation

1. The pool dehumidification unit manufacturer provides all the controls for the unit.
2. Refer to the sequence of operations in specification 15900 for requirements.

L. Acceptable Manufacturers:

1. Des Champs, Inc.
2. Innovent.
3. Engineered Air.
4. Alternate Manufacturers:
 - a. Alternate manufacturers must provide a list of 5 successful installations in the Denver area of similar size and application. This list must include owner contacts (name and phone number), date of installation, and description of the equipment including heating/cooling systems, dehumidification capacity, airflow capacity, and ventilation air capacity.
 - b. Project is based on the specified equipment. Any additional costs associated with using alternate manufacturer's equipment shall be borne by the installing contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with manufacturer's printed instructions except where more stringent requirements are shown or specified, and except where manufacturer's technical representative directs otherwise.
- B. Install unit where shown on drawings. Provide three feet clearance around sides and four feet around compressor compartment of unit for air flow and service.

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- C. Provide and install all water piping, drains and controls for proper operation of unit.

3.2 START-UP

- A. Start-up service shall be provided by the equipment manufacturer's authorized representative and shall include complete testing of all controls and unit operation. The agency responsible for start-up shall record the refrigeration pressures and electrical operating data. Copies of this data are to be supplied to the owner.
- B. All units shall be thoroughly cleaned by the installing contractor in accordance with the manufacturer's instructions prior to being placed into service.
- C. A complete operating and maintenance manual, including wiring diagrams, start-up and operating sequence and material list shall be provided to the owner.
- D. The owner shall be provided with complete instruction of operating and maintenance procedures.

3.3 WARRANTY

- A. One year parts and material and labor warranty on the entire unit.
- B. Drive Line Warranty - A four year extended parts warranty shall be provided on the:
 - 1. Compressors
 - 2. Compressor Motor Contactors
 - 3. Fan Motors
 - 4. Fan Motor Starters
 - 5. Pool Water Condenser
 - 6. Pool Water Condenser Solenoid Valves & Coils
 - 7. Liquid Expansion Solenoid Valves & Coils
 - 8. Air Condenser Solenoid Valves & Coils
 - 9. Blowers, Wheels & Housings
- C. AutoGuard Service - For units equipped with a modem and phone line, the manufacturer shall call the unit once a week for the first two years and download the fault code history log as well as review the performance and status of the unit. If a problem is detected, the manufacturer's service department shall call the owner's representative to further diagnose and solve the problem.

END OF SECTION 15770

SECTION 15800 - AIR DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

- A. Types of equipment specified in this section include the following:
 - 1. Metal Ductwork.
 - 2. Ductwork Accessories.
 - 3. Grilles, Registers & Diffusers.
 - 4. Louvers and Dampers.
 - 5. Rooftop Heating & Cooling Units.
 - 6. Fans.
 - 7. Ventilators.

1.3 SUBMITTALS

- A. Within 30 days after award of contract, submit a shop drawing for approval to the structural engineer showing size and location of all openings through structural members. Do not proceed until the shop drawing has been reviewed, approved and returned.
- B. Submit engineered sizing calculations of flue manufacturer. Calculations shall be based on actual equipment used by the successful contractor, layout and arrangement of equipment, etc.

1.4 SPECIAL PROJECT WARRANTY

- A. Warranty on Compressor and Heat Exchanger: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, compressors and/or heat exchangers with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.
 - 1. Warranty Period: 5 years from date of substantial completion.

1.5 TEST AND BALANCE COORDINATION

- A. Prior to starting work, the contract documents shall be given to the Test and Balance contractor for his review. If there are any areas of the air distribution system that cannot be balanced, due to the configuration of the system, a Request for Clarification shall be made in a timely manner to allow revisions to the documents before the systems are installed.

PART 2 - PRODUCTS

2.1 METAL DUCTWORK

- A. Galvanized Sheet Metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ASTM A 527, lockforming quality; with G 90 zinc coating in accordance with ASTM A 525; and mill phosphatized for exposed locations.
- B. Aluminum sheet: Where indicated, provide aluminum sheet complying with ASTM B 209, Alloy 3003, Temper H14.

2.2 MISCELLANEOUS DUCTWORK MATERIALS

- A. General: Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.
- B. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, stains and discolorations, and other imperfections, including those which would impair painting.
- C. Fittings: Provide radius type fittings fabricated of multiple sections with maximum 15 degree change of direction per section. Unless specifically detailed otherwise, use 45 degree laterals and 45 degree elbows for branch takeoff connections. Where 90 degree branches are indicated, provide conical type tees.
- D. Duct Liner: Fibrous glass, complying with Thermal Insulation Manufacturers Association (TIMA) AHC-101; of 1" thick. The liner shall meet the Life Safety Standards as established by NFPA 90A and 90B. The 1" duct liner shall conform to the requirements of ASTM C 1071, with a NRC not less than .70 and a thermal conductivity no higher than .25 at 75°F mean temperature. The surface coating shall contain an immobilized EPA registered anti-microbial agent as tested in accordance with ASTM-G-21 and 423 "Type A Mountain." Shop or field cut of insulation shall be coated with a sealant approved for use in duct systems.
- E. Round Duct Liner: Fibrous glass, complying with Thermal Insulation Manufacturers Association (TIMA) AHC-101; of 1" thick. The liner shall meet the Life Safety Standards as established by NFPA 90A and 90B. The 1" duct liner shall conform to the requirements of ASTM C 1071, with a NRC not less than .70 and a thermal conductivity no higher than .25 at 75°F mean temperature. The surface coating shall contain an immobilized EPA registered anti-microbial agent as tested in accordance with ASTM-G-21 and 423 "Type A Mountain." Shop or field cut of insulation shall be coated with a sealant approved for use in duct systems. The liner shall be provided with factory-made, evenly spaced kerfs to allow the material to conform to the inside diameter of round air ducts.
- F. Duct Sealant: Non-hardening, non-migrating mastic or liquid elastic sealant, type applicable for fabrication/installation detail, as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork.
- G. Duct Cement: Non-hardening migrating mastic or liquid neoprene based cement, type applicable for fabrication/installation detail, as compounded and recommended by manufacturer specifically for cementing fitting components, or longitudinal seams in ductwork.
- H. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.

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1. Except where space is indicated as "High Humidity" area, interior support materials of not less than 1/4" diameter or 3/16" thickness may be plain (not galvanized).
 2. For aluminum ductwork, provide aluminum support materials except where materials are electrolytically separated from ductwork.
- I. Flexible Ductwork:
1. Low Pressure Flexible Ducts: Duct shall be factory pre-insulated with a solid inner liner formed by a reinforced aluminum laminate material mechanically locked or bonded together by a corrosive resistant galvanized steel helix, covered with a minimum 1-1/2" thick fiberglass blanket and sheathed in a polyethylene vapor barrier. The insulation shall have a maximum 0.23 "C" factor, to meet FHA/HUD requirements and a vapor barrier permeability of 0.10 perms (ASTM E96-Procedure A). The duct shall have a positive working pressure rating of 6" w.g. (all diameters), negative working pressure rating of 1" w.g. (all diameters) and at a maximum operating temperature of 180°F (all diameters). Pressure rating based on test with temperature and velocity applied. the duct shall comply with the latest NFPA 90A Bulletin and be UL-181 listed as a Class I Air Duct.
 2. Acceptable Manufacturers:
 - a. Flexmaster.
 - b. Glenflex.
 - c. Hercules Industries.
- J. Spin-in Fittings: Conical, bellmouth spin-in fittings may be used for duct taps and shall include quadrant dampers on all lines to air devices (diffusers and grilles) even though a volume damper may be specified for the air device. (This does not apply for high pressure duct). The spin collar fitting shall be made from G-90 galvanized sheet metal. The construction shall have a fabricated minimum overall length of 7". The location of spin-in fittings in the ducts shall be determined after terminals are hung or the location of the light fixtures is known so as to minimize flexible duct lengths and sharp bends.
- K. Underslab Ducts: For ductwork placed in concrete slabs, or under slab on grade, fabricate ductwork of one of the following materials:
1. Galvanized Steel.
 2. Vinyl Chloride Coated Steel.
 3. Stainless Steel.

2.3 DUCTWORK FABRICATION

- A. Shop fabricate ductwork of gages and reinforcement complying with SMACNA "HVAC Duct Construction Standards".
- B. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with centerline radius equal to associated duct width; and fabricate to include turning vanes in elbows where shorter radius is necessary. Limit angular tapers to 30 degrees for contracting tapers and 20 degrees for expanding tapers.
- C. Fabricate ductwork with duct liner in each section of duct where indicated. Laminate liner to internal surfaces of duct in accordance with instructions by manufacturers of lining and adhesive, and fasten with mechanical fasteners.
- D. Factory Fabricated: At installer's option, provide factory-fabricated duct and fittings, in lieu of shop-fabricated duct and fittings. Factory fabricated duct shall not be less than 26 ga. and shall be constructed according to SMACNA standards.

2.4 DAMPERS

- A. Low Pressure Balancing Dampers: Provide dampers of single blade type or multiblade type, constructed in accordance with SMACNA "HVAC Duct Construction Standards".
- B. Counterbalanced Relief Dampers: Provide dampers with parallel blades, counterbalanced and factory-set to relieve at indicated static pressure. Construct blades of 16-gauge aluminum, provide 1/2" diameter ball bearings, 1/2" diameter steel axles spaced on 9" centers. Construct frame of 2" x 1/2" x 1/8" steel channel for face areas 25 sq. ft. and under; 4" x 1-1/4" x 16-gauge channel for face areas over 25 sq. ft. Provide galvanized steel finish on frame with aluminum touch-up.
- C. Acceptable Manufacturers:
 - 1. Air Balance, Inc.
 - 2. American Warming & Ventilating, Inc.
 - 3. Arrow Louver and Damper; Div. of Arrow United Industries, Inc.
 - 4. Greenheck
 - 5. Louvers & Dampers, Inc.
 - 6. Nailor Industries, Inc.
 - 7. Penn Ventilator Co.
 - 8. Pottorff.
 - 9. Ruskin Mfg. Co.
 - 10. Vent Products.

2.5 TURNING VANES

- A. Manufactured Turning Vanes: Provide turning vanes constructed of 1-1/2" wide single wall curved blades set at 3/4" o.c., supported with bars perpendicular to blades set at 2" o.c., and set into side strips suitable for mounting in ductwork.
- B. Acoustic Turning Vanes: Provide acoustic turning vanes constructed of airfoil shaped aluminum extrusions with perforated faces and fiberglass fill.
- C. Acceptable Manufacturers:
 - 1. Aero Dyne Co.
 - 2. Airsan Corp.
 - 3. Anemostat Products Div.; Dynamics Corp. of America.
 - 4. Barber-Colman Co.
 - 5. Duro Dyne Corp.
 - 6. Titus Products Division, Phillips Industries, Inc.

2.6 QUADRANT LOCKS

- A. Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.
- B. Acceptable Manufacturers:
 - 1. Ventfabrics, Inc.
 - 2. Young Regulator Co.

2.7 DUCT ACCESS DOORS

- A. General: Provide duct access doors of size required.
- B. Construction: Construct of same or greater gage as ductwork served, provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one side hinged, other side with one handle-type latch for doors 12" high and smaller, 2 handle-type latches for larger doors. Provide 12 x 12 for hand access and 24 x 24 for head and shoulder access.
- C. Acceptable Manufacturers:
 - 1. Air Balance Inc.
 - 2. Duro Dyne Corp.
 - 3. Pottorff.
 - 4. Ruskin Mfg. Co.
 - 5. Ventfabrics, Inc.

2.8 PRESSURE RELIEF DOOR

- A. Provide pressure relief door in the ductwork where indicated on the plans or where the ductwork could be subject to excessive pressure build-up due to quick closure of fire dampers. The door shall be constructed of 12 gauge galvanized steel with a 12 gage galvanized steel frame. The door shall be sealed with a ¼" thick gasket. The door shall be insulated with 1" fiberglass 1 ½ lb. insulation or as consistent with the duct insulation. The door shall have a spring-loaded mechanism to automatically close the door after pressure has been relieved. Door shall be adjustable for pressures of 3" w.c. to 8" w.c. The door pressure setting shall be adjustable in the field. The door shall be welded to the ductwork or installed with high pressure sealing cement and screws.
- B. Acceptable Manufacturers:
 - 1. Kees.
 - 2. Ruskin.

2.9 FLEXIBLE CONNECTIONS

- A. General: Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment.
- B. Acceptable Manufacturers:
 - 1. American/Elgen Co.; Energy Div.
 - 2. Duro Dyne Corp.
 - 3. Flexaust (The) Co.
 - 4. Ventfabrics, Inc.

2.10 EXTERIOR GRADE FLEXIBLE CONNECTIONS

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- A. General: Provide flexible duct connections suitable for exterior applications where ductwork connects to vibration isolated equipment. Construct flexible connections of heavy glass flameproof fabric coated with chlorosulfurated polyethylene crimped into duct flanges for attachment to duct and equipment. Make airtight weatherproof joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment.
- B. Acceptable Manufacturers:
 - 1. Ventfabrics, Inc.
 - 2. Engineer approved equal.

2.11 GRILLES, REGISTERS AND DIFFUSERS

- A. General: Except as otherwise indicated, provide manufacturer's standard air device where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Performance: Provide air devices that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- C. Ceiling/Wall Compatibility: Provide air devices with border styles that are compatible with adjacent ceiling/wall systems, and that are specifically manufactured to fit into ceiling/wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling/wall construction which will contain each type of air device.
- D. Types: Provide air device of type, capacity, and with accessories and finishes as listed on grilles, register and diffuser schedule.
- E. Acceptable Manufacturers:
 - 1. Krueger Mfg. Co.
 - 2. Metal Aire Co.
 - 3. Nailor Industries, Inc.
 - 4. Price.
 - 5. Titus Products Div.; Philips Industries, Inc.

2.12 LOUVERS

- A. General: Except as otherwise indicated, provide manufacturer's standard louvers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Performance: Provide louvers that have minimum free area as scheduled, and minimum pressure drop for each type as listed in manufacturer's current data, complying with louver schedule. Performance data must bear AMCA Certified Ratings Seal for Air Performance and Water Penetration.
- C. Substrate Compatibility: Provide louvers with frame and sill styles that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to general construction drawings and specifications for types of substrate which will contain each type of louver.
- D. Materials: Construct of aluminum extrusions, ASTM B 221, Alloy 6063-T52. Weld units or use stainless steel fasteners.

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- E. Louver Screens: On inside face of exterior louvers, provide 1/2" square mesh for outside air louvers and exhaust air louvers and 1/4" square mesh for combustion air louvers. Mesh shall be anodized aluminum wire bird screens mounted in removable extruded aluminum frames. Delete square mesh when louver is used in a return air application.
- F. Acceptable Manufacturers:
 - 1. Aiolite Co.
 - 2. Arrow United Industries, Inc.
 - 3. Dowco Corp.
 - 4. Greenheck
 - 5. Louvers & Dampers, Inc.
 - 6. Penn Ventilator Co., Inc.
 - 7. Pottorff.
 - 8. Ruskin Mfg. Co.

2.13 ROOFTOP UNITS (SMALL COMMERCIAL)

- A. General: Provide factory-assembled and tested rooftop units as indicated, designed for roof or slab mounting, consisting of compressors, condensers, evaporator coils, condenser fans, supply fans, exhaust fans, refrigeration and temperature controls, filters, and dampers. Provide capacities and electrical characteristics as scheduled.
- B. Casing: Provide manufacturer's standard casing construction, corrosion protection coating, and exterior finish. Provide removable panels and/or access doors for inspection and access to internal parts. Insulate casing with 1" thick minimum thermal insulation. Provide knockouts for electrical and piping connections. Provide condensate drain connection.
- C. Evaporator Fans: Provide forward-curved, centrifugal, belt-driven fans with adjustable sheaves or direct-driven fans; and permanently lubricated motor bearings.
- D. Condenser Fans: Provide propeller-type, direct-driven fans with permanently lubricated bearings.
- E. Coils: For evaporator and condenser, provide non-ferrous construction with aluminum plate fins mechanically bonded to seamless copper tubes; with brazed tubing joints.
- F. Compressors: Provide serviceable, semi-hermetic, or fully hermetic compressors, in accordance with manufacturer's published technical data. Provide vibration isolators and crankcase heaters. Provide hot-gas bypass valve and piping on one compressor for variable air volume systems.
- G. Safety Controls: Provide the following controls, each designed for manual reset:
 - 1. Low pressure cutout.
 - 2. High pressure cutout.
 - 3. Compressor motor overload protection.
- H. Heat Exchangers: Provide manufacturer's stainless steel for gas-fired heat exchangers and burners.
 - 1. Controls: Provide the following controls:
 - a. Redundant gas valve.
 - b. Intermittent pilot ignition.
 - c. Electronic spark ignition system.
 - d. High limit cutout.

e. Forced draft proving switch.

I. Economizer Control: Provide economizer control consisting of return and outside air dampers, outside air filter, fully modulating electric control system with dry bulb control, and adjustable mixed-air thermostat. Design system for 100% outside air capability. Provide automatic changeover through adjustable economizer control device.

J. Accessories: Provide the following accessories as indicated and/ or scheduled:

1. Curb: Provide insulated roof curb under unit, constructed in accordance with NRCA Standards. Provide seal strip between curb and unit, and wood nailer for flashing. For deck slopes, fabricate support units to form level top edge.
2. Thermostat: Provide thermostat assembly for staged heating and cooling with manual or automatic changeover on standard subbase.
3. Hail Guards: Provide manufacturer's coil guards for condenser coil protection.

K. Acceptable Manufacturers:

1. Aaon, Inc.
2. Carrier Air Conditioning; Div. of Carrier Corp.
3. McQuay International.
4. Trane Co.
5. York; Div. of Borg-Warner Corp.

2.14 IN-LINE CABINET FAN

A. Provide centrifugal in-line cabinet fan of type, size and capacity as scheduled.

B. Provide AMCA certified ratings seal.

C. Type: Provide galvanized steel housing lined with acoustical insulation, adaptable for suspended installation. Provide centrifugal fan wheels mounted on motor shaft with fan shrouds, all removable for service. Provide integral backdraft damper fan discharge.

D. Motor: Provide permanent split-capacitor motor, permanently lubricated, with grounded cord and plug.

E. Electrical: Provide junction box for electrical connection on housing, and receptacle for motor plug-in.

1. Furnish remote fan speed control, solid state, capable of controlling fan speed from full speed to approximately half speed.

F. Acceptable Manufacturers:

1. Greenheck.
2. Loren Cook Co.
3. Penn Ventilator Co., Inc.

2.15 CENTRIFUGAL ROOF VENTILATORS

A. General: Provide AMCA certified centrifugal roof type, curb mounted, power ventilators of type, size, and capacity as scheduled, and as specified herein.

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- B. Type: Centrifugal fan, direct or belt driven as scheduled. Provide aluminum, galvanized steel, or fiberglass weatherproof housings as scheduled. Provide square base to suit roof curb. Provide permanent split-capacitor type motor for direct driven fans; capacitor-start, induction-run type motor for belt driven fans.
1. Housing Design: Hooded dome type.
 2. Housing Design: Hooded low contour type.
 3. Housing Design: Upblast type.
 4. Housing Design: Louvered penthouse type.
- C. Range Hood Exhaust Fans: Fans shown on drawings to serve range hoods shall be U.L. listed for grease removal and shall have been tested under high temperature exhaust (300°F) and abnormal flare-up (600°F) conditions. The fans shall be constructed and installed in accordance with NFPA 96.
- D. Electrical: Provide factory-wired non-fusible type disconnect switch at motor in fan housing. Provide thermal overload protection in fan motor. Provide conduit chase within unit for electrical connection.
- E. Bird Screens: Provide removable bird screens, 1/2" mesh, 16- gauge aluminum or brass wire.
- F. Dampers: Provide gravity-actuated dampers in curb bases as scheduled on drawings.
- G. Acceptable Manufacturers:
1. Greenheck.
 2. Loren Cook Co.
 3. Penn Ventilator Co., Inc.

2.16 AXIAL ROOF/WALL VENTILATORS

- A. Provide AMCA certified axial roof type, curb mounted, power ventilators of type, size, and capacity as scheduled, and as specified herein.
- B. Type: Axial fan, direct or belt driven as scheduled. Provide aluminum, galvanized steel, or fiberglass weatherproof housings as scheduled. Provide square base to suit roof curb. Provide permanent split-capacitor type motor for direct driven fans; capacitor-start, induction-run type motor for belt driven fans.
1. Housing Design: Hooded dome type.
 2. Housing Design: Hooded low contour type.
- C. Electrical: Provide factory-wired non-fusible type disconnect switch at motor in fan housing. Provide thermal overload protection in fan motor. Provide conduit chase within unit for electrical connection.
- D. Bird Screens: Provide removable bird screens, 1/2" mesh, 16- gauge aluminum or brass wire.
- E. Dampers: Provide gravity-actuated dampers in curb bases.
- F. Acceptable Manufacturers:
1. American Cool Air.
 2. Greenheck.
 3. Loren Cook Co.
 4. Penn Ventilator Co., Inc.

2.17 CEILING VENTILATORS

- A. Centrifugal Ceiling Exhausters: Provide AMCA certified centrifugal ceiling exhausters, designed for ceiling or wall mounting, of type, size and capacity as scheduled.
- B. Type: Provide galvanized steel housing lined with acoustical insulation, adaptable for ceiling or wall installation. Provide centrifugal fan wheels mounted on motor shaft with fan shrouds, all removable for service. Provide integral backdraft damper at fan discharge.
- C. Grille: Provide integral grille with flange on intake with attachment to fan housing.
- D. Motor: Provide permanent split-capacitor motor, permanently lubricated, with grounded cord and plug.
- E. Electrical: Provide junction box for electrical connection on housing, and receptacle for motor plug-in.
- F. Furnish remote fan speed control, solid state, capable of controlling fan speed from full speed to approximately half speed.
- G. Accessories: Provide manufacturer's standard roof jack, wall cap, and transition fittings as indicated on drawings or schedules.
- H. Acceptable Manufacturers:
 - 1. Greenheck.
 - 2. Loren Cook Co.
 - 3. Penn Ventilator Co., Inc.

2.18 CORROSIVE AIR VENTILATION FANS

- A. General: Provide AMCA certified PVC utility fans of size, arrangement, capacities, and accessories as scheduled.
- B. Housings: Shall be constructed of strong high-density polypropylene with no air leakage and shall be field rotatable to any of the 8 standard discharge positions. Motor support stand shall be constructed of 14 gauge galvanized steel with painted finish and added foot support. All fan mounting hardware shall be stainless steel.
- C. Wheels: Provide forward curved type and constructed of polypropylene with uniform molded blades as scheduled. The fan wheel shall be supplied with a motor shaft bushing and hub cap constructed of polypropylene. Wheels shall be electronically and dynamically balanced.
- D. Shafts: Stainless steel shaft.
- E. Motors: Provide explosion proof type, UL listed motors.
- F. Accessories: Provide the following accessories as indicated and/or scheduled:
 - 1. Damper: Provide adjustable non-corroding airflow damper.
- G. Acceptable Manufacturers:
 - 1. Fan America, Inc.
 - 2. Plastec.

2.19 DIRECT VENT

- A. General: Provide two-pipe vent system, consisting of pipe sections, fittings and accessories required by manufacturer for complete installation.
- B. Material: Construct pipe of material determined by manufacturer's recommendations.
- C. Accessories: Provide manufacturer's standard accessory items or as indicated for complete installation.

2.20 TYPE B DOUBLE WALL GAS VENTS

- A. General: Provide double wall gas vents, UL-listed for Type B, consisting of double wall metal construction pipe sections, barometric damper, roof cap, fittings and accessories required for complete installation.
- B. Material: Construct inner pipe of sheet aluminum, and outer pipe of galvanized sheet steel, both of the following minimum thickness:

<u>Size</u>	<u>Inner Pipe</u>	<u>Outer Pipe</u>
Round sizes up to 6"	0.12"	28-gauge
Round sizes 7" to 18"	0.14"	28-gauge
Round sizes 20" to 24"	0.018"	26-gauge
Oval sizes up to 4"	0.012"	28-gauge
Oval sizes 5" to 6"	0.014"	28-gal

- C. Accessories: Provide manufacturer's standard accessory items or as indicated, for complete installation.
- D. Acceptable Manufacturers:
 - 1. American Metal Products Co.; Div. of Masco Corp.
 - 2. General Products Co., Inc.
 - 3. Selkirk Metalbestos.
 - 4. Van-Packer Co.

2.21 DOUBLE WALL METAL STACKS (POSITIVE PRESSURE)

- A. General: Provide double wall metal stacks of size and height as indicated, and of materials, and having accessories as specified herein, for use as a positive pressure flue system.
- B. UL-Listing: Provide double wall metal stacks, laboratory-tested and listed by UL, for use with building heating equipment burning gas, solid, or liquid fuels as described in NFPA 211.
- C. The stack system shall be designed and installed to be gas tight to prevent leakage of combustion products into the building. The system shall be designed and installed to compensate for all flue gas induced thermal expansion.
- D. Construction: Provide 1" minimum air space between walls. Construct inner jacket of Type 316 or 304 stainless steel, 0.035" thick. Construct outer jacket of aluminum coated steel of the following thickness:

1. Size 10" to 24": 0.025" thick.
 2. Size 26" to 48": 0.034" thick.
- E. Accessories: Provide accessories of types and sizes as indicated, each bearing factory-applied UL-label, and where not otherwise indicated, provide type and size required to comply with breeching connections, and spatial conditions.
1. Ventilated Roof Thimble: Consisting of ventilated thimble, ventilated flat roof flashing, and storm collar.
 2. Exit Cone: Consisting of inner cone, and outer jacket, designed to increase stack velocity of 150%.
 3. Stack Cap: Consisting of inverted cone secured to top of stack, designed for partial rain protection and low flow resistance.
- F. Acceptable Manufacturers:
1. Ampco.
 2. Metal Fab.
 3. Selkirk Metalbestos – Type PS.
 4. Stacks.
 5. Van Packer

PART 3 - EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which ductwork accessories and equipment are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF METAL DUCTWORK

- A. General: Assemble and install ductwork in accordance with SMACNA Seal Class "A" and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor.
- B. Inserts: Install concrete inserts for support of ductwork in coordination with framework, as required to avoid delays in work.
- C. Field Fabrication: Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.
- D. Field Modifications: Ductwork modified in the field shall maintain the same free area as shown on the Drawings. In no case shall the aspect ratio of modified ductwork exceed 4 to 1 without permission of the Engineer.
- E. Routing: Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and

other structural and permanent enclosure elements of building. Limit clearance to ½" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

- F. Electrical Equipment Spaces: Do not route ductwork through transformer vaults and their electrical equipment spaces and enclosures.
- G. Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 1-1/2". Fasten to duct and substrate.
- H. Installation: Install metal ductwork in accordance with SMACNA HVAC Duct Construction Standards as follows:
 - 1. Natatorium Return: Aluminum sheet metal.
 - 2. All other supply, return and exhaust: Galvanized sheet metal.
- I. Sealant: Seal all supply, return and exhaust ductwork with duct sealant or duct cement in accordance with SMACNA HVAC Duct Construction Standards.

3.3 INSTALLATION OF DUCT LINER

- A. General: Install duct liner in accordance with SMACNA HVAC Duct Construction Standards. Duct sizes shown on plans are clear inside dimensions. Increase duct sizes accordingly.
- B. Extent of Duct Liner:
 - 1. All rectangular supply air ductwork
 - 2. All rectangular return air ductwork (except in Natatorium).
 - 3. All transfer air ductwork.
 - 4. All transfer air boots.
 - 5. Exposed spiral ductwork (except in Natatorium).
 - 6. Where shown otherwise.

3.4 INSTALLATION OF FLEXIBLE DUCTS

- A. Maximum Length: For any duct run using flexible ductwork, do not exceed 8' - 0" extended length or as required by local authorities.
- B. Installation: Install in accordance with Section III of SMACNA's, "HVAC Duct Construction Standards, Metal and Flexible".

3.5 INSTALLATION OF DUCTWORK ACCESSORIES

- A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

- B. Install turning vanes in square or rectangular 90 degree elbows in supply, return and exhaust air systems, and elsewhere as indicated.
- C. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.
- D. Install access doors for the following:
 - 1. Access to dampers.
 - 2. Access to fire dampers and smoke-fire dampers (one on each side of damper) in duct.
 - 3. Access to heating coils (one on each side of coil) in duct.
 - 4. Access to control devices.

3.6 INSTALLATION OF GRILLES, REGISTERS, AND DIFFUSERS

- A. General: Install grilles, registers and diffusers in accordance with manufacturer's written instructions and in accordance with recognized industry practices to ensure that products serve intended functions.
- B. Locate ceiling grilles, registers and diffusers, as indicated on general construction "Reflected Ceiling Plans".
- C. Provide code approved support for grilles, registers and diffusers in lay-in ceilings.

3.7 INSTALLATION OF ROOFTOP UNITS

- A. General: Install rooftop units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Support: Install units on roof curb, in accordance with National Roofing Contractor's Association (NRCA) installation recommendations.
- C. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
 - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-16 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.
- D. Start-up rooftop units, in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- E. Grounding:
 - 1. Provide positive equipment ground for rooftop unit components.

3.8 INSTALLATION OF FANS

- A. General: Install fans where indicated, in accordance with manufacturer's installation instructions, and with recognized industry practices, to ensure that fans comply with requirements and serve intended purposes.

- B. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
 - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-16 sections. Ensure that rotation is in direction indicated and intended for proper performance. Do not proceed with fan start-up until wiring installation is acceptable to fan Installer.

3.9 INSTALLATION OF POWER AND GRAVITY VENTILATORS

- A. General: Except as otherwise indicated or specified, install ventilators in accordance with manufacturer's installation instructions and recognized industry practices to ensure that ventilators serve their intended function.
 - 1. Solder bottom joints and up 2" of side joints of duct under roof ventilator to retain any moisture entering ventilator.
- B. Roof Curbs: Furnish roof curbs to roofing Installer for installation.
- C. Remove shipping bolts and temporary supports within ventilators. Adjust dampers for free operation.

3.10 EXTRA STOCK

- A. Provide one complete extra set of filters for each air handling system. If system is designed to include pre-filters and after-filters, provide only pre-filters. Install new filters at completion of air handling system work, and prior to testing, adjusting, and balancing work. Obtain receipt from Owner that new filters have been installed.

3.11 INSTALLATION OF DOUBLE WALL METAL STACKS

- A. General: Assemble and install stack sections and accessories in accordance with manufacturer's installation instructions, and in compliance with UL-listing.
- B. Seal joints between sections in accordance with manufacturer's installation instructions, and using only sealants recommended by manufacturer.
- C. Hang horizontal round breechings with encircling strap and strap hanger (of same size); except for sizes over 50" in diameter, install pair of strap hangers bolted to opposite sides of angle reinforcing rings or flanged joints. Support breechings at 10'-0" spacing with hangers as follows for corresponding diameters.
 - 1. Up to 30" Diameter: 1" x 16-ga strap hangers.
 - 2. 31" to 50" Diameter: 1-1/2" x 16-ga strap hangers.
 - 3. 51" to 84" Diameter: Pairs of 1-1/2" x 16-ga strap hangers.

3.12 INSTALLATION OF VENTS

- A. General: Provide two-pipe vent system, consisting of pipe sections, fittings and accessories required by manufacturer for complete installation.
- B. Accessories: Provide manufacturer's standard accessory items for complete installation.

3.13 INSTALLATION OF TYPE B GAS VENTS

- A. General: Install Type B double wall gas vents in accordance with manufacturer's installation instructions. Maintain UL-listed minimum clearances from combustibles. Assemble pipe and accessories as indicated for complete installation.

3.14 FIELD QUALITY CONTROL

- A. Leakage Tests: After each duct system which is constructed for duct classes over 3" is completed, test for duct leakage in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Repair leaks and repeat tests until total leakage is less than 1% of system design air flow.
- B. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.
- C. Upon completion of installation of equipment and after motor has been energized with normal power source, test equipment to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment which cannot be satisfactorily corrected.
- D. Upon completion of installation and prior to initial operation, test and demonstrate that air terminals, and duct connections to air terminals, are leak-tight.
- E. Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.

3.15 EQUIPMENT CONNECTIONS

- A. General: Connect metal ductwork to equipment as indicated, provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery. Provide access doors as indicated.

3.16 ADJUSTING AND CLEANING

- A. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration. Clean existing ductwork to be reused.
- B. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.
- C. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.
- D. Temporary Closure: At ends of breeching which are not connected to equipment or stacks at time of installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.

3.17 SPARE PARTS

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- A. Furnish to Owner, with receipt, 3 operating keys for each type of air outlet and inlet that require them.
- B. Furnish to Owner, with receipt, one spare set of belts for each belt driven centrifugal fan.
- C. Furnish to Owner, with receipt, one set of filters for each unit requiring filters.

3.18 TRAINING OF OWNER'S PERSONNEL

- A. Provide services of manufacturer's technical representative for 1/2 day to instruct Owner's personnel in operation and maintenance of heating and cooling units.
 - 1. Schedule training with Owner, provide at least 7-day notice to Contractor and Engineer of training date.

END OF SECTION 15800

SECTION 15900 - TEMPERATURE CONTROL SYSTEMS - DDC

PART 1 - GENERAL

1.1 WORK DESCRIPTION

- A. Scope: This section contains general requirements for all work to be provided by the Temperature Controls Contractor. All requirements of Division 1 apply to all work of this section.
- B. Refer to Section 15010, Electric Wiring And Safety Device Work And Material Responsibilities for electrical, mechanical and temperature control contractor coordination of responsibilities.
- C. The temperature controls contractor shall be responsible for providing and verifying all control sequences described in this section or in the Sequence of Operations regardless of whether the sequence uses the building automation system, unitary controls or third party control systems, or any combination of systems. Any deviation from the sequence of operations, including limitations caused by the lack of ability of the building automation system to interact with unitary or third party controls shall be clearly and prominently described as a deviation in the temperature controls submittal. The temperature controls contractor shall be responsible for coordinating and assuring the sequence of operations will be compatible with all equipment, including equipment purchased by other contractors. The temperature controls contractor will be responsible for correcting any interface problems that prevent the system from operating according to the sequence of operations.
- D. Work Included: It is the intent of this specification for the building automation system to be fully networked and installed as a complete package by the Temperature Controls Contractor. The system shall include all computer software and hardware, controllers, sensors, transmission equipment, system workstations, local panels, installation, engineering, supervision, acceptance test, training, warranty service and, at the owner's option, extended warranty service.
- E. All controller hardware and software provided under this section shall be BACnet or LONMARK compliant to provide the owner with an open, interoperable direct digital control system that will allow microprocessor control hardware and software from different control, fire alarm or card access system manufacturers to be integrated to this control system.
- F. The system shall be capable of supporting an unlimited number of clients using a standard Web Browser such as Internet Explorer or Netscape Navigator.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Drawings and general provisions of the Contract, including General and supplementary conditions and Division-1 specifications sections, apply to work of this section.
 - 1. Products furnished but not installed under this section:
 - a. Valves, flow switches, flow sensors, thermowells and pressure taps to be installed under Sections 15060 and 15500.
 - b. Automatic dampers to be installed under Section 15800.
 - 2. Products connected but not furnished or installed under this section:
 - a. Duct smoke detectors provided under Division 16 and installed under Section 15800.

3. Coordination with electrical:
 - a. Installation of all line voltage power wiring by Division 16.
 - b. Each motor starter provided under Division 15, shall be furnished with individual control power transformer to supply 120 volt control power and auxiliary contacts (one N.O. and one N.C.) for use by this section.

1.3 QUALIFICATIONS

- A. The control system shall be furnished, engineered, and installed by the manufacturer's local factory authorized office. The control contractor shall have factory trained technicians to provide instruction, routine maintenance, and emergency service within 48 hours upon receipt of request.
- B. Control system components shall be new and in conformance with the following applicable standards for products specified:
 1. American Society for Testing and Materials, ASTM.
 2. Institute of Electrical and Electronic Engineers, IEEE.
 3. National Electrical Manufacturers Association, NEMA.
 4. Underwriters Laboratory, UL (UL 916).
 5. FCC Regulation, Part 15, Section 156.
 6. National Fire Protection Association, NFPA.
 7. Local Building Codes.

1.4 SUBMITTALS

- A. General: All submittal requirements specified shall be provided as a single complete package, bound in a 3 ring binder. Provide six (6) submittal copies or the amount specified in Division 1, whichever is greater. Incomplete submittal packages will be returned un-reviewed. A partial submittal consisting of a damper and valve schedule will be accepted for projects with short construction schedules, provided a written request is submitted to the engineer. Submittal requirements are intended to eliminate or minimize engineering of either control hardware or software in the field, and shall be adhered to.
- B. Sequences of Operation Submittals: The Controls Contractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:
 1. An overview narrative of the system generally describing its purpose, components and function.
 2. All interactions and interlocks with other systems.
 3. Detailed delineation of control between any packaged controls and the building automation system, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
 4. Written sequences of control for packaged controlled equipment.
 5. Sequences of control for the following modes of operation: Start-up, Warm-up, Cool-down, Normal Occupied, Unoccupied, and Shutdown.
 6. Capacity control sequences and equipment staging.
 7. Temperature and pressure control: setbacks, setups, resets, etc.
 8. Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
 9. Effects of power or equipment failure with all standby component functions.
 10. Sequences for all alarms and emergency shut downs.
 11. Seasonal operational differences and recommendations.

- C. Drawings: The controls contractor shall submit AutoCAD (Version 2000 or higher) generated schematic drawings in hard copy and electronic media for the entire control system, for review and approval before work shall begin. The hard copy drawings shall be submitted on 8½" x 11" or 11" x 17" sheets with drawing information sized such that all drawing information is legible. The submittal drawings shall include the following:
1. A one page diagram depicting the system architecture complete with a communications riser and peripheral devices.
 2. Floor plan layouts including locations of controlled equipment, communication bus and/or network wiring layout, thermostat locations, and terminal unit controllers with communication address identifiers.
 3. Mechanical room layouts including locations of controlled equipment, communication and network wiring layout, and panel locations with unit communication address identifiers.
 4. Point-to-point wiring diagrams for each HVAC system accurately depicting:
 - a. All temperature controls located on a schematic diagram of the controlled HVAC system.
 - b. Start-stop arrangement for each piece of equipment.
 - c. Equipment interlocks.
 - d. Wiring terminal numbers.
 - e. Special connection information required for properly controlling the mechanical equipment.
 - f. Control enclosure interior and exterior (face) layouts.
 5. A bill of material reference list with drawing tag identifiers, application description, manufacturer, model number, and quantity.
 6. Sequences of operation which shall identify each major component (hardware and software) involved in the control scheme by its tag identifier.
 7. Software flow diagrams for each sequence of operation. Provide detail of all parameters; of inputs, outputs, PID loops, and auxiliary control functions. This requirement applies to both text editing and function block programming types. DDC systems that utilize block programming shall submit the flow diagrams utilizing the actual object oriented blocks, with a key of block types and block descriptions.
 8. An updated as-built version of the control drawings and sequences of operation shall be included in the final controls O&M manual submittal.
- D. Technical Data: The submittal shall also include manufacturers catalog data describing each item of control equipment or component provided and installed for the project. Include and identify all data needed to show adherence to the corresponding specification section. Provide compressor sizing calculations if pneumatic devices are utilized.
- E. Damper Schedule: Provide a damper schedule with tag identifiers, application descriptions, damper sizes, damper arrangements, product type/name, actuator type, and actuator quantity for each damper. Include damper/actuator product cut sheets and identify all technical data needed to show adherence to the corresponding specification section.
- F. Valve Schedule: Provide a valve schedule which describes valve tag identifiers, application descriptions, specified GPM's, close-off rating, valve Cv ratings, pressure drop at rated Cv, port arrangement and actuator type for each valve. Include valve/actuator product cut sheets and identify all technical data needed to show adherence to the corresponding specification section.
- G. Specification Compliance: Irrespective of any prior approval to bid, the submittals shall include a specification compliance analysis for review and approval before work shall begin. The compliance document shall address each paragraph of Part 1, Part 2, Part 3, and Part 4 of the specification by indicating COMPLY, or EXCEPTION. Do not indicate COMPLY unless the proposed system exactly meets the paragraph requirement. If EXCEPTION is indicated, then provide a clear and concise explanation of the variance from the specifications and the effect this has on the specified system.

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performance. A schematic diagram showing the proposed system architecture and describing the expendability and capacity of the proposed system shall be included. The schematic shall have all non-applicable items clearly deleted and shall indicate the quantity of each component to be utilized to meet the requirements of this specification. The Engineer shall retain the right to accept or reject any listed exceptions to the specification.

H. Acceptance Test Plan:

1. Submit a detailed description of acceptance testing procedures that will be utilized to confirm proper operation of all sequences of operation and points, along with acceptance testing checkoff sheets.

I. Training Plan: Submit a detailed description of the training to be provided to Owner's personnel for the Engineer's approval. Plan shall include comprehensive details on: course outline, schedule, synopsis, training materials required/supplied and shall include the identity and credentials of the course instructor(s).

J. One-Year Warranty Support Plan: Submit a detailed description of the plan to support the owner during the one-year warranty period. Provide comprehensive details for: standard workday emergency problem response methods, planned preventative maintenance schedules, training and other plan information for the Engineer's approval.

1.5 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software the Owner and the party providing the software will enter into a software license agreement with provisions for the following:

1. Limiting use of software to equipment provided under these specifications.
2. Limiting copying.
3. Preserving confidentiality.
4. Prohibiting transfer to a third party.

PART 2 - PRODUCTS

2.1 BIDDING REQUIREMENTS

A. Contractors wishing to bid temperature controls shall present a stand-alone temperature controls price.

B. The temperature controls price may be predicated on using a particular brand of mechanical equipment, but must be clearly stated.

C. An alternate price may be given in the event the desired brand of mechanical equipment is not used.

D. Acceptable manufacturers:

1. Siemens Control System installed by Local Factory Office.
2. Johnson Controls installed by Local Factory Office.
3. Control Systems International installed by Western Building Services.
4. Siebe controls installed by Long and Associates.
5. Trane Company installed by Local Factory Office.

2.2 SYSTEM ARCHITECTURE

- A. The complete electronic DDC temperature control system shall be comprised of five levels of control. Provisions for expansion of all levels of the DDC system shall be provided with this project such that a need for future "gateway" or "repeater" expansion hardware and software is not required:
1. The First Level is comprised of electronic sensors, valves, dampers, actuators, switches, relays, and transducers, etc.
 2. The Second Level includes dedicated zone controllers for VAV box, and FTU units.
 3. The Third Level is comprised of local controllers for control of large primary mechanical systems such as air handling systems or heating/chilled water systems.
 4. The Fourth Level consists of the system controller(s) which are used for high level global programming functions and system networking.
 5. The Fifth Level is the System Workstation which includes the hardware and software necessary for an operator/engineer to interface with the control system.

2.3 SENSOR/TRANSMITTERS

- A. Temperature Sensors: Temperature sensors shall be linear precision elements with ranges appropriate for applications, accurate within 1°F over the entire span:
1. Space (room) sensors shall be available with setpoint adjustment, space temperature indication, and override switch. Space sensors used for terminal unit applications shall have a communications jack for connection to a laptop computer. The user shall be able to read actual cfm and set minimum maximum cfm setpoints plus other air balance criteria such as cfm calibration, fan start point, open-close damper, open-close valve and reheat flow setpoint through the space temperature sensor communication jack:
 - a. Provide occupant temperature setpoint adjustment and room temperature indication for all administrative office applications.
 - b. Provide blank covers with overrides switches for all public areas.
 2. Duct mounted averaging sensors shall utilize a sensing element incorporated in a copper capillary with a minimum length of 20 feet. The sensor shall be installed according to manufacturer's recommendation and looped and fastened at a minimum of every 36 inches.
 3. Sunshields shall be provided for outside air sensors.
 4. Thermowells for all immersion sensors shall be stainless steel or brass as required for application.
 5. The following are typical sensor application ranges:
 - a. Space: 20°F - 100°F
 - b. Pool Water: 50°F - 200°F
 - c. Outside Air: -40°F - 140°F
 - d. Mixed Air: 20°F - 100°F
- B. Differential Pressure Sensor: Differential pressure sensor shall be temperature compensated and shall vary the output voltage with a change in differential pressure. Sensing range shall be suitable for the application with accuracy of +/- 2% of range and repeatability of +/- 0.5% of range. Sensor shall be capable of withstanding up to 150% of rated pressure for air applications and 300% of rated pressure for water applications without damage.
- C. Humidity Sensors: Humidity sensors shall be of the solid-state type using a hygroscopic polymer sensing element. The sensor shall vary the output voltage with a change in relative humidity. Sensors shall be available for room or duct mounting, with a minimum range of 30% - 80% ± 5%.

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- D. Air Velocity Sensors: Sensor shall use thermal anemometry to determine air flow rate. Repeatability shall be ± 25 FPM; accuracy $\pm 5\%$ of range. The anemometer shall use constant temperature differential technology and operate from 30°F to 120°F.
- E. Occupancy Sensor: Occupancy sensor shall be of the passive infrared or ultrasonic receiver type. As a minimum the occupancy sensor shall provide adjustments for timed-on delay and sensor sensitivity.

2.4 AUXILIARY ELECTRIC CONTROL DEVICES

- A. Control Relays: Shall be UL listed plug-in type with dust cover, LED "energized" indicator and integral H-O-A switch. Contract rating, configuration and coil voltage shall be suitable for the application.
- B. Manual Control Switches: Shall be UL listed for use in NEMA 1 enclosures with contact arrangement and rating suitable for the application. Bat handle or knob actuator with nameplate clearly identifying function of each switch position.
- C. Line Voltage Thermostats: Line Voltage Thermostats shall be U.L. listed with SPDT contacts, switching at an adjustable setpoint with a range of 55° to 85°F. Provide lockable metal guards for all thermostats located in areas where mechanical damage or tampering may occur.
- D. Differential Pressure Switches: Pressure differential switches (air or water service) shall be UL listed, DPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application or as specified. Switches shall be capable of withstanding up to 150% of rated pressure for air applications and up to 300% of rated pressure for water applications. Duct high pressure switches shall be provided with contacts that require manual resetting.
- E. Current Sensing Relays: Current Sensing Relays shall be U.L. listed and of the proper range. The switch output contact shall be rated for 30VDC, Threshold setting shall be fully adjustable within the selected range. Response time shall be 0.25 seconds or less. Provide current sensing relays on all fans and pumps for status sensing unless otherwise noted.
- F. Low Temperature Thermostats: Low Temperature Thermostats shall be U.L. listed, DPDT snap-acting, pilot duty rated (125 VA, minimum), NEMA 1 enclosure with manually adjustable set point and differential suitable for the application or as specified. Switches shall be actuated by the coldest 1' of a 20' capillary and shall be provided with contacts that require manual resetting. The element shall be properly supported to cover the entire downstream side of the heating coil with a minimum of three loops. Separate thermostats shall be provided for each 25 square feet of coil face area or fraction thereof. The setpoint shall be 25°F unless otherwise specified on the plans or sequence of operation.
- G. Flow Switches: Flow Switches shall be U.L. listed and shall be of the paddle type equipped with DPDT contacts to establish proof of flow. Flow switches shall be of the vapor-proof type.
- H. Control Transformers: Shall be UL listed Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.
- I. Damper End Switches: Shall be UL listed line voltage SPDT snap-acting pilot duty rated (125 VA minimum) NEMA 1 enclosure, with roller type actuating arm suitable for damper position application.
- J. Breakglass Chiller Room Emergency Stop Switch: Shall be UL listed for line voltage with SPDT snap-acting pilot duty rated (125 VA minimum). Provide weather tight enclosure for exterior mounted applications.
- K. Smoke Detectors: Shall be as specified in the schedule of responsibilities:

1. Smoke detectors located in air handling units or ducts shall be complete with duct-mounting accessories as recommended by manufacturer. Provide multiple units for larger duct areas consistent with manufacturer's recommendations.
2. Provide all control interlock wiring from fire/smoke alarm system relay contacts to HVAC controls unless this wiring is noted in the Division 16 plans or specifications

2.5 CONTROL VALVES

A. General:

1. All valves to heating coils which are part of an air handling system which takes in outside air shall open for full supply water flow whenever a loss of power or air supply to the valves occurs.
2. Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - a. Water Valves:
 - 1) Two-way - 125% of total system (pump) head.
 - 2) Three-way - 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
3. The temperature control contractor shall size control valves for proper control characteristics for each application. Control valves shall be sized for a pressure drop between 3 to 5 psig at full flow condition.
4. The valve trim shall consist of a removable cage providing valve plug guiding throughout the entire travel range. A stainless steel stem shall be provided. Bonnet, cage, stem and plug assembly shall be removable for servicing.
5. All modulating valves shall have equal flow characteristics, i.e., for equal increments of valve stem stroke the change in flow rate with respect to valve stroke will be expressed as a constant percent of the flow rate at the time of the change.
6. All control valves over 3/4 inch shall have a minimum rangeability (the ratio of the maximum controllable flow to the minimum controllable flow) of 50 to 1.
7. All two position isolation valves shall be line size. Butterfly valves may be used for any isolation valve application.

B. Valve Characteristics:

1. Valves - 1/2" to 2": Valves shall be constructed with a cast iron bronze body and screwed ends. The body rating shall be a minimum of 250 psig.
2. Valves - 2 1/2" and above: Valves shall be constructed with a cast iron body and have flanged connections. The body rating shall be a minimum of 125 psig.

C. Valve Actuators:

1. Valve actuators shall have a cast aluminum or cast iron housing.
2. Actuators shall have sufficient power to operate the valve and provide for tight shut-off at the differential pressures encountered.
3. Provide spring return actuators for all applications unless noted otherwise.
4. Where required by the sequence of operation, valves shall be capable of being sequenced with other valves or other actuated devices. Where such sequencing is required, the actual spring range, when adjusted for spring shift, shall be such that no overlapping occurs. In the event that spring shift causes an overlap, a pilot positioner shall be furnished.
5. Electric actuators shall be oil-immersed gear train, rotary, hydraulic or magnetic type except as noted otherwise.

6. Electric actuators for vav and reheat terminal unit applications may be three point floating type for valves that are 3/4 inch or less. These actuators are not required to be spring-return.
7. Actuators providing control by temperature change media within the actuator are not acceptable.

2.6 CONTROL DAMPERS

- A. Motorized dampers, unless otherwise specified elsewhere, shall meet the following:
 1. Frame of 16 gauge steel structural hat channel.
 2. Blades of 14 gauge galvanized steel, roll-formed airfoil-type design with extruded vinyl blade edge seals mechanically locked into the blade edge.
 3. Stainless steel (28 gauge minimum) jamb seals of flexible, compression type.
 4. Control shaft shall be 1/2" dia. removable shaft. Linkage shall be located outside of airstream.
 5. Leakage shall be a maximum of 0.10% of maximum flow based on a pressure differential of 1.0" w.g.
 6. Airfoil type dampers shall be used for any applications where the air velocities are greater than 1500 FPM.
 7. Provide a minimum of one damper actuator per damper section.
- B. Unless otherwise scheduled, the control dampers for outdoor/return air mixing box dampers shall be parallel blade, arranged to direct airstreams towards each other. Dampers used for air volume or pressure control modulating applications shall be opposed blade type. All other dampers may be parallel or opposed blade type.
- C. Damper Actuators:
 1. Pneumatic actuators shall be piston type with aluminum housing and replaceable diaphragm.
 2. Electric actuators shall be direct coupled typed.
 3. Unless otherwise noted, all actuators must be spring return type. Under no circumstances shall capacitors or batteries be used in lieu of spring return.
 4. Actuators for VAV terminal control may be non-spring return.

2.7 LOCAL CONTROL PANELS

- A. All relays, switches, transducers and other field interface devices, for equipment located within the mechanical equipment rooms, shall be panel mounted. Each local controls panel shall have door mounted devices as shown on the drawings. Provide a convenience 120 VAC receptacle in each panel. All electrical devices, within the panels shall be wired to a numbered terminal strip. All wiring within the panel shall be run in wiring tray in accordance with NEMA and UL standards, and shall meet all local codes. Panels shall be NEMA type suitable for applications as required. Provide a final as-built control drawing, reduced, laminated, and mounted inside of the panel door. Provide panel with 20% spare mounting capacity.

2.8 MISCELLANEOUS

- A. The Controls Contractor shall furnish all electric relays and coordinate with the supplier of magnetic starters for the auxiliary contact requirements. All electric control devices shall be of a type to meet current, voltage, and switching equipment of their particular application. Relays shall be provided with 24 VAC coils and contacts shall be rated at 10 amps minimum.

2.9 ZONE CONTROLLER HARDWARE

- A. General: Each HVAC Zone Controller shall be a stand-alone DDC controller. The controller shall include all hardware and software required for communications with the system controller. An individual zone controller shall be dedicated for each zone terminal device. Individual zone controllers are not required for constant volume duct reheat coil applications, but may be provided at Temperature Control Contractor's option.
- B. Programs: The control program shall reside in the zone controller. The application program shall be maintained in ROM. The default database, ie. setpoints and configuration information, shall be stored in EEPROM. Controllers requiring local setting of potentiometer or dip switches for control strategies are not acceptable. No batteries can be used for memory protection.
- C. Stand-Alone: Controllers requiring the application or database to be downloaded from a host or share processing with a "master controller" shall not be acceptable. After a power failure the zone controller must run the control application using the current setpoints and configuration.
- D. Communications: Communication to the system controller shall be 9600-baud asynchronous.
- E. Input-/Output: Each zone controller shall have the necessary quantities of inputs and output for the selected duty. Inputs shall be individually electrically isolated from other inputs, outputs, communications, and power. All inputs shall feature an auto-calibrate function to eliminate sensing errors.
- F. Connections: All electrical connections shall be made to the combination terminal strip and base assembly. To insure long term reliability, all electrical terminations shall be screw type.
- G. The logic card, containing all active electrical components, shall be easily installable and removable from the wiring base, without the use of tools or the removal of any electrical wiring. Products that require disconnection of wiring from logic card before removal will be required to supply and install a quick disconnect type inter-connection.
- H. All controllers shall be interoperable controllers bearing the applicable BACnet or LONMARK logo on each controller that is provided.

2.10 ZONE CONTROLLER SOFTWARE

- A. The zone controller software shall be provided with the capabilities required by the specific application.
- B. Each input, output or calculation result shall be capable of being assigned to the network controller for system networking.

2.11 LOCAL CONTROLLER HARDWARE

- A. General: The Local Controllers shall be a local control loop microprocessor-based controller installed at each mechanical system; i.e., air handling unit, heating boiler, chiller. The controller shall execute local control sequences, independent of a workstation. All control loops and setpoints shall be stored in EEPROM or other non-volatile field reprogrammable memory. Each controller shall be addressable by a workstation or a portable laptop computer. Where local controllers are used for constant volume duct reheat coil applications, group reheat zones to a local controller by floor, air handling unit, service, etc.
- B. Scan: Controller shall continuously scan and maintain the most recent data in EEPROM for retrieval by a remote workstation and by the local controller software programs.

- C. Isolation: Control, communication, and power circuits for each controller shall be individually electrically isolated to protect against transients, spikes, and power surges. All inputs and outputs shall be individually optically isolated from other inputs and outputs, power, communication, and field wiring. Optical isolation shall be provided either as an integral component of the controller or provided as a separate interface device between the controller and field wiring.
- D. Servicing: For ease of servicing, each Controller shall consist of a removable plug-in circuit board. Products which require disconnection of wiring from the local controller logic card before removal shall supply and install a quick disconnect type interconnection.
- E. All controllers shall be interoperable controllers bearing the applicable BACnet or LONMARK logo on each controller that is provided.
- F. Database: All field control database shall be entered, changed or downloaded to the local controllers via a portable service tool or system workstation.
- G. Auto-Calibration: All inputs shall feature an auto-calibrate function to eliminate sensing errors.
- H. Input/Output Modules: Provide the following input/output capabilities:
- I. Universal inputs which can accept industry standard analog signals (4-20 mA, 0-5 VDC, etc.) and binary contact closures:
 - 1. Digital outputs may be latched or momentary contact type.
 - 2. Analog outputs shall have a 1% resolution over total output span of 100%.

2.12 LOCAL CONTROL SOFTWARE

- A. General: Provide complete controller software to execute all mechanical system local loop controls functions.
- B. Control Parameters: The software blocks in the local controller shall produce all of the necessary reverse acting and/or direct acting PI² signals as required by the control sequence. The proportional and integral values which make up the PI² output value shall be readable and modifiable, at the system workstation or the portable service tool to facilitate tuning of control loops.
- C. Networking: Each input, output, or calculation result shall be capable of being assigned to the system controller for system networking.
- D. Programming Functions: Provide the following standard temperature control loop programming functions:
 - 1. Control Block Programming.
 - 2. PI² or PID Control.
 - 3. Serial Load Staging.
 - 4. Binary Load Staging.
 - 5. Analog Load Staging.
 - 6. Master-Submaster Routines.
 - 7. Anti-Windup for Integrated Loops.
 - 8. Weekly/Daily/Holiday Scheduling.
 - 9. Optimum Start/Stop Programming.
 - 10. Automatic Trending with Adjustable Sample Rates.

2.13 SYSTEM CONTROLLER HARDWARE

- A. General: The system controller shall be a microprocessor based, multi-tasking real time system controller that provides advanced system programming, uplink and downlink communication, polling and other supervisory functions for zone and local controllers. Provide the system controller with a minimum 9600 baud auto-dial auto-answer modem for remote network access and remote alarm reporting.
- B. Operating Environment: The control shall be capable of operating in an environment of 32° to 122°F and 10 to 90% relative humidity non-condensing.
- C. Power Loss/Restart: The controller shall be tolerant of power failures. Memory shall be non-volatile or unit shall hold memory of to 30 days minimum on back-up batteries. When a power failure has occurred and power (normal or emergency) is restored, automatically and without operator intervention, the controller shall execute the following restart procedures:
 - 1. Come on line.
 - 2. Update all monitored functions.
 - 3. Implement special building start-up strategies as required.
 - 4. Resume operation based on current time and status.
- D. Stand-Alone: The controller shall be a true no-host system that does not require a PC or "Host" computer to perform any control functions or communications.
- E. Isolation: Field communication ports shall be individually electrically isolated to protect against transients, spikes, and power surges. The ports shall be optically isolated from each other, the controller circuit board and from power wiring. Optical isolation shall be provided either as an integral component to the controller or provide as a separate interface device between the controller and field wiring.
- F. Self Diagnostics: The controller shall contain in this program, a self-test procedure for checking communications and verify the functionality of the CPU memory and database.
- G. The system controller shall be the integration point for ASHRAE Standard 135-1995 BACnet or LONMARK technology communication protocols. The system controller shall also provide all tools for Java enabled Web browser access via the local area networks (Intranet) and wide area networks (Internet).
- H. Graphical User Interface (GUI):
 - I. The GUI shall be completely icon driven, multi-tasking and employing a graphical operating environment. The GUI shall not only be for real-time access to any system(s) on the LAN but shall also allow the operator an easy method of information management. Information management shall mean the massaging and manipulation of any system real time or historical data into integrated applications such as report generators, spreadsheets, X/Y charts, database managers, etc. Complete file management and data transfer, such as copying, moving files, automatic and manual means of "cutting and pasting" of data items from one application to another shall be provided as an integral part of this GUI. This GUI shall be completely Windows "compliant":
 - a. Menu and System Access:
 - 1) This GUI shall provide an easy and absolute method of menu and system access. The menu system shall provide the entry point into the entire GUI array of applications and programs. All the GUI programs and Windows programs shall be accessible through this menu system.

- 2) This menu system shall be able to call any operator specific menu or menus allowing complete versatility in how the menu structure is designed and used.
- b. System Security:
- 1) System security shall be on an application by application basis. During the setup or editing of a particular user the owner shall be able to enable or disable the use of any application or function within an application for each user of the system. Each user security access record shall list each of the applications to which the user has access and the functions that are permitted from within each of these applications. The users shall be assigned discrete passwords in order to have access to any particular application or function within the system.
 - 2) As well as application protection each user shall be assigned to a personalized menu (see Menu and System Access). This shall allow for each user to have their own discrete menu system for access into the various applications and dynamic graphic screens.
- c. Dynamic Graphics:
- 1) The dynamic graphic portion of this GUI shall allow the operator to access any system information via a system penetration method. System penetration shall allow the operator to begin at an entire site plan and then zoom in to a particular area for closer inspection and then further zoom in on this area and so on until the detailed color graphic display of a desired portion of the facility is represented.
 - 2) As a minimum a graphic screen shall be designed showing the building, each floor, each major piece of mechanical equipment within each building that is being monitored/controlled, all of which will display the data for each area dynamically.
 - 3) Dynamic point display shall be user selectable from at least the following options: standard text readout, font, style, size, foreground and background colors, border style, plus discrete movement animation allowing animation displays for items such as dampers, gauges, fans, switches, lights, alarm activity, etc.
 - 4) Each mechanical and electrical system that is monitored/controlled by the system shall have a unique dynamic color graphic. The display will be provided by the control contractor and approved by the engineer.
 - 5) The graphical user interface shall allow the user to easily create new displays and modify existing displays. A library of standard HVAC equipment, control devices, mechanical systems, tables, lines, circles, rectangles, squares, arrows, etc. shall be provided to allow easy implementation of the changes/additions to the system.
 - 6) The program shall allow any standard JPG or GIF file to be displayed with dynamic data overlaid on to the display.
- d. Centralized Scheduling and Modification:
- 1) Calendars shall be provided for displaying and modification of any of the controller's time clock functions. Holidays and special functions shall be clearly marked on the calendar. Changes shall be permanent or, for one time or multiple occurrences. Global changes shall be allowed for similar schedules.
- e. Alarm Annunciation:
- 1) Upon the incidence of an alarm an alarm window shall be displayed showing the point in alarm, the time and date of the alarm and a user -selected predefined alarm message (and optionally printed to a user defined printer, printers and/or dumb terminal devices). Alarms shall be displayed regardless of the application in use including any Windows applications. The program shall display the unacknowledged

- alarms. The user shall be able to selectively enable or disable the alarm reminder in the event there are unacknowledged alarms.
- 2) Acknowledgment of alarms shall be from an alarm "pop-up" display and/or from a separate alarm summary. Acknowledgment shall be by a specific event, date range, class, or specific alarm definition and condition. Upon acknowledging the alarm, the name of the operator acknowledging the alarm and the time and date will be associated with the acknowledgment. This data will be stored to the alarm history file and printed to the chosen printers or terminal devices.
 - 3) Automatic or manual display of associated dynamic graphic screens shall be provided for each alarm upon the alarm occurrence.
 - 4) The user shall be automatically placed back to the application or graphic in use at the time of alarm occurrence upon exiting the alarm handling mode.
 - 5) A current alarm summary shall be provided which will dynamically display only alarms that are currently in alarm. As alarms are returned from their respective alarm states the current alarm summary shall be dynamically updated to reflect the change.
- f. Trend Management:
- 1) The GUI shall automatically perform time based periodic collection of real time point data and subsequently store it to the systems hard disk.
 - 2) Storage and manipulation of sampled points shall only be limited by disk space. Sampling rates shall be user selectable from instantaneous (once a second) to longer periods of time such as one week. Collection of data shall be user selectable to start and stop on specific times and dates.
 - 3) Charting of the trend data shall be an integral part of the trend management program. Third party graphing packages such as Excel or Lotus 123 shall not be required to implement this program. Multiple points shall be capable of displaying on the same chart. Multiple X/Y charts may be run simultaneously displaying either real time data (instantaneous) or historical. X/Y scaling shall be either automatic or user selectable for any chart displayed, each chart may have different scaling. X scales shall be user selectable allowing for display of data over a wide range of times and dates. Display of multiple years of data shall be allowed. The chart display shall be capable of displaying a window of time for multiple years.
- g. Multi-tasking:
- 1) The GUI shall be capable of true multi-tasking capabilities. The user shall be able to use other non-related programs while still running all GUI applications with no interruptions. This shall include the use of real time data in other applications.
- h. The user interface shall employ Web browser-like functionality for ease of navigation. This interface shall include, but not be limited to, forward/backwards buttons, home button and a context sensitive locator line (similar to a URL line).
- i. Graphic screens on the Web Browser client shall support hypertext links to other Web pages on other Internet or Intranet sites.
 - j. User log-on identification and passwords shall use Java authentication techniques to prevent unauthorized access.

2.14 SYSTEM CONTROLLER SOFTWARE

- A. General: The network controller software shall be multi-tasking, menu-driven, in English language. The software shall operate on a database comprised of control blocks which resemble control hardware devices (receiver controllers, gradual relays, higher or lower of two pressure relays, time delay relays, etc.). The Controls Contractor shall configure these control blocks to attain the proper sequence of control. The user shall be able to add, delete, or modify all control blocks on-line as required.

- B. Passwords: Provide a minimum of multiple levels of user definable passwords.
- C. Help Menu: On-line location sensitive help shall be provided for each menu item, describing the consequences of making the highlighted menu selection.
- D. Login: A login message shall be displayed every time the workstation is connected to a network controller.
- E. Backup and Restore: The database in each network controller shall be uploaded to the System Workstation, for archival purposes, and shall be re-downloaded to each network controller at any time. Operating system changes, parameter changes, upgrades and enhancement for network controllers shall be downline loadable from the System Workstation, or via dial-in from a remote location.
- F. Programming Functions: The software blocks shall provide all the necessary mathematics, logic, utility, and control functions necessary for proper sequence of control. These functions shall be contained in the network controller operating system to be available in any combination for field programming the unit through RAM memory. As a minimum, these routines shall include, but not be limited to, energy management strategies such as:
1. Time or Event Based Scheduling.
 2. Adaptive Optimum Start/Stop.
 3. Demand Limiting/Load Shedding.
 4. Enthalpy Control.
 5. Hot Water/Outdoor Air Reset.
 6. Run Time Totalization.
 7. Alarm Detection and Dial Out.
 8. Night Setback.
 9. Historical Trending.
- G. Alarms: The network controller shall be capable of comparing analog and digital readings to predetermined high and low limits and annunciate each time a value enters or returns from an alarm condition. Unique high and low limits shall be supplied for each analog point in the system. They system shall be capable of suppressing selected alarm reporting when the primary equipment from which the alarm point is based is in the inactive state. The alarm features of the network controller software shall, as a minimum, provide the following:
1. Digital, Analog, and Hi/Lo settings and deadband.
 2. Sliding Alarm Limits.
 3. Conditional Alarming.
 4. Alarm inhibiting through feedback loop.
 5. Fluttering Alarm Suppression.
 6. Separate Tailored Alarm Messages for each alarm.
 7. Auto dial of any alarm condition to a minimum of 10 phone numbers.
- H. Communication Diagnostics: The network controller software shall be programmed for self-diagnosing of failure, automatically without query by the operator. In the event of communications failure or limited power failure, the system shall be capable of both notifying a local operator of the specific occurrence, as well as auto dialing the condition to a remote site. Auto-dial out shall be configurable to repeat the alarm while the situation remains unattended and unacknowledged. In addition to automatic self-diagnostics, communications statistics on zone and general application controller communications shall be maintained. These statistics shall tabulate total communications attempted versus successful and unsuccessful communications by unit number. The option to reset communications statistics to zero (0) at any time shall be provided.

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- I. Interfaces to Other Manufacturer's Equipment: Where specified, each Network Controller shall be equipped with standard software blocks with which to interface to other manufacturer's equipment. The software blocks shall be defined by the Controls Contractor to read/write analog values and digital status to/from other manufacturer's equipment for alarm, trend, operator advisory, graphic display and other system uses. Communications between the Network Controller and other manufacturer's equipment shall occur in the same manner and with the same software as that used for communications with Dedicated and General Application Controllers.
- J. The software shall employ object-oriented technology for representation of all data and control devices within the system. In addition, adherence to industry standards for ASHRAE BACnet and LONMARK is required to assure interoperability between control system manufacturers. The control contractor must provide a PICS document showing the installed system's BACnet compliance level of 3.
- K. The software must incorporate the ability to access all data using Java enabled browsers without requiring proprietary operator interface and configuration programs.
- L. The software shall allow alarms to be routed to E-mail messages and paging services.
- M. Access to the system controller shall be via the Internet from a remote location and from a local computer operator's station (when specified) by direct connection to an Ethernet LAN. The control contractor shall provide a connection to the Internet to enable this access via high-speed modem or via the Intranet to a corporate server providing access to an Internet Service Provider. The owner shall pay monthly access charges for the connection and service provider.

2.15 OPERATOR INTERFACE STATION

- A. Provide an operator workstation and locate as directed by the owner. The workstation shall include the following:
 - 1. Dedicated IBM PC or 100% compatible computer, Pentium.
 - 2. Intel Pentium Processor @ 3.0 GHZ or faster 512 KB cache.
 - 3. Intel 440 BX chipset or later, 100 GB Ultra ATA Hard Drive.
 - 4. 1.44 MB 3.5" Floppy Drive, 48X or faster Read/Write CD-Rom, 512 MB SD-RAM.
 - 5. Standard Video Graphics, 512 MB on board RAM memory.
 - 6. One printer port and page printer (Ink Jet or Laser) for report printing.
 - 7. Serial/Parallel communication ports, Ethernet Controller, (4) minimum USB 2.0 ports.
 - 8. Microsoft Compatible Mouse.
 - 9. CD-RW with DVD for backup.
 - 10. Surge Protector.
 - 11. 19" LCD Flat Screen display monitor.
 - 12. Windows XP Professional or other acceptable operating system requested by the owner.

2.16 WIRING AND CONDUIT

- A. All wire will be copper and meet the minimum wire size and insulation class listed below:

<u>Wire Class</u>	<u>Wire Size</u>	<u>Isolation Class</u>
Power	12 Gauge	600 Volt
Class One	14 Gauge Std.	600 Volt
Class Two	18 Gauge Std.	300 Volt

<u>Wire Class</u>	<u>Wire Size</u>	<u>Isolation Class</u>
Class Three	18 Gauge Std.	300 Volt
Communications	Per Mfr.	Per Mfr.

- B. Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit.
- C. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.
- D. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum 1/2 inch galvanized EMT. Compression fittings shall be used for interior locations and watertight compression fittings for exterior locations. Provide conduit seal off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.
- E. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.
- F. Junction boxes shall be provided at all cable splices, equipment terminations, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location J-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.
- G. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire management system shall be in conduit.

2.17 COAXIAL CABLE

- A. Coaxial cable shall conform to RG62 or RG59 rating.
- B. Provide plenum rated coaxial cable when running in return air plenums.

2.18 FIBER OPTIC CABLE

- A. Acceptable fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140. Only glass fiber is acceptable, no plastic.
- B. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BAS contractor shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

2.19 ENCLOSURES

- A. All controllers and field interface panels shall be mounted in new enclosures unless otherwise stated in this specification.

- B. All outside mounted enclosures shall meet the NEMA-4 rating.

PART 3 - EXECUTION

3.1 PROJECT MANAGEMENT

- A. Provide a project manager who shall, as a part of his duties, be responsible for the following activities:
 - 1. Coordination between the Contractor and all other trades, Owner, local authorities, and the design team.
 - 2. Scheduling of manpower, material delivery, equipment installation and checkout.
 - 3. Maintenance of construction records such as project scheduling and manpower planning and AutoCad for project co-ordination and project record drawings.

3.2 SYSTEM SETUP AND INSTALLATION

- A. System setup and installation shall include but is not limited to the following:
 - 1. Database entry and database setup of all input and output points, including alarm printouts with individual alarm messages, as described on the input/output point list.
 - 2. Programming and full setup of all sequences described in the sequence of operation section of the specification as shown in Part 4 - Sequence of Operation & Points List.
 - 3. Complete checkout and testing of all functions, operations and features of the building automation system as described in this specification including, but not limited to, all features and functions utilized in the system setup as well as features and capabilities of the software and hardware described as provided and installed but not implemented or used at this time.

3.3 WIRING INSTALLATION METHODS

- A. Install systems and materials in accordance with manufacturer's instructions, rough-in drawings and equipment details. Install electrical components and use electrical products complying with requirements of applicable Division 16 sections of these specifications.
- B. The term "control wiring" is defined to include the providing of wire, conduit, and miscellaneous materials as required for mounting and connecting electric or electronic control devices as follows:
 - 1. Consist of wiring in pilot circuits of contractors, starters, relays, etc., and wiring for valve and damper operators.
 - 2. For single phase devices where power current passes through controller, wiring between controller and device shall be considered control wiring; wiring to device from electric panel shall be considered power wiring.
- C. Install control wiring system in conduit for electric/electronic control systems. Conceal wiring, except in mechanical rooms and areas where other conduit and piping are exposed. UL plenum rated cable shall be allowable in air plenums as approved by local codes. All control wiring shall be installed in a neat and workmanlike manner parallel to building lines with adequate support. Provide shielded cabling where required to prevent noise from being superimposed on control system wiring. Both conduit and plenum wiring shall be supported from or anchored to structural members. Conduit or plenum wiring supported from or anchored to piping, duct supports, the ceiling suspension system, or the electrical conduits is not acceptable. Wiring buried in slab on grade concrete or explosion proof areas shall be in rigid metal conduit. Provide adequate strain relief for all field terminations.

- D. Number-code or color-code conductors, excluding those used for individual zone controls, appropriately for future identification and servicing of control system.
- E. All line voltage power wiring required because of substitution of equipment specified in this section, shall be provided by this section.

3.4 CONTROL DEVICE LOCATIONS

- A. Adjustable sensors and thermostats shall be mounted according to the requirements of the Americans with Disabilities Act (ADA) and the American National Standards Institute (ANSI) requirements. The contractor shall submit coordination documents to the architect indicating intended sensor/thermostat locations including intended mounting heights for architect review and approval. Upon completion of the architect's comments, the documents shall be submitted to the mechanical engineer for final review.
- B. Remote control devices not in local panels shall be accessible for adjustment and service -- below 7' above finished floor whenever possible.
- C. Locate all temperature control devices wired under Division 16.
- D. Local control enclosures shall be mounted at eye level for accessibility and service, and located within 50 feet of the system served, unless otherwise shown on the plans.

3.5 IDENTIFICATION

- A. All control equipment shall be clearly identified by control shop drawing designation as follows:
 - 1. Control valves and damper actuators - brass tags or engraved bakelite tags
 - 2. Other remote control devices - metal tags or laser printed, adhesive backed, metalized polyester film labels.
 - 3. Control Enclosures - engraved nameplate with panel number and system served.
 - 4. Control Conduit Junction Boxes - Painted medium blue.

3.6 MOUNTING AND INSTALLATION PRACTICES FOR DEVICES

- A. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.
- B. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.
- C. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
- D. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
- E. Outdoor air sensor shall be placed in a location approved by the engineer.

3.7 LOCAL CONTROL PANELS

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- A. All relays, switches, transducers and other field interface devices, for equipment located within the mechanical equipment rooms, shall be panel mounted. Panels shall be NEMA type suitable for applications as required with hinged door and key-lock latch. Size for 20% spare mounting capacity.
- B. Manual switches and indicating devices shall be flush-mounted on the panel face. Provide engraved bakelite or lithographed metal nameplates for all items on the panel face with white 1/2 inch high letters on a black background. Paper or embossed labels are not acceptable.
- C. Mount internal components securely on steel removable sub-panels. Each component shall be individually labeled with function and device identification, as shown on the control shop drawings. Label information shall be printed with a laser printer on adhesive backed metalized polyester film. Paper or embossed labels are not acceptable.
- D. Interconnections between internal and face-mounted devices pre-piped and wired with color-coded tubing/conductors shall be neatly installed in plastic tray and/or tie-wrapped. All wiring within the panel shall be run in wiring tray in accordance with NEMA and UL standards, and shall meet all local codes. Terminals for field connections shall be UL listed for 600V service, individually identified per control shop drawings, with adequate clearance for field wiring. Control air terminations for field connection shall be individually identified control shop drawings.
- E. Provide a convenience 120 VAC receptacle in each panel, a fused on/off power switch, and main air gauge for control power sources to each local panel. Provide a final as-built control drawing, reduced, laminated, and mounted inside of the panel door.

3.8 MOUNTING AND INSTALLATION PRACTICES FOR ZONE AND LOCAL CONTROLLERS

- A. Controllers are to be mounted vertically.
- B. The 120 VAC power wiring to the network of Controllers shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral, and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.
- C. Utilize a true earth ground. Do not use a corroded or galvanized pipe, or structural steel.
- D. Controllers will be clearly labeled with the model number of the controller. In addition, all status lights will be identified with labels to indicate their function.

3.9 SOFTWARE INSTALLATION

- A. The Contractor shall provide all labor necessary to install, initialize, start-up, and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.

3.10 SYSTEM ACCEPTANCE

- A. General: The system installation shall be complete and tested for proper operation prior to acceptance testing for the Owner's authorized representative. A letter shall be submitted to the Engineer requesting system acceptance. This letter shall certify all controls are installed and the software programs have been completely exercised for proper equipment operation. Acceptance testing shall commence at a mutually agreeable time within ten (10) calendar days of request. When the test procedures have been demonstrated to the Owner's representative and pass, the system will be accepted. The One-Year Warranty Support Plan shall begin at this time.

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- B. Acceptance Test Procedures: DDC control panels shall be demonstrated via a functional end-to-end test. Prior to an acceptance test review by the Engineer, the contractor shall submit a point by point checklist to the Engineer with descriptions of how the following tests were performed. Such that:
1. All output channels shall be commanded (on/off, stop/start, adjust, etc.) and their portion verified.
 2. All analog input channels shall be verified for proper operation.
 3. All digital input channels shall be verified by changing the state of the field device and observing the appropriate change of displayed value.
 4. Automatic control operation of PID control loops shall be verified by introducing an error or change into the system and observing the proper corrective system response.
 5. Automatic control operation of sequences of operation shall be verified by introducing an error or change into the system and observing the proper corrective system response.
 6. Selected time and setpoint schedules shall be verified by changing the schedule and observing the correct response on the controlled outputs.
 7. Communication with each DDC control panel shall be demonstrated.
 8. All available and specified system reports and logs shall be demonstrated at the system workstation.
 9. Correct system start-up and shutdown procedures shall be demonstrated.
 10. All controllers shall be demonstrated to operate in a standalone mode.
 11. Workstation Operator commands will be explained and demonstrated.
 12. If any point or sequence should fail testing, perform necessary repair action and retest failed point and all interlocked points.
- C. Project Record Documentation: After a successful acceptance demonstration, submit project record drawings of the completed project for final approval. After receiving final approval, supply three (or as specified in Division 1) complete project record drawing sets (maximum ANSI "D" size), together with AutoCad diskettes to the owner. The original master site software license and disposition of any required software keys shall be included.
- D. Operation and Maintenance Manuals: Submit six (6) copies (or as specified in Division 1) of operation and maintenance manuals. Include the following:
1. Update all drawings and data required in the control submittal to a finalized form and add the following information:
 - a. An operator's manual which will include detailed instructions for all operations of the system.
 - b. A programmer's manual which will include all information necessary to perform programming functions.
 - c. A language manual which will include a detailed description of the language used and all routines used by the system.
 - d. An operator's reference table listing the addresses of all connected input points and output points. Settings shall be shown where applicable.
 - e. Complete program listing file and parameter listing file for all programs.
 - f. A copy of the warranty.
 - g. Operating and maintenance cautions and instructions.
 - h. Recommended spare parts list.

3.11 TRAINING

- A. Contractor shall provide to the engineer a training class outline prior to any scheduled training.
- B. Training sessions shall be provided for the Owner's personnel by factory trained control engineers and technicians.

- C. The control contractor shall conduct four - four (4) hour on-site training sessions as a course for designated owner's personnel in the maintenance and operation of the control system. One course shall be given prior to system acceptance and one additional course shall be provided during the Warranty Support Plan period.
- D. The course shall include instruction on specific systems and instructions for operating the installed system on include as a minimum:
 - 1. HVAC system overview
 - 2. Operation of Control System
 - 3. Function of each Component
 - 4. System Operating Procedures
 - 5. Programming Procedures
 - 6. Maintenance Procedures

3.12 WARRANTY

- A. Warranty: The control system shall be warranted to be free from defects in both material and workmanship for a period of one (1) year of normal use and service. This warranty shall become effective the date the owner accepts the system. The warranty shall include standard workday emergency problem response and all Warranty Support Plan preventative maintenance items (i.e. sensor calibration, linkage adjustment, etc.). An emergency service number shall be provided to the owner. Response shall be within four (4) hours to the phone call. Provide information and costs to the owner for an Extended Support Agreement prior to Warranty Support Plan period expiration.
- B. Upgrades: Include all controller firmware and software updates for the installed system version at no additional cost to the system owner during the warranty period.

3.13 SPARES

- A. Provide one each of the following spare parts:
 - 1. Room Sensor
 - 2. Zone Controller Board (one of each type)
 - 3. Local Controller Board (one of each type)

3.14 EXPANSION

- A. System Controller Hardware and Software must be provided with expansion capabilities for the addition of control, points, etc. for future remodel of remainder of building.

PART 4 - SEQUENCE OF OPERATIONS AND POINTS LISTS

4.1 DESCRIPTION OF SYSTEMS

- A. Pool Dehumidification Unit Control.
- B. Rooftop Unit Control – Constant Volume.
- C. Heating Coil – Duct Mounted - Electric.

- D. Hydronic Heating – Pools
- E. Four Pipe Fan Coil Unit.
- F. Fans.
- G. Miscellaneous DDC Controls.
- H. Miscellaneous Non-DDC Controls.

4.2 GENERAL

- A. Control: All HVAC Systems shall be controlled with Direct Digital Control (DDC) according to the point list contained in this section of the specifications and shall be stand-alone. Additional points or software programming not listed in the point list but which are required to meet the following sequences of operation shall be provided.
- B. Mounting: All Controllers, Relays, Transducers, etc., required for stand-alone control shall be housed in a NEMA enclosure rated for the installed conditions, with a lockable door.
- C. Setpoints: All setpoints shall be adjustable. All control loops shall utilize PI² or PID control algorithms unless otherwise specified in the sequence of operation.
- D. Feedback: Provide feedback position as a DDC system analog input on each actuator (excluding terminal unit equipment actuators) that is controlled with simulated analog outputs such as tri-state digital output pairs or pulse width modulation.
- E. Alarms: All general application controller and network controller communication failures shall be capable of being annunciated at a remote workstation printer as an alarm. All specified I/O device alarms shall be capable of being annunciated at a remote system workstation or remote workstation printer with alarm messages tailored for the alarm by system type and device type
- F. Normal positions for dampers and valves are as follows:
 - 1. Outside air damper - Closed
 - 2. Return air damper - Open
 - 3. Exhaust air damper - Closed
 - 4. Pool Heating water valve - Closed

G. Control Symbols Key:

Symbol	Description
AUX	Auxiliary Contact
AQT	Air Quality Transmitter
CR	Control Relay
DM	Damper Motor
FA	Fire Alarm
FZ	Low Limit Thermostat
HOA	Hand/Off/Auto
IS	Current Switch
IT	Current Transmitter
PDT	Pressure Differential Transmitter
PDS	Pressure Differential Switch
PT	Pressure Transmitter

Symbol	Description
PS	Pressure Switch
SD	Smoke Detector
S/F	Smoke/Fire
S/S	Start/Stop
SC	Smoke Control
TS	Temperature Switch
TT	Temperature Transmitter
VFD	Variable Frequency Drive
VM	Valve Motor
TT	Temperature Transmitter
VM	Valve Motor

4.3 POOL DEHUMIDIFICATION UNITS CONTROLS [(PDU-1)]

A. Design Intent:

1. This unit is a constant volume air handler that utilizes up to 100% outside air for dehumidification.
2. The unit consists of a constant volume supply fan, gas-fired heat exchanger, dx refrigerant coil, air-to-air heat exchanger, and exhaust fan with a VFD.

B. Safety Control:

1. The supply and exhaust fans shall de-energize if the smoke detector, freeze protection thermostat or high discharge pressure safeties are energized.
2. The outside air damper shall close when the fans stop.

C. Occupied/Unoccupied Mode:

1. The unit shall run continuously 24/7.
2. When The Disconnect Switch is in ON Position: Unit is energized, the outside air damper opens to its minimum position and the recirculation damper opens to its maximum recirculation position. When dampers are at their minimum/maximum positions the supply fan is energized and the unit exhaust fan is energized on its minimum VFD setting.
3. When Disconnect Switch is OFF: Supply and exhaust fans are de-energized, outside air damper closes and the exhaust gravity damper closes.

D. Pool Space Temperature Control:

1. Heating: The controller with temperature sensor located in the pool space shall stage the gas-fired heat exchanger to maintain the space setpoint (82° F, adj.).
2. Hydronic heating water control valves must be provided and installed by the ATC contractor.
3. Cooling: The controller with temperature sensor located in the pool space shall stage the condensing unit to maintain the space setpoint (85° F, adj.).

E. Pool Space Humidity Control: A controller with humidity sensor and differential pressure sensor mounted in the pool space shall control the position of the outside air damper, recirculation damper, exhaust fan VFD and stage the condensing unit to control space humidity.

1. Winter Operation: (Outside air dew point below 55° F)

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- a. On a rise in humidity above the setpoint (50% RH, adj.) the controller shall modulate the outside air damper open, and modulate the recirculation damper closed. The exhaust fan shall operate in accordance with the Space Pressure Control sequence of operation.
 - b. On a fall in humidity below the setpoint (50% RH, adj.) the controller shall modulate the outside air damper closed, and modulate the recirculation damper open. The dampers will not modulate closed past their minimum positions. The exhaust fan VFD shall modulate the exhaust fan speed to maintain a slight negative pressure in the pool space.
2. Summer Operation: (Outside air dew point above 55° F)
- a. On a rise in humidity above the setpoint (60% RH, adj.) the controller shall position the outside air damper and recirculation dampers to their maximum outside air and minimum recirculation air positions and stage the condensing unit to maintain room humidity. The exhaust fan VFD shall modulate the exhaust fan speed to maintain a slight negative pressure in the pool space.
 - b. On a fall in humidity below the setpoint (60% RH, adj.) the controller shall position the outside air damper and recirculation air dampers to their maximum outside air and minimum recirculation positions and stage the condensing unit to maintain room humidity. The exhaust fan VFD shall modulate the exhaust fan speed to maintain a slight negative pressure in the pool space.
3. Purge Mode: When the purge mode is initiated, the purge mode outside air damper opens, all heat exchanger face/bypass dampers open, the purge mode exhaust bypass damper opens, and the recirculation damper closes. The gas-fired heat exchanger shall modulate to maintain the space temperature setpoint. The humidity and pressure controls are overridden during this mode, and the refrigeration system is locked out.
- F. Heat Exchanger Outside Air Face/Bypass Damper Sequence: The controller will have a defrost sensor mounted in the exhaust airstream leaving the heat exchanger.
1. Winter Defrost Mode (exhaust air temperature leaving HX below 33° F): Controller will modulate face/bypass dampers to prevent the exhaust airstream temperature from dropping below 33° F. The bypass damper modulates open and the face damper modulates closed to prevent frosting on the heat exchanger.
 2. Energy Recovery Mode (exhaust leaving air temperature above 33° F): Face damper fully open, bypass damper fully closed. All outside air passes through the heat exchanger.
 3. Note: All temperature settings are field adjustable.
- G. High/Low Limits: If the supply air leaving the unit drops below 40°F (adj.) or above 130° F (adj.) the controller shall close the OSA damper and initiate an alarm.
- H. Remote unit ON/OFF: The controller shall have an input allowing a remote source to turn the unit on or off.
- I. Space Pressure Control:
1. Provide an air monitoring device on the outside air intake. The exhaust fan shall run continuously such that the exhaust air amount exceeds the amount of outside air being introduced into the space. The VFD minimum speed shall correspond to the minimum exhaust airflow as listed on the schedule.
 2. The exhaust fan VFD is controlled to maintain the natatorium space pressure at a negative pressure of -0.04" w.c. (adj) relative to the wet area of the adjacent pool locker room, but the exhaust airflow shall not fall below the scheduled minimum.

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3. An additional outdoor pressure sensor shall be provided to override the exhaust fan minimum speed and increase the speed until the natatorium space pressure is negative (-0.01" w.c. (adj)) with respect to the outdoor pressure.
4. Whenever the natatorium space pressure is positive with respect to the outdoor air pressure, an alarm shall be generated through the BAS system.

J. Controls:

1. Controls shall be provided by the dehumidification unit manufacturer. The system shall perform per the specified sequence of operation. The pool unit shall have the capability of operating independent of the building BAS.
2. The external equipment associated with the unit (heating coil control valve and pump) shall have control wiring wired back to the pool unit control panel and controlled by the pool unit control panel.
3. Control system shall interface with the building DDC system. The BAS shall have the ability for the following read/write control functions associated with the pool unit:
 - a. Pool unit enable.
 - b. Pool unit disable.
 - c. Space temperature.
 - d. Space pressure.
 - e. Purge mode enable/disable.
 - f. Condensing unit status.
4. The BAS shall have the ability for the following read only control functions associated with the pool unit:
 - a. All associated temperatures.
 - b. Smoke detectors.
 - c. Freeze stat.
 - d. Filter status.
 - e. All other associated alarms.

4.4 ROOFTOP UNIT CONTROL (RTU-1) – CONSTANT VOLUME

A. Design Intent:

1. These are constant volume units. The units have a supply fan, exhaust fans, outside air economizer cycle, gas heat section, and DX cooling.

B. Safety Control:

1. Smoke detector located on the return shall de-energize the fans and alarm the building automation system upon detection of smoke.
2. The outside air and exhaust air dampers shall close and return air damper shall open when the fans stop.

C. Occupied/Unoccupied Mode:

1. The occupancy mode (occupied/unoccupied) shall be determined through the building automation system.
2. Occupied Mode:
 - a. The supply fan shall run continuously.

- b. Exhaust fan control:
 - 1) The unit exhaust fan damper shall modulate airflow to maintain a building pressure of 0.05" w.c. (adj.) positive pressure.
 - c. Outside air damper control:
 - 1) The outside air damper shall open to minimum ventilation position. The outside air damper shall operate in response to the economizer controls.
 - d. Space temperature control:
 - 1) Modulate the gas heat exchanger or stage the DX compressors to maintain the space temperature of a single room sensor.
 - e. Morning warm up: The space temperature shall be used to determine the amount of time to preheat the space to the occupied setpoint by the normal occupied time. It will vary from 0 minutes when the space temperature is equal or greater than 71° F to 120 minutes when the temperature is equal or less than 58° F. The supply fan shall run with the outside air damper closed and the return air damper open. The unit is indexed to occupied control at the scheduled start time.
 - f. All parameters shall be independently adjustable.
3. Unoccupied Mode:
- a. The outside air damper shall close, and the return air damper shall open. The fan shall cycle and the gas heat shall modulate to maintain reduced temperature setpoint when any sensor has a call for heating.
4. Override:
- a. Provide an override push button in the space to override the unoccupied mode and enable the occupied mode for 3 hours.

D. Points List:

DESCRIPTION	TYPE	DEVICE	COMMENTS
Supply Fan Start/Stop	DO	CR	
Supply Fan Status	DI	IS	
Discharge Air Temp	AI	TT	Alarm
Mixing Dampers	AO	DM	Modulating
Smoke Detection	DI	Input	Alarm
Low Limit Thermostat	DI	Input	Alarm
Mixed Air Temperature	AI	TT	
Filter Status	AI	PDT	Alarm High Pressure

4.5 ROOFTOP UNIT CONTROL (RTU-2 &3) – CONSTANT VOLUME

A. Design Intent:

- 1. These are constant volume units. The units have a supply fan, exhaust fans, outside air economizer cycle, gas heat section, and DX cooling.

B. Safety Control:

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1. The outside air and exhaust air dampers shall close and return air damper shall open when the fans stop.

C. Occupied/Unoccupied Mode:

1. The occupancy mode (occupied/unoccupied) shall be determined through the building automation system.

2. Occupied Mode:

- a. The supply fan shall run continuously.
- b. Exhaust fan control:
 - 1) The unit exhaust fan damper shall modulate airflow to maintain a building pressure of 0.05" w.c. (adj.) positive pressure.
- c. Outside air damper control:
 - 1) The outside air damper shall open to minimum ventilation position. The outside air damper shall operate in response to the economizer controls.
- d. Space temperature control:
 - 1) Modulate the gas heat exchanger or stage the DX compressors to maintain the space temperature of a single room sensor.
- e. Morning warm up: The space temperature shall be used to determine the amount of time to preheat the space to the occupied setpoint by the normal occupied time. It will vary from 0 minutes when the space temperature is equal or greater than 71° F to 120 minutes when the temperature is equal or less than 58° F. The supply fan shall run with the outside air damper closed and the return air damper open. The unit is indexed to occupied control at the scheduled start time.
- f. All parameters shall be independently adjustable.

3. Unoccupied Mode:

- a. The outside air damper shall close, and the return air damper shall open. The fan shall cycle and the gas heat shall modulate to maintain reduced temperature setpoint when any sensor has a call for heating.

4. Override:

- a. Provide an override push button in the space to override the unoccupied mode and enable the occupied mode for 3 hours.

D. Points List:

DESCRIPTION	TYPE	DEVICE	COMMENTS
Supply Fan Start/Stop	DO	CR	
Supply Fan Status	DI	IS	
Discharge Air Temp	AI	TT	Alarm
Mixing Dampers	AO	DM	Modulating
Low Limit Thermostat	DI	Input	Alarm
Mixed Air Temperature	AI	TT	
Filter Status	AI	PDT	Alarm High Pressure

4.6 HEATING COIL – DUCT MOUNTED – ELECTRIC

A. Occupied/Unoccupied:

1. In the occupied mode the electric coil shall stage on to maintain the space temperature at 70° F.
2. In the unoccupied mode the electric coil shall stage on to maintain the space temperature at 60° F.
3. Disable the electric coil in the unoccupied mode.

B. Safety:

1. Provide an airflow switch, which shall disable the coil upon loss of air flow.

4.7 FANS

A. EF-2: Fans shall be controlled by a reverse acting thermostat to maintain space temperature.

B. EF-3,4: Manual wall switch with pilot light by Division 15 shall energize the fan.

C. EF-5: Manual wall switch shall energize fan. Unit mounted speed controller shall control the air volume.

D. EF-1: The fan shall be controlled by the occupied/unoccupied schedule through the building automation system. Fans shall energize during the occupied mode.

4.8 SPLIT SYSTEM FAN COIL UNIT.

A. Control

1. The FCU-1 blower shall operate continuously
2. The electric heating coil and air cooled condensing unit ACCU-1 shall stage on and off to satisfy the space temperature sensor.
3. A general alarm shall be generated if, the blower, electric heating coil or condensing unit shall fail.
4. The motorized damper on LVR-4 shall be normally open. The damper shall close if the FCU-1 blower fails.

4.9 MISCELLANEOUS DDC CONTROL

A. Domestic Hot Water Circulation Pump PP-1: The pump shall be controlled by the occupied/unoccupied schedule through the building automation system.

B. Building Static Pressure Sensor: Provide monitoring of building static pressure differential with respect to atmosphere with a pressure differential sensor. Provide one (1) sensor per rooftop unit.

C. Sump Pump/Sewage Ejector: Pumps shall operate through their own integral control system. Monitor status and sound alarm through DDC system upon pump failure.

D. Pool System Controller: Provide a general alarm to the building automation system through auxiliary contacts provided by the controller manufacturer.

4.10 MISCELLANEOUS NON-DDC CONTROL

A. Unit Heater Control (Electric):

1. Provide single-temperature room thermostat to cycle fan motor and electric element to maintain constant space temperature. Provide integral residual heat sensor to continue fan operation until element temperature falls below pre-set point.

B. Cabinet Unit Heater Control (Electric):

1. Provide single-temperature room thermostat to cycle fan motor and electric element to maintain constant space temperature. Provide integral residual heat sensor to continue fan operation until element temperature falls below pre-set point.

C. Pool Heating Control (Electric):

1. The pool heaters will be provided with its own controls. Refer to Section 15550 for the controls equipment and sequence.

END OF SECTION 15900

