Rrosstarrant architects

Burgin Independent Schools Addition & Renovation

Burgin Independent Board of Education Burgin, Kentucky

> RTA 1904 BG 19-262

Project Manual

Volume 2 of 2 September 2019

Architect

RossTarrant Architects, Inc. p 859.254.4018

Mechanical & Electrical Engineer CMTA, Inc. p 859.253.0892

> Structural Engineer Structural Design Group, Inc. p 615.255.5537

INDEX TO SPECIFICATIONS FOR BURGIN INDEPENDENT SCHOOLS ADDITION & RENOVATION BURGIN, KENTUCKY RTA 1904 BG 19-262

VOLUME 2 OF 2

DIVISION 20 - N	MECHANICAL			
200100	General Provisions - Mechanical	1 - 18		
200200	Scope of the Mechanical Work	1 - 2		
200300	Shop Drawings, Descriptive Literature, Maintenance Manuals,	1 - 3		
	Parts Lists, Special Keys & Tools			
200400	Demolition and Salvage	1 - 2		
200500	Coordination Among Trades, Systems Interfacing and Connection	1 - 2		
	of Equipment Furnished by Others			
201100	Sleeving, Cutting, Patching and Repairing	1 - 3		
201200	Excavation, Trenching, Backfilling & Grading			
201300	Pipe, Pipe Fittings, and Pipe Support	1 - 7		
202100	Valves and Cocks	1 – 3		
202110	Access to Valves, Equipment, Filters, Etc.	1 – 1		
202200	Insulation – Mechanical	1 - 4		
202300	Thermometers & Others, Monitoring Instruments	1 – 1		
202400	Identifications, Tags, Charts, Etc.	1 – 3		
202500	Hangers, Clamps, Attachments, Etc.	1 - 4		
203100	Testing, Balancing, Lubrication and Adjustments	1 – 3		
DIVISION 21 – H	FIRE SUPPRESSION			
210100	Fire Protection System	1 - 8		
DIVISION 22 – F	PLUMBING			
220100	Plumbing Specialties	1 - 7		
220200	Plumbing Fixtures, Fittings and Trim	1 - 4		
220300	Plumbing Equipment	1 – 1		
220400	Water Bottle Filling Stations	1 – 1		
	-			
DIVISION 23 – H	HEATING, VENTILATING AND AIR CONDITIONING			
230200	HVAC Equipment and Hydronic Specialties	1 - 46		
230300	Condensate Drainage System	1 - 1		
231100	Registers, Grilles, Diffusers & Louvers	1 - 1		
231200	Sheet Metal and Flexible Duct	1 - 6		
DIVISION 25 – E	BUILDING AUTOMATION			
250100	Motor Starters and Other Electrical Requirements for Mechanical	1 - 4		
	Equipment			
250200	Controls – Direct Digital	1 - 4		
DIVISION 26 – ELECTRICAL				
260501	General Provisions – Electrical	1 – 19		
260502	Scope of the Electrical Work	1 - 2		
260503	Shop Drawings, Literature, Manuals, Parts List, and Special Tools	1 - 4		
260504	Sleeving, Cutting, Patching and Repairing	1 - 2		
260505	Demolition, Restoration and Salvage	1 – 1		

260508	Coordination Among Trades, Systems Interfacing and Connection of Equipment Furnished by Others	1 - 2
260519	Conductors, Identification, Splicing Devices & Connectors	1 – 9
260526	Grounding	1 - 4
260529	Hangers and Supports for Electrical Systems	1 – 6
260531	Cabinets Outlet Boxes and Pull Boxes	1 – 3
260533	Raceways & Fittings	1 - 12
260533	Exception Trenching Backfilling and Grading	1 - 2
260544	Identifications	1 1
260333	Electrical Distribution Equipment	1 - 1 1 11
262450	Electrical Distribution Equipment	1 - 11 1 2
202430	Wiging Devices and Plotes	1 - 3
26/212	Surge Suppression Systems	1 - 0 1 6
204515	Lighting Einturgs and Lampa	1 - 0 1 7
203115	Notwork Lighting Systems	1 - 7
203110	Network Lighting Systems	1 - 8
DIVISION 27 – C	COMMUNICATIONS	1 7
270610	Voice/Data Communications System	I - /
270640	CATV Distribution System	1 - 6
275100	Paging/Intercom System	1 - 8
275110	Cafeteria Sound System	1 - 25
275313	GPS Wireless Clock System	1 – 10
DIVISION 28 – H	ELECTRONIC SAFETY & SECURITY	
281353	AV Intercom System	1 - 7
282300	Digital Video Surveillance Systems	1 - 8
283100	Fire Alarm System	1 - 21
DIVISION 31 – H	EARTHWORK	
311000	Site Clearing	1 - 2
311500	Protection of Existing Trees	1 - 4
312200	Grading	1 - 4
312316	Excavation	1 - 4
312316.13	Trenching	1 - 5
312316.26	Rock Removal	1 - 2
312319	Dewatering	1 - 2
312323	Fill	1 - 5
312323.13	Flowable Fill	1 - 4
312513	Permanent Erosion Controls	1 - 2
313116	Termite Control	1 - 2
313413	Flexible Concrete Erosion Control Mat	1 - 2
DIVISION 32 – F	EXTERIOR IMPROVEMENTS	
321123	Aggregate Base Courses	1 – 3
321216	Asphalt Paving	1 - 3
321313	Concrete Paving	1-6
321313	Pavement Joint Sealants	1 - 4
321613	Concrete Curbs and Gutters	1 - 6
321713	Parking Rumpers	1 - 2
321723 13	Painted Pavement Markings	1 - 3
321725.15	Tactile Warning Surfacing	1 - 1
3231120	Chain Link Fanana and Catas	1 - 4 1 - 3
323110	Unain Link Fences and Gales	
14117	Ornamental Metal Fences and Gates	1 - 5 1 - 5
329219	Ornamental Metal Fences and Gates	1 - 5 1 - 5
329219	Ornamental Metal Fences and Gates Seeding	1 - 5 1 - 5 1 - 4 1 - 3
329219 329223 329300	Ornamental Metal Fences and Gates Seeding Sodding Plants	1 - 3 1 - 5 1 - 4 1 - 3 1 - 8

DIVISION 33 – UTILITIES

334101 Site Storm Drainage Piping	1 - 3
334413.13 Catch Basins and Curb Inlets	1 – 3
334413.23 Cleanouts and Drains	1 - 2
334416 Trench Drains	1 - 2
334903 Storm Drainage Outlets	1 - 2
334913 Storm Drainage Manholes, Frames and Covers	1 - 2
334993Downspout Boots	1 – 3

END OF INDEX TO SPECIFICATIONS

SECTION 200100 - GENERAL PROVISIONS - MECHANICAL

1. GENERAL

- A. The Advertisement for Bids, Instructions to Bidders, Bidding Requirements, General, Special and Supplementary Conditions, and all other contract documents shall apply to the Contractor's work as well as to each of his Sub-Contractor's work. All manufacturers, suppliers, fabricators, contractors, etc. submitting proposals to any part if for work, services, materials or equipment to be used on or applied to this project are hereby directed to familiarize themselves with all documents pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.
- B. Each Proposer shall also be governed by any unit prices and Addenda insofar as they may affect his part of the work or services.
- C. The work included in this division consists of the furnishing of all labor, equipment, transportation, excavation, backfill, supplies, material, appurtenances and services necessary for the satisfactory installation of the complete and operating Mechanical System(s) indicated or specified in the Contract Documents.
- D. Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the Mechanical Systems in a substantial manner, in compliance with the requirements stated, implied or intended in the drawings and/or specifications, shall be included as part of this Contract.
- E. It is not the intent of this section of the specifications to make any Contractor, other than the General Contractor, responsible to the Owner, Architect and Engineer. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be routed through the General Contractor to the Architect, then to the Engineer. Also, this section of the specifications shall not be construed as an attempt to arbitrarily assign responsibility of work, material, equipment or services to a particular trade or Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be optional.
- F. It is the intent of this Contract to deliver to the Owners a "like new" project once work is complete. Although plans and specifications are complete to the extent possible, it shall be the responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials required for the complete installation without additional cost to the Owner.
- G. In general, and to the extent possible, all work shall be accomplished without interruption of existing facilities operations. The Contractor shall advise the Owners at least two weeks prior to the interruption of any services or utilities. The Owners shall be advised of the exact time that interruption will occur and the length of time the interruption will last. Failure to comply with this requirement may result in complete work stoppage by the Contractors involved until a complete schedule of interruptions can be developed.
- H. Definitions and Abbreviations
 - Contractor Any Contractor whether proposing or working independently or under the supervision of a General Contractor who installs any type of mechanical work (Controls, Plumbing, HVAC, Sprinkler, Gas Systems, etc.) or, the General Contractor.
 - (2) Engineer The Consulting Mechanical-Electrical Engineers either consulting to the Owners, Architect, other Engineers, etc. In this case: CMTA, Inc., Consulting Engineers.

- (3) Architect The Architect of Record for the project.
- (4) Furnish Deliver to the site in good condition and turn over to the Contractor who is to install.
- (5) Provide Furnish and install complete, tested and ready for operation.
- (6) Install Receive and place in satisfactory operation.
- (7) Indicated Listed in the Specifications, shown on the Drawings or Addenda thereto.
- (8) Typical Where indicated repeat this work, method or means each time the same or similar condition occurs whether indicated or not.
- (9) Contract Documents All documents pertinent to the quality and quantity of work to be performed on this project. Includes, but not limited to: Plans, Specifications, Instructions to Bidders, General and Special Conditions, Addenda, Alternates, Lists of Materials, Lists of Sub-Contractors, Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Schedules of Value, Periodical Payment Requests, Construction Contract with Owners, etc.
- (10) Proposer Any person, agency or entity submitting a proposal to any person, agency or entity for any part of the work required under this contract.
- (11) OSHA Office of Safety and Health Administration.
- (12) KBC Kentucky Building Code.
- (13) The Project All of the work required under this Contract.
- (14) NEC National Electrical Code.
- (15) NFPA National Fire Protection Association.
- (16) ASME American Society of Mechanical Engineers.
- (17) AGA American Gas Association.
- (18) SMACNA Sheet Metal and Air Conditioning Contractors National Association.
- (19) ANSI American National Standards Institute.
- (20) ASHRAE American Society of Heating, Refrigeration and Air Conditioning Engineers.
- (21) NEMA National Electrical Manufacturers Association.
- (22) UL Underwriters Laboratories.
- (23) ADA Americans with Disabilities Act.
- (24) IMC International Mechanical Code.
- (25) IECC International Energy Conservation Code.

- (26) IFGC International Fuel Gas Code.
- I. Required Notices:
 - (1) Ten days prior to the submission of a proposal, each proposer shall give written notice to the Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, Proposers signify that they have included the cost of all required items in the proposal and that the Proposer will be responsible for the safe and satisfactory operation of the entire system.

2. INTENT

- A. It is the intention of the Contract Documents to call for finished work, tested and ready for operation.
- B. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

3. DRAWINGS AND SPECIFICATIONS

- A. The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Engineer for approval before proceeding with the work. The drawings are not intended to show every item which may be necessary to complete the systems. All proposers shall anticipate that additional items may be required and submit their bid accordingly.
- B. The drawings and specifications are intended to supplement each other. No Proposer shall take advantage of conflict between them, or between parts of either. Should this condition exist, the Proposer shall request a clarification not less than twelve days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be final.
- C. The drawings and specifications shall be considered to be cooperative and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.
- D. Contractor shall make all his own measurements in the field and shall be responsible for correct fitting. He shall coordinate this work with all other branches of work in such a manner as to cause a minimum of conflict or delay.
- E. The Engineer shall reserve the right to make adjustments in location of piping, ductwork, equipment, etc. where such adjustments are in the interest of improving the project.
- F. Should conflict or overlap (duplication) of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume that he is to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.
- G. Unless dimensioned, the mechanical drawings only indicate approximate locations of equipment, piping, ductwork, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions, whether given in figures or scaled, shall be verified in the field to ensure no conflict with other work.

- H. Each Proposer shall review all drawings including Architectural, Mechanical, Electrical, Fire Protection, Landscaping, Structural, Surveys, etc., to ensure that the work he intends to provide does not encroach a conflict with or affect the work of others in any way. Where such effect does occur, it shall be the Proposer's responsibility to satisfactorily eliminate any such encroachment conflict or effect prior to the submission of his proposal. Each Proposer shall in particular ensure that there is adequate space to install his equipment and materials. Failure to do so shall result in the correction of such encroachment conflict or effect of any work awarded the proposer and shall be accomplished fully without expense to others and that they are reasonably accessible for maintenance. Check closely all mechanical and electrical closets, chases, ceiling voids, wall voids, crawl spaces, etc., to ensure adequate spaces.
- I. Where on the drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornamentation or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.
- J. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.
- K. Where on the Drawings or Addenda the word typical is used, it shall mean that the work method or means indicated as typical shall be repeated in and each time it occurs whether indicated or not.
- L. <u>Special Note</u>: Always check ceiling heights indicated on Architectural Drawings and Schedules and ensure that they may be maintained after all mechanical and electrical equipment is installed. Do not install equipment in the affected area until the conflict is resolved.

4. EXAMINATION OF SITE AND CONDITIONS

A. Each Proposer shall inform himself of all of the conditions under which the work is to be performed, the site of the work, the structure of the ground, above and below grade, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work. Each Proposer shall also fully acquaint himself with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services, availability of utilities, etc. His proposal shall cover all expenses or disbursements in connection with such matters and conditions. No allowance will be made for lack of knowledge concerning such conditions after bids are accepted.

5. EQUIPMENT AND MATERIALS SUBSTITUTIONS OR DEVIATIONS

- A. When any Contractor requests approval of materials and/or equipment of different physical size, capacity, function, color, access, it shall be understood that such substitution, if approved, will be made without additional cost to anyone other than the Contractor requesting the change regardless of changes in connections, space requirements, electrical characteristics, electrical services, etc., from that indicated. In all cases where substitutions affect other trades, the Contractor requesting such substitutions shall advise all such Contractors of the change and shall remunerate them for all necessary changes in their work. Any drawings, Specifications, Diagrams, etc., required to describe and coordinate such substitutions or deviations shall be professionally prepared at the responsible Contractor's expense. Review of Shop Drawings by the Engineers does not in any way absolve the Contractor of this responsibility.
- B. Notwithstanding any reference in the specifications to any article, device, product, material, fixture, form, or type of construction by name, make or catalog number, such reference shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition; any devices, products, materials, fixtures, forms, or types of construction which, in the judgment of the Engineer, are equivalent to those

specified are acceptable, provided the provisions of Paragraph (A) immediately preceding are met. Requested substitutions shall be submitted to the Engineer a minimum of twelve days prior to bids.

- C. Wherever any equipment and material is specified exclusively only such items shall be used unless substitution is accepted in writing by the Engineers.
- D. Each Proposer shall furnish along with his proposal a list of specified equipment and materials which he is to provide. Where several makes are mentioned in the specifications and the Contractor fails to state which he proposes to furnish, the Engineer shall choose any of the makes mentioned without change in price. Inclusion in this list shall not ensure that the Engineers will approve shop drawings unless the equipment, materials, etc., submitted in shop drawings is satisfactorily comparable to the items specified and/or indicated.

6. SUPERVISION OF WORK

A. The Contractor shall personally supervise the work for which he is responsible or have a competent superintendent, approved by the Engineers, on the work at all times during progress with full authority to act for him.

7. CODES, RULES, PERMITS, FEES, INSPECTIONS, REGULATIONS, ETC.

- A. The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, inspections and other costs, including all utility connections, meters, meter settings, taps, tap fees, extensions, water and/or sewer system development charge, etc. in connection with his work. He shall also file all necessary plans, prepare all documents and obtain all necessary approvals of all governmental departments and/or the appropriate municipality or utility company having jurisdiction, whether indicated or specified or not. He shall hire an independent Registered Engineer to witness installations and provide necessary certifications where required by utility companies, municipal agencies or others that have review authority. He shall also obtain all required certificates of inspection for his work and deliver same to the Engineers before request for acceptance and final payment for the work. Ignorance of Codes, Rules, Regulations, Laws, etc. shall not render the Contractor irresponsible for compliance. The Contractor shall also be versed in all Codes, Rules and Regulations pertinent to his part of the work prior to submission of a proposal.
- B. The Contractor shall include in his work, without extra cost, any labor, materials, services, apparatus and drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether or not indicated or specified.
- C. All materials furnished and all work installed shall comply with the National Fire Codes of the National Fire Protection Association, with the requirements of local utility companies, or municipalities and with the requirements of all governmental agencies having jurisdiction.
- D. All materials and equipment so indicated and all equipment and materials for the electrical portion of the mechanical systems shall bear the approval label of, or shall be listed by the Underwriters' Laboratories (UL), Incorporated. Each packaged assembly shall be approved as a package. Approval of components of a package shall not be acceptable. Where required by the Code and/or the Authority Having Jurisdiction, provide the services of a field labeling agency to provide a UL label for the entire system in the field under evaluation.
- E. All plumbing work is to be constructed and installed in accordance with plans and specifications which have been approved in their entirety and/or reflect any changes requested by the State Department of Health. Plumbing work shall not commence until such plans are in the hands of the Contractor.

- F. All Heating, Ventilation and Air Conditioning work shall be accomplished in accordance with the Kentucky Building Code (KBC) and amendments thereto, the latest standards recognized by the American Society of Heating, Refrigerating and Air Conditioning and the National Fire Protection Association. Contractor shall secure a permit from the Division of HVAC. Final inspection certificate shall be provided by Contractor and a copy included in Operation and Maintenance Manuals.
- G. All pressure vessel installations shall comply with the State, and/or Federal Code applicable. A Certificate of Final Boiler Inspection shall be required.
- H. The Contractor shall furnish three (3) copies of all Final Inspection Certificates obtained to the Engineer when work is complete. Final payment for work will be contingent upon compliance with this requirement.
- I. Where minimum code requirements are exceeded in the Design, the Design shall govern.
- J. The Contractor shall ensure that his work is accomplished in accord with the OSHA Standards and that he conducts his work and the work of his personnel in accord with same.
- K. All work relating to the handicapped shall be in accord with regulations currently enforced by the Department of Housing, Buildings and Construction, Commonwealth of Kentucky and the American Disabilities Act.
- L. All work in conjunction with a natural gas installation shall, in addition to all other Codes, Rules, Regulations, Standards, etc., comply with the requirements of the local gas supplier and/or standards and recommendations of the American Gas Association.
- M. All work in relation to domestic water systems shall, in addition to all other Codes, Rules, Regulations and Standards, be in compliance with the requirements of the local water utility company and the adopted edition of the 10 States Standards.
- N. All work in relation to the installation of sanitary or storm sewers shall, in addition to all other Codes, Rules, Regulations and Standards, be in compliance with the local agency governing such installations and the adopted edition of the 10 States Standards.
- O. All work relating to the handicapped shall be in accord with regulations currently enforced by the Department of Housing, Buildings, and Construction, Commonwealth of Kentucky and the American Disabilities Act.

8. EQUIPMENT AND PIPING SUPPORT

A. Each piece of equipment, apparatus, piping, or conduit suspended from the structure or mounted above the floor level shall be provided with suitable structural support, pipe stand, platform or carrier in accordance with the best recognized practice. Such supporting or mounting means shall be provided by the Contractor for all equipment and piping. Exercise extreme care that structural members of building are not overloaded by such equipment. Provide any required additional bracing, cross members, angles, support, etc., as indicated or required by the Structural Engineer. This, in some instances, will require the Contractor to add an angle to a joist to transfer the load to a panel point. If in doubt, contact the Structural Engineer.

9. DUCT AND PIPE MOUNTING HEIGHTS

A. All exposed or concealed ductwork, piping, etc., shall be held as high as possible unless otherwise noted and coordinated with all other trades. Exposed piping and ductwork shall, insofar as possible, run perpendicular or parallel to the building structure.

10. COST BREAKDOWNS (SCHEDULE OF VALUES)

A. Within thirty days after acceptance of the Contract, the Contractor shall furnish to the Engineer, one copy of a detailed cost breakdown on each respective area of work. These cost breakdowns shall be made in a format approved by the Engineer. Payments will not be made until satisfactory cost breakdowns are submitted.

11. CORRECTION PERIOD

- A. All equipment, apparatus, materials, and workmanship shall be the best of its respective kind. The Contractor shall replace all parts at his own expense, which are proven defective as described in the General Conditions. The effective date of completion of the work shall be the date of the Architect's or Engineer's <u>Statement of Substantial Completion</u>. Items of equipment which have longer guarantees, as called for in these specifications, shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final acceptance. Such use of equipment shall not invalidate the guarantee except that the Owner shall be liable for any damage to equipment during this period, due to negligence of his operator or other employees. Refer to other sections for any special or extra warranty requirements.
- B. It is further clarified that all required and specified warranties shall begin on the date of Substantial Completion, not at the time of equipment start-up.
- C. All gas fired heat exchangers shall have 20-year warranty.
- D. All compressors shall have five-year warranty.

12. CHANGES IN MECHANICAL WORK

REFER TO GENERAL AND SPECIAL CONDITIONS.

13. CLAIMS FOR EXTRA COST

REFER TO GENERAL AND SPECIAL CONDITIONS.

14. SURVEY, MEASUREMENTS AND GRADE

- A. The Contractor shall lay out his work and be responsible for all necessary lines, levels, elevations and measurements. He must verify the figures shown on the drawings before laying out the work and will be held responsible for any error resulting from his failure to do so.
- B. The Contractor shall base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.
- C. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the contract documents, he shall promptly notify the

Engineer and shall not proceed with this work until he has received instructions from the Engineer on the disposition of the work.

15. TEMPORARY USE OF EQUIPMENT

- A. The permanent heating and plumbing equipment, when installed, may be used for temporary services, with the consent of the Engineers. Should the permanent systems be used for this purpose the Contractors shall make all temporary connections required at their expense. They shall also make any replacement required due to damage wear and tear, etc., leaving the same in "as new" condition.
- B. Permission to use the permanent equipment does not relieve the Contractors from the responsibility for any damages to the building construction and/or equipment which might result because of its use.

16. TEMPORARY SERVICES

A. The Contractor shall arrange any temporary water, electrical and other services which he may require to accomplish his work. Refer also to General and Special Conditions.

17. RECORD DRAWINGS

A. The Contractor shall ensure that any deviations from the Design are as they occur recorded in red, erasable pencil on record drawings kept at the jobsite. The Engineer shall review the record documents from time to time to ensure compliance with this specification. Compliance shall be a contingency of final payment. Pay particular attention to the location of under floor sanitary and water lines, shut-off valves, cleanouts and other appurtenances important to the maintenance and operation of Mechanical Systems. Also, pay particular attention to Deviations in the Control Systems and all exterior utilities. Keep information in a set of drawings set aside at the job site especially for this purpose. Deliver these record drawings electronically in AutoCAD 2000 format along with the hand marked field set to the Engineer. Electronic bid drawings will be furnished to the Contractor for his use.

18. MATERIALS AND WORKMANSHIP

- A. All equipment, materials and articles incorporated in the work shall be new and of comparable quality to that specified. Each Proposer shall determine that the materials and/or equipment he proposes to furnish can be brought into the building(s) and installed within the space available. In certain cases, it may be necessary to remove and replace walls, floors and/or ceilings and this work shall be the responsibility of the Contractor. All equipment shall be installed so that all parts are readily accessible for inspection, maintenance, replacement of filters, etc. Extra compensation will not be allowed for relocation of equipment for accessibility or for dismantling equipment to obtain entrance into the building(s). Ensure, through coordination, that no other Contractor seals off access to space required for equipment, materials, etc.
- B. Materials and equipment, where applicable, shall bear Underwriters' Laboratories label where such a standard has been established.
- C. Use extreme care in the selection of equipment and its installation to ensure that noise and vibration are kept at a minimum. The Engineer's determination shall be final and corrections to such discrepancies shall be made at the cost of the Contractor.
- D. Each length of pipe, fitting, trap, fixture and device used in the plumbing or drainage systems shall be stamped or indelibly marked with the weight or quality thereof and with the manufacturer's mark or name.

E. All equipment shall bear the manufacturer's name and address. All electrically operated equipment shall bear a data plate indicating required horsepower, voltage, phase and ampacity.

19. COOPERATION AND COORDINATION WITH OTHER TRADES

- A. The Contractor shall give full cooperation to all other trades and shall furnish in writing with copies to the Engineer, any information necessary to permit the work of other trades to be installed satisfactorily and with the least possible interference or delay.
- B. Where any work is to be installed in close proximity to, or will interfere with work of other trades, each shall cooperate in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than 1/4" = 1'-0", clearly indicating how his work is to be installed in relation to the work of other trades, or so as not to cause any interference with work of other trades. He shall make the necessary changes in his work to correct the condition without extra charge.
- C. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

20. QUALIFICATIONS OF WORKMEN

- A. All mechanical work shall be accomplished by qualified workmen competent in the area of work for which they are responsible. Untrained and incompetent workmen, as evidenced by their workmanship, shall be summarily relieved of their responsibilities in areas of incompetency. The Engineer shall reserve the right to determine the quality of workmanship of any workman and unqualified or incompetent workman shall refrain from work in areas not satisfactory to him. Requests for relief of a workman shall be made through the normal channels of Architect, Contractor, etc.
- B. All plumbing work shall be accomplished by Journeymen Plumbers under the direct supervision of a Master Plumber as defined and clarified under Kentucky State Plumbing Law Regulations and Code. Proof and Certification may be requested by the Engineer.
- C. All sheet metal, insulation and pipe fitting work shall be installed by workmen normally engaged or employed in these respective trades, except where only small amounts of such work are required and are within the competency of workmen directly employed by the Contractor involved.
- D. All automatic control systems shall be installed by workmen normally engaged or employed in this type work.
- E. All electrical work shall be installed only by competent workmen under direct supervision of a fully qualified Electrician.

21. CONDUCT OF WORKMEN

A. The Contractor shall be responsible for the conduct of all workmen under his supervision. Misconduct on the part of any workman to the extent of creating a safety hazard, or endangering the lives and property of others, shall result in the prompt relief of that workman. The consumption of alcoholic beverages or other intoxicants, narcotics, barbiturates, hallucinogens or debilitating drugs on the job site is strictly forbidden.

22. PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be entirely responsible for all material and equipment furnished by him in connection with his work and special care shall be taken to properly protect all parts thereof from physical, sun, and weather damage during the construction period. Such protection shall be by a means acceptable to the manufacturer and Engineer. All rough-in soil, waste, vent and storm piping, ductwork, etc., shall be properly plugged or capped during construction in a manner approved by the Engineer. Equipment damaged, stolen or vandalized while stored on site, either before or after installation, shall be repaired or replaced by the Contractor at his own expense.

23. SCAFFOLDING, RIGGING AND HOISTING

A. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery onto the premises of any equipment and apparatus furnished. All such temporary appurtenances shall be set up in strict accord with OSHA Standards and Requirements. Remove same from premises when no longer required.

24. BROKEN LINES AND PROTECTION AGAINST FREEZING

A. No conduits, piping, troughs, etc. carrying water or any other fluid subject to freezing shall be installed in any part of the building where danger of freezing may exist without adequate protection being given by the Contractor whether or not insulation is specified or indicated on the particular piping. All damages resulting from broken and/or leaking lines shall be replaced or repaired at the Contractor's own expense. If in doubt, contact the Engineer. Do not install piping across or near openings to the outside whether they are carrying static or moving fluids or not. Special Note: Insulation on piping does not necessarily ensure that freezing will not occur.

25. CLEANING

- A. The Contractor shall, at all times, keep the area of his work presentable to the public and clean of rubbish and debris caused by his operations; and at the completion of the work, shall remove all rubbish, debris, all of his tools, equipment, temporary work and surplus materials from and about the premises, and shall leave the area clean and ready for use. If the Contractor does not attend to such cleaning upon request, the Engineer may cause cleaning to be done by others and charge the cost of same to the Contractor. The Contractor shall be responsible for all damage from fire which originates in, or is propagated by, accumulations of his rubbish or debris.
- B. After completion of all work and before final acceptance of the work, the Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of piping, equipment, fixtures and all other associated or adjacent fabrication.

26. CONCRETE WORK

- A. The Contractor shall be finally responsible for the provisions of all concrete work required for the installation of any of his systems or equipment. He may, at his option, arrange with the others to provide the work. This option, however, will not relieve the Contractor of his responsibilities relative to dimensions, quality of workmanship, locations, etc. In the absence of other concrete specifications, all concrete related to Mechanical work shall be 3000 psi minimum compression strength at 28 days curing and shall conform to the standards of the American Concrete Institute Publication AC1-318. Heavy equipment shall not be set on pads for at least seven (7) days after pour. Insert 6-inch steel dowel rods into floors to anchor pads.
- B. All mechanical equipment (tanks, heaters, chillers, boilers, pumps, air handling units, etc.) shall be set on a minimum of 4" tall concrete pads. Pads shall be taller where required for condensate traps. All concrete

pads shall be complete with all pipe sleeves, anchor bolts, reinforcing steel, concrete, etc. as required. Pads larger than 18" in width shall be reinforced with $\frac{1}{2}$ " round bars on 6" centers both ways. Bars shall be approximately 3" above the bottom of the pad. All parts of pads and foundations shall be properly rodded or vibrated. If exposed parts of the pads and foundations are rough or show honeycomb after removing forms, all surfaces shall be rubbed to a smooth surface. Chamfer all square edges one-half inch.

- C. In general, concrete pads for equipment shall extend four (4) inches beyond the equipment's base dimensions. Where necessary, extend pads 30 inches beyond base or overall dimensions to allow walking and servicing space.
- D. Exterior concrete pads shall be four (4) inches minimum above grade and four (4) inches below grade on a tamped four (4) inch dense grade rock base unless otherwise indicated or specified. Surfaces of all foundations and bases shall have a smooth finish with one-half (1/2) inch chamfer on exposed edges.
- E. All exterior below grade concrete structures (utility vaults, grease traps, manholes, etc.) shall be provided with exterior waterproofing. Waterproofing shall be hot-fluid applied rubberized-asphalt waterproofing membrane with elastomeric sheets at edges, corners, and terminations of membrane for continuous watertight construction. Apply in layers and reinforce as required to provide uniform seamless membrane minimum 4mm thickness. Also, seal penetrations into and out of the structure watertight. Provide Link-Seal modular seal or equal.

27. NOISE, VIBRATION OR OSCILLATION

- A. All work shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the Engineer. In case of moving machinery, sound or vibration noticeable outside of room in which it is installed, or annoyingly noticeable inside its own room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer shall be corrected in an approved manner by the Contractor at his expense.
- B. All equipment subject to vibration and/or oscillation shall be mounted on vibration supports whether indicated or not suitable for the purpose of minimizing noise and vibration transmission, and shall be isolated from external connections such as piping, ducts, etc. by means of flexible connectors, vibration absorbers, or other approved means. Unitary equipment, such as small room heating units, small exhaust fans, etc., shall be rigidly braced and mounted to wall, floor or ceiling as required and tightly gasketed and sealed to mounting surface to prevent air leakage and to obtain quiet operation. Flush and surface mounted equipment such as diffusers, grilles, etc., shall be gasketed and affixed tightly to their mounting surface.
- C. The Contractor shall provide supports for all equipment furnished by him. Supports shall be liberally sized and adequate to carry the load of the equipment and the loads of attached equipment, piping, etc. All equipment shall be securely fastened to the structure either directly or indirectly through supporting members by means of bolts or equally effective means. If strength of supporting structural members is questionable, contact Engineers.

28. ACCESSIBILITY

A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in double partitions and hung ceilings for the proper installation of his work. He shall cooperate with all others whose work is in the same space. Such spaces and clearances shall, however, be kept to the minimum size required.

- B. The Contractor shall locate and install all equipment so that it may be serviced, and maintained as recommended by the manufacturer. Allow ready access and removal of the entire unit and/or parts such as valves, filters, fan belts, motors, prime shafts, etc.
- C. The Contractor shall provide access panels for each concealed valve, control damper or other device requiring service as shown on engineer's plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work.

29. RESTORATION OF NEW OR EXISTING SHRUBS, PAVING, SURFACES, ETC.

A. The Contractor shall at his expense restore to their original conditions all paving, curbing, surfaces, drainage ditches, structures, fences, shrubs, existing or new building surfaces and appurtenances, and any other items damaged or removed by his operations. Replacement and repairs shall be in accordance with good construction practice and shall match materials employed in the original construction of the item and shall be to the satisfaction of the Architect and/or Engineer.

30. MAINTENANCE OF EXISTING UTILITIES AND LINES

- A. The locations of all piping, conduits, cables, utilities and manholes existing, or otherwise, that comes within the contract construction site, shall be subject to continuous uninterrupted service with no other exception than the Owner of the utilities permission to interrupt same temporarily.
- B. Utilities and lines, where known, are indicated on the drawings. Locations and sizes are approximate. Prior to any excavation being performed, the Contractor shall ascertain that no utilities or lines are endangered by new excavation. Exercise extreme caution in all excavation work.
- C. If utilities or lines occur in the earth within the construction site, the Contractor shall probe and locate the lines prior to machine excavation or blasting in the respective area. Electromagnetic utility locators and acoustic pipe locators shall be utilized to determine where metallic and non-metallic piping is buried prior to any excavation.
- D. Cutting into existing utilities and services where required shall be done in coordination with and only at times designated by the Owner of the utility.
- E. The Contractor shall repair to the satisfaction of the Engineer, any surfaces or subsurface improvements damaged during the course of the work, unless such improvement is shown to be abandoned or removed.
- F. Machine excavation shall not be permitted with ten feet of electrical lines or lines carrying combustible and/or explosive materials. Hand excavate only.
- G. Protect all new or existing lines from damage by traffic, etc. during construction. Repairs or replacement of such damage shall be at the sole expense of the party responsible.

31. SMOKE AND FIRE PROOFING

A. The Contractor shall fire and smoke stop all openings made in fire or smoke rated walls, chases, ceilings and floors in accord with the KBC. Patch all openings around ductwork and piping with appropriate type material to stop smoke at smoke walls and provide commensurate fire rating at fire walls, floors, ceilings, roofs, etc. Back boxes in rated walls shall be a minimum distance apart as allowed by code to maintain the rating. If closer provide rated box or fireproofing in code approved manner.

32. MOTORS

- A. Motors shall be built in accordance with the latest standards of NEMA and as specified. Motors shall be tested in accordance with standards of A.S.A. C50, conforming to this and all applicable standards for insulation resistance and dielectric strength.
- B. Each motor shall be provided by the equipment supplier, installer or manufacturer with conduit terminal box, and N.E.C. required disconnecting means as specified or required. Three-phase motors shall be provided with external thermal overload protection in their starter units. Single-phase motors shall be provided with thermal overload protection, integral to their windings or external, in control unit. All motors shall be installed with NEMA-rated starters as specified and shall be connected per the National Electrical Code.
- C. The capacity of each motor shall be sufficient to operate associated driven devices under all conditions of operation and load and without overload, and at least of the horsepower indicated or specified. Each motor shall be selected for quiet operation, maximum efficiency and lowest starting KVA per horsepower. Motors producing excessive noise or vibration shall be replaced by the responsible contractor. See Division 26 of Specifications for further requirements related to installation of motors.

33. CUTTING AND PATCHING

- A. The Contractor shall provide his own cutting and patching necessary to install his work. Patching shall match adjacent surfaces and shall be to the satisfaction of the Architect and Engineer.
- B. No structural members shall be cut without the approval of the Engineer and all such cutting shall be done in a manner directed by him.
- C. When installing conduit, pipe, or any other work in insulated concrete form (ICF) walls, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the mechanical and electrical work is complete. Furthermore, all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

34. CURBS, PLATES, ESCUTCHEONS & AIR TIGHT PENETRATIONS

- A. In all areas where ducts are exposed and ducts pass thru floors, the opening shall be surrounded by a 4-inchhigh by 3-inch-wide concrete curb.
- B. Escutcheon plates shall be provided for all pipes and conduit passing thru walls, floors and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the pipe or conduit. Where plates are provided for pipes passing thru sleeves which extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.
- C. Seal all duct, pipe, conduit, etc., penetrations through walls and floors air tight. If wall or floor assembly is rated then use similarly rated sealing method.

35. WEATHERPROOFING

A. Where any work pierces waterproofing including waterproof concrete, the method of installation shall be as approved by the Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings permanently watertight.

36. OPERATING INSTRUCTIONS, MAINTENANCE MANUALS AND PARTS LISTS

- A. Upon completion of all work tests, the Contractor shall instruct the Owner or his representative(s) fully in the operations, adjustment and maintenance of all equipment furnished. The time and a list of representatives required to be present will be as directed by the Engineer. Turn over all special wrenches, keys, etc., to the owner at this time.
- B. The Contractor shall furnish three (3) complete bound sets for delivery to the Engineer of typewritten and/or blueprinted instructions for operating and maintaining all systems and equipment included in this contract prior to substantial completion. All instructions shall be submitted in draft, for approval, prior to final issue. Manufacturer's advertising literature or catalogs alone will not be acceptable for operating and maintenance instructions.
- C. The Contractor, in the instructions, shall include a preventive maintenance schedule for the principal items of equipment furnished under this contract and a detailed, parts list and the name and address of the nearest source of supply.
- D. The Contractor shall frame under Lexan in the main mechanical room all temperature control diagrams and all piping diagrams.

37. PAINTING

- A. In general, all finish painting shall be accomplished under the Painting Section of the specifications by the Contractor; however, unless otherwise specified under other sections of these specifications, the following items shall be painted:
 - (1) All exposed piping, valve bodies and fittings (bare and insulated), including hangers, platforms, etc.
 - (2) All mechanical equipment not factory finished. Aluminum and stainless-steel equipment, motors, identification plates, tags, etc. shall not be painted. All rust and foreign matter shall be thoroughly removed from surfaces prior to painting. All baked enamel factory finish of equipment which may have been scratched or chipped shall be touched up with the proper paint as recommended and supplied by the manufacturer.
 - (3) All ductwork exposed in finished areas (bare and insulated), all grilles, diffusers, etc. not factory finished. Paint the inside surfaces of all interior duct surfaces visible from any register, grille or diffuser opening on all jobs; surfaces shall receive one (1) prime coat of Rustoleum 1225 red "galvinoleum" or other approved equivalent primer and rust inhibitor and one (1) coat of Rustoleum 1579 jet black "Speedy Dry" enamel or approved equivalent applied in accordance with the manufacturer's recommendations.
 - (4) All insulated piping, ductwork and equipment shall be properly prepared for painting by the Contractor where mechanical items are to be painted. In the case of externally insulated duct and pipe, the Contractor shall provide 6 oz. canvas jacket with fire retardant lagging. The jacket shall be allowed to dry properly before applying paint to avoid shrinking after painting and exposing unpainted surfaces. The Contractor, at his option, may provide double wall ductwork in lieu of externally insulated ductwork with canvas jacket and lagging.

38. ELECTRICAL CONNECTIONS

A. The Contractor shall furnish and install all (1) temperature control wiring; (2) equipment control wiring and (3) interlock wiring. The Contractor shall furnish and install all power wiring complete from power source

to motor or equipment junction box, including power wiring thru starters, and shall furnish and install all required starters not factory mounted on equipment.

- B. The Contractor shall, regardless of voltage, furnish and install all temperature control wiring and all associated interlock wiring, all equipment control wiring and conduit for the equipment that the Contractor furnishes. He may, at his option, employ at his own expense, the Electrical Contractor to accomplish this work.
- C. After all circuits are energized and completed, the Contractor shall be responsible for all power wiring, and all control wiring shall be the responsibility of the Contractor. Motors and equipment shall be provided for current characteristics as shown on the drawings.
- D. The Contractor shall furnish motor starters of the type and size required by the manufacturer for all equipment provided by him, where such starters are necessary. Starters shall have overloads for each phase.

39. FINAL CONNECTIONS TO EQUIPMENT

A. The Contractor shall finally connect to mechanical services, any terminal equipment, appliances, etc., provided under this and other divisions of the work. Such connections shall be made in strict accord with current codes, safety regulations and the equipment manufacturer's recommendations. If in doubt, contact the Engineers prior to installation.

40. REQUIRED CLEARANCE FOR ELECTRICAL EQUIPMENT

A. The NEC has specific required clearances above, in front, and around electrical gear, panels etc. The Contractor shall not install any piping, ductwork, etc., in the required clearance. If any appurtenance is located in the NEC required clearance, it shall be relocated at no additional cost.

41. INDEMNIFICATION

A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

42. HAZARDOUS MATERIALS

- A. The Contractor is hereby advised that it is possible that asbestos and/or other hazardous materials are or were present in this building(s). Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of his work, ensure that his workers are aware of this potential and what they are to do in the event of suspicion. He shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall ensure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.
- B. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.

- C. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise him immediately.
- D. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

43. ABOVE-CEILING AND FINAL PUNCH LISTS

- A. The Contractor shall review each area and prepare a punch list for each of the subcontractors, as applicable, for at least two stages of the project:
 - (1) For review of above-ceiling work that will be concealed by tile or other materials well before substantial completion.
 - (2) For review of all other work as the project nears substantial completion.
- B. When <u>all</u> work from the Contractor's punch list is complete at each of these stages and <u>prior</u> to completing ceiling installations (or at the final punch list stage), the Contractor shall request that the Engineer develop a punch list. This request is to be made in writing seven days prior to the proposed date. After all corrections have been made from the Engineer's punch list, the Contractor shall review and initial off on <u>each</u> item. This signed-off punch list shall be submitted to the Engineer. The Engineer shall return to the site <u>once</u> to review each punch list and all work <u>prior to</u> the ceilings being installed and at the final punch list review.
- C. If additional visits are required by the Engineer to review work not completed by this review, the Engineer shall be reimbursed directly by the Contractor at a rate of \$140.00 per hour for extra trips required to complete either of the above-ceiling or final punch lists.



The following is CMTA's guide for Division 20-25 required information relative to the Schedule of Values. Please utilize all items that pertain to this project and add any specialized system as required. A thorough and detailed schedule of values will allow for fair and equitable Pay Application approval and minimize any discrepancies as to the status of the job.

DIVISION 20-25 – MECHANICAL Field Representative: Project Engineer:						
Description of Work	Scheduled Value	Labor	Material			
Shop Drawings						
Mobilization/Permits						
Demolition						
Plumbing Underslab						
Sanitary Above Slab Rough-in						
Plumbing Fixtures						
Plumbing Inspections						
Sprinkler Plan Submittals						
Fire Protection Exterior						
Fire Protection Vault						
Fire Protection Interior						
Storm Piping Interior						
Plumbing Shop Drawings						
Mechanical Shop Drawings						
Domestic Water Piping						
Domestic Water Insulation						
Gas Piping Exterior						
Gas Piping Interior						

HVAC Sheet Metal		
Rooftop Units		
Grilles & Diffusers		
Insulation		
Controls		
Factory Start-Up Reports		
Owner Training		
Record Drawings		
O & M Manuals		
Punchlist/Closeout		
Controls Check-out		

END OF SECTION 200100

SECTION 200200- SCOPE OF THE MECHANICAL WORK

1. GENERAL

- A. The Mechanical work for this Contract shall include all labor, materials, equipment, fixtures, excavation, backfill and related items required to completely install, test, place in service and deliver to the Owner the complete mechanical systems in accordance with the accompanying plans and all provisions of these specifications. This work shall primarily include, but is not necessarily limited to the following:
 - (1) Complete exterior domestic water service finally connected to the local domestic water system.
 - (2) Complete exterior sanitary sewer system connected to the local system.
 - (3) Complete interior storm drainage system.
 - (4) Complete exterior fire protection system.
 - (5) Interior domestic hot, cold and recirculating hot water system.
 - (6) Interior soil, waste and vent systems.
 - (7) Roof drainage system.
 - (8) All plumbing equipment, fixtures and fittings.
 - (9) 100% automatic sprinkler system.
 - (10) All mechanical exhaust systems.
 - (11) All insulation associated with mechanical systems.
 - (12) Condensate drainage systems.
 - (13) Complete heating, ventilation and air conditioning systems.
 - (14) Final connection of all mechanical equipment furnished by others (e.g., kitchen equipment).
 - (15) Complete natural gas piping systems.
 - (16) All applicable services and work specified in Section 200100; General Provisions Mechanical.
 - (17) All specified or required control work.
 - (18) Provide all required motor starters, etc. not provided under the electrical sections.
 - (19) One year guarantee of all mechanical equipment, materials and workmanship.
 - (20) Thorough instruction of the owner's maintenance personnel in the operation and maintenance of all mechanical equipment.
 - (21) Thorough coordination of the installation of all piping, equipment and any other material with other trades to ensure that no conflict in installation.

- (22) Approved supervision of the mechanical work.
- (23) Excavation, backfilling, cutting, patching, sleeving, concrete work, etc., required to construct the mechanical systems.
- (24) Prior to submitting a bid, the Contractor shall contact all serving utility companies to determine exactly what each utility company will provide and exactly what is required of the Contractor and shall include such requirements in his base bid.
- (25) Procurement of all required permits and inspections, including fees for all permits and inspection services and submission of final certificates of inspection to the Engineers (Plumbing, Boiler, HVAC, etc.).
- (26) All necessary coordination with gas, water, and sewer utility companies, etc., to ensure that work, connections, etc., that they are to provide is accomplished.
- (27) Factory start-up of all major equipment (including terminal HVAC equipment) and submission of associated factory start-up reports to the Engineer.

END OF SECTION 200200

SECTION 200300 - SHOP DRAWINGS, DESCRIPTIVE LITERATURE, MAINTENANCE MANUALS, PARTS LISTS, SPECIAL KEYS & TOOLS

1. GENERAL

- A. The Contractor's attention is directed also to the General and Special Conditions and Section 200100 General Provisions Mechanical as well as to all other Contract Documents as they may apply to his work.
- B. The Contractor shall prepare and submit to the Engineer, through the General Contractor and the Architect (where applicable) within thirty (30) days after the date of the Contract, a minimum of seven (7) copies of all shop drawings, certified equipment drawings, installation, operating and maintenance instructions, samples, wiring diagrams, etc. on all items of equipment specified hereinafter.
- C. Submittal data shall include specification data including metal gauges, finishes, accessories, etc. Also, the submittal data shall include certified performance data, wiring diagrams, dimensional data, and a spare parts list. Submittal data shall be reviewed by the Engineer before any equipment or materials is ordered or any work is begun in the area requiring the equipment.
- D. All submittal data shall have the stamp of approval of the Contractor submitting the data as well as the General Contractor and the Architect (if applicable) to show that the drawings have been reviewed by the Contractor. Any drawings submitted without these stamps of approval may not be considered and will be returned for proper resubmission.
- E. It shall be noted that review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.
- F. The Engineers review of shop drawings, schedules or other required submittal data shall not relieve the Contractor from responsibility for: adaptability of the item to the project; compliance with applicable codes, rules, regulations and information that pertains to fabrication and installation; dimensions and quantities; electrical characteristics; and coordination of the work with all other trades involved in this project. Any items that differ from the Drawings or Specifications shall be flagged by the Contractor so the Engineer will be sure to see the item. Do not rely on the Engineer to "catch" items that do not comply with the Drawings or Specifications. The Contractor is responsible for meeting the Drawings and Specification requirements, regardless of whether or not something does not get caught by the Contractor or Engineer during shop drawing reviews.
- G. Equipment shall not be ordered and no final rough-in connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractor. It shall be the Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. The Contractor shall coordinate with all the other trades having any connections, roughing-in, etc. to the equipment.
- H. If the Contractor fails to comply with the requirements set forth above, the Engineer shall have the option of selecting any or all items listed in the Specifications or on the drawings; and the Contractor shall be required to furnish all materials in accordance with this list.
- I. Colors for equipment in other than mechanical spaces shall be selected from the Manufacturer's standard and factory optional colors. Color samples shall be furnished with the shop drawing submission for such equipment.

- J. Shop Drawing Submittals
 - All submittals for HVAC equipment shall include all information specified. This shall include air and water pressure drops, RPM, noise data, face velocities, horsepower, voltage motor type, steel or aluminum construction, and all accessories clearly marked.
 - (2) All items listed in the schedules shall be submitted for review in a tabular form similar to the equipment schedule.
 - (3) All items submitted shall be designated with the same identifying tag as specified on each sheet.
 - (4) Any submittals received in an unorganized manner without options listed and with incomplete data will be returned for resubmittal.

2. SHOP DRAWINGS

Shop Drawings, descriptive literature, technical data and required schedules shall be submitted on the following:

Duct Insulation (External) Condensing units/Split systems Pipe Insulation Water Heaters Pumps Air Handling Units Controls Plumbing Fixtures Roof Drains Sheet Metal Piping Exhaust Fans Kitchen Equipment Heaters

SPECIAL NOTES:

- 1) Upon substantial completion of the project, the Contractor shall deliver to the Engineers (in addition to the required Shop Drawings) three (3) complete copies of operation and maintenance instructions and parts lists for each item marked (1) above. These documents shall include at least:
 - a. Detailed operating instructions
 - b. Detailed maintenance instructions including preventive maintenance schedules.
 - c. Addresses and phone numbers indicating where parts may be purchased.
- Shop drawings for the Control Systems shall include detailed, scaled plans and schematic diagrams indicating the function and operation of the system.
- 3) Shop drawings for the Building Fire Protection System shall be prepared and stamped by a Certified Contractor and shall meet the criteria of the Department of Housing, Buildings and Construction and submitted to the Engineer. After the Engineer's review, they shall

be submitted by the Contractor to the proper state authorities along with the required State review fee.

- 4) The Contractor shall submit to the Boiler Inspector's Office the required documentation and review fees for a boiler permit. The boiler permit shall be submitted to the Engineer along with the Boiler Shop Drawings.
- 5) The Contractor shall submit Material Safety Data sheets for all chemical treatment and anti-freeze solutions.

3. SPECIAL WRENCHES, TOOLS, ETC.

(1) The Contractor shall furnish, along with equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed under the Contract. Wrenches shall include necessary keys, handles and operators for valves, cocks, hydrants, etc. A reasonable number of each shall be furnished.

END OF SECTION 200300

SECTION 200400 - DEMOLITION AND SALVAGE

1. GENERAL

A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

2. DEMOLITION

A. INTENT

It is the intent of this section to completely remove all components of any existing mechanical system no longer in use that will be open to view in, or will interfere with the operations of the completed building, or which will, in any way, interfere with project construction. Components of the existing mechanical systems which do not meet the above criteria, may be abandoned in place in a safe, workmanlike, code approved manner.

B. PLUMBING

- (1) All existing piping not to be reused, shall be removed when located in accessible chases, accessible ceiling spaces, crawl spaces, mechanical rooms, exposed, etc.
- (2) Unless otherwise indicated, the Contractor shall be responsible for patching and repairing all holes, etc. in the ceilings, walls, and floors where plumbing piping is removed.
- (3) All lines abandoned in place shall be made safe in compliance with the Kentucky Plumbing Code.

C. HVAC

- (1) Remove from the project area all piping not to be reused and hangers, specialties, etc. that are accessible or that become accessible during construction and/or interfere in any way with any part of the construction or would be exposed in the completed building.
- (2) Remove all temperature controls and related items that are accessible or become accessible during construction.
- (3) Remove all existing heating and ventilating equipment not indicated to be reused from the building.
- (4) The Contractor shall be responsible for the removal and/or relocation of any HVAC piping, equipment, fittings, valves, etc. which may, in the course of construction, interfere with the installation of any new and/or relocated Architectural, Structural, Mechanical or Electrical Systems at no increase in the contract price.
- (5) Unless otherwise indicated, the Contractor shall be responsible for the patching and repairing of all holes, etc. in the ceiling, wall and floors where HVAC equipment is removed.
- (6) Unless otherwise noted, when removing equipment sitting on a concrete pad, also remove the concrete pad and patch and repair floor to match adjacent surfaces.

D. REFRIGERANT RECOVERY

- (1) The Contractor shall have a licensed refrigerant recovery technician evacuate all refrigerants from all refrigeration equipment being removed in accordance with EPA guidelines and regulations. The Contractor shall take all necessary precautions to not accidentally vent refrigerants to the atmosphere. The recovered refrigerant shall be offered to the Owner. If the Owner refuses it then it becomes the property of the Contractor.
- E. THERMOSTAT, THERMOMETER, AND MERCURY BEARING DEVICE DISPOSAL
 - (1) The Contractor shall dispose of all mercury bearing materials in accordance with state and federal guidelines. The Contractor shall take all necessary precautions to not accidentally allow mercury to be released from the device during demolition.

END OF SECTION 200400

SECTION 200500 - COORDINATION AMONG TRADES, SYSTEMS INTERFACING AND CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

1. COORDINATION

- A. The Contractor is expressly directed to read the General Conditions and all detailed sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural and Structural drawings, to the end that complete coordination between trades will be affected. Special attention shall be given to the points where ducts or piping must cross other ducts or piping, where lighting fixtures must be recessed in ceilings, and where ducts, piping and conduit must fur into walls, soffits, columns, etc. It shall be the responsibility of the Contractor to leave the necessary room for other trades. No extra compensation will be allowed to cover the cost of removing piping, conduit, ducts, etc., or equipment found encroaching on space required by others.
- B. The Contractor shall be responsible for coordination with the Electrical trade to ensure that he has made provision for connections, operational switches, disconnect switches, fused disconnects, etc. for electrically operated equipment provided under this division of the specifications, or called for on the plans.
- C. If any discrepancies occur between accompanying drawings and these specifications and drawings and specifications covering other Contracts, each trade shall report such discrepancies to the Architect far enough in advance so that a workable solution can be presented. No extra payment will be allowed for relocation of piping, ductwork, conduit, and equipment not installed in accordance with the above instructions, and which interfered with work and equipment of other trades.
- D. In all areas where air diffusers and lighting fixtures are to be installed, the Contractor shall coordinate their respective construction and installations so as to provide combined symmetrical arrangements.

2. INTERFACING

The Contractor shall ensure that coordination is affected relative to interfacing of systems. Some interface points are (but not necessarily all):

- A. Connection of Domestic Water System to water service mains.
- B. Connection of Natural Gas System to natural gas service.
- C. Connection of Fire Protection System to domestic water service.
- D. Connection of Sanitary sewer house line to municipal service.
- E. Connection of Storm Drainage System to site system.
- F. Connection of all controls to equipment.
- G. Electrical power connections to electrically operated (or controlled) equipment.

3. CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

A. The Contractor shall make all connections to equipment furnished by others, or relocated from the existing structure, whenever such equipment is shown on any part of the drawings or mentioned in any part of the Specifications, unless otherwise specifically specified hereinafter.

- B. Supervision to assure proper functioning and operation shall be provided by the Contractor.
- C. Items indicated on the drawings as rough-in only (RIO) will be connected by others. The Contractor shall be responsible for rough-in provisions only.
- D. For items furnished by others, relocated, or RIO, the Contractor shall obtain from the supplier or shall field determine as appropriate, the exact rough-in locations and connection sizes for the referenced equipment.
- E. The Contractor shall be responsible for coordinating to determine any and all final connections that he is to make to equipment furnished by others.

4. RECORD DRAWINGS

A. Each Contractor shall ensure that any deviations from the Coordination Drawings are recorded as they occur, in red erasable pencil on Coordination Drawings kept at the jobsite. Upon completion of a particular phase, the Mechanical Contractor shall incorporate all field deviations into the Coordination Drawings to be utilized as Record Drawings. The Engineer shall review the Record Documents from time to time to ensure compliance with this specification. Compliance shall be a contingency of final payment. Pay particular attention to the location of under floor sanitary and water lines, shut-off valves, cleanouts and other appurtenances important to the maintenance and operation of Mechanical Systems. Also, pay particular attention to Deviations in the Control Systems and all exterior utilities. Keep information in a set of drawings set aside at the job site especially for this purpose. The Record Drawings shall be distributed electronically (on CD) to the Construction Manager, Owner, Architect and Engineer for their Records.

END OF SECTION 200500

SECTION 201100 - SLEEVING, CUTTING, PATCHING AND REPAIRING

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.
- B. The Contractor shall be responsible for all openings, sleeves, trenches, etc., that he may require in floors, roofs, ceilings, walls, etc., and shall coordinate all such work with the General Contractor and all other trades. <u>Coordinate with the General Contractor, any openings which he is to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction</u>. Improperly located openings shall be reworked at the expense of the Contractor.
- C. The Contractor shall plan his work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for piping, ductwork, conduit, etc., to go through; however, when this is not done, the Contractor shall do all cutting and patching required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Engineer. Any damage caused to the buildings by the workmen of the responsible Contractor must be corrected or rectified by him at is own expense.
- D. The Contractor shall notify other trades in due time where he will require openings or chases in new concrete or masonry. He shall set all concrete inserts and sleeves for his work. Failing to do this, he shall cut openings for his work and patch same as required at his own expense.
- E. The Contractor shall be responsible for properly shoring, bracing, supporting, etc., any existing and/or new construction to guard against cracking, settling, collapsing, displacing or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements shall be promptly and properly made good to the satisfaction of the Engineer.
- F. All work improperly done or not done at all as required by the Mechanical Trades in this section, will be performed by the Contractor at the direction of the trade whose work is affected.

2. SLEEVES, PLATES AND ESCUTCHEONS

- A. The Contractor shall provide and locate all sleeves and inserts required for his work before the floors and surface being penetrated are built, otherwise the Contractor shall core drill for pipes where sleeves and inserts were not installed, or where incorrectly located. Core drilling is the only acceptable alternative to sleeves. Do not chisel openings. Where sleeves are placed in exterior walls or in slabs on grade, the space between the pipe or conduit and the sleeves shall be made completely and permanently water tight.
- B. Pipe that penetrates fire and/or smoke rated assemblies shall have sleeves installed as required by the manufacturer of the rating seal used.
- C. At all other locations either pipe sleeves or core drilled openings are acceptable.
- D. Where thermal expansion does not occur, the wall may be sealed tight to the pipe or insulation.
- E. Insulation, that requires a vapor barrier (i.e., cold water or refrigerant piping, etc.), must be continuous through the sleeve/cored hole. For other piping, insulation may stop on either side of the sleeve.

- F. Sleeves shall be constructed of 24-gauge galvanized sheet steel with lock seam joints or Schedule 40 pipe. Sleeves in floors shall extend 1" above finished floor level.
- G. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction.
- H. In all areas where ducts are exposed and ducts pass thru floors, the opening shall be surrounded by a 4-inchhigh by 3-inch-wide concrete curb.
- I. Escutcheon plates shall be provided for all pipes and conduit passing thru walls, floors and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the pipe or conduit. Where plates are provided for pipes passing thru sleeves which extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.

3. CUTTING

- A. All rectangular or special shaped openings in plaster, stucco or similar materials, including gypsum board, shall be framed by means of plaster frames, casing beads, wood or metal angle members as required. The intent of this requirement is to provide smooth even termination of wall, floor and ceiling finishes as well as to provide a fastening means for grilles, diffusers, lighting fixtures, etc.
- B. Mechanical, plumbing, and fire protection contractors shall coordinate all openings in new and existing masonry walls with the General Contractor; and, unless otherwise indicated on the Architectural drawings, provide lintels for all openings required for the work (Louvers, wall boxes, exhaust fans, etc.). Lintels shall be sized as follows:
 - (1) New Openings up to 48" in width: Provide one 3-1/2"x3-1/2"x3/8" steel angle for each 4" of masonry width. Lintel shall have 8" bearing on either side.
 - (2) New Openings over 48" in width: Consult the Project Structural Engineer.
- C. No cutting is to be done at points or in a manner that will weaken the structure and unnecessary cutting must be avoided. If in doubt, contact the Engineer.
- D. Pipe openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.
- E. Openings in metal building walls shall be made in strict accord with building suppliers recommendations.

4. PATCHING AND REPAIRING

- A. Patching and repairing made necessary by work performed under this division shall be included as a part of the work and shall be done by skilled mechanics of the trade or trades for work cut or damaged, in strict accordance with the provisions herein before specified for work of like type to match adjacent surfaces and in a manner acceptable to the Engineer.
- B. Where portions of existing lawns, shrubs, paving, etc. are disturbed for installation of work of this Division, such items shall be repaired and/or replaced to the satisfaction of the Engineer.
- C. Where the installation of conduit, ducts, piping, etc. requires the penetration of fire or smoke rated walls, ceilings or floors, the space around such conduit, duct, pipe, etc., shall be tightly filled with an approved non-combustible fire insulating material satisfactory to maintain the rating integrity of the wall, floor or ceilings affected.
- D. Where ducts penetrate fire rated assemblies, fire dampers shall be provided with an appropriate access door.
- E. Piping passing through floors, ceilings and walls in finished areas, unless otherwise specified, shall be fitted with chrome plated brass escutcheons of sufficient outside diameter to amply cover the sleeved openings and an inside diameter to closely fit the pipe around which it is installed.
- F. Stainless steel collars shall be provided around all ducts, large pipes, etc., at all wall penetrations; both sides.
- G. Where ducts, pipes, and conduits pass through interior or exterior walls, the wall openings shall be sealed air tight. This shall include sealing on both sides of the wall to ensure air does not enter or exit the wall cavity. This is especially critical on exterior walls where the wall cavity may be vented to the exterior.

SECTION 201200 - EXCAVATION, TRENCHING, BACKFILLING AND GRADING

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.
- B. The Contractor shall include all excavating, filling, grading, and related items required to complete his work as shown on the drawings and specified herein or as required to complete, connect and place all mechanical systems in satisfactory operation.
- C. Unless otherwise shown or required, provide separate trenches for sewers, water lines and other underground raceways, with a minimum of 10 feet measured from outside diameter between pipes. In locations, such as close to buildings where separate trenches for sewers and water lines are impractical, lay the water pipe on a solid shelf at least 2'-0" above the top of the sewer and 2-0" to the side. Electric and fuel lines shall always be placed in a separate trench. All exterior lines shall have a minimum earth cover of thirty (30) inches to top of pipe, unless otherwise indicated.
- D. Water lines crossing under sewer lines, or crossing less than 2 feet above sewer lines, must be encased for a distance not less than 5 feet on either side of the point of crossover.

2. SUBSURFACE DATA

A. Materials to be excavated shall be unclassified, and shall include earth, rock, or any other material encountered in the excavating to the depth and extent indicated on the drawings and specified herein. No adjustment in the Contract sum will be made on account of the presence or absence of rock, shale, or other materials encountered in the excavating. This paragraph is written to include the removal of all rock with no extras, whether rock is indicated or not.

3. BENCH MARKS AND MONUMENTS

A. Maintain carefully all bench marks, monuments and other reference points. If disturbed or destroyed, replace as directed.

4. EXCAVATION

- A. Excavate trenches of sufficient width for proper installation of the work. When the depth of backfill over sewer pipe exceeds 10 feet, keep the trench at the level of the top of the pipe as narrow as practicable. Trench excavation for piping eight inches and smaller shall not exceed thirty-inch width for exterior lines and twenty-four-inch width for interior lines.
- B. Sheet and brace trenches as necessary to protect workmen and adjacent structures. Comply with local regulations or, in the absence thereof, with the "Manual of Accident Prevention in Construction" of the Associated General Contractors of America, Inc., and current OSHA Standards. Do not remove sheeting until trench is backfilled sufficiently to protect pipe and prevent injurious caving. Where removal of sheeting and/or bracing is hazardous, leave in place. Cut off such sheeting not to be removed at least 3 feet below finished grade.
- C. Rules and regulations governing the respective utilities shall be observed in executing all work under this heading. Active utilities discovered in the course of excavation shall be protected or relocated in

accordance with written instructions from the Engineer. Inactive and abandoned utilities encountered in trenching operations shall be removed and abandoned with ends plugged or capped in accord with current codes and safe practice. If in doubt, contact Engineers. Machine excavation shall not be allowed within ten (10) feet of existing electric lines or lines carrying combustible materials. Use only hand tools.

- D. The removal of rock shall be accomplished by use of hand or power tools only. Blasting shall not be permitted unless authorized in writing by the Engineer. Any damage to existing structures, exterior services, or rock intended for bearing, shall be corrected at the Contractor's expense.
- E. Perform final grading of trench bottoms by hand tools; carry machine excavation only to such depth that soil bearing for pipes and raceways will not be disturbed. Grade the bottom of trenches evenly to ensure uniform bearing for all piping and raceways. Cut bell holes as necessary for joints and jointmaking. Except as hereinafter specified, bottom of trenches for bell and spigot pipe, flanged pipe, etc. shall be shaped to the lower quadrant of pipe with additional excavation for bell or flange. Piping installed where it rests on bell, or flange and/or is supported with blocks or wedges will not be accepted.
- F. Keep trenches free from water while construction therein is in progress. Under no circumstances lay pipe or appurtenances in water. Pump or bail water from bell holes to permit proper jointing of pipe. Any water pumping from this Contractor's trenches which is required during construction, shall be included in this Contract.
- G. In no case shall excavation work be accomplished that will damage in any way the new structure, existing structures, equipment, utility lines, large trees to remain, etc. The Contractors shall take the necessary steps to prevent flow of eroded earth by water or landslide onto the property of others, or against the structures. The repair of all such damage or any other damage incurred in the course of excavation shall be borne by the responsible Contractor.
- H. Use surveyor's level to establish elevations and grades.
- I. The Contractor shall accept the site as he finds it and remove all trash, rubbish and material from the site prior to starting excavation of his work.
- J. The Contractor shall provide and maintain barricades and temporary bridges around excavations as required for safety. Temporary bridges shall be provided where excavations cross paved areas and walks. The Contractor shall maintain these bridges in a safe and passable condition for all traffic until removal. Refer to OSHA Standards for such installations and comply with same in all details.
- K. Pay particular attention to existing utilities and lines to avoid damage. The locations of existing lines which are indicated on the plans were taken unconfirmed from drawings prepared for previous construction and locations are approximate only. Also, certain water, gas, electric, storm and sanitary sewer lines and other underground appurtenances, active or abandoned, may not appear on the drawings. It shall be each Mechanical Contractor's responsibility to ascertain the location of all lines and excavate with caution in their area.

5. BACKFILL AND SURFACE REPAIR

A. Backfilling for mechanical work shall include all trenches, manhole pits, storage tank pits, and/or any other earth and/or rock openings which are excavated under this Contract. Backfilling shall be carefully performed and the surface restored to its original level to receive new finish. Wherever trenches and earth openings have not been properly filled and/or settlement occurs, they shall be re-excavated, re-filled and properly compacted, smoothed off and finally made to conform to the level of the original ground surface.

- B. Unless otherwise indicated or specified, all piping shall be bedded on four (4) inches minimum of compacted naturally or artificially graded mixture of crushed gravel, crushed stone, or crushed sand with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve on undisturbed soil excavated as described hereinbefore. Install tracer wire above pipe. Cover the pipe with twelve (12) inches of compacted backfill to prevent settlement above and around the new pipe. The backfill shall be naturally or artificially graded mixture of crushed gravel, crushed stone, or crushed sand with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve. The backfill shall be naturally or artificially graded mixture of crushed gravel, crushed stone, or crushed sand with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve. Prior to placing this second level of backfill, apply all required coatings and coverings to pipe, apply required tests and check the grading of the pipe to ensure that it is correct and that the pipe is free of swags, bows or bends. Also check lines for leaks at this point and repair as required. Once all of the preceding is accomplished, continue backfill with clean, debris and rock free earth tamped at six (6) inch intervals. Finish the backfill as specified following. Note: Water settling of backfill will be permitted only as an aid to mechanical compacting.
 - (1) When installing any type of pipe below building footing, parallel or perpendicular to the footing, the area underneath the footing and in the zone of influence shall be backfilled with cementitious flowable fill. The zone of influence is the area within a 45-degree angle projecting down from the bottom edge of footers on all sides of the footing. Piping within flowable fill shall be isolated from the fill by a layer of heavy duty felt paper. Piping installed in trenches backfilled with flowable fill shall be anchored to the soil below prior to backfilling.
- C. Backfill beneath areas to be seeded or sodded within six (6) inches of finished grade. The remaining six (6) inches shall be backfilled with clean top soil.
- D. Backfill beneath paved areas, walks, etc. shall be brought to proper grade to receive the sub-base and paving. No paving shall be placed on uncompacted fill or unstable soil.
- E. Backfill for natural gas lines shall be in strict accordance with the utility company or local municipalities requirements. If in doubt, contact the utility company or local municipality and/or the Engineer.
- F. Wherever, in the opinion of the Engineer, the soil at or below the requisite pipe grade is unsuitable for supporting piping, special support shall be provided as directed by the Engineer.
- G. Unsuitable material and surplus excavated material not required for backfill shall be removed from the site. The location of dump and length of haul shall be the affected Contractor's responsibility.
- H. Provide and place any additional fill material from off the site as may be required for backfill. Fill obtained from off site shall be of kind and quality as specified for backfill and the source approved by the Engineer and shall be brought to the site by the Contractor requiring the fill.
- I. In the absence (if not specified or indicated elsewhere in the drawings or specifications to be done by others) of such work by others, the Contractor shall lay new sod over his excavation work. Level, compress and water in accord with sound sodding practice.
- J. When running any type of piping below a footer or in the zone of influence the piping shall be backfilled with cementitious flowable fill. The zone of influence is the area under the footer within a 45-degree angle projecting down from the bottom edge of the footer on all sides of the footer. Additionally, grease traps, manholes, vaults, and other underground structures shall be held away from building walls far enough to be outside of the zone of influence.
- K. Warning Tape and Tracer Wire

Provide a yellow and black plastic tape in all trenches 6" above the buried utility that identifies the utility about to be encountered. For non-metallic pipe a #12 copper wire shall also be laid in the trench to aid in future location of the piping. A foil faced warning tape may be used in lieu of the plastic tape and wire.

L. All manholes, vaults, and similar underground structures shall have the top elevation set flush with finished grade unless specifically noted otherwise.

6. MINIMUM DEPTHS OF BURY (TO TOP OF PIPE)

In the absence of other indication, the following shall be the minimum depth of bury of exterior utility lines. (Check drawings for variations).

A.	Domestic Water Lines	36 inches.
B.	Fire Protection Lines	42 inches.
C.	Storm Lines	20 inches.
D.	Sanitary Lines (Exterior)	36 inches.
E.	Natural Gas Lines	36 inches.
F.	Condensate	20 inches.

SECTION 201300 - PIPE, PIPE FITTINGS AND PIPE SUPPORT

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.
- B. When a pipe size is not indicated, the Contractor shall request the pipe size from the Engineers. All piping shall be installed straight and true, parallel or perpendicular to the building construction. Piping shall be installed so as to allow for expansion without damage to the building finishes, structure, pipe, equipment, etc., use offsets, U-bends or expansion joints as required. Where a section of piping is not indicated but is obviously required for completion of the system, the Contractor shall provide same at no additional cost to the project. No mitered joints or field fabricated pipe bends shall be accepted. Pipe shall clear all windows, doors, louvers and other building openings.
- C. All pipe shall be supported in a neat and workmanlike manner and wherever possible, parallel runs of horizontal piping shall be grouped together on trapeze type hangers. Vertical risers shall be supported at each floor line with approved steel pipe riser clamps. The use of wire or perforated metal to support pipes will not be permitted. Hanging pipes from other pipes shall not be permitted. Spacing of pipe supports shall not exceed eight feet for pipes up to 1-1/4 inches and ten feet on all other piping. Small vertical pipes (1 inch and less) shall be bracketed to walls, structural members, etc. at four (4) foot intervals so as to prevent vibration or damage by occupants. Insulated piping shall be supported on a rigid insulation block at each hanger so as to prevent crushing of insulation by hangers. Hangers shall pass completely around the insulation jacket and a steel protective saddle shall be applied to prevent compression of the insulation. (Refer to Specifications Section entitled INSULATION-MECHANICAL).
- D. Where piping rests directly on a hanger, clip, bracket or other means of support, the support element shall be of the same material as the pipe, (e.g., copper to copper, ferrous to ferrous, etc.) or shall be electrically isolated one from the other so as to prevent pipe damage by electrolysis. Pay particular attention and do not allow copper pipe to rest on ferrous structural members, equipment, etc. without electrolytic isolation.
- E. In general, piping shall be installed concealed except in Mechanical, Janitor Rooms, etc. unless otherwise indicated, and shall be installed underground or beneath concrete slabs only where indicated. All lines at ceilings shall be held as high as possible and shall run so as to avoid conflicts with other trades, and to facilitate the Owner's use and maintenance. Location of pipe in interior partitions shall be carefully coordinated with whoever will construct the partitions after the piping is in place. Where exposed risers occur, they shall be kept as close to walls as possible.
- F. Installation of pipe shall be in such a manner as to provide complete drainage of the system toward the source. Drain valves shall be provided at all drainage points on pipes. Drain valves shall be 1/2" size gate type with 3/4" hose thread end and vacuum breaker. Label each drain valve.
- G. All hot and cold-water piping shall be kept a sufficient distance apart so as to prevent heat transfer between them. Cold water piping shall also be kept apart from refrigerant hot gas lines.
- H. Piping carrying water or other fluids subject to freezing shall not be installed in locations subject to freezing; if in doubt, consult Engineer.
- I. Piping for all drainage systems shall be installed to permit flow, trapping, and venting in accord with current codes and sound practice.

- J. All cast iron soil pipe and fittings shall be coated inside and out with coal tar varnish.
- K. Non-metallic piping shall be installed in strict accordance with the manufacturer's instructions. If no such instructions are available, consult Engineers.
- L. Nipples shall be of the same material, composition and weight classification as pipe with which installed.
- M. Where piping is not indicated on the plans, but is obviously or apparently required, contact the Engineers prior to submission of a bid proposal.
- N. Pay particular attention to conflict of piping with other work. Do not install until conflict is resolved. If necessary, contact Engineers.
- O. Piping materials in each system shall, to the extent practicable, be of the same material. Frequent changes of material (for example, from copper to steel) shall be avoided and in no case, shall be accomplished without use of insulating unions and permission of the Engineers.
- P. Apply approved pipe dope (for service intended) to <u>all</u> male threaded joints. Pay particular attention to dope for fuel gas lines. The dope shall be listed for such use.
- Q. High points of closed loop hot water heating systems shall have manual or automatic air vents as indicated or required unless automatic air vents are specifically indicated. Pipe to suitable drainage point.
- R. All piping shall be capped or plugged during erection as required to keep clean and debris and moisture free.
- S. The entire domestic hot, cold and recirculating hot water piping system shall be sterilized in strict accord with requirements of the Department of Health Codes, Rules and Regulations for the State which the work is being accomplished in.
- T. Provide expansion joints where shown on the plans and where required by good practice. Expansion joints shall be guided and anchored in accordance with the recommendations of the Expansion Joint Manufacturer's Association.
- U. Where plastic pipe penetrates a fire rated assembly, it shall be replaced with a metal threaded adapter and a metal pipe per code.
- V. Foam Core PVC is not permitted
- W. Where piping penetrates interior or exterior walls, the wall shall be sealed air tight. Refer to the sleeving, cutting, patching and repairing section of the specifications for additional requirements.
- X. Provide thrust blocks on all storm, sanitary, water, steam, hot, chilled, condenser, etc., and any other piping subject to hammering. Thrust blocks shall be provided at all turns.
- Y. All piping to hydronic coils shall be full size all the way to the coil connection on the unit. If control valve is smaller than pipe size indicated, transition immediately before and after control valve. Also, if coil connection at unit is a different size than the branch pipe size indicated, provide transition at coil connection to unit. <u>On 3-way valve applications, the coil bypass pipe shall be full size.</u>

Z. Provide check valves on individual hot and cold-water supplies to each mixing valve (including each sensor style faucet, safety shower, mop sink, etc.) and each showerhead with a diverter valve (including all ADA showers). This requirement shall not be satisfied by mixing valves or fixtures with internal check valves. Independent external check valves are required.

2. UNIONS AND FLANGES AND WELDED TEES

- A. Screwed unions, soldered unions or bolted flanges shall be provided as required to permit removal of equipment, valves and piping accessories from the piping system. Keep adequate clearances for coil removal, rodding, tube replacement, motor lubrication, filter replacement, etc. Flanged joints shall be assembled with appropriate flanges, gaskets and bolting. Gaskets for steam piping systems shall be flexitalic spiral wound type. The clearance between flange faces shall be such that the connections can be gasketed and bolted tight without imposing undue strain on the piping system.
- B. Dielectric insulating unions or couplings shall be used wherever the adjoining materials being connected are of dissimilar metals such as connections between copper and steel pipe.
- C. Tee connections for welded pipe shall be made up with welding fittings. Where the size of the side outlet is such that a different connection technique than on the run is required, a weldolet, sockolet, or threadolet type fitting may be used for the branch in place of reducing tees only where the branch is 2/3 the run size or smaller.

3. SPECIFICATIONS STANDARDS

All piping and material shall be new, made in the United States and shall conform to the following minimum applicable standards:

- A. Steel pipe; ASTM A-120, A-53 Grade A, A-53 Grade B.
- B. Copper tube; Type K, L, M; ASTM B88-62; Type DWV ASTM B306-62.
- C. Cast iron soil pipe; ASA A-40.1 and CS 188-59.
- D. Cast iron drainage fittings; ASA B16.12.
- E. Cast iron screwed fittings; ASA B16.4.
- F. Welding fittings; ASA B16.9.
- G. Cast brass and wrought copper fittings; ASA B16.18.
- H. Cast brass drainage fittings; ASA B16.23.
- I. Solder; Handy and Harmon, United Wire and Supply; Air Reduction Co. or equivalent.
- J. PVC plastic pipe; ASTM D1785.

4. PITCH OF PIPING

All piping systems shall be installed so as to drain to a low point. Certain minimum pitches shall be required for this drainage. For proper flow and/or for proper operation, the following pitches shall be required:

A. Interior Soil, Waste and Vent Piping:

1/4 inch per foot in direction of flow where possible but in no case less than 1/8" per foot.

B. Exterior Sanitary Lines:

Not less than one (1) percent fall in direction of flow and no greater than indicated.

C. Roof Leaders:

1/8 inch per foot where possible.

D. Condensate Drain Lines from Cooling Equipment:

Not less than 1/4 inch per foot in direction of flow.

E. All Other Lines:

Provide ample pitch to a low point to allow 100 percent drainage of the system.

5. APPLICATIONS

- A. General Notes
 - (1) Where plastic piping penetrates a fire rated assembly, it shall be replaced with a threaded metal adapter and metal pipe or whatever means necessary to maintain the separation rating in accordance with local plumbing and fire codes.
 - (2) Plastic piping or any materials with a flame and smoke spread rating not approved for plenum use shall not be permitted in supply, return, relief or exhaust plenums.
 - (3) PVC or plastic piping shall not be used under paving, roads or areas where vehicular traffic is expected.
 - (4) PVC or plastic piping whether specifically listed or not may not be used in high rise buildings or anywhere else prohibited by code.
- B. Sanitary Sewer Exterior
 - (1) Service weight cast iron piping with bell and spigot fittings complying with ASTM A 74. All joints shall be compression gasket type.
 - (2) SDR 35 PVC pipe extruded from Type 1, Grade 1 polyvinyl chloride material. PVC pipe shall have a bell type fitting on one end. All joints shall be solvent cement type, made in accordance with the Kentucky Plumbing Code.
 - (3) Service weight hubless cast iron with manufacturer's approved bands.
- C. Natural Gas Piping Exterior

Exterior natural gas piping shall be thermoplastic gas pressure pipe with fittings complying with ASTM D 2513. All gas piping shall be installed per NFPA 54.

- D. Domestic Water Piping Exterior
 - (1) Type "K" hard copper with wrought copper fittings and brazed joints.
 - (2) Schedule 150 ductile iron piping with cement mortar lining and rubber gasketed joints.
 - (3) Schedule 40 PVC pipe, NSF approved for underground domestic cold-water pipe, with solvent weld joints. All piping and joints shall meet the Kentucky Plumbing Code.
 - (4) Class 200 PVC. Piping shall meet AWWA C900 requirements, be UL listed, Factory Mutual approved and NSF approved. Joints shall have spigot pipe ends with a flexible elastomeric ring seated in a groove to provide water tight seal. Minimum burst pressure to be 900 psi when tested in accordance with ASTM D1599.
- E. Fire Protection Exterior and Interior

Refer to the Fire Protection System section of these specifications.

- F. Soil Waste and Vent Piping General Requirements
 - (1) Water closet floor flanges and ells shall be cast iron regardless whether PVC piping is allowed or not.
 - (2) Soil and waste piping serving mechanical rooms, laundries and kitchens shall be cast iron regardless whether PVC piping is allowed or not. Cast iron will also be required at any other location where waste water temperature can exceed 120°F. Cast iron shall extend a minimum of 35' past last waste inlet.
- G. Soil, Waste and Vent Piping (Below Slab)
 - (1) Schedule 40 PVC pipe with drainage pattern fittings and solvent cement joints made in accordance with the Kentucky Plumbing Code. Foam core piping is not permitted.
 - (2) Service weight hubless cast iron with manufacturer's approved bands.
- H. Soil, Waste and Vent Piping (Above Slab)
 - (1) Service weight hubless cast iron pipe with manufacturer's approved bands.
 - (2) Service weight cast iron hub and spigot piping with lead and oakum joints or compression gasket joints.
 - (3) Schedule 40 galvanized steel piping with screwed ends and cast-iron drainage pattern fittings for piping 2" and less in size. Provide pipe adapters for connector of cast iron pipe at slab.
 - (4) Type DWV copper drainage piping with cast bronze drainage pattern fittings with solder joints.
 - (5) Schedule 40 PVC pipe with drainage pattern fittings and solvent cement joints made in accordance with the Kentucky Plumbing code.
- I. Roof Leaders/Interior Storm Sewer Piping/Overflow Roof Leaders

- (1) Service weight hubless cast iron pipe with manufacturers approved bands. Horizontal pipe and fittings 6" and larger, shall be suitably braced to prevent horizontal movement. Provide bracing in accordance to CIPI 301-00. Provide "Holdrite" bracing system or approved equal.
- (2) Schedule 40 PVC pipe with drainage pattern fittings and solvent cement joints.
- J. Natural Gas Piping Interior
 - (1) Schedule 40 black steel pipe with malleable iron threaded fittings for pipe sizes 2" and smaller.
 - (2) Schedule 40 black steel pipe with wrought steel buttwelded fittings for pipe sizes 2-1/2" and larger.
 - (3) Gas piping on the roof shall have expansion loops on all piping runs 75 feet or greater.

NOTES:

- (1) All gas piping shall be installed per NFPA 54.
- (2) Unions or valves shall not be installed in an air plenum.
- (3) Piping below slab must be sleeved and vented.
- (4) Piping installed in concealed locations shall not have mechanical joints.
- K. Domestic Cold, Hot and Recirculating Hot Water Piping (Above Slab)
 - (1) Type "L" hard copper tubing with wrought copper fittings with lead free solder equivalent in performance to 95/5. (Maximum lead content of solder and flux is 2%).
- L. Domestic Cold, Hot and Recirculating Hot Water Piping (Below Slab)

Type "K" hard or soft copper tubing with wrought copper fittings and brazed joints. There shall be no joints beneath slabs.

- M. Hydronic Piping (Heat Pump Systems)
 - (1) 2" and Smaller: Schedule 40 black steel pipe with screwed fittings or Type "L" hard copper tubing with wrought copper fittings and 95/5 solder.
 - (2) 2-1/2" and Larger: Schedule 40 black steel pipe with 125# welded or flanged joints. Weldolets may be used for branch line connections to pipe mains. Type "L" hard copper piping with wrought copper fittings and 95/5 solder may be installed.
 - (3) Schedule 40 Victaulic 107/W07 or engineer approved equivalent mechanical grooved pipe couplings and fittings with 125# rating minimum may be used. Install gaskets as recommended by the manufacturer. Piping system shall be rated for minimum of 250°F water temperature. Mechanical grooved piping may <u>not</u> be used if system water temperature exceeds 250°F.
 - a. Roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions, which may or may not include torque settings, torque wrenches, extreme lubricant and specified gaps. Engineer reserves the right to inspect any and all installation of product. Factory trained representative must periodically visit the job site and provide on-site training.

Grooved pipe shall be produced using the RG5200i/5200i fully automated grooving tool, where applicable, that provides groove traceability documents, corresponding identification marks on the pipe, and confirm all critical dimensions fall into the required tolerance range as listed by the tool manufacturer.

- (4) Special Notes:
 - a. Dielectric unions shall be provided at all connections of dissimilar materials.
 - b. Copper and steel piping shall not be mixed in the mechanical room.
 - c. Piping shall meet all State Boiler Code requirements. Pay particular attention to welded pipe requirements for hot water systems.
 - d. Takeoffs and branch piping to individual coils or heat pumps shall not be connected to the bottom of hydronic mains. Connection to mains shall be at the side of the main. Also refer to details on the drawings.
- N. Air Vent Discharge Lines

Type "L" soft copper; wrought copper fittings, 95/5 solder.

O. Refrigerant Piping

Interior Piping for Variable Refrigerant Flow Systems 1/8" to 1-3/8" shall be ACR soft copper tube with long radius bends of soft copper tube. Provide ACR hard copper tube in all sizes for systems other than Variable Refrigerant Flow. Interior lines larger than 1-3/8" shall be ACR hard copper tube. All exterior lines shall be ACR hard copper tube. Fitting shall be wrought or forged copper with silver solder joints and minimum 15% silver content.

- (1) General Installation Notes:
 - a. Contact Engineer 24 hours prior to installation of refrigerant lines or evacuation of refrigerant system.
 - b. Refrigerant lines installation must meet HVAC equipment manufacturer's recommendations.
 - c. While installing or soldering refrigerant lines, system must continuously be purged with nitrogen.
 - d. After system is installed, the refrigerant system must be evacuated to 25 microns for eight hours.
- P. Condensate Drain Lines
 - (1) Type "DWV" copper, wrought copper, lead free solder.
 - (2) Schedule 40 PVC with solvent welded fittings.
- Q. Water Heater Relief Line

Type "M" copper tubing with sweat fittings and 95/5 solder.

SECTION 202100 - VALVES AND COCKS

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.
- B. The Contractor shall provide all valves required to control, maintain and direct flow of all fluid systems indicated or specified. This shall include, but may not be limited to all valves of all types including balancing cocks, air cocks, lubricated plug cocks, packed plug cocks, special valves for special systems, etc., for all Mechanical Systems.
- C. All valves shall be designed and rated for the service to which they are applied.
- D. The following type valves shall not be acceptable: Zinc, plastic, fiber or non-metallic.
- E. Ball valves with temperature and pressure ports are <u>not</u> an acceptable alternative to the balancing valves specified herein. Valves that do not comply with these specifications shall be removed and replaced by the Contractor with no increase in contract price.
- F. Each type of valve shall be of one manufacturer, i.e., gate valves, one manufacturer, globe valves, one manufacturer, silent check valves, one manufacturer, etc. The following valve manufacturers shall be acceptable: Lunkenheimer, Tour & Anderssen, Powell, Nibco, Crane, Jenkins, T & S Brass, Walworth, Milwaukee, DeZurik, Consolidated Valve Industries, Inc., Victaulic, Bell & Gossett, Flow Design, Watts.
- G. All valves shall comply with current Federal, State and Local Codes.
- H. All valves shall be new and of first quality.
- I. All valves shall be full line size. Valves and hydronic specialties shall not be reduced to coil or equipment connection size. Size reductions shall be made at the connection to the equipment.
- J. Angle stops for plumbing fixtures shall be quarter turn ball type.
- K. All valves for use in potable water systems shall comply with federal lead-free requirements that the lead content of wetted surfaces cannot exceed 0.25% by weight.

2. LOCATION OF MAINTENANCE VALVES

Maintenance valves and unions, installed so as to isolate equipment from the system shall be installed at the following locations:

- A. At each plumbing fixture.
- B. At each air handling unit, and make-up air unit.
- C. At each unit heater.
- D. At each heating or cooling coil.

E. At all other locations indicated on the drawings.

3. WORKMANSHIP AND DESIGN

A. Handwheels for valves shall be of a suitable diameter to allow tight closure by hand with the application of reasonable force without additional leverage and without damage to stem, seat and disc. Seating surfaces shall be machined and finished to ensure tightness against leakage for service specified and shall seat freely. All screwed valves shall be so designed that when the screwed connection is properly made, no interference with, nor damage to the working parts of the valve shall occur. The same shall be true for sweat valves when solder or brazing is applied.

4. TYPES AND APPLICATION

A. GATE VALVES

Gate Valves shall be of the wedge disc type, permit straight line flow, complete shut-off and designed so that when the valve is wide open, it can be packed under pressure. Valves 1-1/2 inches and smaller shall be bronze, with ends to suit piping and non-rising stem. The valve shall have a deep stuffing box for long contact with the stem, packing gland and filled with high quality packing. Valves 2 inches thru 4 inches shall be iron body bronze mounted with flanged ends and non-rising stem. Boiler stop valves and valves larger than 4 inches shall be iron body bronze mounted flanged ends with outside screw and yoke with rising stem. Working pressure for bronze valves shall be 150 pounds and iron valves 125 pounds when installed in piping with system pressures up to 100 pounds per square inch and 250 pounds for 100 pounds per square inch and over. 2" and under NIBCO T133, greater than 2" NIBCO F619. All gate valves 2" and smaller for use in potable water systems shall meet federal requirement to be lead free containing less than 0.25% lead by weight of wetted area. NIBCO F768B.

B. GLOBE VALVES

Globe Valves shall permit control of flow rate from full flow to complete shut-off and designed that when the valve is wide open it can be repacked under pressure, and have a deep stuffing box with gland and filled with high quality packing. Valves 1-1/2 inches and smaller shall be bronze with ends to suit piping union bonnet, and with stainless steel plug type disc and seat of not less than 500 Brinnell hardness. Valves 2 inches and larger shall be iron body bronze mounted with flanged ends, yoke bonnet, and disc guide. Working pressure for bronze valves shall be 150 pounds and iron valves 125 pounds when installed in piping with system pressures up to 100 pounds per square inch and 250 pounds for 100 pounds per square inch and over. 1-1/2" and under NIBCO T256AP, greater than 1-1/2" NIBCO F768B.

C. CHECK VALVES

Check Valves shall be horizontal swing type with two-piece hinges, disc construction seats to be bronze and bronze discs or with composition face depending on service and provide silent operation. Valves 1-1/2 inches and smaller shall be bronze with ends to suit piping, have full area "Y" pattern body and integral seats. Valves 2 inches and larger shall be iron body brass mounted and with flanged ends. Working pressure for bronze valves shall be 150 psi and iron valves 125 psi when installed in piping with system pressures up to 100 psi and 250 psi for 100 psi and over. 3" and under NIBCO T433Y, greater than 3" NIBCO F918B (for less than 100 psi systems) greater than 3" NIBCO F968B (for 100 psi or greater systems).

D. BALL VALVES (NON-POTABLE)

Ball Valves shall have removable lever handle with vinyl grip, adjustable stem gland screw, reinforced Teflon stuffing box ring, blow out proof stem, bronze body, reinforced Teflon seats, chrome plated steel ball as manufactured by Consolidated Valve Industries, Inc., Lunkenheimer, Apollo, Jenkins, Nibco or equivalent. Provide a stem extension so that the base of the handle is 1/4" above the insulation similar to Nibseal. NIBCO T5800-70.

E. BALL VALVES (POTABLE WATER)

All valves for use in potable water systems 2" and smaller contain less than 0.25% lead by weight and comply with federal lead free potable water requirements. Ball valves shall have a removable lever handle with vinyl grip, adjustable stem gland screw, reinforced Teflon stuffing box ring, blowout proof stem, stainless steel or bronze body, reinforced Teflon seats, stainless steel or chrome plate steel ball as manufactured by Apollo, Aslo, Nibco, Milwaukee, or equivalent. Provide a stem extension so that they bas of the handle is ¼" above the insulation similar to Nibseal. NIBCO S-585-66-LF.

F. BUTTERFLY VALVES

Butterfly valves shall be line sized cast iron body, lug style, 200 PSI rating (bubble tight) EPT or Viton seat, cartridge type; high strength stem. Disc to have ground and polished seating surface. Operator shall be locking lever style. Quality equivalent to Crane Monarch series. 3" and under NIBCO LD3222-3, greater than 3" NIBCO LD322-5. Valves 6" and over shall have gear driven operators.

G. BALANCING VALVES

Bell & Gossett, Model CB circuit setter balancing valve or approved equivalent. Calibrated balancing valve shall have flanged connections suitable for 125# working pressure at 250°F. 4" and up shall be rated at 175# at 250°F working pressure. Provide with brass readout valves fitted with an integral EPT insert and check valve. Each balance valve shall have a calibrated nameplate to assure specific valve settings and be constructed with internal seals to prevent leakage.

H. AIR COCKS

Straight nose; Lunkenheimer Fig. 476; bronze; tee handle; bent nose; Lunkenheimer Fig. 478, 125#; bronze; tee handle.

I. GAUGE COCKS

Straight, Lunkenheimer, Fig. 1178; 125#; bronze; tee handle. FIP.

J. LUBRICATED PLUG COCKS

2" and under; Homestead Fig. 601; 150#; semi-steel; screwed; 2-1/2" and over; Homestead Fig. 602; ±50#; semi-steel; flanged.

K. PACKED PLUG COCKS

2" and under; DeZurik Fig. 425-S; 175#; semi-steel; screwed. 2-1/2" and over; DeZurik Fig. 425-F; 175#; semi-steel; flanged.

SECTION 202110 - ACCESS TO VALVES, EQUIPMENT, FILTERS, ETC.

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Requirements-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.
- B. All mechanical equipment shall be installed in a manner which allows ready access to all components requiring service, adjustments, shutoff, etc.
- C. Filters shall be accessible, removable and replaceable without disconnecting mounting brackets, piping, wiring, etc.
- D. All oil cups, grease cups, grease fittings, etc. shall be accessible without disassembly of equipment, piping, ductwork, etc. (Extended oilers or grease fittings may be required).
- E. Provide access doors or panels for all equipment, valves, dampers, filters, fire dampers, etc. in concealed spaces not otherwise provided with suitable access. (Lay-in ceilings shall be considered acceptable access; splined or drywall ceilings shall not).
- F. All valves, unions, strainers, cleanouts, volume dampers, and test points shall be accessible.
- G. Access panels in lay-in ceilings shall be labeled with a lamacoid plate to indicate location of equipment, filters, valves, etc.
- H. Access panels in fire rated walls shall bear the same rating as the wall.
- I. Each fire damper shall be provided access through the duct to allow reset of the damper. This may be either a gasketed sheet metal panel over a suitable opening or a factory-built access panel. The panel shall be at least one and one-half (12) inch larger than the opening all around and shall be held in place with sheet metal screws sufficiently to ensure that it is air tight. Manually check the size and location of each of these openings to ensure that the fire damper may be manually reset by use of hand only.
- J. Contractor shall coordinate the finish of all access doors and panels installed in finished areas with Architect.

2. ACCESS DOORS

Refer to Sheet Metal and Flexible Duct section of the specifications.

SECTION 202200 - INSULATION - MECHANICAL

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.
- B. Work under this section shall include all labor, equipment, accessories, materials and services required to furnish and install all insulation, fittings and finishes for all mechanical systems specified herein and/or as indicated.
- C. Application of insulation materials shall be done in accordance with manufacturer's written recommendations. Where thickness of insulation is not specified, use applicable thickness recommended by manufacturer for specific use. Insulation shall be applied by a company regularly engaged in the application of insulation and any work deemed unacceptable by the Engineers shall be removed and properly installed at the expense of the Contractor.

2. MANUFACTURERS

A. Insulation shall be as manufactured by Manville, Knauf, CertainTeed, Owens-Corning, Armacell or approved equivalent. Insulation sundries, adhesives, and jackets/covers shall be as made by Benjamin Foster, Zeston, Speedline, Proto, Childers, Vimasco or approved equivalent.

3. FIRE RATINGS AND STANDARDS

- A. Insulations, jackets and facings shall have composite fire and smoke hazard ratings as tested by ASTM E-84, NFPA 255 and UL 723 procedures not exceeding Flame Spread 25, Smoke Developed 50.
- B. Adhesives, mastics, tapes and fitting materials shall have component ratings as listed above.
- C. All products and their packaging shall bear a label indicating above requirements are not exceeded.
- D. Duct linings shall meet the Erosion Test Method in compliance with UL Publication No. 181.

4. GENERAL APPLICATION REQUIREMENTS

- A. Insulation shall be applied on clean, dry surfaces in a neat and workmanlike manner reflecting the best current practices in the trade. Insulation shall not be applied to piping, ductwork or equipment until tested, inspected and released for insulation.
- B. All insulation shall be continuous through walls, ceiling openings and sleeves. However, insulation shall be broken through fire walls. All covered pipe and ductwork is to be located a sufficient distance from walls, other pipe, ductwork and other obstacles to permit the application of the full thickness of insulation specified. If necessary, extra fittings and pipe are to be used. No noticeable deformation of insulation or discontinuity of vapor seal, where required, will be accepted.
- C. "Concealed", where used herein, shall mean hidden from sight as in trenches, chases, furred spaces, pipe shafts, or above hung finished ceilings. "Exposed" shall mean that piping or equipment is not "concealed" as defined above. Piping and equipment in service tunnels, mechanical equipment rooms, storage areas, or unfinished rooms is to be considered as "exposed".
- D. Existing and/or new insulation removed and/or damaged during course of construction shall be repaired or replaced as directed by the Engineer.

- E. Vapor barrier jackets shall be applied with a continuous unbroken vapor seal. Do not use staples thru the jacket. NO EXCEPTIONS!
- F. All insulation shall be installed with joints butted firmly together.
- G. The Contractor shall ensure that all insulation (piping, ductwork, equipment, etc.) is completely continuous along all conduits, equipment, connection routes, etc. carrying cold fluids (air, water, other) and that condensation can, in no way, collect in or on the insulation, equipment, conduits, etc. Any such occurrence of condensation collection and/or damage therefrom shall be repaired solely at the expense of the Contractor.

5. PIPING SYSTEMS

A. GENERAL

- (1) Bevel insulation and jacket at all points where insulation terminates at unions, flanges, valves and equipment. Note: Applies to hot water lines only; cold water lines require continuous insulation.
- (2) Pipe insulation shall extend around valve bodies to above drain pans in hydronic equipment over pumps, etc. to ensure no condensation drip or collection.
- (3) Factory molded fittings may be installed in lieu of built-up fittings. Jackets to be the same as adjoining insulation. Insulated fittings must have same or better K factors than adjoining straight run insulation.
- (4) Valves, flanges and unions shall only be insulated when installed on piping whose surface temperature will be at or below the dew point temperature of the ambient air.
- (5) Insulation shall not extend through fire and smoke walls. A UL-listed penetration system shall be used for each fire or smoke wall penetration in accordance with KBC. Materials used such as caulk, sleeves, etc. shall be manufactured by 3M, Hilti, or equal.

B. INSULATION SHIELDS

(1) Metal insulation shields are required at all pipe hangers where the piping is insulated. Metal shields shall be constructed of galvanized steel, formed to a 180-degree arc. Insulation shields shall be the following size:

PIPE SIZE	SHIELD GAUGE	SHIELD LENGTH
2" AND LESS	20	12"
2 1/2" TO 4"	18	12"
5" TO 10"	16	18"
12" AND GREATER	14	24"

C. INSULATION MATERIAL (FOR THE FOLLOWING SYSTEMS)

Insulation shall be Owens-Corning Model 25ASJ/SSL, or approved equivalent fiberglass pipe insulation with an all service jacket. The insulation shall be a heavy density, pipe insulation with a K factor .23 at 75°F mean temperature. The insulation shall be wrapped with a vapor barrier jacket. Approved manufacturers are listed in Section 2 – Manufacturers. The jacket shall have an inside foil surface with self

sealing lap and a water vapor permeability of .02 perm/inch. All circumferential joints shall be vapor sealed with butt strips. All insulation shall be installed in strict accordance with the manufacturers' recommendations. The following pipes shall be insulated with the thickness of insulation as noted.

- (1) Domestic Cold Water
 - a. Piping 3" or less use 1/2" thick insulation. Provide an additional ¹/₂" layer of insulation 3" above and 3" below vertical pipe supports.
 - b. Piping 4" or greater use 1" thick insulation.
- (2) Domestic Hot Water and Recirculating Hot Water.
 - a. Piping $1\frac{1}{2}$ " or less use $1\frac{1}{2}$ " thick insulation.
 - b. Piping 2" or greater use 2" thick insulation.
- (3) Horizontal Roof Leaders.
 - a. Piping 3" or less use 1/2" thick insulation
 - b. Piping 4" or greater use 1" thick insulation
- (4) Condensate Drain Lines.
 - a. Piping $1\frac{1}{2}$ " or less use 1/2" thick insulation
 - b. Piping 2" or greater use 1" thick insulation
- (5) Refrigerant Liquid and Suction Lines Interior & Exterior

IMCOA, Nomaco, or Armacell closed cell polyethylene, 1.5 Lbs/Ft³ density, 0.24 BTU-Hr.-Ft³-°F/in at 75°F thermal conductivity, zero vapor permeance, 25/50 flame and smoke spread per NFPA 90 requirements. Elastomeric closed cell insulations that meet the above requirements are also allowed. Install insulation per the manufacturer's requirements. Provide UV protective coating for all exterior refrigerant lines.

a. All pipe sizes: $1\frac{1}{2}$ " thick

D. JACKETS

(1) Exposed (Exterior)

In addition to the insulation specified for the exterior pipe, provide .016" aluminum jacket or PVC jacket 0.05" thick. The jackets shall be installed as recommended by the manufacturer to maintain water tight seal. All longitudinal and transverse seams to be sealed water tight. PVC jacket shall be Ceel-Co, Proto, or Zeston.

6. DUCTWORK SYSTEMS

A. GENERAL

(1) Duct sizes indicated are the net free area inside clear dimensions; where ducts are internally lined, overall dimensions shall be increased accordingly.

- (2) Duct insulation shall extend completely to all registers, grilles, diffusers, and louver outlets, etc., to ensure no condensation drip or collection. The backs of all supply diffusers, plenums, grilles, etc. shall be insulated only if indicated by details on the drawings.
- (3) All flexible duct connections on insulated ductwork shall be externally insulated.
- (4) All duct outside of building envelope, including rooftop duct, duct in unconditioned attic spaces above the insulation, etc. shall have two layers of specified insulation. This shall apply to supply air, exhaust air where air is run through energy recovery unit, outside air, return air, and combustion air intake ducts.

B. EXTERNAL INSULATION

- (1) Supply Air
- (2) Outside Air external to building (Exterior)
- (3) Exhaust Air external to building (Exterior)

Owens/Corning "Faced Duct Wrap - Type 100", or approved equal, 2" thick fiberglass duct wrap, **1.0 pcf** density factory laminated to a reinforced foil kraft vapor barrier facing (FRK) with a 2" stapling flange at one edge. Flame spread 24, smoke developed 50, vapor barrier performance 0.02 perms per inch. K factor shall not exceed .26 at 75°F. mean temperature. Minimum R-value of the 2" thick insulation shall be 7.4 out of package and 6.0 installed.

C. JACKETS

(1) Exposed (Exterior)

In addition to the insulation specified for the exterior pipe, provide .016" aluminum jacket or PVC jacket 0.05" thick. The jackets shall be installed as recommended by the manufacturer to maintain water tight seal. All longitudinal and transverse seams to be sealed water tight. PVC jacket shall be Ceel-Co, Proto, or Zeston.

2. MECHANICAL EQUIPMENT

A. ROOF DRAIN SUMPS

(1) Owens-Corning Model 475-FR or approved equivalent rigid board insulation with exterior vapor barrier jacket formed to bottom of sump basin. Insulation shall have a K factor of .22 at 75°F. mean temperature. Insulation shall be 1" thick. Insulation shall be formed to roof drain sump. Vapor barrier shall remain continuous.

SECTION 202300 - THERMOMETERS & OTHERS, MONITORING INSTRUMENTS

1. GENERAL

A. The Contractor shall include all thermometers, pressure gauges and/or compound gauges at the locations indicated.

2. THERMOMETERS AND PRESSURE GAUGES

- A. All thermometers and gauges shall be readable from a standing position on the floor.
- B. Thermometers shall be linear, alcohol filled, graduated in 1°F. Or less and shall have adequate range for service intended.
- C. Pressure gauges shall be Bourdon Type, circular, 3" face, black letters on white face graduated in 2 PSI or less and shall have adequate range and shall be manufactured for service intended. Provide with pig tail connectors and gauge cocks.
- D. Pressure gauges and thermometers subject to vibration shall be mounted remotely away from vibrating pipe surface, etc., with flexible tubing.
- E. Mount thermometers in approved wells and install with thermal grease. Do not make direct contact of base with fluid in pipe.
- F. Gauges and thermometers shall be Marsh, Marshalltown, Weksler or equivalent.
- 3. Provide, when indicated on the plans, on the inlet and outlet of each terminal unit, a "Pete's Plug" or equivalent pressure/temperature test station. Furnish two (2) matching thermometers and pressure gauges to the owner upon project completion.

SECTION 202400 – IDENTIFICATIONS, TAGS, CHARTS, ETC.

1. GENERAL

A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

2. VALVE TAGS AND CHARTS

A. Provide and install on each valve in the Mechanical Systems a 1-1/2" diameter circular brass tag fitted to each valve so that it cannot be removed. Each tag shall be embossed consecutively with letter and number identifiers as to system and purpose respectively. Letter identifiers shall be as follows:

HPS	Heat Pump Supply
HPR	Heat Pump Return
DCW	Domestic Cold Water
DHW	Domestic Hot Water
RHW	Recirculating Hot Water
FP	Fire Protection
NG	Natural Gas
RF	Refrigerant Piping

Number identifiers shall be determined by the Contractor sequentially. For example, valve No. HC-1 may be maintenance stops for fan coil units. HC-2 maintenance stops for air heaters, etc.

- B. Provide three (3) copies of typewritten valve charts indicating each valve identifier, the valves purpose and its location. For example: "HC-1 Fan Coil Maintenance Stop-one valve at supply and return of each fan coil unit." One (1) copy of this chart shall be mounted in suitable wood frame(s) with clear plastic or glass covers in a conspicuous location in the Mechanical Room. Two other copies shall be turned over to the Engineers.
- C. Where more than one major Mechanical room is indicated for the project, install mounted valve schedule in each major Mechanical Room, and repeat only main valves which are to be operated in conjunction with operations of more than single Mechanical Room.

3. PIPING IDENTIFICATION

A. GENERAL

(1) Provide stenciled markers and arrows indicating direction of flow on all piping installed under this Contract. Markers and arrows shall be painted on the piping using machine cut stencils. All letters shall be sprayed using fast drying lacquer paint. All markers and arrows shall be properly oriented so that descriptive name may be easily read from the floor. At the Contractor's option, Setmark or equivalent manufactured marking system may be substituted for field marking. The following table describes the size of the color field and size of the identification letter which shall be used for pipes of different outside pipe diameters.

OUTSIDE DIAMETER OF	
PIPE	SIZE OF LETTERS
OR COVERING	

INCHES	INCHES
3/4 TO 1-1/4	1/2
1-1/2 TO 2	3/4
2-1/2 TO 6	1-1/4
8 TO 10	2-1/2
OVER 10	3-1/2

- (2) "Concealed", where used herein, shall mean hidden from sight as in trenches, chases, furred spaces, pipe shafts, or above hung finished ceilings. "Exposed" shall mean that piping or equipment is not "concealed" as defined above. Piping and equipment in service tunnels, mechanical equipment rooms, storage areas, or unfinished rooms is to be considered as "exposed".
- (3) All piping shall be marked not less than every 15 linear feet above a ceiling system, every 10 feet in a mechanical room, and at all points where lines pass through walls or floors.

PIPE+	ABBREVIATION
Domestic Cold Water	D.C.W.
Domestic Hot Water	D.H.W.
Recirculated Hot Water	R.H.W.
Natural Gas	NAT. GAS
Sanitary Sewer Piping	SAN.
Sanitary Vent Piping	VENT
Storm Sewer Piping	STORM
Fire Protection Water	F.P.
Pipe	A.B.B.
Heat Pump Supply	H.P.S.
Heat Pump Return	H.P.R.
Refrigerant	R.F.

(4) Provide identifiers as indicated in the following table where manufactured marking systems are used:

4. EQUIPMENT IDENTIFICATION

A. All equipment, except in finished rooms, shall be identified by stenciling the title of the equipment as taken from the plans in a position that is clearly visible from the floor. The letters shall be made with black paint and shall be not less than two inches high. The titles shall be short and concise and abbreviations may be used as long as the meaning is clear. Lamacoid plates are also acceptable. In finished rooms or outdoors, equipment shall be identified by engraved nameplates.

5. DUCTWORK IDENTIFICATION

A. All ductwork shall be identified as to the service of the duct and direction of flow. The letters shall be at least two inches high and the flow arrow shall be at least six inches long. The letters and flow arrow shall be made by precut stencils and black oil base paint with aerosol can. Concealed ducts need not be identified.

6. ACCESS THROUGH LAY-IN CEILINGS

A. Mark the ceiling T-bar nearest the ceiling panel access to equipment, valves, damper, filter, duct heaters, etc., with a small red lamacoid plate with name of item above ceiling.

SECTION 202500 - HANGERS, CLAMPS, ATTACHMENTS, ETC.

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Provisions -Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.
- B. Each Contractor's attention is also directed to Section 201300, Pipe, Pipe Fittings and Pipe Support.
- C. This section includes, but is not limited to, furnishing and installing dampers, supports, anchors, and accessories for piping, ductwork, equipment, etc. Furnishing and installing shall be by each trade for the completion of their work.
- D. Power driven anchors and expansion anchors shall be permitted only when permission is granted in writing by the Architect and Engineer.

2. MATERIALS AND EQUIPMENT

A. Hangers, Clamps, Attachments, Etc.:

	SIZE	SPECIFICATION
1. Pipe Rings	2" pipe and smaller	Adjustable swivel split ring or split pipe ring, Grinnell Figures 104 and 108, Elcen, Fee & Mason, or approved equivalent.
2. Pipe Clevis	2-1/2" pipe and larger	Adjustable wrought Clevis type, Grinnell Figure 260, Elcen, Fee & Mason, or approved equivalent.
3. Pipe Clevis	All	Steel Clevis for insulated pipe, Elcen Figure 12A, Grinnell, Fee & Mason or approved equivalent.
4. Rise Clamps	All	Extension pipe or riser clamp, Grinnell Figure 261, Elcen, Fee & Mason or approved equivalent.
5. Beam Clamps and Attachments	All	Grinnell Figure numbers listed or, Elcen, Fee & Mason, or approved equivalent. Malleable beam clamp with extension piece figure 229; I- beam clamp figure 131; C-clamp figures 83, 84, 85, 86, 87, and 88.
6. Brackets	All	Welded steel brackets medium weight, Grinnell Figure 195, Elcen, Fee & Mason or approved equivalent.

7. Concrete Inserts	All	Grinnell Figure numbers listed or, Elcen, Fee & Mason or approved equivalent. Wrought steel insert Figure 280 and wedge type insert Figure 281.
8. Concrete Fasteners	All	Self-drilling concrete inserts, Phillips, Grinnell, Elcen or approved equivalent.
9. Ceiling	All	Grinnell Figure numbers listed or Elcen, Fee & Mason, or approved equivalent. Pipe hanger flange Figure 153, adjustable swinging hanger flange Figure 155, ceiling flanges Figures 128 and 128R, and adjustable ceiling flange Figure 116.
10. Rod Attachments	All	Grinnell Figure numbers listed or Elcen, Fee & Mason, or approved equivalent. Extension piece Figure 157, rod coupling Figure 136, and forged steel turnbuckle Figure 230.
11. U-Bolts	All	Standard, U-bolt, Grinnell Figure 137, Elcen, Fee & Mason, or approved equivalent.
12. Welded Pipe Saddles	All	Pipe covering protection saddle sized for thickness of insulation, Grinnell Figure 186, Elcen, Fee & Mason or approved equivalent.
13. Pipe Roll	All	Adjustable swivel pipe roll, Grinnell Figure 174, Elcen, Fee & Mason, or approved equivalent.
14. Protection Saddle	All	18-gauge sheet metal pipe protection saddle, Elcen Figure 219, Fee & Mason, Power Strut, or approved equivalent.
15. Hanger Rods	All	Steel, diameter of the hanger threading, ASTM A-107.
16. Miscellaneous Steel	All	Steel angles, rods, bars, channels, etc., used in framing for supports and fabricated brackets, anchors, etc., shall conform to ASTM-A-7.
17. Concrete Channel Inserts	All	Continuous slot inserts, Unistrut, or approved equivalent. Heavy duty Series P-3200 or Light Duty Series P-3300 as required.
18. Adjustable Spot Insert	All	Adjustable spot insert Unistrut, or approved equivalent, P-3245. Design load 1000 lbs.

3. INSTALLATION

- A. Unless otherwise specifically indicated or hereinafter specified in the specifications, all supporting, hanging and anchoring of piping, ductwork, equipment, etc., shall be done by each trade as is necessary for completion of the work and shall be as directed in the following paragraphs:
 - (1) Supporting and hanging shall be done so that excessive load will not be placed on any one hangers so as to allow for proper pitch and expansion of piping. Hangers and supports shall be placed as near as possible to joints, turns and branches.
 - (2) For concrete construction, utilize adjustable concrete inserts for fasteners. Expansion anchors and power-driven devices may be used when approved in writing by the Architect/Engineer. Utilize beam clamps for fastening to steel joists and beams and expansion anchors in masonry construction. When piping is run in joists, piping shall be top mounted on trapeze type hangers with each pipe individually clamped to trapeze hanger.
 - (3) Trapeze hangers shall be supported by steel rods of sufficient diameter to support piping from joists or concrete construction. Where desired or required, piping may be double mounted on trapeze hangers. Where conditions permit, trapeze hangers may be surface mounted on exposed joists by means of approved beam clamps, or to concrete construction by means of approved adjustable inserts or expansion anchors.
 - (4) Install all miscellaneous steel other than designed building structural members as required to provide means of securing hangers, supports, etc., where piping does not pass directly below or cross steel joists.
 - (5) Piping shall not be supported by the equipment to which it is connected. Support all piping so as to remove any load or stress from the equipment.
 - (6) Where piping, etc., is run vertically, approved riser clamps, brackets or other means shall be utilized at approximately 10'-0" center to center minimum and an approved adjustable base stand or fitting on concrete support base shall be utilized at the base of the vertical run.
 - (7) Where piping is run along walls, knee braced angle frames or pipe brackets with saddles, clamps, and rollers (where required) mounted on structural brackets fastened to walls or columns shall be used.
 - (8) Support all ceiling hung equipment, with approved vibration isolators.
 - (9) Where copper tubing is specified, hangers shall be of copper clad type when piping is uninsulated.
 - (10) Uninsulated piping hung from above shall be supported with ring and clevis type pipe hangers. Uninsulated piping mounted on trapeze and wall bracket type support shall be held in place with Ubolts. U-bolts shall allow for axial movement in the piping.
 - (11) All insulated piping shall be supported with clevis type and/or pipe roll hangers. Hangers shall be sized to allow the pipe insulation to pass through the hangers. Install insulation protection saddles at all hanger locations. Welded pipe saddles shall be installed at all hangers on piping 5" and larger. The pipe saddles shall be sized for the thickness of insulation used. Hangers shall fit snugly around outside of insulation saddles.
 - (12) Under no conditions will perforated band iron or steel wire driven hangers be permitted.

- (13) In general, support piping at the following spacing:
 - a. Steel and copper piping 5 feet intervals for piping 3/4" and smaller. 6 feet intervals for 1 $\frac{1}{4}$ " and 1" pipe. 8-foot intervals for piping 1 $\frac{1}{2}$ " to 3". 10-foot intervals piping 3 $\frac{1}{2}$ " and larger.
 - b. Polyethylene piping 4-foot intervals for piping 2" and smaller. 5-foot intervals for 3" pipe. 6-foot intervals for 4", 6", and 8" pipe. 7-foot intervals for 10" and larger pipe.
 - c. PVC piping 4-foot intervals for piping 1 1/2" and smaller. 5-foot intervals for 2 and 2 $\frac{1}{2}$ " piping. 6-foot intervals for 3" pipe and larger.
 - d. Where the manufacturer of the pipe has more strict guidelines, the manufacturer's recommendations shall be followed.

SECTION 203100 - TESTING, BALANCING, LUBRICATION AND ADJUSTMENTS

1. GENERAL

- A. The General Conditions, Instructions to Bidders, Section 200100, and other Contract Documents are a part of this specification and shall be binding on all Mechanical Contractors. It shall be each Contractor's responsibility to apprize himself of all information pertinent to his work prior to submitting his proposal. No adjustments will be made in this Contract which is a result of failure to comply with this requirement.
- B. The Engineer, or his authorized representative, shall be notified by the Contractor twenty-four (24) hours in advance of any tests called for in these specifications or required by others. Any leaks or imperfections found shall be corrected and a new test run to the satisfaction of the Engineer or his authorized representative. Upon completion of a test, a written approval of that part of the work will be given to the Contractor. Only after written approval, signed by the Engineer, shall the Contractor apply insulation or paint or allow his work to be furred-in. This written approval, however, does not relieve the Contractor of the responsibilities for any failure during the guarantee period. The expense of all tests shall be borne by the Contractor, along with all temporary equipment, materials, gauges, etc. required for tests.

2. PLUMBING

- A. Piping shall be tested before being insulated or concealed in any manner. Where leaks or defects develop, required corrections shall be made and tests repeated until systems are proven satisfactory.
- B. Water piping systems shall be subjected to a hydrostatic test of one hundred fifty pounds. The system shall be proven tight after a twenty-four (24) hour test.
- C. The house drain line, interior storm sewers, interior rain water conductors, and all soil, waste and vent piping shall be subjected to a hydrostatic test of not less than a 10-foot head or an air test of not less than 5 lbs. per sq. inch using a mercury column gauge and shall hold for 15 minutes.
- D. Exterior sewer lines to the termination point outside the building shall be subject to a ten-foot hydrostatic test or an approved smoke test. These lines shall be subjected to a second test after 2 feet of backfill has been properly installed.
- E. After fixtures have been installed, the entire plumbing system, exclusive of the house sewer, shall be subjected to an air pressure test equivalent to one-inch water column and proven tight. The Contractor responsible shall furnish and install all of the test tees required, including those for isolating any portion of the system for tests.
- F. Thermometers and gauges shall be checked for accuracy. If instruments prove defective, they shall be replaced.
- G. The Contractor shall perform all additional tests that may be required by the Kentucky Department of Health or other governing agency.
- H. Set temperature control on water heaters and adjust tempering valves as required.
- I. Balance the water flow rate of each domestic hot water recirculating pump. Set the flow rate for each balancing valve in the recirculating hot water system. If flow rates are not indicated, contact the engineer for each balance valve GPM.
- J. Any leaks or imperfections found shall be corrected and a new test run until satisfactory results are obtained. The cost of repair or restoration of surfaces damaged by leaks in any system shall be borne by the Contractor.
- K. The compressed air system shall be tested for leaks for eight (8) hours at 250 PSI.

L. The natural gas piping shall be tested in accordance with requirements and/or recommendations of the local gas company.

3. HEATING, VENTILATING AND AIR CONDITIONING

- A. The test and balance of this system shall be by a contractor who employs only the services of a certified AABC or independent NEBB firm whose sole business is to perform test and balance services. The test and balance contractor shall report all deficiencies to the engineer.
- B. The Mechanical Contractor shall test all piping before being insulated or concealed in any manner. Where leaks or defects develop, required corrections shall be made and tests repeated until systems are proven satisfactory. Water piping systems shall be subjected to a hydrostatic test of not less than one hundred pounds and shall be proven tight after a twenty-four (24) hour test.
- C. All motors, bearings, etc. shall be checked and lubricated as required during start-up procedures. All automatic, pressure regulating and control valves shall be adjusted. Excessive noise or vibration shall be eliminated. Provide all start-up documents to Designer prior to any test and balance services.
- D. System balancing, where required, shall be performed only by persons skilled in this work. The system shall be balanced as often as necessary to obtain desired system operation and results.
- E. All fan belts shall be adjusted for proper operation of fans.
- F. All deficiencies observed by the Test and Balance Contractor shall be reported immediately to the Engineer and Mechanical Contractor.
- G. For the purpose of placing the heating, ventilating and air conditioning system in operation according to design conditions and certifying same, final testing and balancing shall be performed in complete accordance with AABC Standards for Total System Balance, Volume Six (2002), for air and hydronic systems as published by the Associated Air Balance Council. The following systems shall be test and balance:
 - 1) Balance all supply, return and exhaust air grille to within 10% of design air flow rate.
 - 2) Balance all exhaust air fans and record inlet static pressure.
 - 3) Balance the kitchen range hood supply/exhaust air system.
 - 4) Balance domestic hot water return system including all balance valves and record settings and flows.
 - 5) Adjust all adjustable diffusers to minimize air drafts and eliminate suspended light fixture sway. Furthermore, adjustable diffusers in spaces with ceilings taller than 9 feet shall be adjusted to eliminate air stratification during heating season.
 - 6) Balance all rooftop and ground mounted air handlers.
 - 7) Heat pump supply and return to console units.
- I. The Test and Balance agency shall provide lifts, scaffolding, etc. as required to balance devices in areas with high ceilings such as gymnasiums, auditoriums, atriums, cupolas, etc. The Test and Balance agency may coordinate with the General Contractor or Mechanical Contractor to arrange for these items to be provided to access high devices, however, it is emphasized the Contractor is finally responsible for providing the means required to balance all devices.
- J. Instruments used for testing and balancing of air and hydronic systems shall have been calibrated within a period of six months prior to balancing. All final test analysis reports shall include a letter of certification listing instrumentation used and last date of calibration.
- K. Test and Balance agency is to provide sizing of fan or motor sheaves required for proper balance. The Mechanical Contractor will purchase and install all sheaves and belts as required. This includes new and existing equipment.
- L. Four (4) copies of the complete test reports shall be submitted to the Consulting Engineer prior to final acceptance of the project. Preliminary test reports shall be submitted when requested.
- M. The Contractor shall provide and coordinate their work in the following manner:
 - (1) Provide sufficient time before final completion date so that tests and balancing can be accomplished.
 - (2) Provide immediate labor and tools to make corrections when required without undue delay.
- N. The Contractor shall put all heating, ventilating and air conditioning systems and equipment and range hood system into full operation and shall continue the operation of same during each working day of testing and balancing.
- O. Balance all water and air systems. Be sure to include:
 - (1) Domestic Hot Water Recirculating System.
- P. Automatic Flow Control Balance Valves
 - (1) Verify that each installed automatic flow control device matches the GPM indicated on the drawings.
 - (2) Verify that the actual pressure at each automatic flow control device is within the pressure limits specified by the valve manufacturer.

4. FIRE PROTECTION SYSTEM

A. Test in accord with local Fire Marshall requirements and/or requirements or recommendations of NFPA Regulations.

SECTION 210100 - FIRE PROTECTION SYSTEM

1. GENERAL

- A. The General Conditions, Instructions to Bidders, Section 200100, 1. A, and other Contract Documents are a part of this specification and shall be binding on the Contractor. It shall be the Contractor's responsibility to apprise himself of all information pertinent to his work prior to submitting his proposal. No adjustments will be made in this Contract which is a result of failure to comply with this requirement.
- B. No Contractor, other than those regularly engaged in the installation of approved and franchised automatic sprinkler systems, will be considered or approved for the work under this section of the specifications. Bidders must have had not less than five (5) years experience in the fabrication and erection of such systems: wet, dry and rack storage types, and shall have completed installations similar and equivalent in scope to this system under approval by one or more of the recognized Underwriting Associations in the Insurance Field.
- C. Before submitting bid, examine all Mechanical, Architectural, and Structural Drawings, visit the site and become acquainted with all conditions that may, in any way whatsoever, affect the execution of this work. Also, the Contractor shall coordinate with the rating bureau and insuring agency to verify adequacy of water supply for the proposed sprinkler system extension.
- D. The Contractor shall take his own measurements and be responsible for exact size and location of all openings required for installation of this work. Figured dimensions where indicated are reasonably accurate and should govern in setting out work. Detailed method of installation is not indicated. Where variations exist between described work and approved practice, the Engineer shall be consulted for directive.
- E. It is the intent of the Plans and Specifications to provide a general layout only and locate major equipment, piping, etc. Variations in head locations, pipe routing, etc., may be anticipated by the Contractor and shall be coordinated with all other trades and indicated on the drawings and descriptive literature called for hereinafter. It shall be the express responsibility of the Contractor to provide all required materials and equipment and perform all work required to install a complete and approved installation.
- F. All materials and methods shall be in accordance with applicable codes, regulations and/or ordinances and meet approval of local inspection authority and the State Fire Marshal. Also, all work shall comply with the latest editions of the National Board of Fire Underwriters, National Fire Protection Association, OSHA Regulations, the National Building Code, the Life Safety Code, IMC Code and the Southern Building Code (Where applicable). The local insuring agency shall review plans prepared and submitted by the Contractor but shall have no authority to make changes once work has begun.
- G. All work performed under this section shall be accomplished in close harmony with all other trades. All work not so coordinated shall be removed and reinstalled at the expense of the Contractor.
- H. The Contractor shall submit a proposed layout to the Engineer prior to submittal to the Fire Marshal's Office.

2. SCOPE OF WORK

A. Furnish all material, labor, tools, equipment and supervision required for installation of a complete fire protection and stand pipe system as indicated on the project drawings. Include all necessary piping,

sprinkler heads, test connections, valves, drains, cabinets, siamese connections, fire hydrants, fire pump, etc.

- B. The Contractor shall provide flushing and sterilization of all water lines in accordance with current Kentucky Plumbing Codes, Rules and Regulations and shall make connection to domestic water mains in accord with current rules and regulations of the State Department of Sanitary Engineering and Division of Water.
- C. Provide stand pipes with fire hose cabinets or fire valves as indicated or as required to meet the requirements of NFPA and the local fire authority.
- D. Provide sprinklers in attics, overhangs, awnings, cooler/freezers, in accessible spaces and all other areas required by NFPA and the local fire authority.
- E. Provide dry pipe systems or freeze proof heads as required to provide continuous coverage without freezing.

3. WATER SUPPLIES AND SYSTEM LAYOUT CRITERIA

A. Where flow and pressure data are available, they are indicated on the project drawings. The Contractor shall independently verify all such information and notify the engineer of any discrepancies discovered prior to beginning the work. Where no flow information is indicted on the project drawings, the Contractor shall obtain it and indicate it on the shop drawing submittal. Piping systems shall be hydraulically sized based on the most conservative flow information obtained. No adjustments in the contract amount will be allowed for failure of the Contractor to obtain adequate flow information.

4. DRAWINGS AND DESCRIPTIVE LITERATURE

- A. The Contractor shall prepare and submit to the Engineers, seven (7) copies of detailed drawings indicating his proposed Automatic Sprinkler System. These drawings shall indicate minimally the following components when they are used in the system.
 - (1) Name and address of Owner, Architect and Engineers.
 - (2) Make and type of sprinkler heads (Catalog cuts).
 - (3) Make and type of fire department connection (Catalog cuts).
 - (4) Make and type of post indicator valve (Catalog cuts).
 - (5) Make and type of detector check valve (Catalog cuts).
 - (6) Make and type of electric alarm bell (Catalog cuts).
 - (7) Make and type of retard chamber (Catalog cuts).
 - (8) Make and type of flanged check valve (Catalog cuts).
 - (9) Make and type of flanged gate valve (Catalog cuts).
 - (10) Make and type of automatic drains (Catalog cuts).
 - (11) Make and type of pipe hangers (1 catalog cut of each make and/or type).
 - (12) Make, type and electrical characteristics of:
 - a. The pressure sensing switch*.
 - b. The post indicator supervisory switch*.
 - c. The main gate valve supervisory switch*.
 - d. The flow switch*.
 - e. Air compressor.
 - (13) Make and type of supervised O.S & Y valve.

- (14) Make and type of indicating butterfly valve.
- (15) Make and type of reduced pressure backflow preventer.

<u>Note</u>: All layouts and drawings are to be closely coordinated with the work of <u>all</u> other trades. The Engineers will, upon request, provide a complete set of Architectural, Structural, Mechanical and Electrical Plans and Specifications to aid the Contractor in this work.

*<u>SPECIAL NOTE</u>: 1) The items (indicated by asterisk) must be clearly coordinated with the Fire Alarm System supplier. 2) Supervisory switches located in wet locations (i.e., fire protection vault) shall be provided with NEMA 6 enclosures.

- (16) On a set of drawings to the same scale as the drawings accompanying these specifications, indicate:
 - a. Each head location coordinated with lights, diffusers and other ceiling mounted device.
 - b. Location of all risers, mains, runout lines, etc.
 - c. Size of all risers, mains, runout lines, etc.
 - d. Location and type of pipe hangers.
 - e. All other information required by the Kentucky Department of Housing, Buildings and Construction.

The Contractor shall submit these drawings to the Engineer through the General Contractor/Construction Manager and Architect where applicable. The Contractor shall submit reviewed drawings to the Kentucky Department of Housing, Buildings and Construction for their review and approval. No work shall be done until drawings are approved by the Kentucky Department of HBC.

5. SYSTEM DRAINAGE

- A. The entire Standpipe and Sprinkler System (except that part which is below grade and will not freeze) shall be installed so as to allow 100% drainage.
- B. All sprinkler branch piping shall be installed so as to drain back to the main riser.
- C. Approved 2" drawoff piping shall be provided on sprinkler risers with discharge piping running to nearest floor drain or open air.
- D. Where sprinkler piping is trapped, an approved auxiliary draw-off shall be provided and neatly installed.
- E. All draw-offs shall have a metal tag labeled "Sprinkler Drain."

6. INSPECTIONS AND TESTS

- A. Furnish all labor, equipment and conduct all required tests in the presence of the Owner and Engineer or designated representative.
- B. All piping and devices comprising the fire protection system shall be tested under hydrostatic pressure of not less than 200 PSI and maintained for not less than two (2) hours.
- C. Upon completion of his work, the Contractor shall submit a written and signed certificate to the Engineers indicating that he performed the above prescribed tests and rectified all malfunctions arising there from.

7. PERMITS

A. The Contractor shall obtain and pay for all necessary state, municipal, county, city and other permits and fees and pay all State taxes which are applicable.

8. GUARANTEE

A. All workmanship, equipment and material shall be guaranteed in writing against defects from any cause, other than misuse, for a period of one year after date of final acceptance.

9. ACCEPTANCE CERTIFICATE

A. Upon completion, the Contractor shall submit to the Engineers, a properly filled out "Sprinkler Contractor's Certificate Covering Materials and Tests." (4 copies).

10. CLEANING

A. Upon completion of this work all debris, material, and equipment shall be removed from the building and premises; all piping shall be cleaned ready for finish painting. Note: Do not remove rust inhibitive primer specified hereinafter.

11. PAINTING

A. All fire protection piping, fittings, etc., shall have one factory or shop coat of rust inhibitive primer. The Contractor shall thoroughly clean all such items in areas where the piping will be exposed so as to readily receive the finish coat specified in the Architectural Division of Painting. Colors shall be as specified in Identification Section of these specifications.

12. PIPE LAYING

A. Bell holes shall be excavated accurately to size and barrel of pipe shall bear firmly on bottom of trench throughout its length. All foreign matter and dirt shall be removed from the inside of the pipe before it is lowered into its position in the trench, and it shall be kept clean by approved means during and after laying. At times when pipe laying is not in progress, the open ends of pipe shall be closed by approved means, and no trench water shall be permitted to enter the pipe. Cutting of pipe, where necessary, shall be done in a neat and workmanlike manner, without damage to pipe. Refer also to Excavation.

13. EQUIPMENT AND MATERIALS

A. Signs

Appropriate code approved and required signs shall be installed on all control valves, drains, inspector's test, etc., indicating the function, installation, etc. Signs shall be neatly affixed with rust inhibitive screws, rivets or where hung from piping; with stainless steel No. 14 AWG wire.

B. Finish

All exposed materials such as valves, fire department connections, sprinkler heads, fire pump test headers, etc., shall be brass or chrome-plated brass.

- C. Check Valves
 - 2-1/2" and over; listed and approved by UL and FM; marked SV-FM; 175# working pressure; 1 BBM; flanged; equivalent to Mueller, Scott or Lunkenheimer.

- (2) 2" and under; 150# working pressure; bronze; screwed; equivalent to Jenkins, Scott or Lunkenheimer.
- D. Pipe & Fittings
 - (1) Nipples and fittings shall be of same material, composition, and weight classification as pipe in which installed.
 - (2) Up to 2" (Interior) Schedule 40 ASTM A-53 black steel; 125# cast iron screwed fittings or Schedule 10, ASTM A-135 black steel with victaulic or similar type approved fittings.
 - (3) 2-1/2" and larger (Interior) Schedule 40 black steel with flanged, welded or victaulic (or similar) type approved fittings or Schedule 10, ASTM A-135 black steel with victaulic or similar type approved fittings.
 - (4) Blazemaster or approved equivalent CPVC SDR 13.5 pipe UL listed for fire protection use. CPVC is not allowed for dry pipe systems and is only allowed in light hazard occupancies. Piping must be installed in accordance with the manufacturer's recommendation and all governing bodies having jurisdiction.
 - (5) Exterior: Class 200 PVC piping for exterior fire protection piping. Piping shall meet AWWA C900 requirements, be UL listed, Factory Mutual approved and NSF approved. Joints shall have spigot pipe ends with a flexible elastomeric ring seated in a groove to provide water tight seal. Minimum burst pressure to be 900 psi when tested in accordance with ASTM D1599. No. 8 copper wire (tracer wire) shall parallel all exterior PVC pipe.
- E. Clamps and Anchors
 - (1) Furnish and install approved clamps, as required, at all (45 degree) 1/8 bends, (90 degree) 1/4 bends and flange and spigot pieces to the straight pipe to ensure permanent anchorage of all fire lines. Clamps, clamp rods, nuts, washers, and glands shall be coated with a quick drying coal tar bituminous paint after installation.
- F. Hangers
 - (1) All piping shall be adequately and permanently supported in an approved manner on approved hangers (Submit with drawings).
- G. Sleeves and Escutcheon Plates
 - (1) Furnish and install sleeves for pipes where piping penetrates masonry walls; exterior wall sleeves to be watertight. Fire and smoke stop all penetrations through fire and smoke walls and coordinate with General Contractor for locations.
 - (2) Furnish and install cast brass chrome plated split ring type escutcheons where piping penetrates walls, ceilings and floors, whether in finished areas or not.
- H. Electric Wiring
 - (1) All electric wiring for the system which may be required shall be installed in accordance with the National Board of Fire Underwriters, and National Electric Code. The cost of this electric wiring

shall be included under this Contract. All electrical wiring and conduit installed in fire protection pits shall be sealed watertight.

- I. Inspection Test Connections & Pressure Gauges
 - (1) A 1" inspection test connection as required by the Kentucky Building Code. Discharge shall run to open air.
 - (2) Control valve for test connection shall be installed not over 7' above the floor.
 - (3) A pressure gauge at the inspection. Test connection at each location indicated on the Plans. Pressure gauges shall be 2-1/2" diameter and readable from the floor.
- J. Gate Valves
 - 2-1/2" and over; listed and approved by UL and FM; marked SV-FM; 175# working pressure; 1 BBM; OS&Y; flanged; cast iron discs; bronze seat rings; four-point wedging mechanism; equivalent to Mueller, Scott or Lunkenheimer.
 - (2) 2" and under; 150# working pressure; bronze; rising stem; screwed; bronze discs; bronze seat rings; two-point wedging mechanism; equivalent to Jenkins, Scott or Lunkenheimer.
- K. Sprinkler Head Cabinet
 - (1) Furnish and install a cabinet, clearly labeled, with four (4) sprinklers of each type complete with required wrenches. Locate as directed by Engineer. Label "Sprinkler Heads."
- L. Fire Department Connection
 - (1) Furnish and install a fire department connection with threads as approved by the local fire department; cast brass polished and chromium plated; with connection sizes and lettering as directed by the local authority having jurisdiction.
- M. Siamese Hose Connection
 - (1) Furnish and install on the fire protection pit and on the roof where required by the local authority a siamese hose connections with threads as approved by the local Fire Department. Unit shall be similar to Larsen's No. 15 sidewalk siamese, size: 2-1/2" x 2-1/2" x 6". Coordinate threads type with local Fire Department.
- N. Post Indicator Valve
 - (1) Furnish and install a post indicator valve as required by the local authority. It shall be listed and approved by Underwriters Laboratories and Associated Factory Mutual Laboratories; Marked SV-FM; vertical; non-adjustable; with electric supervisory switch, handle, view window, brass padlock with (2) keys; gate valve to meet gate valve specifications, except to have non-rising stem and mechanical joint ends; equivalent to Mueller, Scott or Lunkenheimer.
- O. Detector Check Valve
 - (1) Furnish and install detector check valve as required by the local authority. It shall be listed and approved by Underwriter Laboratories and Associated Factory Mutual Laboratories; 175# working

pressure; IBBM; flanged; with tapped bosses each side for by-pass meter trimming; equivalent to Viking, Badger or Grinnell.

- (2) The Contractor shall contact the servicing water company and ascertain their policy pertaining to the by-pass water meter; if not furnished by water company. The Contractor shall furnish and install the by-pass meter and trimming as detailed on the drawings.
- P. Sprinkler Heads

Gem, Grinnell, Star, Viking, Reliable, Central or approved equivalent as follows:

- (1) Where piping is exposed: "Standard up right."
- (2) Where piping is concealed above finished ceilings, provide two pieces, semi recessed, white plated sprinkler heads with removable escutcheon.
- (3) Install sprinkler head guards where heads are subject to physical abuse. Heads located below seven
 (7) feet above floor, etc.
- (4) Flexible Fire Protection Head Drops may be installed. Install in accordance with NFPA and manufacturer's requirements.
- (5) Sprinkler head degree ratings shall be determined by the area serviced in accord with current Codes and Standard Practices. Indicate degree ratings on submitted Shop Drawings.
- (6) The Contractor shall submit to the Engineer for inspection, one (1) sample of each type of sprinkler head, proposed to be used on the project.
- (7) Where heads are installed in a tile ceiling, they shall be installed in the middle of the tiles, at half or quarter points along the length of the tiles. Install sprinkler heads at quarter points of center scoured 2' X 4' ceiling tiles.
- (8) Provide high temperature heads around range hoods, kitchen equipment, kilns, boilers, water heaters and other heat producing equipment.
- Q. Water Motor Gong
 - (1) Furnish and install a water motor gong.

Grinnell, Viking, Mueller or equivalent.

- R. Retard Chamber
 - (1) Same as water motor gong.
- S. Flow Indicator Switches
 - (1) Furnish and install flow indicator switches as required by NFPA 13. All flow indicator switches shall be UL approved. Coordinate with Fire Alarm System supplier/installer. Provide a set of dry contacts on each flow switch for interface to the Control System if this control point is specified in the Controls Section.

- T. Tamper Switches for Water Shut-Off Valves
 - (1) Furnish and install tamper switches where required by NFPA 13. All tamper switches shall be UL approved. Coordinate with fire alarm system supplier/installer. All tamper switches located in fire protection pits shall be waterproof, capable of operating beneath water similar to Potter PTS Series and be NFPA approved.
- U. Fire Hydrant
 - (1) Furnish and install fire hydrants as approved by local Fire Department.
- V. Reduced Pressure Backflow Preventer
 - (1) Refer to plumbing specialties section of these specifications.

14. GUARANTEE

A. All workmanship, equipment and material shall be guaranteed in writing against defects from any cause, other than misuse, or vandalism, for a period of one year after date of final acceptance.

SECTION 220100 - PLUMBING SPECIALTIES

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work specified in this section.
- B. The Contractor shall provide all equipment and specialties complete with trim required and connect in a manner conforming to the Kentucky Building Code.
- C. The Contractor shall obtain exact centerline rough-in dimensions between partitions, walls, etc. as required for lay-out of his rough-in work. All work shall be roughed-in so that all exposed piping will be straight and true without bends or offsets.
- D. Prior to final inspection, test by operation at least twice, all equipment.
- E. Prior to final inspection, remove all stick-on labels, dirt, grease, other removable stampings, lettering, etc. from equipment and specialties and thoroughly clean same.
- F. All equipment and specialties shall be installed as recommended by the manufacturer in a neat and workmanlike manner. Unacceptable workmanship shall be removed and replaced at the installing Contractor's cost.
- G. All pipes, valves, fittings, fixtures, etc. for use in potable water systems 2" and below shall comply with federal lead-free requirements that the lead content of wetted surfaces cannot exceed 0.25% by weight.
- H. The Contractor shall raise or lower existing floor drains and/or clean outs to be flush with new floor surface.

2. DRAINAGE SPECIALTIES

- A. GENERAL
 - (1) Provide all drainage specialties indicated, specified and/or required to provide complete and acceptable removal of all storm, sanitary, waste, laboratory waste, etc. from the building and into approved receptors.
 - (2) Drainage specialties shall be on non-electrolytic conduction to the material to which they are connected.
 - (3) Drainage specialties shall be installed in a manner so as to ensure no leakage of toxic or odorous gases or liquids and shall have traps and/or backflow preventers where required. Nor shall they allow backflow into other or existing systems.

B. CLEANOUTS - INTERIOR (CO)

- (1) In addition to cleanouts indicated, provide cleanouts in soil and waste piping and storm drainage at the following minimum locations:
 - a. At base of each stack.
 - b. At fifty (50) foot maximum intervals in horizontal lines.
 - c. At each change of direction of a horizontal line.

- d. As required by current KBC.
- e. As required to permit rodding of entire system. (If in doubt, contact Engineers.)
- (2) Water closets, slop sinks and other fixtures with fixed traps shall not be accepted as cleanouts.
- (3) Cleanouts and/or test tees concealed in inaccessible pipe spaces, walls and other locations shall have an eight (8) inch by eight (8) inch (minimum) access panel or cover plates shall be set flush with finished floors and walls and shall be key or screw driver operable.
- (4) Access panels for cleanouts shall be of the Zurn, 1460 series or equivalent by Josam or Watts. They may, at the Contractor's option, be Perma-Coated steel, prepared to receive finish. The Contractor shall coordinate the finish of all access panels installed in finished areas with Architect.
- (5) Cleanouts and access panels shall be sized so as to permit the entry of a full sized rodding head capable of one hundred percent circumferential coverage of the line served.
- (6) Provide a non-hardening mixture of graphite and grease on threads of all screwed cleanouts during installation.
- (7) Do not install cleanouts against walls, partitions, etc. where rodding will be difficult or impossible. Extend past the obstruction.
- (8) In finished walls, floors, etc., ensure that cleanouts are installed flush with finished surfaces and, where required, grout or otherwise finish in a neat and workmanlike manner.
- (9) Cleanouts shall be as manufactured by Zurn, Josam, Jay R. Smith, Watts, MIFAB, Ancon or equivalent, similar to the following:
 - a. Zurn, Z-1440 cleanouts or Z-1445 cleanout tee at base of exposed stack and at change in direction of exposed lines.
 - b. Zurn, Z-1440 cleanout or Z-1445-1 cleanout tee where stacks are concealed in finished walls
 - c. Zurn, ZN-1400-T cleanout with square scoriated top in finished concrete and masonry tile floors.
 - d. Zurn, ZN-1400-Tx cleanout with square recessed top for tile in vinyl and linoleum finished floors.
 - e. Zurn, ZN-1400-Z cleanout with round recessed top for terrazzo floors.
 - f. Zurn, Z-1400-HD cleanout with tractor cover for exterior locations. Provide concrete supporting pad crowned to shed water. Refer to drawings for pad size.
 - g. Mueller, No. D-731 or D-714, Nibco, Flage or equivalent for cleanouts in copper waste with cover plates and/or access panels listed for other cleanouts.
 - h. Threaded hex head type cleanouts of same materials as pipe for piping 2" and smaller.
 - i. Zurn, cleanout with round top with adjustable retainer for carpet area. Install flush with carpet.

C. FLOOR DRAINS

- (1) Provide floor drains at locations indicated and/or as required by Kentucky Building Code. Install in a neat and workmanlike manner. Coordinate locations with appropriate persons or party to ensure floor pitch to drain where required.
- (2) Install floor drains in strict accordance with manufacturer's recommendations and the KBC unless otherwise indicated.
- (3) Ensure by coordination with the appropriate persons or party that spaces served by a floor drain(s) has a water seal extending at least three (3) inches from the floor of the space served on all floors above the lowest level.
- (4) The floor drains shall be Zurn, Josam, Watts, Jay R. Smith, MIFAB, Sioux Chief or equivalent.

D. TRAP PRIMERS

Provide trap primers for all floor drains and open receptacle. Acceptable Trap Primer Manufacturers included Zurn, Precision Plumbing Products and Sioux Chief.

E. CLEANOUTS (EXTERIOR) (ECO)

Provide exterior cleanouts at each location indicated and in the manner indicated. Permanently set all exterior cleanouts centered in a 30" X 30" X 6" deep concrete pad. The top of the concrete pad shall be flush with finished grade. The top of the cleanout box shall be flush with the top of the pad and shall be stamped "CO."

F. ROOF DRAINS

(1) Each drain shall be provided complete with a three (3) foot by three (3) foot, four (4) pound sheet lead flashing and clamping collar. Roof drains shall be installed in strict accordance with the drain manufacturers and roofing manufacturer's instructions. Provide all accessories required for a complete installation.

3. WATER SUPPLY SPECIALTIES

A. GENERAL

- Provide all water supply specialties indicated, specified and/or required for the complete installation. Install in a neat and workmanlike manner in accordance with the manufacturer's recommendations and the KBC.
- (2) Where required by the KBC, install code approved vacuum breakers in each water supply specialty.

B. FREEZEPROOF WALL HYDRANTS (FPWH)

- (1) Provide code approved wall hydrants at each location indicated in a neat and workmanlike manner. Affix tight to walls and ensure that the feed piping is on the <u>heated</u> side of the building insulation blanket.
- (2) Where hydrants are of handwheel type, remove handwheels and turn over to owners in an envelope labeled "Wall Hydrants" exterior upon completion of the project.

- (3) Where hydrants have key operators, turn over at least two (2) keys in an envelope labeled "Wall Hydrants" to owners upon completion of the project.
- (4) Where hydrants have lockable boxes, turn over at least two (2) keys in an envelope labeled "Wall Hydrants, Exterior" to owners upon completion of project.
- (5) Mount all wall hydrants at least twenty (20) inches above finished exterior grade. Where this is not possible or practical, contact Engineers.
- (6) Wall hydrants shall be as follows or equivalent:
 - a. Zurn 1300 or equivalent, 3/4", encased, flush, non-freeze wall hydrant with key lock and combination backflow preventer/vacuum breaker.

C. HOSE BIBBS (HB)

- (1) Provide code approved hose bibbs with vacuum breakers and male threaded spouts at each location indicated and as follows:
- (2) Do <u>not</u> install hose bibbs spaces which do not have existing planned or installed floor drains even if sill cocks are indicated for these areas.
- (3) Hose bibbs shall be mounted at eighteen (18) inches above finished floor served.
- (4) The hose bibb shall be Zurn or equivalent similar to the following:
 - a. Zurn Z1350-VB Model. Encased moderate climate wall hydrant for narrow wall installation. Complete with bronze body, all bronze interior parts, replaceable seat washer, screwdriver operated stop valve in supply, key operated control valve, and ³/₄ [19] IP female inlet and ³/₄ [19] male hose connection standard. Adjustable stainless-steel box furnished with hinged cover, cylinder lock and "WATER" stamped on cover. Provide with 3/4 adapter vacuum breaker.
- D. WATER HAMMER ARRESTORS (WHA): Provide water hammer arrestors at each location indicated and/or as required to eliminate hydrostatic on the domestic water system. Provide at least one water hammer arrestor at all quick acting valve locations including:

Automatic Clothes Washers – Type "A" Commercial Dishwashers – Type "B" Mop Basins (downstream of check valve) – Type "A" Flush valve fixtures - Type "B" (Each toilet room with 1-3 flush valve fixtures shall have its own Type "B" water hammer arrestor.)

- (1) Multiple Fixtures Branch Line Less Than 20' Long: The preferred location for a Zurn Shoktrol is at the end of the branch line between the last two fixtures when the branch lines do not exceed 20' in length, from the start of the horizontal branch line to the last fixture supply on this line.
- (2) Multiple Fixtures Branch Line More Than 20' Long: On branch lines over 20' in length, use two Shoktrols whose capacities total the requirement of the branch. Locate one unit between the last and next to last fixture and the other unit approximately midway between the fixtures.

- (3) Water hammer arrestors shall be Zurn, Z-1700, Shoktrol, Smith, Josam, Wade, or equivalent. Water hammer arrestors shall be stainless steel, bellows type. Field fabricated capped cylinders shall<u>not</u> be acceptable.
- (4) Note: Provide insulation unions where arrestors are of dissimilar material from the piping served (unless piping is non-conducting, such as ABS or PVC).

MARK	MANUFACTURER & MODEL	SIZE	P.D.I. SIZE
ТҮРЕ "А"	ZURN, Z-1700 # 100	1-11	А
TYPE "B"	ZURN, Z-1700 # 200	12-32	В
ТҮРЕ "С"	ZURN, Z-1700 # 300	33-60	С
TYPE "D"	ZURN, Z-1700 # 400	61-113	D

E. PRESSURE REDUCING VALVES (PRV)

Install at each location indicated and/or as required to reduce domestic building water service to a maximum of eighty (80) PSIG code approved pressure reducing stations with by-pass. Install in a manner indicated or as required. Provide unions and stops for removal of station. PRV shall be adjustable from thirty (30) percent above or below <u>reduced</u> pressure. Where this cannot be attained with single stage, provide multi-staged reduction.

F. REDUCED PRESSURE BACKFLOW PREVENTERS (RPBP)

Watts #909 or equivalent reduced pressure backflow preventer. Provide with gate valves for isolation, FDA food grade strainer and air gap fitting. RPBP shall be UL listed.

G. DOUBLE CHECK VALVE ASSEMBLY

Watts #709, Watts #757, or equivalent double check valve assembly. Provide with FDA approved food grade strainer and gate valves for isolation. Assembly shall be UL listed.

4. GENERAL SPECIALTIES

A. VACUUM BREAKERS AND BACK FLOW PREVENTERS

Where required by the KBC, whether indicated or not, provide approved vacuum breakers or backflow preventers at the following locations.

- (1) Where domestic water system connects to fire protection system.
- (2) Where domestic water system connects to hydronic system.
- (3) At any hose (threaded) tap on the domestic water system.

B. ROOF FLASHINGS

All plumbing vents or other plumbing passing thru the roof shall be flashed as approved by the KBC and as recommended by the roofing manufacturer and/or Contractor.

C. GAS PRESSURE REGULATORS

Provide gas pressure regulators for all gas fired equipment that requires a lower pressure than what is delivered to the appliance. Regulators shall be installed in accordance with the requirements of NFPA 54 and/or International Fuel Gas Code, whichever is more stringent.

SECTION 220200 - PLUMBING FIXTURES, FITTINGS AND TRIM

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.
- B. The Contractor shall provide all fixtures complete with trim required and connect in a manner conforming to the State Plumbing Code.
- C. The Contractor shall obtain exact centerline rough-in dimensions between partitions, walls, etc. as required for lay-out of his rough-in work. All work shall be roughed-in so that all exposed piping will be straight and true without bends or offsets.
- D. All exposed piping or in casework below sinks, stops, traps, tailpieces, etc., shall be code approved chrome plated brass unless otherwise indicated or specified. Water supplies shall connect through walls with stops and chrome plated escutcheons with set screws.
- E. All fittings, fixtures and trim shall be new unless otherwise indicated or specified. They shall also be of equivalent quality, dimensions, material, etc. as those specified. All faucets, shower heads, drains, levers, trim, etc. shall be constructed of metal and not plastic.
- F. Handicapped fixtures shall be mounted as recommended by the KBC and ADA.
- G. All fixtures shall be mounted as recommended by the manufacturer. Fixtures shall be rigidly mounted to walls and floors. Pay particular attention to flush valves and bracket concealed portion to building structure during rough-in. Loose, shaky flush valves, lavatories, etc. shall not be acceptable.
- H. Prior to final inspection open all faucets and allow to run for fifteen (15) minutes, then remove all faucet aerators and thoroughly clean until smooth flow is obtained.
- I. Prior to final inspection, test by operation at least twice:
 - (1) (Where applicable) adequate flow of hot and/or cold water at;
 - a. Shower Heads
 - b. All Faucets
 - c. Flush Valves and Tanks
 - d. Hose Bibbs
 - e. Sill Cocks
 - f. All Other Valved Hot and/or Cold-Water Openings in the Plumbing System
 - (2) All toilet seats
- J. Prior to final inspection, remove all stick-on labels, dirt, grease, other removable stampings, lettering, etc. from plumbing fixtures and thoroughly clean same.
- K. All sink and lavatory traps shall have screw in plugs in the bottom for ease of cleaning and have mechanical fittings for ease of removal.

- L. All fixtures shall be set level and true and shall be grouted into finished walls, floors, etc. in a neat and workmanlike manner with an approved waterproof non-yellowing grout for such service.
- M. <u>Special Note for Handicap Grab Rails</u>: Coordinate top of shower valves, flush valves, flush tank, etc., with location of grab rails as shown on the architectural plans. The Contractor shall install all items to allow for installation, removal and service without removal of the grab bar.
- N. All exposed drain pipes and domestic water piping under handicap accessible sinks and lavatories shall be insulated in accordance with ADA requirements and shall have a vinyl plastic covering over all insulation.
- O. The Contractor shall obtain a copy of the casework shop drawings and confirm sinks, faucets, gas turrets, etc., will fit in the space provided. Additionally, in ADA applications with handicap sink base cabinets, the Contractor shall limit the total distance from the bottom of the sink to the bottom of the P-trap and coordinate waste pipe rough-in height to ensure the proper installation of the handicap sink base cabinet front closure panel. The Contractor shall not order sinks until he confirms no conflicts occur and shall adjust sink sizes if required. If the Contractor orders sinks, faucets, etc., that do not fit in the casework supplied, he shall replace them at no additional cost.
- P. All lavatories, sinks, etc. shall be supplied with center rear drain outlets where necessary to avoid conflict with casework, handicapped kneeboards, etc. If the Contractor orders sinks that do not fit in the casework supplied, he shall replace them at no additional cost.
- Q. All single supply faucets shall be provided with mechanical mixing valves unless otherwise noted. Mechanical mixing valves shall have hot and cold-water inlet connections, common outlet, in-line check valves, and adjustable temperature setting. Mixing valves shall be Moen model 104424 or equal. Provide one mixing valve per single supply faucet unless otherwise noted. Contractor shall provide all required connections and set mixing valve to required temperature.
- R. All gooseneck faucets shall have rigid spouts, unless swing spouts are specified. If swing spouts are specified, the spout shall have a maximum swing of 140 degrees from side to side.
- S. All plumbing fixtures shall comply with federal lead-free requirements that the lead content of wetted surfaces cannot exceed 0.25% by weight.
- T. All water closet handles on ADA water closets shall be located on the approach side of the fixture.

2. FIXTURES AND TRIM

Available Manufacturers: Subject to compliance with requirements of manufacturers offering plumbing fixtures and trim. Plumbing fixtures and trim, which may be incorporated in the work include, but are not limited to, the following:

A. Plumbing Fixtures - Water Closet, Lavatory, and Urinal

American Standard, U.S. Plumbing Products Eljer Plumbingware Div., Wallace-Murray Corp. Kohler Co. Crane Plumbing Universal-Rundle Toto Zurn Co. Sloan Fixtures B. Plumbing Trim

American Standard, U.S. Plumbing Products Chicago Faucet Co. Kohler Co. Delta Co. T&S Brass & Bronze Work Co. (Commercial) Zurn Co. Just Co. Speakman Co. Moen Commercial

C. Flush Valves

Delany Co. Sloan Valve Co. Zurn Co. American Standard

D. Fixture Seats

Bemis Mfg. Co. Church Seat Co. Olsonite Corp., Olsonite Seats

E. Water Coolers

Elkay Mfg. Co. Halsey Taylor Div., King-Sealey Thermos Co. Haws Drinking Faucet Co. Western Drinking Fountains, Div. of Sunroc Corp. Oasis Co. Acorn AQUA

* Acceptable wall hung water coolers shall be equal to Oasis P8AM, Elkay EZS8 or Halsey Taylor HAC8FS. All other wall hung water coolers shall be subject to review of the Engineer.

F. Service Sinks and Mop Basins

American Standard, U.S. Plumbing Products Eljer Plumbingware Div., Wallace-Murray Corp. Fiat Products Kohler Co. Stern-Williams Co., Inc. Florestone

G. Stainless Steel Sink

Elkay Mfg. Co. Just Mfg. Co. Moen, Div. of Stanadyne/Western Sterling Co.

H. Fixture Carriers

Josam Mfg. Co. Jay R. Smith Tyler Pipe Zurn Industries Watts

I. Shower

Bradley Co. Zurn Co. Symmons Industries, Inc. Chicago Faucets Speakman Company Powers Acorn Co. Moen Commercial

J. Canwash

Zurn Industries Murdock Woodford Watts

K. Washer/Dryer Connection Box

Guy Gray Co. Wolverine Brass, Inc.

L. P-Trap Insulation Kit (Trap Wrap)

Truebro Brocar Plumberex

Note: Kitchen, Special Equipment, Etc.

Contractor to provide final plumbing connections to all of the equipment furnished by Owner including, but not limited to: chrome supplies, stops, continuous drains, drain tailpiece, Kentucky Code "P" traps and escutcheons.

3. FIXTURE SELECTION

A. Refer to drawings for fixture schedule.

SECTION 220300 - PLUMBING EQUIPMENT

1. GENERAL

- A. All plumbing equipment shall comply with the latest provisions of KBC.
- B. Provide magnesium anodes for water heaters and storage tanks.

2. WATER HEATER

A. See schedule on the drawings.

3. RECIRCULATING DOMESTIC HOT WATER PUMPS

A. Thrush, Armstrong, Bell and Gossett or approved equivalent all bronze in-line centrifugal circulating pump with mechanical seals, drip proof motor and all required overloads, starters and disconnects.

SECTION 220400 – WATER BOTTLE FILLING STATIONS

1. GENERAL

- A. The Contractor shall provide water bottle filling stations complete with trim required and connect in a manner conforming to the State Plumbing Code.
- B. The Contractor shall obtain exact centerline rough-in dimensions between partitions, walls, etc. as required for lay-out of his rough-in work. All work shall be roughed-in so that all exposed piping will be straight and true without bends or offsets.
- C. Handicapped fixtures shall be mounted as recommended by the KBC and ADA.
- 2. Water Bottle Filling Stations
 - A. Water Coolers and Bottle Filling Station

Elkay Mfg. Co. Halsey Taylor Div., King-Sealey Thermos Co. Haws Drinking Faucet Co. Oasis Co. Acorn AQUA

Bottle filling station with bilevel ADA cooler, filtered 8 GPH, mechanically activated, hands free visual filter monitor, filtered, green ticker, laminar flow, antimicrobial, real drain furnished with flexi-guard safety bubbler, electronic bottle filler sensor with mechanical front and side bubbler pusher activation. Product shall be wall mounted.

Bottle filler retro-fit station, filtered, non-refrigerated, hands free, visual filter monitor, filtered, green ticker, laminar flow, electronic bottle filler sensor activation. Wall mounted.

SECTION 230200 - HVAC EQUIPMENT AND HYDRONIC SPECIALTIES

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.
- B. The Contractor shall provide in complete working order the following heating, ventilation and air conditioning equipment located as indicated and installed, connected and placed in operation in strict accordance with the manufacturer's recommendations. All equipment shall be factory painted and, where applicable, factory insulated and shall, where such standards exist, bear the label of the Underwriters Laboratory.
- C. Each subcontractor shall be responsible for their own completion of System Verification Checklists/Manufacturer's Checklist.
- D. Factory startup is required for all HVAC equipment. In general, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians and shall complete and submit start-up reports/checklists. This shall include air handling units, boilers, chillers, cooling towers, VFDs, etc.
- E. All HVAC equipment shall comply with the latest provisions of ASHRAE Standard 90 and/or International Energy Conservation Code 2012, whichever is more stringent.
- F. Installation of all heating, ventilating and air conditioning systems shall be performed by a master HVAC contractor licensed in the state the work will be performed.
- G. Note to Suppliers and Manufacturers Representative furnishing proposals for equipment for the project:
 - (1) Review the Controls Section of these Specifications (if applicable) to determine controls to be furnished by the equipment manufacturer, if any. The Contractor shall provide all controls with equipment unless specifically listed otherwise.
 - (2) Review the section of these specifications entitle: SHOP DRAWINGS, DESCRIPTIVE LITERATURE, MAINTENANCE MANUALS, PARTS LISTS, SPECIAL KEYS, TOOLS, ETC., and provide all documents called for therein.
 - (3) Ensure that the equipment which you propose to furnish may be installed, connected, placed in operation and easily maintained at the location and in the space allocated for it.
 - (4) Determine from the Bid Documents the date of completion of this project and ensure that equipment delivery schedules can be met so as to allow this completion date to be met.
 - (5) Where manufacturers' temperature controls are specified, they shall be in full compliance with International Mechanical Code Section 606 including automatic smoke shut down provisions.
 - (6) Provide factory start-up on site by a factory representative (not a third-party contractor) for all HVAC equipment, heat pumps, rooftop units, etc. Submit factory start-up reports to the Engineer.

- (7) Provide training to the Owner by a factory representative for each type of equipment. Training shall be a minimum of eight (8) hours on site and the Engineer shall be notified one (1) week in advance of the training. Training shall only occur when the systems are complete and 100% functional. All training shall be video taped.
- (8) Review the Section on Motor Starters and Electrical Requirements for Mechanical Equipment.
- (9) Equipment incorporating energy recovery wheels shall be provided with an aluminum wheel with molecular sieve desiccant, 4 angstrom maximum sieve size. Wheels shall be certified in accordance with ASHRAE 84 or ARI 1060 standards.
- (10) All condensate producing equipment shall be provided with a condensate trap as recommended by the equipment manufacturer and a condensate overflow switch.
- (11) Provide low ambient and all required controls and accessories on all HVAC equipment to ensure they can provide cooling during the winter season.
- (12) All outdoor HVAC equipment shall be provided with hail guards.
- (13) Provide a complete air tight enclosure with opening door that seals air tight for all filters on air moving equipment.
- (14) All equipment shall be furnished for a single point electrical connection unless specifically excluded as a requirement.

2. EQUIPMENT

A. HP-1: VARIABLE REFRIGERANT FLOW OUTDOOR HEAT PUMP

Acceptable Manufacturers: Daikin, LG, Samsung, Trane, Mitsubishi.

Part 1 – GENERAL

1.01 SYSTEM DESCRIPTION

The variable capacity, heat pump air conditioning system shall be a Daikin Variable Refrigerant Volume Series (heat/cool model) split system. The system shall consist of multiple evaporators using PID control, and Daikin VRV®IV-S model condensing unit. The RXTQ outdoor units shall be a nominal 3 ton, 4 ton, or 5 ton direct expansion (DX), air-cooled heat pump air-conditioning system, inverter driven variable speed compressor, multi-zone split system, using R-410A refrigerant. The outdoor unit may connect an indoor evaporator capacity up to 130% to that of the outdoor condensing unit capacity. All indoor units are each capable of operating separately with individual temperature control.

The Daikin outdoor unit shall be interconnected to indoor unit models and shall range in capacity from 7,500 Btu/h to 54,000 Btu/h in accordance with Daikin's engineering data book detailing each available indoor unit. The indoor units shall be connected to the condensing unit utilizing Daikin's REFNET[™] specified piping joints and headers to ensure correct refrigerant flow and balancing. T style joints are not acceptable.

Operation of the system shall permit either cooling or heating of all of the indoor units. Each indoor unit or group of indoor units shall be able to provide set temperature independently via a local remote controller, an Intelligent Touch Controller (ITC), an Intelligent Touch Manager (ITM) or a BMS interface.

The RXTQ outdoor unit model numbers and the associated number of connectable indoor units per RXTQ outdoor unit is indicated in the following table. Each indoor unit or group of indoor units shall be independently controlled.

Model Number	Nominal Capacity (Tons)	Number of Connectable Indoor Units
RXTQ36TAVJU	3	6

1.02 VRVIV-S FEATURES AND BENEFITS

- A. Voltage Platform Heat pump condensing unit shall be 208/1/60 configuration.
- B. Advanced Zoning A single system shall provide for up to 10 zones.
- C. Independent Control Each indoor unit shall use a dedicated electronic expansion valve for independent control.
- D. VFD Inverter Control Each condensing unit shall use a high efficiency, variable speed "inverter" compressor coupled with inverter fan motors for superior part load performance.
 Compressor capacity shall be modulated automatically to maintain a constant suction pressure, while varying the refrigerant volume for the needs of the cooling or heating loads.
 Indoor units shall use PID control to control superheat to deliver a comfortable room temperature condition.
- E. Variable Refrigerant Temperature (VRT) Control Each condensing unit shall utilize an algorithm to automatically adjust the refrigerant suction and condensing temperatures in response to the heating and cooling loads, and in response to the current weather conditions. The VRT control shall be capable of being customized in the following modes and sub-modes:
 - 1. Automatic (factory preset) The Automatic VRT mode shall allow the target evaporator temperature (Te) and target condensing temperature (Tc) to float based on outdoor ambient temperature conditions, and shall incorporate the following sub-modes:
 - i. Powerful
 - ii. Quick
 - iii. Mild (factory preset)
 - 2. High Sensible The High Sensible mode shall allow the system Te and Tc values to be programmed to series of fixed Te and Tc values. The High Sensible mode shall also be capable of incorporating the following sub-modes:
 - i. Eco
 - 3. Basic The Basic mode shall disable the VRT control of the outdoor unit and allow the system to operate with constant Te and Tc values.
- F. Flexible Design -
 - 1. Systems shall be capable of up to 230ft (70m) of linear piping (295ft / 90m equivalent length) between the condensing unit and furthest located indoor unit unit.
 - 2. Systems shall be capable of up to 984ft (300m) total "one-way" piping in the piping network.
 - 3. Systems shall have a vertical (height) separation of up to 98ft between the condensing unit and the indoor unit units.
 - 4. The outdoor unit shall connect an indoor evaporator capacity up to 130% of the outdoor condensing unit capacity.
- G. Simple Wiring Systems shall use 2 wire, multi-stranded, non-shielded and non-polarized daisy chain control wiring.
- H. Space Saving Each system shall have a condensing unit module footprint of the following dimensions:

RXTQ36TAVJU:39"H x 37"W x 12-5/8"D

- I. Advanced Diagnostics Systems shall include a self diagnostic, auto-check function to detect a malfunction and display the type and location.
- J. Advanced Controls Each system shall have at least one remote controller capable of controlling up to 16 indoor unit units.

1.03 QUALITY ASSURANCE

- A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 Heating and Cooling Equipment and bear the Listed Mark.
- B. All wiring shall be in accordance with the National Electric Code (NEC).

- C. Each combination shall be rated in accordance with Air Conditioning, Heating and Refrigeration Institute's (AHRI) Standard 210/240 and bear the AHRI label.
- D. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
- E. The outdoor unit will be factory charged with R-410A.

1.04 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer's recommendations.

System	Combined With	Nominal Cooling Capacity	EER	SEER	Nominal Heating Capacity	COP	Low Heating Capacity	COP	HSPF
		Btu/hr	95°F		Btu/hr	47°F	Btu/hr	17°F	
	Non Ducted Indoor Units								
RXTQ36TVJU	Ducted Indoor Units								
	Mixed Ducted and Non Ducted Indoor Units								
RXTQ48TVJU	Non Ducted Indoor Units								
	Ducted Indoor Units								
	Mixed Ducted and Non Ducted Indoor Units								
RXTQ60TVJU	Non Ducted Indoor Units								
	Ducted Indoor Units								
	Mixed Ducted and Non Ducted Indoor Units								

Part 2 - WARRANTY

2.01 STANDARD WARRANTY

This warranty applies to compressor and all parts and is limited in duration to ten (10) years starting from the substantial completion date which is one of the two dates below:

Part 3 – PERFORMANCE

3.01 The VRVIV-S RXTQ system performance shall be in accordance with AHRI 210/240 test conditions as shown in the performance table below.

Performance Conditions:

Cooling: indoor temp. of 80°F DB, 67°F WB and outdoor temp. of 95°F DB. Heating: indoor temp. of 70°F DB and outdoor temp. of 47°F DB, 43°F WB. Equivalent piping length: 25ft

3.02 OPERATING RANGE

The operating range in cooling will be 23°F DB to 122°F DB (-5°C – 50°C). The operating range in heating will be -5°F WB to 60°F WB (-20°C – 15.5°C). Cooling mode indoor room temperature range will be 57°F-77°F WB (14°C – 25°C). Heating mode indoor room temperature range will be 59°F-80°F DB (15°C – 26.6°C)

3.03 REFRIGERANT PIPING

Model RXTQ36TAVJU - The system shall be capable of refrigerant piping up to 164 actual feet (50m) or 213 equivalent feet (65m) from the outdoor unit to the furthest indoor unit, a total combined liquid line length of 820 feet (250m) of piping between the condensing and indoor units, and with 98 feet (30m) maximum vertical difference between the outdoor unit and indoor units without any oil traps. The system shall be capable of 33 feet (10m) vertical separation between indoor units on the same system.

REFNET[™] piping joints and headers shall be used to ensure proper refrigerant balance and flow for optimum system capacity and performance. T style joints shall not be acceptable as this will negatively impact proper refrigerant balance and flow for optimum system capacity and performance.

3.04 DESIGN BASIS

The HVAC equipment basis of design is Daikin. All bidders shall furnish the minimum system standards as defined by the base bid model numbers, model families or as otherwise specified herein (see Key General Specifications Alternate Supplier Checklist). In any event, the contractor shall be responsible for all specified items and intents of this document without further compensation.

Part 4 – PRODUCTS

4.01 OUTDOOR UNIT

- A. General: The outdoor unit is designed specifically for use with VRV series components.
 - The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of a Daikin swing compressor, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separator, service ports and suction line accumulator. Liquid and suction lines must be individually insulated between the outdoor and indoor
 - units.The outdoor unit can be wired and piped with outdoor unit access from the left, right, rear or bottom.
 - 3. The connection ratio of indoor units to outdoor unit shall be permitted up to 130%.
 - 4. The outdoor system shall be able to support the connection of up to 10 indoor unit's dependant on the model of the outdoor unit.
 - 5. The sound pressure level standard shall be that value as listed in the Daikin engineering manual for the specified models at 3 feet from the front of the unit. The outdoor unit shall be capable of operating automatically at further reduced noise during night time.
 - 6. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.
 - 7. The outdoor unit shall allow for side-by-side installation with minimum spacing.
 - 8. The following safety devices shall be included on the condensing unit; high pressure switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
 - 9. To ensure the liquid refrigerant does not flash when supplying to the various indoor unit units, the circuit shall be provided with a sub-cooling feature.
 - 10. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation.
 - 11. The outdoor unit shall be capable of heating operation at 0°F dry bulb ambient temperature without additional low ambient controls.
- B. Unit Cabinet:

- 1. The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.
- C. Fan:
 - 1. The condensing unit fan(s) shall consist of propeller type, direct-drive fan motors that have multiple speed operation via a DC (digitally commutating) inverter.

Model Number	Fan Motor Output (W) & Quantity
RXTQ36TAVJU	200 x 1

- 2. The fan shall be a horizontal discharge configuration with a nominal airflow maximum range of 3,740 CFM.
- 3. Nominal sound pressure levels shall be as shown below.

Model Number	Sound Pressure Level dB(A)

	Cooling / Heating Modes		
RXTQ36TAVJU	58 / 61		

- 4. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
- 5. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
- D. Condenser Coil:
 - 1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
 - 2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
 - 3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube.
 - 4. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film type E1.
- E. Compressor:
 - The Daikin inverter scroll compressor shall be variable speed (PAM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity shall be controlled to eliminate deviation from target value.
 - 2. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed swing type.
 - 3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
 - 4. The capacity control range shall be 14% to 100%.
 - 5. The compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
 - 6. Oil separators shall be standard with the equipment together with an intelligent oil management system.
 - 7. The compressor shall be mounted on vibration dampening rubber grommets to minimize the transmission of vibration, eliminating the standard need for external spring isolation.
- F. Electrical:
 - 1. The power supply to the outdoor unit shall be 208/230 volts, 1 phase, 60 hertz +/- 10%.

Power Supply Voltage			;		
208-230V/1/60			187V-253V		
Γ	Model	MCA		MOP	Compressor RLA
Γ	RXTO36TAVJU	16.5		25	15.3

- 2. The control voltage between the indoor and outdoor unit shall be 18VDC non-shielded, stranded 2 conductor cable.
- 3. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor unit with one 2-cable wire, thus simplifying the wiring operation.

4. The control wiring lengths shall be as shown below.

	Outdoor to Indoor Unit	Outdoor to Central Controller	Indoor Unit to Remote Control		
Control Wiring Length	6,665 ft	3,330 ft	1,665 ft		
Wire Type	18 AWG, 2 wire, non-polarity, non-shielded, stranded				

B. CAS-1 VARIABLE REFRIGERANT FLOW INDOOR UNIT

Part 1 – GENERAL

1.05 QUALITY ASSURANCE

- A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995/CAN/CSA-C22.2 No. 236-05 (R2009) – Heating and Cooling Equipment and bear the Listed Mark.
- B. All wiring shall be in accordance with the National Electric Code (NEC)/Canadian Electrical Code (CEC).
- C. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
- D. The outdoor unit will be factory charged with R-410A.

1.06 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer's recommendations.

Part 2 - WARRANTY

STANDARD WARRANTY

This warranty applies to compressor and all parts and is limited in duration to ten (10) years starting from the date of substantial completion.

Part 3 – PERFORMANCE

3.01 DESIGN BASIS

The HVAC equipment basis of design is Daikin. All bidders shall furnish the minimum system standards as defined by the base bid model numbers, model families or as otherwise specified. In any event the contractor shall be responsible for all specified items and intents of this document without further compensation.

Part 4 – PRODUCTS

4.01 FXZQ-TAVJU −VISTATM 2x2 CASSETTE UNIT

A. General: Daikin indoor unit model FXZQ-TAVJU shall be a ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with a decoration panel grille. It shall be available in capacities from 5,800 Btu/h to 18,000 Btu/h. Model numbers are FXZQ05TAVJU, FXZQ07TAVJU, FXZQ09TAVJU, FXZQ12TAVJU, FXZQ15TAVJU, FXZQ18TAVJU to be connected to outdoor unit model RXYQ / RXYMQ / RWEYQ / RWEQ heat pump and REYQ / RELQ / RWEYQ / RWEQ heat recovery model. The decoration panel shall be a four-way air distribution type, with fresh white (Munsell N9.5) or Daikin Silver color, impact resistant with a washable decoration panel. The supply air is distributed via motorized louvers

which can be horizontally and vertically adjusted from 0° to 90° . Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote controls. The indoor units sound pressure shall range from 25.5 dB(A) to 33 dB(A) at low speed measured at 5 feet below the unit.

- B. Performance: Each unit's performance is based on nominal operating conditions:
- C. Indoor Unit:
 - 1. The Daikin indoor unit FXZQ-TAVJU shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
 - 2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
 - 3. Both refrigerant lines shall be fully insulated from the outdoor unit or nearest branch connection into the refrigerant network.
 - 4. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.
 - 5. Return air shall be through the concentric panel, which includes a resin net mold resistant filter.
 - 6. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 24-13/16" of lift, measured from the drain outlet, and has a built in safety shutoff and alarm.
 - 7. The indoor units shall be equipped with a return air thermistor.
 - 8. The indoor unit will be powered with 208~230V/1-phase/60Hz.
 - 9. The voltage range will be 253 volts maximum and 187 volts minimum.
- D. Unit Cabinet:
 - 1. The cabinet shall be space saving and shall be located into the ceiling.
 - 2. Three auto-swing positions shall be available to choose from via field setting.
 - 3. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
 - 4. Fresh air intake shall be possible by way of direct duct installation to the side of the indoor unit cabinet.
 - 5. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
- E. Decoration Panel:
 - The FXZQ-TAVJU series shall be compatible with three optional decoration panels:
 - 1. VISTA Decoration panel white (BYFQ60C3W1W).
 - i. The decoration panel shall be a four-way air distribution type and constructed of impact resistant polymer.
 - ii. The decoration panel dimensions shall measure 24-7/16" x 24-7/16" and shall fit into a standard 2x2 ceiling grid with no overlap of adjacent tiles.
 - iii. The four air discharge outlet louvers shall be independently motorized and controllable. Each louver shall have a visual indicator to easily identify the louver and simplify the airflow configuration.
 - iv. The louver outlets shall be capable of closure to allow for 3-way and 2-way air distribution.
 - v. The decoration panel shall be a low profile design, extending 5/16" below the ceiling.
 - vi. The decoration panel shall be compatible with the optional space and presence sensor kit, model BRYQ60A2W.
 - vii. The decoration panel color shall be fresh white (Munsell N9.5).

- 2. VISTA Decoration panel silver and white (BYFQ60C3W1S).
 - i. The decoration panel shall be a four-way air distribution type and constructed of impact resistant polymer.
 - ii. The decoration panel dimensions shall measure 24-7/16" x 24-7/16" and shall fit into a standard 2x2 ceiling grid with no overlap of adjacent tiles.
 - iii. The four air discharge outlet louvers shall be independently motorized and controllable. Each louver shall have a visual indicator to easily identify the louver and simplify the airflow configuration.
 - iv. The louver outlets shall be capable of closure to allow for 3-way and 2-way air distribution.
 - v. The decoration panel shall be a low profile design, extending 5/16" below the ceiling.
 - vi. The decoration panel shall be compatible with the optional space and presence sensor kit, model BRYQ60A2S.
 - vii. The decoration panel color shall be fresh white (Munsell N9.5) and a specialty Daikin Silver color.
- 3. Legacy FXZQ-MVJU9 decoration panel (BYFQ60B3W1).
 - i. The FXZQ-TAVJU cassette body shall be compatible with the legacy 2x2 decoration panel BYFQ60B3W1.

F. Fan:

- 1. The fan shall be driven by a direct-drive DC motor with statically and dynamically balanced impeller and shall have three user-selectable speeds available: high, medium, and low.
- 2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output of 50W.
- 3. The airflow rate shall be available in high, medium, and low settings.
- 4. When FXZQ-TAVJU is connected with either the BRC1E73 Navigation Remote Controller or the DCM601A71 I-Touch Manager, the Auto fan mode shall be selectable.
- G. Filter:
 - 1. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.
- H. Coil:
 - 1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
 - 2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
 - 3. The coil shall be a 2-row cross fin copper evaporator coil with 22 FPI design completely factory tested.
 - 4. The refrigerant connections shall be flare connections and the condensate will be 1 1/32 inch outside diameter PVC.
 - 5. A condensate pan shall be located under the coil.
 - 6. A condensate pump with a 24-13/16" lift, measured from the drain outlet, shall be located below the coil in the condensate pan with a built in safety alarm.
 - 7. A thermistor will be located on the liquid and gas line.
- I. Electrical:
 - 1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
 - 2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
 - 3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.
- J. Control:
 - 1. The unit shall have controls provided by Daikin to perform input functions necessary to operate the system.
 - 2. The unit shall be compatible with a Daikin Intelligent Touch Manager advanced multizone controller.
- K. Optional Accessories Available:
 - 1. VISTA Decoration panel white (BYFQ60C3W1W)
 - 2. VISTA Decoration panel silver & white (BYFQ60C3W1S)
 - 3. Legacy FXZQ decoration panel (BYFQ60B3W1)
 - 4. Space and Presence sensor kit white (BRYQ60A2W)
 - a. Sensor kit shall be color matched to pair with the VISTA decoration panel BYFQ60C3W1W. Space and presence sensor kit is not compatible with BYFQ60B3W1.
 - 5. Space and Presence sensor kit silver (BRYQ60A2S)
 - a. Sensor kit shall be color matched to pair with the VISTA decoration panel BYFQ60C3W1S. Space and presence sensor kit is not compatible with BYFQ60B3W1.
 - 6. Sealing member of air discharge outlet (BDBHQ44C60)
 - Panel spacer (KDBQ44BA60A)

 a. Panel spacer is compatible only with BYFQ60B3W1.
 - 8. Direct fresh air intake kit (KDDQ44XA60).
 - 9. Infrared remote controller and receiver white (BRC082A42W) a. Receiver shall be color matched
 - 10. Infrared remote controller and receiver silver (BRC082A42S)
 - 11. Infrared remote controller and receiver (BRC082A41W)
 - 12. Wired remote controller (BRC1E73)
 - 13. Adaptor for wiring (KRP1C75)
 - 14. Wiring adaptor for electrical appendices (KRP4A74)
 - 15. Installation box for adaptor PCB (KRP1BA101)
 - 16. Remote "in-room" sensor kit (KRCS01-4B).
 - i. The Daikin wall mounted, hard wired remote sensor kit is recommended for ceilingembedded type fan coils, which often result in a difference between set temperature and actual temperature. The sensor for detecting the temperature can be placed away from the indoor unit (branch wiring is included in the kit).
- C. SS-1 AND CU-1 SPLIT SYSTEM DX

Acceptable Manufacturer's: Daikin, LG, Samsung, Trane, Mitsubishi.

Part 1- GENERAL

1.01.1 SYSTEM DESCRIPTION

The variable capacity, heat pump system shall be a Daikin Inverter Driven series (heat/cool model) split system. The system shall consist of a wall mounted evaporator model FTX12NMVJU exclusively matched to outdoor model RX12NMVJU direct expansion (DX), air-cooled, Daikin swing, variable speed, inverter driven compressor using R-410A refrigerant. The outdoor unit is a horizontal discharge, variable speed, single fan unit using a single phase power supply. The system shall have a self diagnostic function, 3-minute time delay mechanism and have a factory pre-charge of R-410A adequate for 33 feet of total line set length. The system shall have automatic restart capability after a power failure has occurred and a low voltage cut-off feature to prevent stalling during power supply issues.

1.01.2 QUALITY ASSURANCE

- A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 / CSA C22.2 No. 236 Heating and Cooling Equipment and bear the Listed Mark.
- B. All wiring shall be in accordance with the National Electric Code (NEC).

- C. Each combination shall be rated in accordance with Air Conditioning Refrigeration Institute's (ARI) Standard 210/240 and bear the ARI label.
- D. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
- E. The outdoor unit will be factory charged for a line set length of 33 feet of refrigerant with R-410A refrigerant.
- F. A holding charge of dry nitrogen shall be provided in the evaporator.
- G. System Efficiency shall meet or exceed 18 SEER, 12.5 EER and 9 HSPF.

1.01.3 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer's recommendations.

Part 2 – WARRANTY

2.01 WARRANTY

This warrants all parts of this heating or air conditioning unit.

A. Commercial Installations: This warranty applies to heating and air conditioning units installed in buildings other than residences and covers defects in materials and workmanship that appear under normal use and maintenance. Warranty coverage begins on the date of substantial completion. The warranty lasts for a period up to 5 YEARS.

2.03 INSTALLATION REQUIREMENTS

Installation must comply with installation manual. It is recommended the system be installed by a contractor/dealer who has been through Daikin training programs.

Part 3 - PERFORMANCE

3.01 The system performance shall be in accordance with AHRI 210/240 test conditions as shown in the performance table below.

CCU-1	SS-1	Cooling Capacity Rated (Min. ~ Max.)	Heating Capacity Rated (Min. ~ Max.)	SEER	EER	HSPF
RX12NMVJU	FTX12NMVJU	10,900 (4,400 ~ 13,300)	13,500 (4,400 ~ 16,400)	19	12.5	9

The cooling performance is based on 80° F DB / 67° F WB for the indoor unit and 95° F DB / 75° F WB for the outdoor unit and 25 feet of piping. The heating performance is based on 70° F DB / 60° F WB for the indoor unit and 47° F DB / 43° F WB for the outdoor unit and 25 feet of piping.

3.02 The operating range in cooling will be 50° F DB ~ 115° F DB, and down to -4° F DB when optional wind baffle used and Jumper is cut on ODU.

- 3.03 The operating range in heating will be $5^{\circ}F$ WB ~ $65^{\circ}F$ WB.
- 3.04 The system shall be capable of maximum refrigerant piping as follows. For the 9k btu and 12k btu a max of 65-5/8 feet, with 49-1/4 feet vertical difference. For the 18k btu and the 24k btu a max of 98-1/2 feet, with 65-5/8 feet maximum vertical difference, without any oil traps or additional components.

Part 4 – PRODUCTS

4.01 INDOOR UNIT

General:

The indoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. Both liquid and suction lines must be individually insulated between the outdoor and indoor units. A. Unit Cabinet:

- 1. The indoor unit shall have a white, "wipe-clean" finish.
- 2. The drain and refrigerant piping shall be accessible from six (6) positions for flexible installation (right side, right back, and right bottom; and left side, left back, and left bottom.
- 3. The cabinet shall be supplied with a mounting plate to be installed onto a wall for securely mounting the cabinet.
- 4. The cabinet includes:
 - i. Indoor unit ON/OFF switch, capable of being used when the remote controller is missing. When switch is used, the default setting is AUTO mode, 77°F temperature setting, and AUTO airflow rate.
 - ii. OPERATION lamp that turns green when activated
 - iii. TIMER lamp that turns orange when activated
 - A Signal Receiver that receives signals from the remote controller at a maximum distance of 23 ft. When the unit receives a signal, you will hear the following: 2 beeps – operation start, 1 beep – Setting changed, 1 long beep – Operation stop.
- B. Fan:
 - 1. The evaporator fan shall be an assembly consisting of a direct-driven fan by a single motor.
 - 2. The fan shall be statically and dynamically balanced and operate on a motor with permanent lubricated bearings.
 - 3. An auto-swing louver for adjustable air flow (vertically) is standard via the wireless remote control furnished with each system.
 - 4. The indoor fan shall offer a choice of five speeds, plus quiet and auto settings.
 - 5. The fan shall have a delayed start when initially put into HEAT operation, giving time for the evaporator coil to heat up and preventing a cold draft from entering the room.

- C. Filter:
 - 1. The return air filter provided will be a mildew resistant, removable and washable filter. Two titanium apatite photocatalytic air purifying filters are included for additional air filtration.
- D. Coil:
 - 1. The evaporator coil shall be a nonferrous, aluminum fin on copper tube heat exchanger.
 - 2. All tube joints shall be brazed with silver alloy or phoscopper.
 - 3. All coils will be factory pressure tested.
 - 4. A condensate pan shall be provided under the coil with a drain connection.
- E. Electrical:
 - 5. The outdoor unit shall be powered with 208-230 volts, 1 phase, and 60 hertz power. The indoor unit shall receive 208-230 volt, 1 phase, 60 hertz power from the outdoor unit.
 - 6. The allowable voltage range shall be 187 volts to 253 volts.
- F. Control:
 - 1. The unit shall have a backlit, wireless remote infra-red controller capable to operate the system. It shall have Cooling Operation, Heating Operation, Automatic Operation, Dry Operation and Fan Only Operation.
 - The controller shall consist of an On/Off Power switch, Mode Selector, Fan Setting, Swing Louver, On/Off Timer Setting, Temperature Adjustment, °C or °F Temperature Display, Comfort Mode, Econo Mode, and Powerful Operation.
 - i. On/Off switch powers the system on or off.
 - ii. Mode selector shall operate the system in auto, cool, heat, fan, or dry operation.
 - iii. Fan setting shall provide five fan speeds, plus quiet and auto settings.
 - iv. Swing louver shall adjust the airflow (horizontal and vertical) blades.
 - 1. Vertical movement controlled via remote, horizontal movement controlled manually.
 - v. On/Off timer is used for automatically switching the unit on or off.
 - Night Set mode automatically engaged with Off Timer is set. This setting automatically adjusts the temperature setting 0.9°F (0.5°C) up in COOL, 3.6°F (2.0°C) down in HEAT to prevent excessive cooling or heating during sleeping hours.
 - vi. Temperature adjustment allows for the increase or decrease of the desired temperature.

- vii. Comfort Mode directs the airflow upwards while in COOL operation and downward while in HEAT operation. This function prevents air from blowing directly on the occupants in the room.
- viii. Econo operation is a function which enables efficient operation by limiting the maximum power consumption value. This function will also prevent the circuit breaker from tripping when the unit operates alongside other appliances on the same circuit.
- ix. Powerful operation allows quick cool down or heating up in the desired space to achieve maximum desired temperature in the shortest allowable time period.
- 3. The controller shall be able to display two-digit fault codes extracted from the indoor unit to aid in troubleshooting.
- Temperature range on the remote control shall be 64°F to 90°F in COOL mode, 50°F to 86°F in HEAT mode, and 64°F to 86°F in AUTO mode. The temperature shall be controlled in 1° increments.
- 5. The indoor unit microprocessor has the capability to receive and process commands via return air temperature and indoor coil temperature sensors enabled by commands from the remote control.
- 6. The unit shall also have the capability to connect to a smart-device app via wireless adapter.
- G. Sound:
 - 1. Indoor unit sound levels shall not exceed:

SS-1	Cooling Mode Sound Level (H/M/L/SL) dB(A)	Heating Mode Sound Level (H/M/L/SL) dB(A)
FTX12NMVJU	45 / 37 / 30 / 19	45 / 37 / 30 / 26

*values are measured approximately 3 feet away with JIS standard operating conditions.

5.02.1 OUTDOOR UNIT

General:

The outdoor unit shall be specifically matched to the corresponding indoor unit size. The outdoor unit shall be complete factory assembled and pre-wired with all necessary electronic and refrigerant controls. The outdoor shall be controlled by a microprocessor and dedicated EEV's shall be provided for capacity control during part load of the indoor unit. A. Unit Cabinet:

- 1. The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.
- 2. The outdoor unit will come furnished with four (4) mounting feet, mounted across the base pan, to allow bolting to a cement pad or optionally supplied mounting bracket.

- 3. This assembly will be able to withstand a maximum rated wind pressure of 194psf Lateral, 94psf Uplift. See document TER-16-3088.
- B. Fan:
 - a. The fan shall be a direct drive, propeller type fan.
 - b. The motor shall be inverter driven, permanently lubricated type bearings, inherent.
 - c. A fan guard is provided on the outdoor unit to prevent contact with fan operation.
 - d. Airflow shall be horizontal discharge.
- C. Coil:
 - a. The outdoor coil shall be nonferrous construction with corrugated fin tube.
 - b. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film type E1, rated for up to 1000 hours salt spray.
 - c. Refrigerant flow from the condenser will be controlled via a metering device.
 - d. Automatic defrost will remove any frost from the outdoor unit allowing the system to maintain heating capacity.
- D. Compressor:
 - a. The outdoor compressor shall be a patented, variable speed Daikin swing inverter-driven compressor. The one piece action reduces noise, extends life, boasts higher efficiency and reduces energy consumption.
 - b. The outdoor unit shall have an accumulator and four-way reversing valve.
 - c. PVE Refrigerant Oil shall be used to provide improved lubrication & better chemical stability, and no hydrolysis, leading to higher product reliability.
 - d. The compressor shall have an internal thermal overload.
 - e. The outdoor unit can operate with a maximum vertical height difference of 65-5/8 feet and overall maximum length of 98-1/2 feet without any oil traps or additional components.
 - f. The compressor shall have a quick-warming function to prevent pumping liquid refrigerant in low-ambient conditions.
- E. Electrical:
 - a. The electrical power requirement is 208-230 volt, 1-phase, and 60 Hz power.
 - b. The voltage range limitations shall be a minimum of 187 volts and a maximum of 253 volts.

- F. Sound:
 - a. Outdoor unit sound levels shall not exceed:

CU-1	Cooling Mode Sound Level dB(A)	Heating Mode Sound Level dB(A)	
RX12NMVJU	49	49	

*values are measured approximately 3 feet away with JIS standard operating conditions.

5.03 SYSTEM DIAGNOSTICS

GENERAL:

The system shall be capable of producing 2-digit fault codes:

- A. Controls
 - 1. I/R controller
 - 2. Wi-fi module
- B. D-Checker software: The D-Checker software has the ability to display error codes and values for every sensor on the system through the outdoor unit. The sensor data points shall be graphed or recorded for export to a spreadsheet. The spreadsheet can then be analyzed to troubleshoot operational issues or acknowledge proper operation.
- C. DEDICATED OUTSIDE AIR SYSTEM (DOAS-1)
- 1. GENERAL

SECTION INCLUDES

1. Packaged Rooftop air conditioners

REFERENCES

- 1. AFBMA 9 Load Ratings and Fatigue Life for Ball Bearings.
- 2. AMCA 99—Standards Handbook
- 3. AMCA 500—Test Methods for Louver, Dampers, and Shutters.
- 4. AHRI 340/360 Unitary Large Equipment
- 5. NEMA MG1—Motors and Generators
- 6. National Electrical Code.
- 7. NFPA 70—National Fire Protection Agency.

- 8. SMACNA—HVAC Duct Construction Standards—Metal and Flexible.
- 9. UL 900—Test Performance of Air Filter Units.

SUBMITTALS

- 1. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, electrical characteristics and connection requirements.
- 2. Product Data:
 - a. Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, and electrical characteristics and connection requirements.
 - b. Provide computer generated fan curves with specified operating point clearly plotted.
 - c. Manufacturer's Installation Instructions.

OPERATION AND MAINTANENCE DATA

1. Maintenance Data: Provide instructions for installation, maintenance and service

QUALIFICATONS

- 1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience, who issues complete catalog data on total product.
- 2. Startup must be done by trained personnel experienced with rooftop equipment.
- 3. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters and remote controls are in place, bearings lubricated, and manufacturers' installation instructions have been followed.

DELIVERY, STORAGE, AND HANDLING

- 1. Deliver, store, protect and handle products to site.
- 2. Accept products on site and inspect for damage.
- 3. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

2. PRODUCTS

- A. MANUFACTURERS
 - 1. Basis of Design: Daikin Applied
 - a. Trane, AAON

B. GENERAL DESCRIPTION

- 1. Furnish as shown on plans, Daikin Applied Rebel Single zone Heating and Cooling Unit(s) model DPS. Unit performance and electrical characteristics shall be per the job schedule.
- 2. Configuration: Fabricate as detailed on prints and drawings:
 - a. Return plenum / economizer section
 - b. Filter section
 - c. Cooling coil section
 - d. Supply fan section
 - e. Condensing unit section
- 3. The complete unit shall be cETLus listed.
- 4. The unit shall be ASHRAE 90.1-2016 compliant and labeled.

- 5. Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-410 Refrigerant and oil.
- 6. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.
- 7. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.
- Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values. All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.
- 9. Warranty: The manufacturer shall provide 12-month parts only warranty. Defective parts shall be repaired or replaced during the warranty period at no charge. The warranty period shall commence at startup or six months after shipment, whichever occurs first.

C. CABINET, CASING, AND FRAME

- Panel construction shall be double-wall construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 2" thick with an R-value of 13.0, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches w.g.
- 2. Exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished panel surfaces to withstand a minimum 1000-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.
- 3. Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.
- 4. The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.

D. OUTDOOR/RETURN AIR SECTION

- 1. Unit shall be provided with a 100% outdoor air hood. The 100% outdoor air hood shall allow outdoor air to enter from the back of the unit, at the draw-through filter section. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include a bird screen to prevent infiltration of foreign materials and a rain lip to drain water away from the entering air stream.
- 2. Daikin Applied UltraSeal low leak dampers shall be provided. Damper blades shall be fully gasketed and side sealed and arranged vertically in the hood. Damper leakage shall be less than 1.5 CFM/Sq. Ft. of damper area at 1.0 inch static pressure differential. Leakage rate to be tested in accordance with AMCA Standard 500. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers. Control of the dampers shall be from a factory installed actuator.

3. Control of the outdoor dampers shall be by a factory installed actuator. Damper actuator shall be of the modulating type. Damper to open when when supply fan starts, and close when supply fan stops.

E. ENERGY RECOVERY

- 1. The rooftop unit shall be provided with an AHRI certified rotary wheel air-to-air heat exchanger in a cassette frame complete with seals, drive motor and drive belt. The energy recovery wheel shall be an integral part of the rooftop unit with unitary construction and does not require field assembly. Bolt-on energy recovery units that require field assembly and section to section gasketing and sealing are not acceptable.
- The wheel capacity, air pressure drop and effectiveness shall be AHRI certified per AHRI Standard 1060. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Airto-Air Heat Exchangers For Energy Recovery Ventilation Equipment.
- 3. The rooftop unit shall be designed with a track so the entire energy recovery wheel cassette can slide out from the rooftop unit to facilitate cleaning.
- 4. The unit shall have 2" Merv 7 filters for the outdoor air before the wheel to help keep the wheel clean and reduce maintenance. Filter access shall be by a hinged access door with ¹/₄ turn latches.
- 5. The matrix design shall have channels to reduce cross contamination between the outdoor air and the exhaust air. The layers shall be effectively captured in aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belt(s) of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
- 6. The total energy recovery wheel shall be coated with silica gel desiccant permanently bonded without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
- 7. Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning.
- 8. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel. Wheels shall be connected to the shaft by means of taper lock hubs.
- 9. The exhaust air fan shall be a direct drive SWSI plenum fan. The exhaust fan shall be sized for the airflow requirements per the construction schedule. The unit controller shall control the exhaust fan to maintain building pressure. A VFD shall be provided for the exhaust fan motor or the exhaust fan motor shall be an ECM motor. The rooftop unit shall have single point electrical power connection and shall be ETL listed.
- 10. The control of the energy recovery wheel shall be an integral part of the rooftop unit's DDC controller. The DDC controller shall have visibility of the outdoor air temperature, leaving wheel temperature, return air temperature, and exhaust air temperature. These temperatures shall be displayed at the rooftop units DDC controller LCD display. All of these temperatures shall be made available through the BACnet interface.

11. The rooftop unit DDC controller shall provide frost control for the energy recovery wheel. When a frost condition is encountered the unit controller shall stop the wheel. When in the frost control mode the wheel shall be jogged periodically and not be allowed to stay in the stationary position.

F. EXHAUST FAN

- 1. Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
- 2. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- 3. The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.

G. FILTERS

1. Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2" prefilter and a 4" final filter. The unit design shall have a hinged access door for the filter section. The manufacturer shall ship the rooftop unit with 2" MERV 8 construction filters. The contractor shall furnish and install, at building occupancy, the final set of filters per the contract documents.

H. COOLING COIL

- 1. The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.
- 2. The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.
- 3. The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.
- 4. The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.
- 5. The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

I. SUPPLY FAN

1. Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim.

The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additonal maintenance.

- 2. All fan assemblies shall employ solid steel fan shafts. Heavy-duty pillow block type, self-aligning, grease lubricated ball bearings shall be used. Bearings shall be sized to provide a L-50 life at 250,000 hours. The entire fan assembly shall be isolated from the fan bulkhead with a flexible collar and mounted on 1" spring isolators.
- 3. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment.
- 4. Supply fan and motor assembly combinations larger than 8 hp or 22" diameter shall be internally isolated on 1" deflection, spring isolators and include removable shipping tie downs.
- 5. The motor shall be T Frame and open drip proof. Ovrload protection and speed control is provided by the factory installed VFD and rooftop unit controller. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- 6. The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

J. VARIABLE AIR VOLUME CONTROL FOR BALANCING PURPOSES

- An electronic variable frequency drive shall be provided for the supply air fan. Each drive shall be factory installed out of the air stream in a conditioned cabinet. Drives shall meet UL Standard 95-5V. The completed unit assembly shall be listed by a recognized safety agency, such as ETL. Drives are to be accessible through a hinged door assembly. Mounting arrangements that expose drives to high temperature unfiltered ambient air are not acceptable.
- 2. The unit manufacturer shall install all power and control wiring.
- 3. The supply air fan drive output shall be controlled by the factory installed main unit control system and drive status and operating speed shall be monitored and displayed at the main unit control panel.

K. HEATING SECTION

- 1. The rooftop unit shall include an electrical resistance heating coil section. Staged electric heating coil modules shall be factory installed downstream of the supply air fan in the heating section of the rooftop unit. Heating coils shall be constructed of a low watt density, nickel chromium alloy resistance wire with intermediate supports that include ceramic bushings. The electrical contactors shall be of the full line-breaking type with all the electrical power legs being disconnected when the contactors are not energized. All electrical circuit wiring shall be designed with copper conductors, aluminum wires are not acceptable. Heating element branch circuits shall be individually fused to a maximum of 48 Amps per NEC requirements. The power supply for the electric heater shall be factory wired into the units main power block or disconnect switch.
- 2. The heating modules shall have an automatic reset, high temperature limit safety protection. A secondary high limit protection shall also be provided that requires a manual reset. An airflow switch shall be provided with the heating module to prevent the electric heater from operating in the event of no airflow.
- 3. The electric heat elements shall be controlled by the factory installed DDC unit control system. The heater shall have proportional SCR control. The unit controller shall modulate the electric heater to maintain the discharge air temperature setpoint.

4. Field installed heating modules shall require a field ETL certification. Duct heaters mounted within the rooftop unit in the field shall not be acceptable. The manufacturer's rooftop unit ETL certification shall cover the complete unit including the electric heating modules.

L. CONDENSING SECTION

- 1. Outdoor coils shall have seamless copper tubes, mechanically bonded into aluminum plate-type fins. The fins shall have full drawn collars to completely cover the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high-pressure air under water.
- Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit from ambient condition of 0~120°F. Mechanical cooling shall be provided to 0° F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.
- 3. The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite materia
- 4. The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature. The inverter compressor shall have a separate oil pump and low oil safety protection.
- 5. Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.
- 6. Each circuit shall be dehydrated and factory charged with R-410A Refrigerant and oil.

M. ELECTRICAL

1. Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.

N. CONTROLS

1. Provide a complete integrated microprocessor based Direct Digital Control (DDC) system to control all unit functions including temperature control, scheduling, monitoring, unit safety protection, including compressor minimum run and minimum offtimes, and diagnostics. This system shall consist of all required temperature sensors, pressure sensors, controller and keypad/display operator interface. All MCBs and sensors shall be factory mounted, wired and tested.

- 2. The stand-alone DDC controllers shall not be dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor shall maintain existing set points and operate stand alone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in nonvolatile memory. No settings shall be lost, even during extended power shutdowns.
- 3. The DDC control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.
- 4. All digital inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.
- 5. The DDC controller shall have a built-in time schedule. The schedule shall be programmable from the unit keypad interface. The schedule shall be maintained in nonvolatile memory to insure that it is not lost during a power failure. There shall be one start/stop per day and a separate holiday schedule. The controller shall accept up to sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.
- 6. The keypad interface shall allow convenient navigation and access to all control functions. The unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:
 - a. Return air temperature.
 - b. Discharge air temperature.
 - c. Outdoor air temperature.
 - d. Space air temperature.
 - e. Outdoor enthalpy, high/low.
 - f. Compressor suction temperature and pressure
 - g. Compressor head pressure and temperature
 - h. Expansion valve position
 - i. Condenser fan speed
 - j. Inverter compressor speed
 - k. Dirty filter indication.
 - l. Airflow verification.
 - m. Cooling status.
 - n. Control temperature (Changeover).
 - o. VAV box output status.
 - p. Cooling status/capacity.
 - q. Unit status.
 - r. All time schedules.
 - s. Active alarms with time and date.
 - t. Previous alarms with time and date.
 - u. Optimal start
 - v. Supply fan and exhaust fan speed.
 - w. System operating hours.
 - 1) Fan

- 2) Exhaust fan
- 3) Cooling
- 4) Inndividual compressor
- 5) Heating
- 6) Economizer
- 7) Tenant override
- 7. The user interaction with the keypad shall provide the following:
 - a. Controls mode
 - 1) Off manual
 - 2) Auto
 - 3) Heat/Cool
 - 4) Cool only
 - 5) Heat only
 - 6) Fan only
 - b. Occupancy mode
 - 1) Auto
 - 2) Occupied
 - 3) Unoccupied
 - 4) Tenant override
 - c. Unit operation changeover control
 - 1) Return air temperature
 - 2) Space temperature
 - 3) Network signal
 - d. Cooling and heating change-over temperature with deadband
 - e. Cooling discharge air temperature (DAT)
 - f. Supply reset options
 - 1) Return air temperature
 - 2) Outdoor air temperature
 - 3) Space temperature
 - 4) Airflow (VAV)
 - 5) Network signal
 - 6) External (0-10 vdc)
 - 7) External (0-20 mA)
 - g. Temperature alarm limits
 - 1) High supply air temperature
 - 2) Low supply air temperature
 - 3) High return air temperature
 - h. Lockout control for compressors.
 - i. Compressor interstage timers
 - j. Night setback and setup space temperature.
 - k. Building static pressure.
 - 1. Economizer changeover
 - 1) Enthalpy
 - 2) Drybulb temperature
 - m. Currently time and date
 - n. Tenant override time
 - o. Occupied/unoccupied time schedule

- p. One event schedule
- q. Holiday dates and duration
- r. Adjustable set points
- s. Service mode
 - 1) Timers normal (all time delays normal)
 - 2) Timers fast (all time delays 20 sec)
- 8. If the unit is to be programmed with a night setback or setup function, an optional space sensor shall be provided. Space sensors shall be available to support field selectable features. Sensor options shall include:
 - a. Zone sensor with tenant override switch
 - b. Zone sensor with tenant override switch plus heating and cooling set point adjustment. (Space Comfort Control systems only)
- 9. To increase the efficiency of the cooling system the DDC controller shall include a discharge air temperature reset program for part load operating conditions. The discharge air temperature shall be controlled between a minimum and a maximum discharge air temperature (DAT) based on one of the following inputs:
 - a. Airflow
 - b. Outside air temperature
 - c. Space temperature
 - d. Return air temperature
 - e. External signal of 1-5 vdc
 - f. External signal of 0-20 mA
 - g. Network signal
- O. ROOF CURB
 - 1. A prefabricated heavy gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb shall be a minimum of 14" high and include a nominal 2" x 4" wood nailing strip. Gasket shall be provided for field mounting between the unit base and roof curb.

P. CHP-WATER SOURCE HEAT PUMP

1. GENERAL

A. Work Included:

- (1) The contractor shall furnish and install where shown on the plans, packaged water source heat pumps. Sizes, types and performance shall be as indicated in the unit schedule. Each unit shall be complete with factory furnished components and accessories as shown in the plans and as herein specified.
- (2) Provide labor, materials, equipment and services to perform operations required for the complete installation and related work as required in contract documents.
- (3) Electrical work required as an integral part of the temperature control work is indicated on the mechanical drawings, and is the responsibility of this contractor to provide the complete system to perform the full sequence of operation shown, or as described in this specification.
- B. Submittals:
 - (1) Shop drawings including weights, dimensions, and required clearances for service.

- (2) Electrical data, including minimum circuit ampacity and maximum overcurrent protection required, time delay fuse type or HACR circuit breaker required.
- (3) Computer generated Certified Performance data at project application conditions.
- (4) Installation details.
- C. Quality Assurance:
 - (1) Heat pump performance shall be certified in accordance with ARI/ISO Standard 13256-1 and shall have the correct ARI/ISO and CUL labels affixed to the chassis. Heat pump performance at scheduled project operating conditions shall be substantiated by computer generated output data.
 - (2) Heat pumps shall be listed by a nationally recognized safety-testing laboratory or agency, such as Underwriters Laboratory (UL), or Electrical Testing Laboratory (ETL), or Canadian Standards Association (CSA).

2. PRODUCTS

- A. General:
 - (1) Electrical All Water Source Heat Pump units shall be suitable for continuous operation with a supply voltage variation, measured at the factory power connection point, of +/- 10% of the nameplate voltage. A control box shall be located within the unit and shall contain controls for standard components such as compressor, reversing valve, electric heat coil, and fan motor operation and shall have a 50VA 24V control circuit transformer and a terminal block for low voltage field wiring connections. Unit shall be nameplated to accept time delay fuses or HACR circuit breaker for branch overcurrent protection of the power source. All heat pump nameplate electrical utilization voltages shall be in conformance with ANSI Standard C84.1 as follows:

Nameplate Voltage	Phase	Distribution Voltage	Service, No of Conductors
115	1	120	2
208	1	208	2
230	1	240	2
265	1	277	2

- (2) Cabinet Unit exterior cabinetry shall be broken down into three separate panels (front panel and side panels) and shall be constructed of 16-gauge galvanized steel, pre-painted with Antique Ivory or Cupola White color. Access panels with direct contact with conditioned air shall be lined internally with acoustic type dual density fibrous glass insulation or fiber-free, cellular type insulation. Fiberglass insulation shall have edges sealed or tucked under flanges to prevent glass fibers from entering the supply air stream. All construction shall meet the National Fire Protection Association Standard NFPA 90A. Unit sub-base shall be constructed of pre-painted 16-gauge steel and have a built in filter track for easy filter replacement from the front of the unit.
- (3) Chassis Each console unit shall incorporate a hinged controls enclosure for easy access to water piping or service valves. All sections of the blower housing shall be insulated with fiberglass or cellular type insulation to help reduce noise and minimize heat transfer. The compressor shall be totally enclosed within a sheet metal compartment and shall be insulated with fiberglass or cellular type insulation to minimize noise due to vibration from the compressor. The compressor must be mounted on a mass plate system consisting of a heavy gauge steel plate and visco-elastic material to reduce noise due to vibration. The compressor compartment must have a removable access panel for service of the compressor and related refrigerant components. The condensate pan must be made of a material that is non-corrosive, high-density polyethylene plastic preferred.

- (4) Configuration Units shall be provided configured as shown on the plans, in one of the following air-flow arrangements (note: "Right" or "Left" side shall be determined when viewing the water piping side of the unit):
 - a. Bottom Inlet/Top discharge
- (5) Blower Motor A two-speed PSC blower motor shall be provided on 7,000 BTUH through 18,000 BTUH units. Factory motor wiring shall be set for optimum fan performance. Field wire cutting, stripping, or terminal application to conductors shall not be required for motor speed change.
- (6) Blower All direct drive console units shall be top discharge, as shown on the drawings. The blower system shall be made up of a tangential fan wheel with support bearings on either end for maximum support and fan wheel stability. The direct drive fan motor shall be secured to the chassis with three screws and be easily removed for ease of service without having to disassemble any part of the fan housing. Clam-shell style blower systems shall not be accepted.
- (7) Refrigerant Circuit A sealed refrigerant circuit, consisting of a high efficiency rotary compressor mounted on rubber vibration isolation grommets (spring isolators shall not be accepted), air-to-air refrigerant finned tube coil, refrigerant flow metering device (TXV), water-to-refrigerant coaxial tube type heat exchanger, high pressure safety cutout and fusible pressure relief factory-installed on the refrigerant circuit. Heat pump conditioners shall additionally contain a pilot-operated refrigerant reversing valve. The reversing valve shall be energized for heating operation. High and low side refrigerant service valves shall be provided. The refrigerant flow-metering device shall be a thermostatic expansion valve. Refrigerant will be HFC R-410A in all MHC/MHW sizes 7,000 through 18,000 BTUH.
- (8) Safety Controls High pressure switch and low temperature safety sensor shall be wired through a latching lockout circuit to disable the unit until it is reset electrically by interrupting the power supply to the unit. Automatic reset by wall sensor switching shall not be allowed. All safety switches shall be normally closed, opening upon fault detection. Control logic dependent upon the closing of a normally open switch shall not be allowed to preclude the possibility of simple, easily corrected faults being escalated into compressor or heat exchanger failure due to loss of integrity in control wiring.
- (9) Air Section The air section of the unit shall be isolated from the compressor and control section with insulated chassis walls to minimize the transmission of compressor noise and to permit operational service testing with the compressor compartment cover removed.
- (10) Filters All units shall be provided with a half-inch thick, throwaway type fiberglass filter installed in a factory mounted three-sided filter frame built into the sub-base and arranged for front removal.
- (11) Supply and return, condenser water connections shall be straight, non-belled copper pipe to allow brazing of hose kits or service valves by an experienced installer. Plastic condensate drain tube shall not be less than ³/₄" ID, clear plastic with formed trap to prevent gas from coming up through the condensate pan and entering the air stream. Supply, return, and condensate drain shall be connected to loop and drain piping as detail on mechanical drawings.
- (12) Plastic Condensate Pan Units shall be standard with a high-density polyethylene plastic, quadsloped drain pan. Metal drain pans are not acceptable. Condensate drain tubing shall have a formed, internal trap. Drain pan shall be easily removed from the chassis for cleaning or replacement.
- (13) Control System (Microtech III Unit Controller)
 - a. The base control board shall be the main component of a common hardware platform, which is capable of satisfying multiple WSHP control scenarios. The primary design focus for the base controller shall be to incorporate only those essential features that are common across various WSHP configurations, while at the same time insuring flexible expansion

capability. This flexibility will exist in the form of plug-in interface cards and/or I/O expansion cards that meet the requirements that are specific to unique WSHP configurations.

- b. Microprocessor / Memory Requirements: The Microtech III controller will be microprocessor-based and have capabilities, performance, and memory sufficient to execute the various functions detailed in this specification. This document will not specify a type, a manufacturer, or a family of microcontroller to be considered for use. However, at a minimum, the following features are deemed essential:
 - Serial Peripheral Interface (SPI or compatible) and SCI (Serial Communications Interface) communications capability at bit rates of at least 15625bps and 9600bps, respectively.
 - A sufficient number of A/D conversion channels that are present either on chip or through the use of a SPI compatible A/D converter. Maximum conversion time per channel – 100ms, minimum bit resolution – 10 bit.
 - 3) A sufficient number of programmable binary I/O lines necessary to accommodate the worst case number of SPI chip select lines plus all other binary inputs and outputs. Memory shall be non-volatile flash of sufficient size to accommodate all firmware, application code, drivers, sub-routines, tables, libraries, etc., plus a minimum of 20% spare memory capacity for future feature enhancements.
- c. The I/O expansion board shall provide a means of adding I/O capability to the base controller in the form of extra analog inputs, binary inputs, and binary outputs. The board will communicate serially via SCI with the base controller in order to handle the necessary I/O requirements. The primary use of the I/O expansion board will be to satisfy the additional I/O requirements of dual compressor units. Some configurations may also require options such as fan speed control and electric heater coil control.
- Analog Inputs: 8 total (Condensate Overflow, Brownout Detection, Discharge Air Temperature (DAT) Sensor, Suction-Low Temp Sensor, Leaving water temperature (LWT) sensor, Room or Return temp sensor/Timed Override Switch, Setpoint Adjust, Fan Mode -Heat/Cool/Auto). Entering Water Temperature (EWT) input is included on the I/O expansion board to be used in boiler-less system, electric heat coil applications.
 - Condensate Overflow. The presence of excessive condensate in the condensate drain pan is detected by a condensate sensor, which consists of a metal terminal ring mounted just below the top of the condensate pan. The analog input dedicated to condensate sensing must be capable of detecting the conductivity of water between the ring terminal and chassis ground. The conductivity trip point is 2.5 micro-ohms.
 - 2) Brownout Detection. This analog input will measure the 24VAC input voltage applied to the controller as a means of indirectly monitoring line voltage applied to the unit. The 24VAC input, once rectified, filtered, and fed to an appropriate voltage divider, will be applied to the analog input as a DC voltage level proportional to the input voltage. At a minimum, the measurable range will be between 70 and 120% of the corresponding unit nameplate voltage. Due to the tolerances involved with the various components associated with this approach, calibration will occur during factory test when exactly 100% nameplate voltage is applied to the unit while in cooling mode. The digitized value of the resultant DC voltage applied to the analog input during the calibration period will be saved within the controller (in non-volatile memory) and used as a reference value for subsequent operation in the field. The brownout trip and recovery

levels are a function of the application software and are listed elsewhere in this specification.

- 3) DAT Sensor, Suction-Low Temp Sensor, Room Sensor/Timed (Tenant) Override. Sensing element shall be equivalent to NTC Thermistor – 10K ohms @ 25°C, 0.2°C interchangeability. Advanced Thermal Products – Curve Z. NOTE: The Timed (Tenant) Override switch will short out the Room sensor thermistor. Sensing range shall be 0 to 158°F with a resolution of 1°F and an accuracy of +/- 1.5°F Maximum Total Error.
- 4) 2-Wire Potentiometer Input (Setpoint Adjust). The Setpoint Adjust circuit of a remote room sensor shall consist of a 1.5K-ohm 2-wire potentiometer. The wiper of the potentiometer will be connected to the analog input. The other lead of the potentiometer is tied to analog common. The 0 1.5K-ohm range will be interpreted by the base controller as an offset to the current temperature setpoint -3 to +3 degrees For a range of 55 to 95 degrees F (jumper selectable and scaled accordingly in software).
- 5) Switched Fixed Resistor Inputs (Fan On/Auto, Heat/Cool/Auto). The Room Sensor shall incorporate switches and fixed resistors that present different resistance values to a single analog input which correspond to the fan and operating mode functions detailed below. This specification will not dictate what the specific resistance values should be, but the designer should exercise due diligence with regards to selecting values that will be unmistakably discerned given such variables as resistance tolerances, wire/cable resistance, switch resistance, electrical noise imposed on cable runs, etc. be "Heat/Cool/Auto".

Two-position Fan Switch Functions shall be "Fan ON/Fan AUTO".

Three-position Operating Mode Switch Functions shall be "Heat/Cool/Auto".

- e. Binary Inputs. 18 total (High Pressure, Emergency Shutdown, 8-Board level jumpers, 6 thermostat, Occupied/Unoccupied) compatible with existing Mark IV installations that employ the Occupied/Unoccupied control.
 - 1) The High Pressure switch shall be part of an interlock circuit that interrupts power to the on-board compressor relay coil. Since this is a low voltage safety circuit as defined by UL, the designer must apply appropriate spacing as dictated by the relevant UL standards. As part of HP switch state detection, this circuit must sense the current flowing through the on-board compressor relay coil and communicate this information to the HP binary input. The current sensing circuit (Example device: NEC/CEL PS2501-1-A opto-isolator) must be upstream of the High Pressure switch, i.e., between the control output and the HP switch. In the unlikely event that the compressor binary output or HP current sensing circuit fails closed, the HP switch can still perform its intended safety function by opening the compressor relay coil circuit.
 - 2) Emergency Shutdown (see note below). This binary input will detect the presence of an earth grounded signal, which is supplied by an external, remote set of contacts such as those provided by a Condenser Loop Water Controller. This requirement is needed in order to maintain compatibility with existing Mark IV installations that also use a daisy-chained grounded signal wired to multiple units for Emergency Shutdown signaling. Note: Since the Mark IV Emergency Shutdown input is also capable of accepting 24VAC & 24VDC and existing Mark IV installations may use these voltages in lieu of

ground, an external signal converter or relay may be required to convert 24VAC or 24VDC signals to a grounded signal.

- f. Binary Outputs: 9 total (Fan, Compressor 1 / Compressor 1 Low Speed, Reversing Valve, Isolation valve/Pump Request, 3 Board Status LEDs, Room Sensor Status LED, Thermostat "A" output)
- g. Emergency Shutdown: The controller will be in remote shutdown when the emergency shutdown contact closes. Remote shutdown is provided so that when properly connected to a water loop controller or remote switch, the emergency shutdown input can be used to shut down the water source heat pump. When in remote shutdown no other thermostat or control inputs will have effect on unit operation. No faults or modes have higher priority than remote shutdown. Remote shutdown or brownout modes have the same level of priority. When the unit is in remote shutdown mode the following occurs:

The compressor is immediately de-energized (minimum on timer is ignored)				
The reversing valve is immediately de-energized				
The fan is immediately de-energized				
The alarm output is de-energized.				
When the emergency shutdown input is opened the unit will automatically return to normal				
operation.				

- h. Intelligent Reset: (Low pressure and Low temperature in heating only). The "Fault Retry" feature helps to minimize nuisance trips of automatic lockouts caused by low-pressure or low temperature faults. This feature automatically clears these faults the first two times they occur within a 24-hour period and triggers an automatic lockout on the 3rd fault. The retry count is reset to zero every 24 hours. The fault retry feature does not apply to a high pressure fault which causes an immediate lockout and requires a manual reset, or condensate overflow or brownout faults which are self-clearing.
- i. Short Cycle Protection & Random Start: After power cycle, or deactivation of certain alarms, or when leaving the unoccupied mode, a new random compressor start-delay time between 300 and 360 seconds shall be generated. Compressor minimum OFF (360 sec) and compressor minimum ON (180 sec) timers prevent compressor short cycling and prevents units from starting simultaneously after coming back from an unoccupied cycle.
- j. Microtech III Unit Controller and I/O Expansion Board Fault and Status LEDs: There will be no Fault/Status LEDs on the base controller or optional I/O expansion board, however separate optional remote LED boards shall plug into either in order to provide visual access to the face of the control enclosure.
- k. The Baseboard status LED's shall operate as follows (mode/faults are listed in order of priority):

Description		Yellow	Green	Red
Emergency Shutdown		OFF	Flas h	OFF
Low Voltage Brownout	Fault	OFF	Flas h	OFF
Compress or #1 High Pressure (HP1)	Fault	OFF	OFF	Flash
Compress or #1 Low Pressure (LP1)	Fault	OFF	OFF	ON
Compress or #1 Low Suction Temp (LT1) Sens or Fail	Fault	Flash	Flas h	ON
Compress or #1 Low Suction Temp (LT1)	Fault	Flash	OFF	OFF
Room Temp Sens or Fail (with Room Sens or Control Only)	Fault	Flash	Flas h	ON
Condens ate Overflow (Cooling & Dehumidification Modes Only)	Fault	ON	OFF	OFF
Low Entering Water Temp (Heating Compress or Inhibit; No Display with Boilerless EH)		Flash	OFF	Flash
Serial EEPROM Corrupted	Fault	ON	ON	ON
Service Test Mode Enabled	Mode	Flash	Flas h	Flash
Uno ccupied Mode		ON	ON	OFF
Occupied, Bypasis, Standby, or Tenant Override Modes	Mode	OFF	ON	OFF

1 57				
Description	Туре	Yellow	Green	Red
Invalid Jumper Configuration	Fault	Flash	Flash	OFF
Bas eboard Communication Fail	Fault	OFF	Flash	Flash
Compress or #2 High Pressure (HP2)	Fault	OFF	OFF	Flash
Compress or #2 Low Pressure (LP2)	Fault	OFF	OFF	ON
Compress or #2 Low Suction Temp (LT2) Sensor Fail	Fault	Flash	Flash	ON
Compress or #2 Low Suction Temp (LT2)	Fault	Flash	OFF	OFF
Entering Water Temp Sensor Fail (with Boilerless Electric Heating)	Fault	Flash	Flash	ON
Service Test Mode Enabled	Mode	Flash	Flash	Flash
Uno coupied Mode	Mode	ON	ON	OFF
Occupied, Bypass, Standby, or Tenant Override Modes	Mode	OFF	ON	OFF

1. The I/O expansion status LED's shall operate as follows (mode/faults are listed in order of priority):

m. The room sensor status LED shall operate as follows (status displays are listed in order of priority):

-	• /	
LED ON Time (Sec)	LED OFF Time (Sec)	Operating Mode
0.5	0.5	Alarm Condition or Network "Wink" Operation Active
0.0	Continually	Bypass Mode Is Active
0.5	5.5	Unoccupied Mode
5.5	0.5	Standby Mode
Continually	0.0	Occupied Mode

- (14) Warranty- The contractor shall provide one full year warranty for furnishing parts on site, and labor to replace any part of the unit, which becomes defective in normal operation, from the date of SUBSTANTIAL COMPLETION by the manufacturer's representative, or first beneficial use of the unit. The hermetic motor compressor shall be warranted for an additional four years.
 - a. Manufacturer's warranty time periods may or may not coincide with the contractor's time period of obligation, but where the manufacturer's warranty contains an expiration date based upon the equipment shipping date, the contractor shall not be relieved of responsibility for covering the full time periods listed above.
 - b. The contractor shall be responsible for all shipping expenses not included by the manufacturer, both to procure the replacement part, and to return any defective parts to the manufacturer, as they may require.
 - c. The contractor's replacement warranty obligation after the first year shall be limited to furnishing of replacement parts only, and shall not include repair labor costs or materials such as refrigerant, oils, dehydration, refrigerant- moisture dryers, air filters, or drive belts.
 - d. The owner shall be responsible for providing replacement filters beyond the spares provided in the original contract, and for filter installation labor.
- B. Basis of Design
 - (1) Model types HFC R-410A MHC or MHW by Daikin Applied
- C. Acceptable Alternates
 - (1) Ckimate Master, Daikin, Water Furnace, Trane

3. EXECUTION

A. INSTALLATION:

- (1) Install equipment in strict accordance with manufacturer's instructions and as to be compatible with intent of the respective system performance requirements.
- (2) No field provided apparatus, electrical or mechanical, shall be fastened to the heat pump cabinet with screws, without the prior written approval by the manufacturer's representative.
- (3) A discrete grounding conductor shall be provided, sized in accordance with the National Electrical Code (NEC), for each heat pump unit. The use of conduit or water piping for grounding purposes is unacceptable.
- (4) Piping and electrical connections shall be located to eliminate any interference with removal and replacement of the air filter.
- (5) Contractor shall clean each unit of construction dust and debris.
 - a. And install new filters at time of commissioning,
 - b. And shall supply to the owner one complete set of spare filter for each unit on the project.
- (6) Heat pump units shall not be used as "construction heaters" at any time during any phase of construction. Very low temperatures, harmful vapors, gypsum dust from dry wall finishing, may all damage the unit and affect its efficiency and useful service life. Failure to properly protect the unit from construction dirt and debris and from condensation forming within the unit may cause electronic component failure, and void the manufacturer's warranty.
- (7) Coordinate installation with work as part of "Control Systems" section.
- (8) Manufacturer's Field Service Engage the services of factory authorized service technicians to provide equipment start-up to verify installation for proper operation and compliance with manufacturer's recommendations, and to assist the contractor in making adjustments, and to assist in field testing as follows:
 - a. Inspect for visible damage to casing, coils and internal parts.
 - b. Inspect for visible traces of refrigerant leaks (oil, etc.) and then leak check.
 - c. Inspect all electrical connections and torque to manufacturer's recommendations, both power and control. Verify correctness.
 - d. Verify that filters are provided as specified and are installed properly.
 - e. Verify that proper clearances for both operation and servicing have been provided.
 - f. Verify that the unit has been cleaned of all construction dust and debris.
 - g. Verify proper fan rotation, where applicable.
 - h. Start unit in accordance with manufacturer's written instructions.
 - i. Observe initial unit operation to verify suitability for continuous operation for a period of time of sufficient duration to permit system air balancing.

F. RTU-1 AND RTU-2 PACKAGED ROOFTOP UNITS

1. GENERAL

- A. SECTION INCLUDES
 - (1) Packaged Rooftop air conditioners

B. REFERENCES

- (1) AFBMA 9 Load Ratings and Fatigue Life for Ball Bearings.
- (2) AMCA 99—Standards Handbook
- (3) AMCA 210—Laboratory Methods of Testing Fans for Rating Purposes
- (4) AMCA 500—Test Methods for Louver, Dampers, and Shutters.
- (5) AHRI 340/360 Unitary Large Equipment
- (6) NEMA MG1—Motors and Generators

- (7) National Electrical Code.
- (8) NFPA 70—National Fire Protection Agency.
- (9) SMACNA—HVAC Duct Construction Standards—Metal and Flexible.
- (10) UL 900—Test Performance of Air Filter Units.
- C. SUBMITTALS
 - (1) Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, electrical characteristics and connection requirements.
 - (2) Product Data:
 - a. Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, and electrical characteristics and connection requirements.
 - b. Provide computer generated fan curves with specified operating point clearly plotted.
 - c. Manufacturer's Installation Instructions.

D. OPERATION AND MAINTANENCE DATA

- (1) Maintenance Data: Provide instructions for installation, maintenance and service
- E. QUALIFICAITONS
 - (1) Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience, who issues complete catalog data on total product.
 - (2) Startup must be done by trained personnel experienced with rooftop equipment.
 - (3) Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters and remote controls are in place, bearings lubricated, and manufacturers' installation instructions have been followed.
- F. DELIVERY, STORAGE, AND HANDLING
 - (1) Deliver, store, protect and handle products to site.
 - (2) Accept products on site and inspect for damage.
 - (3) Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

2. PRODUCTS

- A. MANUFACTURERS
 - (1) Basis of Design: Daikin Applied
 - a. Acceptable manufacturers: Daikin, Aaon, Trane.

B. GENERAL DESCRIPTION

- (1) Furnish as shown on plans, Daikin Applied Rebel Single zone Heating and Cooling Unit(s) model DPS. Unit performance and electrical characteristics shall be per the job schedule.
- (2) Configuration: Fabricate as detailed on prints and drawings:
 - a. Return plenum / economizer section
 - b. Filter section
 - c. Cooling coil section
 - d. Supply fan section
 - e. Gas heating section.
 - f. Condensing unit section
- (3) The complete unit shall be cETLus listed.

- (4) The unit shall be ASHRAE 90.1-2016 compliant and labeled.
- (5) Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-410 Refrigerant and oil.
- (6) The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.
- (7) All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.
- (8) Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values. All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.
- (9) Warranty: The manufacturer shall provide 12-month parts only warranty. Defective parts shall be repaired or replaced during the warranty period at no charge. The warranty period shall commence at the date of substantial completion.
- C. CABINET, CASING, AND FRAME
 - (1) Panel construction shall be double-wall construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 1" thick with an R-value of 7.0, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches w.g.
 - (2) Exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished panel surfaces to withstand a minimum 1000-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.
 - (3) Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.
 - (4) The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.

D. OUTDOOR/RETURN AIR SECTION

(1) Unit shall be provided with an outdoor air economizer section. The economizer section shall include outdoor, return, and exhaust air dampers. The economizer operation shall be fully integral to the mechanical cooling and allow up to 100% of mechanical cooling if needed to maintain the cooling discharge air temperature. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include moisture eliminator filters to drain water away from the entering air stream. The outside and return air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be parallel blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 1.5 cfm / square foot of damper area at 1" differential pressure in according with testing defined in AMCA 500. A barometric exhaust damper shall be provided to exhaust air out of the

back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges. Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type. A comparative enthalpy control shall be provided to sense and compare enthalpy in both the outdoor and return air streams to determine if outdoor air is suitable for "free" cooling. If outdoor air is suitable for "free" cooling, the outdoor air dampers shall modulate in response to the unit's temperature control system.

(2) Provide a field installed Duct/Space mounted C02 sensor. Outside air damper position will modulate between the Demand Control Ventilation Limit (minimum position setpoint) and the Ventilation Limit (maximum non-economizer position setpoint) to satisfy the space requirements. Damper position will be controlled to the greater of the two command signals, either minimum outside air flow or space IAQ (CO2).

E. EXHAUST FAN

- (1) Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
- (2) The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- (3) The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.

F. FILTERS

(1) Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2" prefilter and a 4" final filter. The unit design shall have a hinged access door for the filter section. The manufacturer shall ship the rooftop unit with 2" MERV 8 construction filters. The contractor shall furnish and install, at building occupancy, the final set of filters per the contract documents.

G. COOLING COIL

- (1) The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.
- (2) The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.
- (3) The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.
- (4) The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.

(5) The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

H. HOT GAS REHEAT

- (1) Unit shall be equipped with a fully modulating hot gas reheat coil with hot gas coming from the unit condenser
- (2) Hot gas reheat coil shall be a Micro Channel design. The aluminum tube shall be a micro channel design with high efficiency aluminum fins. Fins shall be brazed to the tubing for a direct bond. The capacity of the reheat coil shall allow for a 20°F temperature rise at all operating conditions.
- (3) The modulating hot gas reheat systems shall allow for independent control of the cooling coil leaving air temperature and the reheat coil leaving air temperature. The cooling coil and reheat coil leaving air temperature setpoints shall be adjustable through the unit controller. During the dehumidification cycle the unit shall be capable of 100% of the cooling capacity. The hot gas reheat coil shall provide discharge temperature control within +/- 2°F.
- (4) Each coil shall be factory leak tested with high-pressure air under water.
- I. SUPPLY FAN
 - (1) Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additonal maintenance.
 - (2) All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment.
 - (3) Supply fan and motor assembly combinations larger than 8 hp or 22" diameter shall be internally isolated on 1" deflection, spring isolators and include removable shipping tie downs.
 - (4) The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
 - (5) The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

J. VARIABLE AIR VOLUME CONTROL

(1) The unit controller shall proportional control the ECM motors on the supply fan based on space temperature. The unit controller shall increase/decrease the speed of the supply fan in order to maintain the space temperature within its setpoint and deadband. The unit controller shall provide discharge air temperature control with the compressor modulation.

K. HEATING SECTION

- (1) The rooftop unit shall include a natural gas heating section. The gas furnace design shall be one natural gas fired heating module factory installed downstream of the supply air fan in the heat section. The heating module shall be a tubular design with in-shot gas burners.
- (2) The module shall be complete with furnace controller and control valve capable of 10:1 modulating operation.

- (3) The heat exchanger tubes shall be constructed of stainless steel.
- (4) The module shall have an induced draft fan that will maintain a negative pressure in the heat exchanger tubes for the removal of the flue gases.
- (5) Each burner module shall have two flame roll-out safety protection switches and a high temperature limit switch that will shut the gas valve off upon detection of improper burner manifold operation. The induced draft fan shall have an airflow safety switch that will prevent the heating module from turning on in the event of no airflow in the flue chamber.
- (6) The factory-installed DDC unit control system shall control the gas heat module. Field installed heating modules shall require a field ETL certification. The manufacturer's rooftop unit ETL certification shall cover the complete unit including the gas heating modules.

L. CONDENSING SECTION

- (1) Outdoor coils shall be cast aluminum, micro-channel coils. Plate fins shall be protected and brazed between adjoining flat tubes such that they shall not extend outside the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high-pressure air under water.
- (2) Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit from ambient condition of 25~120°F. Mechanical cooling shall be provided to 25° F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.
- (3) The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite materia
- (4) The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature. The inverter compressor shall have a separate oil pump and an oil separator for each compressor that routes oil back to the compressor instead of through the discharge line.
- (5) Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.
- (6) Refrigerant circuit shall have a bypass valve between the suction and discharge refrigerant lines for low head pressure compressor starting and increased compressor reliability. When there is a call for mechanical cooling the bypass valve shall open to equalizing the suction and discharge pressures. When pressures are equalized the bypass valve shall close and the compressor shall be allowed to start.
- (7) Each circuit shall be dehydrated and factory charged with R-410A Refrigerant and oil.
- M. ELECTRICAL
 - (1) Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit

protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.

(2) A single non-fused disconnect switch shall be provided for disconnecting electrical power at the unit. Disconnect switches shall be mounted internally to the control panel and operated by an externally mounted handle.

N. CONTROLS

- (1) Provide a complete integrated microprocessor based Direct Digital Control (DDC) system to control all unit functions including temperature control, scheduling, monitoring, unit safety protection, including compressor minimum run and minimum offtimes, and diagnostics. This system shall consist of all required temperature sensors, pressure sensors, controller and keypad/display operator interface. All MCBs and sensors shall be factory mounted, wired and tested.
- (2) The stand-alone DDC controllers shall not be dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor shall maintain existing set points and operate stand alone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in nonvolatile memory. No settings shall be lost, even during extended power shutdowns.
- (3) The DDC control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.
- (4) All digital inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.
- (5) The DDC controller shall have a built-in time schedule. The schedule shall be programmable from the unit keypad interface. The schedule shall be maintained in nonvolatile memory to insure that it is not lost during a power failure. There shall be one start/stop per day and a separate holiday schedule. The controller shall accept up to sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.
- (6) The keypad interface shall allow convenient navigation and access to all control functions. The unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:
 - a. Return air temperature.
 - b. Discharge air temperature.
 - c. Outdoor air temperature.
 - d. Space air temperature.
 - e. Outdoor enthalpy, high/low.
 - f. Compressor suction temperature and pressure
 - g. Compressor head pressure and temperature
 - h. Expansion valve position

- i. Condenser fan speed
- j. Inverter compressor speed
- k. Dirty filter indication.
- 1. Airflow verification.
- m. Cooling status.
- n. Control temperature (Changeover).
- o. VAV box output status.
- p. Cooling status/capacity.
- q. Unit status.
- r. All time schedules.
- s. Active alarms with time and date.
- t. Previous alarms with time and date.
- u. Optimal start
- v. Supply fan and exhaust fan speed.
- w. System operating hours.
 - 1) Fan
 - 2) Exhaust fan
 - 3) Cooling
 - 4) Inndividual compressor
 - 5) Heating
 - 6) Economizer
 - 7) Tenant override
- (7) The user interaction with the keypad shall provide the following:
 - Controls mode

a.

c.

- 1) Off manual
- 2) Auto
- 3) Heat/Cool
- 4) Cool only
- 5) Heat only
- 6) Fan only
- b. Occupancy mode
 - 1) Auto
 - 2) Occupied
 - 3) Unoccupied
 - 4) Tenant override
 - Unit operation changeover control
 - 1) Return air temperature
 - 2) Space temperature
 - 3) Network signal
- d. Cooling and heating change-over temperature with deadband
- e. Cooling discharge air temperature (DAT)
- f. Supply reset options
 - 1) Return air temperature
 - 2) Outdoor air temperature
 - 3) Space temperature
 - 4) Airflow (VAV)
 - 5) Network signal

- 6) External (0-10 vdc)
- 7) External (0-20 mA)
- g. Temperature alarm limits
 - 1) High supply air temperature
 - 2) Low supply air temperature
 - 3) High return air temperature
 - Lockout control for compressors.
- i. Compressor interstage timers
- j. Night setback and setup space temperature.
- k. Building static pressure.
- 1. Economizer changeover
 - 1) Enthalpy

h.

- 2) Drybulb temperature
- m. Currently time and date
- n. Tenant override time
- o. Occupied/unoccupied time schedule
- p. One event schedule
- q. Holiday dates and duration
- r. Adjustable set points
- s. Service mode
 - 1) Timers normal (all time delays normal)
 - 2) Timers fast (all time delays 20 sec)
- (8) If the unit is to be programmed with a night setback or setup function, an optional space sensor shall be provided. Space sensors shall be available to support field selectable features. Sensor options shall include:
 - a. Zone sensor with tenant override switch
 - b. Zone sensor with tenant override switch plus heating and cooling set point adjustment. (Space Comfort Control systems only)
- (9) To increase the efficiency of the cooling system the DDC controller shall include a discharge air temperature reset program for part load operating conditions. The discharge air temperature shall be controlled between a minimum and a maximum discharge air temperature (DAT) based on one of the following inputs:
 - a. Airflow
 - b. Outside air temperature
 - c. Space temperature
 - d. Return air temperature
 - e. External signal of 1-5 vdc
 - f. External signal of 0-20 mA
 - g. Network signal
- O. ROOF CURB
- (1) A prefabricated heavy gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb shall be a minimum of 14" high and include a nominal 2" x 4" wood nailing strip. Gasket shall be provided for field mounting between the unit base and roof curb.

G. VENTILATING FANS

(1) Ventilating fans shall be of the type, capacity, size, etc. here-in-after scheduled. Catalog numbers are listed as design criteria only. Alternate selections will be accepted provided quality, function, etc. are equivalent. All fans shall be UL listed, complete with all required disconnects and starters and shall be AMCA rated and certified. Model numbers listed are Greenheck, acceptable alternates are Pen, Carnes, Acme, Shipman, Jenn-Aire and Loren-Cook. The Architect shall select the color for all exposed fans.

H. HYDRONIC SPECIALTIES

(1) Manufacturers

Subject to compliance with the specified and scheduled requirements the following manufacturers will be considered, but not limited to:

- Hoffman Amtrol/Thrush Armstrong/Aurora Bell & Gossett Patterson Taco Victaulic Wheatley
- (2) Manual Air Vents

Provide, where shown on the plans, at each rise in piping and where required a manual air vent.

(3) Automatic Air Vents

Provide, where shown on the plans, automatic air vents.

(4) Expansion Loops

Expansion loops shall be Metaflex Metra loops or Engineer approved equivalent. Install with pipe guides and anchors as recommended by the manufacturer in all piping runs 75 feet long or greater and also where indicated on the plans.

Alternatively, in water piping systems, use adequate numbers of Victaulic Style 77 flexible couplings in header piping to accommodate thermal growth and contraction, and as required for the elimination of expansion loops. (In accordance with Victaulic recommendations and as approved by the Engineer). Where expansion loops are required in Victaulic piping systems, use Victaulic flexible couplings on the loop(s).

2. FACTORY START-UP REPORTS

A. Provide factory start-up on site by a factory representative (not a third-party contractor) for all HVAC equipment, including, heat pumps, rooftop units, etc. Submit factory start-up reports to the Engineer. The Mechanical Contractor and the Controls Contractor shall have a representative on site to correct all deficiencies noted by the factory representative. For each deficiency noted, documentation of corrective action taken shall be submitted to Engineer.

- B. At a minimum, the report submitted to the Engineer shall include the following data:
 - (1) Water Source Heat Pumps
 - a. High voltage power supply is correct and accordance with the unit nameplate.
 - b. The phasing of the unit is correct per the compressor rotation.
 - c. The field wiring and circuit protection is the correct size.
 - d. The low voltage control circuit wiring is correct per the unit wiring diagram.
 - e. The piping system is clean and complete.
 - f. Verify water flow is established and circulating through all units.
 - g. The condensate line is properly sized, run, trapped and pitched.
 - h. The indoor blower turns freely without rubbing.

Start-up checklist and log: Upon unit start-up, the following items shall be checked and logged for each water source heat pump. Note, the items listed below must be verified/checked before the system is put into full operation:

- i. Entering fluid temperature (heat and cool mode)
- j. Leaving fluid temperature (heat and cool mode)
- k. Temperature differential (heat and cool mode)
- 1. Return air temperature (heat and cool mode)
- m. Supply air temperature (heat and cool mode)
- n. Water coil heat exchanger (water pressure "in" psig) (heat and cool mode)
- o. Water coil heat exchanger (water pressure "out" psig) (heat and cool mode)
- p. Pressure differential (psig) (heat and cool mode)
- q. Compressor amps
- r. Compressor volts
- s. Compressor discharge line temperature (after 10 minutes)
- t. Refrigerant charge (oz.)
- u. Test drain pan operation
- v. Check and note strainer condition.
- w. Check and note filter condition.
- (2) Outside Air Units/Energy Recovery Units
 - a. Fan rotation
 - b. Recovery wheel rotation
 - c. Confirm all wiring connections are correct
 - d. Confirm all field wiring is correct
 - e. Adjust belt tensions and alignments
 - f. Confirm pipe connections are correct
 - g. Confirm sequence of operation is correct
 - h. Confirm damper operation
- (3) Air Handling Units
 - a. Verify economizer operation
 - b. Verify operating per sequence of control
 - c. Discharge air temperature sensor calibration

- d. Discharge static pressure
- e. Dirty filter differential pressure switch function
- f. Outside air temperature sensors calibration
- g. Return air temperature sensor calibration
- h. Airflow monitoring station calibration
- i. VFD response to pressure sensors or other DDC input
- j. Smoke detection shut down
- k. Freeze protection sequence
- 1. Fan bearings lubrication
- m. Fan not vibrating
- n. Fan motor volts / amps
- o. Check drive belt tension
- p. Check sheave alignment
- q. Coils clean
- r. Dampers operating properly
- s. Filters clean
- t. Fan rotation direction

3. HEATING/COOLING SYSTEM CLEANING

A. GENERAL

The heating/cooling system for this contract is a hydronic heat pump system and there are several precautions which must be observed during its installation. The Contractor is advised to read all of the manufacturer's instructions prior to commencing the installation.

B. SYSTEM START-UP

The Contractor shall include as a part of his work a factory system fill and start-up by an authorized Factory Representative of the unit manufacturer.

C. CLEANING AND FLUSHING HYDRONIC PIPING SYSTEMS

- (1) During construction, extreme care shall be exercised to prevent all dirt and other foreign matter from entering the pipe or other parts of the system. Pipe stored on the project shall have the open ends capped and equipment shall have all openings fully protected. Before erection, each piece of pipe, fitting or valve shall be visually examined and all dirt removed.
- (2) After the system is complete it shall be thoroughly cleaned before placing in operation to rid the system of dirt, biological contamination, piping compound, loose mill scale, oil and any and all other material foreign to the water.
- (3) Before chemical cleaning and sterilization of the entire system, the loop field shall be flushed and purged until free of dirt, debris, and air. During the chemical cleaning and sterilization process the supply and return run-outs shall be temporarily connected together at each heat pump location.
- (4) After purging of the field loop the Contractor shall add an approved system cleaning solution at the recommended concentration to the entire system. Circulate the system with cleaner for the time recommended by the chemical manufacturer. After prescribed circulation time, flush the system until cleaner is removed.

- (5) After chemical cleaning, the entire system shall be sterilized. Introduce a solution of sodium hypochlorite to achieve a chlorine residual of 25 to 50 ppm. Maintain this chlorine level for 12 to 24 hours. Flush out system until chlorine residual in system equals that of the makeup water.
- (6) After the system has been completely cleaned and sterilized as specified herein, the individual heat pumps shall be connected permanently to the supply and return runouts and the system filled for operation under normal closed loop conditions. Within 48 hours of the completion of the sterilization implement a water treatment program to passivate all metal surfaces.

4. HVAC SYSTEM START-UP PROCEDURE

A. GENERAL

- (1) The goal of this procedure is for a few units to run as much as possible with the coils as cold as possible to "wring out" the water and allow it to drain away in the condensate drain pans. Allowing all units to cycle on and off, running for short periods of time, does not dehumidify the air in the building. Starting the system without following the steps outlined will raise the relative humidity in the building and most likely cause condensation on some of the building surfaces and HVAC system that the Contractor will be responsible to correct.
- (2) The high humidity and condensation occurs in school buildings at start up primarily because the building is only partly occupied (or not occupied) when the HVAC system is started. Most people believe that the answer to this problem is to turn the thermostats down very low. The assumption is that cold air will not hold moisture. That is not true. What happens is that the thermostats are quickly satisfied thermally because there is very little cooling load on the building and the cooling equipment. The terminal units then only have to run for a very short period of time to keep the thermostats satisfied and the relative humidity of the air is in fact raising. The goal is to cause the moist air to pass over coils which are cooling it and drying it without allowing more moist air to be introduced into the building.
- (3) To reduce the always present high humidity start-up problem, we have devised this start-up procedure that will minimize the adverse effects of the start-up. As the building sits at start-up, all of the walls, floor, and ceilings are saturated with moisture from the air and also moisture is being released from the drying paint and curing concrete and mortar.
- (4) The following procedure will slowly bring down the temperature and humidity in the lightly loaded building. It will also allow the HVAC equipment to more closely match the actual building load without students and equipment in use.

To reach these goals we require the following:

- (1) Set 1/3 of the units (approximately every third unit) on 74°F (no lower). Set the other thermostats for a cooling setpoint of 90°F so the units will not cool. Override the controls so that the fans in all units will circulate air.
- (2) Leave all of the interior doors open to allow the air to mix throughout the building.
- (3) Close all exterior windows and doors.
- (4) Turn off all exhaust fans and outside air units. Outside air unit exhaust and outside air dampers shall be closed.
- (5) Leave all of the lights on in the building to provide a cooling load.

(6) Provide portable electric heaters or dehumidifiers in any room that shows signs of condensation.

Here is a list of things you should not do:

- (1) Do not prop the exterior doors open during construction or while moving in furnishings.
- (2) Do not start all of the units until students are starting school. When students start school the normal setpoints, schedules, and fan cycling shall begin.

END OF SECTION 230200
SECTION 230300 - CONDENSATE DRAINAGE SYSTEM (FOR COOLING EQUIPMENT)

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Conditions-Mechanical and to all other Contract Documents as they apply to this section of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.
- B. The Contractor shall provide a complete condensate drainage system to carry all condensate discharge from all cooling equipment from the building. Condensate system shall be installed in accordance with IMC. Provide condensate overflow switch for all condensate producing equipment.
- C. Pipe installation and fabrication shall be in accordance with the section of these specifications entitled PIPE, PIPE FITTINGS AND PIPE SUPPORT and as hereinafter specified.
- D. All piping shall be installed concealed, unless specifically noted otherwise and shall be installed under slabs or underground only when specifically indicated.
- E. Lines installed in ceiling spaces shall be held at the maximum possible elevation and shall be coordinated with all other trades to avoid conflicts.
- F. Condensate drain lines shall be pitched 1/4 inch per foot and installed with cleanout plugs at each change in direction and/or at thirty (30) foot intervals. Where this minimum pitch cannot be attained, contact Engineers.
- G. Horizontal runs of condensate drain lines shall be supported at six (6) foot intervals maximum, or more frequently where required to prevent sags and low spots.
- H. Lengths of horizontal lines shall be held at a minimum due to potential lint collection.
- I. Provide condensate traps in accordance with the manufacturer's recommendations.

2. MATERIAL

A. Refer to Section of these Specifications entitled: PIPE, PIPE FITTINGS AND SUPPORT.

3. INSULATION

A. Refer to Section of these Specifications entitled: INSULATION - MECHANICAL.

END OF SECTION 230300

SECTION 231100 - REGISTERS, GRILLES, DIFFUSERS & LOUVERS

1. REGISTERS, GRILLES AND DIFFUSERS

A. GENERAL

Alternate R, G & D selections, other than manufacturers and models listed below, will be accepted, provided quality, function and characteristics are equivalent. Acceptable alternates are Price, Titus, Metalaire, Carnes, Anemostat, Kruegar, and Tuttle & Bailey. Shop drawings shall identify and list all characteristics of each device exactly as scheduled herein. Finishes shall be selected by the Architect. If Architect elects not to select color, all colors shall be off-white. Factory color samples shall be submitted with shop drawings.

B. SELECTION

Refer to the Selections Scheduled on the Drawings.

3. LOUVERS

A. GENERAL

Alternate louver selections, other than manufacturer and model listed below, will be accepted, provided quality, function and characteristics are equivalent. Acceptable alternates are Ruskin, Air Balance, Airline, Airstream, Louvers and Dampers and Penn. Shop drawings shall identify and list all characteristics of each device exactly as scheduled herein. Finishes shall be selected by the Architect unless scheduled otherwise.

B. LINTELS

Provide lintels above all louvers as required. Refer to the lintel schedule in Specification Section 201100.

C. SELECTION

Refer to the Selections Scheduled on the Drawings.

END OF SECTION 231100

SECTION 231200 - SHEET METAL AND FLEXIBLE DUCT

1. GENERAL

- A. The Contractor's attention is directed to the General and Special Conditions, General Requirements-Mechanical and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.
- B. This branch of the work includes all materials, labor and accessories for the fabrication and installation of all sheet metal work as shown on the drawings and/or as specified herein. Where construction methods for various items are not indicated on the drawings or specified herein, all such work shall be fabricated and installed in accordance with the recommended methods outlined in the latest edition of SMACNA's HVAC Duct Construction Standards, Metal and Flexible, and its subsequent addenda. HVAC duct systems shall be fabricated and installed in accordance with the SMACNA duct construction standards (SMACNA-HVAC and SMACNA-Seismic) including Appendix B of the Seismic Restraint Manual Guidelines for Mechanical Systems. These references and plate numbers shall be used by the Engineer for required sheet metal thicknesses and final acceptance of methods of fabrication, hanging, accessories, etc. All equipment furnished by manufacturers shall be installed in strict accord with their recommended methods.
- C. Ductwork shall be constructed and installed per the latest edition of the International Mechanical Code.
- D. Ductwork shall be kept clean at all times. Ductwork stored on the job site shall be placed a minimum of 4" above the floor and shall be completely covered in plastic. Installed ductwork shall be protected with plastic to prohibit dust and dirt from entering the installed ductwork, air handling unit, terminal devices, etc. Provide temporary filters on <u>all</u> return grilles and duct openings if the units are running prior to the building being satisfactorily cleaned. Do not install the ductwork if the building is not "dried-in". If this is required, the open ends of duct shall be covered in plastic to protect. The Owner/Engineer shall periodically inspect that these procedures are followed. If deemed unacceptable, the Contractor shall be required to clean the duct system utilizing a NADCA certified Contractor.

Prior to purchase and fabrication of ductwork (shop fabricated or manufactured), the Contractor shall coordinate installations with new and existing conditions. Notify the Engineer if there are any discrepancies for resolution.

- E. Provide a SMACNA duct cleanliness level "C" per the latest SMACNA standards. [Refer to LEED / Healthcare Requirements]
- F. If separate filter grilles are specified for an HVAC unit the Contractors shall remove any unit mounted filters and blank off the unused filter access opening with sheet metal and seal air tight.
- G. Wall Penetrations: Where ducts penetrate interior or exterior walls, the walls shall be sealed air tight. Refer to the sleeving, cutting, patching, and repairing section of the specifications for additional requirements.
- H. Duct dimensions indicated are required <u>inside clear</u> dimensions. Plan duct layouts for adequate insulation and fitting clearance.

2. LOW PRESSURE DUCTWORK

- A. General (Low Pressure)
 - (1) Double turning vanes shall be installed in all square turns and in any other locations indicated.

- (2) Provide a "high efficiency" type take-off with round damper (Flexmaster STOD-B03 or approved equal) for all round duct branches from a rectangular main to a GRD. Refer to the detail on the drawings for all installation requirements.
- (3) Cross-break all ducts where any duct section dimension or length is 18" or larger.
- (4) Air volume dampers shall be installed in each duct branch takeoffs and/or where indicated, whichever is more stringent. All such dampers shall be accessible without damage to finishes or insulation and shall be provided where required for proper system balance.
- (5) Splitter dampers shall be provided in all rectangular supply air duct tees. Damper blade operator shall extend a minimum two inches thru the insulation.
- (6) Unless otherwise dimensioned on the drawings, all diffusers, registers and grilles shall be located aesthetically and symmetrically with respect to lighting, ceiling patterns, doors, masonry bond, etc. Locate all supply, return and exhaust diffusers and grilles in the locations shown on the architectural reflected ceiling plan.
- (7) Ducts shall be hung by angles, rods, 18 ga. minimum straps, trapezes, etc., in accordance with SMACNA's recommended practices. Duct supports shall not exceed 12 ft intervals. There shall be no less than one set of hangers for each section of ductwork. Where ductwork contains filter sections, coils, fans or other equipment or items, such equipment or items shall be hung independently of ductwork with rods or angles. Do <u>not</u> suspend ducts from purlins or other weak structural members where no additional weight may be applied. If in doubt, consult the structural engineer.
- (8) Provide approved flexible connectors at inlet and outlet of each item of heating and cooling equipment whether indicated or not. Install so as to facilitate removal of equipment as well as for vibration and noise control.
- (9) All ductwork connections, fittings, joints, etc., including longitudinal and transverse joints, seams and connections shall be sealed. Seal with medium pressure, smooth-textured, water based duct sealant. Sealant shall be UL 181B-M listed, UL 723 classified, NFPA 90A & 90B compliant, permanently flexible, nonflammable, and rated to 15" wg. Apply per manufacturer's recommendations. Contractors shall ensure no exposed sharp edges or burrs on ductwork.
- (10) All angular turns shall be made with the radius of the center line of the duct equivalent to 1.5 times the width of the duct.
- (11) Miscellaneous accessories such as test openings with covers, latches, hardware, locking devices, etc., shall be installed as recommended by SMACNA and/or as indicated. Test openings shall be placed at the inlet and discharge of all centrifugal fans, coils, VAV boxes, fan sections of air handling units, at the end and middle of all main trunk ducts and where indicated. All such openings shall be readily accessible without damage to finishes.
- (12) Whether indicated or not, provide code approved, full sized fire dampers at all locations where ductwork penetrates fire rated walls. Fire stop rating shall meet or exceed the rating of the wall. Provide an approved access panel at each fire damper located and sized so as to allow hand reset of each fire dampers. All such fire dampers and access panels shall be readily accessible without damage to finishes. Refer to Architectural Plans for locations of fire rated walls. All access doors shall be 16"x16" or as high as ductwork permits and 16" in length.

- (13) The Contractor who installs the sheet metal shall furnish to the Air Balancing Contractor, a qualified person to assist in testing and balancing the system.
- (14) All fans and other vibrating equipment shall be suspended by independent vibration isolators.
- (15) The interior surface of the ductwork connecting to return/exhaust air grilles shall be painted flat black. The ductwork shall be painted a minimum of 24" starting from the grille.
- B. Materials (Low Pressure Single Wall)
 - (1) Ductwork, plenums and other appurtenances shall be constructed of the following:
 - a. Steel sheets, zinc coated, Federal Specification 00-S-775, Type I, Class E & ASTM A93-59T with G-90 zinc coating or aluminum alloy sheets 3003, Federal Specification AA-A-359, Temper H-14. Utilize Aluminum in MRI Scan Rooms or NMR Room applications.
 - b. Exposed ductwork in finished spaces requiring insulation such as gymnasiums, etc., shall be dual wall ductwork.
 - (2) Ductwork, plenums and other appurtenances shall be constructed of the materials of the minimum weights or gauges as required by the latest SMACNA 2" W.G. Standard or the below table, whichever is more stringent. When gauge thickness differs, the heavier gauge shall be selected. The below table shall serve as a minimum:

	ROUND DUCT	RECTANGULAR DUCT	
DIA., INCHES	GAUGE	WIDTH, INCHES	GAUGE
3 TO 12	26	UP TO 12	26
12 TO 18	24	13 TO 30	24
19 TO 28	22	31 TO 54	22
29 TO 36	20	55 TO 84	20
37 TO 52	18	85 AND ABOVE	18

- C. Miscellaneous (Low Pressure)
 - (1) Un-insulated Flexible ductwork (Use Only Where Indicated)
 - a. Un-insulated flexible ductwork shall be corrugated aluminum. No sections shall be greater than five feet in length. Ductwork shall be UL rated and in accordance with IMC.
 - b. Flexible ductwork installed in a return or exhaust or other negative static pressure application shall be rated for installation in negative pressure systems.
 - (2) Insulated Flexible Duct (Use Only Where Indicated)

- a. Owens/Corning or equivalent, 1 ½" inch thick fiberglass insulation; flexible liner; with aluminum pigment vinyl vapor barrier facing. Insulated flexible duct shall meet Fire Hazards Standards of NFPA 90A and IMC, flame spread not to exceed 25, smoke develop and fuel contributed not to exceed 50 when tested in accordance with ASTM-E84. Minimum R-value of 6.0, tested in accordance with ASTM C177.71. Flexible duct may be used only for runouts and no sections shall be more than five feet in length.
- b. When flexible duct is located in areas where it will be visible because the ceiling allows views to the ductwork above, the flexible duct shall be black. The black color shall be factory coloring and not field applied.
- c. Flexible duct shall not be used in areas where there is no ceiling.
- d. Flexible ductwork installed in a return or exhaust or other negative static pressure application shall be rated for installation in negative pressure systems
- (3) Flexible Connectors: Duro-Dyne, Ventfabrics, Inc., U.S. Rubber or equivalent; conforming to NFPA Pamphlet No. 90-A; neoprene coated glass fabric; 20 oz. for low pressure ducts secured with snap lock.
- (4) Turning Vanes: Duro-Dyne or equivalent fabricated as recommended by SMACNA: noiseless when in place without mounting projections in ducts. All turning vanes shall be double blade type.
- (5) Splitter Damper: Splitter damper shall be constructed of 16-gauge galvanized steel. Provide with operating hardware by Ventfabrics, Inc. to include damper blade bracket, ball joint bracket and operator shaft. Operator shall extend two inches from duct to allow for external insulation, where required. Regulator shall seal operator shaft air tight. Install hardware as recommended by manufacturer.
- (6) Access Doors; In Ductwork: Flexmaster TBSM, Air Balance, Vent Products or equal. Access doors for rectangular ducts shall be 16"x16" where possible. Otherwise install as large an access door as height permits by 16" in length. Door shall be 1" thick double-wall insulated with continuous hinge and cam lock. Provide in ducts where indicated or where required for servicing equipment whether indicated or not. Provide a hinged access door in duct adjacent to all fire, smoke and control dampers for the purpose of determining position. Access doors shall also be provided on each side of duct coils (water, electric, steam, etc.) and downstream side of VAV boxes and CAV boxes.
- (7) Architectural Access Doors in Ceilings or Walls: Provide where required to access equipment, dampers, valves, filters, etc. Provide Kees D Panel, Cesco, Milcor or equal. Panels shall be 24"x24" in size and constructed with 16 gauge galvannealed steel for door and frame. In finished areas, provide with primed steel with 1" border to accept architectural specified finish. In Mechanical, Electrical, or service spaces, provide brushed satin finish with 1" border. Door shall include three (3) screwdriver operated cam latches and concealed continuous pivoting rod hinge. Door shall open 175 degrees. For masonry construction, furnish frames with adjustable metal masonry anchors. For fire rated units, provide manufacturer's standard insulated flush panel/doors with continuous piano hinge and self-closing mechanism. The Contractor shall include all required access doors in the bid and shall coordinate with the General Contractor prior to the bid to ensure a complete project.
- (8) Volume Dampers (Rectangular): Ruskin, Model MD35 or Empco, Air Balance; Louvers and Dampers, Titus, Carnes, Cesco/Advanced Air, Creative Metals, United Air, Pottorf rectangular volume dampers. Frames shall be 4" x 1 "x 16-gauge galvanized steel. Blades shall be opposed blade 16-gauge galvanized steel with triple crimped blades on 6" centers. Linkage shall be concealed in jamb. Bearings shall be ¹/₂" nylon. Maximum single section size shall be 48" wide and 72" high. Provide

with Ventfabrics 2" high elevated dial regulator to avoid damper handle from conflicting with duct insulation. Provide permanent mark on dial regulator to mark air balance point.

- (9) Volume Dampers (Round): Ruskin, Model MDRS25 or, Empco, Air Balance; Louvers and Dampers, Titus, Carnes, Cesco/Advanced Air, Creative Metals, United Air, Pottorff round volume dampers. Dampers shall be butterfly type consisting of circular blade mounted to axle. Frames shall be 20-gauge steel, 6" long. Damper blades shall be 20-gauge galvanized steel. Axle shall be 3/8"x6" square plated steel. Bearing shall be 3/8" nylon. Provide with Ventfabrics 2" high elevated dial regulator to avoid damper handle from conflicting with duct insulation. Provide permanent mark on dial regulator to mark air balance point.
- (10) Fire Dampers: Fire dampers shall comply with IMC and shall be constructed and tested in accordance with UL Safety Standard 555. Each fire damper shall have a 1-1/2 or 3-hour fire protection rating as required by fire wall. Damper shall have a 165°F fusible link, and shall include a UL label in accordance with established UL labeling procedures. Fire damper shall be equipped for vertical or horizontal installation as required by the location shown. Fire dampers shall be installed in wall and floor openings utilizing 16-gauge minimum steel sleeves, angles, other materials, practices required to provide an installation equipment to that utilized by the manufacturer's instructions. All fire dampers shall be dynamic. Static fire dampers are not allowed. Provide velocity level and pressure level as required for application (if in doubt, contact Engineer). Fire dampers shall be Ruskin Type DIBD for 1-1/2-hour rating or Ruskin Type DIBD 23 for a 3-hour rating. Other acceptable manufacturers are Air Balance, Prefco, Greenheck, Nailor, or Safe Air. Provide an access door for fire damper reset at all fire damper locations.

3. DISHWASHER EXHAUST DUCT

A. All exposed exhaust duct shall be 22-gauge stainless steel duct with liquid tight continuous external weld of all seams and joints. All concealed exhaust duct shall be 24-gauge aluminum with liquid tight joints. Provide dielectric connection between steel and aluminum ductwork. All ductwork shall be sloped a minimum of 1/8" per foot so as to drain back toward the dishwasher.

4. DRYER VENT

- A. All dryer ducting shall be a minimum of 4" in diameter. Refer to the drawings for exact duct sizing.
- B. Dryer vent ductwork shall be rigid metal 20-gauge aluminum duct. Duct joints shall be installed so that the male end of the duct points in the direction of the airflow. Joints shall be secured with metal tape (not duct tape). Do not use rivets or screws in the joints or anywhere else in the duct as these will incur lint collection
- C. Length of concealed rigid metal ducting shall not exceed the allowable length of 35 feet. Deduct 5 feet from the allowable length for every 4" 90-degree elbow and 4" 2.5 feet for every 45-degree fitting. lengths may vary per local codes and dryer manufacturer's recommendations. Install per 2012 IMC Section 504 Clothes Dryer Exhaust. Provide a complete, working in-line booster fan system, including power, if the maximum allowable duct length is exceeded.
- D. Flexible transition hose connection at the dryer shall be the aluminum flexible duct type. Do not use the plastic or vinyl.
- E. Termination of dryer venting shall be to the exterior with a proper hood or roof jack equipped with a backdraft damper. Hood/jack shall be painted with suitable exterior grade paint and color per the Owner's direction. Small orifice metal screening shall not be part of the hood or roof jack as this will trap lint and

block the opening. The hood opening shall point down and maintain a minimum of 12 inches of clearance between the bottom of the hood and the ground or other obstruction.

END OF SECTION 231200

SECTION 250100 - MOTOR STARTERS AND OTHER ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

1. MOTOR STARTERS-GENERAL

- A. Where motor starters are required for mechanical equipment they are to be the responsibility of the Contractor furnishing the equipment as outlined herein.
- B. Motor starters shall be furnished by the Equipment Supplier with his equipment. Coordinate all requirements for starters with equipment suppliers and other trades.
- C. Motor starters shall be NEMA style. I.E.C.-style starters are not to be provided. Their sizing and installation shall be coordinated with the equipment manufacturer's requirements and in accordance with the National Electrical Code.
- D. Unless otherwise noted, provide combination starter/disconnects for all equipment requiring a starter.

2. ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

- A. All mechanical equipment shall be provided for single point electrical connection unless specifically noted to the contrary. Refer to schedules and other sections of these specifications for further requirements. It is the responsibility of the Contractor to coordinate the electrical characteristics of all equipment with the electrical provisions indicated on the Contract Documents. The Contractor shall notify the Engineer in writing ten calendar days prior to bid of any discrepancy so a written clarification by Addendum may be made. If such notice is not given, the Contractor shall be responsible for any and all costs or delays associated with any changes required. Specification of equipment characteristics made during review of shop drawings shall not relieve the Contractor of this responsibility.
- B. The equipment manufacturer shall provide internally mounted fuses with his equipment, as required, to comply with the U.L. listing on the equipment name plate. (i.e., hermetically sealed compressors or equipment with name plate data that recommends or requires fuse protection.) See also, National Electrical Code, Article 440, and other applicable sections of the N.E.C.
- C. It is the Contractor's responsibility to furnish and install fusible or non-fusible disconnect switches or circuit breakers for disconnecting means as required by the Code for <u>all</u> electrically powered equipment. All power wiring from source, thru disconnecting means and motor starters to motor terminals or equipment junction box is to be furnished and installed by the Contractor. Each separate contractor engaged for the project shall coordinate with all other trades to ensure all necessary equipment and labor is included for fully functioning mechanical systems, installed per code requirements. Unless otherwise notes, provide combination starter/disconnects for all equipment requiring a starter.
- D. Final electrical connection of equipment shall be verified for proper voltage requirements in conjunction with the motor nameplate patch and actual wiring configuration. Any costs associated with damage to appliances motors, equipment, etc., connected to incorrect supply voltage shall be borne by the Contractor.
- E. Refrigeration condensing units with internal compressors shall be furnished with integral starter. The Contractor is to furnish and install a fusible disconnecting means with fuses sized to motor nameplate requirements. Coordinate wiring, mounting and style of disconnect switch at unit in field.
- F. All interlock or other control wiring, unless specifically noted otherwise, is the responsibility of the Contractor.

- G. All equipment shall be suitably enclosed. All enclosures for equipment shall be rated and approved for the environment in which it operates. (i.e., NEMA 1, NEMA 3R, NEMA 7, NEMA 12, etc.) Verify the requirement with the installation condition if not indicated on the plans.
- H. Observe the following standards for manufacturers of equipment and selection of components.
 - (1) Starters, control devices and assemblies: NEMA, U.L. (I.E.C. style not acceptable)
 - (2) Enclosures for electrical equipment: NEMA, U.L.
 - (3) Enclosed switches: NEMA, U.L.
 - (4) All electrical work, generally: National Electrical Code
 - (5) All electrical work in industrial occupancies: J.I.C. standards
 - (6) All electrical components and materials: U.L. listing required.
- I. Where required, the Contractor is to provide mounting rails or channels to install starters with code-required clearances. Framing shall be solidly anchored by welding expansion shields in masonry or other approved anchorage. Frames are to be constructed of steel angles or pre-manufactured channel systems such as Unistrut, Kindorf or B-Line Company. Framing material shall be pre-finished with corrosion-resistant material or painted with two coats corrosion-resistant oil-based enamel.

3. REQUIREMENTS FOR MECHANICAL EQUIPMENT, 1/2 H.P OR LESS

- A. This section describes requirements for small mechanical equipment such as (but not limited to) package terminal heating/cooling units, (water source heat pumps, etc.) VAV boxes, unit heaters, vertical and horizontal unit ventilators, exhaust fans, in-line fans, fan coil units, cabinet heaters and the like.
- B. Small equipment with motor(s) of 1/2 H.P., single phase or less are generally not required to be furnished with NEMA-style starter(s), unless otherwise noted.
- C. For such equipment, provide integral contactor or horsepower-rated relay where controlled by thermostat or other type of switch. Contactors or relays shall be as recommended by the manufacturer of the equipment, suitable for the service duty.
- D. Provide transformer within unit as required to derive low voltage A.C. for thermostat control or derive from temperature controls panel, if available.
- E. Provide internal fusing for unit motor and other loads in fuse block or in-line fuseholder. See also Article 2-B, this Section.
- F. Where externally-mounted disconnecting means is required and would be impractical, unsightly or inappropriate in the judgment of the Engineer, disconnects shall be located within the unit. These disconnects may be fusible H.P.-rated snap switches or manual starters with overload elements, as required. Locate this and other electrical equipment within enclosure where easily accessible behind access panel or door on unit, and as acceptable to the electrical inspector or local authority having jurisdiction. Refer to mechanical equipment schedules for further information.
- G. Where fractional horsepower duplex pumps such as water circulators, sump pumps, etc. are provided, they shall be provided with alternators, cordsets, etc., as required for a complete installation.

4. REQUIREMENTS FOR MECHANICAL EQUIPMENT, 3/4 H.P. OR LARGER

- A. This section describes requirements for mechanical equipment such as (but not limited to) exhaust fans, larger air handling units, cooling tower fans, water source heat pumps, chilled or hot water pumps, D.X. roof-top units, air compressors and the like.
- B. Provide premium efficiency motors.
- C. Equipment provided with motor(s) of 3/4 H.P. and larger, single or three-phase are required to be furnished with starters suitable for the load(s) specified. It is recommended that starters be furnished integrally with or mounted on equipment for field wiring by the Contractor. Where starters are furnished separate from equipment, furnish templates or rough-in diagrams to the appropriate contractor for his use in installation.
- D. All starters shall be size 0 minimum. They shall be constructed and tested in accord with latest edition of NEMA standards. All starters shall be across-the-line magnetic type, unless indicated otherwise. On motors of 20 H.P. or greater rating, the supplier shall provide starters capable of limiting inrush currents. These shall be of the wye-delta, reduced voltage open-transition type, or electronic controlled, as required. Do not utilize closed transition starters unless specifically indicated.
- E. Magnetic starters shall be furnished with the following characteristics and accessories as a minimum. See other sections of these specifications and mechanical schedules for further requirements.
 - Contacts shall be silver-alloy, double-break type. Contacts shall be replaceable without removal of wiring or removal of starter from enclosure. Number of contacts shall be as required for service indicated. Contacts shall be gravity dropout type, positive operation.
 - (2) Coil voltage shall be 120 volts, A.C., 60 HZ or less, as required to suit control systems available voltages. Coils shall be of molded construction, rated for continuous duty. Provide coil clearing contact as required.
 - (3) Provide control transformer of adequate K.V.A. as required on all starters with line-to-line voltages higher than 120 volts A.C. Provide fuse block and slow-blow fuse to protect control transformer per NEMA, N.E.C. and U.L.
 - (4) Provide hand-off-auto selector switch in face of starter, wired into hand and off switch positions. Auto position (if needed) to be field wired as indicated on plans or schedules for automatic control. Provide a green run pilot light.
 - (5) Provide NEMA Class 20 resettable overload relays, accurately sized to the motor nameplate rating of the motor served and the temperature differential between motor and controller. Overloads shall be easily replaceable, and resettable without opening enclosure, via a push button or similar means. Class 10 or Class 30 overloads may be used, depending on the type of anticipated service.
 - (6) Provide at least one N.O. and one N.C. auxiliary contact (field-convertible to opposite operation) with each starter. Refer to mechanical details or schedules for additional requirements, if any. All starters shall have space for two additional single-pole contacts.
 - (7) All starters shall be thru-wiring type.
 - (8) Provide phase failure sensing relay to open starter coil circuit (on loss of one or more phases) on all three-phase starters controlling motors of 15 H.P. or larger.

(9) Provide power factor correction capacitors on motors of 15 H.P. or larger where predicted power factor based on manufacturer's data will fall below 0.90%. Capacitors shall be of the unit-cell type, in single enclosure with discharge resistors and tank overpressure circuit interrupter for safety.

5. REQUIREMENTS FOR WIRING

- A. All wiring, including controls, interlock, miscellaneous power, sensors, thermostats, etc., shall be installed in metallic raceway systems that are in compliance with all Division 26 requirements of these Specifications, unless specifically noted otherwise. Open cabling systems will only be permitted where specifically permitted within the Division 26 Specifications and if less than 50 volts A.C. peak-to-peak or 50 volts maximum D.C.
- B. Where open cabling is permitted, it shall be installed with proper support as specified in the Division 26 Specifications.
- C. Where open cabling is permitted, and installed in environmental air plenum (return, relief, supply, etc.), the materials installed shall be in compliance with N.E.C. Articles 700, 725, 770 (for fiber optic), 780 and 800.
- D. Where open cabling is permitted, it shall only be installed open in accessible spaces. Where concealed in walls, it shall be routed through raceways to outlet box(es) for the terminal device.

6. INVERTER DUTY MOTORS

- A. Motors which are controlled by variable frequency drive shall be:
 - (1) NEMA MG-1 Part 31 rated for Inverter Duty.
 - (2) Furnished with shaft grounding kit for all motors:
 - a. Motors less than 100 HP in size shall be furnished with shaft grounding kit, Aegis SGR Bearing Protection Ring or equal. One shaft grounding ring and related hardware shall be provided on drive end or non-drive end of motor per manufacturer's instructions. These shall be factory mounted and installed on the exterior of the motor to allow for visual inspection. Ground motor frame per manufacturer's instructions. Install kit in strict accordance with manufacturer's instructions.
 - b. Motors Pumps greater than 100 HP to 1000 HP in size shall be furnished with shaft grounding kit, Aegis SGR Bearing Protection Ring or equal. Provide shaft grounding ring on drive end and non-drive end of motor per manufacturer's instructions. Additionally, provide insulated bearing journals to further reduce risk of current dissipation through bearings. Ground motor frame per manufacturer's instructions. Install kit in strict accordance with manufacturer's instructions.

END OF SECTION 250100

SECTION 250200 - CONTROLS – DIRECT DIGITAL

1. GENERAL

- A. The Contractor shall furnish all labor, materials, equipment and services required to provide a complete temperature control system as specified and as shown on the plans.
- B. Prior to the installation of or payment for any work, the Contractor shall prepare submittals which shall be reviewed by the Architect and Engineer. These submittals shall include a complete control diagram and sequence of operation of the entire system, plus engineering data on all devices used.
- C. The Contractor shall be a licensed installer of HVAC temperature controls by a national temperature controls manufacturer. Acceptable manufacturers are Trane, Siemens, Johnson, Honeywell, Andover, TAC, Invensys, Alerton or Automated Logic. The installer shall have 5 years experience and installed a minimum of 8 systems of similar size. Their offices shall be within 150 miles of the project site.
- D. The system herein specified shall be free from defects in workmanship and material under normal use and service if, within twelve (12) months from the date of acceptance by the Engineer, any of the equipment herein described is proved to be defective in workmanship or material, it will be adjusted, repaired, or replaced free of charge by the Contractor.
- E. All equipment, unless specified to the contrary, shall be fully proportioning and adjustable. The Control System shall consist of all room thermostats, air stream thermostats, valves, damper operators, relays, freeze protection equipment, dampers, panels, and other accessory equipment not provided with the equipment to fill the intent of the specifications and drawings.
- F. Complete freeze protection equipment shall be provided at all required locations. Freeze protection thermostats shall have twenty-foot elements and be capable of de-energizing the circuit when any point along the element reaches the set point of the thermostat. Freezestat elements shall be placed on the leaving side of each heating coil, so that every square foot on the heating coil is protected. On heating coils larger than eighteen (18) square feet, provide multiple freezestats wired in series. The Contractor shall ensure that all freeze protection devices and equipment has been fully tested prior to the heating season and shall so certify in writing to the Engineers. The cost of replacement of equipment damaged by freeze-up caused by improper freeze protection or faulty control equipment shall be borne by the Contractor.
- G. All units, controls, equipment, heat pumps, etc., and controls shall reset automatically when power is restored after an outage.
- H. All control wiring concealed in walls and exposed in mechanical rooms, closets, etc., shall be in conduit. Provide plenum rated wiring where cable is concealed above ceilings. Do not paint wiring. The Contractor is responsible for protecting wiring from paint. Any painted cabling shall be replaced.
- I. All dampers shall be capable of operating properly with the system pressures encountered. This shall include modulating and shut-off functions.
- J. The Contractor shall also refer to the mechanical maintenance, HVAC equipment, and all other sections of the specifications for additional control requirements.
- K. Provide smoke detectors and shut down control for all air handling units and combined air systems as required by the KBC and IMC Section 606.

- L. All DDC controllers or control modules shall have covers to protect the circuit boards. All wiring shall be anchored securely within 6" of the controller.
- M. Provide all control dampers, etc. not supplied with the equipment or required to accomplish the sequences specified.
- N. The Contractor shall provide all refrigeration control and interlock wiring as recommended by the equipment manufacturer.
- O. Wiring and required conduit in connection with the control system(s), including power wiring of any voltage, shall be installed by the Contractor. The Contractor may, at his option, engage the Electrical Contractor to accomplish this work. It is emphasized however, that the Contractor is finally responsible for all such work.
- P. Electric power for the control panels, modules, unit controller, damper motors, etc., shall be derived from the building electric system. Power shall not be derived from the HVAC equipment power source or equipment low voltage transformers (internal or integral).
- Q. The electrical work required for the installation of the control system(s), shall be provided by the Contractor in accordance with all National and Local Electrical Codes. All wiring shall be concealed except in Mechanical Rooms. All electrical work specified under this division of the specifications shall also comply with Division 26 of these specifications.
- R. All exterior electrical work, equipment, etc. shall be waterproofed.
- S. Controls system and all related components shall comply with ASHRAE Standard 135 (BACnet protocol).

2. OWNER'S TRAINING

- A. The Contractor shall provide full instructions to designated personnel in the operation, maintenance, and programming of the system. The training shall be specifically oriented to the system and interfacing equipment installed. Four hours of Owner Training shall be provided at substantial completion, again after 6 months and again 1 year after substantial completion. The Owner Training shall include an overview of the entire HVAC system operation, temperature sensor setpoint manipulation, critical alarm training and graphics display overview. Subcontractors shall be present during Owner training sessions.
- B. The Contractor shall provide a Sign-in Sheet and Meeting Minutes of the training. The Contractor shall also video record the initial training sessions. Complete Operations and Maintenance Manuals shall be reviewed by the Contractor during training.

3. CONTROL SYSTEM CHECKOUT AND TESTING – BY CONTROLS CONTRACTOR PRIOR TO DEMONSTRATION AND ACCEPTANCE

- A. Startup Testing. Complete startup testing to verify operational control system before notifying Owner of system demonstration. Provide Owner with schedule for startup testing. Owner may have representative present during any of all startup testing.
 - (1) Calibrate and prepare for service each instrument, control, and accessory equipment furnished under Section 250200.
 - (2) Verify that control wiring is properly connected and free of shorts and ground faults.
 - (3) Enable control systems and verify each input device's calibration. Calibrate each device according to manufacturer's recommendations.

- (4) Verify that binary output devices such as relays, solenoid valves, two-position actuators and control valves, and magnetic starters, operate properly and that normal positions are correct.
- (5) Verify that analog output devices such as I/Ps and actuators are functional, that start and span are correct, and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel.
- (6) Prepare a log documenting startup testing of each input and output device, with technician's initials certifying each device has been tested and calibrated. Submit log to Engineer for review.
- (7) Verify that system operates according to sequences of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules. Tune PID loops and each control routine that requires tuning.
- (8) Alarms and Interlocks.
 - a. Check each alarm with an appropriate signal at a value that will trip the alarm.
 - b. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction.
 - c. Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

4. EQUIPMENT

A. CONTROL PANEL(S)

(1) Each system shall be provided with a local panel for mounting of all relays, switches, controllers, and thermometers associated with that system. Where one cabinet will not accommodate all the equipment necessary for one system, a second cabinet shall be mounted and bolted adjacent to it. Cabinets shall be provided with a 2/3's door. All devices shall be provided with lamacoid plastic nameplates for identification.

B. THERMOSTATS

- (1) General
 - a. All thermostats shall have a "warmer-cooler" knob. This control shall allow the space occupants to reset the temperature up or down a predetermined amount. This amount, or no amount at all, shall be settable thru the BAS.
 - b. The thermostat shall have an unoccupied override button and an integral communications port.
 - c. The thermostat shall have no integral thermometer.
 - d. All thermostats provided for the project shall be similar in size and appearance.
 - e. Provide tamper-proof guards for all wall mounted thermostats selected by Owner.
 - f. All thermostats shall be mounted on a plastic base or other insulating material to prevent wall coupling effect.
 - g. Thermostats shall be mounted with the top at a maximum of 48" A.F.F. and shall be mounted to comply with A.D.A.
 - h. Thermostats shall provide temperature dead band of 5° F as required by IECC 2012.

i. Thermostat, or any other DDC sensor back box in rated walls shall be a minimum distance apart as allowed by code to maintain the rating. If closer, provide rated box or fireproofing in code approved manner.

C. DAMPERS

(1) Several louvers of practical widths shall be provided for larger dampers. Modulating dampers shall have opposed blades. Dampers shall have edge and end seals. Dampers shall be Ruskin CD-60 or better. Maximum leakage rate shall be 2 CFM per square foot at 1" W.G. pressure differential for dampers greater than 12" wide. Leak rate for dampers 12" and less shall be 3 CFM per square foot. NOTE: Do not mount outside air dampers so close to water coils, piping, etc., that freeze-up may occur due to a leaky damper.

D. RELAYS AND SWITCHES

(1) Relays and switches shall be of the positive and gradual acting type and shall be furnished and installed as required for the successful operation of the system. All switches shall have suitable indicating plates.

E. VALVES

(1) All valves shall be of the fully modulating and silent type unless otherwise specified. They shall provide accurate control of the heating or cooling medium under all load conditions. All valves 2-inches or smaller shall have brass or bronze bodies with screwed ends. Valves 2-1/2 inches and larger shall have iron bodies, brass or bronze trimming with flange ends. Valves shall be normally open or normally closed as required. Valves shall be installed with the stem in the upright position or as recommended by the valve manufacturer.

5. **DEMONSTRATION**

A. A complete demonstration and readout of the capabilities of the monitoring and control system shall be performed. The contractor shall demonstrate on -site with the Owner and Engineer that all points and sequences operate as designed.

The warranty does not start until all controls, graphics, points, etc. are functioning.

All controls functioning on _____ Date

Witnessed by ____

END OF SECTION 250200

SECTION 260501 - GENERAL PROVISIONS - ELECTRICAL

1. GENERAL

- A. The Instructions to Bidders, General and Special Conditions, and all other contract documents shall apply to the Contractor's work as well as to each of his Sub Contractor's work. Each Contractor is directed to familiarize himself in detail with all documents pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.
- B. The Contractor shall be governed by any alternates, unit prices and Addenda or other contract documents insofar as they may affect his part of the work.
- C. The work included in this division consists of the furnishing of all labor, equipment, transportation, supplies, material and appurtenances and performing all operations necessary for the satisfactory installation of complete and operating electrical systems indicated on the drawings and/or specified herein.
- D. Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the electrical systems in a substantial manner, in compliance with the requirements stated, implied, or intended in the drawings and specifications, shall be included as part of this Contract. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten days prior to bid. In the absence of such written notice and by the act of submitting his bid, it shall be understood that the Contractor has included the cost of all required items in his bid, and that he will be responsible for the approved satisfactory functioning of the entire system without extra compensations.
- E. It is not the intent of this section of the specifications (or the remainder of the contract documents) to make any specific Contractor, other than the Contractor holding the prime contract, responsible to the Owner, Architect and Engineer. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be done through the Contractor to the Architect (if applicable), then to the Engineer.
- F. This section of the Specifications or the arrangement of the contract documents shall not be construed as an attempt to arbitrarily assign responsibility for work, material, equipment or services to a particular trade Contractor or Sub-Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be the responsibility of the Contractor holding the prime contract.
- G. It is the intent of this Contract to deliver to the Owner a "like new" project once work is complete. Although plans and specifications are complete to the extent possible, it shall be responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials to be installed by other trades without additional cost to the Owner.
- H. The Contractor shall provide interim life safety and fire detection measures as required by the Authority Having Jurisdiction, Division 1 specifications, NFPA, and applicable Codes. This includes temporary relocations of heat/smoke detection, exit signage, and egress lighting in existing buildings as applicable.
- I. In general, and to the extent possible, all work shall be accomplished without interruption of the existing facilities' operations. Each Contractor shall advise the Architect, Owner and Engineer (as applicable) in writing at least one week prior to the deliberate interruption of any services. The Owner shall be advised of the exact time that interruption will occur and the length of time the interruption will occur. Failure to

comply with this requirement may result in complete work stoppage by the Contractors involved until a complete schedule of interruptions can be developed.

- J. Whenever utilities are interrupted, either deliberately or accidentally, the Contractor shall work continuously to restore said service. The Contractor shall provide tools, materials, skilled journeymen of his own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without request for extra compensation to the Owner, except where otherwise provided for in the contract document.
- K. The Contractor shall be responsible for maintaining existing fire alarm, paging, access control, intrusion detection, CCTV, nurse call systems, etc., in occupied spaces in renovation and addition projects. The Contractor shall be required to disconnect and remove all existing devices in renovated areas (where directed as such) without affecting system operations. All costs associated with said work shall be borne by the Contractor.
- L. Definitions:
 - (1) Prime Contractor The Contractor who has been engaged by the Owner in a contractual relationship to accomplish the work.
 - (2) Electrical Contractor Any Contractor whether bidding or working independently or under the supervision of a General Contractor, that is: the one holding the Prime Contract and who installs any type of Electrical work, such as: power, lighting, television, telecommunications, data, fiber optic, intercom, fire detection and alarm, security, video, underground or overhead electrical, etc.

<u>Note</u>: Any reference within these specifications to a specific entity, i.e., "Electrical Contractor" is not to be construed as an attempt to limit or define the scope of work for that entity or assign work to a specific trade or contracting entity. Such assignments of responsibility are the responsibility of the Contractor or Construction Manager holding the prime contract, unless otherwise provided herein.

- (3) Electrical Sub-Contractor Each or any Contractor contracted to, or employed by, the Electrical Contractor for any work required by the Electrical Contractor.
- (4) Engineer The Consulting Mechanical-Electrical Engineers, either consulting to the Owner, Architect, other Engineers, etc.
- (5) Architect The Architect of Record for the project, if any.
- (6) Furnish Deliver to the site in good condition.
- (7) Provide Furnish and install in complete working order.
- (8) Install Install equipment furnished by others in complete working order.
- (9) Contract Documents All documents pertinent to the quality and quantity of all work to be performed on the project. Includes, but not limited to: Plans, Specifications, Addenda, Instructions to Bidders, (both General and Sub-Contractors), Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Construction Manager's Assignments, Architect's Supplemental Instructions, Periodical Payment Requests, etc.

2. INTENT

- A. It is the intent of these specifications and all associated drawings that the Contractor provide finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready for use."
- B. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

3. ELECTRICAL DRAWINGS AND SPECIFICATIONS

- A. The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed insofar as possible. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted in writing to the Engineer for review before proceeding with the work. The Contract Drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Contractors shall, however, anticipate that additional offsets may be required and submit their bid accordingly.
- B. The drawings and specifications are intended to supplement each other. No Contractor or supplier shall take advantage of conflict between them, or between parts of either, but should this condition exist, the Contractor or supplier shall request a clarification of the condition at least ten days prior to the submission of bids so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be the determining factor. In all instances, unless modified in writing and agreed upon by all parties thereto, the Contract to accomplish the work shall be binding on the affected Contractor.
- C. The drawings and specifications shall be considered to be cooperative and complimentary and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.
- D. The Contractor shall make all his own measurements in the field and shall be responsible for correct fitting. He shall coordinate this work with all other branches of work in such a manner as to cause a minimum of conflict or delay.
- E. The Engineer shall reserve the right to make minor adjustments in location of conduit, fixtures, outlets, switches, etc., where he considers such adjustments desirable in the interest of concealing work or presenting a better appearance.
- F. The Contractor shall evaluate ceiling heights called for on Architectural Plans. Where the location of Electrical equipment may interfere with ceiling heights, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work on the part of the Contractor or unduly delay the work.
- G. Special Note: Always check ceiling heights indicated on Drawings and Schedules and insure that these heights may be maintained after all mechanical and electrical equipment is installed. If a conflict is apparent, notify the Engineer in writing for instructions.
- H. Should overlap of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume that he is to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.
- I. The drawings are intended to show the approximate location of equipment, materials, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions whether

given in figures or scaled shall be verified in the field. In case of conflict between small and large scale drawings, the larger scale drawings shall take precedence.

- J. The Contractor and his Sub Contractors shall review all drawings in detail as they may relate to his work (structural, architectural, site survey, mechanical, etc.). Review all drawings for general coordination of work, responsibilities, ceiling clearances, wall penetration points, chase access, fixture elevations, etc. Make any pertinent coordination or apparent conflict comments to the Engineers at least ten days prior to bids, for issuance of clarification by written addendum.
- K. Where on any of the drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornament or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

4. EXAMINATION OF SITE AND CONDITIONS

- A. The Contractor shall inform himself of all of the conditions under which the work is to be performed, the site of the work, the structure of the ground, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work. All Contractors or suppliers shall carefully examine all Drawings and Specifications and contract documents to determine the kind and type of materials to be used throughout the project and which may, in any way, affect the execution of his work.
- B. The Contractor shall fully acquaint himself with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services, availability of temporary or permanent utilities, etc. The Contractor shall include in his work all expenses or disbursements in connection with such matters and conditions. The Contractor shall verify all work shown on the drawings and conditions at the site, and shall report in writing to the Engineer ten days prior to bid, any apparent omissions or discrepancies in order that clarifications may be issued by written addendum. No allowance is to be made for lack of knowledge concerning such conditions after bids are accepted.

5. EQUIPMENT AND MATERIALS SUBSTITUTIONS OR DEVIATIONS

- A. When any Contractor requests review of substitute materials and/or equipment, and when under an approved formal alternate proposal, it shall be understood and agreed that such substitution, if approved, will be made without additional cost regardless of changes in connections, spacing, service, mounting, etc. In all cases where substitutions affect other trades, the Contractor offering such substitutions shall advise all such Contractors of the change and shall reimburse them for all necessary changes in their work. Any drawings, Specifications, Diagrams, etc., required to describe and coordinate such substitutions or deviations shall be professionally prepared at the responsible Contractor's expense. Special Note: Review of Shop Drawings by the Engineer does not absolve the Contractor of this responsibility
- B. References in the specifications to any article, device, product, material, fixture, form, or type of construction by name, make, or catalog number shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition. Each Contractor, in such cases, may, at his option, use any article, device, product, material, fixture, form, or type of construction which in the judgment of the Engineer is equivalent to that specified, provided the provisions of paragraph (A) immediately preceding are met. Substitutions shall be submitted to the Engineer a minimum of ten days prior to bid date for approval to bid in written form thru addenda or other method selected by the Engineer. If prevailing laws of cities, towns, states or countries are more stringent than these specifications regarding such substitutions, then those laws shall prevail over these requirements.

- C. Wherever any equipment and material is specified <u>exclusively</u> only such items shall be used unless substitution is accepted in writing by the engineers.
- D. The Contractor shall furnish along with his proposal a list of specified equipment and materials which he proposes to provide. Where several makes are mentioned in the Specifications and the Contractor fails to state which he proposes to furnish, the Engineer shall have the right to choose any of the makes mentioned without change in price.
- E. The Contractor shall review the contract documents and if a material substitution form is required for each proposed substitution, it shall be submitted per requirements.

6. SUPERVISION OF WORK

A. Each Contractor and Sub-Contractors shall personally supervise the work or have a competent superintendent on the project site at all times during progress of the work, with full authority to act for him in matters related to the project.

7. CODES, RULES, PERMITS, FEES, REGULATIONS, ETC.

- A. The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, and other costs including utility connections or extensions, in connection with his work. As necessary, he shall file all required plans, utility easement requests and drawings, survey information on line locations, load calculations, etc., prepare all documents and obtain all necessary approvals of all utility and governmental departments having jurisdiction; obtain all required certificates of inspection for his work and deliver same to the Engineer before request for acceptance and final payment for the work.
- B. Ignorance of Codes, Rules, regulations, utility company requirements, laws, etc., shall not diminish or absolve Contractor's responsibilities to provide and complete all work in compliance with such.
- C. The Contractor shall include in the work, without extra cost, any labor, materials, services, apparatus or drawings required in order to comply with all applicable laws, ordinances rules and regulations, whether or not shown on drawings and/or specified.
- D. All materials furnished and all work installed shall comply with the current edition of the National Electrical Codes, National Fire Codes of the National Fire Protection Association, the requirements of local utility companies, and with the requirements of all governmental agencies or departments having jurisdiction.
- E. All material and equipment for the electrical systems shall bear the approval label, or shall be listed by the Underwriters' Laboratories, Incorporated. Listings by other testing agencies may be acceptable with written approval by the Engineer.
- F. All electrical work is to be constructed and installed in accordance with plans and specifications which have been approved in their entirety and/or reflect any changes requested by the State Fire Marshal, as applicable or required. Electrical work shall not commence until such plans are in the hands of the Electrical Contractor.
- G. The Contractor shall insure that his work is accomplished in accord with OSHA Standards and any other applicable government requirements.
- H. Where conflict arises between any code and the plans and/or specifications, the code shall apply except in the instance where the plans and specifications exceed the requirements of the code. Any changes required

as a result of these conflicts shall be brought to the attention of the Engineer at least ten working days prior to bid date, otherwise the Contractor shall make the required changes at his own expense. The provisions of the codes constitute minimum standards for wiring methods, materials, equipment and construction and compliance therewith will be required for all electrical work, except where the drawings and specifications require better materials, equipment, and construction than these minimum standards, in which case the drawings and specifications shall be the minimum standards.

8. COST BREAKDOWNS/SCHEDULE OF VALUES

A. Within thirty days after acceptance of the Contract, the Contractor is required to furnish to the Engineer one copy of a detailed cost breakdown on each respective area of work. These cost breakdowns shall be made on forms provided or approved by the Engineer or Architect. Payments will not be made until satisfactory cost breakdowns are submitted. Refer to the end of this section for a sample of expected level and breakout being required.

9. CORRECTION PERIOD

- A. All equipment, apparatus, materials, etc., shall be the best of its respective kind. The Contractor shall replace all materials at his own expense, which fail or are deemed defective as described in the General Conditions. The effective date of completion of the work shall be the date each or any portion of the work is accepted by the Architect or Engineer as being substantially complete.
- B. Items of equipment which have longer guarantees, as called for in these specifications or as otherwise offered by the manufacturer, such as generators, engines, batteries, transformers, etc., shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final acceptance of the work. The Owner reserves the right to use equipment installed by the Contractor prior to date of final acceptance. Such use of equipment shall in no way invalidate the guarantee except that Owner shall be liable for any damage to equipment during this period due to negligence of his operator or other employee.

10. INSPECTION, APPROVALS AND TESTS

- A. Before requesting a final review of the installation from the Architect and/or Engineer, the Contractor shall thoroughly inspect his installation to assure that the work is complete in every detail and that all requirements of the Contract Documents have been fulfilled. Failure to accomplish this may result in charges from the Architect and/or Engineers for unnecessary and undue work on their part.
- B. The Contractor shall provide as part of this contract electrical inspection by a competent Electrical Inspection Agency, licensed to provide such services in the Commonwealth of Kentucky. The name of this agency shall be included in the list of materials of the Form of Proposal by the Contractor. All costs incidental to the provision of electrical inspections shall be borne by the Electrical Contractor.
- C. The Contractor shall advise each Inspection Agency in writing (with an information copy of the correspondence to the Architect and/or Engineer) when he anticipates commencing work. Failure of the Inspection Agency to inspect the work in the stage following and submit the related reports may result in the Contractor's having to expose concealed work not so inspected. Such exposure will be at the expense of the responsible Contractor.
- D. Inspections shall be scheduled for rough as well as finished work. The rough inspections shall be divided into as many inspections as may be necessary to cover all roughing-in without fail. Report of each such

inspection visit shall be submitted to the Architect, Engineer and the Contractor within three days of the inspection.

- E. Approval by an Inspector does not relieve the Contractor from the responsibilities of furnishing equipment having a quality of performance equivalent to the requirements set forth in these plans and specifications. All work under this contract is subject to the review of the Architect and/or Engineer, whose decision is binding.
- F. Before final acceptance, the Contractor shall furnish three copies of the certificates of final approval by the Electrical Inspector (as well as all other inspection certificates) to the Engineer with one copy of each to the appropriate government agencies, as applicable. Final payment for the work shall be contingent upon completion of this requirement.
- G. The Contractor shall test all wiring and connections for cross connects, continuity and grounds before equipment and fixtures are connected, and when indicated or required, demonstrate by continuity/load/voltage test and Megger Test the installation of any circuit or group of circuits. Where such tests indicate the possibility of faulty insulation, locate the point of such fault, replacing same with new and demonstrate by further test the elimination of such defect. The secondary service entrance conductors from the utility (source) transformer to the main service disconnecting means shall be megger tested. The results of this test shall be turned over to the engineer for review and approval. Any conductor failing the test shall be replaced and any costs associated shall be borne by the contractor.

11. COMPUTER-BASED SYSTEM SOFTWARE

A. For all equipment, controls, hardware, computer-based systems, programmable logic controllers, and other materials provided as a part of the work, software that is installed shall be certified in writing to the Engineer and Owner by the manufacturer and/or writer to be free of programming errors that might affect the functionality of the intended use.

12. CHANGES IN ELECTRICAL WORK

REFER TO GENERAL AND SPECIAL CONDITIONS.

13. CLAIMS FOR EXTRA COST

REFER TO GENERAL AND SPECIAL CONDITIONS.

14. SURVEYS, MEASUREMENTS AND GRADES

- A. The Contractor shall lay out his work and be responsible for all necessary lines, levels, elevations and measurements. He must verify the figures shown on the drawings before laying out the work and will be held responsible for any error resulting from his failure to do so.
- B. The Contractor shall base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work.
- C. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the drawings and specifications, he shall notify the Engineer thru normal channels of job communication and shall not proceed with his work until he has received instructions from the Engineer.

15. TEMPORARY USE OF EQUIPMENT

- A. The permanent electrical equipment, when installed, may be used for temporary services, subject to an agreement among the Contractors involved, the Owner, and with the consent of the Engineer. Should the permanent systems be used for this purpose, each Contractor shall pay for all temporary connections required and any replacements required due to damage without cost, leaving the equipment and installation in "as new" condition. The Contractor may be required to bear utility costs, user fees, etc.
- B. Permission to use the permanent equipment does not relieve the Contractors who utilize this equipment from the responsibility for any damages to the building construction and/or equipment which might result because of its use.

16. TEMPORARY SERVICES

A. The Contractor shall arrange for temporary electrical and other services which he may require to accomplish his work. In the absence of other provisions in the contract, the Contractor shall provide for his own temporary services of all types, including the cost of connections, utility company fees, construction, removal, etc., in his bid.

17. RECORD DRAWINGS

A. The Contractor shall insure that any deviations from the design are being recorded daily or as necessary on record drawings being maintained by the Contractor. Dimensions from fixed, visible permanent lines or landmarks shown in vertical and horizontal ways shall be utilized. Compliance shall be a requirement for final payment. Pay particular attention to the location of underfloor or underground exterior incontract or utility-owned or leased service lines, main switches and other appurtenances important to the maintenance and safety of the Electrical System. Keep information in a set of drawings set aside at the job site especially for this purpose. Deliver these record drawings electronically to the Engineer in AutoCad 2000 format (or more recent version) along with the hand marked field set. Electronic bid drawings will be furnished to the Contractor for his use at the completion of the work.

18. MATERIALS AND WORKMANSHIP

- A. All electrical equipment, materials and articles incorporated in the work shall be new and of comparable quality to that specified. All workmanship shall be first-class and shall be performed by electricians skilled and regularly employed in their respective trades. The Contractor shall determine that the equipment he proposes to furnish can be brought into the building(s) and installed within the space available. All equipment shall be installed so that all parts are readily accessible for inspection, maintenance, replacement, etc. Extra compensation will not be allowed for relocation of equipment for accessibility or for dismantling equipment to obtain entrance into the building(s).
- B. All conduit and/or conductors shall be concealed in or below walls, floors or above ceilings unless otherwise noted. All fixtures, devices and wiring required shall be installed to make up complete systems as indicated on the drawings and specified herein.
- C. All materials, where applicable, shall bear Underwriters' Laboratories label or that of another Engineerapproved testing agency, where such a standard has been established.
- D. Each length of conduit, wireway, duct, conductor, cable, fitting, fixture and device used in the electrical systems shall be stamped or indelibly marked with the makers mark or name.

- E. All electrical equipment shall bear the manufacturer's name and address and shall indicate its electrical capacity and characteristics.
- F. All electrical materials, equipment and appliances shall conform to the latest standards of the National Electric Manufacturers Association (NEMA) and the National Board of Fire Underwriters (NBFU) and shall be approved by the Owner's insuring agency if so required.

19. QUALIFICATIONS OF WORKMEN

- A. All electrical work shall be accomplished by qualified workmen competent in the area of work for which they are responsible. Untrained and incompetent workmen as evidenced by their workmanship shall be relieved of their responsibilities in those areas. The Engineer shall reserve the right to determine the quality of workmanship of any workman and unqualified or incompetent workmen shall refrain from work in areas not satisfactory to him. Requests for relief of a workman shall be made through the normal channels of responsibility established by the Architect or the contract document provisions.
- B. All electrical work shall be accomplished by Journeymen electricians under the direct supervision of a licensed Electrician. All applicable codes, utility company regulations, laws and permitting authority of the locality shall be fully complied with by the Contractor.
- C. Special electrical systems, such as Fire Detection and Alarm Systems, Intercom or Sound Reinforcement Systems, Telecommunications or Data Systems, Lightning Protection Systems, Video Systems, Special Electronic Systems, Control Systems, etc., shall be installed by workmen normally engaged or employed in these respective trades. As an exception to this, where small amounts of such work are required and are, in the opinion of the Engineer, within the competency of workmen directly employed by the Contractor involved, they may be provided by this Contractor.

20. CONDUCT OF WORKMEN

A. The Contractor shall be responsible for the conduct of all workmen under his supervision. Misconduct on the part of any workmen to the extent of creating a safety hazard, or endangering the lives and property of others, shall result in the prompt relief of that workman. The consumption or influence of alcoholic beverages, narcotics or illegally used controlled substances on the jobsite is strictly forbidden.

21. COOPERATION AND COORDINATION BETWEEN TRADES

- A. The Contractor is expressly directed to read the General Conditions and all detailed sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural, Mechanical, Structural and other pertinent Drawings, to the end that complete coordination between trades will be affected.
- B. Refer to Coordination Among Trades, Systems Interfacing and Connection of Equipment Furnished by Others section of these Specifications for further coordination requirements.

22. PROTECTION OF EQUIPMENT

A. The Contractor shall be entirely responsible for all material and equipment furnished by him in connection with his work and special care shall be taken to properly protect all parts thereof from damage during the construction period. Such protection shall be by a means acceptable to the Engineer. All rough-in conduit shall be properly plugged or capped during construction in a manner approved by the Engineer. Equipment damaged while stored on site either before or after installation shall be repaired or replaced (as determined by the Engineer) by the responsible Contractor.

23. CONCRETE WORK

- A. The Contractor shall be responsible for the provision of all concrete work required for the installation of any of his systems or equipment. If this work is provided by another trade, it will not relieve the Electrical Contractor of his responsibilities relative to dimensions, quality of workmanship, locations, etc. In the absence of other concrete specifications, all concrete related to Electrical work shall be 3000 PSI minimum compression strength at 28 days curing and shall conform to the standards of the American Concrete Institute Publication ACI-318. Heavy equipment shall not be set on pads for at least seven days after pour.
- B. All concrete pads shall be complete with all pipe sleeves, embeds, anchor bolts, reinforcing steel, concrete, etc., as required. Pads larger than 18" in width shall be reinforced with minimum #4 round bars on 6" centers both ways. All reinforcing steel shall be per ASTM requirements, tied properly, lapped 18 bar diameters and supported appropriately up off form, slab or underlayment. Bars shall be approximately 3" above the bottom of the pad with a minimum 2" cover. All parts of pads and foundations shall be properly rodded or vibrated. If exposed parts of the pads and foundations are rough or show honeycomb after removing forms properly adhered repairs shall be made. If structural integrity is violated, the concrete shall be replaced. All surfaces shall be rubbed to a smooth finish.

<u>Special Note</u>: All pads and concrete lighting standard bases shall be crowned slightly so as to avoid water ponding beneath equipment.

- C. In general, concrete pads for small equipment shall extend 6" beyond the equipment's base dimensions. For large equipment with service access panels, extend pads 18" beyond base or overall dimensions to allow walking and servicing space at locations requiring service access.
- D. Exterior concrete pads shall be 4" minimum above grade and 4" below grade on a tamped 4" dense grade rock base unless otherwise noted or required by utility company. Surfaces of all foundations and bases shall have a smooth finish with three-quarter inch radius or chamfer on exposed edges, trowelled or rubbed smooth. All exterior pads shall be crowned approximately 1/8" per foot, sloping from center for drainage.

24. RESTORATION OF NEW OR EXISTING SHRUBS, PAVING, ETC.

A. The Contractor shall restore to their original condition all paving, curbing surfaces, drainage ditches, structures, fences, shrubs, existing or new building surfaces and appurtenances, and any other items damaged or removed by his operations. Replacement and repairs shall be in accordance with good construction practice and shall match materials employed in the original construction of the item to be replaced. All repairs shall be to the satisfaction of the Engineer, and in accord with the Architect's standards for such work, as applicable.

25. MAINTENANCE OF EXISTING UTILITIES AND LINES

A. The locations of all piping, conduits, cables, utilities and manholes existing, or otherwise, that come within the contract construction site, shall be subject to continuous uninterrupted maintenance with no exception unless the Owner of the utilities grants permission to interrupt same temporarily, if need be. Provide one week's written notice to Engineer, Architect and Owner prior to interrupting any utility service or line. Also see Article 1. - General, this section.

- B. Known utilities and lines as available to the Engineer are shown on the drawings. However, it is additionally required that, prior to any excavation being performed, each Contractor ascertain that no utilities or lines, known or unknown, are endangered by the excavation.
- C. If the above mentioned utilities or lines occur in the earth within the construction site, the Contractor shall first probe and make every effort to locate the lines prior to excavating in the respective area. Electromagnetic utility locators and acoustic pipe locators shall be utilized to determine where metallic and non-metallic piping is buried prior to any excavation.
- D. Cutting into existing utilities and services shall be done in coordination with and as designated by the Owner of the utility. The Contractor shall work continuously to restore service(s) upon deliberate or accidental interruption, providing premium time and materials as needed without extra claim to the Owner.
- E. The Contractor shall repair to the satisfaction of the Engineer any surface or subsurface improvements damaged during the course of the work, unless such improvement is shown to be abandoned or removed.
- F. Machine excavation shall not be permitted within ten feet of existing gas or fuel lines. Hand excavate only in these areas, in accord with utility company, agency or other applicable laws, standards or regulations.
- G. Protect all new or existing lines from damage by traffic, etc. during construction.
- H. Protect existing trees, indicated to remain with fencing or other approved method. Hold all new subsurface lines outside the drip line of trees, offsetting as necessary to protect root structures. Refer to planting or landscaping plans, or in their absence, consult with the Architect.

26. SMOKE AND FIRE PROOFING

A. The Contractor shall not penetrate rated fire walls, ceilings or floors with conduit, cable, bus duct, wireway or other raceway system unless all penetrations are protected in a code compliant manner which maintains the rating of the assembly. Smoke and fire stop all openings made in walls, chases, ceiling and floors. Patch all openings around conduit, wireway, bus duct, etc., with appropriate type material to smoke stop walls and provide needed fire rating at fire walls, ceilings and floors. Smoke and fire proofing materials and method of application shall be approved by the local authority having jurisdiction.

27. QUIET OPERATION, SUPPORTS, VIBRATION AND OSCILLATION

- A. All work shall operate under all conditions of load without any objectionable sound or vibration, the performance of which shall be determined by the Engineer. Noise from moving machinery or vibration noticeable outside of room in which it is installed, or annoyingly noticeable noise or vibration inside such room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer shall be corrected in an approved manner by the Contractor (or Contractors responsible) at his expense.
- B. All equipment subject to vibration and/or oscillation shall be mounted on vibration supports suitable for the purpose of minimizing noise and vibration transmission, and shall be isolated from external connections such as piping, ducts, etc., by means of flexible connectors, vibration absorbers or other approved means. Surface mounted equipment such as panels, switches, etc., shall be affixed tightly to their mounting surface.

C. The Contractor shall provide supports for all equipment furnished by him using an approved vibration isolating type as needed. Supports shall be liberally sized and adequate to carry the load of the equipment and the loads of attached equipment, piping, etc. All equipment shall be securely fastened to the structure either directly or indirectly through supporting members by means of bolts or equally effective means. No work shall depend on the supports or work of unrelated trades unless specifically authorized in writing by the Architect or Engineer.

28. FINAL CONNECTIONS TO EQUIPMENT

A. The roughing-in and final connections to all electrically operated equipment furnished under this and all other sections of the contract documents or by others, shall be included in the Contract and shall consist of furnishing all labor and materials for connection. The Contractor shall carefully coordinate with equipment suppliers, manufacturers representatives, the vendor or other trades to provide complete electrical and dimensional interface to all such equipment (kitchen, hoods, mechanical equipment, panels, refrigeration equipment, etc.).

29. WELDING

A. The Contractor shall be responsible for quality of welding done by his organization and shall repair or replace any work not done in accordance with the Architect's or structural Engineer's specifications for such work. If required by the Engineer, the responsible Contractor shall cut at least three welds during the job for X-raying and testing. These welds are to be selected at random and shall be tested as a part of the responsible Contractor's work. Certification of these tests and X-rays shall be submitted, in triplicate, to the Engineer. In case a faulty weld is discovered, the Contractor shall be required to furnish additional tests and corrective measures until satisfactory results are obtained.

30. ACCESSIBILITY

- A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in partitions and above suspended ceilings for the proper installation of his work. He shall cooperate with the General Contractor (or Construction Manager) and all other Contractors whose work is in the same space, and shall advise each Contractor of his requirements. Such spaces and clearances shall be kept to the minimum size required to ensure adequate clearance and access.
- B. The Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include but not be limited to junction boxes, pull boxes, contactors, panels, disconnects, controllers, switchgear, etc. Minor deviations from drawings may be made to allow for better accessibility, and any change shall be approved where the equipment is concealed.
- C. Each Contractor shall provide (or arrange for the provision by other trades) the access panels for each concealed junction box, pull box, fixtures or electrical device requiring access or service as shown on Engineer's plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work. All access panels shall be installed in accord with the Architect's standards for such work.
- D. Access Doors; in Ceilings or Walls:
 - (1) In mechanical, electrical, or service spaces:

14 gauge aluminum brushed satin finish, 1" border.

(2) In finished areas:

14 gauge primed steel with 1" border to accept the architectural finishes specified for the space. Confirm these provisions with the Architect prior to obtaining materials or installing any such work.

(3) In fire or smoke rated partitions, access doors shall be provided that equal or exceed the required rating of the construction they are mounted in.

31. ELECTRICAL CONNECTIONS

- A. The Contractor shall furnish and install all power wiring complete from power source to motor or equipment junction box, including power wiring through starters. The Contractor shall install all starters not factory mounted on equipment. Unless otherwise noted, the supplier of equipment shall furnish starters with the equipment. Also refer to Divisions 11, 14, 20, 21, 22, 23 and 25 of the Specifications, shop drawings and equipment schedules for additional information.
- B. All control, interlock, sensor, thermocouple and other wiring required for equipment operation shall be provided by the Contractor. All such installations shall be fully compliant with all requirements of Division 26 and 27 regardless of which trade actually installs such wiring. Motors and equipment shall be provided for current and voltage characteristics as indicated or required. All wiring shall be enclosed in raceways unless otherwise noted.
- C. Each Contractor or sub-contractor, prior to bidding the work, shall coordinate power, control, sensor, interlock and all other wiring requirements for equipment or motors with all other contractors or sub-contractors, to ensure all needed wiring is provided in the Contract. Failure to make such coordination shall not be justification for claims of extra cost or a time extension to the Contract.

32. MOTORS

- A. Each motor shall be provided by the equipment supplier, installer or manufacturer with conduit terminal box and N.E.C. required disconnecting means as indicated or required. Three-phase motors shall be provided with external thermal overload protection in their starter units. Single-phase motors shall be provided with thermal overload protection, integral to their windings or external, in control unit. All motors shall be installed with NEMA-rated starters as specified and shall be connected per the National Electrical Code.
- B. The capacity of each motor shall be sufficient to operate associated driven devices under all conditions of operation and load and without overload, and at least of the horsepower indicated or specified. Each motor shall be selected for quiet operation, maximum efficiency and lowest starting KVA per horsepower as applicable. Motors producing excessive noise or vibration shall be replaced by the responsible contractor. See Division 20, 22 and 23 of the Specifications for further requirements and scheduled sizes.
- C. All three-phase motors shall be tested for proper rotation. Correct wiring if needed and retest. Document testing and corrective action in operations and maintenance manual.

33. CUTTING AND PATCHING

A. Unless otherwise indicated or specified, the Contractor shall provide cutting and patching necessary to install the work specified in this Division. Patching shall match adjacent surfaces to the satisfaction of the Engineer and shall be in accord with the Architect's standards for such work, as applicable.

- B. No structural members shall be cut without the approval of the Structural Engineer and all such cutting shall be done in a manner directed by him.
- C. When installing conduit, pipe, or any other work in insulated concrete form (ICF) walls, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the mechanical and electrical work is complete. Furthermore all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

34. ANCHORS

A. Each Contractor shall provide and locate all inserts required for his work before the floors and walls are built, or shall be responsible for the cost of cutting and patching required where inserts were not installed, or where incorrectly located. Each Contractor shall do all drilling required for the installation of his hangers. Drilling of anchor holes may be prohibited in post-tensioned concrete construction, in which case the Contractor shall request approved methods from the Architect and shall carefully coordinate setting of inserts, etc., with the Structural Engineer and/or Architect.

35. WEATHERPROOFING

- A. Where any work pierces waterproofing, including waterproof concrete, the method of installation shall be as approved by the Architect and/or Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings absolutely watertight.
- B. Wherever work penetrates roofing, it shall be done in a manner that will not diminish or void the roofing guarantee or warranty in any way. Coordinate all such work with the roofing installer.

36. OPERATING INSTRUCTIONS

- A. Upon completion of all work and all tests, each Contractor shall furnish the necessary skilled labor and helpers for operating his systems and equipment for a period of three days of eight hours each, or as otherwise specified. During this period, instruct the Owner or his representative fully in the operations, adjustment, and maintenance of all equipment furnished. Give at least one week's written notice to the Owner, Architect and Engineer in advance of this period. The Engineer may attend any such training sessions or operational demonstrations. The Contractor shall certify in writing to the Engineer that such demonstrations have taken place, noting the date, time and names of the Owner's representative that were present.
- B. Each Contractor shall furnish three complete bound sets for approval to the Engineer of typewritten and/or blueprinted instructions for operating and maintaining all systems and equipment included in this contract. All instructions shall be submitted in draft, for approval, prior to final issue. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instructions.
- C. Each Contractor, in the above mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this contract and a detailed, easy to read parts list and the name and address of the nearest source of supply.
- D. Formatting & content shall follow the guidelines outlined in the latest version of ASHRAE Applications Handbook, Guideline 4. As a minimum, the following shall be included:
 - The operation and maintenance document directory should provide easy access and be well organized and clearly identified.

- Emergency information should be immediately available during emergencies and should include emergency and staff and/or agency notification procedures.
- The operating manual should contain the following information:
 - I. General Information
 - a. Building function
 - b. Building description
 - c. Operating standards and logs
 - II. Technical Information
 - a. System description
 - b. Operating routines and procedures
 - c. Seasonal start-up and shutdown
 - d. Special procedures
 - e. Basic troubleshooting
- The maintenance manual should contain the following information:
 - I. Equipment data sheets
 - a. Operating and nameplate data
 - b. Warranty
 - II. Maintenance program information
 - a. Manufacturer's installation, operation, and maintenance instructions
 - b. Spare parts information
 - c. Preventive maintenance actions
 - d. Schedule of actions
 - e. Action description
 - f. History
- Test reports document observed performance during start-up and commissioning.

37. SCAFFOLDING, RIGGING AND HOISTING

A. The Contractor shall furnish all 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.

38. CLEANING

- A. The Contractor shall, at all times, keep the area of his work presentable to the public and clean of rubbish caused by his operations; and at the completion of the work, shall remove all rubbish, all of his tools, equipment, temporary work and surplus materials, from and about the premises, and shall leave the work clean and ready for use. If the Contractor does not attend to such cleaning immediately upon request, the Engineer may cause cleaning to be done by others and charge the cost of same to the responsible Contractor. Each Contractor shall be responsible for all damage from fire which originates in, or is propagated by, accumulations of his rubbish or debris.
- B. After completion of all work and before final acceptance of the work, each Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of materials, equipment and all associated fabrication. Pay particular attention to finished area surfaces such as lighting fixture lenses, lamps, reflectors, panels, etc.

39. PAINTING

A. Each fixture device, panel, junction box, etc., that is located in a finished area shall be provided with finish of color and type as selected or approved by the Architect or Engineer. If custom color is required, it shall be provided at no additional cost to the Owner. All other equipment, fixtures or devices located in finished or unfinished areas, that are not required to have or are provided with finish color or coating shall be provided in a prime painted condition, ready to receive finish paint or coating. All galvanized metal in finished areas shall be properly prepared with special processes to receive finish paint as directed and approved by the Architect.

40. INDEMNIFICATION

A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

41. HAZARDOUS MATERIALS

- A. The Contractor is hereby advised that it is possible that asbestos and/or other hazardous materials are or were present in this building(s). Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of his work, insure that his workers are aware of this potential and what they are to do in the event of suspicion. He shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.
- B. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.
- C. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise him immediately.
- D. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

42. ABOVE-CEILING AND FINAL PUNCH LISTS

- A. The Contractor shall review each area and prepare a punch list for each of the subcontractors, as applicable, for at least two stages of the project:
 - (1) For review of above-ceiling work that will be concealed by tile or other materials well before substantial completion.

- (2) For review of all other work as the project nears substantial completion.
- B. When <u>all</u> work from the Contractor's punch list is complete at each of these stages and <u>prior</u> to completing ceiling installations (or at the final punch list stage), the Contractor shall request that the Engineer develop a punch list. This request is to be made in writing seven days prior to the proposed date. After all corrections have been made from the Engineer's punch list, the Contractor shall review and initial off on <u>each</u> item. This signed-off punch list shall be submitted to the Engineer. The Engineer shall return to the site <u>once</u> to review each punch list and all work <u>prior to</u> the ceilings being installed and at the final punch list review.
- C. If additional visits are required by the Engineer to review work not completed by this review, the Engineer shall be reimbursed directly by the Contractor by check or money order (due net 10 days from date of each additional visit) at a rate of \$140.00 per hour for extra trips required to complete either of the above-ceiling or final punch lists.



Phone: 859 253-0892 - Fax: 859 231-8357

The following is CMTA's guide for required electrical information relative to the Schedule of Values. Please utilize all items that pertain to this project and add any specialized system as required. A thorough and detailed schedule of values will allow for fair and equitable Pay Application approval and minimize any discrepancies as to the status of the job.

Electrical

Description of Work	Scheduled Value	Labor	Material
Shop Drawings			
Mobilization/Permits			
Temporary Utilities			
Demolition			
Site Utilities			
Switchgear			
Branch Panels			
Feeder Conduit			
Branch Conduit			
Feeder Wire			
Branch Wiring			
Emergency Generator			
Fire Alarm Conduit & Wiring			
Fire Alarm Devices			
Cabletray & Accessories			
Light Fixture Interior			
Light Fixture Exterior			
Lighting Control System			
Wiring Devices			
---	--	--	
Surge Suppression			
Chemical Grounding System			
Intercom/Paging Conduit			
Intercom/Paging Wiring			
Intercom/Paging Devices			
CCTV System Conduit			
CCTV System Wiring			
CCTV System Devices			
Intrusion Detection Conduit			
Intrusion Detection Wiring			
Intrusion Detection Controller & Devices			
Voice/Data System Conduit			
Voice/Data System Wiring			
Voice/Data System Devices &			
Audio/Video System Conduit			
Audio/Video System Wiring			
Audio/Video System Devices &			
Electrical Inspection			
Owner Training			
Record Drawings			
O & M Manuals			
Punch List / Closeout			

SECTION 260502 - SCOPE OF THE ELECTRICAL WORK

1. GENERAL

Each Electrical Contractor's attention is directed to Section 260501 - General Provisions, Electrical, and all other Contract Documents as they apply to his work.

2. SCOPE OF THE ELECTRICAL WORK

The Electrical work for this project includes all labor, materials, equipment, fixtures, excavation, backfill and related items required to completely install, test, verify place in service and deliver to the Owner complete electrical systems in accordance with the accompanying plans and all provisions of these specifications. This work shall primarily include, but is not limited to the following:

- A. All conduits, conductors, outlet boxes, fittings, etc.
- B. All switchgear, panels, disconnect switches, fuses, transformers, contactors, starters, etc.
- C. Fault Current Coordination Study.
- D. All wiring devices and device plates.
- E. All light fixtures and lamps.
- F. Emergency generator.
- G. Electrical connection to all electrically operated equipment furnished and/or installed by others, including powered casework, kitchen equipment, etc.
- H. Digital video surveillance system.
- I. Security intrusion detection system.
- J. Lightning protection system.
- K. Voice/Data wiring system.
- L. CATV wiring and distribution system.
- M. Paging/Intercom distribution system.
- N. Master clock distribution system.
- O. Gym/Cafeteria/Auditorium Sound reinforcement system.
- P. Fire alarm system.
- Q. Wireless sound enhancement system.
- R. Nurse call system.
- S. Physiological monitoring system.

- T. Theatrical lighting/dimming system.
- U. All necessary coordination with electric utility company, telephone company, cable television company, etc. to ensure that work, connections, etc., that they are to provide is accomplished and that service to this facility is delivered complete prior to occupancy.
- V. Paying all necessary fees and cost for permits, inspections, work by utility companies (power, telephone, CATV, etc). The Contractor shall contact the utility companies prior to submitting a bid to determine exactly these charges will be.
- W. Prior to submitting a bid, the Contractor shall contact all serving utility companies to determine exactly what each utility company will provide and exactly what is required of the Contractor and the Contractor shall include all such requirements in his base bid.

SECTION 260503 - SHOP DRAWINGS, LITERATURE, MANUALS, PARTS LISTS, AND SPECIAL TOOLS

1. SHOP DRAWINGS

- A. Each Contractor shall submit to the Architect and/or Engineer, within thirty days after the date of the Contract, seven sets of shop drawings and/or manufacturer's descriptive literature on all equipment required for the fulfillment of his contract. Each shop drawing and/or manufacturer's descriptive literature shall have proper notation indicated on it and shall be clearly referenced so the specifications, schedules, light fixture numbers, panel names and numbers, etc., so that the Architect and/or Engineer may readily determine the particular item the Contractor proposes to furnish. All data and information scheduled, noted or specified by hand shall be noted in color red on the submittals. The Contractor shall make any corrections or changes required and shall resubmit for final review as requested. Review of such drawings, descriptive literature and/or schedules shall not relieve the Contractor from responsibility for deviation from drawings or specifications unless they have, in writing, directed the reviewer's attention to such deviations at the time of submission of drawings, literature and manuals; nor shall it relieve them from responsibility for errors or omissions of any nature in shop drawings, literature and manuals; nor shall it relieve them from responsibility for errors or omissions of any nature in shop drawings, literature and manuals.
- B. If the Contractor fails to comply with the requirements set forth above, the Architect and/or Engineer shall have the option of selecting any or all items listed in the specifications or on the drawings, and the Contractor will be required to provide all materials in accordance with this list.
- C. Review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the installing Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.
- D. The Engineer's review of shop drawings, schedules or other required submittal data shall not relieve the Contractor from responsibility for the adaptability of the equipment or materials to the project, compliance with applicable codes, rules, regulations, information that pertains to fabrication and installation, dimensions and quantities, electrical characteristics, and coordination of the work with all other trades involved in this project.
- E. No cutting, fitting, rough-in, connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractors concerned. It shall be each Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. Each Contractor shall coordinate with all the other Contractors having any connections, roughing-in, etc., to the equipment, to make certain proper fit, space coordination, voltage and phase relationships are accomplished.
- F. In accord with the provisions specified hereinbefore, shop drawings, descriptive literature and schedules shall be submitted on each of the following indicated items as well as any equipment or systems deemed necessary by the Engineer:

Power Equipment

- Fault current coordination study (submit along with switchgear & panelboards).
- Switchgear and panelboards.
- Circuit breakers or fusible switches, per each type.
- Dry-type transformers.

- Liquid-filled pad-mount transformers and their accessories.
- Power and lighting contactors.
- Disconnect switches.
- Fuses, per each type required.
- Magnetic starters, if not submitted with unit equipment by supplier.
- Control components (relays, timers, selector switches, pilots, etc.)
- Primary cable (over 600 volts) and each style of termination fitting for primary cable.
- Building service grounding electrode components.
- Metering devices.
- Bus duct and each type of fitting for bus duct.
- Emergency generator, engine fuel system and transfer switch, with all required generator system accessories, such as battery charger, batteries, exhaust system and its insulation, fuel pumps, day tanks, etc.
- Lightning protection system.
- Transient voltage surge suppression system.
- Grounding system.

Raceways

- Cable tray and each type of cable tray fitting.
- Wireways and each type of wireway fitting.
- Surface-mounted metal or plastic raceways, with each type of fitting.
- J-hook or Bridle ring assemblies.

Devices

- Each type of wiring device and their coverplates.
- Floor boxes, each by type, with required accessories.
- Data/voice/video wallplates, each by type.
- Any special items not listed above.

Lighting

- Light fixtures, each by type, marked to indicate all required accessories and lamp selection. Also provide original color selection chart to allow Architect and/or Engineer to indicate color selection.
- Lamps, each by type.
- Ballast, each by type.
- Lighting standards or poles.
- Photocells, time clocks or other lighting accessories.
- Lighting control system schematic, functional & programming data, along with building specific floor plan drawings indicating each device, master controller, input device locations and specific interconnect/wiring requirements for each device.

Systems

<u>Note</u>: Each system submittal is to be complete with legible cutsheets for all devices, equipment, special wiring, etc. Include system specific wiring schematics showing each device and its specific interconnect/wiring requirements. For rack mounted equipment, provide a scalable elevation drawing with proposed component locations & specific interconnect wiring requirements for each component/panel. Also provide scale building specific layout drawings that indicate device placement, wiring, etc. Refer to the specific system's specification for additional submittal requirements where required.

- Fire alarm system.
- Closed circuit television security system.
- Intrusion detection system.
- Building paging/intercom audio system.
- Clock/program system.
- Telephone system.
- Video system.
- Data network.
- Sound reinforcement system(s).
- Wireless intercom system.

Miscellaneous

- Control panel assemblies.
- Non-standard junction/pullboxes.
- Manholes, hand holes, and all outdoor electrical equipment and fittings.

2. SPECIAL WRENCHES, TOOLS AND KEYS

A. Each Contractor shall provide, along with the equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed by him. Wrenches shall include necessary keys, handles and operators for valves, switches, breakers, etc. and keys to electrical panels, emergency generators, alarm pull boxes and panels, etc. At least two of any such special wrench, keys, etc. shall be turned over to the Architect prior to completion of the project. Obtain a receipt that this has been accomplished and forward a copy to the Engineer.

3. FIRE ALARM SHOP DRAWINGS

A. The Contractor and equipment supplier shall submit to the Architect and/or Engineer, fire alarm system shop drawings complete with catalog cuts, descriptive literature and complete system wiring diagrams for their review prior to the Contractor's submittal to the Commonwealth's Department of Housing, Buildings and Construction or other governing authority for their review. No work shall be done until drawings are approved by the Kentucky Department of Housing, Buildings and Construction.

4. MAINTENANCE AND OPERATION MANUALS

- A. Prior to substantial completion of the project, the Contractor shall deliver to the Engineers (in addition to the required Shop Drawings) three complete copies of operation and maintenance instructions and parts lists for all equipment provided. Formatting and content shall follow the guidelines outlined in the latest version of ASHRAE Application Handbook, Guideline 4. As a minimum, the following shall be included:
- The operation and maintenance document directory should provide easy access and be well organized and clearly identified.
- Emergency information should be immediately available during emergencies and should include emergency and staff and/or agency notification procedures.
- The operating manual should contain the following information:
 - I. General Information
 - a. Building function
 - b. Building description
 - c. Operating standards and logs

- II. Technical Information
 - a. System description
 - b. Operating routines and procedures
 - c. Seasonal start-up and shutdown
 - d. Special procedures
 - e. Basic troubleshooting
- The maintenance manual should contain the following information:
 - I. Equipment data sheets
 - a. Operating and nameplate data
 - b. Warranty
 - II. Maintenance program information
 - a. Manufacturer's installation, operation, and maintenance instructions
 - b. Spare parts information
 - c. Preventive maintenance actions
 - d. Schedule of actions
 - e. Action description
 - f. History
- Test reports document observed performance during start-up and commissioning.

SECTION 260504 - SLEEVING, CUTTING, PATCHING AND REPAIRING

1. GENERAL

- A. The Contractor shall be responsible for all openings, sleeves, trenches, etc. that he may require in floors, roofs, ceilings, walls, etc. and shall coordinate all such work with the General Contractor and all other trades. <u>He shall determine and coordinate any openings which he is to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction</u>. Improperly located openings shall be reworked at the expense of the responsible Contractor.
- B. The Contractor shall plan his work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for conduit, buss duct, conductors, wireways, etc. to go through; however, when this is not done, this Contractor shall do all cutting and patching required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Architect. Any damage caused to the building by the workmen of the responsible Contractor must be corrected or rectified by him at his own expense.
- C. The Contractor shall cut holes in casework, equipment panels, etc. (if any), as required to pass pipes in and out.
- D. The Contractor shall notify other trades in due time where he will require openings of chases in new concrete or masonry. He shall set all concrete inserts and sleeves for his work. Failing to do this, he shall cut openings for his work and patch same as required at his own expense.
- E. Openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.
- F. Cast iron sleeves shall be installed through all walls where pipe enters the building below grade. Sleeves shall be flush with each face of the wall and shall be sufficiently larger than the entering pipe to permit thorough caulking with lead and oakum between pipe and sleeve for waterproofing.
- G. In all cases, sleeves shall be at least two inches larger than nominal pipe diameter.
- H. Sleeves passing through roof or exterior wall or where there is a possibility of water leakage and damage shall be caulked water tight for horizontal sleeves and flashed and counter-flashed with lead (4 lb.) or copper and soldered to the piping, lapped over sleeve and properly weather sealed. Any roof penetration shall not void or lessen the warranty in any way.
- I. All rectangular or special shaped openings in plaster, stucco or similar materials including gypsum board shall be framed by means of plaster frames, casing beads, wood or metal angle members as required. The intent of this requirements is to provide smooth even termination of wall, floor and ceiling finishes as well as to provide a fastening means for lighting fixtures, panels, etc. Lintels shall be provided where indicated over all openings in bearing walls, etc.
- J. No cutting is to be done at points or in a manner that will weaken the structure and unnecessary cutting must be avoided. If in doubt, contact the Architect.
- K. The Contractor shall be responsible for properly shoring, bracing, supporting, etc. any existing and/or new construction to guard against cracking, settling, collapsing, displacing or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements, shall be promptly and properly made good to the satisfaction of the Architect.

L. All work improperly done or not done at all as required by the Contractor will be performed by others. The cost of this work shall be paid for by the Contractor who is in non-compliance with the Contract.

2. SLEEVES, PLATES AND ESCUTCHEONS

- A. The Contractor shall provide and locate all sleeves required for his work before the floors and surface being penetrated are built, otherwise the Contractor shall core drill for conduits where sleeves were not installed, or where incorrectly located. Core drilling is the only acceptable alternative to sleeves. Do not chisel openings. Where sleeves are placed in exterior walls or in slabs on grade, the space between the conduit and the sleeves shall be made completely and permanently water tight.
- B. Conduits that penetrates fire and/or smoke rated assemblies shall have sleeves installed as required by the manufacturer of the rating seal used.
- C. At all other locations either pipe sleeves or core drilled openings are acceptable.
- D. Where thermal expansion does not occur, the wall may be sealed tight to the conduit.
- E. Sleeves shall be constructed of rigid steel conduit. Sleeves in floors shall extend 6" above finished floor level.
- F. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction.
- G. In all areas where ducts are exposed and ducts pass thru floors, the opening shall be surrounded by a 4 inch high by 3 inch wide concrete curb.
- H. Escutcheon plates shall be provided for all conduit passing thru walls, floors and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the pipe or conduit. Where plates are provided for pipes passing thru sleeves which extend above the floor surface, provide deep recessed plates to conceal the sleeves.
- I. When installing conduit, pipe, or any other work in insulated concrete form (ICF) walls, the responsible subcontractor for the work shall provide spray foam insulation to patch the rigid insulation to maintain full integrity of the insulating value of the wall after the mechanical and electrical work is complete. Furthermore all new work shall NOT be installed in concrete center of wall. All mechanical and electrical installations shall be on the interior side of the concrete.

SECTION 260505 - DEMOLITION, RESTORATION AND SALVAGE

1. GENERAL

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and all other divisions of these specifications apply to work specified in this section.

2. DESCRIPTION OF WORK

- A. This section covers all demolition, restoration and salvage required to perform the electrical work indicated on the drawings, specified and/or as required to complete the project. It is the intent of this section of work to remove all existing electrical equipment, materials, etc. which are not required for the completed building and to restore any and all finished surfaces to their original type and conditions. To accomplish these requirements, the Contractor(s) shall, at his own expense, engage the services of others already performing finish work on this project. All work shall be completed to the satisfaction of the Architect/Engineers whose decisions shall be final. This requirement shall apply to all restoration work whether indicated or specified.
- B. The Contractor shall lawfully dispose of any removed P.C.B.-bearing ballasts (containing polychlorinated biphenyl), and all mercury-vapor bearing lamps, in accordance with all state, local, federal and other applicable laws and regulations.

3. ELECTRICAL

- A. Where electrical fixtures, equipment or other materials are removed and/or relocated, all abandoned conduit and conductors shall be removed in exposed areas. In concealed areas, materials shall be abandoned in place or removed as indicated and patch all openings.
- B. The Contractor shall be responsible for the removal and/or relocation of any electrical equipment, fixtures, devices, appurtenances, etc., which may, in the course of construction, interfere with the installation of any new and/or relocated Architectural, Mechanical, Electrical, Structural or Fire Protection Systems whether indicated or not.

4. REPAIR

A. Unless otherwise indicated, the Contractor shall be responsible for the patching and repairing of all holes, etc. in the ceiling, wall and floors where electrical equipment is removed.

5. SALVAGE

A. It is the intent of this section to deliver to the Owner all components of any electrical system which may be economically reused by him. The Contractor shall make every effort to remove reusable components without damage and deliver them to a location designated by the Owner.

SECTION 260508 - COORDINATION AMONG TRADES, SYSTEMS INTERFACING AND CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

1. COORDINATION

- A. The Contractor is expressly directed to read the General Conditions and all sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural, Plumbing, Fire Protection, Mechanical and Structural drawings, to the end that complete coordination between trades will be affected. Each Contractor shall make known to all other contractors the intended positioning of materials, raceways, supports, equipment and the intended order of his work. Coordinate all work with other trades and proceed with the installation in a manner that will not create delays for other trades or affect the Owner's operations.
- B. Special attention to coordination shall be given to points where raceways, fixtures, etc., must cross other ducts or conduit, where lighting fixtures must be recessed in ceilings, and where fixtures, conduit and devices must recess into walls, soffits, columns, etc. It shall be the responsibility of each Contractor to leave the necessary room for other trades. No extra compensation or time will be allowed to cover the cost of removing fixtures, devices, conduit, ducts, etc. or equipment found encroaching on space required by others.
- C. The Contractor shall be responsible for coordination with all trades to insure that they have made provision for connections, operational switches, disconnect switches, fused disconnects, etc., for electrically operated equipment provided under this or any other division of the specifications, or as called for on the drawings. Any connection, circuiting, disconnects, fuses, etc., that are required for equipment operation shall be provided as a part of this contract.
- D. If any discrepancies occur between accompanying drawings and these specifications and drawings and specifications covering other trade's work, each trade shall report such discrepancies to the Architect far enough in advance so that a workable solution can be presented. No extra payment will be allowed for relocation of fixtures, devices, conduit, and equipment not installed or connected in accordance with the above instructions.
- E. In all areas where air diffusers, devices, lighting fixtures and other ceiling-mounted devices are to be installed, the Mechanical Trade(s) and the Electrical Trade and the General Trades shall coordinate their respective construction and installations so as to provide a combined symmetrical arrangement that is acceptable to the Architect and Engineer. Where applicable, refer to reflected ceiling plans. Request layouts from the Architect or Engineer where in doubt about the potential acceptability of an installation.

2. INTERFACING

Each Electrical Trade, Specialty Controls Trade, Mechanical Trade and the General Trades, etc., shall insure that coordination is affected relative to interfacing of all systems. Some typical interface points are (but not necessarily all):

- A. Connection of Telecommunications (voice, video, data) lines to Owner's existing or new services.
- B. Connection of Power lines to Owner's existing or new services.
- C. Connection of fuel oil and exhaust piping to emergency generator and furnishing of fuel for testing unit. Provide a full tank at final acceptance.
- D. Connection of all controls to equipment.

- E. Electrical power connections to electrically operated (or controlled) equipment.
- F. Electrical provisions for all equipment provided by other trades or suppliers within this contract.

3. CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

- A. Each Contractor shall make all connections to equipment furnished by others, whenever such equipment is shown on any part of the drawings or mentioned in any part of the Specifications, unless otherwise specifically specified hereinafter.
- B. All drawings are complementary, one trade of the other. It is the Contractor's responsibility to examine all drawings and specifications to determine the full scope of his work. The project Engineers have arranged the specifications and drawings in their given order solely as a convenience in organizing the project, and in no way shall they imply the assignment of work to specific trades, contractors, subcontractors or suppliers.
- C. Supervision to assure proper installation, functioning and operation shall be provided by the Contractor furnishing the equipment or apparatus to be connected.
- D. Items indicated on the drawings as rough-in only (RIO) will be connected by the equipment supplier or Owner, as indicated. The Contractor shall be responsible for rough-in provisions only as indicated. These rough-ins shall be in accord with the manufacturer's or supplier's requirements.
- E. For items furnished by others, relocated, or RIO, the Contractor shall obtain from the supplier or shall field determine as appropriate, the exact rough-in locations and connection sizes for the referenced equipment.
- F. The Contractor shall be responsible for coordinating with the General and all other trades, as necessary, to determine any and all final connections that he is to make to equipment furnished by others.

SECTION 260519 - CONDUCTORS, IDENTIFICATION, SPLICING DEVICES & CONNECTORS

1. GENERAL

- A. This section of the Specifications covers all of the electrical power, lighting, and control power (line voltage) conductors, but does not include communications, data or signal system conductors, which are specified separately in these specifications.
- B. All conduits installed without conductors shall have a 200 lb. test nylon string installed for future use, tied off securely at each end.
- C. No more than 40% conduit fill is permitted for <u>any</u> conduit system, including video, intercom, data, power or other signal circuits unless specifically indicated otherwise on the plans.
- D. Lighting circuits: No more than five conductors shall be installed in conduit except for switch legs and travelers in multi-point switching arrangements.
- E. Receptacle circuits: If multiple circuits are pulled in a single homerun, a dedicated neutral shall be provided for each phase conductor. In these cases, a maximum of seven conductors are permitted in a single conduit. Conductors shall be derated per N.E.C.
- F. Intentional or unintentional painting of exposed low voltage or line voltage cabling is prohibited. The contractor shall ensure that exposed cabling is adequately protected from direct painting or overspray whether painting is required within the electrical specifications or required by other disciplines/trades. The contractor shall review the painting requirements for all disciplines and shall provide cabling protection as required. Where exposed cabling is being installed in exposed ceiling or wall spaces that are required to be painted, the contractor shall provide alternate options for cable colors and shall provide submittals for such cabling to engineer for approval.

2. MATERIALS

A. CONDUCTORS

- (1) All conductors shall be 98% conductive annealed copper unless otherwise noted, UL listed and labeled.
- (2) Lighting and receptacle branch circuits shall be not less than No. 12 copper wire or of the sizes shown on the drawings with Type THW, THHN or THWN insulation. All feeder circuits shall be Type THW or THWN of the size as shown on the Contract Drawings. THHN wiring shall only be installed in overhead, dry or damp locations. THWN or THW wiring shall be used for all circuits pulled in underground or other wet locations.
- (3) Conductors No. 10 and smaller sizes of wire shall be solid. Conductors No. 8 and larger sizes shall be stranded.
- (4) Conductors for fire alarm wiring shall be stranded and in full compliance with N.E.C. 760. All fire alarm conductors shall be installed within conduit and enclosed junction boxes.
- (5) All wire on the project shall be new, in good condition, and shall be delivered in standard coils or reels.
- (6) The color of the wire shall be selected to conform with Section 210-5 of the latest edition of the National Electrical Code. Refer also to 260519-4, Color Coding.

- (7) All equipment grounding conductors shall have green color insulation or if larger than #8, shall be taped for two inches, green color at every termination and pullbox access point.
- (8) Conductors used for motor connections and connections to vibrating or oscillating equipment shall be extra flexible.
- (9) Conductors for main ground from neutral bus, equipment grounding bus, building steel, grounding grid and main cold water pipe connection shall be bare copper.
- (10) All conductors shall be identified by color code and by means of labels placed on conductors in all junction boxes and at each terminal point with Brady, Ideal, T & B or approved equivalent labels indicating source, circuit No. or terminal No.
- (11) Branch wiring and feeder conductors that are greater than 100' in length shall be increased at least one size to compensate for voltage drop. All circuits shall be installed and sized for a maximum 2% voltage drop. As calculated using 80% of the supply breaker rating as the load. Adjust conductors and conduit size accordingly for actual field installed conditions.

B. SPLICING DEVICES & CONNECTORS

- (1) Splicing devices for use on No. 14 to No. 10 AWG conductors shall be pressure type such as T & B "STA-KON", Burndy, Reliable or approved equivalent.
- (2) Wire nuts shall be spring pressure type, insulation 600V, 105°C insulation, up to #8 size. Greater than #6 Cu shall be a compression type connection, 600V insulation, cold shrink tubing, taped to restore full insulation value of the wire being spliced.
- (3) Pressure crimp-applied ring type (or fork with upturned ends) terminations shall be employed on motor and equipment terminals where such terminals are provided on motor and equipment leads or on all stranded wire terminations using No. 10 AWG or smaller conductors.
- (4) Splices, where necessary, shall be made with hydraulically-set "Hy-press" or equivalent crimped connectors. All splices shall be insulated to the full value of the wiring insulation using a cold-shrink kit or the equivalent in built-up materials.
- (5) Large connectors (lugs) at terminals shall be mechanical type, hex-head socket or crimp-on style, installed per the manufacturer's recommendations.
- (6) Exterior underground connections made between bare ground wires or to ground rods shall be exothermically welded, "Cadweld" or equivalent.
- (7) The use of split-bolt clamps will be permitted in wireways at service entrance only. Torque to 55 footpounds or as recommended by manufacturer.
- (8) No aluminum conductors shall be used.

3. INSTALLATION

A. The pulling of all wires and cable on this project shall be performed in strict compliance with applicable sections of the National Electrical Code. No conductor entering or leaving a cabinet or box shall be deflected in such a manner as to cause excess pressure on the conductor insulation. Conductors shall only be installed after insulating bushings are in place.

- B. The radius of bending of conductors shall be not less than eighteen times the outside diameter of the conductor insulation or more, if recommended by the manufacturer.
- C. Conductors installed within environmental air plenums shall be per N.E.C. Article 800 and other applicable codes, with FEP-type insulation or an approved equivalent. Also provide plenum-rated tie-wraps where plastic straps or other supports, etc., are installed in plenum areas.
- D. Where indicated, communications conductors that are installed exposed shall not be routed across ceilings or ductwork. They shall be held up against building structure or against permanent support members. They shall be installed in such a manner that they do not interfere with the access to or operation of equipment or removal of ceiling tiles. Tie-wraps shall be installed in such a manner so as to bundle conductors neatly, allowing runouts of single conductors or groups to drop down to equipment served. Install grommeting where dropping out of trays or into panels or service columns. Install sleeves with bushings where penetrating partitions. Firestop sleeves with approved material. Do not penetrate firewalls if so indicated on plans. Refer to the drawings for support requirements and details on routing exposed communications conductors.
- E. Conductors for isolated power systems shall be installed in as short a run of conduit as practicable. No pulling soap shall be used on conductors in isolated power systems.
- F. Where conductors are installed in industrial facilities, they shall be per J.I.C. standards.
- G. Maximum permissible pulling tensions, as recommended by the manufacturer for any given type of cable or wire installed shall not be exceeded. Utilize special remote readout equipment as required to ensure compliance. Use particular caution when installing twisted pair data cable or fiber optic cables -- forces permitted for pulling in are typically very low for these cable types.
- H. All cables and wiring, regardless of voltage, installed in manholes or cable vaults shall be routed in such a manner to provide a minimum of 6 feet of slack cable for future splicing. Install cables along walls by utilizing the longer route from entry to exit. If both routes are symmetrical, provide a loop of cable secured to wall. All cables shall be tied to insulated cable supports on wall-mounted racks, spaced a maximum of three feet apart.
- I. Where multiwire branch circuits are allowed, the phases and neutral shall be wire-tied together in the panelboard and in all pull boxes.

4. COLOR CODING DISTRIBUTION VOLTAGE CONDUCTORS, 600 VOLT OR LESS

- A. Conductors to be color coded as follows:
 - (1) 120/208 Volt Conductors
 Phase A Black
 Phase B Red
 Phase C Blue
 Neutral Solid White or White with tracer stripe to match phase conductor
 - (2) 277/480 Volt Conductors
 Phase A Brown
 Phase B Orange
 Phase C Yellow
 Neutral Solid Gray or White with tracer stripe to match phase conductor

- (3) Isolated Power Conductors (Type XLP or XHHN)
 Phase A Brown with colored stripe other than white, green or grey
 Phase B Device or Neutral- Orange with colored stripe other than white, green or grey
 Phase C Yellow with colored stripe other than white, green or grey
 Neutral on Three-Phase Systems- Solid White or White with tracer stripe to match phase conductor
- Note: Further identify isolated power conductors with 2" wide purple tape at all terminations and junctions.
- (4) Control Wiring Red, or as indicated.
- (5) Conductors within enclosures that may be energized when enclosure disconnect is off yellow, or taped with 1/2" yellow tape every 6" of length, inside enclosure. Provide lamacoid plate warning sign on front of enclosure where this condition occurs.
- (6) D.C. Wiring Positive Light Blue Negative - Dark Blue

5. COMMUNICATIONS CONDUCTORS

- A. Communications conductors shall be of type suitable for the service, installed in accordance with the manufacturer's recommendations for pulling tensions, support, terminations, proximity to high power fields, etc. Types not indicated on this schedule but indicated on plans shall be as noted or required for the service. If in doubt, contact the Engineer for clarification.
- B. Plenum-rated conductors (per N.E.C.) shall be installed where required by codes. If installation is thru an approved raceway system that excludes the wiring from the plenum, non-plenum type may be used.
- C. All communications cables shall be furnished and installed in compliance with U.L. 444, U.L. 13, N.E.C. 800, 725, 760 and all applicable codes and standards, for premises or riser installations.
- D. Riser cables shall be provided in accord with current edition of the N.E. Code.
- E. Schedule of Wiring Types Plenum-Rated

Data Circuits	24 AWG, 4 Pair Certified Category Six augmented U.T.P. Plenum-Rated	Anixter #CMP-00424 FAS-5B Superior Essex TE Connectivity Belden Equivalent Berk-Tek Equivalent
Voice Circuits	24 AWG, 4 Pair Certified Category Six augmented U.T.P. Plenum-Rated	Anixter #CMP-00424 FAS-5B Superior Essex TE Connectivity Belden Equivalent Berk-Tek Equivalent
Voice Circuits	24 AWG, 4 Pair Category Five U.T.P. Plenum-Rated	Anixter #CMP-00422 HAH-3 Superior Essex TE Connectivity Belden Equivalent Berk-Tek Equivalent

Video Drops	RG-6/U Coaxial, 18 AWG Solid Conductor, Plenum-Rated	Belden #89120 Superior Essex TE Connectivity Belden Equivalent Berk-Tek Equivalent
Video Trunks	RG-11/U Coaxial, 14 AWG Solid Conductor, Plenum-Rated	Belden #89292 Superior Essex TE Connectivity Belden Equivalent Berk-Tek Equivalent
T-1 Premises Extension Cable	T-1, 4 Pair 22 AWG, Plenum-Rated Pairs Individually Shielded	Anixter #CMP-00422T1-3 Superior Essex TE Connectivity Belden Equivalent Berk-Tek Equivalent
6-Strand Fiber (or # of Strands as Noted)	Multimode 50/125 Micron, Plenum-Rated	Anixter #370-COROM2-TBD-06 Superior Essex TE Connectivity Siecor Equivalent Berk-Tek Equivalent
Speaker Cable	22 AWG. 1 Pair Shielded	Belden #88761 Superior Essex TE Connectivity W.P.W. Equivalent Anixter Equivalent
Speaker Cable, with Call-In Unshielded Pair	22 AWG. 1 Pair Shielded, 1 Pair 22 AWG. Unshielded	Belden #88723 Superior Essex TE Connectivity W.P.W. Equivalent Anixter Equivalent
100 Pair Telephone Cable	24 AWG. 100 Pairs, Non-Plenum Exchange Cable, Wet Location Rated, Gel-Filled Certified Category Three	Anixter #E-010024DFC Superior Essex TE Connectivity Belden Equivalent A.T.&T. Equivalent

- OR -

F. Schedule of Wiring Types - Non-Plenum Rated

Certified Category Six augmentedSuperior EssexU.T.P.TE ConnectivityBelden Equivalent
--

		Berk-Tek Equivalent
Voice Circuits	24 AWG, 4 Pair Certified Category Six augmented U.T.P.	Anixter #CM-00423PND-6A-06 Superior Essex TE Connectivity Belden Equivalent Berk-Tek Equivalent
Voice Circuits	24 AWG, 4 Pair Category Three U.T.P.	Anixter #CM-00422 BAG-3 Superior Essex Belden Equivalent W.P.W. Equivalent
Video Drops	RG-6/U Coaxial 18 AWG Solid Conductor	Belden #9060 Superior Essex Anixter Equivalent W.P.W. Equivalent
Video Trunks	RG-11/U Coaxial, 14 AWG Solid Conductor	Belden #1523A Superior Essex E Connectivity Anixter Equivalent W.P.W. Equivalent
T-1 Premises Extension Cable	T-1, 4 Pair 22 AWG, Pairs Individually Shielded	Anixter #CM-00422 MIGT-3 Superior Essex TE Connectivity Belden Equivalent Berk-Tek Equivalent
6-Strand Fiber (or # of Strands as Noted)	Multimode 50/125 Micron	Anixter #370-947-SMODE-12 Superior Essex TE Connectivity Siecor Equivalent Berk-Tek Equivalent
12-Strand Fiber (or # of Strands as Noted)	Singlemode 8.3/125 Micron	Superior Essex TE Connectivity Siecor Equivalent Berk-Tek Equivalent
Speaker Cable	22 AWG. 1 Pair Shielded, Plenum-Rated, Stranded	Belden #9414 Superior Essex TE Connectivity Equivalent W.P.W. or Anixter
Speaker Cable with Call-In Pair	22 AWG. 1 Pair Shielded, 1 Pair 22 AWG. Unshielded for Call- In, Plenum-Rated	Belden #8730 Superior Essex TE Connectivity W.P.W. Equivalent Anixter Equivalent
100 Pair Telephone Cable	24 AWG. 100 Pairs, Non-Plenum Exchange Cable, Wet Location Rated, Gel-Filled, Certified	Anixter #E-010024DFC Superior Essex TE Connectivity

Category Three, Installed in Metal	Belden Equivalent
Conduit	A.T.&T. Equivalent

6. HIGH VOLTAGE PRIMARY CABLE

- A. High voltage primary cable shall be rated for aerial, direct burial, open tray, wet location and submersible underground service. Cable shall be I.P.C.E.A. listed and UL listed for the use indicated.
- B. Cable shall be rated 15 K.V., nominal. Insulation shall be XLP, XLPE or approved equivalent with a nominal 133% value.
- C. Cable shall be shielded, grounded, with extruded 8 mil. semiconducting layer bonded to the insulation. Provide with copper drain wires served over semiconducting layer.
- D. Cable shall be installed in accordance with manufacturer's recommendations, with particular attention to termination, handling, bending radii and pull tension recommendations.
- E. The conductor shall be copper with Class "B" stranding per ASTM B-8.
- F. Cable shall be as manufactured by G.E., Anaconda, Phelps-Dodge, Okonite, or approved equivalent.
- G. Cable shall be manufactured per the following standards: UL 1072 and ICEA for medium voltage cable.
- H. (1) Cable shall be terminated at pad-mount transformer or as indicated with pre-manufactured load-break, dead-front elbows and fittings compatible with cable and rated for the purpose. Pre-manufactured elbows and other types of fittings indicated shall be as manufactured by Elastimold Co., Blackburn-ITT, R.T.E. Corporation, S & C Company or other approved equivalent.
 - (2) Cable terminators for 15 K.V., 200 ampere connection shall be ANSI Standard 386-1877 200 amp hotstick operable load break elbow with voltage test point. The elbow shall be furnished with the necessary cable adapter for terminating the copper cable used.
 - (3) Electrical ratings shall be as follows:

Voltage	
Continuous and Load Break Current	
BIL	
Withstand Voltage (AC)	
Short-Time Current	10,000 amps, rms, sym., 17 seconds.

- (4) Cable terminators for 15 K.V., 600 ampere connection shall be ANSI Standard 368-1977 premolded dead break unit for terminating 15 KV shielded cable. The connector shall be fully shielded, of dead front operation and shall be fully submersible. The connector shall be furnished with proper adapters for terminating the copper cable used.
- (5) The connectors shall have the following ratings:

Voltage	
Continuous Current	
BIL	
8 Hour Overload	
Withstand Voltage (AC)	

I. Cable shall be color coded at all terminations and junctions as follows:

Phase A - Black Phase B - Red Phase C - Blue

Follow the above color coding unless otherwise indicated or required by system user.

- J. Cable grounding at all terminations shall be in accord with the manufacturer's recommendations and applicable codes.
- K. A full size (matching phase conductors) copper 600 volt insulated ground is to be provided with each primary circuit.
- L. Installation, termination and testing of primary power cables shall be accomplished by Journeymen Electricians with at least three years experience with such work.
- M. In lieu of using pre-manufactured elbows and other fittings, installer may substitute field-build and taped stress cones or other type of termination, subject to written prior approval of the engineer. In requesting such approval, submit complete data on materials proposed to be used and tools to be used in cutting and stripping cable.
- N. All new primary cable shall be high-potential tested in accord with criteria outlined herein. Where taps, splices or terminations to existing primary cables are indicated on the plans, the Engineer reserves the right to request high-potential testing of the existing cable or systems to determine their suitability and safety, if not so indicated on the plans.
- O. Always field verify exact primary power voltage potentials with the supplying utility and report any discrepancy from that indicated on the plans to the Engineer prior to placing any primary cable in service.

7. TESTING OF PRIMARY CABLE

- A. All new primary cable shall be tested prior to energization in accord with the following criteria, or other approved method.
 - (1) Use equipment made by one of the following (or approved equivalent) and abide by their operation rules for their respective equipment:
 - a. Associated Research, Inc.
 - b. J.G. Biddle Company
 - c. Hipotronics, Inc.
 - d. Von Corporation
 - (2) Clear cable of all equipment, switchgear, etc. for elbows, install insulation plugs. On cable end, insulate by high voltage taping, insulating jar or plastic. All terminations and splices shall be completely and properly grounded. All adjacent equipment shall be grounded, where danger of flashover exists.
 - (3) A sphere gap in parallel with the 100,000 volt D.C. "Hipot" tester shall be calibrated for sparkover at 70 KV D.C.

- (4) The direct current test voltage shall be applied in increments of 5 KV and shall be left at the step for 1 minute. Saturate cable for 15 minutes at test voltage as in (5) below.
- (5) Test: (as appropriate)
 - a. 15 KV cables with open terminations at 55 KV D.C.
 - b. 15 KV cables with elbow termination at 45 KV D.C., or to the limit of the elbow or splice. Verify with manufacturer.

<u>SPECIAL NOTE</u>: It is suggested that tests be performed when relative humidity is 50 to 60% or less in clear, dry weather for greater safety.

- (6) Record the leakage current at each step and at end of saturation time.
- (7) Acceptance: The above procedure with less than 100 microamperes of current registered.
- (8) Proof test on existing cable at 35 KV for 5a and 35 KV for 5b above.
- (9) After test (in order listed):
 - a. Turn tester power off.
 - b. Discharge tester and cable thru a resistive discharge device (8 MEGOHM discharge stick).
 - c. Ground cable thru a grounding means (#12 AWG THW wire to ground).
 - d. Disconnect tester.
- (10) For Safety:
 - a. Wear high voltage gloves at all times.
 - b. Treat cable and tester as high voltage at all times.
 - c. Remember, D.C. static charges can be very harmful.
- (11) All tests must be made in the presence of the Engineer and shall be recorded on a form sheet signed by the person performing the test and dated. Three (3) copies shall be submitted to the Engineer. Provide 48 hour advance written notice to Engineer.

SECTION 260526 - GROUNDING

1. GENERAL

- A. All metallic conduit, raceways, cable trays, wireways, supports, cabinets and equipment shall be grounded in accordance with the latest issue of the National Electrical Code, as shown on the Contract Drawings and in accord with the requirements of the local authority having jurisdiction, as applicable.
- B. The size of the equipment grounding conductors, grounding electrode conductors and service grounding conductors shall be not less than that given in Article No. 250 of the National Electrical Code, and/or as shown on the Contract Drawings. Where ungrounded conductor sizes are increased to minimize voltage drop, grounded conductor sizes shall be increased in the proper proportion.
- C. Grounding bus and non-current carrying metallic parts of all equipment and raceway systems shall be securely grounded by connection to common ground.
- D. The service entrance main ground bus shall also be connected to the main cold metallic water pipe within three feet of where it enters the building, on both the house and street sides of the main shut-off valve with a properly sized bonding jumper. A properly sized bonding jumper shall also be provided to the frame of any steel structure utilized in the construction. The steel frame of the building (if any) shall be made electrically continuous.

2. MATERIALS

- A. Ground wires and cables shall be of the AWG sizes shown on the Contract Drawings or shall be sized in accord with the prevailing codes. All ground wires and cables shall be copper.
- B. All grounding fittings shall be heavy cast bronze or copper of the mechanical type except for underground installations or interconnection of grounding grid to cable, columns and ground electrodes, which shall be thermically welded type as manufactured by Cadweld, Burndy Co., Therm-O-Weld, or approved equivalent. Other bonding clamps or fittings in above ground locations shall be as manufactured by O.A. Co., T & B, Burndy, or approved equivalent.
- C. Ground electrode pipe systems shall be solid copper construction. Ground rods shall be 5/8" minimum diameter, eight feet long, copperweld steel. All ground electrode systems shall be installed in accord with manufacturer's recommendations, U.L. listings, National Electrical and National Electrical Safety Codes.

3. INSTALLATION

- A. All grounding conductors shall be protected from mechanical injury and shall be rigidly supported. Where ground conductors are run through flexible conduit and through panelboard switchboard or motor control center feeders, they shall be securely bonded to such conduit thru the use of grounding bushings at the entrance and exit. All connection of equipment shall be made with an approved type of solderless connection and same shall be bolted or clamped to equipment or conduit.
- B. All equipment grounding conductors to lighting fixtures, devices, receptacles, electric heaters, furnace and other equipment not exceeding No. 8 AWG in size shall be green colored Type "THWN".
- C. Equipment ground connections to GFI circuit breakers shall be carried and bonded to each outlet on the circuit. Provide a separate equipment grounding conductor with green color insulation.

- D. Resistance to the grounding at the service entrance equipment shall be in accordance with the N.E.C. for style of construction and shall not exceed ten ohms as measured by the described testing method.
- E. All circuits shall have a separate grounding conductor, except as otherwise noted.
- F. When grounding systems are completely installed and all grading in the area of the service grounding electrode has been completed up to finish elevations, perform a fall-of potential or other approved test to determine actual system resistance to earth. Report results to the Engineer in writing. Refer to testing provisions in this section of specifications.
- G. Where separately-derived systems are utilized as part of the power distribution network, the neutral leg of the secondary side of generators, transformers, etc., shall be connected to a grounding electrode in accordance with the manufacturer's recommendations.
- H. The Contractor shall ensure that the ground return path thru building structural steel or other means is electrically continuous back to the service grounding electrode and is of adequate capacity and impedance to carry the maximum expected fault or other current. Where no electrically continuous steel building frame is available, the Contractor shall provide a properly sized ground bar and ground conductor routed back to the main facility ground bus.
- I. Where a building's steel frame is made electrically discontinuous by masonry breaks (as at firewalls, etc.), the Contractor shall provide an accessible thermically welded bonding jumper of #500MCM copper to bond the building steel frame sections together, making the entire steel frame electrically continuous. The installation of these bonding jumpers shall be reviewed by the Engineer prior to their being covered by construction.
- J. Where lightning protection systems are utilized on the work, their electrodes and conductors shall be electrically segregated from the building service ground, except where connections to structural elements are required for the proper installation of these systems. Lightning protection grounds shall only be utilized for lightning grounding applications, in accord with U.L. and manufacturer's recommendations.
- K. Grounding connections shall <u>never</u> be made to fire protection, natural gas, flammable gas or liquid fuel piping, except where specifically indicated on the plans.
- L. Where dielectric fittings are utilized in piping systems, the piping system shall <u>not</u> be utilized as a ground path. Bonding jumpers shall not be utilized to bridge over such fittings. Piping systems shall <u>not</u> be utilized as ground paths except where specifically required by codes in the case of water piping.

4. GROUNDING ELECTRODE SYSTEM

- A. The ground electrode system shall be as specified herein. The system shall not require maintenance throughout the expected life span of the materials.
- B. Ground system shall be an electrolytic rod type, as manufactured by Lyncole XIT Grounding, Superior Grounding Systems, L.E.C., Inc. (Chem-Rod), or approved equivalent. Electrode(s) shall be placed as shown on the plans, installed exactly per manufacturer's recommendations. Electrodes shall be installed vertically, 12 feet of overall length (or length as indicated), set in a drilled hole and backfilled per manufacturer's instructions with a special clay slurry surrounding the rod. Provide a concrete protection box with cast iron grate for the top of the rod termination. Ground system shall be per the following:
 - (1) Manufacturer: Lyncole XIT Grounding (or approved equivalent).
 - (2) Source: Lyncole XIT Grounding, 22412 S. Normandie Ave., Torrance, CA 90502 1-800-962-2610

- (3) Shaft Configuration: Straight.
- (4) Shaft Length: 12 feet (or as otherwise indicated).
- (5) Listings: U.L.-467J, ANSI 633.8.
- (6) Material: Type K Copper.
- (7) Construction: Hollow tube, 2.125" O.D., chemical filled with non-hazardous metallic salts.
- (8) Weight 3.5 lbs. per foot of length, nominal.
- (9) Ground Wire Termination: Exothermic ("Cadweld" by Contractor) connection to 4/0 conductor, with U-bolt with pressure plate provided as test point.
- (10) Average Life Expectancy: 25 Years.
- (11) Model Number: K2-(length)CS.
- (12) Provide grounding system with the following components: protective box, backfill material. Box to be concrete with cast iron, tamper-resistant lid, backfill to be "Bentonite" clay.
- C. Installation of Pipe Ground System
 - (1) Pipe ground systems shall be installed exactly as required by the system manufacturer. The Contractor shall be diligent to observe the excavation, sealing tape removal, slurry backfill and all other critical requirements.
 - (2) Note: <u>NEVER</u> USE SAND OR ORDINARY EARTH AS A BACKFILL MATERIAL
- D. Pipe grounding system shall be warranted unconditionally by the Contractor for a period of one year from the date of substantial completion.

5. GROUND TESTING PROCEDURE

- A. The actual resistance to earth of the service grounding electrode shall be measured by the Contractor via the fall-of-potential method. This testing shall be accomplished after the grounding electrode has been completely installed and the finished grade is achieved.
- B. The results of the testing shall be summarized in a written report by the Contractor, which shall be forwarded to the Engineer for review. The report shall also be included with the operation and maintenance manuals for the Owner's information and future reference. This report is to also contain a detailed description and illustrations of the testing procedure, along with the name and model number of the testing instrument(s).
- C. For the actual testing, the Contractor shall follow the procedures outlined below. A self-contained instrument such as a "Megger" or "Ground OHMMETER" shall be used that is designed to eliminate the influence of stray current effects on the accuracy of the measurements.
 - (1) Connect one side of the instrument to the grounding electrode conductor where it connects to the facility main ground bus (point C1). Disconnect and isolate the grounding electrode conductor for the test.
 - (2) Drive a copperweld reference electrode probe (point C2) into earth between 300 and 500 feet away from C1 and connect to measurement instrument.
 - (3) Drive the movable grounding probe (C3) into earth at ten equally spaced intervals, in a straight line between C1 and C2 points and note the E/I=R resistance readings on a graph at each point.
 - (4) The resistance measurements in OHMS taken from the flat part of the curve shall be averaged to determine the true grounding electrode resistance to earth.

- (5) At completion of testing, remove reference electrode C2 and all temporary wiring and connections.
- (6) If actual measurements of grounding electrode indicate a resistance greater than five OHMS, contact the Engineer for instructions. If deemed necessary by the Engineer, additional electrodes shall be placed and the measurement process repeated until the desired ground potential achieved.

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.
- B. Related Sections include the following:
 - 1. Division 26 Section "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of [five] <Insert number> times the applied force.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

- 1. Steel slotted support systems.
- 2. Nonmetallic slotted support systems.
- B. Shop Drawings: [Signed and sealed by a qualified professional engineer.] Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Nonmetallic slotted channel systems. Include Product Data for components.
 - 4. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- 1.7 QUALITY ASSURANCE
 - A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code -Steel."
 - B. Comply with NFPA 70.

1.8 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - h. <Insert manufacturer's name>.

- 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
- 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
- 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
- 6. Channel Dimensions: Selected for applicable load criteria.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. Fabco Plastics Wholesale Limited.
 - d. Seasafe, Inc.
 - e. <Insert manufacturer's name>.
 - 3. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 - 4. Fitting and Accessory Materials: Same as channels and angles[, except metal items may be stainless steel].
 - 5. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: [Steel] [Steel and malleable-iron] hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

- 3) MKT Fastening, LLC.
- 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
- 5) <Insert manufacturer's name>.
- 2. Mechanical-Expansion Anchors: Insert-wedge-type, [zinc-coated] [stainless] steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 - 6) <Insert manufacturer's name>.
- 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
- 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
- 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
- 6. Toggle Bolts: All-steel springhead type.
- 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as [required by] [scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in] NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted [or other]support system, sized so capacity can be increased by at least [25] <Insert number> percent in future without exceeding specified design load limits.

- 1. Secure raceways and cables to these supports with [two-bolt conduit clamps] [single-bolt conduit clamps] [single-bolt conduit clamps using spring friction action for retention in support channel].
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, [EMT] [IMC] [RMC] [EMT, IMC, and RMC] may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 - 6. To Steel: [Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts] [Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69] [Spring-tension clamps].
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate[by means that meet seismic-restraint strength and anchorage requirements].
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use [3000-psi (20.7-MPa)] <Insert value>, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "[Cast-in-Place Concrete] [Miscellaneous Cast-in-Place Concrete]."
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Comply with requirements in Division 09 [painting Sections] [Section "High-Performance Coatings"] for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

SECTION 260531 - CABINETS, OUTLET BOXES AND PULL BOXES

1. GENERAL

- A. This section of the specifications covers all electrical cabinets, outlet boxes and pull boxes.
- B. Continuous runs of conduit shall have properly sized pull boxes at least each eighty-five feet of run, or as near as possible to that limit.

2. MATERIALS & INSTALLATION

- A. Cabinets, Outlet and Pull Boxes:
 - (1) Cabinets for lighting and power, telephone, pull boxes, outlet boxes, or any other purposes specified or shown on the Contract Drawings, shall be constructed of code gauge, galvanized steel with sides formed and corner seams riveted or welded before galvanizing. <u>Boxes assembled with sheet metal</u> <u>screws will not be accepted</u>. Pull boxes shall include all boxes used to reduce the run of conduit to the required number of feet or bends, supports, taps, troughs, and similar applications and shall also be constructed as specified above.
 - (2) All cabinets and boxes for NEMA 1 and 1A application shall be provided with knockouts, as necessary, or shall be cut in the field by approved cutting tools which will provide a clean, symmetrically cut opening. All boxes, except panelboards, shall be provided with code gauge fronts with hex head or pan head screw fasteners. Outdoor cabinets shall be hinged cover with pad locking provisions. Fronts for panelboards shall be as specified for panelboards.
 - (3) Ceiling outlet boxes shall be galvanized steel, 4" octagonal, not less than 2 1/8" deep, with lugs or ears to secure covers. Those for use with ceiling lighting fixtures shall be fitted with 3/8" fixture studs fastened to the back of the boxes, where applicable. Provide adequate support with at least a 2 x safety factor for the anticipated fixture weight.
 - (4) Special size concealed outlet boxes for clocks, speakers, alarms, panels, etc., shall be provided by the manufacturer of the equipment.
 - (5) Floor outlet boxes shall be as specified in Section 262726, fully adjustable unless noted or specified otherwise.
 - (6) Unless otherwise noted on the drawings or in the specifications, outlet boxes shall be installed at the following heights to centerline of box:

Wall Switches, Control Stations	
Convenience Outlets	
Convenience Outlets - Above Counters	Bottom at 2" above top of backsplash
T.V. Outlets	
T.V. Outlets - At Wall Brackets	
Desk Telephones	
Wall-Mounted Telephone	
Weatherproof Outlets	
Disconnects, Branch Panelboards	
Fire Alarm Manual Stations	
Fire Alarm Audio and/or Visual Units80" AFF to bottom of devi	ice or 6" below ceiling, whichever is lower.

- (7) The location of outlets, as shown on the drawings, shall be considered as approximate only. It shall be incumbent upon this Contractor to study the general building drawings, with relation to spaces surrounding each outlet, in order to make his work fit the work of others and in order that when the devices or fixtures are installed, they will be symmetrically located and will not interfere with any other work or equipment. Any change in fixture or layout shall be coordinated with and approved by the Engineer before this change is made. Regardless of the orientation shown on the drawings, all devices shall be easily accessible when installed.
- (8) Boxes installed in fire rated assemblies shall not compromise the rating of the assembly. The Contractor is responsible for identifying assembly ratings and construction requirements prior to rough-in.
 - a. Listed single and double gang metallic outlet and switch boxes with metallic or nonmetallic cover plates may be used in bearing and nonbearing wood stud and steel stud walls with rating not exceeding 2 h. The boxes shall be fastened to the studs with the openings in the wallboard facing cut so that the clearance between the boxes and the wallboard do not exceed 1/8 in. The boxes shall be installed so that the surface area of individual boxes do not exceed 16 sq in, and the aggregate surface area of the boxes do not exceed 100 sq in per 100 sq ft of wall surface unless approved alternate protection materials are used.
 - b. Boxes located on opposite sides of walls or partitions shall be separated by a minimum horizontal distance of 24 in. This minimum separation distance between the boxes may be reduced when listed Wall Opening Protective Materials are installed according to the requirements of their Classification.
 - c. Boxes installed on opposite sides of walls or partitions of staggered stud construction shall have listed Wall Opening Protective Materials installed with the boxes in accordance with Classification requirements for the protective materials.
 - d. All installation shall be done in accordance with AHJ requirements.
- (9) All outlets, pull boxes, junction boxes, cabinets, etc., shall be sized per the current edition of the National Electrical Code.
- B. Cabinets, outlet boxes and junction or pull boxes shall be threaded for rigid-threaded conduit, dust-tight, vapor-tight or weatherproof as required for areas other than for NEMA 1 or 1A application. These shall be as manufactured by Crouse-Hinds, Appleton, Killark, or approved equivalent.
 - (1) NEMA 1 or 1A cabinets, outlet boxes or pull or junction boxes shall be as manufactured by Appleton, Steel City, T & B, or approved equivalent.
 - (2) Outlet boxes for switches, receptacles, telephone, etc., concealed in walls shall be galvanized steel, 2" X 4" X 2" with plaster cover for the number of devices as required. Where outlet boxes are installed in walls of glazed tile, brick, concrete block, or other masonry which will not be covered with plaster or in walls covered by wood wainscot or paneling, deep sectional masonry boxes shall be used and they shall be completely covered with the plates or lighting fixtures. This Contractor shall cooperate with the brick layers, block layers and carpenters to insure that the outlet boxes are installed straight and snugly in the walls. Receptacles shall be set vertically in walls, unless noted otherwise.
 - (3) Outlet boxes mounted in glazed tile, brick, concrete block or other types of masonry walls shall be mounted above or below the mortar joint. <u>Do Not Split The Mortar Joint</u>.
- (4) Boxes for more than two devices shall be for the number of devices required and shall be one piece. No ganging of single switch boxes will be allowed.
- (5) Outlets provided shall have only the holes necessary to accommodate the conduit at the point of installation and shall be rigidly secure in position. Boxes with knockouts removed and openings not used shall be replaced or be provided with a listed knockout closure.
- (6) Openings for conduit entrance in cabinets and boxes shall be prefabricated, punched, drilled and/or reamed. The use of a cutting torch for this purpose is prohibited.

SECTION 260533 - RACEWAYS & FITTINGS

1. GENERAL

- A. This section is intended to specify the raceways, conduit, conduit fittings, hangers, junction boxes, splice boxes, specialties and related items necessary to complete the work as shown on the drawings and specified herein.
- B. This section specifies basic materials and methods and is a part of each Division 26, 27 and 28 that implies or refers to electrical raceways specified therein.
- C. The types of raceways specified in this section include the following:
 - (1) Steel electrical metallic tubing. (E.M.T.)
 - (2) Rigid galvanized steel conduit. (G.R.S.)
 - (3) Intermediate metal conduit (I.M.C.).
 - (4) Rigid aluminum conduit.
 - (5) Flexible metal conduit (aluminum or steel)
 - (6) Liquid tight flexible metal conduit.
 - (7) Rigid nonmetallic conduit.
 - (8) Surface metal raceways.
 - (9) Wireways, wall ducts and trench ducts.
 - (10) Cable tray or cable trough.
 - (11) Duct banks, and their construction.
- D. All raceways, as listed in 1C. above and otherwise specified herein shall be provided in compliance with latest editions of all applicable U.L., NEMA, N.E.C. and A.N.S.I. standards. All conduit, raceways and fittings shall be Underwriters Laboratories listed and labeled, or bear the listing of an agency acceptable to the local authority having jurisdiction.
- E. Conduit and raceways, as well as supporting inserts in contact with or enclosed in concrete shall comply with the latest edition of all A.C.I. standards and the equipment manufacturer's recommendations for such work.
- F. P.V.C. or other non-metallic conduit shall be rated for the maximum operating temperature that could be developed by the conductors it encloses, while in normal operation.
- G. The decision of the Engineer shall be final and binding in any case where a question or inquiry arises regarding the suitability of a particular installation or application of raceways, supports or materials, if other than outlined herein.
- H. Minimum size of conduit shall be 3/4" trade size. All conduit and raceways shall be sized for the number of conductors contained, in accord with the latest edition of the National Electrical Code or any other applicable standards.
- I. The installer of raceway systems shall avoid the use of dissimilar metals within raceway installations that would result in galvanic-action corrosion.

2. MATERIALS

A. STEEL ELECTRICAL METALLIC TUBING

(1) Electrical metallic tubing, (E.M.T.) of corrosion-resistant steel construction shall be permitted for concealed installation in dry interior locations. Electrical metallic tubing shall not be installed in concrete slabs or where exposed to physical damage. Electrical metallic tubing shall be permitted for exposed work in mechanical and electrical rooms and other exposed structure areas where not subjected to physical damage, as determined by the Engineer.

B. RIGID GALVANIZED STEEL CONDUIT

- (1) Rigid galvanized steel conduit shall be used where subject to physical damage for exposed work in mechanical spaces, within factory or other industrial work areas, for exposed fit-up work on machinery, for exposed exterior damp or wet location work, in hazardous atmospheres, in exterior underground locations where installed beneath roadways, where ells occur in underground P.V.C. conduits, or where turning out of concrete encased duct banks, and at other locations as <u>specifically called out</u> on the drawings.
- (2) Rigid galvanized steel conduit shall be used for all building interior power wiring or cables of over 600 Volts.

C. INTERMEDIATE METAL CONDUIT

(1) Unless otherwise indicated on the drawings, intermediate metal conduit (I.M.C.) may be used in any location in place of rigid galvanized steel conduit, as permitted by codes, and as approved by the Engineer.

D. RIGID ALUMINUM CONDUIT

(1) Rigid aluminum conduit, shall be permitted for installation indoors in dry locations only. Under no conditions shall it be cast into concrete slabs or pass thru construction where prolonged contact will degrade the aluminum. All ells used in rigid aluminum conduit systems shall be rigid galvanized steel. Rigid aluminum conduit shall always be used for power wiring greater than 5 KVA and higher than 60 Hz frequency.

E. FLEXIBLE METAL CONDUIT

(1) Flexible conduit shall be used where permitted by NEC. It may be constructed of aluminum or steel. It shall be installed with connectors designed for the purpose. All flexible metal conduit shall be installed as a single piece. No joints shall be installed. Flexible conduit shall not be used in wet or dusty locations or where exposed to oil, water or other damaging environments. An equipment grounding conductor or bonding jumper shall be used at all flexible conduit installations. Maximum permitted length of flexible metal conduit shall be 72", as for light fixture whips unless approved in writing by Engineer.

F. LIQUIDTIGHT FLEXIBLE METAL CONDUIT

(1) Weatherproof flexible metal conduit shall be wound from a single strip of steel, neoprene covered, equivalent to "Liquatite" or "Sealtite" Type "UA". It shall be installed in such a manner that it will not tend to pull away from the connectors. Provide strain relief fittings equivalent to "Kellems" as required where subject to vibration. Flexible connections to motors in dusty areas shall be dust-tight, in areas exposed to the weather - weatherproof.

G. RIGID NON-METALLIC CONDUIT

- (1) Rigid non metallic conduit shall be constructed of P.V.C, nominally schedule 40 weight, except where encased in concrete, where it may be "EB" type. If installation will enclose utility company provided conductors, verify exact type required and install in accord with their standards, if more stringent than this specification.
- (2) Rigid non-metallic conduit may be used in exterior wet or damp locations where installed underslab or underground. It shall not be run in interior locations, except with special permission from the Engineer for use in corrosive environments, and then only if protected from physical damage. No rigid nonmetallic conduit may be installed in environmental air plenums or cast into above-grade concrete slabs. No rigid nonmetallic conduit may be installed in locations where the ambient temperature might exceed the rating of the raceway.
- (3) Where rigid non metallic conduit is placed underground, as for feeder circuits, secondaries or branch circuit runs and where ell is made upward thru a slab on grade, transition the turning ell and the riser to rigid steel conduit to a height of 6" above the concrete slab. Transition may then be made to E.M.T or other approved conduit for remainder of run.
- (4) Flexible nonmetallic conduit shall not be used, except by special permission, obtained in writing from the Engineer.
- (5) Provide equipment grounding conductors of copper, sized as required by codes, in all circuits installed in rigid nonmetallic raceways.

H. SURFACE METAL RACEWAYS

- (1) Surface metal raceways shall be constructed of code gauge corrosion-resistant galvanized steel or aluminum extrusions, and finished in an ivory, buff or grey color as selected by the Architect. Finishes shall be suitable for field painting, prepared by the installing contractor as necessary.
- (2) Surface metal raceways, where used as raceways only, shall be sized for the conductors indicated. Nominal minimum size of such raceways shall be equivalent to Wiremold Co. Series #700, or equivalent by Isotrol or other approved manufacturer.
- (3) Surface metal raceways to be furnished with integral receptacles shall have Simplex Nema 5-20R outlets spaced on centers as indicated on plans. These shall be Wiremold Co. #2200 Series or equivalent Isotrol or other approved manufacturer.
- (4) Surface metal raceways and all components and fittings shall be furnished by a single manufacturer, wherever practical. All trim and cover fittings, flush feed boxes, splices, outlet fittings, etc, necessary for a complete installation shall be provided by the installing contractor. These raceways shall be rigidly mounted with approved fasteners on not to exceed 24" centers in a run, or 6" from ends and on either side of a corner. Refer to plans for notations on exact types of these raceways and outlet configurations.

I. WIREWAYS, WALL DUCT, FLUSH FLOOR TRENCH DUCT

(1) WIREWAYS

a. Wireways of painted steel construction shall be corrosion-resistant, moisture and oil resistant where indicated or necessary. Wireways shall be furnished in norminal sizes of 2 1/2" X 2 1/2", 4" X 4", 6"" X 6", 8" X 8" or 12" X 12", as indicated on plans. Furnish with hinged covers on all

runs and removable covers on all fittings, to allow a continuous unobstructed path for conductor installation. Provide knockouts on all runs, unless otherwise indicated or prohibited by codes.

- b. Provide wireways with hangers of same manufacturer, installed so as to allow unobstructed access to wireway interior. Install at not to exceed 8'-0" centers, closer as needed at fittings and turns. Use 1/4" rod hangers minimum for up to 4"X4", 3/8" rod minimum up to 8"X8", 1/2" rod minimum for 12" X 12".
- c. Wireways shall be equivalent to Square "D" Co. "LD" series, as a minimum standard of construction and quality.

(2) WALL DUCTS

- a. Where wall duct type raceways are indicated to be installed flush, they shall be a minimum 3 1/2" deep by 10" wide (or 18" width, as indicated), furnished with screw covers to overlap flange 1" on each side. Covers shall be furnished in nominal 3'-0" lengths. Provide fully grommeted openings or bushed nipples as needed in coverplates to pass cables thru. Where indicated or required, provide transition fittings between horizontal runs of wireway and wall ducts to properly interface each raceway system.
- b. Where wall ducts are installed flush either vertically or horizontally as a collector duct, provide proper blocking and support in stud walls, adding a layer of studs as needed to prevent undercutting major structural elements of walls. Trim flange shall be set tight to wall surface with 1/16" tolerance each way.
- c. Wall ducts, if indicated to be surface mounted, shall be furnished with flangeless coverplates.
- d. All completed systems shall be provided with a factory prime painted finish, suitable for field finish painting.
- e. Wall ducts shall be equivalent to Square D Company "RWT" Series, as a standard of construction and quality.

(3) TRENCH DUCTS

- a. Trench duct is to be installed flush with finished concrete floor slab with a vertical tolerance to adjacent surfaces of 1/16" plus or minus. Nominal depth of trench duct shall be adjustable from 2 3/8" to 3 1/2", minimum 12" width unless otherwise noted on plans.
- b. Trench duct shall be constructed of code-gauge steel, 14 gauge minimum, with corrosion resistant finish. Surfaces of duct or fittings in contact with concrete shall be painted with two coats of "Asphaltum" or receive equivalent coating or taping prior to placement of concrete.
- c. Furnish trench duct with flat turns, riser transition fittings to wall duct or panelboard as shown, concrete tight couplings, internal barriers as required to separate services, reducers, end closers, tees and all other fittings as indicated or required.
- d. Furnish coverplates of aluminum, 1/4" thickness minimum, with flush fasteners in nominal 24" lengths. Furnish grommeted openings or nipples with insulated bushings as required. Coverplates shall not deflect more than .085" with application of a 200 pound concentrated load. Any compartment over 16" in width shall have additional coverplate support, to meet the deflection criteria above.

- e. Provide (as standard) an aluminum tile trim flange (verify and coordinate with floor finishes). Refer to architectural drawings, where applicable.
- f. Trench duct and coverplates shall be equivalent to Square "D" Company RSV/RCP-AL series, as a standard of quality and construction.

J. CABLE TRAY OR CABLE TROUGH

- (1) Cable tray shall be furnished in all-aluminum construction or galvanized steel construction, as noted and sized on the drawings.
- (2) Galvanized finishes on tray shall be hot-dipped after fabrication for all trays in exterior locations. Mill finished galvanizing may be used where tray is installed indoors in dry locations.
- (3) The installing contractor shall carefully follow the manufacturer's recommendations for hanger sizing and hanger support spacing. The weight per linear foot of tray, fully loaded with a 200% safety factor shall be accounted for in sizing hangers. Refer to manufacturer's instructions and/or the drawings, as applicable for hangers and supports. In no case shall supports be spaced further than 8'-0" apart.
- (4) Cable tray shall be of the ladder type with rungs spaced 12" apart. Side rails shall be of I-Beam or C-Channel construction with welded rungs, depth and width as indicated on the drawings.
- (5) Cable trough shall be similar to cable tray, except bottom shall be a ribbed solid piece, depth and width as indicated on the drawings.
- (6) Cable tray or trough shall be provided with all required fittings for a complete installation. Fittings shall include, but not be limited to: Horizontal and vertical elbows and tees, smooth dropout fittings, end closure plates, fixed (or adjustable) splices as needed for field offsets, reducers, barriers or box connector flanges.
- (7) Cable tray and trough shall be equivalent to Square "D" Company Series CLA/CLG (ladder tray) or CTA/CTG (trough) as a standard of quality and construction.

K. OPEN WIRE MESH CABLETRAY

- (1) Section includes continuous, rigid, welded steel wire mesh cable management system.
- (2) References
 - a. ASTM A 123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - b. ASTM A 510 General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
 - c. ASTM B 633 Electrodeposited Coatings of Zinc on Iron and Steel.
- (3) Design Requirements
 - a. Maximum Deflection Between Supports: L/240.
- (4) Submittals

- a. Product Data: Submit manufacturer's product data, including UL classification.
- b. Shop Drawings: Submit shop drawings indicating materials, finish, dimensions, and accessories. Show layout, support, and installation details.
- c. Manufacturer Qualifications: Submit manufacturer's certification indicating ISO 9002 quality certified.
- (5) Delivery, Storage and Handling
 - a. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
 - b. Storage: Store materials in a dry area indoors, protected from damage, and in accordance with manufacturer's instructions.
 - c. Handling: Protect materials and finishes during handling and installation to prevent damage.
- (6) Manufacturer
 - a. Cablofil, Inc., 8319 State Route 4, Mascoutah, IL, 62258. Phone (618) 566-3230. Toll Free (800) 658-4641. Fax (618) 566-3250. www.cablofil.com, or approved equivalent. Part numbers included in this section are not meant to restrict truly equivalent manufacturers.
- (7) Open Wire Mesh Cabletray System
 - a. Description: Continuous, rigid, welded steel wire mesh cable management system.
 - 1) Mesh System: Permitting continuous ventilation of cables and maximum dissipation of heat.
 - 2) Safety Edge: Continuous safety edge T-welded wire lip.
 - 3) Wire Mesh: Welded at all intersections.
 - b. UL Classification: Straight sections 4" x 8", 12", and 18 inches.
 - c. Material: Carbon steel wire, ASTM A 510, Grade 1008. Wire welded, bent, and surface treated after manufacture.
 - d. Finish for Carbon Steel Wire: Finish applied after welding and bending of mesh.
 - 1) Hot-Dip Galvanizing: ASTM A 123. (Only in exterior, wet or corrosive locations)
 - 2) Flat Black: Powder painted surface treatment using ASA 61 black polyester coating. (In indoor dry locations)
 - e. Nominal Dimensions:
 - 1) Nominal Mesh: 2 x 4 inches.
 - 2) Nominal Straight Section Lengths: 80 inches and 118 inches.

- 3) Width: [6 inches] [8 inches] [12 inches] [18 inches] [24 inches].
- 4) Depth: Four inches in depth for all but 6" wide, which shall be 2" depth.
- 5) Wire Diameter: Nominal .177 inch, minimum.
- f. Fittings: Field fabricated in accordance with manufacturer's instructions from straight sections.
- g. Support System: Standard.
 - 1) Wall Installation: CS Bracket. Maximum tray width of 12 inches (300 mm).
 - 2) Trapeze Mounting to Ceilings: CS Profile. Maximum tray width of 18 inches (450 mm).
 - 3) Ceiling Installation: CSC Bracket. Maximum tray width of 12 inches (300 mm).
 - 4) Fasteners: As required by tray widths. To be furnished by manufacturer.
- h. Hardware: Hardware, including splice connectors, grounding fittings and support components to be furnished by the manufacturer.
- i. Grounding: GTA-2-2 grounding lugs for attachment on tray of continuous ground conductor fixing system.
- (8) Examination
 - a. Examine areas to receive cable management system. Notify the Engineer of conditions that would adversely affect the installation or subsequent utilization of the system. Do not proceed with installation until unsatisfactory conditions are corrected.
- (9) Installation
 - a. Install open wire mesh cabletray system at locations indicated on the drawings and in accordance with manufacturer's instructions.
 - b. Load Span Criteria: Install open wire mesh cabletray system in accordance with span load criteria of L/240.
 - c. Cutting:
 - 1) Cut wires in accordance with manufacturer's instructions.
 - 2) Cut wires with side action bolt cutters to ensure integrity of galvanic protective layer.
 - 3) Cut each wire with 1 clean cut to eliminate grinding or touch-up.
 - d. Install open wire mesh cabletray system using hardware, splice connectors, support components, and accessories furnished by manufacturer.
 - e. Coordinate with other trades to provide as straight and accessible runs as possible. Not all offsets are shown on drawings, but Contractor shall make accessible offsets as required around ductwork, structure, piping or other interferences as required.

L. DUCT BANKS

- (1) Duct banks are defined as a raceway or raceways installed in underground locations, enclosed in a steel-reinforced concrete envelope. They shall be installed where indicated on the drawings or otherwise required.
- (2) All concrete used in duct bank construction shall be 3000 PSI minimum 28 day compressive strength unless otherwise noted, in accord with latest A.C.I. standards. Testing of concrete shall be the responsibility of the Contractor, as directed by the engineer. Place concrete against undisturbed earth, or provide forming as needed.
- (3) Duct bank raceways shall receive a minimum of 3" concrete cover all sides. Minimum size of any duct bank shall be 12" x 12" square, in cross section. In all cases, local and national codes shall apply to duct bank construction where they exceed the requirements of this specification.
- (4) Each corner of duct bank shall receive a minimum No. 4 steel reinforcing bar with 2" minimum concrete cover on all sides. Lap bars fifteen diameters at all splices. Provide stirrup bars bury 60" on center to tie bars together. Stirrups may be #3 bar. Reinforcing steel shall be rigidly supported during pour and vibration, and shall be constructed to ASTM standards.
- (5) Support for encased raceways shall be as recommended by raceway manufacturer, spaced 8'-0" maximum on centers, rigidly fastened to prevent floating of ducts during concrete pours. Supports shall be of a material compatible with the raceway, and shall be of the interlocking type, forming a rigidly braced installation. Provide base type and intermediate type spacers to suit conduit configurations and sizes.
- (6) Where rigid nonmetallic raceways leave concrete duct banks, a transition to rigid steel conduit shall be made <u>18" inside</u> the concrete envelope. Under no circumstances shall PVC, EB or similar ducts exit concrete envelope, except where duct bank ties into a manhole wall. Provide bell ends at such terminations and dowel duct bank rebars 4" into manhole wall with non-shrink grout. Refer to details on drawings, as applicable. Slope all raceways within duct bank systems such that they shall drain into manholes or pull boxes. Provide proper drainage at manholes or pull boxes to prevent water accumulation.
- (7) Where ducts transition thru manholes, pull boxes or at terminating end, each duct shall be specifically identified. A nomenclature as shown on the drawings or as agreed upon by the installer and engineer shall be utilized to identify each individual duct. A permanent means of identifying each duct, such as engraved lamacoid plates or stamped metal tags shall be used.

M. RACEWAY FITTINGS

- (1) Raceway fittings (or condulets) shall be of gray iron, malleable iron or heavy copper-free cast aluminum. They shall be furnished in proper configurations, avoiding excessive plugged openings. Any openings that are left shall be properly plugged. All coverplates shall be gasketed with neoprene or similar approved materials, rated for the environment.
- (2) Where required, raceway fittings shall be provided in explosion-proof configurations rated for the atmosphere. Place conduit seal off fittings at each device in accord with applicable codes. Seal off fittings shall be packed with wadding, and poured with an approved non-shrink sealing compound.

- (3) Where conduit transitions in a run from a cold to a warm environment, (such as at a freezer, refrigerator or exterior wall) sealoff fittings shall be placed on the warm side immediately at the boundary to prevent migration of condensation within raceway systems.
- (4) Expansion fittings shall be provided at all locations where conduits or other raceways cross over expansion joints. Provide copper ground bonding jumpers across expansion fittings.
- (5) Conduit bodies, junction boxes and fittings shall be dust tight and threaded for dusty areas, weatherproof for exterior locations and vapor tight for damp areas. Conduit fittings shall be as manufactured by Crouse Hinds, Appleton, Killark or approved equivalent. All surface mounted conduit fittings as with "FS", "FD", "GUB" Types etc., shall be provided with mounting hubs.
- (6) Where lighting fixtures, appliances or wiring devices are to be suspended from ceiling outlet boxes, they shall be provided with 3/4" rigid conduit pendants. Outlet boxes shall be malleable iron, provided with self-aligning covers with swivel ball joint and No. 14 gauge steel locking ring. Provide safety chain between building structure and ballast housing of light fixtures for all fixtures, appliances or devices greater than 10 lbs weight. Fixtures shall be installed plumb and level.
- (7) Fittings for threaded raceways shall be tapered thread with all burrs removed, reamed ends and cutting oil wiped clean.
- (8) Fittings for E.M.T. conduit shall be of the compression type. Conduit stops shall be formed in center of couplings. All EMT connectors and couplings shall be of formed steel construction.
- (9) Indentation or die-cast fittings shall not be permitted in any raceway system.
- (10) All conduit fittings shall be securely tightened. All threaded fittings shall be engaged seven full threads. Fasteners shall be properly torqued to manufacturer's recommendations.

N. SUPPORTS AND HANGERS

- (1) Supports and hangers shall be installed in accord with all applicable codes and standards. They shall be corrosion resistant, galvanized or furnished with an equivalent protective coating. All electrical raceways shall be hung independently from the building structure with U.L. listed and approved materials. Hangers and supports depending on the support systems of other trades' work shall not be permitted, except with specific approval in writing from the Engineer. The use of tie wire for support or fastening of any raceway system is prohibited. Perforated metal tape shall not be used for raceway support.
- (2) No raceway shall be installed on acoustic tile ceiling tees, or in any location that will impair the functioning, access or code-required clearances for any equipment or system.
- (3) Supports for raceways shall be of materials compatible with the raceway, of malleable iron, spring steel, stamped steel or other approved material. Die-cast fittings are <u>not</u> permitted for supports.
- (4) The installing contractor shall provide all necessary supports and braces for raceways, in a rigid and safe installation, complying with all applicable codes.
- (5) Individual conduits run on building walls or equipment shall be secured by one hole galvanized malleable iron or stamped steel pipe strap or "minerallac" 2-piece straps. The straps are to be anchored by an approved means such as expansion anchors, toggle bolts, through bolts, etc. Where required by codes or other standards, provide spacers behind mounting clamps to space conduits off walls.

- (6) Individual conduits run on building steel shall be secured by means of clamp supports similar and equal to those manufactured by the C.C. Korn Company, Elcen Co., B-Line or approved equivalent. Provide korn clamps, bulb tee clamps, flange clamps, beam clamps, "minerallacs", etc.
- (7) Where feasible, vertical and/or horizontal runs of conduit shall be grouped in common hangers on "trapezes" of channel stock as manufactured by "Unistrut" or equivalent, 1-5/8" minimum depth, 12 gauge. Utilize conduit clamps appropriate to the channel.
- (8) Channel strut systems for supporting electrical equipment or raceways in outdoor wet or corrosive locations shall be constructed of 12 gauge minimum hot dip galvanized steel with 9/16" diameter holes on 8" centers, with finish coat of paint as manufactured by Unistrut, B-Line, Kindorf, or approved equivalent. In indoor dry locations, factory finish paint will be acceptable.
- (9) The minimum diameter of round all-thread steel rods used for hangers and supports shall be 1/4", 20 threads per inch. All-thread rod shall be furnished with a corrosion-resistant finish.
- (10) Welding directly on conduit or fittings is <u>not</u> permitted.
- (11) Provide riser support clamps for vertical conduit runs. Riser support clamps shall be of heavy gauge steel construction. Install riser support clamps at each floor level penetration, or as otherwise required.
- (12) Provide conduit cable support clamps for vertical conductor runs as required or indicated on plans. Clamps to be insulating wedging plug, with malleable iron support ring. Install within properly sized and anchored junction box.
- (13) Spring steel clips and fittings such as those manufactured by HITT-Thomas, Caddy-Erico, or approved equivalent, with black oxide finish are permitted in any indoor dry location for concealed work, where acceptable to the local authority having jurisdiction.

3. INSTALLATION

- A. This Contractor shall lay out and install all conduit systems so as to avoid any other service or systems, the proximity of which may prove injurious to the conduit, or conductors which it confines. All conduit systems, except those otherwise specifically shown to the contrary, shall be concealed in the building construction or run above ceilings. Size of all conduit shall as a minimum conform to the National Electrical Code, unless larger size is indicated on the Contract Drawings.
- B. No conduit larger shall be installed in poured concrete slabs except with permission of the structural engineer. All other shall be held below slab. Conduit shall be held at least 6" from flues or hot water pipes.
- C. All exposed conduit shall be installed with runs parallel or perpendicular to walls, structural members or intersections of vertical planes and ceilings, with right angle turns consisting of cast metal fittings or symmetrical bends unless otherwise shown. All conduit shall have supports spaced not more than eight feet apart.
- D. Conduit shall be installed in such a manner so as to insure against collection of trapped condensation. All runs of conduit shall be arranged so as to be devoid of traps. Trapped conduit runs shall be provided with explosion proof drains at low points. Runs of conduit between junctions shall not have more than the equivalent of three 90° bends.
- E. Junction boxes shall be installed so that conduit runs will not exceed 85', as shown on the Contract Drawings.

- F. Underground electric, cable TV, telephone service or other rigid steel conduit and underfloor rigid steel conduit below the concrete floor slab shall be painted with two coats of bitumastic paint, such as "Asphaltum".
- G. All underground or underfloor conduits shall be swabbed free of all moisture and debris before conductors are pulled.
- H. At least two 1 inch and four 3/4 inch conduits shall be stubbed from flush-mounted panelboards into the nearest accessible area for future use. Provide suitable closures for these stubs. Identify each stub with a suitable hang tag.
- I. Install electrical raceways in accordance with manufacturer's written instructions, applicable requirements of latest edition of the N.E.C., and NECA "Standard of Installation", complying with recognized industry practices.
- J. Coordinate with other trades, including metal and concrete deck trades, as necessary to interface installation of electrical raceways and components.
- K. Level and square raceway runs, and install at proper elevations and required heights. Hold tight to structure or route through joists webbing wherever possible, to maximize available space and not restrict other trades.
- L. Complete installation of electrical raceways before starting installation of cables or wires within raceways.
- M. All underground conduits shall be buried to minimum depth of 24" from the top of the concrete encasement or raceway to finished grade, unless otherwise noted on plans. Observe minimum burial requirements of local utility company where their standards or regulations apply. Conduits containing primary power conductors, (higher than 600 volts to ground) shall be 42" to top below finished grade, unless otherwise noted on plans.
- N. All raceways shall be installed to maintain a minimum of 4" clearance below roof decking.

4. SPECIALTIES

- A. All EMT terminations at junction boxes, panels, etc. shall be made with case hardened locknuts and appropriate fittings, with insulated throat liners. Insulating terminations shall be manufactured as a single unit. The use of split sleeve insulators is <u>not</u> permitted.
- B. All rigid conduit, except main and branch feeders, shall have heavy fiber insulating bushings reinforced with double locknuts. All branch and main feeders shall have insulated bushings with grounding lugs and shall be bonded to enclosures with appropriately sized copper jumpers, except at pad mounted transformers. Bonding jumpers shall be installed as required by the N.E.C. and other applicable codes.
- C. All conduit stubbed through floor during construction shall have openings protected with plastic caps approved for this purpose. Connections on both ends of all flexible conduit shall be equivalent to Thomas and Betts, Ideal, Appleton, Efcor, or approved equivalent, rated for the environment.
- D. All pulling lines left in open conduit systems shall be non-metallic, left securely tied off at each end.
- E. Where spare raceways terminate in switchboards or motor control centers a fishtape barrier shall be provided.

SECTION 260544 - EXCAVATION, TRENCHING, BACKFILLING AND GRADING

1. GENERAL

- A. Each Contractor's attention is directed to Section 260501, General Provisions, Electrical and all other contract documents as they may apply to his work.
- B. Each Contractor shall include all excavating, filling, grading and related items required to complete his work as shown on the drawings and specified herein.
- C. Electrical distribution lines and underground telephone or TV cables shall, in no case, be placed in the same trench with sanitary, storm, domestic or fire protection water lines. Phone cable may, at the Contractor's option, and if acceptable to both utility companies, be placed in a common trench with power lines as long as 8" of earth separation is maintained. T.V. cable shall, in all cases, be placed in a separate trench with two feet separation from electrical power lines.
- D. Depths of bury shall be as indicated on the drawings.

2. SUBSURFACE DATA

- A. Subsurface investigations have been made and the results shown on the drawings. The information was obtained primarily for use in preparing foundation design. Each Contractor may draw his own conclusions therefrom. No responsibility is assumed by the Owner for subsoil quality or conditions other than at the locations and at the time investigations were made. No claim for extra compensation, or for extension of time, will be allowed on account of subsurface conditions inconsistent with the data shown.
- B. Materials to be excavated shall be <u>unclassified</u>, and shall include earth, rock, or any other material encountered in the excavation to the depth and extent indicated on the drawings and specified herein. No adjustment in the Contract sum will be made on account of the presence or absence of rock, shale, or other materials encountered in the excavating.

3. BENCH MARKS AND MONUMENTS

A. Maintain carefully all bench marks, monuments and other referenced points. If disturbed or destroyed, replace as directed.

4. EXCAVATION

- A. Each Contractor shall accept the site as he finds it and remove all trash, rubbish and material from the site prior to starting excavation for his work.
- B. Excavate trenches to sufficient width and depth for proper installation of the work and where required, smooth the bottom on the trench with hand tools.
- C. The removal of rock shall be accomplished by use of hand or power tools only. Blasting shall not be permitted unless authorized in writing by the Architect. Any damage to existing structures, exterior services or rock intended for bearing, shall be corrected at the responsible Contractor's expense.
- D. Keep trenches free from water while construction therein is in progress. Under no circumstances lay conduit or cable in water. Pumping or bailing water from this Contractor's trenches, which is required during construction shall be accomplished at his expense.

E. In no case shall excavation work be accomplished that will damage in any way the new structure, existing structures, equipment, etc. Each Contractor shall take the necessary steps to prevent flow of eroded earth by water or landslide onto the property of others, or against the structures. The repair of all such damage, or any other damage incurred in the course of excavation, shall be borne by the responsible Contractor.

5. BACKFILL

- A. Backfill shall be accomplished with clean debris free earth and the new earth tamped at 12" intervals so as to avoid earth sinks along the trench. The responsible Contractor will be required to return to the project and fill any sunken areas along the route of his work.
- B. Backfill trenches only after conduit and cable have been inspected, tested, and locations of pipe lines have been recorded on "as-built" drawings.
- C. The backfill below paved areas shall be brought to proper grade to receive the sub-base and paving. No paving shall be placed on uncompacted fill.
- D. The backfill below sodded or seeded areas shall be brought to within six inches of finished grade. The remaining six inches shall be backfilled with clean soil.

SECTION 260553 - IDENTIFICATIONS

1. GENERAL

- A. Equipment, disconnect switches, motor starters, pushbutton stations, special device plates, and similar materials shall be clearly marked as to their function and use. Markings shall be applied neatly and conspicuously to the front of each item of equipment with 1/2" white lamacoid plate (or equivalent) with black letters 1/4" high.
- B. The Contractor shall provide clearly legible typewritten directories in each electrical panel indicating the area, item of equipment, etc., controlled by each switch, breaker, fuse, etc. These directories are to be inserted into plastic card holders in each panel. The Contractor shall be required to demonstrate the accuracy of the panel directory for a random sampling of circuits in each panelboard as directed in the field by the Engineer with corrections made immediately soit is imperative that care be taken during installation to insure 100% accurate directories.
- C. All circuit breakers and disconnects serving fire alarm equipment shall be painted red and clearly labeled as Fire Alarm Circuits.
- D. Branch circuit panelboards and switch gear shall be provided with a white lamacoid plastic plate with 1/2" black letters for panel designation and 1/4" black letters showing voltage and feeder information. Branch circuit switches shall be designated as to function. Panelboard and switchgear labels shall indicate the source they are fed from, and the circuit number at that source. Panelboards shall also indicate color coding of the branch circuit phase conductors supplied. Clearly indicate the exact label legend to be furnished with each panelboard and switchgear on the shop drawings for each item of equipment prior to submission of shop drawings.

EXAMPLE:

PANEL "XYZ" FED FROM "MDP – 2" 120/ 208/ 3PH/ 4W – 225A BLACK-RED-BLUE CONDUCTORS

- E. Where branch circuit panelboards and switchgear are connected to an emergency source, the lamacoid plate shall be red, and the word "emergency" shall be incorporated into the legend. In healthcare applications, the NEC designated branch (life safety, critical or equipment branch) shall also be incorporated into the legend, all in ¹/₄" letters. Also provide similar plates and legends for automatic transfer switches, and equipment disconnects 100 amps and larger.
- F. Lamacoid plates shall be located at center of top of trim for branch circuit panels, switch gear, and centered at side for branch circuit switches. Fasten with self-tapping stainless steel screws or other approved method.
- G. The building service disconnect(s) shall be marked with the maximum available fault current available at that location in accordance with NEC Article 110. If a fault current study is not required by this contract, the Contractor shall obtain fault current availability data from the utility company. This requirement applies to both new and existing services if any distribution equipment is changed.

SECTION 262400 - ELECTRICAL DISTRIBUTION EQUIPMENT

1. GENERAL

A. All electrical distribution equipment shall be dead front UL listed for the purpose and application. All equipment shall meet or exceed all applicable requirements of the National Electrical Code (N.E.C.). Any device or component, i.e., switchboard, panel, breaker, switch, etc., used as service entrance equipment, shall be listed for use at 100% of the rated capacity.

<u>*NOTE TO DESIGNER, REMOVE IF NOT APPLICABLE</u> 2. UL RE-CERTIFICAITON OF EXISTING EQUIPMENT

- A. Where existing switchboards, panelboards, motor control centers, and similar are modified in a manner that changes how the original equipment was shipped from the factory the contractor shall obtain a UL Field Evaluation and the equipment shall be provided with new UL certifications and UL Field Evaluation Marking. Modifications include but are not limited to tapping of bussing, dismantling and rebuilding of gear, or the installation of aftermarket breakers, components, etc. UL re-certification shall not be required for the following conditions:
 - (1) If a new breaker listed or classified by the manufacturer for installation in the gear is provided in an existing prepared space. Contractor must submit documentation of this classification if the breaker type is not specifically noted on the panelboard product data.
 - (2) *Removal of existing breakers*
 - (3) Removal of conductors to/from gear
 - (4) Addition of conductors to/from gear

The contractor shall carry all costs associated with the evaluation and re-certification. The contractor shall submit the service agreement with the UL certified for review by the engineer prior to execution. All work shall be approved by the Authority Having Jurisdiction.

3. MAIN SWITCHBOARD - FUSIBLE SWITCH STYLE

- A. Switchboard shall be dead front, totally enclosed, free standing type consisting of sections housing the equipment as indicated. The structure height shall be nominally 92" high, including the base channels. The structure shall be constructed of formed steel channels and angles (12 gauge minimum) to support cover plates, bussing, distribution equipment and other devices to be installed therein. Neutral and ground shall be separate busses. Removable cover plates shall be provided on all sides and top with opening for conduit in bottom. Cover plates and trim shall have formed edges so that no sheared surfaces are exposed. Housing shall be given a rust inhibiting treatment inside and out and finished in light gray baked enamel, per ANSI #49. Connection will be made by entering the switchboard as indicated on the drawings. Provide concrete housekeeping pad, 3" high, with #4 rebar on 6" X 6" centers, per A.C.I. standards. Chamfer edges of pad 1/2".
- B. All bussing shall be 100% annealed copper. The temperature rise above ambient of the bus bars shall not exceed 50NC. Heat rise test shall be conducted in accordance with U.L. Standard UL-67. All joints are to be rigidly bolted to insure maximum conductivity. All bus bars shall extend full length of equipment to permit future additions.
- C. Neutral bussing shall be of the same ampacity as the phase bussing and shall be insulated from the enclosure. Ground bussing shall be sized and shall be bonded to the enclosure per N.E.C. current edition. Service grounding electrode connection shall be made between ground and neutral busses. Provide ground bushings and equipment ground conductor connection on each feeder conduit leaving the switchboard and at the terminal end for each continuous metallic feeder conduit.

- D. The main bus shall be adequately braced to withstand short circuits of 100,000 asymmetric RMS amperes. The line side of branch units shall be bussed with copper connectors unless otherwise indicated or required.
- E. Main switches indicated for service entrance duty of more than 601 ampere rating shall have a bolted pressure contact fusible load break switch. All current carrying parts of the switch shall be silver plated. Fuse compartment shall have a hinged door interlocked with the handle so door cannot be opened with switch in the "ON" position and switch cannot be closed with the door open. Provisions for padlocking switch in the "ON" or "OFF" position shall be provided. Fuses of 601 or greater rating shall be the bolted-on type.
 - (1) Main switches on 277/480 volt systems rated for 1000 amps or above shall have ground fault protection equipment and comply with Article 230-95 of the National Electrical Code.
- F. Distribution section(s) shall consist of the number of quick-make, quick-break fusible switches of sizes as indicated. Units shall be mounted in group type construction and supplied as indicated. Each switch shall be enclosed in a steel enclosure having a hinged cover with an interlock to prevent opening the cover when the switch is in the "ON" position.
- G. Provide an arc energy reducing maintenance switch with local status indicator for all fused switches or equipment rated 1,200 Amps or greater. Provide a local status indicator light for all fuses equipped with maintenance switches. Maintenance switch and indicator shall be mounted to the fuse compartment door or immediately adjacent to the compartment in the switchboard enclosure. Maintenance switch shall have permanently mounted lockout/tagout provisions. Provide labelling to indicate operation instructions for maintenance switch at each switch.
- H. Arc Flash Hazard warning labels shall be affixed to all switchboards in accordance with Article 110.16 of the National Electrical Code. All components protected by a manually-operated arc energy reduction means shall have an additional label affixed that describes the location of the energy reduction means.
- I. Switchboard shall be Square "D", G.E., Siemens, Eaton/Cutler-Hammer or approved equivalent.
- J. Lockable breakers shall be provided for all breakers serving all HVAC equipment, Plumbing equipment, and kitchen appliances.

OR

4. MAIN SWITCHBOARD - CIRCUIT BREAKER STYLE

- A. Switchboard shall be dead front, totally enclosed, free standing or wall mounted, as required or herein specified, housing the equipment as indicated. The switchboard shall meet Underwriters' Laboratories enclosure requirements, and be furnished with an Underwriters' Laboratories label. The entire switchboard is to be Square D I-Line or equivalent construction, G.E., Siemens, Eaton / Cutler Hammer or approved equivalent. Where switchboards are floor-mounted, provide concrete housekeeping pad, 3" high, with #4 rebar on 6" X 6" centers, per A.C.I. standards. Chamfer edges of pad 1/2".
- B. The switchboard shall be dead-front with front accessibility. The switchboard framework shall consist of steel channels bolted to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting. The framework is to be formed of code gauge steel, rigidly welded together to support all cover plate, bussing and component devices. All unused positions shall have closures.

- C. Each switchboard section shall have an open bottom (closed for wall-mounted style) and a top plate for installation and termination of conduit. Top and bottom conduit areas are to be clearly shown and dimensioned on the shop drawings. The wireway front covers shall be secured by screws and hinged, to permit access to the branch circuit breaker load side terminals. The paint finish shall be medium light gray, per ANSI #49, applied by the electro-deposition process over an iron phosphate pre-treatment. Enclosure shall be NEMA 1, with drip shield on top. Provide top covers without knockouts. All conduit entries to be field cut. At top conduit entries, provide weatherproof sealing lock nuts on terminator.
- D. The switchboard bussing shall be of sufficient cross-sectional area to meet UL Standard 891 on temperature rise. Main and/or through busses shall be 100% annealed copper. The through bus shall have an ampacity in amperes as indicated on the drawings and shall be braced to have a short circuit current rating of 100,000 RMS symmetrical amperes unless otherwise indicated. (Where through bus is provided, it shall have provisions for the addition of future sections on the branch or distribution side.) The through bus supports, connections and joints are to be bolted with hex head bolts and belleville washers to minimize maintenance requirements.
- E. Neutral bussing shall be of the same ampacity bussing and insulated from the enclosure. Ground bussing shall be sized and shall be bonded to the enclosure per N.E.C., current edition. Service grounding electrode connection shall be made between ground and neutral busses. Provide ground bushings and equipment ground conductor connection on each feeder conduit leaving switchboard and at the terminal end for each continuous metallic feeder conduit.
- F. Each switchboard, as a complete unit, shall be given a single short circuit current rating by the manufacturer. Such a rating shall be established by actual tests by the manufacturer, in accordance with UL specifications, on equipment constructed similarly to the subject switchboard.
- G. The service disconnect device(s) shall be thermal-magnetic molded case circuit breaker(s) installed totally front accessible and front connectable. Line side of branch circuit breaker connections are to be jaw type plug-on. Ground fault protection shall be provided as required by N.E.C. Article 230-95, where switchboard is rated for 277/480 volts and circuit breaker frame sizes are 1000 amperes or greater, regardless of trip setting.
- H. Group mounted molded case circuit breakers for branch distribution are to be totally front accessible. These circuit breakers are to be mounted in the switchboard to permit installation, maintenance and testing without reaching over any line side bussing. All line and load side connections are to be individual to each circuit breaker. Common mounting brackets or electrical bus connectors will not be acceptable. Line side circuit breaker connections are to be jaw type plug-on, arranged to withstand the anticipated fault currents.
- I. Each circuit breaker is to be furnished with an externally operable mechanical means to trip the circuit breaker, enabling maintenance personnel to verify the ability of the circuit breaker trip mechanism to operate as well as exercise the circuit breaker operating mechanisms.
- J. Include kw, kwh, voltage, amperage metering per phase along with appropriate digital output to interface with campus DDC control system for remote monitoring of power system. Coordinate with controls supplier for a 100% complete installation.
- K. Provide an arc energy reducing maintenance switch with local status indicator for all breakers or equipment rated or adjustable to 1,200 Amps or greater. Provide a local status indicator light for all breakers equipped with maintenance switches. Maintenance switch and indicator shall be mounted to the breaker face or immediately adjacent to the breaker in the switchboard enclosure. Maintenance switch shall have permanently mounted lockout/tagout provisions. Provide labelling to indicate operation instructions for maintenance switch at each switch.

- L. All circuit breakers shall have a minimum ISCA rating of 65,000 amps, A.I.C., unless otherwise noted on the One-Line Diagram.
- M. Arc Flash Hazard warning labels shall be affixed to all switchboards in accordance with Article 110.16 of the National Electrical Code. All components protected by a manually-operated arc energy reduction means shall have an additional label affixed that describes the location of the energy reduction means.
- N. Switchboard shall be Square "D", G.E., Siemens, Eaton/Cutler-Hammer or approved equivalent.
- O. Lockable breakers shall be provided for all breakers serving all HVAC equipment, Plumbing equipment, and kitchen appliances.

5. DISTRIBUTION PANELBOARDS (600 AMPERE OR GREATER)

- A. Panelboard assembly shall be enclosed in a steel cabinet. The rigidity and gauge of steel to be as specified in UL Standard 50 for cabinets. The size of wiring gutters shall be in accordance with UL Standard 67. Cabinets to be equipped with latch and tumbler-type lock on door of trim. Doors over 48" long shall be equipped with three-point latch and vault lock. All locks shall be keyed alike. End walls shall be removable. Fronts shall be of code gauge steel, with gray baked enamel finish electrodeposited over cleaned, phosphatized steel.
- B. The panelboard interior assembly shall be dead front with panelboard front removed. Main lugs or main breakers shall have barriers on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the mains shall have barriers. Bus structure shall be full height of panel.
- C. Panelboard bus structure and main lugs or main breaker shall have current ratings as shown on the panelboard schedule. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or bus bar not to exceed 50°C. rise above ambient. Heat rise tests shall be conducted in accordance with Underwriters Laboratories Standard UL 67. The use of conductor dimensions will not be accepted in lieu of actual heat tests. All panelboards unless otherwise noted shall have space to accept forty-two 20 amp one pole circuit breakers.
- D. Circuit breakers shall be equipped with individually insulated, braced and protected connectors. The front faces of all circuit breakers shall be flush with each other. Large, permanent, individual circuit numbers shall be affixed to each breaker in a uniform position. Tripped indication shall be clearly shown by the breaker handle taking a position between "ON" and "OFF." Provisions for additional breakers shall be such that no additional connectors will be required to add breakers. All panelboards shall be capable of accepting 225 amp 3 pole branch breakers as a minimum unless otherwise noted.
- E. Each panelboard, as a complete unit, shall have a short circuit current rating equal to or greater than the integrated equipment rating shown on schedules on the plans or as determined by verification with local utility company. This rating shall be established by testing with the overcurrent devices mounted in the panelboard. The short circuit tests on the overcurrent devices and on the panelboard structure shall be made simultaneously by connecting the fault to each overcurrent device with the panelboard connected to its rated voltage source. Method of testing shall be per Underwriters Laboratories Standard UL 67. The source shall be capable of supplying the specified panelboard short circuit current or greater. Testing of panelboard overcurrent devices for short circuit rating only while individually mounted is not acceptable. Also, testing of the bus structure by applying a fixed fault to the bus structure alone is not acceptable. Panelboards shall be marked with their maximum short circuit current rating at the supply voltage and shall be UL listed.

- F. Arc Flash Hazard warning labels shall be affixed to all panelboards in accordance with Article 110.16 of the National Electrical Code. All components protected by a manually-operated arc energy reduction means shall have an additional label affixed that describes the location of the energy reduction means.
- G. Provide energy reducing maintenance switch with local status indicator for any breaker or equipment rated or adjustable to 1,200 Amps or greater.
- H. Distribution panelboards shall be Square "D", G.E., Siemens, Eaton/Cutler-Hammer or approved equivalent.
- I. Lockable breakers shall be provided for all breakers serving all HVAC equipment, Plumbing equipment, and kitchen appliances.

6. BRANCH PANELBOARDS

- A. This section covers lighting and power panelboards (refer to schedules, notes on Drawings and the Electrical One-Line Diagram, of the Contract Drawings).
- B. All panelboards shall be of the circuit breaker type, and shall be of one manufacturer.
- C. Branch panelboards shall be as indicated on the drawings and as specified herein. The lighting panelboards shall be of the dead-front, quick-make, quick-break, plug-in circuit breaker type, with trip indicating and trip free handles. All circuits shall be clearly and properly numbered and shall be provided with thermal magnetic protection. The panelboards shall be enclosed in code gauge, galvanized steel cabinets with smooth finished hinged doors without visible external fasteners and heavy chrome locks. Locks shall all be keyed alike. Each door shall have a directory card inside, covered with a plastic shield, filled in with black india ink or typewritten with circuit numbers and description indicated. Room numbers shall be coordinated with final room numbers as selected by Owner -- not numbers on Contract Documents.

<u>Special Note</u>: The room numbers used to fill out the panel directories shall match the actual final name and numbering scheme selected by the Owner. They shall <u>not</u> be filled out per the construction drawing numbering scheme, unless the Contractor is directed to do so by the Architect or Engineer.

- D. Branch panelboards shall be surface or flush mounted as indicated on the Contract Drawings.
- E. Circuit breakers for 120/208 volt systems shall be of 10,000 A.I.C. RMS symmetrical rating unless otherwise indicated on the Contract Drawings. For 277/480 volt systems, provide circuit breakers with 14,000 A.I.C. ratings unless otherwise indicated.
- F. All main bus and connections thereto in branch panelboards shall be copper. All bus bars shall extend full length of panelboards.
- G. All circuit breakers used to switch lights shall be SWD (switching duty) rated and U.L. listed for the purpose.
- H. Where required by the National Electrical Code, provide branch arc-fault circuit interrupters (A.F.C.I.'s) in branch panelboards, whether indicated on the panel schedule or not. They shall be U.L. listed, latest edition.
- I. Where branch circuit breakers feed hermetically, sealed compressor for cooling or refrigeration equipment, provide U.L. listed H.A.C.R.-style circuit breakers.

- J. Where branch circuit breakers are indicated or required to be ground-fault circuit-interrupting type (G.F.C.I.), they shall have test and reset buttons and be U.L. listed, latest edition. Do not share neutrals with other circuits.
- K. Where branch circuit breakers are feeding H.I.D. (high-intensity-discharge) loads, they shall be rated and listed for such loads. Provide proper circuit breaker whether indicated on panel schedules or not.
- L. Arc Flash Hazard warning labels shall be affixed to all panelboards in accordance with Article 110.16 of the National Electrical Code. All components protected by a manually-operated arc energy reduction means shall have an additional label affixed that describes the location of the energy reduction means.
- M. Panels shall be Square "D", G.E., Siemens, Eaton/Cutler-Hammer or approved equivalent.
- N. Lockable breakers shall be provided for all breakers serving all HVAC equipment, Plumbing equipment, and kitchen appliances.

7. INSTALLATION INSTRUCTIONS

- A. Panelboards with circuit breakers installed before the building has been finished and cleaned shall be masked.
- B. All dust and debris shall be removed from the panels before they are energized and placed in service.
- C. All panelboard fronts shall be omitted until final punch list inspection is made. Directories for each panelboard shall be completed and available for review by the Engineer at that time.
- D. All service equipment shall be marked with the maximum available fault current and the date of the calculation. This information shall be obtained in writing from the serving utility. Provide label adjacent to the service disconnecting means. Document action of the fault current shall be included in the operation and maintenance manual. This labeling shall be provided for all new service installations, service upgrades, and any project that adds or replaces distribution panels or branch panel boards.
- E. Where applicable Provide a warning sign on the service entrance equipment indicating type and location of all on-site emergency power sources in accordance with the NEC.
- F. Where applicable Provide warning sign(s) for alternative power devices (photovoltaic, wind, fuel cell, etc.) on all equipment in accordance with the NEC.
- G. All emergency system switchgear, distribution panels and branch panelboards shall be provided with surge protection devices in accordance with the NEC. Refer to Section 264313 Surge Suppression Systems.

8. SAFETY SWITCHES

- A. Provide heavy duty safety switches as a final disconnecting means as required by NEC and/or as indicated on the Contract Drawings.
- B. All safety switches shall be NEMA Type 1, NEMA 3R, NEMA 4 stainless steel, NEMA 12, or as required by the operating environment, Heavy Duty Type HD, UL listed.
- C. All safety switches shall have switch blades that are fully visible in the "OFF" (open) position with the door open.

- D. All current carrying parts shall be plated by an electrolytic process to resist corrosion and to promote cooling.
- E. Switch mechanism shall be quick-make, quick-break, load break rated, such that during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operating handle after the closing and opening action of the contacts has started. The handle and mechanism shall be an integral part of the box (not cover) with facilities for pad locking in the open or closed position with up to three padlocks. Switch doors shall be interlocked with switch handle so that the door can only be opened when the switch is in the "OFF" (open) position.
- F. Arc Flash Hazard warning labels shall be affixed to all switches in accordance with Article 110.16 of the National Electrical Code. All components protected by a manually-operated arc energy reduction means shall have an additional label affixed that describes the location of the energy reduction means.
- G. Switches shall be as manufactured by Square D., G.E., Siemens, Eaton/Cutler-Hammer or approved equivalent.

9. FUSES

- A. Upon completion of the building, the Contractor shall provide the owner with spare fuses as shown below. All fuses shall be Bussmann, Shawmut, Gould or Reliance.
 - (1) 10% (minimum of 3) of each type and rating of installed fuses shall be supplied as spares:
 - (2) Bussmann spare fuse cabinets Catalog No. SFC shall be provided to store the above spares.
- B. No fuses shall be installed in the equipment until the installation is complete, including tests and inspections required prior to being energized. All fuses shall be of the same manufacturer to insure retention of selective coordination, as designed.
- C. Circuits 601 to 6000 amperes shall be protected by current limiting BUSSMANN HI-CAP TIME DELAY FUSES KRP-C. Fuses shall employ "O" rings as positive seals between the end bells and the fuse barrel. Fuses shall be a time-delay type and must hold 500% of rated current for a minimum of 5 seconds, clear 20 times rated current in .01 seconds or less and be listed by Underwriter's Laboratories, Inc., with an interrupting rating of 200,000 amperes R.M.S. symmetrical. The fuses shall be UL Class L.
- D. Circuits 0 to 600 amperes shall be protected by current limiting BUSSMANN LOW-PEAK Dual Element Fuses, LPN-RK (250 volts) or LPS-RK (600 volts). All dual element fuses shall have separate overload and short circuit elements. Fuse shall incorporate a spring activated thermal overload element having a 284°F melting point alloy and shall be independent of the short-circuit clearing chamber. The fuse shall hold 500% of rated current for a minimum of 10 seconds and be listed by Underwriters Laboratories, Inc. with an interrupting rating of 200,000 amperes r.m.s. symmetrical. The fuses shall be UL Class RK1.
- E. Motor Circuits All individual motor circuits rated 480 amperes or less shall be protected by BUSSMANN LOW PEAK DUAL-ELEMENT FUSES LPN-RK (250 volts) or LPS-RK (600 volts). The fuses for 1.15 service factor motors shall be installed in rating approximately 125% of motor full load current except where high ambient temperatures prevail, or where the motor drives a heavy revolving part which cannot be brought up to full speed quickly, such as large fans. Under such conditions the fuse should be 150% to 200% of the Type KRP-C HI-CAP Time Delay Fuses of the rating shown on the drawings. 1.0 service factor motors shall be protected by BUSSMANN LOW-PEAK Dual-Element Fuses LPN-RK (250 volts) or

LPS-RK (600 volts) installed in rating approximately 115% of the motor full load current except as noted above. The fuses shall be UL Class RK1 or L.

F. Circuit breaker panels shall be protected by BUSSMANN LOW-PEAK Dual Element fuses LPN-RK (250 volts) or LPS-RK (600 volts) as shown on the drawings. The fuses shall be UL Class RK1.

10. DISTRIBUTION TRANSFORMERS

- A. The Contractor shall provide dry-type transformers as manufactured by Square "D", G.E., Siemens, Eaton/Cutler-Hammer or equivalent. KVA ratings shall be as indicated on the electrical plans and shall have copper windings.
- B. Three phase transformers are to have 480 volt Delta primary and 120/208V/3 /4W secondary. 30 KVA transformers and larger are to be supplied with 2-22% full capacity taps above and (4) 2-1/2% full capacity taps below primary voltage. Exceptions to the above will be shown on the electrical plans.
- C. Transformers 30 KVA and above shall be Class H, 115°C. and shall have the ability to carry a continuous 15% overload without exceeding a 115°C rise above 40° ambient.
- D. Transformer coils shall be vacuum impregnated with non-hygroscopic, thermosetting varnish. Each layer shall have end fillers or tie downs to provide maximum mechanical strength. Insulation systems and their construction techniques shall be listed by Underwriters Laboratories.
- E. Transformer coils shall have a final wrap of electrical insulating material designed to prevent injury to the coil wire. Transformers having coils with magnet wire visible will not be acceptable.
- F. All cores to be manufactured from a high grade, non-aging, silicon steel with high magnetic permeabilities, low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below saturation to allow for a minimum of 10% over voltage excitation. The cores shall be clamped with structural angles (formed angles not acceptable) and bolted to the enclosure to prevent damage during shipment or rough handling.
- G. The core and coil unit shall be completely isolated from the enclosure by means of a vibration isolating system and shall be so designed as to provide for continual securement of the core and coil unit to the enclosure. Sound isolating systems requiring the removal of all tie down facilities will not be acceptable.
- H. Transformers 15 KVA thru 45 KVA shall be provided with interchangeable mounting for floor or wall.
- I. The maximum top of case temperature shall not exceed 35°C above ambient.
- J. The entire transformer enclosure shall be degreased, cleaned, phosphatized, primed and finished with baked enamel.
- K. The core and coils shall be visibly grounded to the frame of the transformer cubicle by means of a flexible grounding strap of adequate size.
- L. Sound levels shall be guaranteed by the manufacturer and substantiated by certified tests on each unit furnished. The sound levels are not to exceed the following values: 10 to 45 KVA, 42 D.B. to 150 KVA; 45 D.B., 225 to 300 KVA; 50 D.B. and 500 KVA, 54 D.B.
- M. If a particular "K" rating is specified for a dry-type transformer, that rating shall be provided.

N. Transformers shall be as manufactured by Square D, G.E., Eaton/Cutler-Hammer, Siemens, Niagara or approved equivalent.

11. CONTACTORS

- A. General
 - (1) Contactors shall be continuously rated at the specified amperes per pole for all types of ballast and tungsten lighting, resistance and motor load. Contactors shall have totally enclosed, double-break silver-cadmium-oxide power contacts. Auxiliary arcing contacts will not be acceptable. Contact inspection and replacement shall be possible without disturbing line or load wiring. Contactors shall have straight-through wiring with all terminals clearly marked. Contactors shall have a gasketed NEMA Type 1 (NEMA 12 for electrically-held) enclosure, unless otherwise noted or required.
 - (2) Contactors shall be approved per UL 508 and/or CSA, and be designed in accordance with NEMA Standards. They shall be industrial-duty rated for applications to 600 volts maximum. I.E.C.-style contactors are not acceptable.
 - (3) Contactors shall have provisions for factory or field addition of:
 - a. Four N.O. or N.C. auxiliary contacts rated 6 amperes continuous at 600 volts.
 - b. Single or double circuit, N.O. or N.C., 30 or 60 ampere 600 volt power-pole adder.
 - c. Control-circuit fuse holder, one or two fuses.
 - d. 0.2-60 second adjustable interval timer attachment, if so indicated on plans.
 - e. Transient-suppression module for coil control circuit. Coil control to be 120 volts. Provide circuit or step-down transformer.
- B. Electrically Held Lighting Contactors
 - (1) Contactor coils shall be continuously rated and encapsulated, 120 volt rated. Enclosures shall be NEMA 12, to minimize noise transmission.
- C. Mechanically Held Lighting Contactors
 - Coil-clearing contacts shall be supplied so that the contactor coils shall be energized only during the instance of operation. Both latch and unlatch coils shall be encapsulated. Coils shall be rated for 120 volt operation.
 - (2) Lighting contactors shall be Square D Class 8903 or equivalent by G.E., Siemens, Eaton/Cutler-Hammer or Allen-Bradley.

12. LIQUID-FILLED PAD-MOUNT TRANSFORMERS

- A. General
 - Pad-mount transformer shall be liquid filled, concrete pad mounted and completely enclosed with high voltage switching and removable oil fusing. They shall be dead-front type with bushing wells and inserts. Transformer placement shall conform to the requirements of the local authority having

jurisdiction for distance from the building. Verify these clearances and restrictions prior to pouring concrete pads and roughing in any work. Provide all containment pads in accordance with the N.E.C.

- B. Performance Requirements
 - (1) Built to ANSI Standard C57.12.00 1968. ANSI short circuit test (Sample Unit) data, ANSI impulse test full and chopped wave (Sample Unit) data and certified test data (ANSI) (Sample Unit).
 - (2) KVA size As noted on the drawings.
 - (3) Primary voltage As noted on the drawings. <u>Note</u>: Prior to submission of shop drawings, the Contractor shall confirm the primary circuit voltage with the serving utility and indicate this on shop drawings.
 - (4) Secondary voltage As noted on the drawings. <u>Note</u>: An insulated neutral bushing shall be provided where 4-wire service is specified.
 - (5) 60 Hertz frequency.
 - (6) Temperature Rise above ambient shall not exceed 65°C.
 - (7) High conductivity copper coils.
 - (8) Dead-front construction.
 - (9) Provide minimum of two sets of + or 2/1/2% taps with external tap changer switch handle for deenergized operation. On dual-winding transformers provide a non load-break voltage switch, with + or - taps located on the highest voltage side.
 - (10) Impedance not less than 2% and not more than 6.5%.
 - (11) Noise level not to exceed NEMA Standard levels.
 - (12) Bolted connections will be acceptable only from lead to bushing. All other connections shall be welded or adequately crimped, per NEMA and ANSI standards.
 - (13) Provide with dead-front distribution class MOV lightning arrestors, arranged to suit the provided voltage and bushings on the primary side.
 - (14) Transformers shall be liquid filled with a bolted tank cover. Liquid shall be U.L. listed mineral oil, non-P.C.B. bearing. Transformers shall be manufactured, equipped, and installed to conform to the U.L. classification of the liquid.
 - (15) Pad-mounted transformer shall be protected by three "bay-o-net" oil-immersed expulsion fuses, loadbreak with fault sensing elements in parallel with partial range oil-immersed current limiting fuses, primary current sized for the full secondary load amperes times 125% for overload capacity, as the manufacturer recommends.
 - (16) Pad-mounted transformers shall be furnished with a hotstick operable three-phase, load-break primary voltage oil-immersed, 200 ampere 2-position switch to disconnect loop circuit where specified for loop feed.

- (17) Provide test: Completely assembled tank with all accessories in place (except for pressure relief valve) must withstand a test pressure of 5 PSI.
- (18) Transformers shall be loop feed-thru type with six two piece bushing wells with 200 (or 600) amp inserts, arranged to include M.O.V. type lightning arrestors for the specified voltage.

OR

- (19) Shall be radial-feed type, with 200 amp bushing wells with 200 (or 600) amp inserts, including M.O.V. type lighting arrestors for the specified voltage.
- (20) Internal leads shall be of sufficient length to permit field replacement of bushing without opening the tank.
- (21) Transformer paint color shall be Munsell Green, or custom color if required elsewhere in these documents.
- (22) Accessories:
 - a. Liquid level gauge
 - b. Vacuum pressure gauge and valve
 - c. Drain valve with a built-in sampling device
 - d. Upper filling plug
 - e. Pressure-relief valve
 - f. Welded steel tank
 - g. Lifting lugs, skiddable in all directions
 - h. Dial type temperature gauge
 - i. Threaded grounding lug
 - j. Warranty period 2 year, unconditional from date of installation acceptance by the Engineer or Owner
 - k. Permanent nameplate, with data submitted for approval before shipment to site.

SECTION 262450 - ELECTRICAL DISTRIBUTION TRANSFORMERS

1. GENERAL

A. All electrical distribution transformers shall be dead front UL listed for the purpose and application. All equipment shall meet or exceed all applicable requirements of the National Electrical Code (N.E.C.).

2. QUALITY ASSURANCE

- A. Manufacturer shall be ISO 9001 certified.
- B. Transformers shall be CSA certified and UL listed [CE certified outside North America],
- C. Transformers shall be factory tested to CSA C9,
- D. Transformers shall meet all relevant CSA, EPA, IEEE, NEMA, NFPA, and UL standards.

3. SHOP DRAWING SUBMITTALS

- A. Submit shop drawings, in accordance with Section 260503 Submittals, that includes:
 - (1) Enclosure dimensions,
 - (2) Mounting devices,
 - (3) Terminals,
 - (4) Taps,
 - (5) Internal and external component layout,
 - (6) Amperage (neutral),
 - (7) kVA rating,
 - (8) Voltage,
 - (9) Frequency,
 - (10) BIL,
 - (11) Insulation class.

4. INSTALLATION INSTRUCTIONS

- A. All Transformers shall be installed within 10 linear wire feet of the secondary means of disconnect, or a N.E.C. compliant means of disconnect shall be provided.
- B. A minimum of six (6") inch air gap shall be provided between transformer and wall if located adjacent to wall.
- C. Provide a 4" concrete house keeping pad for all floor mounted transformers in accordance with A.C.I. standards.
- D. Provide 4" x 4" x ³/₄" nominal thick vibration isolation pads, four per transformer. Pads shall be Korfund Co. or equal. Transformer is to be anchored in a manner that minimizes transmission of vibration.

5. TYPE "D" DISTRIBUTION TRANSFORMERS

- A. The Contractor shall provide dry-type transformers as manufactured by Power Smith, Power Quality International, Square "D" or equivalent. KVA ratings shall be as indicated on the electrical plans, transformers shall have copper windings.
- B. Three phase transformers are to have 480 volt Delta primary and 120/208V/3 /4W secondary. 30 KVA transformers and larger are to be supplied with 2-1/2% full capacity taps above and (4) 2-1/2% full capacity taps below primary voltage. Exceptions to the above will be shown on the electrical plans.

- C. Transformer coils shall be vacuum impregnated with non-hygroscopic, thermosetting varnish. Each layer shall have end fillers or tie downs to provide maximum mechanical strength. Insulation systems and their construction techniques shall be listed by Underwriters Laboratories.
- D. Transformer coils shall have a final wrap of electrical insulating material designed to prevent injury to the coil wire. Transformers having coils with magnet wire visible will not be acceptable.
- E. All cores to be manufactured from high grade, non-aging, silicon steel with high magnetic permeabilities, low hysteresis and eddy current losses. Magnetic flux densities are to be designed below saturation as required to allow for a minimum of 10% over voltage excitation. The cores shall be clamped with structural angles (formed angles not acceptable) and bolted to the enclosure to prevent damage during shipment or rough handling.
- F. The core and coil unit shall be completely isolated from the enclosure by means of a vibration isolating system and shall be so designed as to provide for continual securement of the core and coil unit to the enclosure. Sound isolating systems requiring the removal of all tie down facilities will not be acceptable.
- G. Primary winding configuration must be 'Delta'.
- H. Secondary winding configuration must provide a zero-sequence reactance of <0.2% at 60Hz at any primary to secondary phase shift.
- I. Secondary winding configuration must provide a zero-sequence impedance of <0.9% at 60Hz at any primary to secondary phase shift.
- J. Transformers 15 KVA thru 45 KVA shall be provided with interchangeable mounting for floor or wall.
- K. The maximum top of case temperature shall not exceed 35°C above ambient.
- L. The entire transformer enclosure shall be degreased, cleaned, phosphatized, primed and finished with baked enamel.
- M. The core and coils shall be visibly grounded to the frame of the transformer cubicle by means of a flexible grounding strap of adequate size.
- N. Sound levels shall be guaranteed by the manufacturer and substantiated by certified tests on each unit furnished. The sound levels are not to exceed the following values: 10 to 45 KVA, 42 D.B. to 150 KVA; 45 D.B., 225 to 300 KVA; 50 D.B. and 500 KVA, 54 D.B.
- O. If a particular "K" rating is specified for a dry-type transformer, that rating shall be provided.
- P. Insulation Class: R (220°C) and shall have the ability to carry a continuous 15% overload without exceeding a 220°C rise above 40° ambient.
- Q. Magnetic field at 1.5 feet: max. 0.1 Gauss
- R. Transformer shall provide an ultra-low zero-sequence impedance path in its secondary three-phase, fourwire subsystem for all zero-sequence currents, including 3rd, 9th, 15th, 21st harmonics, ---.
- S. Transformer shall provide a primary-secondary phase-shift of 0 degree in order to achieve cancellation of 5th, 7th, 11th, 13th, 17th, 19th, 23rd, 25th, --- positive- and negative-sequence harmonic currents on the

units' primary bus, equal to the lesser source of each individual harmonic current through each model, thereby treating all of the foregoing harmonic currents.

- T. NEMA TP1 linear-load efficiency at 35% full load must be verified by NEMA TP2 test method. In addition, non-linear efficiency at 35% full load must be verified by Voltage & Current Difference Measurement Method.
- U. Anti-vibration pads shall be used between the core and the enclosure.
- V. e-Rated® Efficiency: US DOE-CSL3 efficiency requirements.
- W. TVSS (parallel) 160,000 Amps per Phase (L-N, L-L, N-G all at 80,000 Amps each)
- X. Linear Load Efficiency: The transformer shall meet the efficiency requirements of NEMA TP1-2002, EPA Energy Star® and CSA C802.2-00, which are linear load efficiency requirements. Proof of compliance Type Tests, for each transformer type and rating, must be based on NEMA TP2-1998 'Standard Test Method for Measuring the Energy Consumption of Distribution Transformers'. Type Test are required with each submission
- Y. Non-Linear Load Efficiency: The transformer shall meet the efficiency requirements of NEMA TP1-2002 under non-linear loading, which has 100% THDI and a harmonic profile that is based on IEEE Std. 519-1992, Table 4.3 'Spectrum of Typical Switch Mode Power Supplies'. Proof of compliance Type Tests, for each transformer type and rating, must be based on the Voltage and Current Difference Measurement Method, with a minimum accuracy of 0.033%. Type Tests are required with each submission. The Power In Power Out Measurements Method is not acceptable.
- Z. Linear and non-linear losses and efficiencies, which are based on the Sections Y and Z, between 25% full load and 100% full load, must be plotted for each type and kVA rating.

6. **REQUIREMENTS & CERTIFICATIONS**

- A. Evidence of significant relevant application experience.
- B. Quantitative performance data including before/after effect on voltage distortion at load panels that demonstrates the capability to achieve the harmonic mitigation called for in this specification.
- C. Manufacturer shall be ISO 9001 certified.
- D. Device shall be UL Listed, CSA certified and CE Listed.

7. WARRANTY

- A. Manufacturer shall guarantee that the product will perform as described in Section 2.2 of this specification.
- B. Manufacturer shall warrant the product against defective materials and workmanship.
- C. Minimum terms and conditions: 10 year pro-rated, with standard limited liability clauses.

SECTION 262726 - WIRING DEVICES AND PLATES

1. GENERAL

- A. This section of the specifications includes wiring devices, cover plates, weatherproof and dust-tight closures, communications devices and floor outlets.
- B. Wiring devices are listed by manufacturer and catalog numbers to establish the quality and type required. Equivalent devices of other manufacturers will be acceptable with prior approval of the Engineer. Submit cutsheets and/or samples of each type ten days prior to bid date for review and written approval to bid. Insofar as possible, standard application or special application devices shall be by one manufacturer.

2. MATERIALS

ТҮРЕ	RATING	CONFIGURATIO N	COLOR	VENDOR - CAT. #		
RECEPTACLE - DUPLEX COMMERCIAL GRADE	125V, 20A 125V, 15A	NEMA 5-20R NEMA 5-15R	!	HUBBELL CR5362* GE 5362* LEVITON 5362* HUBBELL CR5262** GE 5262** LEVITON 5262**		
	 * USE WHEN ON DEDICATED 20A CKT., OR CALLED OUT ** USE WHEN ON DEDICATED 15A CKT., OR WHEN MORE THAN ONE RECEPTACLE ON A CIRCUIT 					
RECEPTACLE - DUPLEX PREMIUM GRADE	125V, 20A 125V, 15A	NEMA 5-20R NEMA 5-15R	! !	HUBBELL 5352* LEVITON 5362* GE 5362,* HUBBELL 5252** LEVITON 5262** GE 5262**		
	 * USE WHERE ON DEDICATED 20A CKT., OR CALLED OUT ** USE WHERE ON DEDICATED 15A CKT., OR WHERE MORE THAN ONE RECEPTACLE ON A CIRCUIT 					
RECEPTACLE - DUPLEX G.F.I. (SHALL MEET U.L. 943 STANDARD)	125V, 20A	NEMA 5-20R	!	HUBBELL GFR5352A		
RECEPTACLE - SIMPLEX	125V, 20A	NEMA 5-20R	!	HUBBELL 5361		
RECEPTACLE - DUPLEX, SAFETY TYPE (WITH TAMPER- RESISTANT SCREWS)	125V, 20A	NEMA 5-20R	!	HUBBELL HBL-8300- SG		

RECEPTACLE - DUPLEX, SAFETY TYPE (WITH TAMPER- RESISTANT SCREWS)	125V, 15A	NEMA 5-15R	!	HUBBELL HBL-8200- SG
RECEPTACLE, DUPLEX NEON PILOT FACE-RED	125V, 15A	NEMA 5-15R	!	HUBBELL 5262-LHR GE 5362-LHR LEVITON 5362-LHR
RECEPTACLE, SIMPLEX WITH CLOCK HANGER TAB, STAINLESS STEEL PLATE	125V, 15A	NEMA 5-15R	METAL	HUBBELL 5235 LEVITON 658-BR ARROW-HART 5760
RECEPTACLE, DUPLEX ISOLATED GROUND (WITH ORANGE LEGEND PLATE)	125V, 20A	NEMA 5-20R	ORANGE	HUBBELL IG-5362 GE 5362-IG LEVITON 5362-IG
RECEPTACLE, DUPLEX HOSPITAL GRADE (TO BE USED IN ALL PATIENT CARE AREAS, PER N.E.C., ART. 517)	125V, 20A	NEMA 5-15R NEMA 5-20R	!	HUBBELL 8200H GE 8200 LEVITON 8200 HUBBELL 8200H GE 8300 LEVITON 8300
RECEPTACLE, DUPLEX RED COLOR NYLON FACE (FOR EMERGENCY POWER OUTLETS)	125V, 20A	NEMA 5-20R	RED	HUBBELL 5352-RDB GE 5362-RDB LEVITON 5362-RDB
RECEPTACLE, DUPLEX ISOLATED GROUND WITH SURGE SUPPRESSION, INCLUDING INDICATOR LIGHT	125V, 15A	NEMA 5-15R	BLUE DEVICE	HUBBELL 5250S LEVITON 5380 ARROW-HART 5362
RECEPTACLE, SINGLE	250V, 20A	NEMA 10-20R	BLACK	HUBBELL 6810 GE 4124 LEVITON 5032
RECEPTACLE, SINGLE	250V, 30A	NEMA 6-30R	BLACK	HUBBELL 9330 GE 4139 LEVITON 5372
RECEPTACLE, SINGLE	250V, 50A	NEMA 6-50R	BLACK	HUBBELL 9367 GE 4141 LEVITON 5374
SWITCH, SINGLE POLE	120/277V, 20A	SPST	!	HUBBELL HBL-1221 GE 5951 LEVITON 1221
SWITCH, SINGLE POLE - RED TOGGLE (WITH RED COVER PLATE, FOR EMERGENCY LIGHTING CONTROL)	120/277V, 20A	SPST	RED	HUBBELL HBL-1221- RDB GE 5951-RDB LEVITON 1221-RDB
---	------------------	-------	-----	---
SWITCH, THREE-WAY	120/277V, 20A	3-WAY	!	HUBBELL HBL-1223 GE 5953 LEVITON 5953
SWITCH, FOUR-WAY	120/277V, 20A	4-WAY	!	HUBBELL HBL-1224 GE 5954 LEVITON 5954
SWITCH, KEYED	120/277V, 20A	SPST	N/A	HUBBELL HBL-1221- L GE 5951-L LEVITON 1221-L
SWITCH, KEYED	120/277V, 20A	3-WAY	N/A	HUBBELL HBL-1223- L GE 5953-L LEVITON 1223-L
SWITCH, KEYED	120/277V, 20A	4-WAY	N/A	HUBBELL HBL-1224- L GE 5954-L LEVITON 1224-L
NOTE:				

SWITCH, KEYED TO <u>EACH</u> BE FURNISHED WITH ONE HUBBELL #1209 KEY. TURN OVER TO OWNER AT CLOSE OF PROJECT AND OBTAIN RECEIPT FOR VERIFICATION THAT KEYS HAVE BEEN DELIVERED.

SWITCH, MOMENTARY, 3-POSITION, CENTER OFF SWITCH, PILOT (TOGGLE LIT IN OFF POSITION)	120/277V, 20A (VERIFY VOLTAGE USED)	SPDT	!	HUBBELL HBL SERIES GE EQUIVALENT LEVITON EQUIVALENT
SWITCH, PILOT (TOGGLE LIT IN OFF POSITION)	120/277V, 20A (VERIFY VOLTAGE USED)	SPDT OR AS NOTED	CLEAR "LEXAN"	HUBBELL HBL SERIES GE EQUIVALENT LEVITON EQUIVALENT
SWITCH, PILOT (TOGGLE LIT IN ON POSITION)	120/277V, 20A (VERIFY VOLTAGE USED)	SPST OR AS NOTED	CLEAR "LEXAN"	HUBBELL HBL-PL7 SERIES GE EQUIVALENT LEVITON EQUIVALENT

TIN	AER SWITCH	120V	SPST, 15 MINUTE	!	NUTONE VS63 GE EQUIVALENT LEVITON EQUIVALENT
NO	TES:				
1.	1. PROVIDE MATCHING CAP (PLUG) FOR ALL RECEPTACLES 30 AMP RATED AND ABOVE AS REQUIRED FOR EQUIPMENT.				
2.	2. ALL RECEPTACLES SHALL BE BACK OR SIDE-WIRED, CLAMPING TYPE				
3.	3. FOR DRYERS AND RANGES, PROVIDE 3-POLE GROUNDING TYPE AS REQUIRED BY DEVICE. LOCATE DEVICE SO THAT DRYER OR RANGE CAN BE PUSHED TIGHTLY AGAINST WALL.				
4.	4. RECEPTACLES SHALL BE TAMPER RESISTANT AND WEATHER RESISTANT AND MARKED ACCORDINGLY AS REQUIRED BY N.E.C.				
5.	5. ALL RECEPTACLES INSTALLED IN DAMP OR WET LOCATIONS SHALL BE UL LISTED WEATHER RESISTANT TYPE.				
!	! SEE ARTICLE 3, COLOR.				

- A. Small Motor Control Switches:
 - (1) For small line-to-neutral motor loads of 3/4 HP or less, single phase, rated at 120 or 277 volts, provide snap-type, H.P. rated motor starter switch with thermal overloads. Overload heaters sized to match the motor nameplate amperes and the ambient temperature shall be provided. Provide with NEMA 1, NEMA 3R or other enclosure suitable for the location and atmosphere. All manual starters in finished areas shall be in flush-mounted enclosures.

3. COLOR

- A. Color of devices shall be as selected by the architect. Samples (devices, plates or both) may be required to be submitted with other architectural color items by the Contractor. The Contractor shall coordinate any such submission required with other trades, the Prime Contractor or as needed.
- B. Where devices are controlling or supplying emergency power from a standby source, the device color shall be red, as with switch toggles or receptacle fronts. Plate color shall match others on normal power in the building unless otherwise noted.
- C. Where surface finishes next to the devices vary in color or shade throughout the project, the Contractor may be required to provide lighter or darker plates and devices to more closely match wall finishes. These variations are considered to be included in the original contract for construction.

4. MANUAL DIMMERS

A. Manual dimmers for incandescent, MR-lamp incandescent or fluorescent loads shall be matched to the type load intended to be controlled.

- B. Power rating shall be verified by examining the plans and suitable for the load, but in no case less than circuit load. Furnish dimmers in nominal power ranges of 600W, 1000W, 1500 watts, etc.
- C. Manual dimmers shall be provided with all solid state components, complete with choke coil and/or other R.F.I. suppression devices.
- D. Manual dimmers shall be suitable for mounting in single gang outlet box, ganging together in multi-section boxes where indicated, without derating being necessary.
- E. Manual dimmers shall be of the sliding-type, with detent stop at off position, full range control 0-100%. Lutron Company "Nova" Series or equivalent Lithonia, Lightolier.
- F. Manual dimmers for fluorescent lighting or low voltage transformer-fed incandescent fixtures shall be matched to suit the characteristics of the particular manufacturer's electronic ballast or transformer used in the dimming type fixture. Submit shop drawings of dimmer in the same submittal as the lighting fixtures.

5. PLATES AND COVERS

- A. Unless otherwise specified or noted, all wiring device plates and covers shall be smooth thermoplastic, Hubbell "P" Series or equivalent G.E. or Leviton. Color shall match device unless otherwise indicated.
- B. All kitchen, gymnasium or food service area plates shall be bright finish 302 stainless steel.
- C. Cover plates shall be of one manufacturer insofar as possible.
- D. Weatherproof plates for G.F.C.I. receptacles shall be cast aluminum, self-closing, gasketed, suitable for standard box mounting, U.L. listed for wet location use, cover closed. Vertical mounting - Hubbell WP26M, horizontal mounting - Hubbell WP26MH (die-cast zinc) or equivalent Leviton or G.E.
- E. Weatherproof switch plates for toggle-handle switches shall be clear silicone rubber, for standard outlet boxes. Hubbell 1795 or equivalent G.E. or Leviton.
- F. Cover plates for computer, telephone or other system outlets shall be as required to meet supplier or the owner's requirements, as applicable. Color to match other plates on project. Furnish telephone plates with wall-mounting studs if mounted at 48" or higher. See devices schedule below.

6. COMMUNICATIONS DEVICES AND PLATES

- A. Communications devices and wall plates furnished for this project shall all be standard products, of the same manufacturer. They shall consist of a wall plate bezel, capable of holding snap-in devices as indicated.
- B. Color of communications wall plates shall match the color of all other plates furnished on the project, matching switch, receptacles, etc. Verify all color selections with the Architect.
- C. The color of communications wall plate snap-in inserts shall be as noted herein, or shall be per the owner's standards, if applicable. Verify color requirements prior to ordering any materials.
- D. Provide securely-fastened permanent labels in the faceplate of communications wall plates that clearly and legibly indicate the address or unique identifier for an individual jack.

- E. All communications wall plates shall be provided with a bezel capable of holding a minimum of four separate device inserts, unless otherwise noted. Provide blank inserts to close any unused positions, of a color to match the plate.
- F. Communications wall plates and devices shall be as manufactured by Panduit, Lucent Technologies, Leviton, AMP or approved equivalent.

DEVICE INSERT SCHEDULE			
Multimode Fiber Optic (Always Install in Pairs)	FDDI - Compatible 62.5/125μ, ST-Style Grey Color, Female (2 fibers terminated)		
Ethernet Network Data	Category 5 - Enhanced or Category 6, 8 Pos/4 Pair Blue Color RJ-45, EIA/TIA 568AB (4 pairs terminated)		
Voice Circuits 4 Pair	Category 5 - Enhanced or Category 6, 8 Pos/4 Pair White Color RJ-45, EIA/TIA 568B (4 pairs terminated)		
Fiber Optic 2 Strands	"SC"-Style Connectors Mounted in Adjacent Pairs - Black Color		
Voice Circuits 2 Pair	Category 3, 4 Pos/2 Pair Green Color RJ-11 (2 Pairs Terminated)		
Video Circuits	"F" Connector Bulkhead Style White Color (RG-6 coax termination)		
Blank Cover	Color to Match Wall plate		
Wall Plate (4-Port/1 Gang)	Color to Match Wiring Devices Used in Adjacent Areas		
Special Comm. Port for T-1 and Special Communication Circuits	Orange Color RJ-31X, 8 Pos/4 Pairs Terminated		

7. STANDARD SINGLE-SERVICE FLOOR BOXES

- A. In general, floor boxes to be used flush in concrete floors shall be of single-gang stamped steel construction, round, deep style, fully adjustable Hubbell B-2537 Series, Type 1 or equivalent.
- B. Where multiple gangs are indicated on the plans (or elsewhere), multi-gang (up to 3 yokes maximum) stamped steel, rectangular, deep style units shall be used. They shall be fully adjustable, Hubbell B-2432 Series, Type 1, or equivalent. Multiple-gang boxes shall be provided with removable partitions between each section in accord with N.E.C., where power and non-power circuits enter the same box.
- C. In general, all cover plates for floor boxes shall be flush, solid brass. Provide typical plates as listed:

Duplex Outlet	- Round, Duplex Flap - Hubbell S-3925 - Rectangular, Duplex Flap - Hubbell S-3825
Telephone or Data	- Round, Combination 1" or 2 1/8" - Hubbell S-2725 -Rectangular, Combination 1" or 2 1/8" - Hubbell S-2625

- D. Furnish floor boxes with threaded hubs as required to suit conduit routings, 3/4" minimum.
- E. Furnish carpet flanges for all boxes installed in carpeted areas. Flanges to be clear polycarbonate plastic, round Hubbell S-3079 or rectangular, for gangs indicated Hubbell S-308 Series or equivalent.
- F. Floor outlet boxes shall be installed dead level flush with wood, VCT, concrete or other hard surface type floor. Furnish special stop trims for terrazzo where required.
- G. Outlets within floor boxes shall be as specified elsewhere in these specifications.

8. SPECIAL MULTI-SERVICE FLOOR BOXES

- A. In general, floor boxes that are to contain multiple services such as power, data, voice, video, etc., shall be constructed of stamped steel and heavy thermoplastic with barriers or compartments to separate power from signal services per National Electrical Code.
- B. Provide multi-service floor boxes with proper trim for carpet, wood, terrazo, tile or concrete floors, wiring slots, dust covers and proper device plates to hold outlets, jacks, etc. They shall be fully adjustable. Conduit rough-in shall be as required. All tops shall be capable of receiving an insert of the surrounding floor material.
- C. Outlets for multi-service floor boxes shall be as specified elsewhere in these specifications.
- D. Set boxes dead level with flooring and provide proper support by thickening concrete slab, welding angle iron across joists below or other approved means.
- E. Multi-service floor boxes shall be capable of containing a minimum of two duplex receptacles and two 4-position single gang modular plates for voice, video or data jacks and shall be as manufactured by Hubbell #HBLCFB401 base with #HBLTCGNT cover, with all required accessories or equivalent Walker "RFS" Series or Lew. If not installed on carpeted floors, provide flush brass trim.

9. INSTALLATION

- A. All wiring devices in dusty areas, exposed to weather and moisture shall be installed in Type "FS" or similar conduit fittings having mounting hubs, with appropriate cover plates.
- B. Devices that have been installed before painting shall be masked. No plates or covers shall be installed until all finishing and cleaning has been completed.
- C. Provide G.F.C.I. duplex feed-thru style receptacles in accordance with new U.L. Standard 943 where indicated or required by the National Electrical Code, whether specifically called out or not. When a G.F.C.I. receptacle is on a circuit with other non-G.F.C.I. receptacles, it shall always be placed at the homerun point of the circuit and shall be wired to ground-fault interrupt protect the downstream outlets on that circuit unless specifically indicated to the contrary. Provide a "G.F.C.I. protected" label on each downstream outlet.

- D. GFCI devices shall be installed in a "readily accessible" location per NEC requirements. GFCI protected outlets required by plans or code shall be fed by a GFCI breaker or upstream GFCI device if they are not readily accessible.
- E. Where surge suppression outlets are provided, they shall be ANSI Category "A" style. They shall be installed as dedicated-circuit outlets or where indicated with multiple outlets on a circuit, they shall be placed at the homerun point of that circuit and feed-thru wired to protect the downstream outlets on that circuit.
- F. All receptacles shall be installed with ground prong at **top** position.
- G. All outlets not provided with wiring devices shall be closed with a blank plate matching other plates in the area.

END OF SECTION 262726

SECTION 264313 - SURGE SUPPRESSION SYSTEMS

1. GENERAL

- A. Each Contractor's attention is directed to Section 260501, General Provisions Electrical and all other contract documents as they may apply to his work.
- B. Each Surge Suppression Unit (transient voltage surge suppressor, or T.V.S.S.) furnished shall meet or exceed U.L. 1449, Second Edition *Revision* (February 2007), with capacity for each basic Category A, B and C, surge rise time of ten microseconds and a surge duration of at least one thousand microseconds.
- C. <u>SPECIAL NOTE</u>: When using a "Meggar" or similar instrument to test conductors in a panelboard or switchboard, disconnect any T.V.S.S. device connected to any combination of those conductors. Failure to do so may damage or destroy the T.V.S.S. device. If any damage occurs as a result of testing to a T.V.S.S. device, the Contractor shall replace the device.

2. SCOPE OF THE WORK

- A. The Contractor shall provide the necessary labor, materials, wiring and services necessary to provide the complete electrical surge protection systems as specified herein. This work shall include, but is not necessarily limited to:
 - (1) Provision of Surge Suppression Units at certain points in the power distribution network, on telephone, satellite dish leads and cable television service lines as indicated herein or on the drawings.
 - (2) Proper installation of surge suppression unit(s), in accord with shop drawings. Wiring routing, grounding, raceways and all connections shall be in <u>exact accord</u> with manufacturer's recommendations, the National Electrical Code, and any other applicable regulations, local or national, or international.

3. QUALITY ASSURANCE

- A. The manufacturer shall be regularly engaged in production of surge protection equipment, of types, sizes and ratings required, whose products have been satisfactorily used in similar service for not less than three years.
- B. Comply with NEC and NFPA requirements, as applicable to materials and installation of surge protection components and wiring. Surge protection equipment shall be UL listed and labeled for its intended use. TVSS shall be labeled with 200kA Short Circuit Current Rating (SCCR). Where applicable, equipment shall comply with ANSI standards for such equipment.
- C. <u>SPECIAL NOTE</u>: The physical routing, length and connections of the unit's phase, neutral and ground conductors are critical to the performance of surge suppression units. The Contractor shall carefully observe and comply with the manufacturer's installation requirements.

4. SUBMITTALS

A. Product Data: Submit manufacturer's data on surge protection systems and components as part of shop drawing submissions. Indicate all capacity ratings, clamp times, maximum capacities, EMI/RFI attenuation data, withstand capabilities, physical construction and listing agency approvals.

B. Maintenance Data: Submit maintenance instructions for surge suppression system. Include this data in Operation and Maintenance manuals.

5. MATERIALS

A. ACCEPTABLE MANUFACTURERS

Subject to compliance with requirements, manufacturers offering surge protection components which may be incorporated in the work includes, but are not limited to, the ones listed below. Other manufacturers will be considered if their proposed products are in full compliance with these specification requirements.

Surge Protective Devices:

Liebert Corporation, Inc General Electric Corporation Transtector, Inc. Advanced Protection Technologies, Inc. Square D. Inc.

6. T.V.S.S. MINIMUM REQUIREMENTS

T.V.S.S. minimum requirements shall meet or exceed the following criteria:

A. Minimum surge current capability (single pulse rated) per phase shall be:

(1) Service entrance applications:	200 kA per phase (Category "C")
------------------------------------	---------------------------------

- (2) Distribution applications: 120 kA per phase (Category "B")
- (3) Non-receptacle applications: 40 kA per phase (Category "A")
- (4) Receptacle applications: 12 kA per phase (Category "A")
- B. UL 1449 Listed Suppression Voltage Ratings for service entrance shall not exceed the following: (Category "C")

VOLTAGE	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>	MCOV
208Y/120V	400	400	400	150V
240Delta/120V	400	400	400	150V
480Y/277V	800	800	800	320V

(With internal disconnect switch 400V and 800V respectively).

C. UL 1149 Listed Suppression Voltage Ratings for distribution shall not exceed the following: (Category "A" & "B")

VOLTAGE	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>	MCOV
208Y/120V	400	400	400	150V
240Delta/120V	400	400	400	150V
480Y/277V	800	800	800	320V

(With internal disconnect switch 400V and 800V respectively)

(L-N = Line to neutral)

(L-G = Line to ground)

(N-G = Neutral to ground)

(MCOV = Maximum continuous operating voltage)

7. BUILDING ELECTRICAL SERVICE SURGE PROTECTION SYSTEM COMPONENTS

- A. GENERAL
 - (1) Provide UL 1449 Second Edition *Revision* (February 2007) listed and labeled lightning and transient surge protection devices, installed where shown on the drawings and in accord with the manufacturer's recommendations.
 - (2) The surge protection devices shall be shunt type and polyphase, with the ability to conduct high energy transients from line to ground, line to neutral and neutral to ground. Provide in a NEMA 12 enclosure with hinged or screw cover front panel. Provide internal fusing in modules to protect unit.
 - (3) Provide units with EMI/RFI noise attenuation, using 50 ohm insertion loss test: -50 dB at 100 khz, UL 1283 listed, with an insertion ratio of 50:1 using M.I.L. STD 220-A.
 - (4) For each surge suppression unit, categories A, B & C, provide unit function status indicators. These indicators shall be mounted in the face of the equipment panel. Provide green L.E.D., illuminated for normal operation, red L.E.D. for trouble/fault or reduction of surge suppression capacity. Provide an audible alarm with silence switch to alarm at unit on malfunction for category "C" units only. Provide a resettable surge counter for each category "C" unit to indicate each suppression operation of the unit.
 - (5) Enclosures shall be surface-mounted where panels protected are surface-mounted, flush-mounted for all units in finished areas. Where panels protected are flush-mounted, place surge suppression device above or below panel, aligned and square with panel trim.
 - (6) Provide disconnecting means for each surge protection device per the following:

Category "C" Device at Main Service:

40 to 60 Ampere, 3 Pole, 600V, S/N, NEMA 1 disconnect, built into the unit and furnished by the supplier as an integral part of the equipment. Disconnecting means shall be capable of withstanding the available fault currents. Verify fault current with the Contractor.

- Category "B" Devices, at Panels: 30 Ampere, 3 Pole Circuit Breaker in Protected Panel
- Category "A" Devices, at Panels: 30 Ampere, 3 Pole Circuit Breaker in Protected Panel
- (7) Internal Device Overcurrent Protection (Fusing)
 - a. All protection modes (including Neutral to Ground) of each surge suppression device shall be internally fused at the component level with fuse I²t capability allowing the suppressor's maximum rated transient current to pass through the suppressor without fuse operation. Every suppression component of every mode (including Neutral to Ground) shall also be protected by thermal overtemperature controls. If the rated I²t characteristic of the fusing is exceeded, the fusing shall be capable of opening in less than one millisecond and clear both high and low impedance fault conditions. The fusing shall be capable of interrupting up to 200 KA symmetrical fault current with 600 VAC applied. This overcurrent protection circuit shall be monitored, to provide indication of

suppression failure. <u>Conductor level fuses or circuit breakers internal or external to the surge</u> suppression units are not acceptable as meeting this requirement.

B. MAIN SERVICE SURGE SUPPRESSION - CATEGORY "C" UNITS

- (1) Category "C" units shall be installed on the service entrance or building entrance equipment. Units shall be rated 277 volts/480 volts (or 120/208 volts as needed), 3 phase, 4 wire, minimum 200,000 amp (total amps per phase) surge capacity, with less than 5 nanosecond reaction time. Category "C" units installed to protect a switchboard may be built into the switchboard construction if U.L listed for such applications.
- (2) Category "C" withstand capabilities: 5,000 A.N.S.I. Category C3 surges with less than 10% change in clamping voltage.

C. PANELBOARD SURGE SUPPRESSION - CATEGORY "B" UNITS

- (1) Units shall be installed as indicated herein or on the contract drawings, set beside or above the distribution panel indicated, and connected as recommended by the equipment manufacturer.
- (2) All emergency system switchgear, distribution panels and branch panelboards shall be provided with surge protection devices in accordance with the NEC.
- (3) Category "B" units shall be rated for 277-480 volts (or 120/208 volts, as indicated), 3-4 Wire Wye service. Units shall be minimum 120,000 ampere rated per phase, with less than 5 nanosecond reaction time. Provide fusing and fault indicator pilot lights as in (A) General above.
- (4) Category "B" withstand capabilities: 5,000 A.N.S.I. Category C3 surges with less than 10% change in clamping voltage.
- D. BRANCH PANELBOARD SURGE SUPPRESSION CATEGORY "A" UNITS (NON-RECEPTACLE APPLICATIONS)
 - (1) Units shall be installed as indicated herein or on the contract drawings, set beside or above the panelboard indicated, and connected as recommended by the equipment manufacturer.
 - (2) All emergency system switchgear, distribution panels and branch panelboards shall be provided with surge protection devices in accordance with the NEC.
 - (3) Units shall be installed flush in finished areas. Units may be surface-mounted if in unfinished mechanical spaces and the panel protected is also surface-mounted.
 - (4) Category "A" units shall be rated for 277/480 volts or 120/208 volts, three phase, 4 wire wye service as indicated on the drawings. Units shall be rated 40,000 amperes surge current, less than one nanosecond response time. Units shall be fused in accord with (A) General noted above.
 - (5) Furnish unit with red and green indicator lights to signify normal operation and component or suppression capability failure.

E. TELEPHONE AND TELEVISION SURGE SUPPRESSION

(1) As a part of this section of work, the Contractor shall provide or arrange for the installation of U.L. listed lightning and surge arrestors on the incoming telephone and television service lines, as well as on

AM-FM- antenna downleads and the coaxial cables coming into the building from satellite dish antennas and all other types of exterior antennas installed by the Contractor or Owner, where the Contractor installs the coaxial cable for the antenna.

- (2) Arrestors shall be U.L. listed, properly grounded per N.E.C., and shall be located at the service entrance points for each cable installed by a utility company or at the point of building entry for Contractor-installed cables leading in from antennas. Also provide surge arrestors of the proper type for any copper cables that are installed between buildings by the Contractor, if such a condition occurs within the project.
- (3) The Contractor shall arrange for the telephone company to install M-O-V, gas-type or other U.L. listed lightning arrestors on each of their incoming telephone circuits that are terminated for building use.
- (4) Arrestors for coaxial lines shall be rated 25 to 250 MHZ on cable T.V. lines, and 250 MHZ to 1GHZ on satellite dish lead-ins with BNC jacks in/out or as required by antenna connectors.
- (5) Devices as manufactured by Lucent Technologies, Winegard or Liebert Corporation will be acceptable.
- (6) Provide a ground lug for individual surge suppression unit installations, with the recommended ground wire size routed back to the building main electrical ground or ground bar in wiring closet.
- (7) Where multiple surge suppression units are installed, as at service entrance locations, provide a ground bar, copper, with multiple tapped holes and a properly sized ground lead routed back to the building main electrical ground.

8. EXECUTION

- A. Installation of Surge Protection Systems:
 - (1) Install surge protection systems as indicated and in accordance with equipment manufacturer's written instructions, in compliance with applicable requirements of NFPA, local prevailing codes and with UL lightning and power surge protection standards to ensure that surge suppression systems comply with requirements.
 - (2) Coordinate with other work, including electrical wiring work as necessary to interface installation of units.
 - (3) Install conductors with direct, shortest possible phase, neutral and ground paths from all in/out connections, avoiding sharp bends and narrow loops.
 - (4) Install surge suppression units as close as practical to equipment they are protecting. Install appropriate units at main electrical service entrance equipment and secondary branch panelboards as indicated.
 - (5) Refer to the drawings for installation of individual surge suppression devices to protect branch circuits. Also see Section 262726 for (receptacle type) device requirements. All receptacle type surge suppression units shall be wired as feed-thru type, to protect all downstream outlets on that branch circuit unless otherwise indicated.

9. WARRANTIES

- A. All surge suppression equipment shall be unconditionally warrantied by the Contractor for a period of one year from the date of project substantial completion. Where longer manufacturer's warranties are offered, they shall be made available to the Owner. Note these extended warranties in the Operations and Maintenance Manuals.
- B. Category "C" devices to carry 5 year parts and on site labor unconditional warranty.
- C. Category "B" and "A" devices to carry 5 year unconditional replacement warranty.

END OF SECTION 264313

SECTION 265113 - LIGHTING FIXTURES AND LAMPS

1. GENERAL

- A. Furnish and install all lighting fixtures, as herein specified, complete with lamps and accessories for safe and effective operation. All fixtures shall be installed and left in an operable condition with no broken, damaged or soiled parts.
- B. All items furnished shall comply with the latest standards applicable such as U.L., NEMA, etc., and shall bear labels accordingly. All fixtures shall be the color specified or as selected by the Architect. Wherever fixtures have evident damage, they shall be restored to new condition or shall be replaced. Likewise, fixtures showing dirt, dust or finger prints shall be restored to new condition or shall be replaced.
- C. Eight copies of light fixture factory shop drawings and cuts, showing fixture dimensions, photometric data, installation data and, if applicable, air handling data, shall be submitted to the Engineer for written approval 30 days after bid date. (Verify shop drawing quantities with the Architect.)
- D. Locate pendant, surface mounted or chain-hung industrial fixtures in mechanical rooms and similar spaces to avoid ductwork and piping. Locate around and between equipment to maximize the available light. Request a layout from the Engineer if uncertain about an installation.
- E. Alternate fixtures may be substituted for types specified by name or catalog number. Proposed substitutions must be submitted to the Engineer ten working days prior to bid date for written approval to bid. This written approval will only be issued in addendum form.
- F. Where emergency battery packs or integral emergency transfer relays are provided with fixtures, they shall be connected to an unswitched power line and wired in accord with the manufacturer's recommendations. Test buttons and indicator lamps shall be visible and accessible with fixture door open, or shall be remotely flush mounted in the ceiling adjacent to the fixture.
- G. Where remote emergency lighting transfer relays are provided, they shall be flush mounted in the ceiling adjacent to a controlled fixture. They shall be connected to an unswitched power line and installed in accord with the manufacturer's recommendations. Test buttons and indicator lamps shall be visible and accessible without removing ceiling tiles or access panels.
- H. All reflecting surfaces, glass or plastic lenses, ballast housings, parabolic louvers, downlighting Alzak cones and specular reflectors shall be handled with care during installation or lamping to avoid fingerprints or dirt deposits. It is preferred that louvers be shipped and installed with clear plastic bags to protect louvers. At close of project, and after construction air filters are changed, remove bags. Any louver or cone showing dirt or fingerprints shall be cleaned with solvent recommended by the manufacturer to a like-new condition, or replaced as necessary in order to turn over to the Owner new fixtures at beneficial occupancy.
- I. Where fixtures are scheduled to be provided with quartz restrike relay and lamp, for auxiliary or emergency illumination, the controlling relay shall be configured to energize the lamp on cold start or hot lamp restrike.
- J. Refer to architectural details as applicable for recessed soffit fluorescent fixtures or wherever fixture installations depend upon work of other trades. Coordinate all installations with other trades. Verify dimensions of spaces for fixtures, and if necessary, adjust lengths to assure proper fit and illumination of diffuser and/or area below.
- K. The use of pre-terminated lighting connectors ('Reloc' or similar) is prohibited.

2. VOLTAGE

A. All lighting fixtures will be rated 120, 277 or 480 volts, single phase as indicated or required.

3. BALLASTS

- A. Electronic Instant-Start Fluorescent Ballast Specifications
 - (1) Fluorescent ballast to be instant-start high performance electronic to operate at a frequency of 20KHz or higher with less than 2% lamp flicker, at an input voltage of 108 to 132 VAC (120 volt line) or 249 to 305 VAC (277 volt line) at an input frequency of 60 Hz, minimum of .88 ballast factor, power factor of .98. Light output to remain constant for line voltage of ± 4%. Ballast to comply with EMI and RFI limits set by FCC (CFR 47 part 18) for normal electrical equipment and have less than 1.4 lamp current crest factor (or less if required by the fluorescent lamp supplier). Verify this prior to submitting shop drawings. Ballast to meet ANSI Standard 82.41 and be UL listed Class P Type I. Ballast shall be non-PCB bearing.
 - (2) Ballast to have less than 10% total harmonic distortion with less than 6% third harmonic distortion. Ballast to have "A" sound rating with a power factor greater than .99 and have a twenty year rated life. Ballasts used shall operate 1, 2, 3, or 4 T8 lamps as specified in the fixture specification. Use a 2, 3 or 4-lamp ballast to match number of lamps in fixture, and meet all switching requirements as shown on the drawings. Ballasts shall be unconditionally warrantied by the manufacturer for a period of three years from the date of substantial completion.
 - (3) Motorola, Advance, Universal or Valmont are acceptable manufacturers.
 - (4) Provide in-line fuse-holder(s), with fuse sized per manufacturer's recommendations for each 277 volt fixture.

<u>NOTE</u>: No single 2, 3, or 4 lamp ballast with 2 source input will be allowed for any fixture(s) shown supplied by both normal and emergency power.

- B. Metallic vapor lamp (H.I.D.) ballast shall be rated 120 or 277 or 480 volts, 60 Hertz energy-saving high power factor, copper wound, auto regulator type for single lamp, complete with external fuse holder (Bussmann HLR) and as manufactured by Jefferson, G.E., or Advance. All vapor lamp ballasts shall be encapsulated or potted to minimize the amount of audible hum produced. No open core and coil ballasts shall be provided unless specifically indicated in the fixture description. Ballast factor for all H.I.D. ballasts shall be $1.0 \pm 5\%$ tolerance. Ballast shall deliver full wattage, to match the rating of the lamp, assuming proper input voltage, within the tolerance range noted.
- C. Where lighting standards have fuses protecting ballasts, an in-line type of fuseholder shall be located at the base of the pole, readily accessible behind the handhole coverplate. Where multiple circuited luminaires are on a single pole, identify the separate fuseholders.

4. LAMPS

A. Lamps furnished and installed in indicated fixtures shall be as manufactured by G.E., Westinghouse, Phillips, Osram or Venture. Wherever possible, all lamps provided shall be manufactured in the United States of America.

- B. All incandescent lamps shall be rated 130 volts with a medium screw type base (or as required) in wattages less than 300 watts and 130 volts, mogul screw type base in 300 watts and larger.
- C. Fluorescent lamp to be T8 (one inch diameter), various lengths, wattages, rapid start with lamp efficacies of over 97 lumens per watt on electronic ballast, 91 lumens per watt on magnetic ballast, with a color rendering index (C.R.I.) of 65 or higher, medium bi-pin base configuration. Normal color to be 4100° Kelvin unless specified otherwise in fixture list. Normal power input to be 32 watts for 48" lamps. Lamps to have an average life of 15,000 hours at three hours per start. Lamps to operate at 265MA. Osram, Westinghouse, Philips, and General Electric are acceptable manufacturers.
- D. (1) H.I.D. (low or high pressure sodium, mercury vapor, metal halide) lamps shall be suitable for the specified fixture, and as listed in the fixture schedule. All HID lamps shall be furnished with mogul base, unless otherwise noted or required. H.I.D. lamps used in <u>outdoor</u> fixtures shall have <u>clear</u> envelopes, in <u>indoor</u> fixtures they shall have <u>diffuse</u> coatings unless specifically indicated otherwise.
 - (2) Metal halide lamps shall be Osram "Super Metalarc" 4100° Kelvin correlated color and temperature (C.C.T.). Where used in horizontal burning positions, provide with position indicators on base. Consequently, all fixtures specified with horizontal metal halide lamps shall utilize position-oriented sockets, and lamps shall be installed per manufacturer's recommendations. No substitutions are permitted for this brand of metal halide lamp, where indicated for horizontal burning position. All metal halide lamps in any given area shall be the same color temperature rating and C.R.I. Clear lamps shall be 60 C.R.I. minimum, coated lamps shall be 70 C.R.I. minimum.
 - (3) Where a fixture containing an HID lamp utilizes a variable focus or positioning socket, it shall be adjusted for the distribution pattern indicated.
- E. "MR" incandescent lamps shall be 12 volt rated, with appropriate transformer for an eleven volt secondary voltage or as recommended by the lamp manufacturer, with matching dimmer where dimmers are indicated, rated <u>specifically</u> for the lamp/transformer combination. Where M.R. incandescent lamps are indicated to be furnished for line voltages, they shall be rated 130 volts.
- F. Compact fluorescent lamps shall be amalgam type 4-pin by Phillips "PL", G.E. "Biax" or Osram. All compact fluorescent lamp/ballast combinations shall be rated for high power factor. No low power factor lamp/ballast combinations may be used.

5. LIGHT FIXTURE GENERAL REQUIREMENTS

- A. Fluorescent Recessed Lighting Fixtures General Requirements
 - (1) The following are minimum requirements for recessed fluorescent fixtures for lay-in grid, gypsum board, plaster and concealed spline ceilings. Surface-mounted fluorescent fixture requirements shall be similar.
 - (2) Housings shall be a minimum of 4" depth, premium grade, constructed of a minimum 22 gauge die embossed or stiffened cold rolled pre-treated rust-resistant steel. Troffers shall be equivalent to Hubbell "Versaline," Daybrite "Designer," Lightolier equivalent or Lithonia "2SPG" series.
 - (3) All parts shall be finished with polyester powder or white baked enamel (85% minimum reflectance) painted after fabrication. All wiring shall be type TFN, or THWN and shall be covered by the steel ballast cover, wiring channel, or socket track. Exposed wiring is not acceptable. Connection wiring shall be accessible thru a hinged access plate above ballast channel in top of unit.

- (4) Ballasts shall be as specified. If a manufacturer and series number is listed, substitution by other manufacturers shall be of the exact same specification (sound rating, energy consumption, life expectancy, warranties, physical size, heat and temperature ratings), etc. All ballasts shall be instant-start, cool operating, of the electronic energy-saving type, UL and CBM listed.
- (5) The complete light fixture unit shall be UL listed and labeled. Other agency listings may be acceptable with written approval from the Engineer.
- (6) Fixture lens doors shall be reversible, hinged, painted after fabrication, with spring-loaded or other mechanically stable positive action latches.
- (7) Lens shall be as specified for each fixture type. If a specific manufacturer and series number of lens is listed, the substitute shall be of the exact specification (thickness, prism configurations, transparency, efficiency, photometric distribution, hardness, vandal-resistance, etc.). Minimum average thickness of any prismatic lens shall be .125".
- (8) Fixture trim and/or flanges shall conform with ceiling constructions as required. Verify all types prior to submission of shop drawings and indicate any special types on submittals. Fixtures installed in drywall or plaster ceilings to be provided with flange, screed and swing gate anchoring system.
- (9) All fixtures shall be furnished with hold down clips to meet applicable seismic codes, four clips per fixture minimum or the equivalent thereof in the installation trim. Verify thickness of drywall or plaster ceilings prior to submission of shop drawings, to allow for proper trim adjustment.
- (10) Support fixtures with one hanger wire at each end. Hanger wires shall be installed within 15° of plumb, maximum or additional support shall be provided. Wires shall be attached to the fixture body and to the building structure not to the supports of other work or equipment.
- (11) Each type of fluorescent (or other type) lay-in fixture shall be furnished with the proper housing flange or lip to suit the type of lay-in grid(s) being utilized on the project. The Contractor is to verify if narrow or standard grid members are being furnished and provide the proper type of light fixture trim. Indicate any special trims on shop drawing submittals.
- (12) Lamps shall be as specified in lamp section of these specifications, and suitable for use in the fixture intended. If the lighting fixture manufacturer requires a specific lamp for optimum performance, that lamp shall be furnished.
- (13) <u>Do not</u> provide pressure-lock or any other type of lampholder unless specifically indicated to the contrary or required by local codes. Fixtures may be shipped from the factory with lamps installed, at the Contractor's option.
- B. Industrial and Striplight Fluorescent Fixtures General Requirements
 - (1) Units shall have die-formed heavy gauge cold rolled steel channels and die-embossed reflectors.
 - (2) Finishes to be coated with a gloss powder paint or baked enamel finish with a minimum 85% reflectance.
 - (3) Units to have aligner clips where required for a continuous row appearance. Where continuous rows exceed twelve feet in length, provide a "unistrut" channel or similarly adequate mounting to stiffen and align row.

- (4) Units to have captive latches for ballast covers, heavy-duty lampholders and wire guards where specified. Wire guards shall be heavy-duty #14 wire gauge) minimum with corrosion-resistant plated or vinyl finish.
- (5) Ballasts to be as specified herein.
- (6) Units to be UL listed.
- (7) Mounting brackets and hanging mechanisms shall be as specified in fixture descriptions, or as required. Allow a generous safety margin with all support systems, as recommended by the manufacturer.
- C. Recessed Ellipsoidal or Parabolic Cone Downlight General Requirements
 - (1) Fixture to have an extruded or die-cast aluminum lampholder housing. Retaining mechanism shall provide easy access to lamp and ballast junction box. Lamp holders shall be U.L. listed, compatible with the lamp type specified. All sockets shall be porcelain or high temperature plastic. No bakelite or fiber material shall be used.
 - (2) Unit to have a corrosion-resistant steel junction box with hinged access covers and thermal protector.
 - (3) Mounting/plaster frame to be heavy gauge steel with finishing trim friction support springs, for the required ceiling thickness. Trim to be of color as selected by the Architect.
 - (4) Optical system to consist of a specular clear Alzak upper ellipsoidal (or parabolic, as noted) reflector with specular Alzak cone or microgroove matte black baffle as noted in schedule. Units shall have a UL approved clear tempered glass protection lens where used with metal halide or quartz lamp. Where other than clear Alzak cone/reflector color is noted on the schedule, it shall be furnished as specified.
 - (5) Ballast to be HPF CWA 120 or 277 volt. Fixture to have a prewired, encased and potted ballast tray module. Ballast to be best sound rating available (least audible) for the class and wattage of lamp.
 - (6) Provide telescoping channel bar hangers that adjust vertically and horizontally.
 - (7) Minimum flange shall match cone finish or provide painted color as selected by the Architect on black microgroove baffle types.
 - (8) Lamps shall be as specified in lamp section of these specifications.
 - (9) Fixtures to be UL listed for thru-branch circuit wiring, recessed, and damp locations. Where installed in plaster or drywall or other inaccessible ceiling type, they shall be U.L. listed for bottom access.
 - (10) Refer to other sections of this specification for quartz restrike option requirements.
- D. Exit Lights General Requirements
 - (1) Housings and canopies shall be die-cast aluminum or corrosion resistant steel. Mountings shall be wall or ceiling, universal type, to suit the installation conditions.
 - (2) Provide with stencil face, lettering color red, of sizes in accord with code, or as otherwise specified.

- (3) Provide single or double face as scheduled, indicated on plans or as required by the local authority having jurisdiction. Adjust installation position if required for clear visibility, in accord with applicable codes.
- (4) Complete unit to be finished in color as selected by the Architect.Provide directional arrows as indicated on plans, as scheduled to suit the means of egress or as required by the local authority having jurisdiction.
- (5) Lamps shall be long-life type, as specified.
- (6) Where emergency backup battery packs are provided with exit lights, they shall have capacities for continuous operation per applicable codes. They shall have reserve battery capacity to operate remote lamps where indicated.
- E. H.I.D. Lighting Fixtures General Requirements
 - For recessed indoor/outdoor fixtures, housing to be maximum of 20" high, constructed of 22 gauge dieformed, cold rolled steel finished with polyester powder (85% gloss, 89% reflectance) or baked enamel paint. Unit to be painted after fabrication.
 - (2) Surface-mounted indoor or outdoor fixtures shall have aluminum or steel housings as specified, finish or color as selected, wet or damp location U.L. listing as required and full gasketing to prevent insect entry. Provide charcoal or equivalent filter to allow fixture optical assembly to "breathe" for totally enclosed, gasketed fixtures.
 - (3) All wiring to be Type TFN or THWN; all wiring shall be enclosed by ballast covers, flexible conduits, or socket enclosure.
 - (4) Fixtures to have vertical lamp and extruded or die-cast aluminum heat dissipating finned socket housing. Socket shall be porcelain, with lamp shell to be nickel-plated, split type, 4 or 5 KV pulse rating, per U.L. Standards.
 - (5) Where fixtures are scheduled to have metal halide lamps, provide with clear tempered glass shield below lamp.
 - (6) Provide fixtures with high power factor constant wattage auto-transformer (CWA) 120, 277 or 480 volt (as specified or required) ballast, solidly anchored on hinged plate or power drawer that is easily accessible from below fixture. Provide ballast with single or double fusing as needed. Ballasts shall be encapsulated type, best available sound rating(least audible) for the class and wattage of lamp specified. Also see 4(D) above for additional requirements.
 - (7) Provide trim for lay-in, plaster, drywall, etc. applications as needed for recessed fixture.
 - (8) Lamps shall be as specified elsewhere in this section.
 - (9) Refer to other sections of this specification for quartz restrike option requirements.

6. LIGHTING FIXTURE SCHEDULE

<u>Note</u>: Each vendor proposing to bid the materials specified herein below is cautioned to review all requirements of the Contract Documents, as they may apply to the work involved, particularly Specifications Articles 1 thru 5 of this Section. The general materials requirements are to be met in

their entirety by the contractors and vendors supplying these materials. <u>Note</u>: Unless otherwise noted, all 48" dimension fixtures shall be provided with 48" T8 32 watt 2900 lumen 4100°K C.C.T. lamps, quantity as specified, with companion 2, 3 or 4 lamp electronic ballasts. Where fixtures with ballasts have switches that controls lamps individually or in groups, the proper number of separate ballasts shall be provided. Refer to the drawings for specific control information.

TYPE DESCRIPTION: REFER TO THE DRAWINGS

7. PHOTOCELLS

- A. Provide 120, 277 or 480 volt (rated as needed), 1000 or 2000 watt photocells as needed for control of certain circuits or fixtures as indicated on plans. They shall be as manufactured by Tork, Paragon, AMF or approved equivalent.
- B. Mount photocells in locations concealed from sight lines standing on ground unless otherwise noted, in which case the final position shall be as directed by the Architect. Group together (if indicated at one location) and mount on back of parapet wall or otherwise properly support with mounting bracket. Coordinate with roofing installer to ensure that roof penetrations are properly made without violating or reducing the roof warranty in any way. Photocells may be mounted in other locations if it is not practical to install them on roofs or parapets, in which case the Contractor shall request direction for their mounting locations from the Engineer or Architect. Photocells shall always be mounted in a weatherproof, inconspicuous manner.

8. TIMECLOCKS

- A. Provide synchronous motor-driven timeclock(s) to control the indicated loads. The number of poles, their ampacity and voltage withstand shall be to suit the load, but in no case less than 30 amps, 277 volts.
- B. Timeclock coil and motor power shall be 120 volts AC, backed up with seven day spring winder which is automatically replenished in normal operation. Provide a 120 volt control circuit from the nearest available panelboard.
- C. Provide with an astronomical dial, set up and calibrated for the week and month the timeclock is placed in operation. Order unit for the proper geographical latitude for the project site. Also provide day light savings time option and calibrate for April-October dates. Provide instruction to the Owner's representative in proper setting and operation of each type of timeclock provided.
- D. Enclosures for timeclocks shall be surface type, NEMA 1 or NEMA 3R as needed. Where exposed in finished areas, provide flush-style NEMA 1 enclosures.

END OF SECTION 265113

SECTION 265116 – NETWORK LIGHTING SYSTEMS

1. GENERAL

- A. Introduction
 - (1) The work covered in this section is subject to all of the requirements in the General Conditions of the specifications.
 - (2) Contractor shall coordinate all of the work in this section with all the trades covered in the other sections of the specification to provide a complete and operative system.
- B. Description of Work
 - (1) Extent of lighting control system work is indicated by drawings, and by the requirements of this section. It is defined to include low voltage lighting control panels, switch inputs, and wiring.
 - (2) Type of lighting control equipment and wiring specified in this section include the following:
 - a. Low Voltage Lighting Control Panels
- C. Quality Assurance
 - (1) UL & ULc Approvals

a. The control panels shall be tested and listed under the UL 916 Energy Management Equipment standard and CSA C22.2 #205 by a nationally recognized testing laboratory.

(2) NEC Compliance

a. The control system shall comply with all applicable National Electrical Codes regarding electrical wiring standards.

(3) NEMA Compliance

a. The control system shall comply with all applicable portions of the NEMA standards regarding the types of electrical equipment enclosures.

- (4) Component Pre-testing

 a. All control equipment shall undergo strict inspection standards. The equipment shall be
 previously tested and burned-in at the factory prior to installation.
- (5) System Checkout

a. A factory trained technician or factory authorized personnel or contractor shall functionally test the control system and verify performance after installation.

(6) Manufacturer

a. Manufacturer shall have a minimum of 20 years experience in control systems. Manufacturer shall provide off the shelf control products from its inventory. Control systems that require custom assembly and sizing shall not be acceptable. Product shall be PCI Lighting Control Systems ControlKeeper control panel or approved equal.

- D. Submittals
 - (1) Product Data
 - a. Submit manufacturer's data on lighting control system and components.
 - (2) Shop Drawings
 - b. Submit drawings of lighting control panel and accessories including, but not necessarily limited to the low voltage relay panels, power wiring, and switch inputs.

2. PRODUCTS

- A. Materials and Components
 - (1) System Description

- a. The lighting control system shall consist of low voltage relay control panels with 64 programmable switch inputs and shall offer 2 control relays.
- b. Each low voltage lighting control panel shall be microprocessor controlled. Programming shall be accomplished through either the RS-232 port or through the network connection employing the Keeper Enterprise software.
- c. Programmable intelligence shall include Time-Of-Day control, 32 holiday dates, warn occupants of an impending off, timed inputs, preset control, auto daylight savings, astronomical clock w/offsets, and local control, digital switches and network overrides.

TOD	64 Time-Of-Day/holiday schedules for 365 day programming			
Holidays	32 holiday dates			
Warn Off	Flash lights and provide an extra 1 second to 99 minutes of illumination			
Preset	Pre-programmed switch patterns			
Timed Inputs	Switch input timers 1-999 minutes			
Timed Overrides Timed o	verride 1-999 minutes, resumes to normal schedule			
Local Control	From local switch			
Astronomical Clock	Longitude and latitude input with sunset-sunrise offsets to customize outdoor lighting			
Auto Daylight Savings Ac selectable	ljust Automatically adjusts the clock at the appropriate dates,			
Priorities	Establishes a hierarchy for inputs and network control commands			
Masking	Provides permission orientation to switch inputs and network commands thereby ensuring building lighting control integrity.			
Soft-Linking	Group linking for rapid programming			
Global Linking	Each panel shall provide 64 addressable groups for network linking of control commands			

- d. Relays may be designated as either normally open or normally closed from the software. Relay status shall not only disclose commanded relay status but next scheduled state to occur.
- e. Each control panel shall provide a Warn Off (flash the lights) to inform the occupants of an impending Off command. The Warn Off command shall provide an adjustable time duration of 1 second to 99 extra minutes. The occupants may exit the premises with adequate lighting or cancel the Warn Off by overriding the lighting zone. This option occurs with all Off commands except local overrides.
- f. The controller shall permit lighting to be overridden On for after hours use or cleaning. The controller shall provide optional switch timer assignments or timed overrides. The override choices for various relays shall provide special event occurrences and the controller shall return to the programmed state after the override event. Also, the controller shall provide priority and masking choices to customize the functions of switch inputs, thereby enabling switches to function differently at different times of the day to meet special facility operational requirements. These overrides shall be digital, network, or hard-wired inputs.
- h. Programming the controller shall be through the RS-232 port or through the network connection. Communication to the panel or network can be accomplished via, RS-232, RS-485, modem, or TCP/IP.
- i. Priorities and/or Masking shall be assigned to inputs, telephone override, and global commands to insure building integrity. Priorities enable or disable the inputs based on user actuation of overrides. Masks shall permit: On only, Off only and On & Off control for

intelligent after hours utilization of the controlled facility based on Time-Of-Day scheduling in the controller.

- j. The control system shall provide networking between lighting control panels. One network may support a maximum of 254 control panels. Panels shall permit data sharing for global control. All inputs (no limitation) are transferable over the network to create any switching pattern required. The maximum length of the lighting control network shall be 4000 feet. Repeaters are available to extend the network as needed. Networks that rely on a single time clock for system operation shall not be acceptable.
- k. The lighting control system shall log all control events. The controller shall monitor all relay actuations, switch inputs and user intervention. Log reports shall be available for any duration of time the operator chooses through the Head End Controller Software. Runtimes for each relay shall be available from the Head End Controller Software.
- (Optional) The lighting zones may be controlled through a graphical representation of four switches on multiple PC's that are connected to the building LAN. This software package for lighting control overrides is called Vision Switch[®]. The software permits unlimited users connected to the building LAN to control their lighting zones. The software provides immediate feedback to the operator/user of network control overrides.
- m. (Optional) The light control system shall permit LED annunciated digital switches. Each digital switch shall provide status feedback of any control relay in the entire lighting control network.
- (2) Hardware Features
 - A. Diagnostic Aids
 - (1) Each control panel shall incorporate diagnostic aids for confirmation of proper operation, or in case of failure these aids shall guide the individual in rapid troubleshooting of the system.
 - a. The control panels shall employ LED's to indicate:
 - POWER (LED)
 - SYSTEM OK (LED)
 - NETWORK COMMUNICATIONS (LED)
 - ON/OFF STATUS of EACH RELAY (LED)
 - (2) Control systems that do not provide visual self-help diagnostics shall not be acceptable.
 - a. Status Indication of Relays

The system shall provide visible status indication of all relays through the window of each control panel. The visual indication shall disclose On/Off status and relay number. Systems that do not provide relay status while the enclosure door is closed shall not be acceptable.

- B. Operator Interface
 - (1) The control panel programming interface resides in firmware in the control panel. The programming interface shall consist of external software that provides access to all the controller's features. Each panel shall control its own loads from internal memory. A control system that relies on a central control computer/processor or external time clocks shall not be permitted. Systems that utilize blocking diode technology for relay assignments shall not be acceptable.
- C. Overrides
 - The controller shall provide timers for each override. Each override timer shall be capable of 0-999 minutes. Software shall enable or disable overrides based on Priorities, Masks or Time of Day Scheduling.
 - a. Digital Switch

The lighting controller shall support digitally addressable LED annunciated switches. The maximum total number of digital switches that may exist on the lighting control network is

16,256. Each Subnet shall support 64 buttons. The digital switch network requires CAT 5 cable between switches. The digital switches shall control any relay group combination on the lighting control network. Data communications status feedback for system checkout and troubleshooting (transmit and receive LED'S) shall be visible on both the controller and interface.

The digital switch configuration system shall permit custom labeling for multiple button switch locations. The digital switch configuration shall be Decora® form and function.

b. Dry Contact Inputs

The control system shall permit 2 dry contacts inputs for override purposes. Momentary 3 wire or 2 wire (toggle) inputs shall be supported. Maintained contacts shall be supported as 2 wire (SPST) inputs. Inputs shall be dry contacts (24 VDC @ 12 ma. internally supplied to the inputs). The 24 VDC power supply is provided with an auto-resettable fuse. Should an inappropriate electrical connection be made the design will protect the board and switches until the fault is removed. Any switch input shall be software linked to any number of relays for override control. The control panel shall have dry contact inputs on the logic board. Control systems that utilize separate accessories to allow for dry contact switches shall not be acceptable. Control systems that do not supply both digital switches and analog switches from the same controller shall not be permitted. Two wire momentary toggle switches shall be provided unless otherwise noted.

c. Photocell Control

The controller shall accept either dry contact or analog ambient light sensors. The controller shall provide power for the sensor thereby eliminating any external power supply. Sensors shall provide for outdoor, indoor or skylight applications and issue a command to the controller once the threshold is reached. The sensor shall provide either software or user adjustable dead band control.

d. Network Overrides

The controller shall accept network commands issued from other inputs or controllers on the network. The controller shall provide this feature without the need to add extra equipment to the controller. Network overrides can be issued from the Telephone Interface Module (TIM), Modbus® Gateway, DMXGateway, Photocells, Motion Sensors, Digital or Dry Contact Switches, or other controllers. Lighting systems that need to add extra equipment to receive network overrides are not acceptable.

- D. Service Override & Priority Override
 - (1) The control panel shall provide a three position master-service override for the control unit. The service override shall not be accessible from the exterior. Systems that provide a service override on the exterior of the controller shall not be acceptable.
 - (2) The master service override provides a single three-position switch with the option of All Off, Auto, and All On, respectively. This master switch shall operate all of the relays in the controller. This switch shall override and supersede all commands from the logic board when the switch is in the All On or All Off position. The master switch shall function to override all the relays should the logic board programming differ from the space function.
 - (3) The system shall report all master service overrides to the controller and shall be accessible via network query. Systems that cannot determine when the service override is in use shall not be acceptable.
 - (4) The system shall remember the last command to the individual relays. Upon returning the master override switch to the Auto position, the relays shall return to the most recent command state. This will occur even if the last command happened during the master override condition.
- E. Relays
 - (1) The controller shall come standard with electrically held 30amp 120/277VAC relays. The wire terminations shall be able to accept 10 AWG. Relays must be specified Normally Open or

Normally Closed. Relays that are latched or mechanically held are not acceptable. The relays shall be rated for 10 million mechanical operations.

- F. RS-232 port
 - (1) The controller shall provide an RJ-12 connection for RS-232 communications. Programming shall be permitted through either a local connection or remotely through a modem. The Head End Controller software accessory includes a six wire communication cable to connect to the controller. Systems that do not include an on-board RS-232 port for communications are not acceptable.
- G. RS-485 Network
 - (1) The controller shall be able to communicate to other controllers on a daisy chain twisted pair of wires. The RS-485 network shall be referred to as the Lighting Control Network and shall support 254 controllers with a maximum distance of 4000 feet. Each controller shall be optically isolated on the PCI-Net. The networked controllers shall provide optical isolation between controller power supplies for true electrical isolation (communication grounds are 100% isolated). CAT-5 or Belden #9841 shall be approved for network wiring.
- H. Modular Design
 - (1) The control system shall employ all modular connectors to avoid repeat wiring in case of component failure. The system CPU board shall be mounted on standoffs for quick field replacement. All connections for the switch inputs shall incorporate modular connectors. Systems that do not employ modular connectors shall not be acceptable.
- I. Memory Back-up
 - (1) The system shall utilize a memory back-up device that is system integrated and shall be nonserviceable. The data in RAM shall be protected against power interruptions lasting as long as 7 days. The power interrupt protection circuit shall be entirely maintenance-free.
- J. Multi-tapped Transformer
 - (1) The control panel employs a voltage specific transformer. The panel requires specification of either 120 or 277 VAC for each controller location.
- K. Enclosure
 - (1) Each control panel shall be enclosed in a NEMA class 4 enclosure. The low voltage controller shall exist in one size enclosure (7.5"H x 10.5"W x 4"D) with 2 relays per cabinet. The enclosure provides a clear window cover that provides easy visual access for status of control confirmation.
- L. Keeper Enterprise Software
 - (1) The PC based interface software accessory provides access to lighting control system files within a Microsoft® Windows® environment. The Head End Controller software shall support Windows® 2000, Windows® XP and above. The optional software package shall allow individual and network panel programming to be executed locally, via direct connection or remotely through a TCP/IP connection or modem. The central programming software shall permit the user to modify the control panel programmed data and archive for future use. Systems using third party software are not acceptable. Systems that are not capable of creating program backups are not acceptable. The manufacturer shall provide two (2) laptop PCs with the software preloaded. The laptops shall be equivalent to those manufactured by Dell and shall include a 15.4" screen, Centrino Duo 1.8 GHZ processor, minimum 100 Gigabyte hard drive, 1 Gigabyte ram, DVD burner, and minimum type "G" wireless network card.
 - (2) The following features shall be standard in the PC based software:
 - a. Standard Software Features:
 - Real Time Relay Status Monitoring
 - Alpha-Numeric Descriptors

- Communications: Direct, Network, TCP/IP and Modem
- Network Status Indication
- Global Software Modifications
- · Manual Relay Commands
- Remote Pattern Commands
- Preset Options

b.

• User Management – Password protection, and privilege modification for multi-user security

- Logging of Controller Actions (switch inputs, TIM commands, & relay actuations)
- Remote Commander –(entire network global commands from one screen)
- File Maintenance Archive Programs Data Base Restoration Uploading and Downloading of Programs Snap Shots — indication of changes and flawless panel restoration

Software package shall permit the PC to be utilized for other functions (i.e. word processing, database, & etc.) besides lighting control. Systems that require an "on-line" dedicated computer for control system operation shall not be acceptable.

- M. System Management Software Accessories
 - (1) System Management Software Accessories require the Ethernet Interface Module (EIM) accessory, connection to the building LAN and Windows® 2000, Windows® XP or above operating system.
 - a. Graphic Control

The lighting zones shall be controlled through a graphical representation software package. The software provides real-time feedback to the operator of network control overrides. The software shall be accessible through an Ethernet network permitting more than one location control access to the site. The software shall accept AutoCAD® drawing files to reduce programming set up of the control software.

b. Remote Control

A lighting control tool shall employ Ethernet communications and shall control up to four load-groups per computer desktop.

- N. Network Hardware Accessories
 - (1) Analog Input
 - a. Provide additional analog remote sensing to the network. An analog photo sensor shall be connected and shall broadcast photocell light levels/thresholds onto the lighting control network for any specific relay or group of relays to employ. The actual network broadcasted data shall be available for any relay to actuate either an "on/off" at any preset analog value for total global control.
 - b. All relays connected to the network are capable of being set to different analog photo sensor values for total building control.
 - c. The hardware shall permit custom sensors with varying sensing ranges for more user choices. The hardware shall also supply adjustable Minimum ON's, OFF's and Maximum OFF's. The hardware shall provide analog sensor logging so information may be recorded for proper switching control choices.
 - (2) Ethernet Interface Module (EIM)
 - a. Internet Connection Specifications: The control system accessory provides easy access to control panels over a TCP/IP connection by converting sent information into RS-232 communication capable information. This unit operates on standard 110VAC. Manufacturer

shall provide proper cabling from controller to Ethernet Interface Modules. RJ-45 connections are the responsibilities of others.

- (3) Ethernet Interface Module (EIM)
 - a. The control system shall provide intelligent software for the Telephone Interface Module (TIM) option. The optional TIM unit shall allow modem communications and touch-tone overrides from any touch-tone phone. The control system shall be multi-tasking and permit up to one TIM for each control panel.
 - b. Override Operation: Touch-tone interface shall permit the control panel to command preassigned control points ON/OFF. All user interfaces shall be through the twelve Touch-tone keys on the telephone. All entries into the override system shall be prompted by a digitalized voice. Systems not employing voice guided override instruction are not acceptable.
 - **c.** The TIM shall provide individual control passwords. Each password shall allow a preset group designation (number of relays) and the duration of the telephone override. TIM shall also provide a password to prevent entry into the override control system.

3. EXECUTION

- A. Equipment Installation and Documentation
 - (1) Installation

The control system shall be installed and fully wired as shown on the plans by the installing contractor. The contractor shall complete all electrical connections to all control circuits, and override wiring.

- (2) Documentation The contractor shall provide accurate "as-built" drawings to the owner for correct programming and proper maintenance of the control system. The "as-builts" shall indicate the load controlled by each relay and the relay panel number.
- (3) Operation and Service Manuals The factory shall supply all operation and service manuals.
- B. PRODUCT SUPPORT AND SERVICE
 - (1) Factory Support
 - a. Factory telephone support shall be available at no cost to the owner. Factory assistance shall consist of solving programming or application questions concerning the control equipment.

C. SYSTEM DELIVERY AND ACCEPTANCE

- (1) Delivery
 - a. The contractor is responsible for complete installation of the entire system according to strict factory standards and requirements. The following items shall constitute factory standards and requirements:
 - 1. All system equipment shall operate in accordance with specification and industrial standard procedures.
 - 2. An operational user program shall exist in the control system. The program shall execute and perform all functions required to effectively operate the site according to the requirements.
 - **3**. Demonstration of program integrity during normal operation and pursuant to a power outage.

4. Contractor shall provide a minimum of two training hours on the operation and use of the control system. Additional support services shall be negotiated between the contractor and the building owner or manager.

D. WARRANTY

- (1) Warranty
 - a. Manufacturer shall supply a 3-year warranty on all hardware and software. These warranties will be in affect for all installations. Systems that provide special warranties based on installation shall not be acceptable.

END OF SECTION 265116

SECTION 270610 – VOICE/DATA COMMUNICATIONS SYSTEM

1. GENERAL

- A. The Contractor is directed to examine each and every section of these specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described elsewhere that may relate to the provision of the work described herein. Materials and performance requirements are specified elsewhere herein that relate to these systems.
- B. The use of proprietary or copyrighted names or reference to patented trade items within this specification or elsewhere in the Contract Documents is meant only to establish a standard of quality and performance. In no way does such use establish a restrictive competitive bidding situation, or exclude materials or equipment that is truly equivalent to that required. All materials and equipment proposed for installation must meet or exceed all specified requirements.

2. SCOPE OF THE WORK

- A. The Contractor shall furnish all materials, labor, services, purchasing, testing of completely installed systems, etc., that are indicated or required to provide a complete data distribution network for the project.
- B. The data distribution network shall be designed and installed in a format and construction equivalent to the Ethernet "100 Base T" system as it is commonly known and in use throughout the world. It shall be physically wired in a star configuration.
- C. The data distribution system shall be installed complete, except as hereinafter described. The system shall be provided with all wall plates, inserts, wiring, equipment racks and supports, copper and fiber termination equipment, connections, wire terminations and identifications, 120 VAC power outlets, grounding etc., for a completely functioning premises wiring network.
- D. The system hardware and software shall be installed by the Owner or his vendor, unless otherwise noted or specified.
- E. A number of data ports shall be provided, as indicated on the plans. The data ports shall be configured as follows:
 - (1) Installed and wired data insert jacks that are connected to the patch panels in individual star home runs.
 - (2) Data ports shall be completely ready to receive a connection from data generating or receiving device, enabling such device to run on the network in an unrestricted fashion, meeting all network performance parameters, except as may be limited by the connected device itself.
 - (3) Provide single, double, triple, 4-way or other data insert jacks as indicated on the plans. Outlet boxes and conduit runs shall be sized appropriately for 40% fill of conductors used.
 - (4) <u>Special Note</u>: In the design and installation of the individual segments, backbones, routing of cable, connections between segments, wiring concentrators, etc., the current conventional 100 meter limitation of physical wiring distance for copper cable shall be observed.
- F. The Contractor shall coordinate with any other trades in the furnishing of "mixed service" wallplates, such as voice/data/video and voice/data wallplates. The completed installation shall be coordinated with all services incorporated into "mixed-service" plates. Contact other suppliers prior to bid or as needed to effect this coordination.

3. TESTING AND WARRANTIES

- A. The data distribution network, upon completion of the installation, shall be tested in its entirety. This testing shall completely check each data port from the outlet plate, thru the wiring to the patch panel terminations. Test every data cable (and voice cable, if included).
- B. Testing shall encompass all system performance parameters of each port, including attenuation, continuity of wiring to D.C., N.E.X.T. (near end cross talk), cable length, cable I.D., proper pair termination per E.I.A. standards, EMI content, etc., and all significant performance parameters related to Category 5 100 base T (enhanced CAT5) transmission.
- C. All of the network cabling that is installed shall be checked after all terminations are complete with an approved test instrument such as a Microtest, Fluke, PentaScanner, or approved equivalent time domain reflectometer instrument. The testing device shall have an inboard memory that is capable of retaining testing parameters and actual results. The Contractor shall provide a printout summary, cable by cable, using the actual cable I.D. to allow future comparison testing or circuit tracing. Provide the printout summaries on 8-1/2" X 11" paper, three complete sets mounted in a 3-ring binder as part of the project's closeout documentation. Submit the printout summaries to the Engineer for review.
- D. The test results shall be in a form and format that can be easily understood. The results shall be recorded port by port, identified room by room so the results can be traced and repeated if necessary, or checked for performance drift.

Before labeling any device or port or doing any testing, verify that final room number selections have been made by the Owner! Always use the actual room name/numbering scheme.

- E. If network hubs or switches are provided as a part of this contract, the Contractor shall incorporate additional testing to demonstrate the ability of each individual port to make a proper connection thru the selected hub or switch configuration to each designated file server. The Contractor shall provide the necessary equipment and software to accomplish this testing. A testing log similar to that developed from the cable testing shall be provided and bound with the cable testing manuals. This log shall indicate passfail for the connection from the port tested to each of the network segments and/or services, along with a comments space indicating corrective actions taken (if needed) and any other information the Contractor wishes to provide to assist the Owner. This information may be included in the cable testing summary manuals, at the Contractor's option.
- F. The completed data distribution system, in its entirety, shall be unconditionally warranted for a period of one year from the completion of testing and system acceptance by the Engineer and/or Owner.

4. DATA DISTRIBUTION SYSTEM EQUIPMENT AND PERFORMANCE REQUIREMENTS

- A. The cable and connector system shall be capable of operating at up to 100 megabit/second speed, with capability to handle all currently available bus architectures. It shall be compliant with EIA/TIA568A or B (verify termination style with owner prior to beginning work) Standards, latest version, all Category Five enhanced (350mb/second) construction.
- B. Lengths of cabling shall not exceed the published criteria for this type of system. LAN repeaters shall not be considered or used in cabling design, except where specifically required by this specification.
- C. The selection and location of equipment and patch panels shall be made with 15%, or minimum of twenty additional ports for future growth in addition to the ports indicated on the drawings.

- D. Patch panels shall be placed in rack construction at indicated or required locations. The Contractor shall indicate the final locations on the project record drawings. Provide for any needed general construction in bid. Patch panels shall be entirely Category Five construction, Lucent Technologies, Panduit, Leviton, Ortronics, AMP or approved equivalent with RJ-45 jacks as needed, maximum 24 jacks per panel, EIA/TIA 568A and B compliant.
- E. The Contractor shall evaluate the geography of the building and cable layout prior to bid and satisfy himself that the design intent can be met. The design shall be based on the indicated wiring closet locations as shown. If pre-bid analysis indicates the need for additional equipment, wiring, etc., contact the Engineer 10 days prior to bid for clarification by written addendum.
- F. The Contractor is to prepare shop drawings for review prior to purchasing or installing any equipment or wiring. Provide eight sets for review, bound neatly. The review drawings should consist of floor plans indicating all port locations, their style, routings, port address nomenclature, wiring distances, etc. The shop drawing submittal for the system shall include all components, wiring, plates, details, etc., involved in the system.
- G. Submit documentation outlining system testing procedures and equipment for review prior to beginning testing. Testing documentation shall include the proposed formats for cable testing or fiber optic as applicable.
- H. All system wiring to and from ports is to be Category Five enhanced, unshielded twisted pairs. The installation of the wiring shall be thru sleeves, conduit, cable trough and along backboards as indicated on the drawings. The Contractor shall consider the possibility of RFI/EMI in the installation and take all necessary precautions and provide physical separations to ensure proper system performance. Wiring shall be 4 pairs, 22 or 24 AWG, all pairs certified Category Five. If necessary, wiring is to be installed within conduit or other enclosed raceway in plenum ceiling areas. Coordinate all requirements for plenum and non-plenum spaces with other trades and the contract documents or by site verification prior to bidding the work. Cable shall be as specified within these Specifications, Section 260519 Conductors.
- I. All data port insert jacks for outlet boxes shall be installed with all wiring terminated per the manufacturer's recommendations. All data insert jacks shall be Category Five, A.T. & T 110 style with RJ-45 jacks. Products by Ortronics, Lucent Technologies, Panduit, Wiremold, AMP or approved equivalent will be acceptable. See Specifications, Section 262726 Wiring Devices for specifics.
- J. Plates shall be configured for the number of data outlets shown. For certain plates marked voice/data style, provide data port(s), RJ-45 style and Category Five RJ-45 telephone voice jack(s), style as needed by telephone system vendor. Clearly label the "voice" and "data" jacks with black-filled engraved letters, permanent plastic labels, plastic-shielded tags showing the specific drop I.D. number. Additionally, the specified color coding (refer to Specifications Section 262726) shall further identify the jack's function. Coordinate provisions for multi-service plates with each other project supplier (including video systems), prior to bid or as needed after bids, to ensure all needed components are provided in the contract.
- K. Provide 120 volt surge-suppressed AC line power to all system equipment whether indicated on the plans or not. Refer to other sections of these specifications for electrical requirements.
- L. All system wiring shall be neatly draped, labeled, properly supported and terminated at all locations. Provide permanent labeling indicating room number and address. Each patch panel termination for an individual port and each end of each cable 4" from termination shall be permanently marked on panel front. See other requirements this section (N. below) for more specific labeling information.

M. All system installations shall be made in full compliance with the following:

B.I.C.S.I. Standards, current edition
National Electrical Code
Kentucky Building Code
ANSI C2-1981 National Electrical Safety Code
47 CFR Part 68
NFPA 75
EIA/TIA 568A/B (as required by Owner)
Other EIA and I.E.E.E. Standards that Apply to such Installations
Kentucky Education Technology Standards - Current Version as of Bid Date

- N. All cable shall be carefully routed and connected to avoid ground loops and EMI. All racks and equipment enclosures shall be effectively grounded to the nearest ground point provided in electrical spaces. Use only stranded copper, green color wiring, #6 awg minimum for grounds.
- O. At the patch panel rack locations, provide a plexiglas framed or shielded permanently-mounted chart showing the cable schedule for the system, highlighted to show the cables (and equipment, as applicable) at that location. This schedule shall include:
 - (1) Cable Number

Each cable shall have a unique identifier. This number shall be up to 5 characters in length. The first two characters MAY be ALPHA characters, the last three characters MUST be numeric.

(2) Drop ID

The drop id. identifies the cable drop location. This field may be up to six characters in length. This identification shall represent a room number, floor plan grid location, or wiring closet location. Note: It is imperative that the final version of the building room numbering system be utilized in all cable identifications. Verify room numbering system with the Architect or Owner.

(3) Jumper From

This field shall identify whether the drop/grid cable is terminated in THIS wire closet or patched from a device. A drop/grid cable shall terminate on a distribution panel. A patch cable shall jumper from a device unit number.

(4) Termination Point

Grid/riser cable termination point in a rack and panel. This termination is in the DESTINATION wire closet "Jumper From" location.

(5) Length

Cable length in feet.

(6) Jumper To

This field may be up to 11 characters and shall be used to identify the "jumper to" point in THIS wire closet. "Jumper to" may be a device and unit number or distribution panel position.

<u>NOTE</u>: Identify fibre optic cables in similar fashion, as applicable and differentiate their codes by an "FO" prefix.

5. INSTALLATION

- A. Provide installation of racks, rack grounding, rack power, etc. Racks shall be secured to concrete floors but moveable by removal of hex nuts. See other drawings related to this contract for any additional electrical provisions or furnish and install as necessary.
- B. Provide permanent labeling as shown in the sequence chart.
- C. Provide cable/connector/hub testing, as appropriate, to satisfy system installation requirements and verification of proper function.
- D. The Cabling System shall be installed in a professional manner by persons skilled in the trades represented and in accordance with local building codes and applicable provisions of B.I.C.S.I., the National Electrical Code (NEC), except where specifications for the system design and specifications exceed these requirements, where the more stringent standard shall apply.
- E. All electrical materials and equipment installed shall be of new manufacture, and approved by Underwriters Laboratories, Inc., and shall bear the UL label.
- F. Drawings generally indicate work to be done, but do not show all bends, transitions or special fittings required to clear beams, girders, or other work already in place. Contractor shall carefully investigate conditions where wiring conduit and troughs are proposed or installed, and furnish and install any required fittings, offsets, etc. All cutting and patching necessary to install the system shall be provided as a part of this contract, in accord with the established or prevailing standards.
- G. Contractor shall install labels as follows:
 - (1) One label at each end of each cable at the end of the cable sheath, after stripping, four to six inches from termination.
 - (2) One label of port address and/or cable drop I.D. # on the outside of each active outlet plate.
 - (3) One label on the front of the patch panel centered below each associated cable connect.
 - (4) All markings shall be done in a manner that presents a neat, permanent, professional appearance.
- H. Contractor shall bond together cable grounds to distribution rack, and bond rack to building electrical panel ground for ground continuity. Continuity shall be checked with an ohmmeter between adjacent components, to a maximum of one OHM. Provide additional jumpers if necessary. Bond to cable trays within wiring closets, if provided.
- I. All cables from overhead wireways shall be neatly dressed behind distribution panels, providing adequate working space in back of the panels, allowing rack movement and working space.
- J. Equipment racks shall be grounded to building ground using an appropriate size ground wire (minimum #6 AWG). Route to the nearest available panelboard ground bus, preferably the panel that feeds receptacles at the equipment location. Route the ground wire in E.M.T. conduit, with redundant ground bushings.
- K. The equipment racks shall be completely installed before or just as cables are pulled.

Contractor shall use basket grips or other wire pulling apparatus as recommended by the wire manufacturer wherever possible, and exercise care while pulling cable so as not to exceed the maximum allowable pulling strength of any cable.

Contractor shall economize on the use of cable by limiting excess length on runs to one foot at the outlet, and four feet at the distribution panel(s), unless longer lengths are needed to make up terminations with the necessary amount of slack. Leave sufficient slack to allow moving of racks away from wall for easy service access.

- L. Insulated throat conduit fittings shall be used for ends of raceway or sleeves at all locations. Provide 5/8" x 4' x 8' high fire retardant plywood backboard(s) as needed at each wiring closet location. Mount ground wire and surge-suppressing ANSI Category "A" 120 volt outlets at bottom of backboard. Provide quadruplex outlets as needed (minimum of two), with each quad on a dedicated 20 amp circuit from panel, leaving 25% spare outlets for the Owner's future use.
- M. Requirements for grounding, bonding, structural supports, relieving of sharp edges, etc., shall be in accordance with local codes and accepted building practices.
- N. Cable Separation from Power Wiring: (<u>Note</u>: These are recommended <u>guide</u> distances only. The Contractor is responsible for minimizing RFI/EMI problems in the wiring and equipment installations to the point that they do not affect system performance.)
 - (1) The following distances are a guide for separation of data wiring from power voltages up to 480 volts:

	<2kva	2-5kva	>5kva
Unshielded power lines	2.5 in.	39 in.	48 in.
Unshielded power lines enclosed in grounded conduit	5 in.	12 in.	24 in.
Power lines with grounded metallic sheath enclosed in conduit	5 in.	6 in.	12 in.

- (2) Between the data wiring and any fluorescent, neon, or high intensity discharge (HID) lamp fixtures, the minimum clearance shall be six inches, or greater if recommended by the cable or hardware vendors.
- (3) Cables may be installed closer to lighting and convenience outlet power cables (single phase 120V, 20A. maximum), in metal cable channels for limited distances, if the following are observed:
 - Parallel runs of no more than fifteen feet are permissible if a one inch separation between the power cable and the data cable is maintained by separators or suitable retention hardware.
 - Parallel runs of no more than thirty feet are permissible if a two inch separation is maintained. The separation may be less than two inches for a run of up to twelve inches, if no contact occurs between the data cable and the power cable.
- (4) Contractor shall correct the dress of all cables which malfunction due to proximity to power cable, or other interference source revealed by checking or electronic network testing.
- (5) Contractor to verify all listed cable clearances with the system supplier prior to installing any cable and perform his work in accord with the suppliers' requirements.
- (6) Project Completion

Contractor's work shall be considered complete after the following has been accomplished:

- a. Installation is complete, all system testing has been completed and Contractor certifies in writing that the entire system is in working order.
- b. All system labels have been put in place.
- c. All construction debris and scrap materials have been removed from the premises.
- d. All marked up record drawings have been returned to the Engineer.
- e. All unused materials have been returned to the Owner, as Owner directs.
- f. The Engineer has accepted the installation.
- g. The Owner and/or his equipment vendor have accepted the system wiring in its entirety in writing. Forward a copy of this communication to the Architect and Engineer for their records.
- h. The testing logs (3 copies, bound) have been forwarded to the Engineer.

END OF SECTION 270610
SECTION 270640 - CATV DISTRIBUTION SYSTEM

1. SCOPE OF WORK

- A. Furnishing of all labor, project management, materials, tools, equipment necessary for the complete installation of a CATV Distribution System as shown on the plans and as herein specified.
- B. The Electrical Contractor shall provide conduit systems from box to cable tray and mount all boxes for the Systems wiring. The Systems supplier shall provide special boxes for installation by the Electrical Contractor.
- C. It is the intent of these specifications and the accompanying plans that the Contractor furnishes and installs a system complete in every respect and ready to operate. All miscellaneous items and accessories required for such installation, whether or not each such item or accessory as shown on the plans or mentioned in these specifications, shall be furnished and installed.
- D. It shall be the responsibility of each bidder to examine the site, plans and specifications carefully before submitting his bid, with particular attention to errors, omissions and conflicts between city ordinances, plans and specifications. Any such discrepancy discovered shall be brought to the attention of the Engineer and will be included in the Base Bid.
- E. Intentional or unintentional painting of exposed low voltage or line voltage cabling is prohibited. The contractor shall ensure that exposed cabling is adequately protected from direct painting or overspray whether painting is required within the electrical specifications or required by other disciplines/trades. The contractor shall review the painting requirements for all disciplines and shall provide cabling protection as required. Where exposed cabling is being installed in exposed ceiling or wall spaces that are required to be painted, the contractor shall provide alternate options for cable colors and shall provide submittals for such cabling to engineer for approval.

F. SUBMITTALS

- (1) Provide complete brochure information on all components and accessory equipment with the bid documents. All information shall be clearly marked to indicate items provided.
- (2) Contractors wishing to propose systems which differ in any features, functions or operating characteristics other than those outlined in these specifications must do so in writing to the specifying authority at least ten (10) days prior to bid opening. Proposals must include detailed information showing all deviations from the system as specified. Final approval of the alternate system shall be based on the decision of the Owner.

G. REGULATORY LISTING

(1) UL LISTING

All Material and equipment shall be listed, labeled, or certified by Underwriters Laboratories, Inc. The Intercom/paging system shall be UL813 listed as a complete system. All power supplied and computers shall be UL listed. Provide UL listing cards for all components specified herein.

H. MANUFACTURER

The equipment specified herein is that of Blonder Tongue, Peerless, Zenith and Precision Industries Incorporated. These manufacturers constitute the quality of design and construction, operational characteristics, appearance standards, space requirements and field service staffing levels required to comply with the requirements of the specification.

2. PRODUCTS, PERFORMANCE CRITERIA

- A. The system shall comply with the radiation limitations as set forth under Part 15 as amended of the FCC Rules.
- B. All equipment shall be designed and rated for 110 volt, 60 cp's AC operation and shall be UL rated for 24hour day continuous operation.
- C. The system shall have a signal to noise ratio of 43 dB or greater.
- D. The overall system frequency response shall be flat to +/- 1 1/2 dB across the 6-megacycle bandwidth of any television channel.
- E. The overall system shall have a voltage standing wave ratio of 1.2 to 1 or less.
- F. The design and installation of the system shall be such that extensions, additions, or modifications will be possible without altering the system requirement of a voltage standing wave ratio of 1.2 or less.
- G. The signal at any output shall not be less than 1000 microvolts or more than 10,000 microvolts into 75 ohms, except that in areas where direct pickup is possible, the signal shall not be less than 3000 microvolts. The signal at each outlet shall equal or exceed in quality the signal available from the Cable TV Company and shall be within 15 dB of same signal at any other outlet of the system.
- H. Extraneous signal pickup shall be at least 50 dB down from desired normal minimum signal level.
- I. Isolation between outputs and outlets shall not be less than 24 dB.
- J. Upon completion of the system installation it shall be the responsibility of the Contractor to perform the necessary adjustments and balancing of all signals and amplifier level controls to insure proper system operation.
- K. Each cable feeder line shall be inspected for proper termination.
- L. Signal-to-noise test shall employ a Jerrold Model 727 field strength or equivalent. Measurements shall be made at the output of the last amplifier in the system. With the normal levels in the system the field strength meter shall be tuned to the picture carrier of each channel in turn and the reading obtained on the meter noted. The signal shall then be removed and the input of the head end amplifier shall be terminated in 75 ohms. With the field strength meter read the level of remaining noise in the absence of the signal and add a meter correction factor of 4 dB to the reading. The difference between the two readings will give the system's signal-to-noise ratio, and shall not be less than 43 dB.
- M. No visible components of cross channel intermodulation ghosting or beat interference shall appear on the screen of a receiver turned to any normal signal.
- N. Should such a demonstration of performance show that the Contractor has not properly balanced the system and that picture degradation is present or that output gain is not as specified, the Contractor shall make all necessary changes or adjustments and a second performance demonstration will be arranged at no cost to the Owner.

3. EQUIPMENT

A. DISTRIBUTION AMPLIFIERS

- (1) The distribution amplifiers shall be a 19" rack mount, completely solid-state unit for the amplification of TV channels 2-61. Output level for each channel shall be +46dbmV minimum with no visible distortion.
- (2) Amplifier gain controls shall be provided with minimum of 15db control range. Typical amplifier gain shall be 51db.
- (3) The distribution system shall contain built-in regulated power supply to prevent change in output capability, and output level with changes in A-C line voltage of 117 VAC. Systems without regulated power supplies shall not be accepted.
- (4) Amplifier shall be a Blonder-Tongue, RMDA 450-50.

B. SPLITTERS

- (1) "2" way line splitters shall have a flat frequency response over the entire operating band from 500 to 600 MHz. The unit shall be of the hybrid design with a 75-ohm match of 17.0 dB RL minimum on all inputs and outputs. Output isolation shall be not less than 27.0 dB.
- (2) "4" way line splitters shall have a flat frequency response over the entire operating band from 500-600 MHz minimum on all input and outputs. Output isolation shall be not less than 27.0 dB.
- (3) Splitters shall be Blonder-Tongue Model CRS-2 and CRS-4.

C. CABLES

- (1) Each reel of coaxial cable used in the system shall be sweep tested for transmission and structural return loss and be so certified in writing by the cable manufacturer. Transmission sweep tests shall establish conformance to guaranteed loss value from 20-108 MHz 174-216 MHz and 470-890 MHz. Structural return loss tests by sweep method shall show a minimum return loss of 26 dB RL VHF, 16 dB RL UHF, as compared to a fixed 75-ohm reference from 20-108 MHz 174-216 MHz and from 470-890 MHz.
- (2) Coaxial cables shall be run in continuous lengths except for terminations and no splices shall be permitted in any conduit run. Cables shall be installed to avoid sharp bends or physical distortion.
- (3) All cables terminating at amplifiers or splitters shall be tagged as to function and destination.
- (4) The coax cable to rooms shall be plenum ratedRG-6/U coaxial cable with the following properties:
 - a. Nominal impedance: 75 ohms
 - b. Minimum center conductor size: 22 AWG solid
 - c. DC resistance maximum: 50 ohms/M
 - d. Nominal capacitance: 19 pF/ft + or 1 15%
 - e. Shield coverage minimum: 95%
 - f. Minimum number of shields: 2
 - g. Dielectric jacket type: plenum rated
 - h. Nominal velocity of propagation: greater than 70%

- i. 100% sweep tested 5 500 MHz
- (5) All trunk cable shall be plenum rated RG-11U type.

D. DIRECTION TAPOFFS

- (1) All 1,2, or 4 tapoffs shall have a frequency range of 5 to 600 MHz.
- (2) All tapoffs must meet all CATV and SMATV requirements for RF shielding.
- (3) A variety of isolation valves shall be available to balance all signal levels.
- (4) Tapoffs shall be equal to Blonder Tongue CRT series.

E. TV WALL PLATES

Provide a feed through F connector wall plate equal to Blonder Tongue V-1GF-FT at all TV locations.

F. AGILE CHANNEL PROCESSORS

Provide agile heterodyne processors to convert any cable channel in the 50 to 80t MHz frequency range to any channel in the 50 to 550 MHz frequency range. Each unit shall have synthesized frequency control, with a tuning increment of 250 kHz. Frequency selection is accomplished via front panel DIP switches. The unit shall have an output level of +40dBmV. Channel selection shall be as directed by the Owner. The unit shall be equal to a Blonder Tongue model AP-40-550. Provide 12 units for this project.

G. CHANNEL MODULATORS

The channel modulators shall be part of modular headend system. The rack chassis shall have positions for up to 12 modulator or demodulator modules. The chassis shall be equal to Blonder Tongue MIRC-12 chassis with MIPS-12 power supply. The channelized, heterodyne audio/video modulator shall be able to provide an audio and video modulated RF carrier output on any single VHF channel in the 54 to 400 MHz range. The output level shall be +38 dBmV. Channel selection shall be as directed by the Owner. The unit shall be equal to Blonder Tongue model MICM. Provide 12 modules for this project.

H. PASSIVE COMBINERS

Provide passive combiners to combine the outputs of multiple modulators and Processors. These units shall feature high isolation between ports and a low net combining loss from each of the broadband inputs the unit shall be equivalent to Blonder Tongue model OC-12D. Provide units as required to accommodate the total number of channels for this project.

I. EQUIPMENT HOUSING

Provide all cable TV headend equipment in paging/intercom rack. Provide two 120VAC, 20 Amp power circuits in equipment housing for headend equipment.

J. SURGE PROTECTION

Provide a Ditek DT6F or equivalent surge protector and $1 \cong$ conduit with coax as noted on drawings from headend to KET satellite dish location.

K. The Contractor shall provide three 4-head Hi-Fi Sony VCR's and three Sony DVD Players.

4. EXECUTION

A. INSTALLATION

- (1) Install cable in conduit or cable tray, which is provided by the Electrical Contractor.
- (2) All penetrations in smoke or firewalls shall be sealed with fire stop rated for this purpose.
- (3) Provide for adequate ventilation in all equipment racks and take precautions to prevent electromagnetic or electrostatic hum. The installation of all work shall be neat and of professional quality. Cooperate with other trades in order to achieve well-coordinated progress and satisfactory final results. Execute without claim for extra payment minor moves or changes in equipment locations to accommodate equipment of other trades or the architectural symmetry of the facility.

B. WIRING

It shall be the responsibility of the Contractor to furnish and install all plenum rated cable as required to provide a complete and operable system. Cable shall be properly supported above ceilings.

C. TESTING

- (1) Upon completion of the installation, the system must be tested by the manufacturer's representative and all necessary modifications and/or adjustments must be made to assure compliance with this specification.
- (2) All final signal dB levels of TV outlets and amplifier inputs and outputs shall be shown on as built drawings.

D. CERTIFICATION

Upon completion of the testing, the manufacturer or representative shall issue to the Owner a letter of certification attesting to the fact that he has tested and adjusted the system, that all components are properly installed and free of defects, and that the system is in compliance with this specification.

E. INSTRUCTION

The work shall include supplying the services of a field service representative who shall be a full-time employee. The field service representative shall have specialized experience in the operation and maintenance of the system and shall instruct the Owner's personnel in the techniques involved in the operation of the systems. A formal on-site training shall be provided by the Contractor to the owner's representative/maintenance personnel and shall include instructions in the location, inspection, maintenance, testing and operation of all components. Provide a signed copy of the name of the personnel giving the instructions and the personnel of the Owner.

F. DIAGRAMS, DRAWINGS AND INSTRUCTION MANUALS

Furnish bound instruction manuals for the complete system for the Owner's use. Manuals shall include instructions, block and schematic diagrams, wiring diagrams, specification and technical data of the components and "as-built" drawings of the completed system.

G. WARRANTY, SERVICE AND MAINTENANCE

Provide a one-year warranty of the installed system, against defects in material and workmanship. If any defects are found within the warranty period, the defective equipment shall be replaced at no extra charge to Owner for parts or labor.

END OF SECTION 270640

SECTION 275100 - PAGING/INTERCOM SYSTEM

A. GENERAL REQUIREMENTS

- 1. All Bids shall be based on the equipment as specified herein. The CAREHAWK CH1000 Life Safety Communication solution. The specifying authority must approve any alternate system.
- 2. Contractors that wish to submit alternate equipment shall provide the specifying authority with the appropriate documentation, at least 15 business days prior to bid opening. The submitted documentation must provide a feature by feature comparison identifying how the proposed equipment meets the operation and functionality of the system described in this specification. The Contractor shall provide adequate and complete submittal information, prior to bid date, which shall include but not limited to specification sheets, working drawings, shop drawings, and a demonstration of the system. Alternate supplier-contractor must also provide a list to include six installations identical to the system proposed.
- 3. Final approval of the alternate system shall be determined at the time of job completion. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate system at the contractor's expense.

B. SUBMITTALS

- 1. The vendor shall provide the following documentation and service:
 - a) Shop drawings: 3 sets. These drawings shall include the manufacturers' specification sheets, including all component parts.
 - B) As-built drawings: 3 sets. They should include up-to-date drawings including any changes made to the system during installation. Circuit diagrams and other information necessary for the proper operation and maintenance of the system shall be included.
- 2. All material and/or equipment necessary for the proper operation of the system, even though not specifically mentioned in the contract documents, shall be deemed part of this contract.

C. OPERATION AND MAINTENANCE DATA

- 1. Submit operation and maintenance data under provisions of Section < >.
- 2. Include operator instructions for each required mode of operation, routine troubleshooting procedures, manufacturer's operation and maintenance manual for each item of equipment and accessory, and routine cleaning methods and materials.

D. QUALIFICATIONS

- 1. To establish continuity in manufacturer, system components shall be the standard product of one manufacturer. Further, an effort shall be made to establish common sources for equipment of all systems.
- 2. The work to be provided under this Section consists of furnishing and installing all equipment, cabling, and labor required for complete, operable, new life safety communication system for the School < >. These systems shall be referred to as the LIFE SAFETY SYSTEM and their supplier as the LIFE SAFETY CONTRACTOR.
- 3. The LIFE SAFETY CONTRACTOR must be a factory-authorized representative or distributor of all equipment used in the low voltage systems. Further, this contractor must have a minimum of five years of

experience in the specific application of the equipment proposed for these systems. Provide a letter signed by an officer of the manufacturer attesting to the contractor's direct affiliation with the manufacturer.

E. REGULATORY REQUIREMENTS

- 1. The entire installation shall comply with all applicable electrical and safety codes. The LIFE SAFETY SYSTEM and additional applicable equipment shall be tested and certified to UL/CSA 60065. Certifications shall be completed by a Nationally Recognized Testing Laboratory, (UL, CSA, TUV, ect.).
- 2. All equipment with digital apparatus (microprocessors) that generate and use timing signals at a rate in excess of 9,000 pulses per second to compute and operate must meet FCC, Industry Canada regulations, and DOC CSA standards C108.8 (Electromagnetic Emissions). Any non-compliant equipment supplied or installed shall not be accepted and shall nullify the contract.

F. WARRANTY

- 1. The manufacturer shall provide a five year warranty against defects in material and workmanship. All materials shall be provided at no expense to the owner during normal working hours. The warranty period shall begin on the date of acceptance by the owner/engineer. Any warranty less than five years shall not be considered.
- 2. Software service packs released from time to time shall be available to the user for the life of the product at no additional cost.
- 3. The LIFE SAFETY CONTRACTOR supplying the equipment shall show satisfactory evidence, upon request, that they maintain a fully equipped service organization capable of furnishing adequate inspection and service to the system, including replacement parts. The vendor shall be prepared to offer a service contract for the maintenance of the system after the guarantee period. The bidder shall produce evidence that they have a fully experienced and established service organization for at least five years and proven satisfactory installations during that time.

G. USER TRAINING & SUPPORT

- 1. The contractor shall supply up to 8 hours of onsite user training. User training shall consist of operation of all system functions and scheduling software.
- 2. The user shall have access to telephone support from the manufacturer at no additional cost for the life of the product.

H. CABLING PLANT

- 1. The LIFE SAFETY SYSTEM shall be capable of using CAT-5(e), CAT-6, and CAT-3 unshielded cabling. LIFE SAFETY SYSTEMS not capable of using all of the above wire types shall not be considered.
- 2. The LIFE SAFETY SYSTEM shall be capable of using two wire conductors for a speaker and call button referred from herein as a 2-wire circuit. It shall be possible to mix 2-wire and standard 4-wire circuits on the same switching/line card. LIFE SAFETY SYSTEMS that cannot mix 2-wire and 4-wire circuits on the same switching/line card shall not be considered. LIFE SAFETY SYSTEMS that require more than two conductors or require shielded cable shall not be considered.
- 3. It shall be possible to distribute the switching/line cards of the LIFE SAFETY SYSTEM up to 2700 feet using a single home run eight conductor cable. LIFE SAFETY SYSTEMS that require networking of multiple central systems to be distributed shall not be considered. LIFE SAFETY SYSTEMS that require the use of Ethernet components to bridge the 2700 foot distance shall not be considered.

4. It shall be possible to network the LIFE SAFETY SYSTEM with additional systems using copper wire, single mode fiber optic and multimode fiber optic cables. LIFE SAFETY SYSTEMS that do not allow for the use of fiber optic cable shall not be considered.

I. LIFE SAFETY SYSTEM DESIGN

- 1. Only systems designed primarily as a LIFE SAFETY SYSTEM shall be considered. Life safety features shall include but not be limited to; priority based access to voice functions, emergency paging, emergency call-in, covert PC based call-in, pre-recorded emergency announcements, external and internal telephone access, integrated video surveillance, and optional district wide communication functions. Paging systems, traditional school intercom systems, or any system that does not include the above minimum features shall not be considered.
- 2. The LIFE SAFETY SYSTEM shall be of a core design vintage dating from the year 2000 or later. LIFE SAFETY SYSTEMS that use designs dating from before the year 2000 shall not be considered.
- 3. The LIFE SAFETY SYSTEM shall be an event driven design. LIFE SAFETY SYSTEMS using a polling method design shall not be considered.

Microcontroller

- 4. The LIFE SAFETY SYSTEM shall contain a central microcontroller capable of a minimum of 500 MHz processing speed to allow for the addition of future features. LIFE SAFETY SYSTEMS with microcontrollers that run less than 500 MHz shall not be considered.
- 5. The LIFE SAFETY SYSTEM shall have flash based removable storage media of a size no smaller than 1 gigabyte. It shall be possible to remove the storage media from one system to another like system with no need to adjust the configuration files. LIFE SAFETY SYSTEMS that do not use removable flash based media or do not have at least 1 gigabyte of storage shall not be considered.
- 6. The LIFE SAFETY SYSTEM shall have at least 512 Megabytes of system ram. Said RAM shall be removable and upgradable. LIFE SAFETY SYSTEMS that do not use removable RAM or cannot be upgraded not be considered.

Central Cabinet

- 7. The LIFE SAFETY SYSTEM shall contain natively RS232, RS485, USB, and Ethernet ports for communication to any third party system. LIFE SAFETY SYSTEMS that do not contain all of the above communication ports or require additional equipment shall not be considered.
- 8. The LIFE SAFETY SYSTEM shall contain five open collectors, three dry contacts, and six general purpose inputs for third party system integration or for general panic buttons. It shall be possible to expand inputs or outputs to any number needed. LIFE SAFETY SYSTEMS not supporting the minimum inputs and outputs or able to expand to any number shall not be considered.
- The LIFE SAFETY SYSTEM central cabinet shall be a wall mounted. Total weight of the central cabinet shall not exceed 35 lbs. LIFE SAFETY SYSTEMS requiring floor racks or that weigh more than 35 lbs shall not be considered.
- 10. The LIFE SAFETY SYSTEM shall contain no moving parts that suffer from wear or that require maintenance. LIFE SAFETY SYSTEMS that contain moving parts shall not be considered.

- 11. The LIFE SAFETY SYSTEM shall draw no more than 3.5A of current at full load including all system accessories. LIFE SAFETY SYSTEMS that draw more than 3.5A of current at full load shall not be considered.
- 12. The LIFE SAFETY SYSTEM shall have integrated surge protection for all audio ports and switching/line card ports. Said surge protection shall be replaceable in the field with no need to return parts for repair. LIFE SAFETY SYSTEMS that require external surge protection shall not be considered

Amplifiers

- 13. The LIFE SAFETY SYSTEM shall use Class D digital amplifier with at least 250 Watts RMS and 300 Watts peak output. Amplifier distortion shall not exceed 0.2% at 90% load. LIFE SAFETY SYSTEMS using Class B amplifiers or amplifiers not capable of 0.2% maximum distortion shall not be considered.
- 14. The Class D amplifier shall be direct drive 25V constant voltage type. LIFE SAFETY SYSTEMS using transformer based amplifiers shall not be considered.
- 15. The LIFE SAFETY SYSTEM shall filter all voice signals through a Digital Signal Processor (DSP) to maximize voice intelligibility. LIFE SAFETY SYSTEMS not using a DSP shall not be considered.
- 16. The LIFE SAFETY SYSTEM shall have 45 Ohm conversion modules available on a switching/line cards basis to convert the 25V audio signal to 45 Ohm for use with 45 Ohm speakers. LIFE SAFETY SYSTEMS not capable of conversion to 45 Ohm audio on a switching/line card basis shall not be considered.
- 17. The LIFE SAFETY SYSTEM amplifiers shall go to sleep thus reducing their current draw when not in use. LIFE SAFETY SYSTEMS that use amplifiers that do not reduce their current draw when not in use shall not be considered.
- 18. The LIFE SAFETY SYSTEM amplifiers shall have a built in pink noise generator for testing speaker quality and audio levels. LIFE SAFETY SYSTEMS that do not contain a pink noise generator shall not be considered.

Tones

- 19. The LIFE SAFETY SYSTEM shall have at least 25 tones available for bells, reminders, and other events. LIFE SAFETY SYSTEMS with less than 25 tones shall not be considered.
- 20. The LIFE SAFETY SYSTEM shall support WAV type audio files. The user shall be able to add 25+ custom WAV files for use as pre-recorded announcements, bells, reminders, pre-announce tones, or any other system tone. LIFE SAFETY SYSTEMS not allowing users to add WAV files or do not allow for the use of WAV files for any system tone shall not be considered.

Switching/Line Cards

21. The LIFE SAFETY SYSTEM shall support remote switching/line cards with 16 and 32 audio ports sizes available. A single central cabinet shall support up to eight 32 port cards. The switching/line card shall be powered from the central cabinet out to 2700 feet away from the central cabinet. LIFE SAFETY SYSTEMS that do not use remote switching/line cards or require additional power supplies shall not be considered.

Telephone Integration

22. The LIFE SAFETY SYSTEM shall support up to eight FXS Caller-ID enabled telephone ports. FXS ports shall be added as needed in single port configurations. FXS ports shall be used to interface with system Administrative phones, standard telephones, and PBX/KSU/iPBX/VoIP telephone systems. LIFE SAFETY

SYSTEMS that use proprietary telephone ports for Administrative phones or cannot provided eight FXS ports for PBX/KSU/iPBX/VoIP telephone system integration shall not be considered.

Master Clock

- 23. The LIFE SAFETY SYSTEM shall contain an integral master clock. LIFE SAFETY SYSTEMS that do not have an integral master clock shall not be considered.
- 24. The LIFE SAFETY SYSTEM master clock shall correct Sapling, Dukane, Rauland, National time & Signal, American Time & Signal, Simplex, and Latham secondary clocks, analog or digital or both. LIFE SAFETY SYSTEM that do not correct all of the above clock systems shall not be considered.
- 25. The LIFE SAFETY SYSTEM master clock shall be capable of being synchronized by a Network Time Sever (NTP). LIFE SAFETY SYSTEMS that do not synchronize to a NTP server shall not be considered.
- 26. The LIFE SAFETY SYSTEM master clock shall provide for automatic daylight saving time adjustment with leap year programming. LIFE SAFETY SYSTEMS that require user intervention for daylight savings events shall not be considered.
- The LIFE SAFETY SYSTEM master clock shall support unlimited schedules with unlimited events on said schedules. LIFE SAFETY SYSTEMS that do not support unlimited schedules and events shall not be considered.
- 28. The LIFE SAFETY SYSTEM master clock shall be calendar based capable of future event programming at least 30 years in the future. LIFE SAFETY SYSTEMS not using a calendar shall not be considered.
- 29. The LIFE SAFETY SYSTEM master clock shall allow for scheduling tone events, output events, program source events, and video camera events. LIFE SAFETY SYSTEMS not capable of scheduling all of the above event types shall not be considered.

Administrative Telephones

- 30. The LIFE SAFETY SYSTEM shall not require an Administrative console to operate. All system functions shall be accessible via telephone codes from any internal or external telephone. LIFE SAFETY SYSTEMS requiring the use of Administrative telephones shall not be considered.
- 31. The LIFE SAFETY SYSTEM optional Administrative telephone shall have the following features. LIFE SAFETY SYSTEM Administrative telephones not containing the features below shall not be considered.
 - a. Desk & wall mountable
 - b. Minimum 8 line by 20 character back lit display
 - c. Wizard driven menu system for ease of use
 - d. 200 speed dials
 - e. Head set compatible
 - f. Integrated speaker phone for hands free use

Classroom Phones

32. The LIFE SAFETY SYSTEM shall allow for the use of analog and SIP classroom phones. LIFE SAFETY SYSTEMS that do not support both of the above classroom phone types shall not be considered.

Call Buttons

- 33. The LIFE SAFETY SYSTEM shall allow for the use of normally open, normally closed, wireless, and virtual call buttons. LIFE SAFETY SYSTEMS not capable of using all of the above call button types shall not be considered.
- 34. The LIFE SAFETY SYSTEM shall allow for the use of virtual call buttons installed on local PC computers. LIFE SAFETY SYSTEMS that do not support virtual call buttons shall not be considered.

Security Integration

35. The LIFE SAFETY SYSTEM shall allow for the integration of motion sensors, glass break sensors, and door contacts in parallel with call buttons. Events from these sensors shall be capable of being programmed to activate pre-recorded WAV files, outputs, and cameras. LIFE SAFETY SYSTEMS that do not support integration of security sensors shall not be considered.

Video Surveillance

- 36. The LIFE SAFETY SYSTEM shall provide eight transmission paths and control of closed-circuit television (CCTV) UTP type cameras. LIFE SAFETY SYETEMS that do not provide camera transmission paths shall not be considered.
- 37. The LIFE SAFETY SYSTEM shall support cameras connected on the same cable as speaker/call button ports. LIFE SAFETY SYETEMS that require additional cabling for cameras shall not be considered.

J. LIFE SAFETY SYSTEM OPERATION

- The LIFE SAFETY SYSTEM shall allow for user-programmable room number assignment in the form of 3, 4, 5 or 6-digit alphanumeric format for architectural room numbering and a 60 character alpha-numeric caller ID description associated with each audio port. LIFE SAFETY SYETEMS that do not support caller-ID on all ports or require additional equipment to support caller-ID shall not be considered.
- 2. The LIFE SAFETY SYSTEM shall allow for a minimum of 64 page/time/program zones that can be assigned and configured as desired. LIFE SAFETY SYSTEMS with less than 64 zones shall not be considered.
- The LIFE SAFETY SYSTEM shall allow for the assigning of each call-in button to one or more of 32 distinct call-in destination groups. LIFE SAFETY SYSTEMS with less than 32 call-in groups shall not be considered.
- 4. The LIFE SAFETY SYSTEM administrative telephone shall allow for the user to view the alphanumeric room address and the caller-ID information of the calling station and the call priority (e.g., emergency, normal) on the display. The administrative telephone shall use distinctive ringing patterns to annunciate the type of call. LIFE SAFETY SYSTEMS that do not support caller-ID or call priority shall not be considered.
- 5. The LIFE SAFETY SYSTEM shall be capable of receiving 2048 call-ins simultaneously without data collisions or loss of any call-ins. Call-ins shall remain in the system call queue until answered. Emergency Call-ins shall automatically move to the top of the call-in queue and annunciated in the in-use telephone earpiece to notify the user of an emergency call. LIFE SAFETY SYSTEMS that do not maintain a system call queue or do not prioritize call-ins shall not be considered.
- 6. The LIFE SAFETY SYSTEM shall communicate with each classroom loudspeaker hands-free. The staff member or occupant in the classroom need not operate any buttons to reply to a call. The Administrative telephone operator shall be able to use the hands-free speaker phone or handset on an Administrative telephone. LIFE SAFETY SYSTEMS requiring "push to talk" shall not be considered.

- 7. The LIFE SAFETY SYSTEM shall communicate with each classroom phone. The classroom phone shall be integrated with the classroom speaker. If the staff member or occupant in the classroom lifts the classroom phone while in communication over the classroom loud speaker classroom audio will automatically be transferred to the classroom phone. LIFE SAFETY SYSTEMS that do not have loudspeaker-classroom phone integration shall not be considered.
- 8. The LIFE SAFETY SYSTEM shall be capable of classroom phones that can dial emergency personnel in case of an emergency. The classroom phone shall have an integrated dial pad. LIFE SAFETY SYSTEMS that do not support classroom phones with dial pads shall not be considered.
- 9. The LIFE SAFETY SYSTEM shall operate under the following audio priority scheme. LIFE SAFETY SYSTEMS not following the audio priority scheme listed below shall not be considered.
 - a. An emergency page suspends all other audio
 - b. An emergency tone suspends all other audio except the above
 - c. A normal page suspends all other audio except the above
 - d. A tone suspends all other audio except the above
 - e. A program source audio event suspends nothing
 - f. Interrupted lower priority functions shall be restored after conclusion of the higher priority function.
- 10. The LIFE SAFETY SYSTEM shall allow a call-in to be escalated from a normal call-in to an emergency call-in at any time by pressing the call button twice within 2 seconds. LIFE SAFETY SYSTEMS that do not allow for call escalation shall not be considered.
- 11. The LIFE SAFETY SYSTEM shall allow for any connected telephone to place an emergency voice paging announcement. LIFE SAFETY SYSTEM that restricts access to emergency paging shall not be considered.
- 12. The LIFE SAFETY SYSYEM shall allow the activation of connected dormant cameras based on an emergency call-in, security sensor activation, or telephone code. LIFE SAFETY SYSTEMS not allowing for integrated emergency camera functions shall not be considered.
- 13. The LIFE SAFETY SYSTEM shall allow for operation via a GUI based PC based application. The PC application shall allow for emergency paging, normal paging, intercom, activation of any system/user tone, schedule changes, program distribution, call-in management, and on the fly room exclusion. LIFE SAFETY SYSTEMS that do not support PC based control shall not be considered.
- 14. The LIFE SAFETY SYSTEM shall use a PC based GUI scheduling tool for schedules and tone management. This tool shall not allow access to any system configuration controls. This tool shall not prevent the LIFE SAFETY SYSTEM from operating when being used. This tool shall allow the user to schedule events and manage tones over the local LAN/WAN and the Internet. It shall not be required to be directly connected to the central system to use this tool. LIFE SAFETY SYSTEMS that do not separate scheduling and tone functions from any other configuration functions or cannot be used over LAN/WANs or the Internet shall not be considered.
- 15. The LIFE SAFETY SYSTEM shall have a built in 30 day log of every system function and access. LIFE SAFETY SYSTEMS not having a 30 day log shall not be considered.
- 16. The LIFE SAFETY SYSTEM shall have a built in real time system diagnostics application. LIFE SAFETY SYSTEMS that do not have any real time system diagnostics shall not be considered.
- 17. The LIFE SAFETY SYSTEM shall allow for system diagnostics, system log access firmware updates, and programming over the local LAN/WAN or over the Internet. LIFE SAFETY SYSTEMS not providing all of the above functions shall not be considered.

END OF SECTION 275100

SECTION 275110 - CAFETERIA SOUND SYSTEM

1. GENERAL

SCOPE OF WORK

- A. Furnish and install an electronic, frequency-controlled sound system in accordance with these specifications.
- B. Provide new materials and equipment that conform to the applicable requirements of Underwriters' Laboratories (UL), National Electrical Code (NEC), and all applicable local codes.
- C. The work specified herein shall be performed by a Professional AV Contractor including but not limited to the installation of cabling, devices, termination, programming, and training.
- D. Final placement of speaker clusters and steering of coverage patterns is to be determined by the installing AV Contractor providing optimal direct sound field coverage and Intelligibility.
- E. This specification represents information solely concerned with the sound system. Refer to specifications of other trades and contractors for items that might affect the work under this section.
- F. All material and equipment needed for proper operation of the system not specified or described herein shall be deemed part of the specifications.

QUALITY ASSURANCE

- A. All equipment shall be UL listed.
- B. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.
- C. All equipment Installation Practices shall comply with the Local Electric Code.
- D. All equipment and installation practices shall comply with ANSI/INFOCOMM 2M-2010 Standard Guide for Audiovisual Systems Design and Coordination Processes.
- E. All equipment and Installation Practices shall comply with the latest BICSI Telecommunications Distribution Methods Manual (TDMM).
- F. All equipment shall comply with the latest ANSI TIA/EIA-568, 569, 606, 607, 862, standards as applicable.
- G. Performance Verification: All digital video systems shall be pre-tested to verify the complete compatibility of all sending, receiving and distribution components and the performance and integrity of the transmission media. The performance of each system shall be demonstrated, with all proposed components, in the presence of the Design Engineer and/or Owner prior to approval and installation. Any system failing to meet the specified performance requirements shall be rejected and re-configured as required prior to retesting.
- H. All equipment described herein or otherwise required to perform the specified system functions shall be a regular product line, produced by the system manufacturer.

- I. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.
- J. All terminations shall be performed using industry standards. Cold solders, exposed copper in terminal blocks, and wire splicing without prior approval shall be deemed unacceptable.
- K. All cabling shall be in a neat, tidy bundle and routed using existing paths, cable trays, and conduits. Rogue cable paths unless pre-approved shall be deemed unacceptable.
- L. It is the responsibility of the contractor to remove any unacceptable radio interference, buzzing, or noise from cable circuits.
- M. All cable circuits shall contain an acceptable service loop allowing for enough length to re-terminate and/or access and inspect devices without disconnecting or removing cabling.
- N. All audio, video, antenna, and power circuits shall be grouped by signal type with a minimum of 6 inches between each signal group. (I.E. microphone circuits shall be grouped together with a separation of at least 6 inches from all power, video, and antenna circuits).

QUALIFICATIONS

- A. It is the intent of this package to procure a supplier who can provide labor for the installation of new equipment, pulling cables, and for furnishing all cables and accessories necessary. The CONTRACTOR is responsible for leaving in place proper sized conduits with pull wires and boxes for the AV System Contractor use.
- B. The AV equipment package shall be furnished and installed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the AV contractor to utilize a Subcontractor for any portion of the work, unless the Subcontractor has been approved in writing by the Design Engineer or owner based upon adherence to the qualifications listed herein.
- C. The AV System supplier shall be an "AV System Contractor" who regularly engages in the furnishing and installation of both Professional Sound Reinforcement and Video Systems.
- D. The AV System contractor shall be an authorized and certified Dealer of the equipment listed within this specification. A copy of factory programming certification (QSC Control Professional) with respect to the AV Control System shall be included within the submittal package.
- E. The AV System Supplier shall demonstrate to the satisfaction of the A/E and OWNER that they have:
 - a. Adequate staff and equipment to pursue the work properly and expeditiously.
 - b. Adequate technical experience.
 - c. Suitable financial status to meet the obligations of the work.
 - d. Supplier to provide maintenance and warranty service for a period of 1 year after acceptance of installation to be included in the lump sum bid.
- F. The Contractor shall have on staff an AVIXA certified CTS responsible for overseeing the project.

GENERAL CONDITIONS

- A. Offers will only be considered from sound contractors who have at least five years of experience in the furnishing and installation of sound reinforcement systems that employ an equalization device comparable to that specified.
- B. The sound contractor shall employ competent electronic technicians who are trained and knowledgeable in the area of sound systems.
- C. At completion of the installation of the sound system and before final acceptance by the owner or owner's representative, the sound contractor shall furnish two copies of the following:
 - a. Operating manuals, installation manuals, descriptive literature, and other information that is pertinent to the operation and performance of the system.
 - b. Wiring diagrams for equipment and the system that indicate the wire and cable connections, including the connections between the amplifiers and associated loudspeakers.
 - c. Manufacturer's warranties and the sound contractor's warranties.
- D. The sound contractor shall have available to the purchaser a service department capable of servicing all the equipment. Maintenance shall be provided on the premises during normal working hours at no cost to the purchaser for a period of 12 months from the date of system acceptance unless the failure or damage is caused by misuse, neglect, or accident. Service on the premises during other than normal working hours must also be available and may be charged at current labor rates.
- E. The equipment described and furnished under these specifications shall be the standard product of one manufacturer. All equipment items that are identified by model number, type, or brand name are done so to establish the quality, function, and performance required of the specific equipment. Alternates must be approved ten (10) days prior to the bid date. If submitting alternate speakers, provide EASE plots showing coverage at 200 Hz, 500 Hz, and 5 KHz.

SUBMITTALS

- A. A complete list of the major equipment to be used in this system shall be submitted to the owner's representative for approval.
- B. Shop drawings of the following shall be submitted:
 - a. A block drawing that shows the functional relations of all portions of the system.
 - b. 30x42 floor plans at a scale of not less than 1/8'' = 1-0'' showing the locations of the following:
 - i. All locations of AV equipment, mounting type and height.
 - ii. Conduit requirements, rough-in box size requirements and heights
 - iii. Each location where electrical power is required, and the specific configuration of that power connection (voltage, plug type, mounting height, etc.)
 - c. Rack Layout drawings showing components and locations.
 - d. EASE plots showing the proposed location and the area covered by each loudspeaker.
- C. Network Coordination the Contractor shall provide network topology diagram illustrating complete network plan for the project. The contractor shall work with the Owner's IT department to identify all PoE, VLAN, firewall and other networking requirements to provide a fully functioning AV system.
 - a. The Contractor shall obtain blocks of static IP addresses from the Owner's IT department in a timely fashion ahead of implementation as to give the Owner's IT department ample time to develop these IPs.
 - b. A meeting with the Owner's IT department is required to discuss plan of implementation and procedure.

D. Manufacturer's data sheets for each major component of the system shall be submitted.

System Requirements

- A. The audio-visual system contractor shall furnish all the equipment, accessories and necessary material for a complete system as indicated on the drawings and described hereinafter.
- B. The sound system shall contain (2) wireless mics, (3) mic input locations, Bluetooth capability, and be able to amplify any audio from the projection system.
- C. The touch panel shall be capable of controlling all aspects of the system including recalling presets for day to day use, controlling volumes, switching video inputs, lowering/raising the screen, and powering the projector on/off.
- D. The video system shall contain (1) video input wall plate with HDMI/VGA support and (1) rack mounted Bluray player.

O & M MANUALS — FINAL DOCUMENTATION

- A. Copies of all approved shop drawings with the project engineer's specific approval clearly indicated.
- B. Comprehensive Bill of Materials with manufacturers, model numbers, quantities an descriptions.
- C. Owner's manuals for every item of equipment, when available from the manufacturer.
 - a. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information.
- D. Provide statement of warranty with O&M Manuals.
- E. WARRANTY

Warranty the entire system, including all equipment and wiring, to be free of mechanical and electrical defects for a period of one (1) year from the date of system completion and acceptance.

System Bill of Materials

(2) Sennheiser wireless handheld microphone systems with active antenna splitter and directional paddle antennas

(1) Sennheiser handheld wired microphone with 50' microphone cable and straight mic stand

- (3) AtteroTech AES67 microphone input wall plates
- (1) AtteroTech AES67 Bluetooth wall plate
- (1) QSC Q-SYS CORE
- (1) QSC Networked Amplifier
- (16) QSC 6" Ceiling Speakers
- (8) QSC 8" Ceiling Subwoofers
- (1) QSC 8" touch panel
- (1) Denon Bluray player
- (1) Extron HDMI/VGA DTP wall plate
- (1) Extron DTP 4 port HDMI video switcher
- (1) Extron DTP2 HDMI receiver
- (1) Da-Lite Advantage Tensioned 16:10 164" diagonal HD1.3 screen
- (1) Epson 6,000 lumen laser projector and short throw lens
- (1) Lowell wall rack with vented door, cable management, rear rails, and 2-space drawer

Wireless Handheld Microphone

A wireless RF transmission system consisting of a stationary receiver and a handheld transmitter includings a microphone head. The system shall operate within twelve UHF frequency ranges, with a switching bandwidth of up to 42 MHz: 470 – 516 MHz, 516 – 558 MHz, 520 – 558 MHz, 566 – 608 MHz, 606 – 648 MHz, 626 – 668 MHz, 734 – 776 MHz, 780 – 822 MHz, 823 – 865 MHz, 806 – 810 MHz, 925 – 937.5 MHz, 1785 – 1800 MHz;

receiving frequencies shall be 1,680 per range and shall be tunable in 25 kHz steps. The system shall feature 20 fixed frequency banks with up to 12 compatible frequency presets and 1 user bank with up to 12 user programmable frequencies. The receiver shall be menu-driven with a backlit LC display showing the current frequency, frequency bank and channel number, metering of RF level, metering of AF level, lock status, pilot tone evaluation, muting function, and battery status of the associated transmitter. An auto-lock feature shall be provided to prevent settings from being accidentally altered. The receiver shall feature an integrated guitar tuner and shall provide a sound check mode. Some receiver parameters such as receiving frequency, receiver name and pilot tone setting shall be synchronizable with the associated transmitter via an integrated infrared interface. The receiver shall feature a balanced XLR-3M audio output with a maximum output of +18 dBu along with an unbalanced ¹/₄" (6.3 mm) audio output with a maximum output of +12 dBu. The receiver shall have two DATA ports (RJ 10) to set up a multichannel system. Two BNC-type input sockets shall be provided for connecting the antennas. Nominal/peak deviation shall be ± 24 kHz/ ± 48 kHz. Squelch threshold shall be adjustable to three levels: Low (5 dB μ V), Middle (15 dB μ V) and High (25 dB μ V). The receiver shall incorporate the Sennheiser HDX compander system and a defeatable pilot tone squelch. Sensitivity shall be $< 2 \mu V$ for 52 dBA eff S/N with HDX engaged at peak deviation. Adjacent channel rejection shall be $\geq 65 \, dB$ (typical). Intermodulation attenuation shall be $\geq 65 \, dB$ (typical); blocking shall be \geq 70 dB. Four selectable equalizer presets shall be provided: "Flat", "Low Cut" (-3 dB at 180 Hz), "Low Cut/High Boost" (-3 dB at 180 Hz/+6 dB at 10 kHz) and "High Boost" (+6 dB at 10 kHz). Signal-tonoise ratio at 1 mV and peak deviation shall be ≥ 110 dBA. Total harmonic distortion (THD) shall be ≤ 0.9 %. The audio output level shall be adjustable within a 48 dB range in steps of 3 dB. The receiver shall operate on 12 V power supplied from the NT 2-3 CW mains unit (for 100 – 240 V AC, 50/60 Hz). Power consumption shall be 300 mA. The receiver shall have a rugged metal housing; dimensions shall be approximately 190 x 212 x 43 mm (7.48" x 8.35" x 1.69"). Weight shall be approximately 980 grams (2.16 lbs). Operating temperature shall range from -10 °C to +55 °C (+14 °F to +131 °F). The receiver shall be the Sennheiser EM 100 G4. The radio microphone shall be menu-driven with a backlit LC display showing the current frequency, frequency bank and channel number, metering of AF level, transmission status, lock status, pilot tone transmission, muting function, and battery status. An auto-lock feature shall be provided to prevent settings from being accidentally altered. The radio microphone parameters shall either be configurable in the associated receiver's menu and synchronized with the radio microphone via an integrated infrared interface or shall be programmable in the radio microphone menu. Receiver parameters such as receiving frequency, receiver name and pilot tone setting shall be synchronizable with the radio microphone via an integrated infrared interface. The handheld vocal radio microphone shall be equipped with a mute switch, which shall be switchable between "AF on/ off", "RF on/off" and "Disabled" via the user interface. Nominal/peak deviation shall be ± 24 kHz/ ± 48 kHz. Frequency stability shall be $\leq \pm 15$ ppm. RF output power at 50 Ω shall be 30 mW (typical). The radio microphone shall incorporate the Sennheiser HDX compander system and a defeatable pilot tone squelch. Audio frequency response shall range from 80 - 18,000 Hz. Signal-to-noise ratio at 1 mV and peak deviation shall be ≥ 110 dBA. Total harmonic distortion (THD) shall be ≤ 0.9 %. Input sensitivity shall be adjustable within a 48 dB range in steps of 6 dB. Power shall be supplied to the radio microphone by two 1.5 V AA size batteries or by one Sennheiser BA 2015 rechargeable accupack. Nominal voltage shall be 2.4 V, current consumption shall be typical 180 mA at nominal voltage; $\leq 25 \,\mu$ A when radio microphone is switched off. Operating time shall be typical 8 hours. The radio microphone shall have a rugged metal housing; dimensions shall be approximately 50 mm (1.97") in diameter and 265 mm (10.43") in length. Weight including the batteries shall be approximately 450 grams (0.99 lbs). Operating temperature shall range from -10 °C to +55 °C (+14 °F to +131 °F). A range of microphone heads shall be available for the radio microphone.

Provide (2) Sennheiser ew 100 G4-835-S vocal set microphone systems with (1) ASA 214 active antenna distribution system, (2) A 2003 passive directional antennas and (2) WM1 wall mounts.

Wired Microphone

The microphone shall be a dynamic cardioid type designed for lead vocal stage use. It shall have a rugged metal body and a shock-mounted capsule and shall include a hum compensating coil. The frequency response shall be 40 Hz – 16,000 Hz and the sensitivity (free field, no load) shall be 2.7 mV/Pa at 1 kHz. The nominal impedance shall be 350 Ω , with a min. terminating impedance of 1 k Ω . The microphone shall provide a 3-pin XLR connector. Dimensions shall be 48 x 180 mm (1.89" x 7.09"). Weight without cable shall be 330 grams (11.64 oz). Provide (1) Sennheiser e835 wired microphone with (1) 50' microphone cable and (1) straight microphone stand.

Digital Audio Wall Plate

The AES67 interface unit shall provide two mic/line analog inputs on the front panel. Selectable gains of -18dB, -3dB, +25dB, and +40dB, and +48V phantom power option shall be provided via software for the XLR input. The unit shall provide two RCA line level inputs and one 3.5mm TRS line level input. The unit shall provide a 3.5mm TRS line level output, and 2 balanced outputs on depluggable connectors on the side of the unit. These outputs shall have software controlled volume from 0dB to -60dB in 1dB increments. Each analog input shall be included in an AES67 multicast audio transmit stream, and each analog output shall be capable of being driven from a channel within an AES67 multicast audio stream. The internal analog to digital signal conversion shall be performed at 24-bit resolution with a sampling frequency of 48kHz. The AES67 interface unit shall receive power over the Ethernet cable from an 802.3af PoE compliant network switch. The AES67 interface shall be wall mounted in a standard US dual gang junction box. The AES67 interface shall be compatible with Attero Tech unIFY software for flexible control and monitoring in system applications. The AES67 interface shall be compliant with the RoHS directive. The AES67 interface unit shall be compliant with FCC 47CFR Parts 15B and 18 (Class A), EN 55011, ICES-003, CE (EN55022 Class A and EN55024 Class A). The AES67 interface shall be the Attero Tech unA6IO. Provide (3) AtteroTech unA6IO audio wall plates.

Bluetooth Wall Plate

The Dante Bluetooth® interface unit shall provide stereo Bluetooth® wireless connectivity onto a Dante network, and a simple, one-button pairing interface. The unit shall provide two RCA line level inputs and one 3.5mm TRS line level input. The unit shall provide a 3.5mm TRS line level output, on the front of the unit. This outputs shall have software controlled volume. The DanteTM Bluetooth interface shall support bidirectional call-bridging capabilities as well as unidirectional media streaming receiver functionality. The internal analog to digital signal conversion shall be performed at 24-bit resolution with a sampling frequency of 48 kHz. The Dante interface unit shall receive power over the Ethernet cable from an 802.3af PoE compliant network switch. The Dante interface shall be wall mounted in a standard US dual gang junction box. The Dante interface shall be compatible with Attero Tech unIFY software for flexible control and monitoring in system applications. The Dante interface shall be compliant with the RoHS directive. The Dante interface unit shall be compliant with the RoHS directive. The Dante interface unit shall be compliant with the EMI/EMC requirements for FCC and CE. The Dante interface shall be the Attero Tech unD6IO-BT.

Provide (1) AtteroTech unD6IO-BT Bluetooth wall plate.

Digital Audio Processor

The system processor shall provide up to 128 x 128 networked audio channels individually configurable as either O-LAN or AES67 formatted networked audio, networked audio channel count will reduce to 64 x 64 when using video bridging capability on the built-in USB Type-B Device port. The system processor shall support 24 total analog I/O capacity and shall be presented in the following groupings; 8 Mic/Line inputs, 8 Line outputs and 8 Flex Channel I/O which shall be software definable analog inputs or outputs in single channel increments in any combination ratio. The system processor shall be capable of connecting to any host PC, Mac or embedded device via USB and will present itself as up to four virtual external sound devices each offering Speakerphone (with or without Acoustic Echo Cancellation) or a Soundcard plus a single USB Webcam for Soft-Codec conferencing and other applications. The system shall perform all of its real-time audio, video and control processing using Intel® processors running a purpose built, real-time Linux operating system developed by QSC, LLC. The system processor shall operate natively on a standard gigabit Ethernet infrastructure available from a broad range of network infrastructure manufacturers, employing DiffServ quality of service, IEEE 1588-2008 (PTPv2) precision time protocol, IP audio and video transport with floating point format data representation for audio. The system shall not require IEEE 802.1AS, IEEE 802.1Qat or IEEE 802.1Qav support on the network infrastructure to function. The overall system latency from analog input to synchronized analog outputs anywhere on the network shall be fixed at 3.167ms. The system shall also be able to achieve an overall system latency of 3.167ms over Layer-3 routed network infrastructure without any additional hardware, software or connection services between subnets. The system processor shall manage external control interfaces such as Touchscreen Controllers, Paging Stations, Networked Audio I/O Expanders, Network Connected Amplifiers, AV-to-USB Bridging interfaces and IP based PTZ Conference Room Cameras. The system processor shall have the following front panel controls and indicators: blue monochrome OLED display with page forward capacitive touch button, Unit ID capacitive touch button, Power On blue LED, Two USB A Type ports. The system processor shall provide a monochrome 304x96 blue OLED graphics display displaying the device name, design name and system status, LAN A and B settings, and the firmware version. Device Status shall be displayed on the OLED display including I/O status, muting, level present indication, and system status. On the rear panel, the system processor shall have one 3-pin RS232 Euro Block Connector, HDMI Video Out, 16 GPI general purpose control inputs on 20-pin Euro Block Connector, 16 GPO general purpose control outputs on 20-pin Euro Block Connector, RJ11 for POTS telephony, USB Type-B Device port to provide AV-to-USB Bridging capability. Q-SYS Network: LAN A RJ45 1000 Mbps only, LAN B: RJ45 1000 Mbps only. The dimensions of the System processor shall be 1.75" x 19" x 11.12" (44 mm x 483 mm x 356 mm). The system processor shall store a design that shall be comprised of audio, video and control components, wiring, links, text, and graphics on a single or multiple schematic pages. Designs shall include any of the following audio DSP, video, test and measurement components, control components, and layout components: Acoustic Echo Cancellers, Audio

Players, Audio Streaming components, Crossfaders, Crossovers, Delay components, Auto Gain control elements, Compressors, Gates, Duckers, Expanders, Ambient Noise Compensators, Limiters, Gain blocks, Graphic Equalizers, Parametric Equalizers, FIR Filters, All-Pass Filters, Band-Pass Filters, Band-Stop Filters, High-Pass Filters, Low-Pass Filters, FIR High-Pass filters, FIR Low-Pass Filters, Dual-Shelf Equalizers, Notch Filters, Meters, Matrix Mixers, Gain-Sharing Automatic Mixers, Gated Automatic Mixers, Signal Routers, Public Address Routers, Room Combiners, Signal Presence Meters, Tone Generators, Tone and Noise Generators, Dual Trace FFT Measurement Modules, Real Time Analyzers, Signal Injectors, Signal Probes, Logic, Value and Position control functions, Lua scripting components, Command Buttons and Triggers, Camera Router, USB Audio Bridge, USB Video Bridge. The system processor shall support custom user control interfaces either on purpose built touch screen controllers, network computers utilizing a control application or iOS devices via Wi-Fi. Custom control interfaces shall be capable of having multiple user-selectable pages with different controls on each. The system processor and control engine shall be the QSC Q-SYS Core 110f Flex Channel Processor.

Provide (1) QSC Q-SYS Core 110f digital audio processor with (1) 24 port POE Q-SYS certified network switch and (1) TSC-80tw-G2 touch panel.

Networked Digital Audio Amplifier

The power amplifier shall be a four-channel network-processing amplifier that is designed to operate exclusively with a QSC Q-Sys system over a Q-LAN Ethernet network. The power amplifier section shall consist of four amplifier channels, fed by digital audio streams over the Q-Sys network, that provide total power of up to 2500 W (continuous) and shall utilize Flexible Amplifier Summing Technology to distribute that power across one, two, three, or all four channels. An independent Input section shall provide inputs to the Q-Sys system.

The power amplifier section shall have an input impedance of 10k (balanced or unbalanced) and a maximum input level of 3.88 V (1.2V setting) or 12.28 V (3.9 V setting). The power amplifier shall meet the following performance criteria: typical distortion at 8 Ohms of 0.01 to 0.03%; maximum distortion (4 - 8 Ohms) of 1%; frequency response at 8 Ohms of 20 Hz to 20 kHz (+0.2 db / -0.7 db); noise at -109 db (weighted output muted); gain of 38.4 db (on 1.2V setting); damping factor of greater than 150.

The power amplifier section shall combine a class-D power amplifier with a custom power stage. The amplifier shall utilize a low-weight, high-efficiency PowerLight universal switchmode power supply for operation at 100 to 240 VAC, 50 or 60 Hz. The power supply shall incorporate Power Factor Correction (PFC). The amplifier shall offer multi-stage sleep modes for AC power savings.

The amplifier shall provide control of Channel Mute and Gain via both front panel buttons and the Q-Sys system, with changes made at either point immediately updated at the other. The amplifier front panel shall also include Input and Output LED Metering, a 400 x 240 TFT color display, navigation buttons, an LED power button/indicator, a fault indicator, control knob, and cast aluminum handles.

The amplifier back panel shall provide a dual RJ-45 jack for connection to the Q-LAN network, enabling integration into the Q-Sys system for bi-directional passage of digital audio, control signals, and status monitoring data. The back panel shall also provide four analog audio Mic/Line inputs with phantom power, using 3-pin Phoenix connectors, that are routed to Q-Sys via Q-LAN. The back panel shall also provide four touch-proof Phoenix connectors for connecting loudspeakers to the power amplifier channels. The back panel shall also provide eight GPIO terminals enabling Q-Sys control to/from external devices.

The amplifier shall be 3.5 in (89 mm) high, 19 in (482 mm) wide, and 16 in (406 mm) deep. The amplifier shall have a net weight of 21 lb (9.5 kg).

The multi-channel system-processing amplifier shall be the QSC CXD4.3Q.

Provide (1) QSC CXD4.3Q networked amplifier.

6" Recessed Ceiling Speaker

The ceiling mount 2-way co-axial system shall incorporate a 6.5-inch woofer with treated-paper cone and a 19 mm aluminum dome tweeter. The tweeter shall be mounted coaxially in front of the woofer on a waveguide that matches the directivity of the two drivers at the crossover point.

The system shall meet the following performance criteria: conical coverage angle of 140 degrees; frequency response of 65 Hz to 20 kHz +0/-10 dB, measured on axis; sensitivity of 88 dB SPL in half space at 1 meter with an input of 4 V rms; maximum continuous output of 106 dB SPL; maximum peak output of 112 dB SPL on axis at 1 meter; power handling of 60 watts for 8 hours with an IEC noise signal; recommended amplifier power of 120 watts; nominal impedance of 16 ohms.

The loudspeaker shall have a switchable low-distortion, wide-bandwidth laminated core transformer with taps for 60, 30, 15, and 7.5 watts at 70V and 60, 30, and 15 watts at 100V. The system shall be switchable between 16Ω (bypass) and constant-voltage operation.

The loudspeaker shall have a powder coated steel back can. The baffle and the grille shall have either a white (RAL 9010) or black (RAL 9011) paintable finish with UV inhibitors to prevent discoloration. The enclosure shall retain the grille magnetically. Any logo on the grille shall be removable without leaving a blemish.

The loudspeaker shall have a double-stepped long-travel dog-ear blind mounting system that can capture ceiling thicknesses from 0 to 2.25 in. The conduit cover plate shall be removable, retained by a captive Phillips head screw. A mud ring shall be provided to allow pre-installation wiring. The loudspeaker connections shall be a locking 4-pole Euro-block that accepts four 18 AWG wire pairs.

The loudspeaker shall be listed as safe for use in air-handling spaces under UL1480 and UL2043. The loudspeaker shall meet or exceed IP-34 for ingress protection; it shall meet the IEC 60529 IP-X3 splash rating. The switchable transformer shall be listed under UL1876. The baffle shall meet UL94-V0 and UL94-5VB flammability ratings and shall comply with IEC60849/EN60849 safety standards.

The loudspeaker's enclosure shall be 9.32 in (23.7 cm) high and 11.02 in (28.0 cm) in diameter. The loudspeaker shall weigh no more than 9.5 lb (4.3 kg).

The ceiling mount 2-way co-axial system shall be the QSC AD-C6T.

Provide (16) QSC AD-C6T recessed ceiling speakers.

8" Recessed Ceiling Subwoofer

The ceiling mount subwoofer shall incorporate an 8 inch low frequency transducer. The subwoofer's low frequency driver shall be loaded into a ported enclosure. The subwoofer shall have a passive internal crossover network with a 120 Hz low pass filter. The filter shall be defeatable from the front baffle to allow the use of outboard crossovers. The subwoofer shall meet the following performance criteria: frequency response of 28 Hz to 100.0 Hz ± 10 dB, measured on axis with appropriate signal processing; sensitivity of 92.0 dB SPL in free field at 1 meter with an input of 2.83V; continuous output of 112.0 dB SPL; peak output of 118.0 dB SPL on axis at 1 meter; power handling of 100 watts for 8 hours with an IEC noise signal; recommended amplifier power of 200 watts; nominal impedance of 8 ohms.

The loudspeaker shall have a switchable low-distortion, wide-bandwidth laminated core transformer with taps for 60, 30, 15 & 7.5 watts at 70V and 60, 30 & 15 watts at 100V. The subwoofer shall be switchable between 8 Ohm and constant-voltage operation.

The loudspeaker shall have a steel enclosure injection molded high impact polystyrene baffle. It shall have a white paintable finish. Input connectors shall be parallel wired ceramic block or 4-pin Euro terminals in a fire protective sub-chamber. The subwoofer shall have a rails and C-ring for ceiling installation. The front of the subwoofer shall be protected by heavy duty painted aluminum grill.

The subwoofer's enclosure shall be 12.6 in (32.1 cm) high, 12.6 in (32.1 cm) wide and 14.5 in (36.8 cm) deep. The loudspeaker shall weigh no more than 20.0 lb (9.1 kg).

The subwoofer shall be listed as safe for use in air-handling spaces under UL1480 and UL2043. The switchable transformer shall be listed under UL1876 and shall comply with BS/EN 60849 safety standards.

The ceiling mount subwoofer shall be the QSC Audio Products AD-C81Tw. Provide (8) QSC AD-C81Tw recessed ceiling subwoofers. **Bluray Player** Digital System

- System
 - Digital media player (Blu-ray Disc, DVD, CD, SD, USB device [mass storage class]) AVCHD playback format
- Supported Disc Formats
 - o Blu-ray Disc: BD25, BD50, BD-ROM, BD-R, BD-RE
 - DVD: DVD, DVD+R, DVD-R, DVD+RW, DVD-RW
 - CD: CD, CD-R, CD-RW, DTS Music Disc (DTS Audio CD, 5.1 Music Disc), HDCD, Super Video CD (SVCD), Video CD (VCD)
- Supported File Formats
 - o Video: .3gp, .asf, .avi, .dat, .divx, .mkv, .mov, .mp4, .mpg, .m2ts, .ogm, .rmvb, .tp, .ts, .wmv
 - Subtitles: .ass, .smi, .srt, .ssa, .sub
 - Audio: .ape, .flac, .m4a (AAC), .mp3, .wav, .wma
 - Picture: .gif, .jpg (or .jpeg), .png
- Supported File Systems
 - FAT16, FAT32, NTFS
 - SD card with 128GB total capacity
 - USB drive (mass storage class) with 2 TB total capacity
- Video
 - o Resolutions Auto, 480i/576i, 480p/576p, 720p, 1080i, 1080p
 - o Aspect Ratios 16:9 Full, 16:9 Normal, 4:3 Pan & Scan, 4:3 Letterbox
 - System NTSC, PAL, Multi (if supported by TV)
 - o HDMI Color Space: RGB PC Level, RGB Video Level, YCbCr (4:4:4), YCbCr 4:2:2
- Decoding
 - Video: DivX 3, 4, 5, 6; DivX HD; MPEG-1; MPEG-2; MPEG-4; MPEG-4 AVC (H.264); VC-1 (Windows Media Video); Xvid
 - Audio: AAC; Dolby Digital; Dolby Digital Plus; Dolby TrueHD; DTS Digital Surround; DTS-HD; WMA
- Audio
 - Analog Outputs
 - Output Level (balanced XLR): +4 dBu = +1.786 dBV
 - Output Level (unbalanced RCA): +6 dBV

- Digital Output
 - Output Level (coaxial): 0.5V, 75â,
 - Signal Format: AES/EBU
- Surround Audio
 - DTS-Master Audio, DTS-HD High Resolution Audio, DTS Digital Surround, Dolby TrueHD, Dolby Digital (AC-3), Dolby Digital Plus (7.1ch)
- \circ Frequency Response: 20 Hz 20 kHz (+0.5 dB)
- Signal-to-Noise Ratio: > 100 dB (A-weighted)
- Total Harmonic Distortion: < 0.05%
- Dynamic Range: > 100 dB (A-weighted)
- Headroom: 6 dB
- Channel Separation: > 90 dB
- Outputs
 - (2) XLR audio outputs (L/R, balanced)
 - o (2) RCA audio outputs (L/R, unbalanced)
 - o (8) RCA audio outputs (7.1 surround sound)
 - o (1) Coaxial digital audio/visual output
 - (1) HDMI audio/visual output
 - o (1) RJ-45 LAN port
 - (1) 9-pin D-Sub female RS-232C port
 - (1) IEC power connection
- Communication
 - Remote Control
 - Infrared protocol, > 200 mV transmission output level
 - o Serial Remote
 - Connector: 9-pin D-Sub female, RS-232C
 - Mode: Full duplex
 - Baud Rate: 9600 or 38400 bps (selectable)
 - o Ethernet
 - Connector: LAN port
 - Standards: Ethernet (10 Mbps), Fast Ethernet (100 Mbps)
 - Environmental Conditions

- Operating temperature: 41 95 °F (5 35 °C)
- Operating humidity: 25 85%, no condensation
- o General
 - Power
 - Connection: IEC
 - Requirement: 100–240 VAC, 50/60 Hz
 - Consumption: 15 W typical, < 0.5 W standby
 - Dimensions (width x depth x height, with rack ears)
 - 19.00" x 10.75" x 1.73" (483 mm x 273 mm x 44 mm)
 - Weight (with rack ears)
 - 5.9 lbs. (2.7 kg)

Provide (1) Denon DN-500BD MKII Bluray player with (1) 3' Extron Ultra HDMI cable.

4 Input HDMI Switcher

- A. Provide an HDMI twisted pair switcher that shall support up to four HDMI inputs, and shall provide long distance signal distribution of video, with or without embedded audio, and control over a shielded CATx cable
 - a. Rack-mountable switcher for the extension of HDMI and control
 - b. Video input requirements
 - i. Shall provide four (4) HDMI inputs for digital video signals with or without embedded audio
 - ii. Shall support HDMI specifications that include data rates up to 10.2 Gbps, Deep Color up to 12-bit, 3D, and HD lossless audio formats
 - iii. Shall support digital video resolutions up to 4K, including 1080p/60 Deep Color
 - c. Video output requirements
 - i. Shall provide one RJ-45 for connection to an Extron DTP®-enabled product
 - ii. Shall support connection of DVI displays that do not recognize HDMI-specific formats
 - 1. Automatically enable or disable embedded TMDS audio and InfoFrames
 - 2. Automatically set the correct color space
 - Shall provide signal transmission distance capability of 330 feet (100 m) for supported resolutions, including 4K, UHD, 2560x1600, and 1080p @ 60 Hz using a shielded CATx cable
 - Shall be configurable for sending digital video and embedded audio, plus bidirectional RS-232 and IR signals to an HDBaseT-enabled display
 - d. Switching requirements
 - i. Shall provide automatic switching between input sources

- 1. Automatically switch to the active input
- 2. Configurable switching priority when multiple inputs are active
 - a. High to low: highest numbered input has priority
 - b. Low to high: lowest numbered input has priority

e. EDID requirements

- i. Shall provide automatic EDID management between connected devices
 - 1. Provide a set of pre-stored EDID files
 - 2. Support capture of EDID from any connected display
 - 3. Support user uploading of custom-generated EDID files
 - 4. Support assignment of any pre-stored, captured, or custom uploaded EDID file to any input connection

f. HDCP requirements

- i. Shall be HDCP compliant
- ii. Shall provide authentication and maintain continuous verification of HDCP key exchange between connected devices
- iii. Shall provide the option to disable HDCP processing at any HDMI input connection when passing unencrypted content
- iv. Shall provide human-readable visual confirmation of HDCP compliance when encrypted content is routed to a non-compliant display
- v. Shall provide real-time verification of HDCP status for each digital video input
 - 1. Accessible through front panel LEDs
 - 2. Electronically accessible over RS-232 or USB connection
- g. Audio Requirements
 - i. Shall provide audio input connection
 - 1. One HDMI, embedded
 - ii. Shall provide audio output connection
 - 1. One RJ-45, DTP HDMI embedded
 - iii. Shall support multiple embedded audio formats
 - iv. Shall support audio transmission over shielded CATx up to 330 feet (100 meters)
- h. Control/Remote RS-232 and IR Pass-Through over Shielded CATx requirements
 - i. Shall provide connection for AV device control
 - 1. 5-pole captive screw: RS-232 or IR pass-through to DTP-enabled product
- i. Control/Remote Switcher Control requirements

- i. Shall provide connections for remote switcher control
 - 1. 3-pole captive screw: RS-232
 - 2. Mini USB-B: USB 2.0
 - 3. Three (3) 2-pole captive screw: contact closure and tally
 - 4. Three (3) 4-pole captive screw: contact closure and tally
- ii. Shall provide alternatives for configuration and operation
 - 1. Front panel controls
 - 2. Product configuration software connected via USB
 - 3. Serial commands sent over RS-232 and USB connection
 - 4. Contact closure ports shall be configurable for use as input selection
 - 5. Tally output shall provide +5 VDC to light an LED indicating the currently selected input
 - 6. Contact closure and tally ports shall be configurable for independent use
- iii. Shall support disabling of front panel controls to prevent inadvertent or unauthorized changes to configuration settings
- j. General requirements
 - i. Shall provide real-time verification of signal flow and operation
 - 1. Directly readable on RJ-45 signal and link LEDs
 - ii. Shall be compatible with all Extron DTP-enabled products
 - iii. Shall be compatible with CATx shielded twisted pair cable, and Extron XTP DTP 24 shielded twisted pair cable
 - iv. Shall provide power to a connected DTP receiver
 - v. Shall support the use of HDMI to DVI-D cables or adapters for DVI-D signals
 - vi. Enclosure shall be rack-mountable, half rack width, and 1 RU in height
 - vii. Shall be equipped with an external universal AC power supply capable of supporting 100-240 VAC, 50/60 Hz power
 - viii. Shall meet regulatory compliances
 - 1. CE, c-UL, UL
 - 2. CE, C-tick, FCC Class A, ICES, VCCI
 - 3. Appropriate requirements of RoHS and WEEE
 - ix. Shall provide at least three (3) years parts and labor warranty
- k. Approved device shall be the Extron DTP T SW4 HD 4K (60-1625-52); no alternates or equals

Provide (1) Extron DTP T SW4 HD 4K 4-input HDMI switcher. HDMI/VGA Video Input Wall Plate

- A. Provide a two-input decorator-style wallplate twisted pair transmitter that shall support the long distance distribution of video, audio, and control over a shielded CATx cable
 - a. Two-gang decorator-style wallplate transmitter for the transmission of HDMI, VGA, audio, and control
 - b. Video input requirements
 - i. Shall provide one (1) female HDMI Type-A input for digital video signals
 - 1. Supported HDMI specifications include data rates up to 10.2 Gbps, 3D, and HD lossless audio formats
 - ii. Shall provide one (1) female HD-15 input for VGA signals
 - 1. Digitize analog video input signals prior to transmission to the digital video output
 - 2. Support computer and video resolutions up to 4K
 - c. Switching requirements
 - i. Shall provide automatic switching between input sources
 - 1. Automatically switch to the highest-numbered input with an active video signal when multiple inputs are active
 - ii. Shall support RS-232 control
 - iii. Shall support contact closure control
 - d. Audio input requirements
 - i. Shall support embedded digital audio on HDMI input
 - ii. Shall provide two (2) independent analog audio input connections for simultaneous transmission over the same shielded, twisted pair cable
 - iii. Shall allow the HDMI input to be set to pass the embedded digital audio, embed the analog audio, or to automatically embed the analog audio when no digital audio is detected
 - iv. Shall support embedding of the analog audio input signals on the digital video output signal and transport over DTP
 - 1. For 4K HDMI video input, only the original digital audio is switched through the DTP output
 - e. Control input requirements
 - i. Shall provide communication connections for AV device control
 - 1. One bidirectional RS-232 pass-through
 - ii. Shall be RS-232 controllable
 - iii. Shall support input switching via contact closure
 - f. Interconnection requirements
 - i. Shall provide one (1) female RJ-45 twisted pair connection

- ii. Shall support interconnection between transmitter and receiver or DTP®-enabled products
- g. Transmission requirements
 - i. Shall provide a signal transmission distance capability of 230 feet (70 meters) at 4096x2160 at 30 Hz or 2048x1080p at 60 Hz using a shielded CATx cable
 - ii. Shall support digital and analog video, audio, and control over a single, shielded CATx cable
 - iii. Shall support embedded HD lossless audio formats
 - iv. Shall support embedded analog audio
 - v. Shall actively buffer DDC channels
- h. Resolution requirements
 - i. Shall support computer and video resolutions up to 4096x2160 at 30 Hz and 2048x1080p at 60 Hz
 - ii. Shall support RGB and YCbCr color space formats
- i. Audio requirements
 - i. Shall accept additional analog stereo audio signals
 - ii. Shall support multiple embedded audio formats
 - iii. Shall support embedding analog stereo audio signals onto the digital video output signal and transport over DTP
 - iv. Shall support embedded HD lossless audio formats
- j. EDID requirements
 - i. Shall provide automatic EDID management between connected devices
 - 1. Provide user-selection of EDID from any connected display
 - 2. Provide user-selection of EDID from pre-stored data files
 - 3. Maintain continuous EDID communication with the connected source
- k. HDCP requirements
 - i. Shall be HDCP compliant
 - ii. Shall provide the option to disable HDCP processing at the HDMI input connection when passing unencrypted content
- 1. Communication requirements
 - i. Shall support bidirectional RS-232 communication pass-through up to 115200 baud
 - ii. Shall support EDID and HDCP transmission
- m. Power requirements
 - i. Shall support remote power capability

- ii. Shall support being locally powered
- n. Control/Configuration requirements
 - i. Shall support auto-switching between inputs
 - ii. Shall support RS-232 control
 - iii. Shall support contact closure for input selection
 - iv. Shall support product configuration/setup through a product configuration software application connected via USB
- o. General requirements
 - i. Shall be compatible with CATx shielded twisted pair cable, and Extron XTP DTP 24 shielded twisted pair cable
 - ii. Shall support the use of HDMI to DVI-D cables or adapters for DVI-D signals
 - iii. Shall mount in an included two-gang decorator-style wallplate
 - iv. Shall support installation into standard two-gang electrical junction boxes
 - v. Shall provide visual indication for signal presence and power
 - vi. Shall meet regulatory compliances
 - 1. CE, c-UL, UL
 - 2. CE, C-tick, FCC Class A, ICES, VCCI
 - vii. Shall provide at least three (3) years parts and labor warranty
 - viii. Shall be compatible with other DTP-enabled products
- p. Approved device shall be the Extron DTP T UWP 4K 232 D (60-1755-13); no alternates or equals

Provide (1) Extron DTP T UWP 4K 232 D White HDMI/VGA video input wall plate.

HDMI Video Receiver with Audio De-Embedding

- A. Provide an HDMI twisted pair receiver that shall support the distribution of video, audio, and control over a shielded CATx cable
 - a. Rack-mountable receiver for the extension of HDMI, audio, and control
 - b. Video output requirements
 - i. Shall provide one (1) HDMI output for digital video signals with or without embedded audio
 - 1. Supported HDMI 2.0b specifications include data rates up to 18 Gbps, HDR, Deep Color up to 12-bit, 3D, and HD lossless audio formats
 - c. Audio output requirements
 - i. Shall support embedded digital audio on HDMI output
 - ii. Shall provide a dedicated analog audio output connection
 - 1. One (1) five-pole captive screw connector for analog stereo audio
 - d. Control output requirements

- i. Shall provide communication connections for AV device control
 - 1. One bidirectional RS-232 pass-through
 - 2. One bidirectional IR pass-through
- e. Interconnection requirements
 - i. Shall support interconnection between receiver and transmitter or DTP®-enabled products
 - 1. One RJ-45 twisted pair connection
- f. Transmission requirements
 - i. Shall provide signal transmission distance capability of 330 feet (100 meters) for all supported video resolutions using a shielded CATx cable
 - ii. Shall support High Dynamic Range HDR video
 - iii. Shall support video, audio, and control over a single shielded CATx cable
 - iv. Shall actively buffer DDC channels
- g. Resolution requirements
 - i. Shall support computer and video resolutions up to 3840x2160/60 at 4:4:4 chroma sampling
 - ii. Shall support RGB and YCbCr digital video formats
- h. Audio requirements
 - i. Shall provide analog stereo audio de-embedding
 - ii. Shall support analog stereo audio pass-through signals
 - iii. Shall support multiple embedded audio formats
 - iv. Shall support embedded HD lossless audio formats
- i. HDCP requirements
 - i. Shall be HDCP 2.2 compliant with backward compatibility for earlier HDCP versions
 - ii. Shall support the option to disable HDCP processing at the HDMI input connection when passing unencrypted content
 - iii. Shall support human-readable visual confirmation of HDCP compliance when encrypted content is routed to a non-compliant display
- j. Communication requirements
 - i. Shall support bidirectional RS-232 communication pass-through up to 115200 baud
 - ii. Shall support bidirectional IR pass-through
 - iii. Shall support EDID and HDCP transmission
- k. Power requirements
 - i. Shall accept remote power from a DTP2-enabled product

- ii. Shall accept local power
- iii. Shall provide a DIP switch on front panel for selection to provide power to a connected DTP2 transmitter
- 1. General requirements
 - i. Shall include a USB configuration port on the front panel for data access and firmware updates
 - ii. Shall be compatible with CATx shielded twisted pair cable, and Extron XTP DTP 24 shielded twisted pair cable
 - iii. Shall have a 1-inch (2.5 cm) high, quarter rack width metal enclosure
 - iv. Shall provide versatile mounting capability
 - v. Shall provide visual indication of RJ-45 signal and link status for DTP port
 - vi. Shall provide visual indication for signal presence, power, and link status on front panel
 - vii. Shall provide Extron LockIt® HDMI cable lacing brackets
 - viii. Shall support the use of HDMI to DVI-D cables or adapters for DVI-D signals
 - ix. Shall meet regulatory compliances
 - 1. CE, c-UL, UL
 - 2. CE, C-tick, FCC Class A, ICES, VCCI
 - 3. Appropriate requirements of RoHS and WEEE
 - x. Shall provide at least three (3) years parts and labor warranty
 - xi. Shall be compatible with other DTP-enabled products
- m. Approved device shall be the Extron DTP2 R 211(60-1631-53); no alternates or equals

Provide (1) Extron DTP2 R 211 HDMI video receiver with audio de-embedding and (1) 3' Extron Ultra HDMI cable.

Tensioned Recessed Ceiling Projector Screen

The Projection screen(s) shall be 87" (H) x 139" (W), electrically operated 120 volt (60 Hz) not more than 2.4 amp with a quick connect male plug-in connector on the motor. Shall have specially designed motor mounted inside the roller, to be three wire with ground, quick reversal type, oiled for life, with automatic thermal overload cutout, integral gears, capacitor and an electric brake to prevent coasting. To have preset but adjustable limit switches to automatically stop picture surface in the "up" and "down" positions. Junction box shall be externally integrated into the housing making it possible to install the housing and wire to the building's electrical system during construction. The junction box shall contain a quick connect connector that is mounted in the housing for easy plug-in connection to the motorized fabric and roller assembly. The motorized fabric and roller assembly to be installed in the case at the factory or at a later time at the job site. The fabric roller to be of rigid steel. Screen to be designed for left or right-hand motor installation. Screen fabric to be seamless and mildew resistant with black masking borders standard. Each side of the fabric to have tab guide cable system to maintain even lateral tension and hold surface flat. Custom slat bar with added weight maintains vertical tension on the screen surface. The ends of the slat to be protected by heavy duty plastic caps enclosing a preset adjustable mechanism for screen tensioning. Top, front and back of case to be made of extruded aluminum powder coated white. End caps to be of heavy gauge steel powder coated white. Bottom of case to have a removable access door. Door to be of extruded aluminum powder coated white. Bottom of case to be self-trimming, with a built-in flange around the bottom of the case. To be complete with integrated low voltage control unit and three position control switch and cover plate. Suitable for use in environmental air space in accordance with section 300-22 (c) of the National Electric Code, and sections 2 -128,

12-010 (3) and 12-100 of the Canadian Electrical Code, part 1, CSA C22.1. Screen to be listed by Underwriters' Laboratories. Provide (1) Da-Lite Advantage Tensioned 16:10, 87" x 139" screen with HD Progressive 1.3 material. 6,000 Lumen Laser Projector Projection System: Kensington® lock provision, High-aperture Epson 3-chip, 3LCD technology Projection Lens: **Projection Method:** Type: Front / rear / ceiling mount (For Standard Lens) Powered shift/focus / zoom Driving Method: F-number: Varies by lens Epson Poly-silicon TFT Active Matrix Pixel Number: Focal Length: 2,304,000 dots (1920 x 1200) x 3 Varies by lens Color Brightness - Color Light Output: Zoom Ratio: 8000 lumens Varies by lens White Brightness - White Light Output: Lens Shift: 8000 lumens (For Standard Lens) Aspect Ratio: Vertical: ± 67 degrees Supports 4:3, 16:9, 16:10 Horizontal: ± 30 degrees Resolution: Video: 1920 x 1200 (WUXGA) Video Processing: Analog: NTSC / NTSC4.43 / PAL / M-PAL / N-PAL Resize: 640 x 480, 800 x 600, 1280 x 1024, 1400 x 1050 / PAL60 / SECAM **Brightness Uniformity:** HDMI: 480i / 576i / 480p / 576p / 720p /1080i / (typical) 90% 1080p Pixel Arrangement: DVI-D: 480i / 576i / 480p / 576p / 720p / 1080i / Cross stripe 1080p Throw Ratio Range: Video Standards: Varies by lens 3D Y/C separation, 3D noise reduction, mosquito Size - projected distance: noise reduction 50" - 300" DCDi — Directional Correlational Keystone Correction: DeinterlacingMotion-compensated Interlace-Progressive conversion (2:2, 3:2 film detection) (For Standard Lens) Horizontal: ± 30 degrees Super Resolution: Vertical: ± 45 degrees FineFrame Interpolation 8:8 Pull-down Processing Contrast Ratio: Normal, Dynamic Mode: Up to 15,000:1 **Closed Captioning** Connectivity Projector: Color Processing: Standard Connectivity: 10 bit Color Reproduction: Wired: Integrated 100Mbps Up to 1 billion colors Wireless: Optional — 802.11b/g/n Wireless Security: WPA-PSK (TKIP/AES) / WPA2-Effective Scanning Frequency Range: Pixel Clock, Horizontal, Vertical: PSK(TKIP/AES) Remote Control and Management: Pixel Clock 13.5 MHz – 162 MHz (up to UXGA 60 Hz) Epson EasyMP® Monitor Network projection Horizontal 15 KHz – 92 KHz Multi-projection Vertical AMX[®] Device Discovery 50 Hz - 85 Hz Crestron® Integrated Partner and Crestron RoomView® General: Temperature: Extron® IP Link and XTP 32° to 113° F (0° to 45° C) **PJL**ink Weight: Projector Details: 42.2 lb without lens **Display Performance:** Security: NTSC: 480 line Security cable hole PAL: 576 line Lens lock (depends on observation of the multi-burst pattern)

Input Signal: NTSC/NTSC4.43/PAL/M-PAL/N-AL/PAL60/SECAM/480i/576i/480p/576p/720p/1080 i/1080p Pixelworks®:Video Chip 3D Y/C separation, noise reduction motion compensated Interlace-Progressive conversion (2 - 2, 3 - 2 film detection) Interfaces: DVI-D x 1 HDMI x 1 HDBaseT x 1 5-BNC, VGA x 1 Audio in: Mini Stereo x 3 Variable audio out: Mini Stereo x 1 USB connector Type B x 1: For service only USB connector Type A x 1: For wireless only Monitor out: Mini D-sub 15 pin x 1 Serial: RS-232c x 1 Speaker: None Fan Noise: Normal mode: 34 dB ECO mode: 28 dB Audio Output: None Projector Dimensions: Excluding feet and lens: 23.07 x 19.37 x 7.76 (W x D x H) Including feet - with standard lens: 23.07 x 19.37 x 8.31 (W x D x H) Remote Control: Features: Power, source search selection, lens shift, zoom, focus, test pattern selection, A/V Mute, freeze, user ID, auto, aspect, color mode, number, page up and down, E-zoom, volume, help, menu, enter, esc and pointer functions **Operating Distance:** 49 ft **Operating Angle:** Right / Left: Front: ± 60 degrees Rear: ± 30 degrees Upper / Lower: Front: ± 45 to ± 15 degrees Rear: ± 10 to ± 50 degrees Power: Power Supply Voltage: $100 - 240 \text{ V} \pm 10\%$, 50/60 Hz AC Power Consumption: Normal mode: 658 W ECO mode: 434 W Communication on: 2.0W standby Communication off: 0.22 W standby

Provide (1) Epson Pro L1100UNL 6,000 lumen laser projector with short throw #1 lens (ELPLU03). Non-Destructive Surge Suppressor

Load Rating 20 @ 120 volts Power Requirement (no load) 15 watts Surge Let-Through Voltage (6000-volt surge) 0 Volts UL 1449 Adjunct Classification Test Results 1000 surges, 6000 volts, 3000 amps, B3 pulse Measured suppressed voltage 170 volts, no failures Federal Guidelines Grade A, Class 1, Mode 1 (CID A-A-55818) EMI/RFI Filter, Normal Mode (50-ohm load) 40 dB @ 100 kHz; 50 dB @ 300 kHz; 50 dB @ 3 MHz; 50 dB @ 30 MHz EMI/RFI Filter, Common Mode (50-ohm load) 18 dB @ 300 kHz; 30 dB @ 1 MHz; 50 dB @ 5 MHz; 50 dB @ 20 MH Maximum Applied Surge Voltage 6000 volts* Maximum Applied Surge Current Unlimited, due to current limiting* Maximum Applied Surge Energy Unlimited, due to current limiting* Endurance (C62.41-1991 Category B3 pulses) 1 kV>500,000; 3 kV>10,000; 6 kV>1000 Undervoltage Shutdown 90 volts (resume at 100 v) Overvoltage Shutdown 145 volts (resume at 135 v) Maximum Load Inrush Current During Power-up 1000 Joules Remote Turn-on Applied Voltage Range 5 to 30 volts DC Remote Turn-on Current Draw: Contact Closure 1.5 mA 5 V DC Applied Voltage 0.1 mA; 24 V DC Applied Voltage 5.0 mA Auxiliary Relay Contact Rating 30 Volts at 1 Amp LED Output 12 volts DC, maximum 20 mA (resistor required) Dimensions 1.75" H x 19" W x 10.5" D (4.5 x 48.3 x 26.7 cm) Weight 11 lbs (5 kg) Temperature Range 5° to 35° C Humidity Range 5% to 95% R.H., non-condensing Agency Listings ETL and cETL certified to (UL 1449; CSA C22.2 No.8-M1986, R2000)

Provide (1) SurgeX SX-1120RT non-destructive surge suppressor.

16 Space Wall Rack

The E.I.A. compliant, UL2416 listed, welded sectional wall rack shall be Lowell Model No. LWR-1619, which shall consist of a backbox and mounting section made in the U.S.A. from 16 gauge certified U.S. steel. Overall measurements shall be 34.125"H x 19.05"D x 23.06"W (16U racking space). The mounting section shall be 13.06"D with triple formed side-to-bottom, side-to-top wrapped construction to achieve strength equivalent to 3/16" thick steel. It shall include side vents, one pair adjustable mounting rails tapped 10-32 (with mounting hardware), four knockouts for antennas (top and bottom), and integral rails on E.I.A. spacing (top and bottom). The mounting section shall attach to the backbox on the inside with two heavy duty, spring-loaded L-pins (self seating, positive locking), which can be attached on either side to alter swing orientation. The backbox shall be 5.80"D with keyhole mounting slots on 16" centers, 10" x 10" rear opening, embossed dimples and lacing points on the back plane, knockout panels with combination knockouts on top and bottom, and two keyed side locks. The rack shall have a black wrinkle powder epoxy finish.

Provide (1) Lowell LWR-1619 wall rack with (1) LWR-16FV vented door, (1) UDE-214 drawer, (1) CMR cable management, (1) RRD-16, fill all empty spaces.

Microphone Cable

CONDUCTOR PARAMETER

- Number of Pairs: 1
- AWG Size: 22
- Conductor Stranding: 7x30
- Conductor Type: Bare copper
- Nominal DCR: 17 Ohm/1000ft

INSULATION PARAMETER

- Insulation Type: Polypropylene PP
- Insulation Thickness: 0.007 in
- Insulation Color Code: 1. Black 2.Red

SHIELDING PARAMETER

- Shield Type: Overall 100% Aluminum Foil
- Drain Wire Type: Tinned Copper
- Drain Wire AWG: 24 AWG

ELECTRICAL CHARACTERISTICS

- Nom. Cap. Between Conductors: 34 pF/ft
- Nom. Cap. Conductor to Shield: 67 pF/ft

OVERALL CONSTRUCTION PARAMETERS

- Jacket Type: PVC
- Jacket Thickness: 0.020 in
- Nominal Cable O.D.: 0.135 in
- Plenum: No
- NEC UL Rating: CMR, CMG
- RoHS Compliant: Yes
- Pull Tension: 28 lbs
- Bend Radius:1.215 in
- Cable Weight: 14 lbs

Installation microphone cable shall be manufactured by Belden, West Penn Wire, or Windy City Wire. Coordinate speaker cable color with architect.

Speaker Cable

CONDUCTOR PARAMETER

- Number of Conductors: 2
- AWG Size: 14
- Conductor Stranding: 19x27
- Conductor Type: Bare copper
- Nominal DCR: 2.7 Ohm/1000ft
- Cabling Lay Length: 4 in
- Twists/Foot: 3 twist/ft

INSULATION PARAMETER

- Insulation Type: PVC
- Insulation Thickness: 0.012 in
- Insulation Color Code: 1. Black 2. White

SHIELDING PARAMETER

• Shield Type: None

OVERALL CONSTRUCTION PARAMETERS

- Jacket Type: PVC
- Jacket Thickness: 0.017 in
- Nominal Cable O.D.: 0.23 in
- NEC UL Rating: CL3R, FPLR
- RoHS Compliant: Yes
- Pull Tension: 79 lbs
- Bend Radius: 2.07 in
- Cable Weight: 42 lbs

Installation speaker cable shall be manufactured by Belden, West Penn Wire, or Windy City Wire. Coordinate speaker cable color with architect.

Shielded CAT5E

CONDUCTOR PARAMETERS

- Number Of Pairs: 4
- AWG Size: 24
- Conductor Stranding: Solid
- Conductor Type: Bare Copper
- Nominal DCR: 26 Ohm/1000ft

INSULATION PARAMETERS

- Insulation Type: Polyolefin
- Insulation Color Code: 1.Blue, WH-Blue 2.Orange, WH-Orange 3.Green, WH-Green 4.Brown, WH-Brown

SHIELDING PARAMETERS

- Shield Type: Overall 100% Aluminum Foil (F/UTP)
- Drain Wire AWG Size: 24 AWG
- Drain Wire Type: Tinned Copper

ELECTRICAL CHARACTERISTICS

- Nominal Impedance: 100 Ohm
- Nominal Capacitance Between Conductors: 15 pF/ft

OVERALL CONSTRUCTION PARAMETERS

- Total Number of Conductors: 8
- Jacket Type: PVC
- Nominal Cable O.D.: 0.252 in
- Plenum: No
- NEC UL Rating: CMR
- RoHS Compliant: Yes
- ANSI/TIA Category: Category 5E TIA/EIA 568C.2
- TIA Test: ANSI/TIA-568-C.2
- Pull Tension: 35 lbs
- Bend Radius: 1.26 in
- Cable Weight: 29 lbs

Shielded CAT5E cable shall be manufactured by Belden, West Penn Wire, or Windy City Wire. Coordinate speaker cable color with architect.

50 Ohm Wireless Antenna Coax

CONDUCTOR PARAMETER

- Number of Conductors: 1
- AWG Size: 20
- Conductor Stranding: Solid
- Conductor Type: Tinned Copper
- Nominal DCR: 10.1 Ohm/1000ft

INSULATION PARAMETER

- Insulation Type: Foam Polyethylene
- Insulation Thickness: 0.116 in

SHIELDING PARAMETER

• Shield Type: 100% Aluminum Foil 95% Tinned Copper Braid

ELECTRICAL CHARACTERISTICS

- Nominal Impedance: 52 Ohm
- Nom. Cap. Between Conductors: 25 pF/ft

OVERALL CONSTRUCTION PARAMETERS

- Jacket Type: PVC
- Jacket Thickness: 0.031 in
- Nominal Cable O.D.: 0.195 in
- Plenum: No
- NEC UL Rating: CM
- RoHS Compliant: Yes
- Pull Tension: 45 lbs
- Bend Radius: 1.95 in
- Cable Weight: 30 lb

50 Ohm Antenna Coax cable shall be manufactured by Belden, West Penn Wire, or Windy City Wire. Coordinate speaker cable color with architect.

Tests and Adjustments

The Audio Visual Contractor shall perform all tests and adjustments required to obtain the specified performance.

The tests and adjustments shall be performed under the following conditions:

All ceiling tiles, furniture, and other items shall be in their final position and ready for personnel.

Using an AC impedance meter or bridge, the impedance of all loudspeaker circuits at 1kHz shall be measured and recorded while they are disconnected from the amplifier output. This ensures that the speaker circuits are free of faults and will not overload the amplifiers.

The ambient sound level shall be measured and recorded in 1/3-octave bands with all HVAC systems and lights on. The ambient sound level shall also be measured and recorded as a single wide-band, A-weighted (dBA) reading.

The system shall be checked for hum and noise with the 1/3-octave filter off, power amplifier on, and all input volume controls set at 50 percent rotation. The system hum and noise must be inaudible in all areas to be covered by the sound system system.

A pink noise signal shall be applied to the system and adjusted for a working level of 10dB above ambient sound level. The sound system shall be checked for any buzzes, rattles, or other defects.

The uniformity of coverage shall be checked by measuring the 1/3-octave band centered at 500Hz. The level in all areas must not deviate more than +/-3dB. If the number of speakers is not sufficient to meet these requirements, the vendor shall install and supply additional speakers at their own expense to meet these specifications.

The 1/3-octave band frequency response shall be checked, and the system adjusted so that there is a flat response from 250 Hz through to 5kHz. Each octave below and above shall be rolled off at 3 dB per octave.

Provide printed test results of the final system tuning curve, SPL, and STI results. Include these results with the 0 & M Manuals as specified.

END OF SECTION 275110

SECTION 275313 – GPS WIRELESS CLOCK SYSTEMS

1. GENERAL REQUIREMENTS AND SCOPE

- A. Furnish and install a complete new GPS wireless clock system using Primex Wireless Inc. GPS wireless system.
- B. All bids shall be based on the equipment as specified herein. The specifying authority must approve any alternate system.
 - 1) Section Includes:
 - a. Transmission Systems
 - b. GPS Receiver
 - c. Primary Transmitter
 - d. Satellite Transmitter
 - e. Clocks
 - f. Analog
 - g. Digital
- C. Related Sections:
 - 1) Division 260526 Grounding.

D. References:

- 1) This Technical Specification and Associated Drawings.
- 2) Primex Wireless GPS Satellite Time System User Manual.
- 3) Primex Wireless Extended Range 1 W User Guide.
- E. Definitions:
 - 1) GPS: Global Positioning System, a worldwide system that employs 24 satellites in an integrated network to determine geographic location anywhere in the world, and which employs and transmits atomic time, the most accurate and reliable time.
- F. System Description:
 - 1) GPS wireless clock system shall continually synchronize clocks throughout the facility, and shall be capable of clock readouts in multiple time zones where desired.
 - The system shall synchronize all clocks to each other. The system shall utilize GPS technology to provide atomic time. The system shall not require hard wiring. Clocks shall automatically adjust for Daylight Saving Time.
 - 3) The system shall include an internal clock reference so that failure of the GPS signal shall not cause the clocks to fail in indicating time.
 - 4) The system shall incorporate a "fail-safe" design so that failure of any component shall not cause failure of the system. Upon restoration of power or repair of failed component, the system shall resume normal Operation without the need to reset the system or any component thereof.
 - 5) Clock locations shall be as indicated, and clocks shall be fully portable, capable of being relocated at any time.

- 6) The system must operate in accordance with a "Radio Station Authorization", Form FCC 601 LM, granted by the Federal Communications Commission (FCC). This license will be issued to and held by the end user.
- G. Regulatory Requirements:
 - 1) Equipment and components furnished shall be of manufacturer's latest model.
 - 2) The end user will hold a license, known as a "Radio Station Authorization" granted by the FCC.
 - 3) This license grants the end user protected use for wireless transmission at the designated frequency.
 - 4) FCC 1068 A "Telecommunications Bureau Supplemental Information" must be completed and signed by end user prior to license issuance.
 - 5) This license will designate a unique "call sign" for each end user.
 - 6) Transmitter and receiver shall comply with Part 90 of FCC rules as follows:
 - a. This device may not cause harmful interference, and this device must accept interference received, including interference that may cause undesired operation.
 - b. Transmitter frequency shall be governed by FCC Part 90.35.
 - c. Transmitter output power shall be governed by FCC Part 90 257 (b).
 - 7) System shall be installed in compliance with local and state authorities having jurisdiction.
- H. Submittals:
 - 1) Product Data: Submit complete catalog data for each component, describing physical characteristics and schematic interconnect drawing along with method of installation. Submit brochure showing available colors and finishes of clocks.
 - 2) Extended Warranty: Submit copy of optional 4 year extended warranty. Purchased from manufacturer. Primex Wireless Model 14992.
 - 3) Operating License: Submit evidence of application for FCC Radio Station Authorization prior to installing equipment. Furnish the license or a copy of the application for the license, to the Owner/End User prior to operating the equipment. The original license must be delivered to the Owner/End User.
 - 4) Samples: Submit one clock for approval. Approved sample shall be tagged and shall be installed in the work at location directed.
 - 5) Manufacturer's Instructions: Submit complete installation, set-up and maintenance instructions.
- I. Substitutions:
 - 1) Proposed substitutions, to be considered, shall be manufactured of equivalent materials that meet or exceed specified requirements of this Section.
 - 2) Proposed substitutions shall be identified not less than 10 days prior to bid date.
 - 3) Other systems requiring wiring and/or conduit between master and clocks will not be accepted.
 - 4) Other systems using wireless technology in an unlicensed frequency range will not be accepted.

- 5) Other systems using wireless technology where the license is held by any party other than the end user will not be accepted.
- J. Quality Assurance:
 - 1) Permits: Obtain operating license for the transmitter from the FCC.
 - 2) Qualifications:
 - a. Manufacturer: Company specializing in manufacturing commercial time system products with a minimum of 30 continuous years of documented experience including 4 years experience producing GPS wireless time systems.
 - b. Installer: Company with documented experience in the installation of commercial time systems.
 - c. Prior to installation, a site survey must be performed to determine proper transmitter placement.
- K. Delivery Storage and Handling:
 - 1) Deliver all components to the site in the manufacturer's original packaging. Packaging shall contain manufacturer's name and address, product identification number, and other related information.
 - 2) Store equipment in finished building, unopened containers until ready for installation.
- L. Project Site Conditions:
 - 1) Clocks shall not be installed until painting and other finish work in each room is complete.
 - 2) Coordinate installation of GPS receiver for access to the roof or exterior side wall so that the bracket and related fasteners are watertight.
 - 3) Coordinate installation of system antenna for access to the roof to comply with safety standards detailed in manufacturers instructions.
- M. System Startup:
 - 1) At completion of installation and prior to final acceptance, turn on the equipment; ensure that all equipment is operating properly, and that all clocks are functioning.
- N. Warranty:
 - 1) Manufacturer will provide a 1 year warranty on GPS receiver, transmitter, and satellite transmitter. Manufacturer will offer an optional 4 year extended warranty Primex Wireless Part Number14998. All other components will have a 1 year warranty.

2. PRODUCTS

- A. Manufacturer:
 - GPS wireless clock system shall be manufactured by Primex Wireless, Inc., N3211 County Road H, Lake Geneva WI 53147 (800) 537-0464 FAX (262) 248-0061 <u>www.primexwireless.com</u>.
- B. Sequence of Operation:
 - 1) Transmitter Operation: When power is first applied to the transmitter, it checks for and displays the software version. It then checks the position of the switches and stores their position in memory. The transmitter looks for the GPS time signal. Once the transmitter updates its internal clock every time it

receives valid time data from the GPS.

- 2) Analog Clock Operation:
 - a. Apply power or insert batteries. Follow set up procedures detailed in manufacturer's instructions.
 - b. After initial setup, the clock will shut off the receiver. Six times each day, the microprocessor will activate the receiver and starting with the stored channel, it will again look for a valid time signal. If necessary, the clocks will resynchronize to the correct time.
 - c. If the clock has not decoded a valid time signal for a pre-determined number of days, it will go to a step mode. Non signal reception can be caused by low battery voltage. If this occurs, replace the batteries.
- C. Equipment:
 - 1) General: The clock system shall include a transmitter, a roof or window mounted GPS receiver, indicating clocks, and all accessories for complete operation.
 - GPS Receiver: GPS roof mounted, with 10 foot cable (3m) attached (additional Primex Wireless extension cable available: 50ft (15.25m), 100 ft (30.5m), and 200 ft (61m). Coordinate with exact site conditions and furnish accordingly.
 - 3) The GPS Receiver shall be a complete GPS receiver including antenna in a waterproof case, designed for roof or outdoor mounting. Provide mounting bracket for attachment to roof structure.
 - 4) The GPS Receiver cable must be plenum rated where required by local code.
 - 5) Transmitter: Primex Wireless Model 14400-E, consisting of wireless transmitter with GPS receiver, a surge suppressor/battery backup, and a mounting shelf. Unit shall obtain current atomic time from satellite. The clock system shall transmit time continuously to all clocks in the system.
 - 6) Transmission:
 - a. Frequency Range: 72.100 to 72.400 MHz.
 - 7) Transmission Power: 1 watt (30dBm) maximum.
 - 8) Radio technology: narrowband FM.
 - 9) Number of channels: 16.
 - 10) Channel bandwidth: 20 kHz maximum.
 - 11) Transition mode: one-way communication.
 - 12) Data rate: 2 KBps.
 - 13) Operating range: 32 degree F to 158 degrees F (0 degrees C. to 70 degrees C).
 - 14) Transmitter:
 - a. Transmitter output power: +26 to +30 dBm.
 - 15) Frequency deviation: +/- 4 kHz
 - 16) Transmitter power requirements: 120 VAC 60 Hz.

- 17) Internal power requirements: 5 VDC.
- 18) Carrier frequency stability: +/- 20 ppm.
- 19) Transmitter shall have 16 selectable channels to assure interference-free reception.
- 20) Transmitter shall have the following switches:
 - a. Time zone adjustment switches for all time zones in the world. Includes: Eastern, Central, Mountain, Pacific, Alaska, and Hawaii.
- 21) Daylight Saving Time bypass switch.
- 22) 12-hour or 24-hour display.
- 23) Transmitter housing shall be black metal case, 16-3/4 inches (424.4mm) by 12 inches (304.8mm) by 1-7/8 inches (46.4mm) in size.
- 24) An external antenna is included with the transmitter model number. The antenna connects to the transmitter via a 50-ohm 100 ft. coaxial cable. Transmitter housing shall incorporate a display, which shall include the following:
 - a. Time readout
 - b. AM and PM indicator if 12-hour time display is set
 - c. Day and date readout
 - d. Indicator for daylight savings or standard time
 - e. LED which shall flash red in event of reception problem
 - f. GPS reception indicator
- 25) Transmitter shall contain an internal clock such that failure of reception from the GPS will not disable the operation of the clocks.
 - a. Power supply (included)
 - b. Input: 120 volt AC 50/60 Hz, 0.4 amp.
 - c. Output: 9 volt DC, 1.5 amp.
- 26) Antenna:
 - a. An external antenna is included with the transmitter model number. The antenna connects to the transmitter via a 100 ft. (30.5m) 50-ohm coaxial cable.
- 27) Antenna:
 - a. Dimensions: radiating element 29.4 inches (747mm)
 - b. Ground radials 41.5 inches (1063 mm)
 - c. Equivalent flat plate area: 0.68 ft2 (0.063m2)
 - d. Polarization: Vertical
 - e. H-plane beamwidth: omni
 - f. E-plane beamwidth: 78° (half power)
 - g. Max. Input power (75 watts @ 50°)
 - h. Gain: 0 dBd
 - i. VSWR (max) <: 1.5
 - j. Frequency range: 68-78 MHz (broadband)
 - k. Impedance: 50 ohms

- 1. Lightning Protection: Direct Ground
- m. Connector N female
- n. Pole or Wall Mountable
- o. Mounting hardware supplied
- 28) Optional Non-penetrating antenna mast kit:
 - a. Primex Wireless Model ANT-NP1
 - b. Installer must provide ballast material per manufacturer's instructions.
- 29) Building mount antenna mast kit.
 - a. Primex Wireless Model ANT-P1
 - b. Wind survival rating 120mph (200 kph)
- 30) Additional Equipment:
 - a Wireless Receiver Switches: Switches shall receive time packets from the Primary Transmitter and relay the synchronized time to the Satellite Transmitter connected to it. The unit shall include the following:
 - i. Antenna mounted on top of the switch housing, 11-1/2 inches (292mm) long.
 - ii. Power Supply:
 - (1) Input 120 VAC 50/60 Hz, 0.4 amps
 - (2) Output: 9 volt DC, 1.5 amps
 - iii. RS 232 data cable, 5 feet (1.5mm) long
 - iv. Daylight Savings Time bypass switch
 - v. Dimensions: 4-1/4 inches (108mm) long, 5/-3/4 inches (146mm) wide, 1-1/4 inches (31.75mm) deep.
 - vi. Weight: 12 ounces (.34kg)
 - vii. Operating Range: 32 degrees F to 158 degrees F. (0 to 70 degrees C)
 - b. Satellite Transmitters Primex Wireless Model 14401: Satellite Transmitters shall receive the signal from the Wireless Receiver Switches and transmit the signal to the devices in its vicinity, which are out of the range from the Master Transmitter. The unit shall include the following:
 - i. Antenna mounted on top of the housing, 46 inches (1168mm) long.
 - ii. Wireless Receiver Switch.
 - iii. Power Supply Input: 120 VAC, 50/60 Hz, 0.4 amp.
 - iv. Output: 9 volt DC, 1.5 amps.
 - v. 6 foot (1.83m) cord.
 - vi. Transmission Power: 1 watt maximum
 - vii. 72 MHz frequency.
 - c. Traditional analog clocks (battery): Analog clocks shall be wall mounted. Clocks shall have polycarbonate frame and polycarbonate lens. Face shall be white. Hour and minute hands shall be black.
 - i. 9 inch (228.6mm) diameter analog clock: Primex Model 14280
 - ii. 12-1/2 inch (317.5mm) diameter analog clock: Primex Model 14155
 - iii. 16 inch (406.4mm) diameter analog clock: Primex Model 14163
 - iv. 24 inch (610mm) diameter analog clock: Primex Model 14346
 - v. Additional colors, finishes, and dial faces are available from manufacturer.
 - d. Analog clocks shall be battery-operated, and shall have minimum 5-year battery life.

- e. Analog clocks shall be capable of automatically adjusting for Daylight Saving Time. An on-off switch located on the transmitter shall disable this function if desired.
- f. Time shall be automatically updated from the transmitter 6 times per day.
- g. Analog clocks shall remember the time during changing of batteries.
- h. 9 inch (228.6mm) and 12.5 inch (317.5mm) analog clocks shall have a tamper proof/theft resistant clock lock mounting slots.
- i. Analog clock receivers shall be as follows:
 - i. Receiver sensitivity: >-110 dBm
 - ii. Receiver power: two batteries
 - iii. Antenna type: internal
 - iv. Antenna gain: -7 dBd
- j. If the transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded. If signal transmission is not restored after 96 hours, the second hand will "five step" as a visual indicator that the signal has been lost. Should the clocks lose power and signal, the clocks will not function.
- k. Analog clock faces shall bear Owner's logo as indicated on the drawings.
- 1. Traditional analog clocks (AC): Analog clocks shall be wall mounted. Clocks shall have polycarbonate frame and polycarbonate lens. Face shall be white. Hour and minute hands shall be black.
 - i. 12-1/2 inch (317.5mm) diameter analog clock, 24 VAC: Primex Model 14323
 - ii. 12-1/2 inch (317.5mm) diameter analog clock, 120 VAC, Primex Model 14306
 - iii. Additional colors, finishes, and dial faces are available from manufacturer.
- m. Analog clocks shall be AC powered (24 VAC or 120 VAC). Clocks must have an 18 inch (457.2mm) cord with 2 prong plug 9120 VAC) or pigtail(24 VAC) to connect to power source.
- n. Analog clocks shall be capable of adjusting for Daylight Saving Time.
- o. Time shall be automatically be updated from the transmitter 6 times per day.
- p. If power is interrupted, the clock will stop until power resumes. Upon resumption of power, the clock will self correct to the current time.
- q. Clocks shall have a tamper proof/theft resistant clock lock mounting slots.
- r. Analog clock receivers shall be as follows:
 - i. Receiver sensitivity: >-110 dBm
 - ii. Receiver power: 24 VAC or 120 VAC (see model #)
 - iii. Antenna type: internal
 - iv. Antenna gain: -7 dBd
- s. If transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded. If signal transmission is not restored after 48 hours, the second hand will "five step" as a visual indicator that the signal has

been lost. Should the clocks lose power and signal, the clocks will not function.

- t. Analog clock faces shall bear Owner's logo as indicated.
- Digital Clocks: Primex Wireless Model 14201, 4 inch (101.6mm), 7 segment LED display. Clocks shall have polycarbonate frame and polycarbonate lens. LED digits shall be red or green. Overall dimensions: 18 inches (457.2mm) long, 8 inches (203.2mm) wide, 3 inches (76.2mm) deep.
- v. Digital clocks must be able to receive synchronized time signal from Primex Wireless master or satellite transmitter.
- w. Digital clocks must have time and date option.
- x. Digital clocks shall be capable of automatically adjusting for Daylight Savings Time
- y. Power Supply: 120 VAC, 50-60 cycle.
- z. Digital clocks must be viewable from 150 feet (45.7m).
- aa. Wire guards: Provide one for each analog clock as follows:
 - i. Analog clock wire guard Primex Wireless Model 14131, 14 by 14 inch (355.6 by 355.6 mm) size, for nominal 12-1/2 inch (317.5 mm) diameter analog clocks.
 - ii. Analog clock wire guard Primex Wireless Model 14123, 18 by 18 inch (457.2 by 457.2mm) size, for 16 inch (406.4mm) diameter analog clocks.
 - iii. Digital clock wire guard Primex Wireless Model 14388 for 2. 5 inch (63.5mm) LED digital clocks.
 - iv. Digital wire guard Primex Wireless Model 14389 for 4 inch (101.6mm) LED digital clocks.
- bb. Cable Connection Sealant: Radio Shack Coaxial Cable Connector Sealant 278-1645, or approved electrical grade silicone sealant.
- cc. Transmitter Rack.
 - i. Primex Wireless Model 14005, 3 inch (76.2mm) x 16.5 inch (419mm) x 18 inch (457mm), 18 gauge metal, epoxy covered.

3. EXECUTION:

- A. Examination:
 - 1) Verify that construction is complete in spaces to receive equipment and that rooms are clean and dry.
 - 2) Verify that 120 volt electrical outlet is located within 6 feet (1.83m) of location of transmitter and the outlet is operational and properly grounded.
- B. Installation:
 - 1) Furnish all equipment necessary for a complete and operable system.
 - 2) GPS Unit: Install on roof in location indicated, in clear view of the sky. Install unit in location free from standing water, and above accumulations of leaves or debris. Seal cable connection to GPS with cable connection sealant. Any added cable lengths must be protected from outside elements.
 - 3) Transmitter:

- a. Locate transmitter in a penthouse, electrical closet or telecommunications room in a central location in the building. Clearance around all sides of the transmitter to comply with local building codes.
- b. Transmitter is connected to external antenna via a 50 ohm coaxial cable. Typical length 100ft (30.5m). Cable routing should comply with ANSI EIA/TIA-569-A and local building codes. If the cable is routed through conduit, the conduit should be a minimum of 2 inch (50.8mm) diameter.
- c. Transmitter enclosure must be bonded to an earth ground per ANSI EIA/TIA 607, NEC Article 250, and local building codes.
- 4) Antenna:
 - a. Antenna should be mounted to a mast on the roof of the building connecting to the transmitter via a 50-ohm coaxial cable. Consult manufacturer's instruction manual for specific clearances and mounting instructions.
 - b. Antenna must be bonded to an earth ground per ANSI EIA/TIA 607, NEC Article 250, and local building codes. Analog clocks (battery): Perform the following operations with each clock.
- 5) Set clock to correct time in accordance with manufacturer's instructions.
- 6) Observe analog clock until valid signals are received and analog clock adjusts itself to correct time.
- 7) Install the analog clock on the wall in the indication location, plumb, level and tight against the wall. If using 12-1/2" (317.5mm) clock, attach using clock-lock hanging method and suitable fasteners as approved by clock manufacturer.
- 8) Analog clocks (AC): Perform the following operations with each clock:
 - a. Apply power (24 VAC or 120 VAC)
 - b. Observe clock until valid time signal s are received and analog clock adjusts itself to correct time.
 - c. Install the analog clock on the wall in the indicated location, plumb, level, and tight against the wall. Attach using clock-lock hanging method and suitable fasteners as approved by clock manufacturer.
 - d. Wire guards: Secure to wall, using approved theft-resistant fasteners.
- C. Adjusting:
 - 1) Prior to final acceptance, inspect each clock, adjust as required, and replace parts which are found defective.
- D. Cleaning:
 - Prior to final acceptance, clean exposed surfaces of clocks, using cleaning methods recommended by clock manufacturer. Remove temporary labels from clock faces. Do not remove labels from backs of clocks.
- E. Demonstration :
 - 1) Provide training to Owner's representative on setting and adjusting clocks, replacing batteries and routine maintenance.
- F. Protection:
 - 1) Protect finished installation until final acceptance of the project.

G. Testing:

1) All devices must be tested at their operational location under normal operational conditions to assure reception of signal. Contractor to make any required field adjustments, including additional equipment, as required to accommodate field conditions to provide a 100% functioning system.

END OF SECTION 275313

SECTION 281353 - AV INTERCOM SYSTEM

1. GENERAL

A. SECTION INCLUDES

(1) IP Video Intercom. (Aiphone IX Series)

B. RELATED SECTIONS

- (1) Section 33 82 00 Communications Distribution.
- (2) Section 28 18 00 Security Access Detection Equipment.
- (3) Section 28 13 53.10 Security Video Intercom System.

C. REFERENCES

- (1) American National Standards Institute (ANSI/TIA/EIA) 568 Commercial Building Telecommunications Cabling Standard.
- (2) International Organization for Standards (ISO) 9001:2000 Quality Management Systems Requirements.

D. SYSTEM DESCRIPTION

- (1) IP Network Compatible Video Intercom System: A network-based communication and security system featuring video entry security, internal communication, emergency stations, and paging. All units and app in the systems shall be able to unlock doors remotely on a network, assist onsite visitors from an offsite location, broadcast emergency announcements, and communicate using a PoE network.
 - a. Power Source: Power over Ethernet (802.3af).
 - b. Network Interface: 10 BASE-T / 100 BASE-TX Ethernet (RJ-45).
 - c. Network Protocols: IPv4, IPv6, TCP, UDP, SIP, HTTP, HTTPS, MJPEG, RTSP, RTP, RTCP, IGMP, MLD, SMTP, DHCP, NTP, DNS.
 - d. Bandwidth Usage:
 - 1) G.711: 64Kbps x 2 per video call.
 - 2) 64Kbps per monitor.
 - 3) H.264: 24Kbps ~ 2,048Kbps.
 - e. Communication: Hands-free (VOX), push-to-talk (simplex), or handset (full-duplex).
 - f. Video Display: 7 inch color LCD.
 - g. Camera: Type:
 - 1) 1/3 inch color CMOS. 1.23 Megapixels.
 - 2) View Area at 0 degree camera angle mounted at 4 feet 11 inches (1500 mm) AFF: 2 feet 3 inches (700 mm) vertical x 3 feet 9 inch (1150 mm) horizontal at 19 inches (500 mm).
 - h. Video Stream: ONVIF Profile S.
 - i. Door Release: Programmable Form C dry contact, 24V AC/ DC, 500mA (use RY-24L for larger contact rating, which requires 24V DC power supply) or use RY-IP44 with 4 multipurpose relays.
 - j. Wire Type: CAT-5e or CAT-6.
 - k. Distance:
 - 1) Any station to Network Node: 330 feet (100 meters).
- E. SUBMITTALS

- (1) Submit under provisions of Section 01 30 00 Administrative Requirements.
- (2) Product Data: Manufacturer's data sheets on each product to be used, including:
 - a. Preparation instructions and recommendations.
 - b. Storage and handling requirements and recommendations.
 - c. Installation methods.
- (3) Shop Drawings: Submit the following:
 - a. Wiring Diagrams: Indicate wiring for each item of equipment and interconnections between items of equipment.
 - b. Include manufacturer's names, model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
- (4) Installation and Operation Manuals:
 - a. Submit manufacturer's installation and operation manual, including operation instructions and component wiring diagrams.
 - b. Provide detailed information required for Owner to properly operate equipment.
- (5) Warranty: Submit manufacturer's standard warranty.
- (6) Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- (7) Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.
- F. QUALITY ASSURANCE
 - (1) Manufacturer Qualifications: ISO 9001:2015 certified company.
 - (2) Installer Qualifications: Factory trained and experienced with system installations of scope and size required for the Project.
 - (3) Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 - a. Finish areas designated by Architect.
 - b. Do not proceed with remaining work until workmanship is approved by Architect.
 - c. Refinish mock-up area as required to produce acceptable work.
- G. DELIVERY, STORAGE, AND HANDLING
 - (1) Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
 - (2) Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions.
 - (3) Handling: Protect materials during handling and installation to prevent damage.

H. PROJECT CONDITIONS

(1) Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

2. **PRODUCTS**

A. MANUFACTURERS

- Acceptable Manufacturer: Aiphone Corp., which is located at: 6670 185th Ave. NE; Redmond, WA 98052 ; Toll Free Tel: 800-692-0200; Tel: 425-455-0510; Fax: 425-455-0071; Email: request info (marketing@aiphone.com); Web:http://www.aiphone.com
- (2) Substitutions: Not permitted.
- (3) Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 -Product Requirements.
- (4) IP Video Intercom System: IX Series Intercom System as manufactured by Aiphone Corporation.

B. SYSTEM DESIGN

- (1) Master Station(s): Provide _____ master stations.
- (2) Audio Video Door Stations:
 - a. Model IX-DA (Surface Mount): Provide _____
 - b. Model IX-DV (Video Door Station Surface Mount Hands Free): Provide _____.
 - c. Model IX-DVF (Video Door Station Flush Mount Hands Free): Provide _____.
 - d. Model IX-DVF-P (Video Door Station Flush Mount Hands Free): Provide
 - e. Model IX-DVF-RA (Video Door Station Flush Mount Emergency Call Button): Provide
 - f. Model IX-DVF-2RA (Video Door Station Flush Mount Hands Free Emergency Call Button): Provide
- (3) Audio Only Door Stations:
 - a. Model IX-SSA (Video Door Station Flush Mount Hands Free): Provide
 - b. Model IX-SSA-RA (Video Door Station Flush Mount Emergency Call Button): Provide
 - c. Model IX-SSA-2RA (Video Door Station Flush Mount Emergency Call Button): Provide
 - d. Model IX-BA (Surface Mount): Provide
 - e. Model IX-SS-2G (Recessed Mount): Provide .
 - f. Model IX-SSA (Recessed Mount): Provide _____.
- (4) Provide Selective Door/Gate Release.
- (5) Provide Audio/video streaming via ONVIF Profile S.
- (6) Provide ONVIF Profile S camera input (max 500).
- (7) Provide Overhead paging.
- (8) Provide Contact input at door station.
- C. FUNCTIONAL COMPONENTS:
 - (1) Functional Components: As indicated on the drawings or as required to complete system.
 - a. Video Master Station Series IX-MV7:
 - 1) Model IX-MV7-HB (Master Station Black w/Handset).
 - 2) Model IX-MV7-HW (Master Station White w/Handset).
 - 3) Model IX-MV7-B (Master Station Black, Hands Free).
 - 4) Model IX-MV7-W (Master Station White, Hands Free).
 - 5) An IP addressable video master station with a 7 inch color LCD monitor. It can be wall or desk mounted (desk stand included). The IX-MV7 offers handset (duplex) and hands-free (VOX/PTT) communication and call up to 500 other IX stations. It connects directly to a network using CAT-5e/6 cable. This station requires a 802.3af

compliant Power-over-Ethernet network.

- b. Substation Series IX-RS:
 - 1) Model IX-RS-W (White Handset Substation)
 - 2) Model IX-RS-B (Black Handset Substation)
- c. IXW-MA IP Programmable Relay Adaptor: Multi-purpose adaptor PoE screen only. : Provide
- d. RY-IP44 IP Programmable Relay Adaptor:
 - 1) 4 contact inputs and 4 relay outputs (compatible with the IX Series, IS-IP Series, and IPW-1A only).
- e. 2-Wire Network Adapter Model IX-1AS:
 - One 2-wire input with 2 built-in contact outputs; door release and camera call-up. Powered via PoE, Compatible with Aiphone's LE and NE series audio door or substations for connection to Video Master Station Model IX-MV7 over a network.
- f. Wire Network Adapter Model IX-10AS (Ten IX-1AS adaptors in a rack mounted enclosure):
 - Ten 2-wire inputs with ten, 2 built-in contact outputs; door release and camera call-up. Powered via PoE, Compatible with Aiphone LE and NE series audio door or substations for connection to Video Master Station Model IX-MV7 over a network.
- g. Network Paging Adapter Model IX-PA:
 - Address book that supports up to 50 stations and can be connected to 3rd party devices. Can be accessed by an IX-MV7 master station or an instance of the IX Mobile App to allow messages to be broadcast through the IX-PA 600u or 8u output. A 3rd party device can be connected to the audio input to send messages to the paging adaptor address book.
 - Emergency and Assistance Modular Towers: TW-Series.
 - 1) Modular tower design available in three configurations:
 - (a) 2-Module, mid-level tower.
 - (b) 3-Module, dual station tower
 - (c) 3-Module, high level Tower.
 - 2) Color: _____

h.

- 3) Lettering Color: _____. For assistance and emergency signage.
- 4) Top Cover:
 - (a) Top plate, no light.
 - (b) Light cage with blue beacon and strobe.
- 5) UL Listed electrical box included in base module
- 6) Material: 0.25 inch (6.4 mm) zinc treated steel powder coated exterior.
- 7) Camera arm module option with universal pipe threading (1.50 inch NPT Threading x 1 inch (25 mm) long).
- 8) Elongated access panel on back of each module for easier installation and wiring.
- 9) Mounting studs in both top and base modules for internal product (power supply, relay, etc.).
- 10) Weather and vandal resistant.
- 11) Mounting: L-brackets, anchor bolts to foundation meeting size requirements of manufacturer.
- 12) Compatible with IX-Series emergency and assistance stations.
- 13) Beacon / Strobe is always lit; flashes during emergency call-in (Requires 24V DC).
- 14) LED light for station illumination in middle module (Requires 24V DC).
- 15) Call button mounting height and signage meet ADA regulations.
- 16) Compatibility: Use with IX-DVF-2RA, IX-DVF-RA, IX-SSA-2RA, IX-SSA-RA, IS-DVF-2RA, IS-SS-2RA-R, and IS-SS-RA-R
- 17) Compatibility with Non-Emergency Call Stations when using the TW-SPL: IX-DVF, IS-DVF, and IS-IPDVF
- i. 30 Degree Angle Box Model KAW-D 30:
 - 1) Designed for use with one gang mountable video door stations.
 - 45 Degree Mullion Mounting Bracket Model KMB-45:

j.

- 1) Bracket suitable for mounting any of the 1 gang door stations.
- k. Stainless Steel Security Lock Box Model LB-SDVF.
- 1. Electric Door Strike Model EL-12S:
 - 1) The door strike is designed for wood framed wooden doors. The unit operates on $12 \sim 16$ V AC.
- m. Stainless Steel Enclosure Model SBX-ISDVF:
 - 1) 18-Guage Stainless Steel Surface Mount Box for IS-SS/IS-DVF/IS-IPDVF/IX-DF(SS)/IX-DF-HID/RP10 designed for surface mounting door stations.
 - Size: 10-7/16 inches x 5-15/16 inches x 3-5/16 inches (top); 2-5/16 inches (bottom) (265 mm x 151 mm x 84 mm (top); 59 mm (bottom).
 - 3) Weather resistant.
 - 4) Vandal-resistant.
 - 5) Inside space for cabling.
 - 6) Mounts to flat wall surface.
 - 7) Opening at bottom for drainage.
- n. Stainless Steel Enclosure Model SBX-IDVFRA:
 - 18-Guage Stainless Steel Surface Mount Box for IS-DVF-(2)RA, IX-DF-2RA, IX-SS-(2)RA.
 - Size: 11-11/16 inches x 7 inches x 3-5/16 inches (top); 2-5/16 inches (bottom) (297 mm x 178 mm x 84 mm (top); 59 mm (bottom).
 - 3) Weather resistant.
 - 4) Vandal-resistant.
 - 5) Inside space for cabling.
 - 6) Mounts to flat wall surface.
 - 7) Opening at bottom for drainage.
- (2) Wall Boxes:
 - a. Product: WB-CA Stainless Steel Wall Mount Box with Blue Assistance Signage and a Light Cage.
 - 1) ADA (28 CFR Part 36 section 4.4.1) compliant.
 - 2) Lettering: Reflective lettering on both sides of box.
 - 3) Blue Beacon and Strobe: Mounted on top, enclosed in vandal resistant cage.
 - 4) Material: 12-gauge stainless steel.
 - 5) UL Listed electrical box included. 1-gang pattern internal mounting above UL box
 - 6) Surface Mounting: 4 inch (102 mm) depth, ADA compliant.
 - 7) Voltage: 24V DC.
 - 8) Current: 200 mA.
 - 9) Service: Vandal and weather resistant.
 - 10) Compatibility: IX-DVF-2RA, IX-DVF-RA, IX-SSA-2RA, IX-SSA-RA, IS-DVF-2RA, IS-SS-2RA-R, and IS-SS-RA-R emergency and assistance substations.
 - b. Product: WB-CE Stainless Steel Wall Mount Box with Red Emergency Signage and a Light Cage.
 - 1) ADA (28 CFR Part 36 section 4.4.1) compliant.
 - 2) Lettering: Reflective lettering on both sides of box.
 - 3) Blue Beacon and Strobe: Mounted on top, enclosed in a vandal resistant cage.
 - 4) Material: 12-gauge stainless steel.
 - 5) UL Listed electrical box included. 1-gang pattern internal mounting above UL box
 - 6) Surface Mounting: 4 inch (102 mm) depth, ADA compliant.
 - 7) Voltage: 24V DC.
 - 8) Current: 200 mA.
 - 9) Service: Vandal and weather resistant.
 - 10) Compatibility: IX-DVF-2RA, IX-DVF-RA, IX-SSA-2RA, IX-SSA-RA, IS-DVF-2RA, IS-SS-2RA-R, and IS-SS-RA-R emergency and assistance substations.
 - c. Product: WB-HA Stainless Steel Wall Mount Box with Blue Assistance Signage and a Hooded Light.

- 1) ADA (28 CFR Part 36 section 4.4.1) compliant.
- 2) Lettering: Reflective lettering on both sides of box.
- 3) Blue Beacon and Strobe: Mounted on top, enclosed in a vandal resistant stainless steel hood with clear polycarbonate lens.
- 4) Material: 12-gauge stainless steel.
- 5) UL Listed electrical box included. 1-gang pattern internal mounting above UL box
- 6) Surface Mounting: 4 inch (102 mm) depth, ADA compliant.
- 7) Voltage: 24V DC.
- 8) Current: 200 mA.
- 9) Service: Vandal and weather resistant.
- 10) Compatibility: IX-DVF-2RA, IX-DVF-RA, IX-SSA-2RA, IX-SSA-RA, IS-DVF-2RA, IS-SS-2RA-R, and IS-SS-RA-R emergency and assistance substations.
- d. Product: WB-HE Stainless Steel Wall Mount Box with Red Emergency Signage and a Hooded Light.
 - 1) ADA (28 CFR Part 36 section 4.4.1) compliant.
 - 2) Lettering: Reflective lettering on both sides of box.
 - 3) Blue Beacon and Strobe: Mounted on top, enclosed in a vandal resistant stainless steel hood with clear polycarbonate lens.
 - 4) Material: 12-gauge stainless steel.
 - 5) UL Listed electrical box included. 1-gang pattern internal mounting above UL box
 - 6) Surface Mounting: 4 inch (102 mm) depth, ADA compliant.
 - 7) Voltage: 24V DC.
 - 8) Current: 200 mA.
 - 9) Service: Vandal and weather resistant.
 - 10) Compatibility: IX-DVF-2RA, IX-DVF-RA, IX-SSA-2RA, IX-SSA-RA, IS-DVF-2RA, IS-SS-2RA-R, and IS-SS-RA-R emergency and assistance substations.

3. EXECUTION

A. EXAMINATION

- (1) Examine areas to receive integrated security and communication system.
- (2) Notify Architect of conditions that would adversely affect installation or subsequent use.
- (3) Do not begin installation until unacceptable conditions are corrected.

B. PREPARATION

- (1) Verify the following compliance before starting installation.
 - a. The unit turns inoperative during power failure.
 - Keep the intercom wires at least 1 foot (30 cm) away from strong electrical wiring (AC 100-240 V) including, in particular, wiring for inverter electrical appliances. Noise and malfunction could result.
 - c. If a strong light shines on the main unit screen, the picture may turn white or only silhouettes will be visible.
 - d. Other manufacturer's devices (such as sensor, detectors, door releases) used with this system, comply with the manufacturer's installation requirements.
 - e. The LCD panel is manufactured with very high precision techniques, inevitably will have a very small portion of its picture elements always lit or not lit at all. This is not considered a unit malfunction. Please be aware of this in advance.

C. INSTALLATION

(1) Install integrated security and communication system in accordance with manufacturer's instructions at locations indicated on the Drawings.

(2) Mount equipment plumb, level, square, and secure. For video entrance stations and video door stations, comply with manufacturer's design requirements to provide optimum picture quality of station monitoring.

D. SET-UP AND ADJUSTING

(1) Adjust integrated security and communication system for proper operation in accordance with manufacturer's instructions.

E. DEMONSTRATION AND TRAINING

(1) Demonstration:

- a. Demonstrate that integrated security and communication system functions properly.
- b. Perform demonstration at final system inspection by qualified representative of manufacturer.

(2) Instruction and Training:

- a. Provide instruction and training of Owner's personnel as required for operation of integrated security and communication system.
- b. Provide hands-on demonstration of operation of system components and complete system, including user-level program changes and functions.
- c. Provide instruction and training by qualified representative of manufacturer.

F. PROTECTION

(1) Protect installed integrated security and communication system from damage during construction.

END OF SECTION 281353

SECTION 282300 - DIGITAL VIDEO SURVEILLANCE SYSTEMS

1. DESCRIPTION OF SYSTEM COMPONENTS

The digital surveillance system shall consist of the following components:

- A. Digital Camera Server(s) of configuration shown on drawings or specified herein, with all server software installed and pre-configured to be operational automatically upon system start-up. Software shall support camera control and connection, PC screen displays, analog TV displays, automated recording and archiving of camera input, and automated communications. Provide keyboard and mouse. A 17" color PC monitor shall be provided by the installer at each head-end. No external video file or image server and internet or network connection shall be required for full operation of the digital surveillance system.
- B. Remote Access Software utilities with password protected access to the camera server application via dialup phone connection, Ethernet LAN or WAN. The Remote Access Software provided with the digital surveillance system will not be restricted from being copied or freely distributed and can be operated on any compatible PC.
- C. Video Player utility for point-and-click access to stored video files based upon time, date, and camera graphical screen displays. Video files will be capable of being viewed on any MS-Windows environment video player and images will be capable of being captured and viewed by any MS-Windows image viewer. The video control software provided with the digital surveillance system will not be restricted from being copied or freely distributed.
- D. Provide a battery backup uninterruptable power supply with adequate surge suppression to protect computer equipment. Unit to be sized to run all cameras, power supplies, server(s), and monitor for 15 minutes during a utility outage.
- E. All cameras, power supplies, mounts, controllers, cabling, raceways, labor, testing, owner training, etc., as required.

2. DESCRIPTION OF SYSTEM OPERATION

The system shall provide for unattended operation of the following features contained within video server(s) without the need for networked external or off-site devices. In summary, the digital surveillance system shall provide for:

- A. Digital monitoring, recording, playback, and remote observation for the number of cameras noted, continuously and simultaneously.
- B. Digital recording, playback, and file archiving self-contained within a single location of camera server(s).
- C. Multiplexed video monitoring options plus additional analog remote display outputs
- D. Video motion sensing, alarm response, paging, e-mail, and remote monitor site alerting administered by operator selections or automated timers and schedulers.
- E. Remote access capabilities to include choice of multiplexed viewing, recording, camera control, playback, and program administration with secure password protection.
- F. Plug-and-play ethernet (TCP/IP), POTS dial-up, ISDN and PPP Internet connectivity.
- G. Options to include pan/tilt/zoom control, alarm input and output relays, proximity sensing, access control and web-server distribution of video to network clients for view-only monitoring.

H. Provide remote duplicate monitoring with "dumb" terminal (specifically made for the task) remote console as shown on plans. Remote duplicate monitoring may also be accomplished over the building data network via software.

3. CAMERA SERVER SYSTEM STANDARDS

- A. The system shall be compatible with Windows XP or Vista, with both graphical interface for monitoring and control and MS-Windows utilities for operation and setup. It shall be capable of operating on Windows NT and Novell networks allowing remote access over customer computer networks.
- B. The system and software shall support connection of the noted number of cameras with the capability of recording full-stream video of all cameras concurrently, provide display of each camera view as multiple images on an industry standard PC monitor, record digital files for each camera to the camera server=s hard disk, and archive video on internal DAT tape recorder.
- C. The system shall utilize the US-NTSC standard for all video signal input and the system shall be compatible with color CCD cameras supplied with the system.
- D. The system shall be capable of recording and storing compressed digital video files and decompressing files for playback using high-resolution compression technology. Transmission of video for remote access will default to high frame rate H.263 compression. In addition, the system will be capable of saving files as uncompressed .AVI or capable of saving images to TIF files compatible with MS-Windows graphics, video playback, or image enhancement software.
- E. The system shall support remote access of video via POTS or ISDN telephone lines using PC-compatible modems, via Ethernet when connected to a 10/100-baseT LAN or WAN, or via internet connection using an Internet Service Provider. Both telephone dial-up and network TCP/IP remote connections shall be independently selectable and enabled with password protection to eliminate unauthorized access. Provide a proper Ethernet connection at each head-end location from existing hub or switch facilities, using Category 5E cable, RJ-45 jacks and a patch cable. The Owner shall configure the new address into the local area network.
- F. Remote access shall be from a PC-compatible computer (meeting minimum requirements) using an included remote access program. No browser software or internet connection shall be required.
- G. Backup of all video files created within a 24 to 48 hour period shall be automatically accomplished at a predetermined hour each night without user action required. The camera server application and all operation of the server shall not be interrupted or degraded in performance while the backup is being performed. Files archived shall be able to be retrieved by any camera server or PC with the player software installed. Archive capacity shall be determined by the characteristics of the video as it is recorded and shall be user controllable. DAT tape shall be provided with capacities capable of up to 70 gigabytes per tape as specified or indicated. Provide three tapes for each drive.
- H. System shall be of robust design, capable of 7x24 unattended operation with auto-recovery after extended power interruption. Make an interlock/control connection to battery U.P.S. backup unit. The system shall communicate with the UPS for orderly shutdown and restart.
- I. By default, the system shall offer password protection to access system administrator tools or for remote connection authorization. Multiple levels of password protection shall be selectable by user name.

4. CAMERA (VIDEO) SERVER OPERATING SPECIFICATIONS

A. Systems shall be offered for plug-and-play installation direct from the manufacturer. All operator tools shall be of graphical interface or easily understood Windows toolsets using a PC mouse.

- B. Standard capabilities shall allow for immediate display of camera views with the system automatically in operation as long as power is connected. Further access to administrative functions shall require password access, as well as password access being required before the server system will acknowledge a request for remote surveillance connection.
- C. Server display will allow for choice of display formats from one to nine or sixteen cameras. The direct view through the server=s monitor shall feature a digital TV quality overlay of all camera views. In addition, scanning views of specific cameras may be played on the screen as well as being directed to a standard TV set having a video input jack. Specific views may be enlarged to full screen by mouse click.
- D. Video recording and display characteristics shall be administrator selectable for each camera as follows: Image resolution shall be capable of at least 640x480 pixels with lower selectable alternatives; time lapse frame rate shall be adjustable from one second up to the maximum noted in the system specifications and video compression ratio shall be selectable up to 1:60. Each reduction in image quality or frame speed shall allow for greater storage capacity.
- E. Camera characteristics shall be capable of matching all NTSC standard camera types as well as accommodating specific Pan /Tilt /Zoom (P-T-Z) types that shall be able to be controlled by graphical user interface and mouse when connected to the camera server by control cable.

5. SYSTEM SECURITY FUNCTION SPECIFICATIONS

- A. System shall be capable of beginning recording and creating alarm notifications as a result of detecting motion through attached cameras. Detection shall be specified on a camera-by camera basis using customizable screen trigger templates. Motion detection shall be activated by manual input, by user determined time-of-day/day-of-week scheduling, or by external security triggers or motion sensing devices providing closed-contact indication.
- B. When activated by motion, the camera server shall be able to trigger up to 4 external alarm panels or devices via contact closure. The camera server=s operation shall be triggered by incoming contact closure connections. Refer to the drawings or other section of this specification for alarm details.
- C. Alarm notification shall include generating a telephone page immediately upon motion detection trigger or contact closure trigger. Response (although dependent upon the user=s service) will be capable of a notification being received within one minute of the trigger event. Up to three page numbers shall be polled until a connection is made by the camera server. The Contractor shall provide a telephone circuit from the telephone service location to the server location and connect. The Owner will indicate the specific circuit to be used.
- D. Alarm notification shall include activating the remote video monitoring software automatically via POTS dial-out call or TCP-IP log-in connection. Up to three sites shall be polled until a connection is made by the camera server.
- E. Additional alarm notifications shall include audible alarm output from the camera server using a Windows WAV file selectable by the administrator. Visible screen alerts shall direct attention to the camera view causing the triggering event.
- F. The camera server shall log all events including camera triggering, system on and system off, username/password login events, remote connections made. In addition, the capability to create exception logging of video files created under specific pre-determined situations (accessories required to generate the exception logging event).
- G. System shall generate complete time/date/camera stamp on monitoring views, playback views, still frame printed output, and stored video files. The time/date stamp data will be permanently incorporated as a

component of the video image and shall be generated in black or silver with position directed to any of the four image corners.

6. VIDEO STORAGE AND PLAYBACK SPECIFICATIONS

- A. Playback of any stored video file (or any other administrative activity) shall cause no interruption or degradation of performance of the camera server operation.
- B. Video playback shall be facilitated through the use of a graphic appearing Windows-style VCR control screen or approved equivalent with mouse-click command response that allows easy access to video files using a calendar date, time, and camera data table. Files listed shall be able to be played and viewed immediately by simply clicking on a selected file that opens as any other windows video file. Single files or lists of files shall be able to be viewed as real-time, time-lapse, fast forward or reverse, and still frame. Images shall be able to be directly printed using any PC printer attached to the camera server. Printer, if any, shall be furnished by Owner. System shall also be capable of communicating with a network printer via the provided 10/100t ethernet network interface card.
- C. Recorded digital video files shall be stored for direct access and playback on computer hard drives of the size specified. The amount of time available directly on the hard drive depends upon the recording schedule, image resolution, compression, and frame rate chosen in system setup. This can be from several days (high frequency of recording, high resolution, and high frame rate) to several weeks (low occurrence of motion, time lapse and lower resolution) depending upon the user=s preference. This shall be reconfigurable by the Owner via on-screen controls.
- D. Recorded digital video files shall be archived on high-capacity DAT tape for easy recovery and playback. Backup Executive software shall allow for unattended backup and assisted recovery of archived periods of time by calendar date restoration. Once restored from archive, files shall be ready for playback using the calendar search user interface.
- E. Video Player software module required for playback shall not be copy protected and shall not be licensed for distribution. It shall be capable of being duplicated freely.
- F. Video files created by the system shall be capable of being saved as uncompressed, Windows-compatible video (.AVI) files for playback on any MS-Windows PC using the Media Player. The file shall be capable of being played by simply clicking on the filename.

7. OWNERSHIP RIGHTS AND SUPPORT

- A. The system software application license shall be totally user-owned and user-supportable with complete documentation files provided for duplication at will. Reproduction of remote viewing software shall be allowed to enhance the flexibility of remote access to the camera server. Reproduction of the Video Player shall be unrestricted and shall accompany any video files to facilitate viewing. Files may be saved as MS-Windows (.AVI) files at any time.
- B. No additional cost contracts for software support or server maintenance will be required for the first three years. The processor system shall include a complete three-year, on-site, next-business day warranty with optional hardware warranty service extensions available after three years. Future software releases which may include enhancements shall be available at no charge whenever possible. Vendor is to notify Owner via mail, e-mail or phone call of available upgrades during the warranty period.

8. SYSTEM OPTIONS AND ACCESSORIES

The Digital Surveillance System shall accommodate additional capabilities not required for basic operations but that may be required in exceptional situations.

- A. Pan/Tilt/Zoom Interface Controller required to connect automated cameras capable of external motion and image control. The capacity for P-T-Z shall be incorporated into each video head-end.
- B. I/O Relay Panel for receiving alarms from other devices or outputting alarms to external alarm panels.
- C. Proximity sensing access controllers, microchip proximity tags, cards or badges, and electrically activated door locks to support a safe and controlled-access environment.

9. SYSTEM SPECIFICATIONS

A. LOCAL CAMERA VIEWING

(1)	Camera Inputs	NTSC - Number as noted on plans
(2)	Composite Outputs	1 Analog Video Output Multiplexed, 1 Switcher
(3)	Screen Partition	
(4)	System Frame Rate	
(5)	Individual Camera Frame Rate	
(6)	Resolution (pixels)	
(7)	Compression (selectable)	

B. REMOTE CAMERA VIEWING

(1)	Camera Views (selectable)	
(2)	Resolution (selectable)	
(3)	Compression Format.	
(4)	Communication (selectable)TCP/IP:LAN, W	AN, Internet or Dial-up Phone: POTS / ISDN

C. HARD DISK RECORDER / PLAYER

(1)	Record Speed (selectable)	 recorded)
(2)	Cameras Recorded Simultaneously	 selectable)
(3)	Cameras Played-Back	 selectable)

D. RECORDING MODES (SELECTABLE ON-SCREEN)

(1)	Motion Triggered	(Timed Scheduled)
(2)	Constant Record	(Timed or Manual)
(3)	Contact Triggered	(Timed Scheduled)
(4)	Monitor Mode Only	(Screen Display)

E. CPU

(1)	Processor	
(2)	RAM	
(3)	Video	
(4)	Standard Storage	60 Gb Hard-drive
(5)	Archived Storage	upgrade to 70GB SCSI at high/middle schools)
(6)	Communications	56Kb Modem, 10/100mb Ethernet Card

10. EQUIVALENT PRODUCTS

A. Other technologies or systems that do not exactly meet the requirements of this section, that are truly equivalent digital video solutions will be considered as acceptable for this project. Contact the Engineer ten working days prior to the bid date to obtain permission to bid in a written addendum.

B. Equivalent systems that meet the specification requirements as manufactured by R.T.I., Panax, Honeywell or Panasonic will be acceptable.

11. CAMERAS AND VIDEO DISTRIBUTION SYSTEM

A. GENERAL REQUIREMENTS

- (1) It is the purpose and intent of this specification to obtain for the Owner a complete, high quality, reliable camera and video distribution system.
- (2) All necessary equipment, material and labor shall be provided by the Contractor, whether or not specified. All workmanship shall be neat and of the highest quality and conform to prevailing standards.
- (3) The system shall be comprised of completely matched and video service compatible components. Any equipment catalog numbers listed constitute the type and quality of the equipment to be furnished. Other manufacturer's equipment will be acceptable if all performance requirements of this specification are provided.
- (4) All equipment shall be supplied by a factory authorized dealer. In order to assure the Owner of factory warranties, the equipment supplier shall be prepared to provide factory authorization. A supplier not authorized by the manufacturer to furnish the specified equipment will not be acceptable.
- (5) The camera specified is based on equipment manufactured by "Silent Witness." Other systems or equipment as manufactured by Pelco, Burke, Panasonic, Sony, etc., will be acceptable, if provided by authorized dealers of said equipment.
- B. QUALITY ASSURANCE
 - (1) Distributor must have at least 3 years of successful installation experience with products utilizing CCTV equipment similar to that required for this project.
 - (2) Contractor must comply to all applicable requirements of NEC Article, 300, 800, 810 and 820 pertaining to radio and TV equipment and signal distribution systems.
 - (3) Equipment must comply with applicable requirements of UL standards 813 and 983 pertaining to television equipment and accessories which area UL listed and labeled.

C. EQUIPMENT

- (1) CCTV Cameras
 - a. The color cameras shall use a 1/3 inch format, interline transfer, CCD image sensor containing the specified number of active picture elements.
 - b. Camera shall have 420 (indoor) 420 (outdoor) minimum lines of resolution with a minimum object illumination of 1.0 lux at F2.0.
 - c. Camera shall have back focus, line back phase sync adjustments.
 - d. Provide fixed lens with auto iris (mechanical or electronic) of the proper millimeter size for best viewing scene for each camera location at indoor and outdoor locations. lenses shall be provided that fully cover the intended viewing area. Adjustments of lens type may be needed in the field and shall be anticipated in the bid.

- e. Camera shall be 12 to 24 volt AC or DC equal to Silent Witness, Pelco, Sony, Panasonic.
- f. For each outdoor camera, provide 12 to 24 power with remote power supply for housing blower, heaters, etc., as required. Also provide a properly grounded lightning arrestor on the coaxial cable lead-in and the power wiring just inside building entry. Provide 24 volt power to outdoor cameras using discrete power supplies compatible with the camera. Power supply(ies) shall be located at or near at head-end locations. If in doubt about the installation, contact the Engineer for clarification. All wiring for 24 volt power shall be sized per N.E.C., to keep voltage at terminal point within camera operating parameters.
- g. Each camera shall generate a custom unique alphanumeric identifier, visible on any monitor or recorded image. This identifier shall be as requested by the facility operator.
- (2) Camera Enclosures
 - a. Indoor camera enclosure shall be a semi-recessed dome ceiling type with the necessary adjustment radius. Provide tile bridge or rails to support in lay-in ceilings. Domes shall be lightly tinted to hide camera orientation.
 - b. Provide all enclosures with vandal and tamper resistant construction.
 - c. At exterior camera locations, provide weatherproof vandal-resistant housings with powder coat finish, color selected by Engineer, with companion painted mounting plate for roof or parapet installation. Also, provide housing with heaters and defrost blower unit.
 - d. At indoor surface mounted exposed camera locations, provide an adjustable heavy-duty wall bracket mount.
 - e. Where indicated, provide motorized pan-tilt-zoom mount, heavy duty, weatherproof, with proper power supply and RS-485 or similar control compatible with control software. Provide proper cabling to control unit from camera platform. Install lightning protection on this cable at building entry, properly grounded per N.E.C.
- (3) Cable
 - a. Provide RG6/U type, plenum-rated where required, 750hm impedance with copper center conductor, plus 2-18 gauge jacketed, stranded conductors for low voltage power, plenum-rated where required.
 - b. Provide jacketed shielded multi-conductor cable as required for pan-tilt-zoom control and power supply leads. Use plenum-rated cable where required.

D. EXECUTION

- (1) The installation of all work shall be neat and of professional quality. Execute without claim for extra payment minor moves or changes in equipment locations to accommodate equipment. Install so as to eliminate EMI/RFI effects.
- (2) The Contractor shall provide conduit systems to junctions and mount all boxes for the systems wiring as indicated on plans. Special boxes shall be provided by the systems supplier for installation by the Contractor.
- (3) Upon completion of the installation, the system shall be tested by the manufacturer's representative and all necessary modifications and/or adjustments must be made to assure compliance with this specification.

- (4) Upon completion of the testing, the manufacturer or representative shall issue to the Owner a letter of certification attesting to the fact that he has tested and adjusted the system, that all components are properly installed and free of defects, and that the system is in compliance with this specification.
- (5) The work shall include supplying the services of a field service representative who shall be a full-time employee. The field service representative shall have specialized experience in the operation and maintenance of the system and shall instruct the Owner's personnel in the techniques involved in the operation of the systems. A formal on-site training shall be provided to the Owner's representative/maintenance personnel and shall include instructions in the location, inspection, maintenance, testing and operation of all components. Provide a signed copy of the name of the personnel giving the instructions and the personnel of the Owner. The training session shall be a minimum of three hours at each facility or with each individual or group of personnel being trained.
- (6) All cameras shall be connected to digital video server(s) and power supplies in proper fashion, in compliance with N.E.C.

E. WARRANTY, SERVICE AND MAINTENANCE

- (1) Provide a three year unconditional warranty of the installed camera system, against defects in material and workmanship. If any defects are found within the warranty period, the defective equipment shall be replaced at no extra charge to Owner for parts or labor.
- (2) The CCTV supplier shall employ factory trained technical service personnel for service and maintenance of the system should service be required. The supplier shall also instruct the Owner's technical personnel in the operation, care and maintenance of the system.

END OF SECTION 282300

SECTION 283100 - FIRE ALARM SYSTEM

PART 1 GENERAL

1.1 RELATED SECTIONS

- A. Section 13800 Building Automation and Control.
- B. Section 13900 (21 00 00) Fire Suppression.
- C. Section (27 15 00) (Fire Alarm Communications Horizontal Cabling).

1.2 DESCRIPTION

- A. The fire alarm system shall comply with requirements of NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.
- B. The facility shall have an emergency voice alarm communication system. Digitally stored message sequences shall notify the building occupants that a fire or life safety condition has been reported. Message generator(s) shall be capable of automatically distributing up to eight (8) simultaneous, unique messages to appropriate audio zones within the facility based on the type and location of the initiating event. The Fire Command Center (FCC) shall also support Emergency manual voice announcement capability for both system wide or selected audio zones, and shall include provisions for the system operator to override automatic messages system wide or in selected zones.
- C. The system shall be support additional, alternate Fire Command Centers, which shall be capable of simultaneous monitoring of all system events. Alternate Fire Command Centers shall also support an approved method of transferring the control functions to an alternate Fire Command Center when necessary. All Fire Command Centers shall be individually capable of assuming Audio Command functions such as Emergency Paging, audio zone control functions, and Firefighter's Telephone communication functions.
- D. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Command Center (FCC) and designated personnel in other buildings at the site via a multiplex communication network.
- E. The fire alarm system shall be manufactured by an ISO 9001:2008 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994
- F. The FACP and peripheral devices shall be manufactured 100% by a single U.S. manufacturer (or division thereof). It's acceptable for peripheral devices to be manufactured outside of the U.S. by a division of the U.S. based parent company.
- G. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.
- H. The installing company shall employ NICET (minimum Level II Fire Alarm Technology) technicians on site to guide the final checkout and to ensure the systems integrity.

1.3 GUARANTY:

A. The fire alarm control panel, voice panels and any head-end equipment shall have a manufacturer's warranty of a minimum of 3 years.

1.4 POST CONTRACT MAINTENANCE:

- A. Complete maintenance and repair service for the fire detection system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of five (5) years after expiration of the guaranty.
- B. As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, required tests, and list pricing for any replacement products included on the bill of materials, along with the list pricing for products not on the bill of materials; if test and inspection rates are different than full service rates the bid/proposal shall include pricing for all levels for a minimum period of five (5) years Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty.
- C. Include also a quote for unscheduled maintenance/repairs, including hourly rates for technicians trained on this equipment, and response travel costs for each year of the maintenance period. Submittals that do not identify all post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty.

1.5 APPLICABLE STANDARDS AND SPECIFICATIONS:

A. The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards, if applicable.

No. 12	Extinguishing Systems (low and high)
No. 12A	Halon 1301 Extinguishing Systems
No. 13	Sprinkler Systems
No. 15	Water Spray Systems
No. 16	Foam / Water Deluge and Spray Systems
No. 17	Dry Chemical Extinguishing Systems
No. 17A	Wet Chemical Extinguishing Systems
No. 2001	Clean Agent Extinguishing Systems
No. 70	National Electric Code
No. 90A	Air Conditioning Systems
No. 92A	Smoke Control Systems
No. 92B	Smoke Management Systems in Malls, Atria, Large Areas
No. 72	National Fire Alarm Code
No. 101	Life Safety Code

B. National Fire Protection Association (NFPA) - USA:

C. Underwriters Laboratories Inc. (UL) - USA:

No. 268	Smoke Detectors for Fire Protective Signaling Systems
No. 864	Control Units for Fire Protective Signaling Systems
No. 2572	Mass Notification Systems
No. 217	Smoke Detectors, Single and Multiple Station
No. 228	Door Closers - Holders for Fire Protective Signaling Systems
No. 268A	Smoke Detectors for Duct Applications
No. 521	Heat Detectors for Fire Protective Signaling Systems
No. 464	Audible Signaling Appliances
No. 38	Manually Actuated Signaling Boxes
No. 1481	Power Supplies for Fire Protective Signaling Systems
No. 346	Waterflow Indicators for Fire Protective Signaling Systems

No. 1076	Control Units for Burglar Alarm Proprietary Protective Signaling Systems
No. 1971	Visual Notification Appliances
No. 2017	Standard for General-Purpose Signaling Devices and Systems
No.60950	Safety of Information Technology Equipment

- D. Local and State Building Codes.
- E. All requirements of the Authority Having Jurisdiction (AHJ).

1.6 APPROVALS:

A. The system shall have proper listing and/or approval from the following nationally recognized agencies:

UL	Underwriters Laboratories, Inc
ULC	Underwriters Laboratories Canada
FM	Factory Mutual
NYFD	New York Fire Department
CSFM	California State Fire Marshal

- B. The system shall be approved for use in Marine applications by the following agencies.
 - 1. United States Coast Guard
 - 2. Lloyd's Register
 - 3. American Bureau of Shipping
- C. The system shall be certified for seismic applications in accordance with the International Building Code (IBC). For OSHPD applications in California the system shall be Pre-Approved for seismic applications. The basis for qualification of seismic approval shall be via shake table testing.

PART 2.0 PRODUCTS

2.1 Main Fire Alarm Control Panel or Network Node:

A. Main FACP or network node shall be a NOTIFIER Model NFS2-640 and shall contain a microprocessor based Central Processing Unit (CPU) and power supply in an economical space saving single board design. The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, printer, annunciators, and other system controlled devices.

2.2 System Capacity and General Operation

- A. The FACP shall be capable of communicating on Noti-Fire-Net over a Local Area Network (LAN) or Wide Area Network (WAN) utilizing a peer-to-peer, inherently regenerative communication format and protocol. The network shall support communication speed up to 100 Mb and support up to 200 panels / nodes per network.
- B. Each network node shall provide, or be capable of 318 intelligent / addressable devices per SLC loop. The Notification Appliance Circuits shall be programmable to Synchronize with System Sensor, Gentex and Wheelock Notification Appliances.
- C. The system shall include a full featured operator interface control and annunciation panel that shall include a backlit Liquid Crystal Display (LCD), individual color coded system status LEDs, and an alphanumeric keypad with easy touch rubber keys for the field programming and control of the fire and gas detection

system.

- D. The system shall be programmable, configurable, and expandable in the field without the need for special tools, PROM programmers or PC based programmers. It shall not require replacement of memory ICs to facilitate programming changes.
- E. The system shall allow the programming of any input to activate any output or group of outputs. Systems that have limited programming (such as general alarm), have complicated programming (such as a diode matrix), or require a laptop personal computer are not considered suitable substitutes.
- F. The FACP shall support up to 20 logic equations, including "and," "or," and "not," or time delay equations to be used for advanced programming. Logic equations shall require the use of a PC with a software utility designed for programming.
- G. The FACP or each network node shall provide the following features:
 - 1. Drift compensation to extend detector accuracy over life. Drift compensation shall also include a smoothing feature, allowing transient noise signals to be filtered out.
 - 2. Detector sensitivity test, meeting requirements of NFPA 72.
 - 3. Maintenance alert, with two levels (maintenance alert/maintenance urgent), to warn of excessive smoke detector dirt or dust accumulation.
 - 4. Up to nine sensitivity levels for alarm, selected by detector. The alarm level range shall be 0.5 to 2.35 percent per foot for photoelectric detectors, 0.5 to 2.5 percent per foot for ionization detectors, 0.5 to 4.0 percent per foot for acclimate detectors and 1.0 to 4.0 percent per foot for multi-criteria (IntelliQuad and IntelliQuad PLUS) detectors The system shall also support sensitive advanced detection laser detectors with an alarm level range of .02 percent per foot to 2.0 percent per foot. The system shall also include up to nine levels of Pre-alarm, selected by detector, to indicate impending alarms to maintenance personnel.
 - 5. The ability to display or print system reports.
 - 6. Alarm verification, with counters and a trouble indication to alert maintenance personnel when a detector enters verification 20 times.
 - 7. PAS presignal, meeting NFPA 72 requirements.
 - 8. Self optimizing pre-alarm for advanced fire warning, which allows each detector to learn its particular environment and set its prealarm level to just above normal peaks.
 - 9. Cross zoning with the capability of counting: two detectors in alarm, two software zones in alarm, or one smoke detector and one thermal detector.
 - 10. Control-by-time for non-fire operations, with holiday schedules.
 - 11. Day/night automatic adjustment of detector sensitivity.
 - 12. Device blink control for sleeping areas.
 - 13. The FACP shall be capable of coding main panel node notification circuits in March Time (120 PPM), Temporal (NFPA 72 A-2-2.2.2), and California Code. Panel notification circuits (NAC 1,2,3 and 4) shall also support Two-Stage operation, Canadian Dual Stage (3 minutes) and Canadian Dual Stage (5 minutes). Two stage operation shall allow 20 Pulses Per Minute (PPM) on alarm and 120 PPM after 5 minutes or when a second device activates. Canadian Dual stage is the same as Two-Stage except will only switch to second stage by activation of Drill Switch 3 or 5 minute timer. The panel shall also provide a coding option that will synchronize specific strobe lights designed to accept a specific "sync pulse."
 - 14. Network Communication
 - 15. For flexibility and to ensure program validity, an optional Windows(TM) based program utility shall be available. This program shall be used to off-line program the system with batch upload/download, and have the ability to upgrade the manufacturers (FLASH) system code changes. This program shall also have a verification utility, which scans the program files, identifying possible errors. It shall also have the ability to compare old program files to new ones, identifying differences in the two files to allow complete testing of any system operating changes. This shall be in compliance with the NFPA 72 requirements for testing after system modification.

- a. This utility shall provide the ability to create and print NFPA style Test and Inspection reports
- b. This utility shall provide the ability to create and print Device Maintenence information
- 16. The 80-character display keypad shall be an easy to use QWERTY type keypad, similar to a PC keyboard. This shall be part of the standard system and have the capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels shall be provided to prevent unauthorized system control or programming.
- 17. When configured with an optional 640-character display the display shall use 10 "soft" keys for screen navigation or to accomplish dedicated programming functions. Full programming access shall require use of a laptop and the proper programming utility. With the 640 display option the system shall support distributed audio amplifiers on the digital audio loop of the Digital Voice Command.

H. Signaling Line Circuits (SLC)

- 1. Each FACP or FACP network node shall support up to two SLCs. Each SLC interface shall provide power to and communicate with up to 159 intelligent detectors (onization, photoelectric, multicriteria, thermal, laser, fire/CO) and 159 intelligent modules (monitor, control, relay, releasing) for a loop capacity of 318 devices. The addition of the optional second loop shall double the device capacity, supporting a total of 636 devices. Each SLC shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.
- 2. CPU shall receive analog information from all intelligent detectors to be processed to determine whether normal, alarm, prealarm, or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.
- I. Serial Interfaces
 - 1. The system shall include two serial EIA-232 interfaces. Each interface shall be a means of connecting UL Listed Information Technology Equipment (ITE) peripherals.
 - a. EIA-232 interface shall be used to connect an UL-Listed 40 or 80 column printer. Printers that are not UL-Listed are not considered acceptable substitutes.
 - b. The system shall include an EIA-485 port for the serial connection of optional annunciators and remote LCD displays.
 - c. The EIA-485 interface may be used for network connection to a proprietary-receiving unit.
- J. Digital Voice Command Center
 - 1. The Digital Voice Command Center located with the FACP, shall contain all equipment required for all audio control, emergency telephone system control, signaling and supervisory functions. This shall include speaker zone indication and control, telephone circuit indication and control, digital voice units, microphone and main telephone handset. The DVC shall support up to 8 channels of voice when configured with Digital Audio Amplifiers and 4 channels of voice when employing the optional analog output card. Each DVC shall support up to 32 digital audio amplifiers.
 - 2. Function: The Voice Command Center equipment shall perform the following functions:
 - a. Operate as a supervised multi-channel emergency voice communication system.
 - b. Operate as a two-way emergency telephone system control center. Audibly and visually annunciate the active or trouble condition of every speaker circuit and emergency telephone circuit.
 - c. Audibly and visually annunciate any trouble condition for digital tone and voice units required for normal operation of the system.

- d. Provide all-call Emergency Paging activities through activation of a single control switch.
- e. As required, provide vectored paging control to specific audio zones via dedicated control switches.
- f. Provide a factory recorded "library" of voice messages and tones in standard WAV. File format, which may be edited and saved on a PC running a current Windows® operating system.
- g. Provide a software utility capable of off-line programming for the DVCoperation and the audio message files. This utility shall support the creation of new programs as well as editing and saving existing program files. Uploading or downloading the DVC shall not inhibit the emergency operation of other nodes on the fire alarm network.
- h. Support an optional mode of operation with four analog audio outputs capable of being used with UL 864 fire-listed analog audio amplifiers and SLC controlled switching.
- i. The Digital Voice Command shall be modular in construction, and shall be capable of being field programmable without requiring the return of any components to the manufacturer and without requiring use of any external computers or other programming equipment.
- j. The Digital Voice Command and associated equipment shall be protected against unusually high voltage surges or line transients.
- 3. The emergency voice alarm communication system shall incorporate a Two-way emergency telephone communication system.
 - a. Two-way emergency telephone communication circuits shall be supervised for open and short circuit conditions.
 - b. Two-way emergency telephone (Fire Fighter Telephone) communication shall be supported between the Digital Voice Audio Command Center and up to seven (7) remote Fire Fighter's Telephone locations simultaneously on a telephone riser.
 - c. Means shall be provided to connect FFT voice communications to the speaker circuits in order to allow voice paging over the speaker circuit from a telephone handset.
- K. Audio Amplifiers
 - 1. The Audio Amplifiers will provide Audio Power (@25 Volt RMS or 70 RMS) for distribution to speaker circuits.
 - 2. Multiple audio amplifiers may be mounted in a single enclosure, either to supply incremental audio power, or to function as an automatically switched backup amplifier(s).
 - 3. The audio amplifier shall include an integral power supply, and shall provide built-in LED indicators for the following conditions:
 - a. Earth Fault on DAP A (Digital Audio Port A)
 - b. Earth Fault on DAP B (Digital Audio Port B)
 - c. Audio Amplifier Failure Detected Trouble
 - d. Active Alarm Bus input
 - e. Audio Detected on Aux Input A
 - f. Audio Detected on Aux Input B
 - g. Audio Detected on Firefighter's Telephone Riser
 - h. Receiving Audio from digital audio riser
 - i. Short circuit on speaker circuit 1
 - j. Short circuit on speaker circuit 2
 - k. Short circuit on speaker circuit 3
 - 1. Short circuit on speaker circuit 4
 - m. Data Transmitted on DAP A
 - n. Data Received on DAP A
 - o. Data Transmitted on DAP B
 - p. Data Received on DAP B
 - q. Board failure
- r. Active fiber optic media connection on port A (fiber optic media applications)
- s. Active fiber optic media connection on port B (fiber optic media applications)
- t. Power supply Earth Fault
- u. Power supply 5V present
- v. Power supply conditions Brownout, High Battery, Low Battery, Charger Trouble
- 4. The audio amplifier shall provide the following built-in controls:
 - a. Amplifier Address Selection Switches
 - b. Signal Silence of communication loss annunciation Reset
 - c. Level adjustment for background music
 - d. Enable/Disable for Earth Fault detection on DAP A
 - e. Enable/Disable for Earth Fault detection on DAP A
 - f. Switch for 2-wire/4-wire FFT riser
- 5. Adjustment of the correct audio level for the amplifier shall not require any special tools or test equipment.
- 6. Includes audio input and amplified output supervision, back up input, and automatic switch over function, (if primary amplifier should fail).
- 7. System shall be capable of backing up digital amplifiers.
- 8. One-to-one backup shall be provided by either a plug-in amplifier card or a designated backup amplifier of identical model as the primary amplifier.
- 9. One designated backup amplifier shall be capable of backing up multiple primary amplifiers mounted in the same or adjacent cabinets.
- 10. Multi-channel operation from a single amplifier shall be supported by the addition of an optional plug-in amplifier card.
- L. Audio Message Generator (Prerecorded Voice)/Speaker Control:
 - 1. Each initiating zone or intelligent device shall interface with an emergency voice communication system capable of transmitting a prerecorded voice message to all speakers in the building.
 - 2. Actuation of any alarm initiating device shall cause a prerecorded message to sound over the speakers. The message shall be repeated four (4) times. Pre- and post-message tones shall be supported.
 - 3. A built-in microphone shall be provided to allow paging through speaker circuits.
 - 4. System paging from emergency telephone circuits shall be supported.
 - 5. The audio message generator shall have the following indicators and controls to allow for proper operator understanding and control:
 - a. Lamp Test
 - b. Trouble
 - c. Off-Line Trouble
 - d. Microphone Trouble
 - e. Phone Trouble
 - f. Busy/Wait
 - g. Page Inhibited
 - h. Pre/Post Announcement Tone
- M. Controls with associated LED Indicators:
 - 1. Speaker Switches/Indicators
 - a. The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.
 - b. The speaker circuit control panel shall include switches to manually activate or deactivate each speaker circuit in the system.

- 2. Emergency Two-Way Telephone Control Switches/Indicators
 - a. The emergency telephone circuit control panel shall include visual indication of active and trouble status for each telephone circuit in the system.
 - b. The telephone circuit control panel shall include switches to manually activate or deactivate each telephone circuit in the system.
- N. Specific System Operations
 - 1. Smoke Detector Sensitivity Adjust: A means shall be provided for adjusting the sensitivity of any or all addressable intelligent detectors in the system from the system keypad. Sensitivity range shall be within the allowed UL window and have a minimum of 9 levels.
 - 2. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification delay shall be programmable from 0 to 60 seconds and each detector shall be able to be selected for verification. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
 - 3. Point Disable: Any addressable device in the system may be enabled or disabled through the system keypad.
 - 4. Point Read: The system shall be able to display or print the following point status diagnostic functions:
 - a. Device status
 - b. Device type
 - c. Custom device label
 - d. View analog detector values
 - e. Device zone assignments
 - 5. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 800 events. Up to 200 events shall be dedicated to alarm and the remaining events are general purpose. Systems that do not have dedicated alarm storage, where events are overridden by non-alarm type events, are not suitable substitutes. Each of these activations will be stored and time and date stamped with the actual time of the activation. The contents of the history buffer may be manually reviewed, one event at a time, or printed in its entirety. The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable substitutes.
 - 6. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent detector and shall analyze the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is above or below normal limits, then the system will enter the trouble mode, and the particular detector will be annunciated on the system display, and printed on the optional printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
 - 7. Pre-Alarm Function: The system shall provide two levels of pre-alarm warning to give advance notice of a possible fire situation. Both pre-alarm levels shall be fully field adjustable. The first level shall give an audible indication at the panel. The second level shall give an audible indication and may also activate control relays. The system shall also have the ability to activate local detector sounder bases at the pre-alarm level, to assist in avoiding nuisance alarms.
 - 8. Software Zones: The FACP shall support 142 independent programmable software zones
 - 9. The fire alarm control panel shall include a walk test feature. It shall include the ability to test initiating device circuits and notification appliance circuits from the field without returning to the panel to reset the system. Operation shall be as follows:
 - a. Alarming an initiating device shall activate programmed outputs, which are selected to

participate in walk test, for 3 seconds.

- b. Introducing a trouble into the initiating device shall activate the programmed outputs for 8 seconds.
- c. All devices tested in walk test shall be recorded in the history buffer.
- 10. Multiple agent releasing zones: The system shall support up to 10 releasing zones to protect against 10 independent hazards. Releasing zones shall provide up to three cross-zone and four abort options to satisfy any local jurisdiction requirements.
- 11. Mass Notification Override: The system shall be UL 2572 listed for Mass Notification and shall be capable, based on the Risk Analysis, of being programmed so that Mass Notification/Emergency Communications events take precedence over fire alarm events.
- O. Conventional Aspirating Detection
 - 1. An optional air aspiration detection system shall be available.
 - 2. The aspirating system shall support multiple sensitivity settings.
 - 3. The aspirating system shall operate from 24 VDC.
 - 4. The aspirating system shall provide alarm and trouble relays used to activate a fire alarm control panel.
- P. Aspiration System Interface:
 - 1. The system shall be capable of supporting Interface Modules for integrating Vesda Aspiration detectors into SLC loop of the fire alarm control panel. The Interface Module shall support up to 19 detectors detectors, each SLC loop shall support one interface module.
- Q. High Level Aspiration System Interface:
 - 1. The system shall be capable of supporting a High Level Interface for Vesda Aspirating Detection Systems. The interface shall support up to 100 detectors and allow the fire alarm network to monitor and control events on the aspiration system.
- R. Portable Emergency Telephone Handset Jack
 - 1. Portable emergency telephone handset jacks shall be flush mounted on stainless steel plates as indicated on the plans. Jacks shall be approved for emergency telephone system application.
 - 2. Insertion of a portable handset plug into a jack shall send a signal to the fire command center, which shall audibly and visually indicate the on-line condition, and shall sound a "ring" indication in the handset.
 - 3. The two-way emergency telephone system shall support a minimum of seven (7) handsets on line without degradation of the signal.
- S. Fixed Emergency Telephone Handset
 - 1. The telephone cabinet shall be painted red and clearly labeled as "Emergency Telephone." The cabinets shall be located where shown on drawings.
 - 2. The handset cradle shall have a switch connection so that lifting the handset off of the cradle shall send a signal to the fire command center, which shall audibly and visually indicate its on-line (off-hook) condition.
 - 3. On activating the remote phone, the phone earpiece shall sound a telephone ring signal until the master handset is lifted.
 - 4. The two-way emergency telephone system shall support a minimum of seven (7) handsets on line

without degradation of the signal.

T. All interfaces and associated equipment are to be protected so that they will not be affected by voltage surges or line transients consistent with UL standard 864.

U. Communicators

- 1. The UDACT shall be compact in size, mounting in a standard module position of the fire alarm control cabinet. Optionally, the UDACT shall have the ability for remote mounting, up to 6,000 feet from the fire alarm control panel. The wire connections between the UDACT and the control panel shall be supervised with one pair for power and one pair for multiplexed communication of overall system status. Systems that utilize relay contact closures are not acceptable.
- 2. The UDACT shall include connections for dual telephone lines (with voltage detect), per UL/NFPA/FCC requirements. It shall include the ability for split reporting of panel events up to two different telephone numbers.

The UDACT shall be capable of transmitting events in 4+2, SIA, and Contact ID. Communication shall include vital system status such as:

- a. Independent Zone (Alarm, trouble, non-alarm, supervisory)
- b. Independent Addressable Device Status
- c. AC (Mains) Power Loss
- d. Low Battery and Earth Fault
- e. System Off Normal
- f. 12 and 24 Hour Test Signal
- g. Abnormal Test Signal (per UL requirements)
- h. EIA-485 Communications Failure
- i. Phone Line Failure
- 3. The UDACT shall support independent zone/point reporting when used in the Contact ID format. In this format the UDACT shall support transmission of up to 3,064 points. This enables the central station to have exact details concerning the origin of the fire or response emergency.
- 4. The UDACT shall be capable of being programmed with the same programming utility as the host FACP, and saved, edited and uploaded and downloaded using the utility. UDACT shall be capable of being programmed online or offline. The programming utility shall also support upgrading UDACT operating firmware.
- 5. The UDACT shall be capable of generating Central Station reports providing detailed programming information for each point along with the central station point address.
- 6. An IP or IP/GSM Communicator option shall be available to interface to the UDACT and be capable of transmitting signals over the internet/intranet or Cellular (GSM) network to a compatible receiver.
- V. Smoke Control Annunciator
 - On/Auto/Off switches and status indicators (LEDS) shall be provided for monitoring and manual control of each fan, damper, HVAC control unit, stairwell pressurization fan, and smoke exhaust fan. To ensure compliance the units supplied shall meet the following UL categories: UUKL, PAZX, UDTZ, QVAX as well as the requirements of NFPA 90A, HVAC, and NFPA 92A & 92B, Smoke Control. The control System shall be field programmable for either 90A operation or 92A/B operation to allow for future use and system expansion.
 - 2. The OFF LED shall be Yellow, the ON LED shall be green, the Trouble/Fault LED shall be Amber/Orange for each switch. The Trouble/Fault indicator shall indicate a trouble in the control and/or monitor points associated with that switch. In addition, each group of eight switches shall have two LEDS and one momentary switch which allow the following functions: An Amber LED to indicate an OFF-NORMAL switch position, in the ON or OFF position; A Green LED to indicate ALL AUTO switch position; A Local Acknowledge/Lamp Test momentary switch.
 - 3. Each switch shall have the capability to monitor and control two addressable inputs and two

addressable outputs. In all modes, the ON and OFF indicators shall continuously follow the device status not the switch position. Positive feedback shall be employed to verify correct operation of the device being controlled. Systems that indicate on/off/auto by physical switch position only are not acceptable.

- 4. All HVAC switches (i.e., limit switches, vane switches, etc.) shall be provided and installed by the HVAC contractor.
- 5. It shall be possible to meet the requirements mentioned above utilizing wall mounted custom graphic.

2.3 Gateway & Webserver Options

- A. Common Alerting Protocol (CAP) Gateway: The system shall support an optional CAP Gateway (Common Alerting Protocol). The CAP Gateway translates fire system messages to industry standard CAP messages for integration with CAP-compliant clients. A CAP gateway shall be available from the fire alarm control panel manufacturer.
- B. LEDSIGN Gateway: The system shall support an optional and proprietary LEDSIGN Gateway to interface to LED signs that will automatically display emergency messages. The signs shall be capable of storing up to 100 messages that can be activated via system programming with the ability to be manually overridden. The Sign Gateway shall support up to 10 independent signs, each sign capable of playing an independent message. Multiple LEDSIGN Gateways can be used in network applications. An LEDSIGN gateway shall be available from the fire alarm control panel manufacturer.
- C. BACnet Interface Gateway: The system shall be capable of being interfaced with BACNet compliant clients. A BACnet interface supporting BACnet/IP communication shall be available from the fire alarm control panel manufacturer.
- D. MODbus Interface Gateway: The system shall be capable of being interfaced with MODbus compliant clients. A MODbus interface supporting MODbus/TCP communication shall be available from the fire alarm control panel manufacturer.
- E. Noti-Fire-Net Gateway: The system shall support an IP based gateway to enable the panel or local Noti-Fire-Net to be connected to an ONYXWorks workstation via the Internet or Intranet. This gateway shall also support the ability to integrate the system to an interactive firefighter's display. The Noti-Fire-Net Gateway shall be available from the fire alarm control manufacturer.
- F. Webserver: The system shall support a webserver allowing remote connection via the Internet or Intranet. Authorized users will have the ability to view panel/network history, event status and device properties. The webserver shall also support sending event information via email or text to up to 50 registered users, the webserver shall be available from the fire alarm control panel manufacturer.
- G. Web Portal Interface: The system shall be capable of being interfaced with a web portal to integrate with Inspection and Service Manager utilities. The web portal and inspection and service manager utilities shall be available from the fire alarm control panel manufacturer.

2.4 System Components - Addressable Devices

- A. Addressable Devices General
 - 1. Addressable devices shall use simple to install and maintain decade, decimal address switches. Devices shall be capable of being set to an address in a range of 001 to 159.
 - 2. Addressable devices, which use a binary-coded address setting method, such as a DIP-switch, are not an allowable substitute. Addressable devices that require the address be programmed using a special tool or programming utility are not an allowable substitute.
 - 3. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire

alarm control panel Signaling Line Circuits.

- 4. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash green under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady red illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
- 5. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.
- 6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.
- 7. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base options shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications. The system shall also support an intelligent programmable sounder base, the programmable sounder base shall be capable of providing multiple tones based on programming and at a minimum be capable of providing a Temp-4 tone for CO (Carbon Monoxide) activation and a Temp-3 tone for fire activations and be capable of being synchronized with other programmable sounder bases and common area notification appliances; 85 DBA minimum.
- 8. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
- 9. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).
- 10. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
- 11. Addressable devices shall store an internal identifying code that the control panel shall use to identify the type of device.
- 12. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.
- 13. Addressable modules shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box. An optional surface mount Lexan enclosure shall be available.
- B. Addressable Manual Fire Alarm Box (manual station)
 - 1. Addressable manual fire alarm boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status; NOTIFIER model # NBG-12LX. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
 - 2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
 - 3. Manual fire alarm boxes shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.
- C. Intelligent Photoelectric Smoke Detector: The intelligent photoelectric smoke detector shall be NOTIFIER model # FSP-851 and shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
- D. Intelligent VIEW[®] Laser Photo Smoke Detector: The intelligent laser photo smoke detector shall be a spot

type detector, NOTIFIER model # FSL-751, that incorporates an extremely bright laser diode and an integral lens that focuses the light beam to a very small volume near a receiving photo sensor. The scattering of smoke particles shall activate the photo sensor.

- 1. The laser detector shall have conductive plastic so that dust accumulation is reduced significantly.
- 2. The intelligent laser photo detector shall have nine sensitivity levels and be sensitive to a minimum obscuration of 0.02 percent per foot.
- 3. The laser detector shall not require expensive conduit, special fittings or PVC pipe.
- 4. The intelligent laser photo detector shall support standard, relay, isolator and sounder detector bases.
- 5. The laser photo detector shall not require other cleaning requirements than those listed in NFPA 72. Replacement, refurbishment or specialized cleaning of the detector head shall not be required.
- 6. The laser photo detector shall include two bicolor LEDs that flash green in normal operation and turn on steady red in alarm.
- E. Intelligent Ionization Smoke Detector: The intelligent ionization smoke detector shall be NOTIFIER model # FSI-851 and shall use the dual-chamber ionization principal to measure products of combustion and shall, on command from the control panel, send data to the panel representing the analog level of products of combustion.
- F. Intelligent Multi Criteria Acclimating Detector: The intelligent multi-criteria Acclimate[®] Plus[™] detector shall be an addressable device, NOTIFIER model # FAPT-851, that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine its environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.
 - 1. The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).
 - 2. The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.
- G. Intelligent Thermal Detectors: The intelligent thermal detectors shall be NOTIFIER FST- series addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. A high heat thermal detector rated at 190 degrees Fahrenheit shall also be available. The thermal detectors shall connect via two wires to the fire alarm control panel signaling line circuit.
- H. Intelligent Duct Smoke Detector: The smoke detector housing shall accommodate an intelligent photoelectric detector that provides continuous analog monitoring and alarm verification from the panel. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system. The Intelligent Duct Smoke Detector shall support the installation of addressable Photoelectric detector capable or being tested remotely. The Intelligent Duct Detector housing shall be model # DNR(W) and the remote test capable photoelectric smoke detector shall be NOTIFIER model # FSP-851R.

I. IntelliQuad[™] Advanced Multi-Criteria Intelligent Detector

- Intelligent multi-criteria fire detector shall be a NOTIFIER model number FSC-851. Smoke detector shall be an addressable intelligent multi-criteria smoke detector. The detector shall be comprised of four sensing elements, including a photoelectric (light-scattering) particulate sensor, an electrochemical carbon monoxide (CO) sensor, a daylight-filtered infrared sensor and solid state thermal sensor(s) rated at 135°F (57.2°C). The device shall be able to indicate distinct smoke and heat alarms.
- 2. The intelligent multi-criteria detection device shall include the ability to combine the signal of the photoelectric signal with other sensing elements in an effort to react quickly in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a nuisance alarm condition. The product design shall be capable of selecting the appropriate sensitivity levels based on the environment type chosen by user in which it is installed (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes.
- 3. The detector shall be capable of automatically adjusting its sensitivity by means of drift compensation and smoothing algorithms. The detector shall be capable of automatically adjusting its sensitivity by means of drift compensation and smoothing algorithms. The device shall provide unique signals to indicate when 20% of the drift range is remaining, when 100% of drift range is used, and when there is a chamber fault to show unit requires maintenance.
- 4. The detector shall indicate CO trouble conditions including 6 months of sensor life remaining and sensor life has expired. The detector shall indicate a combined signal for any of the following: low chamber trouble, thermistor trouble, CO self test failure, IR self test failure, and freeze warning.
- 5. The detectors shall provide address-setting means on the detector head using rotary switches. Because of the possibility of installation error, systems that use binary jumpers or DIP switches to set the detector address are not acceptable. The detectors shall also store an internal identifying code that the control panel shall use to identify the type of detector. Systems that require a special programmer to set the detector address (including temporary connection at the panel) are labor intensive and not acceptable. Each detector occupies any one of at least 99 possible addresses on the signaling line circuit (SLC) loop. It responds to regular polls from the system and reports its type and status.
- 6. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a switch) or initiated remotely on command from the control panel. There are three test methods: functional magnet, smoke entry aerosol, or direct heat method.
- 7. The detectors shall provide two LEDs to provide 360° visibility. The LEDs are placed into steady red illumination by the control panel indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED, sounder base, and / or relay base (optional accessories). The external remote alarm can be interconnected to other sounder or relay bases for activating all devices in a space via a single alarming unit.
- 8. Two LEDs on the sensor are controlled by the panel to indicate sensor status. Coded signals, transmitted from the panel, can cause the LEDs to blink, latch on, or latch off. Refer to the control panel technical documentation for sensor LED status operation and expected delay to alarm.
- 9. The detectors shall be ceiling-mount and shall be plug-in mounted into a twist-lock base. These detectors shall be constructed of off-white UV resistant polymer and shall be detachable from the mounting base to simplify installation, service and maintenance. Mounting base wiring connections shall be made by means of SEMS screws. The detector shall allow pre-wiring of the base and the head shall be a plug-in type. Mounting base shall be mounted on junction box which is at least 1.5 inches (3.81 cm) deep. Mounting base shall be available to mount to standard junction boxes. Suitable boxes include:
 - a. 4.0" (10.16 cm) square box with and without plaster ring.
 - b. 4.0" (10.16 cm) octagonal box.
 - c. 3.5" (8.89 cm) octagonal box.
 - d. Single-gang box.

- 10. Meets Agency Standards
 - a. ANSI/UL 268 -Smoke Detectors for Fire Alarm Signaling Systems
 - b. CAN/ULC-S529- Smoke Detectors for Fire Alarm Systems
 - c. FM 3230-3250- Smoke Actuated Detectors for Automatic Fire Alarm Signaling

J. IntelliQuadTM PLUS Advanced Multi-Criteria Intelligent Fire/CO Detector

- 1. Advanced Multi-Criteria Fire/CO detector shall be NOTIFIER model # FCO-851 and shall be an addressable advanced multi-criteria smoke detector with a separate signal for carbon monoxide (CO) detection per UL 2075 standards.
- 2. The detector shall be comprised of four sensing elements, including a photoelectric (light-scattering) particulate sensor, an electrochemical CO sensor, a daylight-filtered infrared (IR) sensor and solid state thermal sensor(s) rated at 135°F (57.2°C). The device shall be able to indicate distinct smoke and heat alarms.
- 3. The advanced multi-criteria detection device shall include the ability to combine the signal of the photoelectric signal with other sensing elements in order to react quickly in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a nuisance alarm condition. The detector shall be capable of selecting the appropriate sensitivity levels based on the environment type (office, manufacturing, kitchen, etc.) in which it is installed, and then have the ability to automatically change the setting as the environment changes.
- 4. The CO detector component shall be capable of a functional gas test using a canned test agent to test the functionality of the CO sensing cell.
- 5. The detector shall be capable of automatically adjusting its sensitivity by means of drift compensation and smoothing algorithms. The device shall provide unique signals to indicate when 20 percent of the drift range is remaining, when 100 percent of drift range is used, and when there is a chamber fault to show the unit requires maintenance.
- 6. The detector shall indicate CO trouble conditions, including six months of sensor life remaining and sensor life has expired. The detector shall indicate a combined signal for any of the following: low chamber trouble, thermistor trouble, CO self test failure, IR self test failure, and freeze warning.
- 7. The detector shall provide address-setting means on the detector head using rotary switches. Because of the possibility of installation error, systems that use binary jumpers or DIP switches to set the detector address are not acceptable. The detector shall also store an internal identifying code that the control panel shall use to identify the type of detector. Systems that require a special programmer to set the detector address (including temporary connection at the panel) are labor intensive and not acceptable. Each detector occupies any one of at least 159 possible addresses on the signaling line circuit (SLC) loop. It responds to regular polls from the system and reports its type and status.
- 8. The detector shall provide a test means whereby it will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a switch) or initiated remotely on command from the control panel. There shall be four test methods: functional magnet, smoke entry aerosol, carbon monoxide aerosol or direct heat method.
- 9. The detector shall provide two LEDs to provide 360° visibility. The LEDs shall be placed into steady red illumination by the control panel indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED. The detector must be capable of connecting to a sounder base that provides both temporal 3 and temporal 4 patterns for fire and CO alarm.
- 10. Two LEDs on the sensor shall be controlled by the panel to indicate sensor status. Coded signals, transmitted from the panel, shall cause the LEDs to blink, latch on, or latch off. Refer to the control panel technical documentation for sensor LED status operation and expected delay to alarm.
- 11. The detector shall be plug-in mounted into a twist-lock base. The detector shall be constructed of offwhite, UV-resistant polymer and shall be detachable from the mounting base to simplify installation,

service and maintenance. Mounting base wiring connections shall be made by means of SEMS screws. The detector shall allow pre-wiring of the base and the head shall be a plug-in type. The mounting base shall be mounted on a junction box that is at least 1.5 inches (3.81 cm) deep. The mounting base shall be available to mount to standard junction boxes. Suitable boxes include:

- a. 4.0" (10.16 cm) square box with and without plaster ring.
- b. 4.0" (10.16 cm) octagonal box.
- c. 3.5" (8.89 cm) octagonal box.
- d. Single-gang box.
- e. Double-gang box
- 12. Meets Agency Standards
 - a. ANSI/UL 268 -Smoke Detectors for Fire Alarm Signaling Systems
 - b. CAN/ULC-S529- Smoke Detectors for Fire Alarm Systems
 - c. FM 3230-3250- Smoke Actuated Detectors for Automatic Fire Alarm Signaling
 - d. UL 2075 Gas and Vapor Detector and Sensors Systems Connected
- K. Intelligent Addressable Aspiration Detector: The intelligent aspiration detector shall be NOTIFIER model # FSA-8000 an addressable aspiration detector that communicates directly with the fire alarm control panel via the SLC communication protocol, no modules or high level interfaces shall be required. The fire alarm control panel shall support up to thirty one intelligent aspiration detectors per SLC loop. The aspiration detector shall have dual source (blue LED and infra-red laser) optical smoke detection for a wide range of fire detection with enhanced immunity to nuisance particulates. The FACP shall be capable of monitoring and annunciating up to five smoke event thresholds and eleven trouble conditions. Each event threshold shall be capable of being assigned a discrete type ID at the FACP
- L. Intelligent Addressable Reflected Beam Detector
 - The intelligent single-ended reflected beam smoke detector shall connect with two wires to the fire alarm control panel signaling line circuit (SLC). The detectors shall consist of a transmitter/receiver unit and a reflector and shall send data to the panel representing the analog level of smoke density. The detector shall be capable of being tested remotely via a keyswitch; NOTIFIER model # FSB-200. Model # FSB-200S shall be equipped with an integral sensitivity test feature
- M. Addressable Dry Contact Monitor Module
 - 1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs. The addressable monitor module shall be NOTIFIER model # FMM-1 (Class A or B) or FMM-101 (Class B)
 - 2. The IDC zone shall be suitable for Style D/Class A or Style B/Class B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
 - 3. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch (70 mm) x 1-1/4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED.
 - 4. For multiple dry contact monitoring a module shall be available that provides 10 Style B or 5 Style D input circuits; NOTIFIER model # XP10-M.
- N. Two Wire Detector Monitor Module
 - 1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional

2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device); NOTIFIER model # FZM-1.

- 2. The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
- 3. For multiple 2-wire smoke detector circuit monitoring a module shall be available that provides 6 Style B/Class A or 3 Style D/Class B input circuits; NOTIFIER model # XP6-MA
- O. Addressable Control Module
 - 1. Addressable control modules shall be provided to supervise and control the operation of one conventional circuit of compatible Notification Appliances, 24 VDC powered, polarized audio/visual notification appliances; NOTIFIER model # FCM-1
 - 2. The control module NAC may be wired for Style Z or Style Y (Class A/B) with a current rating of 2 Amps for Style Z and 3 Amps for Style Y;
 - 3. Audio/visual power shall be provided by a separate supervised circuit from the main fire alarm control panel or from a supervised UL listed remote supply.
 - 4. For multiple circuit control a module shall be available that provides 6 Style Y (Class B) or 3 Style Z (Class A) control circuits; NOTIFIER model # XP6-C.
- P. Addressable Releasing Control Module
 - 1. An addressable FlashScan releasing module shall be available to supervise and control compatible releasing agent solenoids; NOTIFIER model # FCM-1-REL.
 - 2. The module shall operate on a redundant protocol for added protection.
 - 3. The module shall be configurable for Style Z or Style Y (Class A/B) and support one 24 volt or two 12 volt solenoids.
- Q. Addressable Relay Module:
 - 1. Addressable Relay Modules shall be available for HVAC control and other network building functions; NOTIFIER model # FRM-1.
 - 2. The module shall provide two form C relays rated at up to 3 Amps resistive and up to 2.0 Amps inductive.
 - 3. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary devices energize at the same time on the same pair of wires.
 - 4. For multiple relay control a module shall be available that provides 6 programmable Form-C relays; NOTIFIER model # XP6-R.
- R. Addressable Two-In / Two-Out Monitor/Relay Module:
 - 1. An addressable Two-In / Two-Out module shall be available; NOTIFIER model # FDRM-1.
 - 2. The two-in/two-out module shall provide two Class B/Style B dry-contact input circuits and two independent Form-C relays rated at up to 3 Amps resistive and up to 2.0 Amps inductive.
- S. Isolator Module: Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building; NOTIFIER model # ISO-X.
 - 1. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.

- 2. The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
- 3. The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.
- T. Smoke Control Annunciator
 - On/Auto/Off switches and status indicators (LEDS) shall be provided for monitoring and manual control of each fan, damper, HVAC control unit, stairwell pressurization fan, and smoke exhaust fan. To ensure compliance the units supplied shall meet the following UL categories: UUKL, PAZX, UDTZ, QVAX as well as the requirements of NFPA 90A, HVAC, and NFPA 92A & 92B, Smoke Control. The control System shall be field programmable for either 90A operation or 92A/B operation to allow for future use and system expansion.
 - 2. The OFF LED shall be Yellow, the ON LED shall be green, the Trouble/Fault LED shall be Amber/Orange for each switch. The Trouble/Fault indicator shall indicate a trouble in the control and/or monitor points associated with that switch. In addition, each group of eight switches shall have two LEDS and one momentary switch which allow the following functions: An Amber LED to indicate an OFF-NORMAL switch position, in the ON or OFF position; A Green LED to indicate ALL AUTO switch position; A Local Acknowledge/Lamp Test momentary switch.
 - 3. Each switch shall have the capability to monitor and control two addressable inputs and two addressable outputs. In all modes, the ON and OFF indicators shall continuously follow the device status not the switch position. Positive feedback shall be employed to verify correct operation of the device being controlled. Systems that indicate on/off/auto by physical switch position only are not acceptable.
 - 4. All HVAC switches (i.e., limit switches, vane switches, etc.) shall be provided and installed by the HVAC contractor.
 - 5. It shall be possible to meet the requirements mentioned above utilizing wall mounted custom graphic.
- U. SpectrAlert Advance Speakers
 - 1. The Speaker appliance shall be System Sensor SpectrAlert Advance model _____ Speaker. The speaker shall be listed to UL 1480 for Fire Protective Signaling Systems. It shall be a dual-voltage transformer speaker capable of operation at 25.0 or 70.7 nominal Vrms. The speaker shall have a frequency range of 400 to 4,000 Hz and shall have an operating temperature between 32°F and 120°F. It shall mount to a 4 x 4 x 2 1/8-inch back box.
 - 2. A universal mounting plate shall be used for mounting ceiling and wall speaker products. The notification appliance circuit and amplifier wiring shall terminate at the universal mounting plate.
 - 3. Speakers shall be plug-in and shall have the ability to check wiring continuity via a shorting spring on the universal mounting plate. The shorting spring shall also provide tamper resistance via an open circuit if the device is removed. Speaker design shall isolate speaker components to reduce ground fault incidents.
 - 4. The speaker shall have power taps (from ¹/₄ watt to 2 watts) and voltage that are selected by rotary switches. All models shall have a maximum sound output of 86 dB at 10 feet and shall incorporate an open back construction.
 - 5. All notification appliances shall be backward compatible.

Ceiling Speaker

Wall Speaker

Wide Band Frequency Response

Wide Band Frequency Response



V. SpectrAlert Advance Speaker Strobes

- 1. The Speaker Strobe appliance shall be System Sensor SpectrAlert Advance model _____ Speaker Strobe. The speaker strobe shall be listed to UL 1971 and UL 1480 and be approved for fire protective signaling systems. It shall be a dual-voltage transformer speaker strobe capable of operation at 25.0 or 70.7 nominal Vrms. The speaker shall have a frequency range of 400 to 4,000 Hz and shall have an operating temperature between 32°F and 120°F. It shall mount to a 4 x 4 x 2 1/8-inch back box.
- 2. A universal mounting plate shall be used for mounting ceiling and wall speaker strobe products. The notification appliance circuit and amplifier wiring shall terminate at the universal mounting plate. Also, SpectrAlert Advance speaker strobes and the Sync•Circuit[™] Module MDL3 accessory, if used, shall be powered from a non-coded notification appliance circuit output and shall operate on a nominal 12 or 24 volts (includes fire alarm panels with built in sync). When used with the Sync•Circuit Module MDL3, 12-volt rated notification appliance circuit outputs shall operate between 8.5 and 17.5 volts; 24-volt rated notification appliance circuit outputs shall operate between 16.5 to 33 volts. If the notification appliances are not UL 9th edition listed with the corresponding panel or power supply being used, then refer to the compatibility listing of the panel to determine maximum devices on a circuit.
- 3. Speaker strobes shall be plug-in and shall have the ability to check wiring continuity via a shorting spring on the universal mounting plate. The shorting spring shall also provide tamper resistance via an open circuit if the device is removed. Speaker strobe design shall isolate speaker components to reduce ground fault incidents.
- 4. The speaker strobe shall have power taps (from ¹/₄ watt to 2 watts) and voltage that are selected by rotary switches. All models shall have a maximum sound output of 86 dB at 10 feet and shall incorporate an open back construction. The strobe shall consist of a xenon flash tube with associated lens/reflector system and operate on either 12V or 24V. The strobe shall also feature selectable candela output, providing options for 15 or 15/75 candela when operating on 12V and 15, 15/75, 30, 75, 110, or 115 when operating on 24V. The strobe shall comply with NFPA 72 and the Americans with Disabilities Act requirement for visible signaling appliances, flashing at 1 Hz over the strobe's entire operating voltage range.
- 5. All notification appliances shall be backward compatible.

Ceiling Speaker Strobe Wall Speaker Strobe

Wide Band Frequency Response

Wide Band Frequency Response



6. Strobe lights shall meet the requirements of the ADA, UL Standard 1971 and be fully synchronized.

PART 3.0 - EXECUTION

3.1. INSTALLATION:

- A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.
- B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.
- C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.
- D. Manual fire alarm boxes shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 inches (1067 mm), nor more than 48 inches (122 mm) above the finished floor.

3.2. TEST:

The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72.

- A. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
- B. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
- C. Verify activation of all waterflow switches.
- D. Open initiating device circuits and verify that the trouble signal actuates.
- E. Open and short signaling line circuits and verify that the trouble signal actuates.

- F. Open and short notification appliance circuits and verify that trouble signal actuates.
- G. Ground all circuits and verify response of trouble signals.
- H. Check presence and audibility of tone at all alarm notification devices.
- I. Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.
- J. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
- K. When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

3.3. FINAL INSPECTION:

A. At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

3.4. INSTRUCTION:

- A. Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.
- B. The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

END OF SECTION 283100

SECTION 311000 - SITE CLEARING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Clearing and protection of vegetation.
- B. Removal of existing debris.
- C. Removal of existing site improvements including pavements, utilities and utility structures, foundations or other site improvements.

1.02 RELATED REQUIREMENTS

- A. Section 011000 Summary: Limitations on Contractor's use of site and premises.
- B. Section 015000 Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
- C. Section 015713 Temporary Erosion and Sediment Control.
- D. Section 017000 Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products.
- E. Section 312200 Grading: Topsoil removal.
- F. Section 312323 Fill: Filling holes, pits, and excavations generated as a result of removal operations.
- G. Section 311500- Protection of Existing Trees

PART 2 PRODUCTS

2.01 MATERIALS

A. Fill Material: As specified in Section 312323 - Fill and Backfill

PART 3 EXECUTION

3.01 SITE CLEARING

- A. Comply with other requirements specified in Section 017000.
- B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

3.02 EXISTING UTILITIES AND BUILT ELEMENTS

- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Protect existing structures and other elements that are not to be removed.
- E. Pavements and slabs are to be saw cut to provide a clean edge. Concrete pavements are to be cut at the nearest control joint to the required demolition area.

3.03 VEGETATION

A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, playing fields, lawns, planting beds, borrow areas (when applicable) and disposal areas (when applicable).

- B. Install substantial, highly visible fences at least 3 feet high to prevent inadvertent damage to vegetation to remain:
 - 1. At vegetation removal limits.
 - 2. Around trees to remain within vegetation removal limits; locate no closer to tree than at the drip line.
 - 3. Around other vegetation to remain within vegetation removal limits.
- C. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.
 - 1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
 - 2. Trees: Sell if marketable; if not, treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.
 - 3. Sod: Re-use on site if possible; otherwise sell if marketable, and if not, treat as specified for other vegetation removed.
- D. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

3.04 **DEBRIS**

- A. Remove debris, junk, and trash from site.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 311500 - PROTECTION OF EXISTING TREES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Protection of existing and newly planted trees is to be performed on the project site and at any areas adjacent to or near the site where construction activities impact the Tree Protection Zone (TPZ). Tree protection will function as follows:
 - 1. The foliage canopy and branching structure are to be kept clear from contact with equipment, vehicles, materials and activities
 - 2. The roots and soil conditions are to be preserved in an intact and non-compacted state
 - 3. No Soil disturbance is permitted within the identified Tree Protection Zone (TPZ) unless otherwise approved.
- B. Work included: Furnish all labor, materials, equipment and services necessary to protect existing trees on site and on adjacent road right-of-way and sites, including but not limited to:
 - 1. Survey and layout, installation, maintenance, adjustment during construction, and final removal of protective barriers and signs.
 - 2. Pruning as required, including hand excavation and root pruning if required and approved by the landscape architect and/or arborist.
 - 3. Excavation, soil stabilizing

1.02 RELATED REQUIREMENTS

- A. Section 011000 Summary: Contract descriptions, description of alterations work, work by others, future work, occupancy conditions, use of site and premises, work sequence.
- B. Section 013000 Administrative Requirements: Submittal procedures, project meetings, progress schedules and documentation, reports, coordination.
- C. Section 015713 Temporary Erosion and Sedimentation Control.
- D. Section 024100 Demolition: Selective demolition, site demolition, structure removal.

1.03 **DEFINITIONS AND PROCEDURES**

- A. Tree Protection Zone (TPZ) (May be interchanged with Critical Root Zone (CPZ) and Drip-Line below): An area around the base of a tree with a radius of 10 times the diameter of the tree's trunk or twenty feet, whichever is greater.
- B. Tree Protection Barrier: any fencing or other barrier material, including supports and bracing for such, to be used to surround and enclose the TPZ.
- C. Critical Root Zone Area (CRZ): The area of undisturbed natural soil around a tree defined by a horizontal circle drawn at grade with the trunk at the center and extending for a radial distance equal to the distance from the center of the trunk to the outermost portion of the drip line.
- D. Drip Line: the area surrounding a tree directly below the outermost portions of the tree canopy, or a circular area with a radius of one-half of the height of the tree extending outward from the center point of the tree.
- E. Warning Sign: A warning sign is to be prominently displayed on each fence at 25- foot intervals.
- F. Root Protection: Materials or devices installed at ground level to protect the root system of trees from compaction during construction.

PROTECTION OF EXISTING	211500 1
TREES	511500 - 1

- G. Root Boring for utility installation: Directional micro-tunneling and boring may be permitted within the limits of the TPZ subject to approval by the Landscape Architect.
- H. Tree Topping: Practice of removing a substantial portion or all of the upper canopy of a tree. Tree Topping will not be allowed in this project.
- I. Root Boring: Boring beneath protected trees to provide a tunnel for the installation of utilities.

PART 2 PRODUCTS

2.01 TREE PROTECTION PRODUCTS

- A. Fencing: 4'-0" high orange plastic 'snow' or barrier fence. Provide steel posts spaced at 6 ft. minimum.
- B. Tree Protection Area Signs: minimum size 12" x 18", may be lettered vertically or horizontally.
 - 1. Size: minimum 12" x 18", vertical or horizontal placement.
 - 2. Text: CAUTION TREE PROTECTION ZONE DO NOT REMOVE. NO DUMPING, BURNING, STORAGE, CUTTING, MACHINERY OR VEHICLES.
 - 3. Material to be painted plywood or other weather resistant material.

PART 3 EXECUTION

3.01 **EXAMINATION**

- A. Prior to the beginning of demolition or construction work, field verify the TPZ for each existing tree to be preserved. Perform any root exploratory excavation necessary to determine root location and condition and/or other existing conditions.
- B. Instruct all construction workers to observe the TPZ limits.

3.02 INSTALLATION

- A. No construction activity including grade changes, surface treatments or excavations of any kind is permitted within the TPZ of any existing tree to remain unless otherwise indicated on the project plan drawings. The area within the TPZ must remain undisturbed at all times.
- B. No root cutting is permitted unless done with the approval of the landscape architect and requiring the services of a qualified arborist or approved tree professional. An exploratory excavation by hand or using a low water pressure hydro vac method must be completed prior to commending with open face cuts outside the TPZ.
- C. Do not store materials or fill within the TPZ.
- D. Do not allow movement, parking or storage of vehicles or equipment within the TPZ.
- E. Do not discharge exhaust into foliage or allow fires under and adjacent to trees.
- F. Do not allow run off of spillage of damaging materials into the TPZ, including but not limited to concrete overflow or sleuth, gas, oil, paint, etc.
- G. Protection Barrier Fencing Layout:
 - 1. Typical Layout: Fencing is to enclose the entire area under the canopy drip line or TPZ (whichever is greater) of each tree or group of trees to be protected throughout the demolition and construction period.
 - 2. Special Layout:
 - a. For trees located within a planting strip or island, and where existing vehicular and/or pedestrian pathways must be kept open for use, only the planting strip or island and landscaped side of the TPZ is to be enclosed with the required fencing

PROTECTION OF EXISTING	211500 2
TREES	511500 - 2

type.

- b. For trees located in a tree well or sidewalk planter pit, the tree is to be wrapped with 2 inches of orange plastic fencing from the ground to the height of the first branch and overlaid with 2 inch thick wooden slats bound securely. Protect the tree bark from direct contact with the slats. Use caution during installation to avoid damage to branches and tree stem.
- H. Install Tree Protection Barrier Fencing
 - 1. Orange safety fence: Embed posts a minimum 18 inches at no more than 5 (five) foot spacing. Fencing is to be tied closed completely surrounding the TPZ.
- I. Install Tree Protection Area and Enclosure Signage.
- J. Water retained trees thoroughly and deeply as necessary to supplement rainfall to maintain plant turbidity without prolonged saturation of the root zone. The method, amount and frequency of watering is to be per the recommendation of the arborist. Monitor soil moisture on a continual basis.
- K. Retained trees may require fertilizing and other measures to stimulate regeneration of lost roots and foliage. Fertilization and other measures are to be per the recommendation of the arborist.
- L. Tree Topping: No Tree Topping will be allowed.
- M. Tree Pruning: Branches which are found to be a barrier to construction or a health and safety hazard may be removed subject to the approval of the landscape architect/arborist.
 - 1. When removing a branch, cut outside the branch bard ridge and collar. Do not make a flush cut adjacent to the trunk of the tree or branch being pruned.
 - 2. Make a partial cut from beneath at a point several inches away from the trunk.
 - 3. Make a second cut from above several inches out from the first cut to allow the limb to fall safely.
 - 4. Complete the removal with a final cut just outside the branch collar (the raised area that surrounds the branch where it joins the trunk).
 - 5. Make all cuts clean and remove any jagged edges carefully.

3.03 INTERFACE WITH OTHER WORK:

A. Coordinate tree protection with all demolition, excavation and utility work in the area.

3.04 FIELD QUALITY CONTROL

- A. See Division 1 for Quality Requirements.
- B. Inspect for existing soil conditions which may be detrimental to tree health and survival; existing utilities within or adjacent to the TPZ; and extent of root system beyond the visible drip line.
- C. Any trees which are found to be in poor or damaged condition are to be evaluated by the landscape architect or arborist. Trees that are deemed to have a minimal chance of survival or which pose a health or safety risk may be removed or pruned by more than one-third subject to approval of the landscape architect/arborist and Owner.

3.05 MAINTENANCE

- A. See Division 1 for additional requirements relating to maintenance service.
- B. Trees are to be watered, aerated and maintained as necessary to ensure survival.
- C. Repair or replace any fencing, ground protection or signage that has been removed or damaged. Inspect installations on a continuous basis.

PROTECTION OF EXISTING	211500 2
TREES	511500 - 5

D. Tree protection devices are to be removed at the end of the project (after final completion) and the area beneath the TPZ returned to original condition.

END OF SECTION

PROTECTION OF EXISTING		311500 - 4
TREES		

SECTION 312200 - GRADING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Removal of topsoil.
- B. Rough grading the site for site structures.
- C. Finish grading.

1.02 RELATED REQUIREMENTS

- A. Section 015713 Temporary Erosion and Sediment Control.
- B. Section 311000 Site Clearing.
- C. Section 312316 Excavation.
- D. Section 312316.13 Trenching: Trenching and backfilling for utilities.
- E. Section 312316.26 Rock Removal.
- F. Section 312323 Fill: Filling and compaction.
- G. Section 329219 Seeding: Finish ground cover.
- H. Section 329223 Sodding: Finish ground cover.
- I. Section 329300 Plants: Topsoil in beds and pits.

1.03 SUBMITTALS

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.04 **DEFINITIONS**

- A. Finish Grade Elevations: Indicated on the Drawings.
- B. Zone of Influence: Area beneath a footing or foundation that extends out from the bottom edge of the footing/foundation at a 45-degree angle down to a depth equal to 3 times the footing width.
- C. Fat Clays: Soil types with the classification of CH and a Plasticity Index (PI) above 30%.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with State of Kentucky, Highway Department standards.

1.06 **PROJECT CONDITIONS**

- A. It is recommended that earthwork be done during the warm and dry months. If earthwork is to be done during cold or wet months, the use of DGA in lieu of general soil fill should be considered for structural and pavement areas. Time extensions will not be considered for any delays due to the Contractor choosing to not use DGA in lieu of general soil fill during cold or wet months.
- B. The Geotechnical Exploration indicates the presence of weak, organic and fat clay (CH) soils. This existing material is to be removed per the report recommendations and in accordance with Specificaiton Section 312316 and Section 312323. It is highly recommended that the Contractor excavate test pits prior to preparation of their bids in order to further clarify the extents of the materials.
- C. The soils found on this site are very sensitive to changes in the moisture content and will quickly degrade in such conditions and when subjected to construction traffic. The Contractor should carefully evaluate equipment to be used on the site so as to minimize degradation of the soils. In

addition, the Contractor is to include in their bid the stabilization or repair of soils that will be affected by construction activities.

D. The new vehicular pavement and stone base areas are not designed for construction traffic and should not be used for construction activities unless they are stabilized using #2 crushed stone and geogrid. Stabilization should include any undercutting and material handling, borrow or disposal necessary to maintain the design subgrade elevations after stabilization has been done. Any areas of subgrade, road base or pavement damage are to be repaired.

PART 2 PRODUCTS

2.01 MATERIALS

A. Topsoil: Excavated from site and free of weeds. Supplement as needed with imported fertile agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; pH value of minimum 5.4 and maximum 7.0. Topsoil to be amended as needed.

PART 3 EXECUTION

3.01 **EXAMINATION**

- A. Verify that survey bench mark and intended elevations for the Work are as indicated.
- B. Verify the absence of standing or ponding water.

3.02 **PREPARATION**

- A. All site grading is unclassified.
- B. Identify required lines, levels, contours, and datum.
- C. Stake and flag locations of known utilities.
- D. Locate, identify, and protect from damage above- and below-grade utilities to remain.
- E. Provide temporary means and methods to remove all standing or ponding water from areas prior to grading. Refer to Specification Section 312319 for additional Dewatering requirements.
- F. Protect site features to remain, including but not limited to bench marks, survey control points, existing structures, fences, sidewalks, paving and curbs, from damage by grading equipment and vehicular traffic.
- G. Protect trees to remain by providing substantial fencing around entire tree at the outer tips of its branches; no grading is to be performed inside this line.
- H. Protect plants, lawns, rock outcroppings and other features to remain as a portion of final landscaping.

3.03 ROUGH GRADING

- A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.
- B. Do not remove topsoil when wet.
- C. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.
- D. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.
- E. See Section 312323 for filling procedures.
- F. Benching Slopes: Horizontally bench existing slopes greater than 1:4 to key fill material to slope for firm bearing.
- G. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

Grading

H. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack surface water control.

3.04 SOIL REMOVAL and STOCKPILING

- A. Stockpile excavated topsoil on site. No topsoil is to be removed from the site. Topsoil stockpile is to be covered or seeded and mulched to protect the pile from erosion.
- B. Stockpile subsoil that is to be re-used on site; remove remainder from site. Cover stockpile to prevent erosion and saturation of the material.
- C. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.

3.05 FINISH GRADING

- A. Before Finish Grading:
 - 1. Verify building and trench backfilling have been inspected.
 - 2. Verify subgrade has been contoured and compacted.
- B. Remove debris, roots, branches, stones, in excess of 1/2 inch in size. Remove soil contaminated with petroleum products and legally dispose of it off-site.
- C. Where topsoil is to be placed, scarify surface to depth of 3 inches.
- D. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches.
- E. Place topsoil to the following compacted thicknesses:
 - 1. Areas to be Seeded with Grass: 6 inches.
 - 2. Areas to be Sodded: 5 inches.
 - 3. Shrub Beds: 18 inches.
 - 4. Flower Beds: 12 inches.
 - 5. Tree Pits: 3x the width of the root ball and 8 inch minimum depth beneath the root ball.
- F. Place topsoil during dry weather.
- G. Remove roots, weeds, rocks, and foreign material while spreading.
- H. Near plants, buildings and other improvements, spread topsoil manually to prevent damage.
- I. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.
- J. Maintain stability of topsoil during inclement weather. Replace topsoil in areas where surface water has eroded thickness below specifications.

3.06 TOLERANCES

- A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) from required elevation.
- B. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch).

3.07 REPAIR AND RESTORATION

- A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.
- B. Other Existing Vegetation to Remain: If damaged due to this work, replace with vegetation of equivalent species and size.

3.08 FIELD QUALITY CONTROL

A. See Section 312323 for compaction density testing.

3.09 CLEANING

- A. Sediment Control/Silt Fencing: Provide fabric silt fencing and other erosion control devices as required and shown on plans to control erosion and allow lawn crew to establish grass uniformly across slope areas.
- B. Remove unused stockpiled topsoil and subsoil. Grade stockpile area to prevent standing water.
- C. Leave site clean and raked, ready to receive landscaping.

END OF SECTION

SECTION 312316 - EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Excavating for building volume below grade, footings, slabs-on-grade, paving, site structures and non-utility excavations in the building pad.
- B. Over-excavation and structural concrete backfill to achieve adequate support for foundations.

1.02 RELATED REQUIREMENTS

- A. Section 015713 Temporary Erosion and Sediment Control: Slope protection and erosion control.
- B. Section 017000 Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring. General requirements for dewatering of excavations and water control.
- C. Section 311000 Site Clearing: Vegetation and existing debris removal.
- D. Section 312200 Grading: Soil removal from surface of site.
- E. Section 312200 Grading: Grading.
- F. Section 312316.13 Trenching: Excavating for utility trenches outside the building to utility main connections.
- G. Section 312316.26 Rock Removal: Removal of rock during excavating.
- H. Section 312319 Dewatering
- I. Section 312323 Fill: Fill materials, backfilling, and compacting.
- J. 312323.13 Flowable Fill

1.03 **DEFINITIONS**

- A. Finish Grade Elevations: Indicated on the Drawings.
- B. Zone of Influence: Area beneath a footing or foundation that estends out from the bottom edge of the footing/foundation at a 45-degree angle down to a depth equal to 3-times the footing width.
- C. Fay Clays: Soil types with the classification of CH and a Plasticity Index (PI) above 30%.

1.04 **PROJECT CONDITIONS**

- A. All excavation is unclassified including bedrock excavation.
- B. Verify that survey bench mark and intended elevations for the Work are as indicated.

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 **EXAMINATION**

A. Verify that survey bench mark and intended elevations for the work are as indicated.

3.02 **PREPARATION**

- A. Identify required lines, levels, contours, and datum locations.
- B. See Section 311000 for clearing, grubbing, and removal of existing debris and site improvements.
- C. See Section 312200 for topsoil removal.
- D. Locate, identify, and protect utilities that remain and protect from damage.

E. Grade top perimeter of excavation to prevent surface water from draining into excavation. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by Architect. Refer to Specification Section 312319 for additional Dewatering requirements.

3.03 EXCAVATING

- A. Excavate to accommodate new structures and construction operations.
- B. Excavate foundations to allow for bearing on sound, durable bedrock. If fractured or non-durable bedrock is encountered, it is to be excavated until sound durable bedrock is encountered.
 - 1. Due to the potential for Karst activity for the project site, **probe holes are to be drilled** beneath all proposed foundations to assess the underlying conditions of the bedrock. Once foundation excavations reach the intended bearing elevation, the contractor is to drill 2-inch diameter probe holes every 25-feet along continous footings to a depth of 5-feet into the underlying bedrock. A minimum of one probe hole is to be drilled for each column footing locaitons. Probe holes are to be observed and underlying conditions documented by the Special Inspector.
- C. Ensure that all areas being re-graded that are not recieving new pavements have a minimum of 24inches of soil cover over bedrock. Refer to Sepecificaiton Section 312316.26 for Rock Removal requirements.
- D. The Geotechnical Report indicates the presence of weak, organic, or fat clay (CH) soils on site. This existing material is to be completely removed within the building footprint and extending 3-feet beyond the building footprint. The excavation is to be proofrolled and brought back up to subgrade elevation in an engineered manner in accordance with the Geotechnical Report and Specificaiton Section 312323.
- E. The Geotechnical Report indicates the presence of fat clay (CH) soils on site. This existing material is to be excavated to a depth of 24-inches below proposed subgrade elevation for new floor slab areas. The excavtion is to be brought back up to subgrade elevation in an engineered manner in accordance with Specification Section 312323.
- F. The Geotechnical Report indicates the presence of fat clay (CH) soils on site. This existing material is to be excavated to a depth of 12-inches below proposed subgrade elevation for new pavement areas. The excavtion is to be brought back up to subgrade elevation in an engineered manner in accordance with Specificaiton Section 312323.
- G. The Geotechnial Report indicates the presence of shallow rock under the proposed building addition. Bedrock is to be removed to a depth of 36-inches below all floor slabs in the area of the Kitchen and 12-inches below all other floor slabs. In areas where bedrock is not encountered before the bottom of the subgrade excavation is reached, the excavation is to be probed with a sounding rod to ensure that bedrock is a minimum of 36-inches below the bottom of the subgrade elevation for the Kitchen area floor slab, and 12-inches below the bottom of the excavation for all other floor slabs. If bedrock is encountered within 36-inches of the Kitchen area floor slab subgrade or within 12-inches for all other floor slabs, the excavation is to be extended to bedrock and the bedrock removed to a minimum depth of 36-inches below the Kitchen area floor slab subgrade elevations. The excavation is to be brought back up to the bottom of floor slab subgrade in an engineered manner using Structural fill in accordance with Specification Section 312316.26 for Rock Removal requirements.
- H. If a excavations inside the building footprint is to be left open for more than 48-hours or when a rain event occurs, the excavation is to be over-excavated an additional 4-inches and a lean concrete mud mat or layer of flowable fill should be placed 4-inches thick over the bottom of the excavation.

- I. Fill areas that do not pass proof-roll are to be undercut and/or stabilized as necessary to provide a stable platform for fill placement.
- J. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- K. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
- L. Do not interfere with 45 degree bearing splay (zone of influence) of foundations without approval from the Architect and approved specific backfill requirements.
- M. Cut utility trenches wide enough to allow inspection of installed utilities.
- N. Hand trim excavations. Remove loose matter.
- O. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 312323.
- P. Provide temporary means and methods, as required, to remove all water from excavations until directed by Architect. Remove and replace soils deemed suitable by classification and which are excessively moist due to lack of dewatering or surface water control. Refer to Specificaiton Section 312319 for additional Dewatering requirements.
- Q. Determine the prevailing groundwater level prior to excavation. If the proposed excavation extends less than 1 foot into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by the Architect. If the proposed excavation extends more than 1 foot into the prevailing groundwater, control groundwater intrusion with a comprehensive dewatering procedures, or as directed by the Geotechnical Engineer. Refer to Specificaiton Section 312319 for additional Dewatering requirements.
- R. Remove excavated material that is unsuitable for re-use from site.
- S. Stockpile excavated material to be re-used in area designated on site 312200.
- T. Remove excess excavated material from site.

3.04 **REPAIR**

A. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 312323.

3.05 FIELD QUALITY CONTROL

- A. See Division 1 for general requirements for field inspection and testing.
- B. Provide for visual inspection of load-bearing excavated surfaces by Architect before placement of foundations.
- C. Provide for probing for bedrock verification and logging.

3.06 CLEANING

- A. Stockpile excavated material to be re-used in area designated on site in accordance with Section 312200.
- B. Remove excavated material that is unsuitable for re-use from site.
- C. Remove excess excavated material from site.

3.07 **PROTECTION**

- A. Divert surface flow from rains or water discharges from the excavation.
- B. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.

- C. Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain foundation subgrade in satisfactory, undisturbed condition.
- D. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.
- E. Keep excavations free of standing water and completely free of water during concrete placement.

END OF SECTION

SECTION 312316.13 - TRENCHING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Excavation, backfilling and compacting for non-utility excavations within the building footprint, and utilities outside the building to utility main connections.

1.02 RELATED REQUIREMENTS

- A. Section 015713 Temporary Erosion and Sediment Control.
- B. Section 312200 Grading: Site grading.
- C. Section 312316 Excavation: Building and foundation excavating.
- D. Section 312316.26 Rock Removal: Removal of rock during excavating.
- E. Section 312323 Fill: Backfilling at building and foundations.
- F. Section 312323.13 Flowable Fill: Backfill of utilities and excavations in the zone of influence of a foundation, footing or structural element inducing a load to the subgrade materials.

1.03 **DEFINITIONS**

- A. Finish Grade Elevations: Indicated on drawings.
- B. Zone of Influence: Area beneath a footing or foundation that extends out from the bottom edge of the footing/foundation at a 45-degree angle down to a depth equal to 3 times the footing width.

1.04 REFERENCE STANDARDS

- A. AASHTO T 180 Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18 in.) Drop 2018.
- B. ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)) 2012, with Editorial Revision (2015).
- C. ASTM D1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method 2007.
- D. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)) 2012, with Editorial Revision (2015).
- E. ASTM D2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method 2015.
- F. ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) 2011.
- G. ASTM D3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth) 2005.
- H. ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils 2010.

1.05 SUBMITTALS

- A. See Division 1 for submittal procedures.
- B. Materials Sources: Submit name of imported materials source.
- C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- D. Compaction Density Test Reports.

1.06 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. General Fill Fill Type Lean Clay (CL): Subsoil excavated on-site or imported as necessary for new work.
 - 1. Graded.
 - 2. Free of lumps larger than 3 inches, rocks larger than 2 inches, and debris.
 - 3. Conforming to ASTM D2487 Group Symbol CL.
 - 4. Having no more than 5-percent rock/gravel in the top 24-inches in landscape areas, and no more than 15-percent rock/gravel in any location.
- B. Structural Fill Fill Type DGA: Conforming to State of [] Highway Department standard.
- C. Flowable Fill (CLSM): A controlled low-strength material made of cement, water, sand, and an airentraining admixture that it can be excavated by hand or use of a backhoe. See Section 312323.13.
- D. Concrete for Surge Block Fill and structure/pipe encasement: Lean concrete with a compressive strenght of 1000 psi.
- E. Pipe Bedding Granular Fill Fill Type #8 crushed limestone: Fine aggregate, conforming to State of Kentucky Highway Department standard.

2.02 ACCESSORIES

A. Geotextile Fabric: Non-biodegradable, non-woven, needle punched, 6-oz/sy(minimum weight).

2.03 SOURCE QUALITY CONTROL

- A. See Division 1 for general requirements for testing and analysis of soil material.
- B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.
- C. If tests indicate materials do not meet specified requirements, change material and retest.
- D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench marks and intended elevations for the work are as indicated.

3.02 **PREPARATION**

- A. All trenching is unclassified, including trenching in bedrock.
- B. Identify required lines, levels, contours, and datum locations.
- C. See Section 312200 for additional requirements.
- D. Locate, identify, and protect utilities that remain and protect from damage.
- E. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving and curbs from excavating equipment and vehicular traffic.
- F. Grade top perimeter of trenching area to prevent surface water from draining into trench. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by the Architect. Refer to Specificaiton Section 312319 for additional

Dewatering requirements.

3.03 TRENCHING

- A. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- B. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
- C. Do not interfere with 45 degree bearing splay of foundations (Zone of Influence) without approval from the Architect and Structural Engineer and approved specific backfill procedures.
- D. Cut trenches wide enough to allow inspection of installed utilities, but no more than twice the pipe diameter or 12-inches, whichever is greater for the total trench width.
- E. Hand trim excavations. Remove loose matter.
- F. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.
- G. Remove excavated material that is unsuitable for re-use from site.
- H. Stockpile excavated material to be re-used in area designated in Section 312200.
- I. Provide temporary means and methods, as required, to remove all water from trenching until directed by the Architect. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control. Refer to Specificaiton Section 312319 for additional Dewatering requirements.
- J. Determine the prevailing groundwater level prior to trenching. If the proposed trench extends less than 1 foot into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by the Architect. Refer to Specification Section 312319 for additional Dewatering requirements.
- K. If a trench is to be left open for more than 48-hours or when a rain event occurs, the trench is to be excavated an additional 4-inches and a lean concrete mud mat or layer of flowable fill should be placed 4-inches thick over the bottom of the excavation. Refer to Specificaiton Section 312319 for additional Dewatering requirements.

3.04 **PREPARATION FOR UTILITY PLACEMENT**

- A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with:
 - 1. Flowable Fill in areas located in the zone of influence of any footing or foundation.
 - 2. Structural Fill in areas within the building footprint or under pavements that are not located in the zone of influence.
 - 3. General Fill in landscape areas
- B. Remove loose soil and any debris from the excavation prior to installing the utility and backfill.
- C. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- D. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.05 BACKFILLING

- A. Backfill to contours and elevations indicated using unfrozen materials.
- B. Employ a placement method that does not disturb or damage other work.
- C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

- D. Maintain optimum moisture content of fill materials to attain required compaction density.
- E. Granular/Crushed Stone Fill: Place and compact materials in equal continuous layers not exceeding 6 inches loose depth when using heavy compaction equipment (sheepsfoot rollers, smooth drums, etc.) and not exceeding 4 inches loose depth when using hand operated or remote controlled equipment.
- F. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches loose depth when using heavy compaction equipment (sheepsfoot rollers, smooth drums, etc.) and not exceeding 4 inches loose depth when using hand operated or remote controlled equipment.
- G. Slope grade away from building minimum 2 inches in 10 ft, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- H. Correct areas that are over-excavated.
 - 1. Thrust bearing surfaces: Fill with concrete.
 - 2. Structural Concrete in areas located in the zone of influence of any footing or foundation.
 - 3. Structural Fill in areas within the building footprint or under vehicular and pedestrian pavements that are not located in the zone of influence.
 - 4. Other areas: Use general fill, flush to required elevation, compacted to minimum 98 percent of maximum dry density.
- I. Compaction Density Unless Otherwise Specified or Indicated:
 - 1. Under slabs-on-grade and similar construction: 98 percent of maximum dry density.
 - 2. At paving: 95 percent of maximum dry density.
 - 3. At landscape locations: 85 percent of maximum dry density.
 - Reshape and re-compact fills subjected to vehicular traffic.

3.06 BEDDING AND FILL AT SPECIFIC LOCATIONS

- A. Utility Piping, Conduits and Duct Bank:
 - 1. Bedding: Use Fill Type Pipe bedding granular fill for the initial 4-inch thick utility setting/leveling bed.
 - 2. If pipe is larger than 12-inches or if there are multiple pipes of any size utilizing the same trench (hoizontally or vertically), then the leveling bed and pipe bedding backfill is to be wrapped in filter fabric.
 - 3. Cover with pipe bedding granular fill to 6-inches above the utility and finish with general fill in non-structural locations, and structural fill in building and pavement locations. If the utility is located within the zone of influence of a foundation, the trench is to be backfilled with flowable fill from the top of the initial utility setting/leveling bed and encompassing the utility until it is at least 1-foot above the zone of influence. When using flowable fill as a utility trench backfill, care should be taken to prevent the utility from floating by using deadman anchors or another anchoring system.
 - 4. Fill up to subgrade elevation.
 - 5. Compact to 98 percent of maximum dry density.
 - 6. Compact in maximum 6 inch loose lifts to 98 percent of maximum dry density.
- B. At Sanitary Pipes:
 - 1. Bedding: Use Fill Type Pipe bedding granular fill for the initial utility setting/leveling bed.

J.

- 2. If pipe is larger than 12-inches or if there are multiple pipes of any size utilizing the same trench (hoizontally or vertically), then the leveling bed and pipe bedding backfill is to be wrapped in filter fabric.
- 3. Cover with pipe bedding granular fill to 6-inches above the utility pipe and finish with general fill in non-structural locations, and structural fill in building and pavement locations. If the sanitary pipe is located within the zone of influence of a foundation, the trench is to be backfilled with flowable fill from the top of the 6-inch cover until it is at least 1-foot above the zone of influence. Felt paper (15 lb) is to be installed around any sanitary standpipes as necessary to prevent the pipe from being in direct contact with the flowable fill. When using flowable fill as a utility trench backfill, care should be taken to prevent the utility from floating by using deadman anchors or another anchoring system.
- 4. Fill up to subgrade elevation.
- 5. Compact to 98 percent of maximum dry density.
- 6. Compact in maximum 6 inch lifts to 98 percent of maximum dry density.

3.07 TOLERANCES

A. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

3.08 FIELD QUALITY CONTROL

- A. See Division 1 for general requirements for field inspection and testing.
- B. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D1557 ("modified Proctor"), AASHTO T 180 or ASTM D698 ("standard Proctor").
- C. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- D. Frequency of Tests: One (1) test for each 150 feet or less of trench length, but no fewer than two (2) tests.

3.09 CLEANING

A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

END OF SECTION
SECTION 312316.26 - ROCK REMOVAL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Removal of identified and discovered rock during excavation.

1.02 RELATED REQUIREMENTS

A. Section 312323 - Fill: Fill materials.

1.03 PRICE AND PAYMENT PROCEDURES

A. All rock excavation is unclassified.

1.04 **DEFINITIONS**

- A. Site Rock: Solid mineral material with a volume in excess of 1/3 cubic yard or solid material that cannot be removed with a 3/4 cubic yard capacity power shovel without drilling.
- B. Trench Rock: Solid mineral material with a volume in excess of 1/6 cubic yard or solid material that cannot be removed with a 3/4 cubic yard capacity power shovel .
- C. Weathered bedrock is not considered to be bedrock in this definition.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

1.06 **PROJECT CONDITIONS**

- A. Schedule Work to avoid disruption to occupied buildings nearby.
- B. Nothing in this specification section relieves the Contractor of any responsibilities for any damage to the existing structures or utilities as a result of rock removal activities.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify site conditions and note subsurface irregularities affecting work of this section.

3.02 **PREPARATION**

A. Identify required lines, levels, contours, and datum.

3.03 ROCK REMOVAL

- A. Bedrock is to be removed as required for all new construction.
- B. Excavate rock as necessary below foundations to provide bearing on sound durable bedrock. If fractured or non-durable bedrock is encountered, it is to be excavated until sound durable bedrock is encountered.
 - 1. Due to the potential for Karst activity for the project site, probe holes are to be drilled beneath all proposed foundations to assess the underlying conditions of the bedrock. Once foundation excavations reach the intended bearing elevation, the contractor is to drill 2-inch diameter probe holes every 25-feet along continuous footings to a depth of 5-feet into the underlying bedrock. A minimum of one probe hole is to be drilled for each column footing location. Probe holes are to be observed and underlying conditions documented by the Special Inspector.

- C. Remove bedrock to provide 24-inches of soil cover, including topsoil, for all areas to be re-graded that are not recieving new pavements.
- D. The Geotechnial Report indicates the presence of shallow rock under the proposed building addition. Bedrock is to be removed to a depth of 36-inches below all floor slabs in the area of the Kitchen and 12-inches below all other floor slabs. In areas where bedrock is not encountered before the bottom of the subgrade excavation is reached, the excavation is to be probed with a sounding rod to ensure that bedrock is a minimum of 36-inches below the bottom of the subgrade elevation for the Kitchen area floor slab, and 12-inches below the bottom of the excavation for all other floor slabs. If bedrock is encountered within 36-inches of the Kitchen area floor slab subgrade or within 12-inches for all other floor slabs, the excavation is to be extended to bedrock and the bedrock removed to a minimum depth of 36-inches below the Kitchen area floor slab subgrade and 12-inches below the all other floor slab subgrade elevations. The excavation is to be brought back up to the bottom of floor slab subgrade in an engineered manner using Structural fill in accordance with Specification Section 312323.
- E. Excavate and remove rock by mechanical methods only; use of explosives is prohibited.
- F. Mechanical Methods: Drill holes and utilize expansive tools or hoe-ramming/jack hammering techniques to fracture rock.
- G. Form level bearing at bottom of excavations.
- H. Remove shaled layers to provide sound and unshattered base for footings.
- I. In utility trenches, excavate to 6 inches below invert elevation of pipe and 24 inches wider than pipe diameter.
- J. Ensure that the rock fracturing and/or rock removal do not create a "bathtub" effect and cause water to pond on the rock surface. This should be accomplished by daylighting the rock excavation and providing a path for water to exit the excavation. Acceptable methods are daylighting the entire excavation with a slope on the remaining bedrock surface that is between 2% and 4% in the direction of the daylighting for areas of large-scale rock removal (greater than 1000 square feet). In areas of 1000 sf or less of rock removal, daylighting can be obtained by creating a trench in the remaining bedrock and providing a perforated pipe with sock and pipe bedding backfill to the point of daylight.
- K. Remove excavated materials from site.
- L. Correct unauthorized rock removal in accordance with backfilling and compacting requirements of Section 312323.
- M. Correct unauthorized rock removal to directions of Architect.

3.04 FIELD QUALITY CONTROL

- A. Provide for visual inspection of foundation bearing surfaces and cavities formed by removed rock.
- B. Provide for visual inspection of removal of heave rock and replacement in an engineered manner that will minimize future settlement or swell of the fractured rock.

SECTION 312319 - DEWATERING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Dewatering of site during construction.

1.02 **RELATED SECTIONS**

- A. Section 312316 Excavation: Excavating for subdrainage system piping and surrounding filter aggregate.
- B. Section 312323 Fill: Filter aggregate, up to subgrade elevation.
- C. Section 312316.13 Trenching: Excavating and backfilling for site subdrainage systems.
- D. Section 312316.26 Rock Removal

1.03 **REFERENCES**

A. ASTM D 2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2003.

1.04 **PROJECT CONDITIONS**

- A. The Contractor is to provide any temporary piping required to reroute downspout and roof drains away from the work areas until the permanent drainage system is installed and in working order.
- B. Damage or destabilization/degradation of the on-site soils due to failure to dewater or otherwise prepare the site will be repaired at the Contractors expense.

1.05 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance:
 - 1. Design, furnish, install, test, operate, monitor and maintain dewatering system of sufficient scope, size and capacity to control surface and ground water flow into excavations and permit construction to proceed on dry stable subgrades.
 - 2. Prevent water from ponding inside foundation walls, including after the floor slabs have been installed, and causing the foundation soils to become saturated.

PART 2 - NOT USED

PART 3 EXECUTION

3.01 INSTALLATION

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades and from flooding the Project site and surrounding areas.
- B. Reroute surface water away from excavated areas. Do not allow water to accumulate in excavations or on footings that have already been installed but not backfilled. Do not use utility, foundation or other trenches as temporary drainage ditches unless specifically designed for only that purpose.
- C. Prevent water from ponding inside the foundation walls, within the building footprint and in pavement areas.
- D. Due to the foundation walls being extended to bedrock, water may become ponded within the building footprint. The Contractor is to install a temporary dewatering system to keep subgrades dry and convey ground and surface water away from excavations and underslab areas for all areas where the foundations create a "tub" affect. The dewatering system is to be maintained until the building is dried-in and water can no longer enter the underslab areas.

- E. The Contractor is to provide and maintain pumps, well points, sumps, suction and discharge lines and other dewatering system components necessary to convey water away from excavations and control the groundwater to a level at least 3'-0" below the lowest point of the excavation.
- F. Do not use open-sump pumping that leads to loss of fines, soil piping, subgrade softening and slope instability.
- G. Dispose of water removed by dewatering in a manner that avoids endangering public health, property and portions of work under construction or completed. Avoid creating an inconvenience to others, and maintain sedimentation controls as required by authorities having jurisdiction.
- H. All dewatering discharge is to be routed to a sediment pond or sediment bags so that the sediment can settle prior to the discharge water leaving the site or entering any waterway or storm sewer.

3.02 FIELD QUALITY CONTROL

- A. Dewatering systems are to be inspected at least weekly and any and all repairs or refinements performed to maintain a fully operational system that achieves the intended purpose.
- B. Standby equipment is to be maintained on site so that it can be immediately installed if failure of primary equipment occurs.

3.03 **PROTECTION**

- A. Protect pipe and dewatering system from other construction activities.
- B. Remove dewatering system at the completion of construction or when determined by the Architect that it is no longer needed. Any holes in interior slabs and voids under the slabs are to be repaired using lean concrete for the voids and an non-shrink concrete repair grout for the slabs.

SECTION 312323 - FILL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Filling, backfilling, and compacting for slabs-on-grade and non-utility excavations located within the building footprint.
- B. Filling holes, pits, and excavations generated as a result of removal (demolition) operations.

1.02 RELATED REQUIREMENTS

- A. Section 015713 Temporary Erosion and Sediment Control: Slope protection and erosion control.
- B. Section 312200 Grading: Site grading.
- C. Section 312316 Excavation: Removal and handling of soil to be re-used.
- D. Section 312316.13 Trenching: Excavating and backfilling for utility trenches outside the building to utility main connections.
- E. Section 312316.26 Rock Removal: Removal of rock during excavating.
- F. Section 312323.13 Flowable Fill

1.03 **DEFINITIONS**

- A. Finish Grade Elevations: Indicated on drawings.
- B. Zone of Influence: Area beneath a footing or foundation that extends out from the bottom edge of the footing/foundation at a 45-degree angle down to a depth equal to 3 times the footing width.

1.04 REFERENCE STANDARDS

- A. ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)) 2012, with Editorial Revision (2015).
- B. ASTM D1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method 2007.
- C. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)) 2012, with Editorial Revision (2015).
- D. ASTM D2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method 2015.
- E. ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) 2011.
- F. ASTM D3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth) 2005.
- G. ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils 2010.
- H. ASTM D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) 2017.

1.05 SUBMITTALS

- A. See Division 1 Sections for submittal procedures.
- B. Materials Sources: Submit name of imported materials source.

- C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used, including manufactured fill.
- D. Compaction Density Test Reports.

1.06 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. General Fill- Fill Type Lean Clay: Subsoil excavated on-site and imported as necessary for new work.
 - 1. Graded.
 - 2. Free of lumps larger than 3 inches, rocks larger than 2 inches, and debris.
 - 3. Conforming to ASTM D2487 Group Symbol CL.
 - 4. Having no more than 5-percent rock/gravel in the top 24-inches in landscape areas, and no more than 15-percent rock/gravel in any location.
- B. Structural Fill- Fill Type DGA: Conforming to State of Kentucky Highway Department standard.
- C. Flowable Fill: A controlled low-strength material made of cement, water, sand, and an air-entraining admixture that it can be excavated by hand or use of a backhoe. See Section 312323.13.

2.02 SOURCE QUALITY CONTROL

- A. See Section 014000 Quality Requirements, for general requirements for testing and analysis of soil material.
- B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.
- C. If tests indicate materials do not meet specified requirements, change material and retest.
- D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. All fill material is unclassified.
- B. Verify that survey bench marks and intended elevations for the Work are as indicated.
- C. Identify required lines, levels, contours, and datum locations.
- D. Verify subdrainage, dampproofing, or waterproofing installation has been inspected.
- E. Verify structural ability of unsupported walls to support imposed loads by the fill.
- F. Proof roll all areas to receive fill prior to placing fill as required in the geotechnical report. Proof rolls should only be done when the soils are are near optimum moisture content. Any areas that do not pass proof roll are to be stabilized and approved in accordance with the Geotechnical Report. Any suitable soils removed as part of the stabilization process due to moisture content issues are to be moisture conditioned and used as fill in other locations.
- G. Confirm that rock has been removed for all areas being re-graded that are not recieving new pavements to provide a minimum of 24-inches of cover below finished grade. Refer to Specificaiton Section 312316.26 for Rock Removal requirements.
- H. Confirm that all weak or organic soils have been removed under the new building footprint and extending 3-feet beyond the extents of the building footprint. Refer to Specification Section 312316

for Excavation requirements.

- I. Confirm that fat clay (CH) material has been removed under all floor slab areas so that no fat clay is located within 24-inches of the top of subgrade. Refer to Specificaiton Section 312316 for Excavation requirements.
- J. Confirm that fat clay (CH) material has been removed under all pavement areas so that no fat clay is located within 12-inches of the top of subgrade. Refer to Specificaiton Section 312316 for Excavation requirements.
- K. Confirm that rock has been excavated and removed to a depth of 36-inches below the subgrade elevation of the Kitchen area floor slab, and 12-inches below the subgrade elevation for all other floor slabs. Refer to Specificaiton Section 312316 for Excavation and Section 312316.26 for Rock Removal requirements.
- L. Verify areas to be filled are not compromised with surface or ground water.

3.02 **PREPARATION**

- A. Scarify and proof roll subgrade surface to a depth of 6 inches to identify soft spots.
- B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill or as outlined per over-excavation below.
- C. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

3.03 FILLING

- A. Fill to contours and elevations indicated using unfrozen materials.
- B. Soils are not to be "over-compacted" or worked in a manner that will cause them to break down and lose strength.
- C. Employ a placement method that does not disturb or damage other work.
- D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- E. Maintain optimum moisture content of fill materials to attain required compaction density.
- F. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches loose depth when using heavy compaction equipment (sheepsfoot rollers, smooth drums, etc.), and not exceeding 4 inches loose depth when using small, hand operated or remote controlled compaction equipment..
- G. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches loose depth when using heavy compaction equipment (sheepsfoot rollers, smooth drums, etc.), and not exceeding 4 inches loose depth when using small, hand operated or remote controlled compaction equipment.
- H. Slope grade away from building minimum 2 inches in 10 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- I. Correct areas that are over-excavated.
 - 1. Load-bearing foundation surfaces: Fill with concrete.
 - Floor slab areas: Use structural fill, compacted to 98 percent of maximum dry density, to slab subgrade elevation in areas outside of the zone of influence of any footings or foundations. All excavations in the zone of influence of any footings or foundations are to be backfilled with concrete.

- 3. Drives and vehicular pavement areas: Use DGA over a layer of Tensar BX1200 geogrid up to the required bottom of pavement crushed stone base elevation.
- 4. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.
- J. Compaction Density Unless Otherwise Specified or Indicated:
 - 1. Under paving, slabs-on-grade and similar construction: 98 percent of maximum dry density.
 - 2. At paving areas: 95 percent of maximum dry density.
- K. Reshape and re-compact fills subjected to vehicular traffic.
- L. Maintain temporary means and methods, as required, to remove all water while fill is being placed as required, or until directed by the Architect. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control. Refer to Specification Section 312319 for additional Dewatering requirements.

3.04 FILL AT SPECIFIC LOCATIONS

- A. Use general fill unless otherwise specified or indicated. Fat clay that has been removed as part of the excavation requirements of these speficiations can only be used as fill in landscape areas where it will be at least 24-inches below subgrade.
- B. Building Pad Mass Fill :
 - 1. Use structural fill.
 - 2. Fill up to subgrade elevations.
 - 3. Maximum depth per lift: 6 inches, compacted.
 - 4. Compact to minimum 98 percent of maximum dry density.
- C. Excavations within the zone of influence (ZOI) of any footing or foundation:
 - 1. Use Flowable Fill. See MEP and Structural Engineer drawings and specifications for utility excavation backfill requirements inside the building footprint.
- D. At Foundation Walls and Footings where excavation was done after the building pad was constructed and within the Zone of Influence:
 - 1. Use flowable fill where excavation was done within the Zone of Influence. Flowable fill is to extend to a minimum of 1-foot above the Zone of Influence.
 - 2. Use structural fill where excavation was done outside of the Zone of Influence.
- E. Against Foundation Walls and Footings where foundation drainage is not required:
 - 1. Use structural fill as backfill against the foundations/stem walls above the top of footing inside the building footprint, and general fill outside of the building footprint above the top of footing. Compact per above requirements.
 - 2. Fill up to subgrade elevation.
 - 3. Do not backfill against unsupported foundation walls.
 - 4. Backfill simultaneously on each side of unsupported foundation walls until supports are in place.
- F. At Lawn Areas:
 - 1. Use general fill.
 - 2. Compact to 85 percent of maximum dry density.

- 3. See Section 312200 for topsoil placement.
- G. Landscape Area Backfill:
 - 1. Do not backfill landscape planting beds, landscape islands, or tree pits with construction or other debris. These areas are to be free of debris and particles 1/2 inch or larger in size, down to a depth of 24 inches minimum.
 - 2. Gravel, rock or concrete particles of no more than 1/2 inch in any dimension, shall constitute no more than 10% of the backfill content of planting beds, planting islands, and tree pits.

3.05 TOLERANCES

A. Top Surface of General Filling: Plus or minus 1 inch from required elevations.

3.06 FIELD QUALITY CONTROL

- A. See Division 1 Sections for general requirements for field inspection and testing.
- B. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167 or ASTM D6938.
- C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with AASHTO T 180, ASTM D1557 ("modified Proctor"), ASTM D698 ("standard Proctor"), AASHTO T 180, ASTM D1557 ("modified Proctor"), ASTM D698 ("standard Proctor"), AASHTO T 180, ASTM D1557 ("modified Proctor") or ASTM D698 ("standard Proctor").
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- E. Frequency of Tests: One (1) test for every 2,000 sq. ft. or sell of paved area or building slab per lift, but in no case fewer than two (2) tests per lift.
- F. The Contractor should anticipate and allow for testing time of encountered and imported materials. Some testing can take three to four business days.
- G. Proof roll compacted fill at surfaces that will be under slabs-on-grade and paving.

3.07 CLEANING

- A. See Section 017419 Construction Waste Management and Disposal, for additional requirements.
- B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

SECTION 312323.13 - FLOWABLE FILL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flowable Fill or Controlled Low Strength Materials (CLSM)
- B. Backfill for site utilities within the zone-of-influence of any footing/foundation.

1.02 RELATED REQUIREMENTS

- A. Section 312316.13 Trenching: Excavation and backfilling for foundations and utilities outside the building footprint.
- B. Section 312323 Fill: Filling and Compaction.

1.03 REFERENCE STANDARDS

- A. ACI 301 Specifications for Structural Concrete for Buildings; American Concrete Institute International; 2010.
- B. ACI 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International; 2000.
- C. ACI 305R Hot Weather Concreting; American Concrete Institute International; 2010.
- D. ACI 306R Cold Weather Concreting; American Concrete Institute International; 2010.
- E. ASTM C33/C33M Standard Specification for Concrete Aggregates; 2011a.
- F. ASTM C39/C39M Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2012.
- G. ASTM C150/C150M Standard Specification for Portland Cement; 2012.
- H. ASTM C173/C173M Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2010b.
- I. ASTM C260 Standard Specification for Air-Entraining Admixtures for Concrete; 2010a.
- J. ASTM C494/C494M Standard Specification for Chemical Admixtures for Concrete; 2011.
- K. ASTM C685/C685M Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2011.
- L. ASTM D4832 Preparation and Testing of Controlled Low Strength Material Test Cylinders
- M. ASTM D5971 Sampling Freshly Mixed Controlled Low Strength Material
- N. ASTM D6103 Flow Consistency of Controlled Low Strength Material
- O. ASTM D6023 Unit Weight, Yield, Cement Content and Air Content (Gravimetric) of Controlled Low Strength Material

1.04 SUBMITTALS

- A. See Division 1 Sections for submittal procedures.
- B. Product Data: Provide data on mix materials and admixtures.
- C. Design Data: Mix design and test results showing that the mix design meets the mix and performance requirements.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

FI	lowa	ble	Fill
	io nu		1 111

312323.13 - 1

- A. Obtain cementitious materials from same source throughout.
- B. Cement: ASTM C150/C150M Air Entraining Type IA portland type, grey color.
- C. Fine Mix Aggregates: ASTM C33.
- D. Water: Clean, and not detrimental to concrete.
- E. Air Entrainment Admixture: ASTM C260.
- F. Chemical Admixtures: ASTM C494/C494M, Type A Water Reducing.
 - 1. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.

2.02 ACCESSORIES

- A. Utility Anchors: Manufactured anchorsSurface Retarder:
 - 1. Manufactured anchoring system to prevent vertical and horizontal movement of the utility during installation and curing of Flowable Fill/CLSM.

2.03 FLOWABLE FILL/CLSM MIX DESIGN

- A. The Flowable Fill/CLSM material is to be a self-leveling and self-compacting, cementitious material with low compressive strength (see below).
- B. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.
- C. If flowable fill is to be pumped, a modified mixture shall be submitted along with test results that indicate that the mix will meet the strength restrictions. In addition, the supplier is to ensure that the air content at the point of discharge from the pump meets the below requirements.
- D. Excavatable Flowable Fill Properties (not-pumped):
 - 1. Compressive Strength, when tested in accordance with ASTM D4832 at 28 days: 30 to 80 psi maximum. Strength shall not exceed 130 psi at 180-days.
 - 2. Fly Ash Content: None
 - 3. Cement Content: 50 to 100 lb per cubic yard.
 - 4. Water: Content to provide self-leveling mix with flowability per below and without excess bleed water.
 - 5. Total Air Content: 20-30 percent, determined in accordance with ASTM D6023.
 - 6. Flowability: 6 to 8 inches in accordance with ASTM D6103.
 - 7. Unit Weight (wet): 90-115 pcf
 - 8. Aggregate Size: Concrete Sand

2.04 MIXING

- A. Transit Mixers: Comply with ASTM C94/C94M.
- B. Do not add water to the mix once the truck has left the concrete plant.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify trench subgrade is acceptable and ready to support fill and future loads.
- B. Verify gradients and elevations of base are correct.

C. Verify that utilities have been properly anchored to eliminate vertical and horizontal movement.

3.02 PREPARATION

- A. Wrap utilities with protective felt paper or other protective wrap as approved by the governing body for the utility.
- B. Notify Testing Agent minimum 24 hours prior to filling operations.

3.03 FORMING

A. Place and secure forms as necessary at the ends of each pour.

3.04 COLD AND HOT WEATHER INSTALLATION

- A. Follow recommendations of ACI 305R when installing during hot weather.
- B. Follow recommendations of ACI 306R when installing during cold weather.
- C. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.
- D. Protect from freezing for a minimum of 36-hours after placement.

3.05 PLACING FLOWABLE FILL/CLSM

- A. Place fill in accordance with ACI 304R.
- B. Place fill material continuously over the full width of the trench/excavation.

3.06 TOLERANCES

- A. The contractor should anticipate a 1/8-inch per foot of depth shrinkage of the Flowable Fill/CLSM material during the initial 7-day curing period.
- B. Maximum Variation From True Position Post-Cure: Plus 1/4 inch (no minus).

3.07 FIELD QUALITY CONTROL

- A. The Owner will employ an independent testing agency to perform field quality control tests, as specified in Division 1 Sections.
 - 1. Provide free access to Flowable Fill/CLSM operations at project site and cooperate with appointed firm.
 - 2. Submit proposed mix design of each class of Flowable Fill/CLSM to inspection and testing firm for review prior to commencement of installation operations.
 - 3. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.
- B. Compressive Strength Tests: ASTM D4832. For each test, mold and cure five Flowable Fill/CLSM test cylinders. Obtain test samples for every truck delivered.
 - 1. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as material it represents.
 - 2. Perform one flowability test and one air content test for each set of test cylinders taken.
 - 3. Perform compression tests at 7-days, 14-days, 28-days, 56-days and 180-days
- C. Maintain records of placed Flowable Fill/CLSM items. Record date, pour time, batch time, location of pour, quantity, air temperature, and test samples taken. All test reports are to by typed.
- D. Any tests or time limits that do not meet the specified requirements are to be reported to the Contractor and that material shall be considered unacceptable. Any material placed that is deemed unacceptable shall be removed and replaced with acceptable material.

3.08 **PROTECTION**

- A. Immediately after placement, protect from premature drying, excessive hot or cold temperatures, and mechanical injury for a minimum of 36-hours.
- B. Do not subject the fill material to foundation or other loads that may exceed the material strength.

SECTION 312513 - PERMANENT EROSION CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Erosion blankets and netting.
- B. Slope protection
- C. protection (non-rip rap)

1.02 RELATED SECTIONS

- A. Section 015713 Temporary Erosion Controls
- B. Section 312200 Grading
- C. Section 312323 Fill: Filling and compaction.
- D. Section 313413 Flexible Concrete Erosion Control
- E. Section 329219 Seeding: Finish ground cover.

1.03 REFERENCES

- A. Kentucky Erosion Prevention and Sediment Control Field Guide by Kentucky Division of Conservation. Refer to these guidelines for construction and maintenance of erosion control items.
- B. Kentucky Division of Water (www.water.ky.gov)

1.04 SUBMITTALS

A. Erosion Control Material Data: Include manufacturer, product and design calculations for each product used.

1.05 **QUALITY ASSURANCE**

A. Perform Work in accordance with State of Kentucky, Highway Department standards.

1.06 **PROJECT CONDITIONS**

- A. Protect above- and below-grade utilities that remain.
- B. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving and curbs from installation equipment and vehicular traffic.

PART 2 PRODUCTS

2.01 MATERIALS

- A. High Velocity Erosion-Control Blankets: Coconut-fiber mat enclosed in a double-net, UV stabilized polypropylene mesh with a minimum 36-month design life. Include manufacturer's recommended biodegradable stakes, 6 inches (150 mm) long. Acceptable products are:
 - 1. Curlex III by American Excelsior Company
 - 2. C125 by North American Green
 - 3. ECC-2 by East Coast Erosion Blankets
- B. Long-Term Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a double-net, photo-degradable woven mesh with a minimum 1-year design life. Include manufacturer's recommended biodegradable stakes, 6 inches long. Acceptable products are:
 - 1. Curlex II by American Excelsior Company
 - 2. S150 by North American Green

- 3. ECS-2 and ECX-2 by East Coast Erosion Blankets
- C. Short-Term Erosion-Control Blankets: Biodegradable twisted jute or spun-coir mesh in a single-net product with straw or coconut-fiber fill. Include manufacturer's recommended steel wire staples, 6 inches long. Acceptable products are:
 - 1. Curlex I by American Excelsior Company
 - 2. S75 by North American Green
 - 3. ECS-1 by East Coast Erosion Blankets
- D. Other Materials: See Section 312323.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that finish grading and intended elevations for the Work are as indicated and that all debris and rock fragments larger than 1/2-inch have been removed from the area to be covered.

3.02 **PREPARATION**

- A. Identify required lines, levels, contours, and datum.
- B. Identify and mark areas to receive erosion controls.

3.03 INSTALLATION

- A. Protect areas to be seeded as follows:
 - 1. Ditches and drainage swales are to receive high-velocity erosion-control blankets.
 - 2. Slopes 4:1 (H:V) or greater are to receive long-term erosion-control blankets.
 - 3. Slopes between 4:1 and 6:1 are to receive short-term erosion-control blankets.
 - 4. If drawings indicate installation of flexible concrete erosion controls, the flexible concrete erosion controls are to be installed over the erosion control blankets and not as a substitute.
- B. Roll out erosion controls beginning at the bottom of the slope or the lowest end of the ditch line.
- C. Overlap ends of the controls a minimum of 24-inches or per the manufacturers recommendation, whichever is larger.
- D. Overlap the edges of the controls a minimum of 12-inches or per the manufacturers recommendation, whichever is larger.
- E. Install biodegradable anchors per the manufacturers recommendation. If erosion controls begin to pull up, slide or otherwise come loose, install additional anchors as needed for proper installation.
- F. Sod can be used for all slopes identified above (not drainage swales or ditches) as a substitute for the listed erosion controls. Sod is to be laid perpendicular to the slope and staked to prevent slipping.

3.04 CLEANING AND PROTECTION

A. Leave site clean and raked, ready to receive landscaping.

END OF SECTION

312513 - 2

SECTION 313116 - TERMITE CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Chemical soil treatment.

1.02 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Vapor barrier placement under concrete slab-on-grade.

1.03 REFERENCE STANDARDS

A. Title 7, United States Code, 136 through 136y - Federal Insecticide, Fungicide and Rodenticide Act 2006.

1.04 SUBMITTALS

- A. See Division 1 Sections for submittal procedures.
- B. Product Data: Indicate toxicants to be used, composition by percentage, dilution schedule, intended application rate.
- C. Test Reports: Indicate regulatory agency approval reports when required.
- D. Manufacturer's Instructions: Indicate caution requirement.
- E. Manufacturer's Certificate: Certify that toxicants meet or exceed specified requirements.
- F. Record and document moisture content of soil before application.
- G. Maintenance Data: Indicate re-treatment schedule .
- H. Warranty: Submit warranty and ensure that forms have been completed in Owner's name.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing this type of work and:
 - 1. Having minimum of three (3) years documented experience.
 - 2. Approved by manufacturer of treatment materials.
 - 3. Licensed in the State in which the Project is located.

1.06 REGULATORY REQUIREMENTS

- A. Conform to applicable code for requirements for application, and comply with EPA regulations.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of toxicants.

1.07 SEQUENCING

A. Apply toxicant 12 hours prior to installation of vapor barrier under slabs-on-grade.

1.08 WARRANTY

- A. See Section 017800 Closeout Submittals, for additional warranty requirements.
- B. Provide five year installer's warranty against damage to building caused by termites.
 - 1. Inspect annually and report in writing to Owner. Provide inspection service for twelve months from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 CHEMICAL SOIL TREATMENT

Termite Control

- A. Toxicant Chemical: EPA Title 7, United States Code, 136 through 136y approved; synthetically color dyed to permit visual identification of treated soil.
- B. Manufacturers: Subject to compliance with requirements, manufacturers offering the following products that may be incorporated into the work include;
 - 1. BASF: Product: Termidor 80 WG: www.basf.com
 - 2. Bayer Environmental Science Corp; [___]: www.backedbybayer.com/pest-management.
 - 3. FMC Professional Solutions; Product Baseline: www.fmcprosolutions.com.
 - 4. Syngenta Professional Products; [____]: www.syngentaprofessionalproducts.com.
- C. Toxicant Chemical: EPA ({\rs\#1}) approved; synthetically color dyed to permit visual identification of treated soil.
- D. Diluent: Recommended by toxicant manufacturer.

2.02 MIXES

A. Mix toxicant to manufacturer's instructions.

PART 3 EXECUTION

3.01 **EXAMINATION**

- A. Verify that soil surfaces are unfrozen, sufficiently dry to absorb toxicant, and ready to receive treatment.
- B. Verify final grading is complete.

3.02 APPLICATION - CHEMICAL TREATMENT

- A. Comply with requirements of U.S. EPA and applicable state and local codes.
- B. Spray apply toxicant in accordance with manufacturer's instructions.
- C. Apply toxicant at following locations:
 - 1. Under Slabs-on-Grade.
 - 2. At Both Sides of Foundation Surface.
 - 3. Soil Within 10 feet of Building Perimeter For a Depth of 1' foot.
- D. Under slabs, apply toxicant immediately prior to installation of vapor barrier.
- E. At foundation walls, apply toxicant immediately prior to finish grading work outside foundations.
- F. Apply extra treatment to structure penetration surfaces such as pipe or ducts, and soil penetrations such as grounding rods or posts.
- G. Re-treat disturbed treated soil with same toxicant as original treatment.
- H. If inspection or testing identifies the presence of termites, re-treat soil and re-test.

3.03 **PROTECTION**

A. Do not permit soil grading over treated work.

SECTION 313413 - FLEXIBLE CONCRETE EROSION CONTROL MAT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Flexible Concrete Mat at pipe and headwall out falls.

1.02 RELATED REQUIREMENTS

- A. Section 312200 Grading.
- B. Section 312316 Excavation.
- C. Section 312323 Fill

1.03 QUALITY ASSURANCE

A. Perform Work in accordance with the manufacturer's recommendations and as outlined below.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Concrete.
- B. Concrete specifications.
 - 1. Mix classification 4000 AE.
 - 2. Strength 4000 PSI per 28 days.
 - 3. Air content 4-8%.
 - 4. Slump 9" after super.
 - 5. Coarse Aggregate max. size 3/8 inch.
 - 6. Maximum water-cement ratio 0.46.
 - 7. Quantities per cubic yard:
 - a. 560 lbs. Type 1 cement.
 - b. 50 lbs granular cement.
 - c. 1220 lbs fine aggregate (sand).
 - d. 1600 lbs course aggregate (gravel).
 - e. 276 lb water.
 - f. 6 oz. Air Entrainment agent.
 - g. 64 oz. 260 AE Admixture.
 - h. 1 lb polyfiber.
 - 8. Concrete Cobblestone sizes: rectangular; 4 inches to 13 inches length/width, 1-3/4 inches to 5 inches thick at the crown.
 - 9. Concrete Cobblestone weight 10 lb per SF minimum.
- C. Geogrid Reinforcement
 - 1. 10oz/sq.yd Mass/Unit Area., ASTM D-5261
 - 2. Aperture size 1.2 inches
 - 3. 70 Percent Open Area, CW02215

Flexible Concrete Erosion Control	212412 1
Mat	515415 - 1

- 4. Wide Width Tensile Strength @ Ultimate Machine Direction and Cross Machine Direction, both 2600 lb/ft, ASTM D-6637.
- 5. Creep Limited Strength Machine Direction and Cross Machine Direction @ 5%, 1610 lb/ft, ASTM D-5262.
- 6. Elongation at Break 4-6%, ASTM-D6637
- 7. Long Term Design Strength, Machine Direction:
 - a. Sand, Silt and Clay and Sandy Gravel, 1465 lb/ft, FHWA NHI-00-044
 - b. 2" Minus Coarse Gravel, 1285 lb/ft, FHWA NHI-00-044

PART 3 EXECUTION

3.01 PLACEMENT

- A. Prepare ground surface per manufacturer's recommendations for specific site conditions including preparation of topsoil planting media.
- B. Seed area per Section 329219 Seeding.
- C. Install long term erosion control blanket over prepared and seeded topsoil prior to installation of the Flexible Concrete Mat.
- D. Place Flexible Concrete Mat roll over erosion control blankets, unroll and cut to length. Overlap flexible concrete mat sections minimum 18 inches and pin unless system is interlocking.
- E. Install anchors along edges and hog ring connectors every 2-feet at adjoining end and every 5-feet along edges of adjacent rolls unless the manufacturer recommends closer spacing.

Flexible Concrete Erosion Control	212412 2
Mat	515415 - 2

RTA 1904

SECTION 321123 - AGGREGATE BASE COURSES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aggregate base course.
- B. Paving aggregates.

1.02 RELATED REQUIREMENTS

- A. Section 312200 Grading: Preparation of site for base course.
- B. Section 312323 Fill: Compacted fill under base course.
- C. Section 321216 Asphalt Paving: Finish and binder asphalt courses.
- D. Section 321313 Concrete Paving: Finish concrete surface course.
- E. Section 321613 Concrete Curbs and Gutters: Finish concrete surface course.
- F. Section 334913 Storm Drainage Manholes, Frames and Covers: Manholes and frames.

1.03 **REFERENCE STANDARDS**

- A. AASHTO M 147 Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses 1965 (2004).
- B. AASHTO T 180 Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18 in.) Drop 2018.
- C. ASTM C136/C136M Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates 2014.
- D. ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)) 2012, with Editorial Revision (2015).
- E. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)) 2012, with Editorial Revision (2015).
- F. ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) 2011.
- G. ASTM D3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth) 2005.
- H. ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils 2010.
- I. ASTM D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) 2017.

1.04 SUBMITTALS

- A. See Division 1 Sections for submittal procedures.
- B. Materials Sources: Submit name of imported materials source.
- C. Aggregate Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- D. Compaction Density Test Reports.

1.05 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

- B. Aggregate Storage, General:
 - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
 - 2. Prevent contamination.
 - 3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Blended Aggregate Type DGA: Pug DGA conforming to State of Kentucky Highway Department standard.
- B. Herbicide: In accordance with State of Kentucky Highway Department Standards .

2.02 SOURCE QUALITY CONTROL

- A. See Division 1 for Quality Requirements for testing and analysis of aggregate materials.
- B. Where aggregate materials are specified using ASTM D2487 classification, test and analyze samples for compliance before delivery to site.
- C. If tests indicate materials do not meet specified requirements, change material and retest.
- D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that survey bench marks and intended elevations for the work are as indicated.
- B. Verify substrate has been inspected, gradients and elevations are correct, and is dry.
- C. Proof-roll areas to receive aggregate base course material and have proof-roll approved by the soils testing agent.
- D. Due to the type of soils encountered on the site, proof-rolling during wet periods or when the existing soils are above optimum moisture content will not be acceptable. All proof-rolling will need to be done during dry conditions.

3.02 **PREPARATION**

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.
- B. Do not place aggregate on soft, muddy, or frozen surfaces.

3.03 INSTALLATION

- A. Under Bituminous Concrete Paving:
 - 1. Place Blended Aggregate Type DGA to thickness identified on the drawings.
 - 2. Compact to 95 percent of maximum dry density.
- B. Under Portland Cement Concrete Paving:
 - 1. Place Blended Aggregate Type DGA to thickness identified on the drawings.
 - 2. Compact to 95 percent of maximum dry density.
- C. Place aggregate in maximum 4 inch layers and roller compact to specified density.
- D. Level and contour surfaces to elevations and gradients indicated.
- E. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.

- F. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.
- G. Use mechanical tamping equipment in areas inaccessible to compaction equipment.
- H. Apply herbicide to finished surface.

3.04 TOLERANCES

- A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.
- B. Scheduled Compacted Thickness: Within 1/4 inch.

3.05 FIELD QUALITY CONTROL

- A. See Division 1 Sections for general requirements for field inspection and testing.
- B. Compaction density testing will be performed on compacted aggregate base course in accordance with ASTM D1556, ASTM D2167 or ASTM D6938.
- C. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with AASHTO T 180, ASTM D698 ("standard Proctor") or ASTM D1557 ("modified Proctor").
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- E. Frequency of Tests: One (1) test for every 2000 sq. ft. or less of paved area per lift but in no case fewer than two (2) tests per lift.
- F. Proof roll compacted aggregate at surfaces that will be under slabs-on-grade.

3.06 CLEANING

A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

SECTION 321216 - ASPHALT PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Double course bituminous concrete paving.

1.02 **RELATED REQUIREMENTS**

- A. Section 312200 Grading: Preparation of site for paving and base.
- B. Section 312323 Fill: Compacted subgrade for paving.
- C. Section 321123 Aggregate Base Courses: Aggregate base course.
- D. Section 321313 Concrete Paving: Concrete substrate.
- E. Section 321313 Concrete Paving: Concrete curbs.
- F. Section 321713 Parking Bumpers: Concrete bumpers.
- G. Section 330513 Manholes and Structures: Manholes, including frames; gutter drainage grilles, covers, and frames for placement by this section.

1.03 **REFERENCE STANDARDS**

- A. AI MS-2 Asphalt Mix Design Methods 2015.
- B. ASTM D946 Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction 2009a.

1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with State of Kentucky Highways standard.
- B. Mixing Plant: Conform to State of Kentucky Highways standard.
- C. Obtain materials from same source throughout.

1.05 FIELD CONDITIONS

- A. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F, or surface is wet or frozen.
- B. Place bitumen mixture when temperature is not more than 15 F degrees below bitumen supplier's bill of lading and not more than maximum specified temperature.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Asphalt Cement: ASTM D946.
- B. Aggregate for Base Course: In accordance with State of Kentucky Highways standards.
- C. Aggregate for Binder Course: In accordance with State of Kentucky Highways standards.
- D. Aggregate for Wearing Course: In accordance with State of Kentucky Highways standards.
- E. Fine Aggregate: In accordance with State of Kentucky Highways standards.
- F. Tack Coat: Homogeneous, medium curing, liquid asphalt in accordance with Kentucky Transportation Cabinet Standard Specifications Section 406.

2.02 ASPHALT PAVING MIXES AND MIX DESIGN

A. Use dry material to avoid foaming. Mix uniformly.

- B. Asphalt Pavement:
 - 1. Binder Course: State of Kentucky Highways standards for CL2 BASE 0.75 D PG 64-22.
 - 2. Wearing Course: State of Kentucky Highways standards for CL2 SURF 0.38 D PG 64-22.
- C. Recycled Asphalt Pavement (RAP): In accordance with State of Kentucky Highway Department Section 409 with a maximum of 15 percent RAP for PG 64-22.
- D. Submit proposed mix design of each class of mix for review prior to beginning of work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that compacted subgrade is dry and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.
- C. Asphalt Pavement may be placed between November 15th and April 1st if the ambient temperature requirements are met or if approved by the architect/engineer.

3.02 **BASE COURSE**

A. Place and compact base course.

3.03 **PREPARATION - TACK COAT**

- A. Apply tack coat in accordance with manufacturer's instructions.
- B. Comply with provisions in KTC Standard Specifications Section 406
- C. Apply tack coat on asphalt or concrete surfaces over subgrade surface at uniform rate of 1/3 gal/sq yd.
- D. Coat surfaces of storm and sanitary sewer structure frames with oil to prevent bond with asphalt pavement. Do not tack coat these surfaces.

3.04 PLACING ASPHALT PAVEMENT - DOUBLE COURSE

- A. Place asphalt binder course within 24 hours of applying primer or tack coat.
- B. Place binder course to compacted thickness identified on the contract drawings.
- C. Place wearing course within 72 hours of placing and compacting binder course. If the wearing course is placed more than 72 hours after the binder course, the binder course is to be cleaned and a tack coat installed prior to the wearing course installation.
- D. Place wearing course to compacted thickness identified on the contract drawings.
- E. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- F. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.
- G. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent.

3.05 TOLERANCES

- A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.
- B. Compacted Thickness: Within 1/4 inch of specified or indicated thickness.
- C. Variation from True Elevation: Within 1/2 inch.
- D. Texture: Surface is to have a tight, smooth, uniform finish. Areas that have an abundance of exposed aggregate or porous texture, as determined by the Architect, shall be re-compacted or replaced as required by the Architect.

3.06 FIELD QUALITY CONTROL

- A. See Division 1 Sections for general requirements for testing and inspections.
- B. Provide field inspection and testing. Take samples and perform tests in accordance with AI MS-2.

3.07 **PROTECTION**

- A. Immediately after placement, protect pavement from mechanical injury for 2 days or until surface temperature is less than 140 degrees F.
- B. All pavements that are soiled or otherwise dirty are to be pressure washed and rinsed upon completion of the construction and landscaping work.

SECTION 321313 - CONCRETE PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete sidewalks, and service drives/ loading dock areas, stair steps, and service drives/ loading dock areas, integral curbs and service drives/ loading areas.

1.02 RELATED REQUIREMENTS

- A. Section 031000 Concrete Forming and Accessories.
- B. Section 312200 Grading: Preparation of site for paving and base and preparation of subsoil at pavement perimeter for planting.
- C. Section 312323 Fill: Compacted subbase for paving.
- D. Section 321123 Aggregate Base Courses: DGA base course.
- E. Section 321726 Tactile Warning Surfacing: Plastic tactile and detectable warning tiles for pedestrian walking surfaces.
- F. Section 321373 Joint Sealers: Sealant for joints.
- G. Section 321613 Concrete Curb and Gutters

1.03 **REFERENCE STANDARDS**

- A. ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete 1991 (Reapproved 2009).
- B. ACI 301 Specifications for Structural Concrete 2010 (Errata 2012).
- C. ACI 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete 2000 (Reapproved 2009).
- D. ACI 305R Hot Weather Concreting 2010.
- E. ACI 306R Cold Weather Concreting 2010.
- F. ASTM A36 Steel plate for plate dowel systems.
- G. ASTM A185/A185M Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete; 2007.
- H. ASTM A615/A615M Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement 2015.
- I. ASTM A1064/A1064M Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete 2015.
- J. ASTM B633 Type II Electroplated zinc for plat dowel systems
- K. ASTM C33/C33M Standard Specification for Concrete Aggregates 2013.
- L. ASTM C39/C39M Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens 2015a.
- M. ASTM C94/C94M Standard Specification for Ready-Mixed Concrete 2015.
- N. ASTM C150/C150M Standard Specification for Portland Cement 2015.
- O. ASTM C173/C173M Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method 2014.
- P. ASTM C260/C260M Standard Specification for Air-Entraining Admixtures for Concrete 2010a.

- Q. ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete 2011.
- R. ASTM C494/C494M Standard Specification for Chemical Admixtures for Concrete 2013.
- S. ASTM C685/C685M Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing 2014.
- T. ASTM D1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) 2004 (Reapproved 2013).
- U. ASTM D1752 Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction 2004a (Reapproved 2013).

1.04 SUBMITTALS

- A. See Division 1 Sections for submittal procedures.
- B. Product Data: Provide data on joint filler, fiber reinforcement, admixtures, fiber reinforcement, curing compound, fiber reinforcement and fiber reinforcement.
- C. Installer qualifications using Fiber reinforcement in finished, exterior concrete pavement.
- D. Design Data: Indicate pavement thickness, designed concrete strength, reinforcement, and typical details.
- E. Samples: Pint size bag of each type of reinforcing fibers with manufacturers information included.

PART 2 PRODUCTS

2.01 FORM MATERIALS

- A. Form Materials: As specified in Section 031000, conform to ACI 301.
- B. Joint Filler: Preformed; non-extruding bituminous type (ASTM D1751) or sponge rubber or cork (ASTM D1752).
 - 1. Thickness: 3/8 inch.

2.02 **REINFORCEMENT**

- A. Reinforcing Steel: ASTM A615/A615M, Grade 80 (80,000 psi) yield strength; deformed billet steel bars; unfinished.
- B. Steel Welded Wire Reinforcement: Plain type, ASTM A1064/A1064M; in flat sheets; unfinished.
- C. Bar Dowels: Heavy Duty Concrete ASTM A615/A615M Grade 40 (280); deformed billet steel bars; unfinished finish.
- D. Plate Dowels: Light and Medium Duty Concrete ASTM A36 steel plates with electroplated zinc coating meeting ASTM B633 Type II. Plate sizes and spacing to meet specified concrete thickness.

2.03 CONCRETE MATERIALS

- A. Obtain cementitious materials from same source throughout.
- B. Concrete Materials: Provide in accordance with State of Kentucky Highways standards.
- C. Cement: ASTM C150/C150M, Normal Type I Portland cement, gray color.
- D. Fine and Coarse Mix Aggregates: ASTM C33/C33M.
- E. Water: Clean, and not detrimental to concrete.
- F. Fiber Reinforcement: Shrinkage crack control, micro synthetic, fibrilated, polypropylene fibers shown to have long-term resistance to deterioration when in contact with alkalis and moisture; 3/4 to 1 inch length and designed to reduce shrinkage cracking of concrete.

- 1. Acceptable Products:
 - a. PSI FIBERSTRAND F by Euclid Chemical
 - b. Procon F-E by Nycon Corporation
 - c. Fibermesh 300 by Propex Operating Company
 - d. Econo-Net by Forta Corporation
- G. Air-Entraining Admixtures: ASTM C260/C260M.
- H. Chemical Admixtures: ASTM C494/C494M, Type A Water Reducing.
 - 1. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.

2.04 ACCESSORIES

- A. Curing Compound: ASTM C309, Type 1, Class A.
- B. Curing Compound:
 - 1. Sonneborn's Sonosil
 - 2. L&M's L&M Cure
 - 3. Dayton Superior's Day Chem Sil-Cure (J-13)
- C. Tactile Warning Surfaces: See Section 321726.
- D. Joint Sealer: Type as specified in Section 321373.

2.05 CONCRETE MIX DESIGN

- A. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.
- B. Micro Fiber Reinforcement: Add to mix at rate of 1.5 pounds per cubic yard, or as recommended by manufacturer for specific project conditions. Fiber is to be added at the plant after all other materials have been added, and have a minimum mix time of 5-minutes..
- C. Concrete Properties:
 - 1. Compressive strength (prior to fiber), when tested in accordance with ASTM C39/C39M at 28 days; 4500 psi. Testing of the concrete mix prior to adding fiber and again after fiber has been added is required to set the compressive strength requirement for fiber reinforced concrete. This should be done for the first pour of each mix design and the results used to confirm future pours.
 - 2. Cement Content: Minimum 600 lb per cubic yard.
 - 3. Water-Cement Ratio: Maximum 0.44 percent by weight.
 - 4. Total Air Content: 6 percent +/- 1%, determined in accordance with ASTM C 173/C 173M.
 - 5. Maximum Slump: 4 inches using base design, 5 inches when using fiber and mid-range water reducer, 6 inches when using a mid-range water reducer, +/- 1-inch.
 - 6. Maximum Aggregate Size: 1 inch.

2.06 MIXING

- A. Transit Mixers: Comply with ASTM C94/C94M.
- B. Do not add water to the mix once the truck has left the concrete plant.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.

3.02 SUBBASE

A. See Section 321123 for construction of base course for work of this Section.

3.03 PREPARATION

- A. Moisten base to minimize absorption of water from fresh concrete.
- B. Coat surfaces of manhole frames with oil to prevent bond with concrete pavement.
- C. When using Macro Fiber reinforcement, a representative of the fiber manufacturer must be on-site during the first pour and finishing process.

3.04 FORMING

- A. Place and secure forms to correct location, dimension, profile, and gradient.
- B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
- C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.05 REINFORCEMENT

- A. Place reinforcement as indicated and per the manufacturers recommendations.
- B. Provide doweled joints at all isolation joints with one end of dowel set in capped sleeve to allow longitudinal movement.

3.06 COLD AND HOT WEATHER CONCRETING

- A. Follow recommendations of ACI 305R when concreting during hot weather.
- B. Follow recommendations of ACI 306R when concreting during cold weather.
- C. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

3.07 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
- B. Do not add water to concrete.
- C. Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.
- D. Place concrete continuously over the full width of the panel and between predetermined construction joints as shown on the plans. Do not break or interrupt successive pours such that cold joints occur.
- E. Place concrete to indicated pattern.

3.08 **JOINTS**

- A. Align curb, gutter, and sidewalk joints.
- B. Place 3/8 inch wide isolation joints at 20 foot intervals and to separate paving from vertical surfaces and other components and in pattern indicated.
 - 1. Form joints with joint filler extending from bottom of pavement to within 1/2 inch of finished surface.

- 2. Secure to resist movement by wet concrete.
- C. Provide tooled contraction control joints:
 - 1. In pattern shown on drawings.
- D. Heavy Duty Concrete Areas Saw cut the tooled contraction joints to a 3/16 inch wide at an optimum time after finishing. Cut 1/3 into depth of slab. Do not cut reinforcement.

3.09 FINISHING

- A. Area Paving: Light broom, texture perpendicular to pavement direction.
- B. Sidewalk Paving: Light broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4 inch radius. Remove tooling marks to prevent a picture frame effect.
- C. Remove "slop" created by the concrete finishing from all joints and edges.
- D. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

3.10 JOINT SEALING

A. See Section 321373 for joint sealer requirements.

3.11 TOLERANCES

- A. Maximum Variation of Surface Flatness: 1/4 inch in 10 ft.
- B. Maximum Variation From True Position: 1/4 inch.

3.12 FIELD QUALITY CONTROL

- A. Allow the independent testing agency to perform field quality control tests, as specified in Division 1.
 - 1. Provide free access to concrete operations at project site and cooperate with appointed firm.
 - 2. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
 - 3. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.
- B. Compressive Strength Tests: ASTM C39/C39M; for each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cu yd or less of each class of concrete placed.
 - 1. Test fiber reinforced concrete prior to the addition of fiber and again after fiber has been added to set the baseline for the fiber reinforced compressive strength, slump and air content. This is to be done for the first pour of each mix design, and the results used for later pour strength requirements.
 - 2. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
 - 3. Perform one slump test and one air content test for each set of test cylinders taken.
- C. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken. All test reports are to by typed.
- D. Any tests or time limits that do not meet the specified requirements are to be reported to the Contractor and that concrete shall be considered unacceptable.

3.13 PROTECTION

A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.

- B. Do not permit pedestrian traffic over pavement for 2 days minimum after finishing.
- C. Do not permit vehicular traffic over pavement until 75 percent design strength of concrete has been achieved.
- D. All pavements that are soiled or otherwise dirty are to be pressure washed and rinsed upon completion of the construction and landscaping work.

SECTION 321373 - PAVEMENT JOINT SEALANTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Expansion and contraction joints within cement concrete pavement.
 - 2. Joints between cement concrete and asphalt pavement.
 - 3. Joints between cement concrete or asphalt pavement and adjacent structures.
- B. Related Sections include the following:
 - 1. Section 321216 Asphalt Paving
 - 2. Section 321313 Concrete Paving: constructing joints in concrete pavement.
 - 3. Section 321613 Concrete Curbs and Gutters

1.03 SUBMITTALS

- A. Product Data: For each joint sealant product indicated.
- B. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.
- C. Qualification Data: For Installer.
- D. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint sealant backings have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for sealants.

1.04 **QUALITY ASSURANCE**

- A. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- B. Preconstruction Compatibility and Adhesion Testing: Submit to joint sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
 - 1. Use ASTM C 1087 or manufacturer's standard test methods to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 - 2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint sealant backings, secondary seals, and miscellaneous materials.
 - 3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 - 4. For materials failing tests, obtain joint sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
 - 5. Testing will not be required if joint sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility

with, joint substrates and other materials matching those submitted.

- C. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency based on testing of current sealant products within a 36-month period preceding the Notice to Proceed with the Work.
 - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 for testing indicated, as documented according to ASTM E 548.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.06 **PROJECT CONDITIONS**

- A. All expansion, isolation and cold joints, including those in concrete curbs, are to receive joint sealant.
- B. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer.
 - 2. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 deg F (4.4 deg C), whichever is higher.
 - 3. When joint substrates are wet or covered with frost.
 - 4. Where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
 - 5. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.02 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint sealant manufacturer based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.03 COLD-APPLIED JOINT SEALANTS

- A. Type S, Grade NS, Class 25 Polyurethane Sealant for Concrete: Single-component, low-modulus, neutral-curing, nonsag urethane sealant complying with ASTM C920
 - 1. Sikaflex-1a
 - 2. Bostik Seal 'N' Flex FC
 - 3. Tremco Vulkem 116

2.04 JOINT SEALANT BACKER MATERIALS

Pavement Joint Sealants
- A. General: Provide joint sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint sealant manufacturer based on field experience and laboratory testing.
- B. Backer Strips for Cold- and Hot-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.05 **PRIMERS**

A. Primers: Product recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint sealant substrate tests and field tests.

PART 3- EXECUTION

3.01 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint sealant performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 **PREPARATION**

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates as recommended by joint sealant manufacturer, based on preconstruction joint sealant substrate tests. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.03 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install backer materials of type indicated to support sealants during application and at position required to produce cross sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of backer materials.
 - 2. Do not stretch, twist, puncture, or tear backer materials.
 - 3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses provided for each joint configuration.
 - 3. Produce uniform, cross sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

- E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealants from surfaces adjacent to joint.
 - 2. Use tooling agents that are approved in writing by joint sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint sealant manufacturer's written instructions, unless otherwise indicated.
- G. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.04 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.05 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations with repaired areas are indistinguishable from the original work.
- B. Apply clean, white, silica sand dusting to the finished tooled surface of the joint sealant to help prevent tracking of the material.

SECTION 321613 - CONCRETE CURBS AND GUTTERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete header curbs, curbs and gutters.

1.02 RELATED REQUIREMENTS

- A. Section 312200 Grading: Preparation of site for paving and base and preparation of subsoil at pavement perimeter for planting.
- B. Section 312323 Fill: Compacted subbase for paving.
- C. Section 321123 Aggregate Base Courses: DGA base course.
- D. Section 321373 Joint Sealers: Sealant for joints.

1.03 REFERENCE STANDARDS

- A. ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; American Concrete Institute International; 1991 (Reapproved 2002).
- B. ACI 301 Specifications for Structural Concrete for Buildings; American Concrete Institute International; 2005.
- C. ACI 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International; 2000.
- D. ACI 305R Hot Weather Concreting; American Concrete Institute International; 1999.
- E. ACI 306R Cold Weather Concreting; American Concrete Institute International; 1988 (Reapproved 2002).
- F. ASTM A 615/A 615M Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 2007.
- G. ASTM C 33 Standard Specification for Concrete Aggregates; 2007.
- H. ASTM C 39/C 39M Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2005.
- I. ASTM C 94/C 94M Standard Specification for Ready-Mixed Concrete; 2007.
- J. ASTM C 150 Standard Specification for Portland Cement; 2007.
- K. ASTM C 173/C 173M Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2008a.
- L. ASTM C 260 Standard Specification for Air-Entraining Admixtures for Concrete; 2006.
- M. ASTM C 309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2007.
- N. ASTM C 494/C 494M Standard Specification for Chemical Admixtures for Concrete; 2008a.
- O. ASTM C 618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2008a.
- P. ASTM C 685/C 685M Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2007.
- Q. ASTM D 1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (nonextruding and Resilient Bituminous Types); 2004 (Reapproved 2008).

R. ASTM D 1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction; 2004a (Reapproved 2008).

1.04 SUBMITTALS

- A. See Division 1 Sections for submittal procedures.
- B. Product Data: Provide data on joint filler, admixtures, curing compound and fiber reinforcement.
- C. Installer qualifications using Macro Fiber reinforcement in finished, exterior concrete.
- D. Design Data: Indicate curb/gutter thickness, designed concrete strength, reinforcement, and typical details. Separate mix designs are required for conventionally formed concrete and machine placed or slip-formed concrete.
- E. Samples: Pint size bag of each type of reinforcing fibers with manufacturers information included.

PART 2 PRODUCTS

2.01 FORM MATERIALS

- A. Form Materials: Conform to ACI 301 and as follows.
- B. Steel forms with self-aligning joints designed to withstand the lateral and vertical loads associated with the concrete placement. Form sections are to be a minimum of 10-feet in length for runs that are 10-feet or longer in length.
- C. Joint Filler: Preformed; non-extruding bituminous type (ASTM D 1751) or sponge rubber or cork (ASTM D 1752).
 - 1. Thickness: 3/8 inch.

2.02 **REINFORCEMENT**

- A. Reinforcing Steel: ASTM A 615/A 615M Grade 40 (280); deformed billet steel bars; unfinished finish.
- B. Steel Welded Wire Reinforcement: Plain type, ASTM A 185/A 185M; in flat sheets; unfinished.
- C. Dowels: ASTM A 615/A 615M Grade 40 (280); deformed billet steel bars; unfinished finish.

2.03 CONCRETE MATERIALS

- A. Obtain cementitious materials from same source throughout.
- B. Concrete Materials: Provide in accordance with State of Kentucky Highways standards.
- C. Cement: ASTM C 150 Air Entraining Type IA portland type, grey color.
- D. Fine and Coarse Mix Aggregates: ASTM C 33.
- E. Fly Ash: ASTM C 618, Class F Optional for mixes used for slip forming of curb and gutter, or slip forming of concrete pavements. Fly ash is not to be used in concrete that is not slip formed or extruded..
- F. Water: Clean, and not detrimental to concrete.
- G. Fiber Reinforcement: Structural, macro synthetic, fibrilated, polypropylene fibers shown to have longterm resistance to deterioration when in contact with alkalis and moisture; 1.5 to 2 inch length and manufactured to provide post-cure concrete strength and increase freeze/thaw resistance.
 - 1. Acceptable Products:
 - a. TUF-STRAND SF by Euclid Chemical
 - b. Nycon-XL200 by Nycon Corporation

- c. Fibermesh 650 by Propex Operating Company
- d. Forta-Ferro by Forta Corporation
- H. Air Entrainment Admixture: ASTM C 260.
- I. Chemical Admixtures: ASTM C 494/C 494M, Type A Water Reducing.
 - 1. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.

2.04 ACCESSORIES

- A. Curing Compound: ASTM C 309, Type 1, Class A.
- B. Joint Sealer: Type as specified in Section 321373.

2.05 CONCRETE MIX DESIGN

- A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
- B. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.
- C. Macro Fiber Reinforcement: Add to mix at rate of 7 pounds per cubic yard, or as recommended by manufacturer for specific project conditions. Fiber is to be added at the plant after all other materials have been added, and have a minimum mix time of 5-minutes.
- D. Concrete Properties:
 - Compressive Strength (prior to adding fiber), when tested in accordance with ASTM C 39/C 39M at 28 days: 4500 psi. Testing of the concrete mix prior to adding fiber and again after fiber has been added is required to set the compressive strength requirement for fiber reinforced concrete. This should be done for the first pour of each mix design and the results used to confirm future pours.
 - 2. Fly Ash Content: Maximum 15 percent of cementitious materials by weight.
 - 3. Cement Content: Minimum 600 lb per cubic yard.
 - 4. Water-Cement Ratio: Maximum 0.44 percent by weight.
 - 5. Total Air Content: 6 percent +/- 1%, determined in accordance with ASTM C 173/C 173M.
 - 6. Maximum Slump: 4 inches using base design, 5 inches when using fiber and mid-range water reducer, 6 inches when using a mid-range water reducer, +/- 1-inch.
 - 7. Maximum Aggregate Size: 1 inch.

2.06 MIXING

A. Transit Mixers: Comply with ASTM C 94/C 94M.

B. Do not add water to the mix once the truck has left the concrete plant.

PART 3 EXECUTION

3.01 **EXAMINATION**

- A. Verify compacted subgrade is acceptable and ready to support imposed loads.
- B. Verify gradients and elevations of base are correct.

3.02 SUBBASE

A. See Section 321123 for construction of base course for work of this Section.

3.03 **PREPARATION**

- A. Moisten base to minimize absorption of water from fresh concrete.
- B. Coat surfaces of storm structure frames with oil to prevent bond with concrete curb/gutter.
- C. Notify Architect minimum 24 hours prior to commencement of concreting operations. Architect is to review and approve sample pours prior to installation of permanent concrete.

3.04 FORMING

- A. Place and secure forms to correct location, dimension, profile, and gradient.
- B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
- C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.
- D. Slip forming can be used for curb and gutter combinations. The slip form machine shall be selfpropelled and designed to place, consolidate and finish the concrete in one pass, and be adjustable to install gutter lines that slope away from the curb where required.

3.05 REINFORCEMENT

- A. Place reinforcement as indicated.
- B. Use fiber reinforcement for all concrete.
- C. Provide doweled joints as indicated with one end of dowel set in capped sleeve to allow longitudinal movement.

3.06 COLD AND HOT WEATHER CONCRETING

- A. Follow recommendations of ACI 305R when concreting during hot weather.
- B. Follow recommendations of ACI 306R when concreting during cold weather.
- C. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

3.07 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
- B. Do not place concrete when base surface is wet.
- C. Concrete can be placed using the slip form technique. If slip forming is used, fiber-reinforced concrete shall be used.
- D. Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.
- E. Place concrete continuously over the full length of the run and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.
- F. Place expansion joints at the beginning and ending of each pour.
- G. Place expansion joints at the beginning and ending of each pour. Place control joints concrete to indicated pattern.

3.08 JOINTS

- A. Align curb, gutter, and sidewalk joints.
- B. Place 3/8 inch wide expansion joints at 40 foot intervals and to separate curb and gutter from adjacent sidewalks, vertical surfaces and other components.

- 1. Form joints with joint filler extending from bottom of pavement to within 1/2 inch of finished surface.
- 2. Secure to resist movement by wet concrete.
- C. Provide sawcut contraction control joints every 8-feet. Where the curb is adjacent to a sidewalk, install contraction joints that align with the sidewalk joints with spacing between 8-feet and 10-feet.
- D. Provide tooled contraction joints between curbs/gutters and adjacent traffic duty pavements.
- E. At 90-degree curb corners, the contraction joint is to be cut parallel to the traffic lane. Diagonal cuts at 90-degree corners are not acceptable.

3.09 FINISHING

- A. Curbs and Gutters: Uniform float finish and round edges. Correct all honeycombed areas by filling with mortar. Do not plaster. Finish the top and face while the concrete is plastic by wetting and rubbing with a carborundum brick. Finish the face of header curbs to 4-inches below the finished ground line. Provide uniform texture and color.
- B. Remove "slop" created by the concrete finishing from all joints and edges.
- C. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.
- D. Exposed macro fibers are to be removed using a propane torch and stiff brush after a minimum of 56days curing of the concrete . Care should be taken to not overheat the concrete and cause it to be discolored, damaged or lose strength.

3.10 JOINT SEALING

A. All expansion joints are to be sealed. See Section 321373 for joint sealer requirements.

3.11 TOLERANCES

- A. Maximum Variation of Surface Flatness and Face Alignment: 1/4 inch in 10 ft.
- B. Maximum Variation From True Position: 1/4 inch.

3.12 FIELD QUALITY CONTROL

- A. Allow an independent testing agency to perform field quality control tests, as specified in Division 1.
 - 1. Provide free access to concrete operations at project site and cooperate with appointed firm.
 - 2. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
 - 3. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.
- B. Compressive Strength Tests: ASTM C 39/C 39M. For each test, mold and cure four concrete test cylinders. Obtain test samples for every 25 cu yd or less of each class of concrete placed.
 - 1. Test fiber reinforced concrete prior to the addition of fiber and again after fiber has been added to set the baseline for the fiber reinforced compressive strength, slump and air content. This is to be done for the first pour of each mix design, and the results used for later pour strength requirements.
 - 2. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
 - 3. Perform one slump test and one air content test for each set of test cylinders taken.

- C. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken. All test reports are to by typed.
- D. Any tests or time limits that do not meet the specified requirements are to be reported to the Contractor and that concrete shall be considered unacceptable.

3.13 **PROTECTION**

- A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.
- B. Do not permit pedestrian traffic into curb/gutter area for 2 days minimum after finishing.
- C. Do not permit vehicular traffic into curb/gutter area until 75 percent design strength of concrete has been achieved.
- D. All concrete curb/gutter that is soiled or otherwise dirty are to be pressure washed and rinsed upon completion of the construction and landscaping work.

SECTION 321713 - PARKING BUMPERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Precast concrete parking bumpers and anchorage.

1.02 RELATED REQUIREMENTS

- A. Section 321216 Asphalt Paving.
- B. Section 321313 Concrete Paving.

1.03 REFERENCE STANDARDS

- A. ASTM A615/A615M Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement 2015.
- B. ASTM C150/C150M Standard Specification for Portland Cement 2015.
- C. ASTM C260/C260M Standard Specification for Air-Entraining Admixtures for Concrete 2010a.
- D. ASTM C330/C330M Standard Specification for Lightweight Aggregates for Structural Concrete 2017a.

1.04 SUBMITTALS

- A. See Division 1 Sections for submittal procedures.
- B. Product Data: Provide unit configuration, dimensions.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Parking Bumpers: Precast concrete, conforming to the following:
 - 1. Nominal Size: 6 inches high, 9 inches wide, 6 feet long.
 - 2. Cement: ASTM C150/C150M, Portland Type I Normal; white color.
 - 3. Concrete Materials: ASTM C330/C330M aggregate, water, and sand.
 - 4. Reinforcing Steel: ASTM A615/A615M, deformed steel bars; unfinished, strength and size commensurate with precast unit design.
 - 5. Air Entrainment Admixture: ASTM C260/C260M.
 - 6. Concrete Mix: Minimum 5,000 psi compressive strength after 28 days, air entrained to 5 to 7 percent.
 - 7. Use rigid molds, constructed to maintain precast units uniform in shape, size and finish. Maintain consistent quality during manufacture.
 - 8. Embed reinforcing steel, and drill or sleeve for two dowels.
 - 9. Cure units to develop concrete quality, and to minimize appearance blemishes such as nonuniformity, staining, or surface cracking.
 - 10. Minor patching in plant is acceptable, providing appearance of units is not impaired.
- B. Dowels: Steel, galvanized finish; 1/2 inch diameter, 16 inch long, pointed tip.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install units without damage to shape or finish. Replace or repair damaged units.

- B. Install units in alignment with adjacent work.
- C. Fasten units in place with 2 dowels per unit.

SECTION 321723.13 - PAINTED PAVEMENT MARKINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Parking lot markings, including parking bays, crosswalks, arrows and handicapped symbols.
- B. Roadway lane markings and crosswalk markings.

1.02 RELATED REQUIREMENTS

- A. Section 321216 Asphalt Paving.
- B. Section 321313 Concrete Paving.

1.03 REFERENCE STANDARDS

- A. MPI (APL) Master Painters Institute Approved Products List; Master Painters and Decorators Association current edition, www.paintinfo.com.
- B. FHWA MUTCD Manual on Uniform Traffic Control Devices for Streets and Highways; U.S. Department of Transportation, Federal Highway Administration Current Edition.

1.04 SUBMITTALS

- A. See Division 1 Sections for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
 - 4. Manufacturer's Testing: Perform testing for Daytime and Nighttime Color, Contrast Ratio, Titanium Dioxide (white paints) and Volatile Organic Content (VOC) on each lot of waterborne acrylic paint to be delivered for use on projects.
 - Certification: Submit manufacturer's certification stating conformance to the requirements of this section for each shipment of waterborne acrylic paint delivered for use on projects. Clearly state the manufacturer, product name, product code, lot number(s), expiration date, color sampling method, test results of manufacturer required testing, and quantity delivered.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver paint in containers of at least 5 gallons accompanied by batch certificate.
- B. Store products in manufacturer's unopened packaging until ready for installation.
- C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.06 FIELD CONDITIONS

A. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Line and Zone Marking Paint: MPI (APL) No. 97 Latex Traffic Marking Paint; color(s) as indicated.
 - 1. Parking Lot Striping:
 - a. White for typical parking spaces

- b. Yellow for no parking areas
- c. Blue for ADA accessible parking and unloading areas
- 2. ADA Parking Symbols: Blue and white per the drawings.
- 3. Substitutions: See Section 016000 Product Requirements.
- B. Temporary Marking Tape: Preformed, reflective, pressure sensitive adhesive tape in color(s) required; Contractor is responsible for selection of material of sufficient durability as to perform satisfactorily during period for which its use is required.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 **PREPARATION**

- A. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- B. Clean surfaces thoroughly prior to installation.
 - 1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.
- C. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.
- D. Establish survey control points to determine locations and dimensions of markings; provide templates to control paint application by type and color at necessary intervals.
- E. Temporary Pavement Markings: When required or directed by Architect, apply temporary markings of the color(s), width(s) and length(s) as indicated or directed.
 - 1. After temporary marking has served its purpose, remove temporary marking by carefully controlled sandblasting, approved grinding equipment, or other approved method so that surface to which the marking was applied will not be damaged.
 - 2. At Contractor's option, temporary marking tape may used in lieu of temporary painted marking; remove unsatisfactory tape and replace with painted markings at no additional cost to Owner.

3.03 INSTALLATION

- A. Begin pavement marking as soon as practicable after surface has been cleaned and dried.
- B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F or more than 95 degrees F.
- C. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.
- D. Comply with FHWA MUTCD manual (http://mutcd.fhwa.dot.gov) for details not shown.
- E. Apply markings in locations determined by measurement from survey control points; preserve control points until after markings have been accepted.

- F. Apply uniformly painted markings of color(s), lengths, and widths as indicated on the drawings true, sharp edges and ends. Standard lane and parking striping widths are 4-inches unless identified otherwise. Standard painted stop bars are 12-inches wide.
 - 1. Apply paint in one coat only.
 - 2. Wet Film Thickness: 0.015 inch, minimum. If asphalt pavement can be seen through the paint, or if voids in the pavement are not filled, additional coat(s) will be required.
 - 3. Width Tolerance: Plus or minus 1/8 inch.
- G. Roadway Traffic Lanes: Use suitable mobile mechanical equipment that provides constant agitation of paint and travels at controlled speeds.
 - 1. Conduct operations in such a manner that necessary traffic can move without hindrance.
 - 2. Place warning signs at the beginning of the wet line, and at points well in advance of the marking equipment for alerting approaching traffic from both directions. Place small flags or other similarly effective small objects near freshly applied markings at frequent intervals to reduce crossing by traffic.
 - 3. If paint does not dry within expected time, discontinue paint operations until cause of slow drying is determined and corrected.
 - 4. Skip Markings: Synchronize one or more paint "guns" to automatically begin and cut off paint flow; make length of intervals as indicated.
 - 5. Use hand application by pneumatic spray for application of paint in areas where a mobile paint applicator cannot be used.
- H. Parking Lots: Apply parking space lines, entrance and exit arrows, painted curbs, and other markings indicated on drawings.
 - 1. Mark the International Handicapped Symbol at indicated parking spaces (blue background with white symbol).
 - 2. Hand application by pneumatic spray is acceptable.
- I. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

3.04 DRYING, PROTECTION, AND REPLACEMENT

- A. Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.
- B. Provide barricades, warning signs, and flags as necessary to prevent traffic crossing newly painted markings.
- C. Allow paint to dry at least the minimum time specified by the applicable paint standard and not less than that recommended by the manufacturer.
- D. Remove and replace markings that are applied at less than minimum material rates; deviate from true alignment; exceed length and width tolerances; or show light spots, smears, or other deficiencies or irregularities.
- E. Remove markings in manner to avoid damage to the surface to which the marking was applied, using carefully controlled sand blasting, approved grinding equipment, or other approved method.
- F. Replace removed markings at no additional cost to Owner.

SECTION 321726 - TACTILE WARNING SURFACING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Plastic tactile and detectable warning tiles for pedestrian walking surfaces.

1.02 RELATED REQUIREMENTS

A. Section 321313 - Concrete Paving: Concrete sidewalks.

1.03 REFERENCE STANDARDS

- A. 36 CFR 1191 Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
- B. 49 CFR 37 Transportation Services for Individuals with Disabilities (ADA) current edition.
- C. AASHTO LRFD Bridge Design Specifications, Customary U.S. Units (6th Edition) 2012.
- D. ADA Standards Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.
- E. ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.
- F. ASTM B117 Standard Practice for Operating Salt Spray (Fog) Apparatus 2011.
- G. ASTM C501 Standard Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser 1984 (Reapproved 2009).
- H. ASTM C903 Standard Practice for Preparing Refractory Castable Specimens by Cold Gunning 2010.
- I. ASTM D2047 Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine 2011.
- J. ASTM D2047 Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine 2011.
- K. ASTM D543 Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents 2014.
- L. ASTM D570 Standard Test Method for Water Absorption of Plastics 1998 (Reapproved 2010).
- M. ASTM D638 Standard Test Method for Tensile Properties of Plastics 2014.
- N. ASTM D695 Standard Test Method for Compressive Properties of Rigid Plastics 2010.
- O. ASTM D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials 2010.
- P. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials 2015a.
- Q. ASTM G155 Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials 2013.
- R. ATBCB PROWAG Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Rightof-Way 2011.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturer's product data, standard details, details specific to this project; written installation and maintenance instructions.

- C. Samples: For each product specified provide two samples, 8 inches square, minimum; show actual product, color, and patterns.
- D. Shop Drawings: Submit plan and detail drawings. Indicate:
 - 1. Locations on project site. Demonstrate compliance with referenced accessibility standards.
 - 2. Sizes and layout.
 - 3. Pattern spacing and orientation.
 - 4. Attachment and fastener details, if applicable
- E. Warranty: Submit manufacturer warranty; complete forms in Owner's name and register with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years documented experience.
- B. Installer Qualifications: Company certified in writing by product manufacturer as having successfully completed work substantially similar to the work of this section.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver to project site in manufacturer's protective wrapping and in manufacturer's unopened packaging.
- B. Store covered and elevated above grade and in manufacturer's unopened packaging until ready for installation. Maintain at ambient temperature between 40 and 90 degrees F.

1.07 WARRANTY

- A. See Section 017800 Closeout Submittals, for additional warranty requirements.
- B. Plastic Tiles: Provide manufacturer's standard five year warranty against manufacturing defects, breakage or deformation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Plastic Tactile and Detectable Warning Surface Tiles:
 - 1. Basis of Design: Armor-Tile, a brand of Engineered Plastics, Inc: www.armortiletransit.com.
 - 2. Substitutions: See Section 016000 Product Requirements.

2.02 TACTILE AND DETECTABLE WARNING DEVICES

- A. Plastic Tactile and Detectable Warning Tiles: ADA Standards compliant, glass fiber and carbon fiber reinforced, exterior grade, matte finish polyester sheet with truncated dome pattern, solid color throughout, internal reinforcing of sheet and of truncated domes, integral radius cut lines on back face of tile; with factory applied removable protective sheeting.
 - 1. Material Properties:
 - a. Water Absorption: 0.20 percent, maximum, when tested in accordance with ASTM D570.
 - b. Slip Resistance: 0.50 minimum dry static coefficient of friction, when tested in accordance with ASTM D2047.
 - c. Compressive Strength: 25,000 pounds per square inch, minimum, when tested in accordance with ASTM D695.

Tactile Warning Surfacing

- d. Tensile Strength: 10,000 pounds per square inch, minimum, when tested in accordance with ASTM D638.
- e. Flexural Strength: 25,000 pounds per square inch minimum, when tested in accordance with ASTM D790.
- f. Chemical Stain Resistance: No reaction to 1 percent hydrochloric acid, motor oil, calcium chloride, gum, soap solution, bleach, or antifreeze, when tested in accordance with ASTM D543.
- g. Abrasion Resistance: 300, minimum, when tested in accordance with ASTM C501.
- h. Flame Spread Index: 25, maximum, when tested in accordance with ASTM E84.
- i. Accelerated Weathering: Delta-E of less than 5.0 at 2,000 hours exposure, when tested in accordance with ASTM G155.
- j. Adhesion: No delamination of tile prior to board failure in a temperature range of 20 to 180 degrees F, when tested in accordance with ASTM C903.
- k. Loading: No damage when tested according to AASHTO LRFD test method HS20.
- 1. Salt and Spray Performance: No deterioration or other defect after 200 hours of exposure, when tested in accordance with ASTM B117.
- 2. Installation Method: Cast in place replaceable.
- 3. Shape: Rectangular.
- 4. Dimensions: 24 inches by width of walk or minimum 36 inches.
- 5. Pattern: In-line pattern of truncated domes complying with ADA Standards.
- 6. Edge: Square.
- 7. Joint: Butt.
- 8. Color: As selected by Architect from manufacturer's standard range.
- 9. Products:
 - a. Armor-Tile, a brand of Engineered Plastics, Inc; Product Herculite Series: www.armor-tile.com.
 - b. Substitutions: See Section 016000 Product Requirements.

2.03 ACCESSORIES

- A. Fasteners: ASTM A666, Type 304 stainless steel
 - 1. Type: Countersunk, color matched composite sleeve anchors
 - 2. Size: 1/4 inch diameter and 1-1/2 inches long.
- B. Adhesive: Type recommended and approved by surfacing tile manufacturer.
- C. Sealant: Elastomeric sealant of color to match adjacent surfaces; approved by surfacing tile manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. When installation location is near site boundary or property line, verify required location using property survey.
- B. Verify that work area is ready to receive work:

- 1. Examine work area with installer present.
- 2. If existing conditions are not as required to properly complete the work of this section, notify Architect.
- 3. Do not proceed with installation until deficiencies in existing conditions have been corrected.
- C. Verify that dimensions, tolerances, and attachment methods for work in this section are properly coordinated with other work on site.

3.02 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's written instructions.
 - 1. Do not install damaged, warped, bowed, dented, abraded, or otherwise defective units.
 - 2. Do not install when ambient or substrate temperature has been below 40 degrees F during the preceding 8 daylight hours.
- B. Field Adjustment:
 - 1. Cut units to size and configuration shown on drawings.
 - 2. Do not cut plastic tiles to less than 9 inches wide in any direction.
 - 3. Locate relative to curb line in compliance with ATBCB PROWAG, Sections 304 and 305.
 - 4. Orient so dome pattern is aligned with the direction of ramp.
 - 5. Align truncated dome pattern between adjacent units.
- C. Install units fully seated to substrate, square to straight edges and flat to required slope.
- D. Align units so that tops of adjacent units are flush and joints between units are uniform in width.

3.03 INSTALLATION, CAST IN PLACE PLASTIC TILES

- A. Concrete:
 - 1. See Section 321313.
- B. Tamp and vibrate units as recommended by manufacturer.
- C. Place and position weights on units while concrete cures as recommended by manufacturer. Ensure no voids or air pockets exist between top surface of concrete and underside of units.

3.04 CLEANING PLASTIC UNITS

- A. Remove protective plastic sheeting within 24 hours of installation.
- B. Remove excess sealant or adhesive from joints and edges.
- C. Clean 4 days prior to date of scheduled inspection.

3.05 PROTECTION

- A. Protect installed units from traffic, subsequent construction operations or other imposed loads until concrete is fully cured.
- B. Touch-up, repair or replace damaged products prior to Date of Substantial Completion.

SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Posts, rails, and frames.
- B. Wire fabric.
- C. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 033000 Cast-in-Place Concrete: Concrete anchorage for posts.
- B. Section 087100 Door Hardware: Gate locking device.
- C. Section 337900 Site Grounding.

1.03 **REFERENCE STANDARDS**

- A. ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2015.
- B. ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2009.
- C. ASTM A428/A428M Standard Test Method for Weight (Mass) of Coating on Aluminum-Coated Iron or Steel Articles 2010 (Reapproved 2014).
- D. ASTM A491 Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric 2011 (Reapproved 2017).
- E. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2015.
- F. ASTM C94/C94M Standard Specification for Ready-Mixed Concrete 2018.
- G. ASTM F567 Standard Practice for Installation of Chain-Link Fence 2014a.
- H. ASTM F1043 Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework 2014.
- I. ASTM F1083 Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures 2013.
- J. CLFMI CLF-SFR0111 Security Fencing Recommendations 2014.
- K. CLFMI CLF 2445 Product Manual 1997.

1.04 SUBMITTALS

- A. See Division 1 Sections for submittal procedures.
- B. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.
- C. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components. See CLFMI CLF-SFR0111 for planning and design recommendations.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

B. Installer Qualifications: Company specializing in installation of products specified in this section with not less than three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Chain Link Fences and Gates:
 - 1. Master-Halco, Inc.: www.masterhalco.com.
 - 2. Merchants Metals: www.merchantsmetals.com.
 - 3. Stephens Pipe and Steel: www.spsfence.com
 - 4. Capitol Wholesale: www.capitolwholesale.com
 - 5. Substitutions: See Section 016000 Product Requirements.

2.02 MATERIALS AND COMPONENTS

A. Materials and Components: Conform to CLFMI CLF 2445.

2.03 MATERIALS

- A. Posts, Rails, and Frames:
- B. See Finishes Section for additional coatings/finish information
- C. Posts, Rails, and Frames: ASTM F1083 Schedule 40 hot-dipped galvanized steel pipe, welded construction, minimum yield strength of 30 ksi.
- D. Formed from hot-dipped galvanized steel sheet, ASTM A653/A653M, HSLAS, Grade 50, with G90 (Z275) zinc coating.
- E. Wire Fabric:
 - 1. ASTM A392 zinc coated ASTM A392 zinc coated steel chain link fabric.
- F. Type specified in Section 033000.

2.04 COMPONENTS

- A. Gate Posts: 4 inch diameter.
- B. Gate Frame: 1.9 inch diameter for welded fabrication.
- C. Fabric: 2 inch diamond mesh interwoven wire, 6 gage thick, top selvage knuckle end closed, bottom selvage twisted tight. All fabric to be Aluminum Coated Steel Fabric (Aluminized): ASTM A491.

2.05 ACCESSORIES

- A. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.
- B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; steel.
- C. Hardware for Single Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches high, 3 for taller gates; fork latch with gravity drop and padlock hasp; keeper to hold gate in fully open position.

2.06 FINISHES

- A. Components (Other than Fabric): Galvanized in accordance with ASTM A123/A123M, at 1.7 oz/sq ft.
- B. Accessories: Same finish as framing.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install framework, fabric, accessories and gates in accordance with ASTM F567.

- B. Place fabric on outside of posts and rails.
- C. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: ASTM F567.
- D. Brace each gate and corner post to adjacent line post with horizontal center brace rail. Install brace rail one bay from end and gate posts.
- E. Install center brace rail on corner gate leaves.
- F. Do not stretch fabric until concrete foundation has cured 28 days.
- G. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.
- H. Ground fence in accordance with Section 337900.

3.02 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch.
- B. Maximum Offset From True Position: 1 inch.

SECTION 323119 - ORNAMENTAL METAL FENCES AND GATES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY OF WORK

A. The Contractor shall provide all labor, materials and appurtenances necessary for installation of the ornamental steel fencing system at the project site.

1.03 **RELATED SECTIONS**

- A. Section 31220 Grading.
- B. Section 312316 Excavation.
- C. Section 030000 Concrete

1.04 SYSTEM DESCRIPTION

- A. Retain terms that remain after this Section has been edited.
- B. The manufacturer shall supply a total powder coated steel fencing system of the design, style, strength and picket interspace defined herein. The system shall include all components (i.e., pickets, rails, column anchorages, gates and hardware) required. The hardware required to provide emergency egress is to be provided as part of specification Section 08710.

1.05 **QUALITY ASSURANCE**

A. The Contractor shall provide laborers and supervisors who are thoroughly familiar with the type of construction involved and materials and techniques specified.

1.06 **REFERENCES**

- A. ASTM A653/A653M: Standard specification for steel sheet, zinc-coated (galvanized) or zinc-iron alloy coated by the hot-dip process.
- B. ASTM B117: Practice for operating salt-spray (fog) apparatus.
- C. ASTM D523:Test Method for specular gloss.
- D. ASTM D822: Practice for conducting tests on paint and related coatings and materials using filtered open-flame carbon-arc light and water exposure apparatus.
- E. ASTM D1654: test method for evaluation of painted or coated speciments subjected to corrisove environments.
- F. D2247: Humidity resistance.

1.07 SUBMITTAL

- A. See Division 1 Sections for submittal procedures.
- B. Product Data: For manufacturers product lines of handrails and railings assembled from standard components.
 - 1. Include product data for grout, anchoring cement and paint products.
- C. Shop Drawings: Show fabrication and installation of handrails and railings. Include plans, elevations, sections, details and attachments to other Work.

- D. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for products with factory-applied color finishes.
- E. Samples for Verification: For each type of exposed finish required, prepared on components indicated below and of same thickness and metal indicated for the Work. If finishes involve normal color and texture variations, including sample sets showing the full range of variations expected.
 - 1. 6-inch (150-mm) long sections of railing profile selected.
 - 2. Fittings and brackets.
- F. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. including lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
 - 1. Product Test Reports: Indicating products comply with requirements, based on comprehensive testing of current products.

1.08 COORDINATION

A. Coordinate installation of anchorages for handrails and railings. Furnish setting drawings, templates and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.09 PRODUCT HANDLING AND STORAGE

A. Upon receipt at the job site, all materials shall be checked to ensure that no damages occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage and to protect against damage, weather, vandalism and theft.

PART 2 MATERIALS

2.01 ACCEPTABLE MANUFACTURER

- A. Ornamental Steel Fence
 - 1. Basis of Design: Design concept and the drawings indicate the size, profiles, dimensional requirements and aesthetics of the following:
 - a. Ameristar Fence Products Inc., Tulsa, OK (Montage Plus Majestic 2-rail).
 - 2. Products by other manufacturers (listed below) may be considered, provided deviations in dimensions and profiles are minor and do not change the design concept as judged by the Architect.
 - a. Betafence USA., 3309 SW Interstate 45, Ennix, TX (Welded Ornamental or UpGrade System, ___(Style)___-rail), Telephone 888-650-4766.
 - b. Other manufacturers which meet the requirements of this specification only as submitted and approved.
- B. Ornamental Aluminum Fence:
 - 1. Ameristar Fence Products Inc., Tulsa, OK (STYLE) (2)-rail).
 - 2. Jerith Manufacturing Company, 1440 McNutty Road, Philadelphia, PA, 1-800-344-2242
 - 3. Ultra Aluminum Manufacturing Co., (200 Series)
 - 4. Other manufacturers which meet the requirements of this specification only as submitted and approved.

2.02 MATERIAL

- A. Steel material for fence panels and posts conforming to the requirements of ASTM A/653/A653M, with a minimum yield strength of 50,000 psi and a minimum zinc coating weight of 0.60oz/sf (276 g/sm.). coating designation G-60.
- B. Fasteners: All fasteners shall be stainless steel with zinc dichromate coating for enhanced corrosion resistance. Phillips head screws shall be used to attach the pickets to the rails while self-drilling, self-tapping phillips head screws shall be used to connect the rails to the posts. All screw heads shall be painted to match the finish of the fence.

2.03 METALS

- A. General: Provide metal free from pitting, seam marks, roller marks, stains, discolorations and other imperfections where exposed to view on finished units.
- B. Brackets, Flanges and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

2.04 FENCE SYSTEMS

- A. Type: Welded steel picket and 2 rail fence panels to be attached to steel posts supplied by the same manufacturer and part of the fence system.
- B. Fence Panels: Fabricated from steel.
 - 1. Construction: 2-rail picket panel.
 - a. Size of picket and spacing of picket. Pickets to be 1" x 1" with maximum 4" o.c. spacing.
 - b. Profile of rail to be flat or square configuration to match pickets.
 - 2. Nominal Size: 96" height by 96" width, with 2" clearance from ground.
- C. Gates: Fabricated from steel to match fence panels
 - 1. Construction: 2-rail framed panel with pickets to match fence panel.
 - 2. Profile of fence frame to be flat or square configuration to match pickets.
 - 3. Nominal Sizes:
 - a. Vehicular Access Gate: double leaf gate to measure 16'-0" from edge to edge of gate by 96" height from ground with 2" ground clearance.
 - 1) Provide drop bar, lockable latch and swing hinges per drawings.
 - b. Pedestrian Gate: single leaf gate to measure 48" from edge to edge of gate by 96" height from ground with 2" ground clearance.
 - 1) Provide lockable latch and swing hinges per drawings.

2.05 **FASTENERS**

- A. Fasteners for Anchoring Handrails and Railings to Other Construction: Select fasteners of type, grade and class required to produce confections suitable for anchoring handrails and railings to other types of construction indicated and capable of withstanding design loads.
- B. Cast-In-Place and Post Installed Anchors: Anchors of type indicated below, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

2.06 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.07 FABRICATION

- A. Pickets, rails and posts shall be pre-cut to specified lengths. Rails shall be pre-punched to accept pickets.
- B. Pickets shall be inserted into the pre-punched holes in the rails and aligned to standard spacing using a calibrated alignment fixture. Aligned pickets and rails to be joined at each picket-to-rail intersection by fusion welding to complete the rigit panel assembly.
- C. Coat the completed panel by multi-stage electrode position coating.
 - 1. Polyester Powder Coating, 3 mil. average film thickness complying with AAMA 2604-98.
 - a. Color and Gloss: As selected by Architect from manufacturer's full range of choices for color and gloss.
- D. Form changes in direction of railing members as follows:
 - 1. As detailed.
- E. Brackets, Flanges, Fittings and Anchors: Provide manufacturer's standard wall brackets, flanges, miscellaneous fittings and anchors to connect handrail and railing members to other construction.
- F. Provide inserts and other anchorage devices to connect handrails and railings to concrete or masonry. Fabricate anchorage devices capable of withstanding loads imposed by handrails and railings. Coordinate anchorage devices with supporting structure.
- G. Shear and punch metals cleanly and accurately. Remove burrs from exposed cut edges.
- H. Cut, reinforce, drill and tap components, as indicated, to receive finish hardware, screws and similar items.
- I. Close exposed ends of railing members as needed with prefabricated end fittings.
- J. Gates: Weld box hinge to post and gate.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. PREPARATION
 - 1. Prior to installation, field verify locations and dimensions of masonry piers and fence posts.
 - 2. Install fence posts in footings as indicated on the drawings and per manufacturer's recommendations.
 - 3. Adjust anchorings to ensure proper alignment. Ensure that posts are spaced at intervals indicated, but not less than that required by structural loads.
 - 4. Install all components to be plumb and so that horizontal installations are free from rack.
 - a. Do not weld, cut or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - b. Align rails so variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (5 mm in 3 m).

- c. Install gates to be level and with hinges functioning without impedement. Install all locking hardware to be properly aligned and functioning without impedement.
- 5. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing handrails and railings and for properly transferring loads to in-place construction.

3.02 CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections and abraded areas of shop paint, and paint exposed areas with same material.

3.03 PROTECTION

- A. Protect finishes of handrails and railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at the time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in field to shop, make required alterations and refinish entire unit, or provide new units.

SECTION 329219 - SEEDING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Preparation of subsoil.
- B. Placing topsoil.
- C. Hydroseeding, mulching and fertilizer.
- D. Maintenance.

1.02 RELATED REQUIREMENTS

- A. Section 015713- Temporary Erosion and Sediment Control
- B. Section 312200 Grading: Topsoil material.
- C. Section 31 2200 Grading: Preparation of subsoil and placement of topsoil in preparation for the work of this section.
- D. Section 312323 Fill: Topsoil material.
- E. Section 312513 Permanent Erosion Controls:

1.03 **DEFINITIONS**

 Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

1.04 SUBMITTALS

- A. Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer ; and watering instructions.
- B. Hydroseed product and maintenance data including a hydroseed physical sample. Submit dry hydroseed material in one gallon bag.
- C. If hydroseeding is to be used in combination with other seeding methods, the contractor is to submit plan for areas to receive each type of seeding method.

1.05 REGULATORY REQUIREMENTS

A. Comply with regulatory agencies for fertilizer and herbicide composition.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable. Deliver seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.
- B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

PART 2 PRODUCTS

2.01 SEED MIXTURE

- A. Seed Mixture:
 - 1. Tall Fescue Grass Type: 40 percent. (Firecracker LS, Aggressor, Falcon IV, Col-M, 3rd Millenium or similar to be approved by the Landscape Architect).

329219 - 1

- 2. Fine Fescue Grass Type: 30 percent. (Reliant IV, Firefly, Epic, Fortitude, Finelawn Petite or similar to be approved by the Landscape Architect)
- 3. Kentucky Blue Grass Type: 20 percent. (Freedom III, Blue Velvet, Midnight, Barrister, Nu Destiny, Quantum Lelap, Brilliant, Everglade or similar to be approved by the Landscape Architect).
- 4. Perennial Rye: 10 percent.
 - a. Approved Varieties:
 - 1) Manhattan 5
 - 2) Divine
 - 3) Secretariat II

2.02 SOIL MATERIALS

A. Topsoil: Type as specified in Section 312200.

2.03 ACCESSORIES

- A. Mulching Material: Wheat straw, free from seeds and weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.
- B. Hydraulic Mulch: Fully biodegradable hydraulic mulch composed of 100% recycled wood fibers, cellulose fibers and wetting agents (including high-viscosity colloidal polysaccharides). The hydraulic mulch is to be sanitized, free from plastic netting, and upon application forms an intimate bond with the soil subsurface to create a porous, absorbent and flexible erosion resistant blanket that allows for rapid germination and accelerated plant growth.
 - Basis of design: SoilCover Blend with Tack by Profile Products, 750 Lake Cook Road, Suite 440, Buffalo Grove, IL 60089. p:800-508-8681, www.profileproducts.com.
- C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: Recommendations per the soil test.
- D. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.

2.04 **TESTS**

- A. Analyze to ascertain percentage of nitrogen, phosphorus, potash, percentage inorganic matter soluble salt content, organic matter content, and pH value.
- B. Submit minimum 10 oz sample of topsoil proposed. Forward sample to approved testing laboratory in sealed containers to prevent contamination.
- C. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that prepared soil base is ready to receive the work of this Section.
- B. For areas that are graded with slopes less than 6:1, hydroseeding may be used in lieu of seed and mulch.

3.02 **PREPARATION**

Seeding

- A. Prepare subgrade in accordance with Section 312200.
- B. Place topsoil in accordance with Section 312200.

3.03 FERTILIZING

- A. Apply fertilizer as recommended in the soil testing results.
- B. Apply after smooth raking of topsoil and prior to roller compaction.
- C. Do not apply fertilizer at same time or with same machine as will be used to apply seed.
- D. Mix thoroughly into upper 3 inches of topsoil.
- E. Lightly water to aid the dissipation of fertilizer.

3.04 SEEDING

- A. Apply seed at a rate of 7 lbs per 1000 sq ft or as recommended by the seed producer and/or soil testing, evenly in two intersecting directions. Rake in lightly.
- B. Do not seed areas in excess of that which can be mulched on same day.
- C. Planting Season: Timeframe for seeding is to be determined by the landscape architect in accordance with weather and project site conditions.
- D. Do not sow immediately following rain, when ground is too dry, or during windy periods.
- E. Immediately following seeding and compacting, apply mulch to a thickness of 1/2 inches. Maintain clear of shrubs and trees.
- F. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.
- G. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches.

3.05 HYDROSEEDING

- A. Apply seed at a rate of 4 lbs per 1000 sq ft or as recommended by the seed producer and/or soil testing, evenly in two directions. Rake in lightly.
- B. Do not seed areas in excess of that which can be mulched on same day.
- C. Apply 2000 lbs of hydraulic mulch with tack per acre or as recommended by the hydroseed manufacturer. Maintain clear of shrubs and trees. Contractor is to submit bill of materials to architect for quantity of materials delivered to site. Contractor is to have a manufacturer representative present on site during the first day of installation of hydraulic mulch.
- D. Contractor is to water hydroseeded area once every 7-days after hydroseeding for that area is complete or as recommended by the manufacturer.
- E. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches.

3.06 **PROTECTION**

- A. Identify seeded areas with stakes and string around area periphery. Set string height to 18 inches. Space stakes at 30 inches.
- B. Protect seeded areas in accordance with Section 312513 Permanent Erosion Controls

3.07 **MAINTENANCE**

- A. Provide maintenance at no extra cost to Owner; Owner will pay for water.
- B. Provide maintenance of seeded areas for three months from Date of Substantial Completion.

Seeding

- C. Mow grass at regular intervals to maintain at a maximum height of 4 inches. Do not cut more than 1/3 of grass blade at any one mowing.
- D. Neatly trim edges and hand clip where necessary.
- E. Immediately remove clippings after mowing and trimming.
- F. Water to prevent grass and soil from drying out.
- G. Roll surface to remove minor depressions or irregularities.
- H. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.
- I. Immediately reseed areas that show bare spots.
- J. Protect seeded areas with warning signs during maintenance period.

SECTION 329223 - SODDING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Preparation of subsoil.
- B. Placing topsoil.
- C. Fertilizing.
- D. Sod installation.

1.02 RELATED REQUIREMENTS

- A. Section 312200 Grading: Topsoil material.
- B. Section 312200 Grading: Preparation of subsoil and placement of topsoil in preparation for the work of this section.
- C. Section 312323 Fill: Topsoil material.

1.03 **DEFINITIONS**

 Weeds: Includes Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

1.04 **REFERENCE STANDARDS**

A. TPI (SPEC) - Guideline Specifications to Turfgrass Sodding 2006.

1.05 **DEFINITIONS**

 A. Weeds: Includes Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

1.06 SUBMITTALS

- A. See Division 1 Sections for submittal procedures.
- B. Certification: Submit certification of grass species and location of sod source.
- C. Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer.
- D. Submit sod watering schedule.
- E. Submit a planting schedule. Coordinate the schedule with the construction work of the project and with expected climatic conditions.
- F. Submit topsoil analysis reports. Provide subsoil analysis reports where needed.
- G. Submit a list of soil amendments as recommended by the topsoil and subsoil analyses and recommendations.

1.07 QUALITY ASSURANCE

- A. Sod Producer: Company specializing in sod production and harvesting with minimum five years experience, and certified by the State of [____].
- B. Installer Qualifications: Company approved by the sod producer.

Sodding

1.08 **REGULATORY REQUIREMENTS**

A. Comply with regulatory agencies for fertilizer and herbicide composition.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sod on pallets. Protect exposed roots from dehydration.
- B. Do not deliver more sod than can be laid within 24 hours.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Sod: TPI (SPEC), Certified Turfgrass Sod quality; cultivated grass sod; type indicated in plant schedule on Drawings; with strong fibrous root system, free of stones, burned or bare spots; containing no more than 5 weeds per 1000 sq ft. Minimum age of 18 months, with root development that will support its own weight without tearing, when suspended vertically by holding the upper two corners.
 - 1. Tall Fescue Grass Type: 40 percent. (Firecracker LS, Aggressor, Falcon IV, Col-M, 3rd Millenium or similar to be approved by the Landscape Architect).
 - 2. Fine Fescue Grass Type: 30 percent. (Reliant IV, Firefly, Epic, Fortitude, Finelawn Petite or similar to be approved by the Landscape Architect)
 - 3. Kentucky Blue Grass Type: 20 percent. (Freedom III, Blue Velvet, Midnight, Barrister, Nu Destiny, Quantum Lelap, Brilliant, Everglade or similar to be approved by the Landscape Architect).
 - 4. Annual Rye: 10 percent.
 - 5. Thickness: "Thick" sod, minimum 1 inch and maximum 1-3/8 inch topsoil base.
 - 6. Machine cut sod and load on pallets in accordance with TPI (SPEC) Guidelines.
- B. Topsoil: as specified in Section 312200.
- C. Fertilizer: [_____]; recommended for grass, with fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated by analysis.
- D. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.

2.02 ACCESSORIES

A. Wood Pegs: Softwood, sufficient size and length to ensure anchorage of sod on slope.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that prepared soil base is ready to receive the work of this section.

3.02 **PREPARATION**

- A. Prepare subgrade in accordance with Section 312200.
- B. Place topsoil in accordance with Section 312200.

3.03 FERTILIZING

- A. Apply fertilizer in accordance with manufacturer's instructions.
- B. Apply after smooth raking of topsoil and prior to installation of sod.
- C. Apply fertilizer no more than 48 hours before laying sod.

- D. Mix thoroughly into upper 2 inches of topsoil.
- E. Lightly water to aid the dissipation of fertilizer.

3.04 LAYING SOD

- A. Moisten prepared surface immediately prior to laying sod.
- B. Lay sod immediately after delivery to site to prevent deterioration.
- C. Lay sod smooth and tight with no open joints visible, and no overlapping; stagger end joints 12 inches minimum. Do not stretch or overlap sod pieces.
- D. Lay smooth. Align with adjoining grass areas. Top of sod surface to meet and match adjoining pavements.
- E. On slopes 6 inches per foot and steeper, lay sod perpendicular to slope and secure every row with wooden pegs at maximum 2 feet on center. Drive pegs flush with soil portion of sod.
- F. Water sodded areas immediately after installation. Saturate sod to 4 inches of soil.
- G. After sod and soil have dried, roll sodded areas to ensure good bond between sod and soil and to remove minor depressions and irregularities.

3.05 MAINTENANCE

- A. Maintain sodded areas immediately after placement until grass is well established and exhibits a vigorous growing condition.
- B. Mow grass at regular intervals to maintain at a maximum height of 3 inches. Do not cut more than 1/3 of grass blade at any one mowing.
- C. Water to prevent grass and soil from drying out.
- D. Roll surface to remove irregularities.
- E. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.
- F. Immediately replace sod to areas that show deterioration or bare spots.
- G. Protect sodded areas with warning signs during maintenance period.
SECTION 329300 - PLANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Preparation of subsoil.
- B. Topsoil bedding.
- C. New trees, plants and ground cover.
- D. Relocated trees, plants and ground cover.
- E. Mulch and Fertilizer.
- F. Tree watering bags.
- G. Maintenance.

1.02 RELATED REQUIREMENTS

- A. Section 312200 Grading: Topsoil material.
- B. Section 312323 Fill: Topsoil material.

1.03 PRICE AND PAYMENT PROCEDURES

- A. Allowances:
 - 1. See Section 012100 Allowances, for cash allowances affecting this section.
 - 2. Allowance includes purchase and delivery of trees, plants, and ground cover. Installation is included in this section and is part of the Contract Sum.
- B. Unit Prices:
 - 1. See Section 012200 Unit Prices, for additional unit price requirements.
 - 2. Topsoil: By the cubic yard. Includes topsoil, placing topsoil.
 - 3. Plants: By the unit. Includes preparation of subsoil, placing topsoil, planting, watering and maintenance to specified time period.

1.04 **DEFINITIONS**

- Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.
- B. Native Plants: plants that are endemic to the region, soil conditions, climate and planting zone of the planting location.
- C. Plants: Living trees, plants, and ground cover specified in this Section , and described in ANSI Z60.1.

1.05 REFERENCE STANDARDS

- A. ANSI/ANLA Z60.1 American National Standard for Nursery Stock 2004.
- B. ANSI A300 Part 1 American National Standard for Tree Care Operations -- Tree, Shrub and Other Woody Plant Maintenance -- Standard Practices 2008.

1.06 SUBMITTALS

A. See Division 1 Sections for submittal procedures.

Pl	ants

- B. Maintenance Data: Include cutting and trimming method ; types, application frequency, and recommended coverage of fertilizer .
- C. Submit list of plant life and native plant sources.
- D. Submit a planting schedule. Coordinate the schedule with the construction work of the project and with expected climatic conditions.
- E. Submit topsoil analysis reports. Provide subsoil analysis reports where needed.
- F. Submit a list of soil amendments as recommended by the topsoil and subsoil analyses and recommendations.
- G. Submit mulch sample(s) and source.
- H. Submit weed barrier manufacturer's data.
- I. Submit tree watering bag catalog cut and manufacturer's product specifications.
 - 1. Submit watering schedule.
- J. Maintenance Contract.

1.07 QUALITY ASSURANCE

- A. Nursery Qualifications: Company specializing in growing and cultivating native and other plants with three years documented experience.
- B. Installer Qualifications: Company specializing in the installation and maintenance of native and other plants with three years experience.
- C. The landscape contractor is to have a supervisor with a minimum of three years experience with the installation and maintenance of native and other plants in similar projects on-site during the preparation of planting areas and throughout planting installation, and during the maintenance period.
- D. Tree Pruner Qualifications: Company specializing in pruning trees with proof of Arborist Certification.
- E. Tree Pruning: Conform to ANSI A300 Part 1.
- F. Tree Root Balls: Trees indicated as balled and burlap wrapped are to be of the minimum size indicated on the planting schedule. Tree spaded trees in wire baskets must meet the requirements listed below.
 - 1. Root Ball Sizing
 - a. Trunk diameter (at caliper height) 1 inches requires root ball width 16", depth 12 inches minimum.
 - b. Trunk diameter 1.5 inches requires root ball width 24 inches, depth 12 inches minimum.
 - c. Trunk diameter 1-3/4 inches to 2 inches requires root ball width 30 inches, depth 15 inches minimum.
 - d. Trunk diameter 2.5 to 2.75 inches inches requires root ball width 35 inches, depth 15 inches minimum.
 - e. Trunk diameter 3 to 3.5 inches requires root ball width 36 inches, depth 18 inches minimum.
 - f. Trunk diameter 4 inches requires root ball width 48 inches, depth 24 inches minimum.

- G. Plant Inspection and Acceptance: All plants and source information are to be made available for the landscape architect to inspect and assess as to size, quality, form, condition and source. This is to be done prior to installation of any plants.
 - 1. Notice is to be given to the landscape architect a minimum of 7 (seven) working days prior to having the plants available to view. Plants may be viewed at the growing nursery or storage nursery/facility if these are within a reasonable distance from the site, or at the project site prior to installation of the plants.
 - 2. Landscape beds and planting pits will be inspected by the landscape architect prior to commencement of planting. The landscape contractor will inform the landscape architect a minimum of 7 (seven) working days in advance of when the planting beds and pits will be ready for planting.

1.08 REGULATORY REQUIREMENTS

- A. Comply with regulatory agencies for fertilizer and herbicide composition.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of plants, fertilizer and herbicide mixture.
- C. Plant Materials: Described by ASTM Z60.1; free of disease or hazardous insects.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.
- B. Protect and maintain plant life until planted. Protect root balls and containers, plant and tree stems and branches, and maintain optimal moisture levels.
- C. Deliver plant life materials immediately prior to placement. Keep plants moist. Cover root balls with mulch or heel in at storage facility or at site if plants cannot be installed immediately upon delivery to the site.

1.10 FIELD CONDITIONS

- A. Do not install plant life when ambient temperatures may drop below 35 degrees F or rise above 85 degrees F.
- B. Do not install plant life when wind velocity exceeds 30 mph.

1.11 WARRANTY

- A. See Section 017800 Closeout Submittals, for additional warranty requirements.
- B. Provide one year warranty.
- C. Warranty: Include coverage for one continuous growing season, for one year from the date of substantial completion. Replace dead or unhealthy plants.
- D. Replacements: Plants of same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.

PART 2 PRODUCTS

2.01 PLANTS

- A. Plants: Species and size identified in plant schedule, grown in climatic conditions similar to those in locality of the work.
- B. Trees, Plants and Ground Cover: Species and size identifiable in plant schedule, grown in climatic and soil conditions similar to those in locality of the Work.

2.02 SOIL MATERIALS

P	ants

A. Topsoil: Imported and/or Excavated from site.

2.03 SOIL AMENDMENT MATERIALS

- A. Fertilizer: Containing fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated in analysis.
- B. Peat Moss: Shredded, loose, sphagnum moss; free of lumps, roots, inorganic material or acidic materials; minimum of 85 percent organic material measured by oven dry weight, pH range of 4 to 5; moisture content of 30 percent.
- C. Bone Meal: Raw, finely ground, commercial grade, minimum of 3 percent nitrogen and 20 percent phosphorous.
- D. Lime: Ground limestone, dolomite type, minimum 95 percent carbonates as indicated by soil analysis.
- E. Water: Clean, fresh, and free of substances or matter that could inhibit vigorous growth of plants.
- F. Herbicide: Organic pre-emergent and post-emergent herbicides.
 - 1. Follow manufacturer's recommendations for suitability for the type of installed plantings being installed, application timing and application procedures.
 - 2. Use post-emergent soaps and safeners where applicable.
 - 3. No Herbicides are to be applied within the rain garden/infiltration basin.
- G. Pesticide: Antimicrobial or conventional active ingredient pesticides that are in compliance with national state and local regulations..
 - 1. Follow manufacturer's recommendations for safe applications.
 - 2. Select pesticide type that is specific to the organism to be treated.
 - 3. Adhere to EPA and State of Kentucky Department of Agriculture Pesticide Regulations.
 - 4. No Pesticides are to be applied within the rain garden/infiltration basin.

2.04 MULCH MATERIALS

A. Mulching Material: hardwood species ground bark, free of growth or germination inhibiting ingredients.

2.05 ACCESSORIES

- A. Wrapping Materials: Tree and plant stems and branches may be covered in burlap for protection from damage during transport. Coverings are to be removed immediately upon delivery to the storage facility or project site.
- B. Root ball wrapping materials: Burlap or polyethylene fabric. Burlap is to be cut down to 2/3 the height of the root ball. Polyethylene fabric is to be removed immediately and completely upon planting.
- C. Root ball materials for tree-spaded trees: galvanized wire baskets are to be truncated and have a 22 degree to 25 degree maximum side angle. Spaded trees with cone shaped wire baskets with a side angle of greater than 25 degrees (typically 30 degrees) are not suitable for clay or loam soils and will not be accepted. Wire baskets are to be cut down to one-third of the height of the basket and the cut section removed.
- D. Stakes: Trees may only be staked where indicated in the drawings and with the approval of the landscape architect. Stakes are to be softwood with pointed end or mild steel angle with pointed end, placed vertically where indicated.

- E. Staking ties are to be flexible material such as rubber ties, and Turnbuckles: of sufficient strength to withstand severe wind pressure but allow moderate movement of the tree stem. Do not use steel wire or turnbuckles.
- F. Plant Protectors: Rubber or heavy fabric sleeves placed over staking ties to protect plant stems, trunks, and branches.
- G. Tree Stem Wrapping: No tree stem wrapping is permitted except temporarily for transportation.
- H. Tree Watering Bags: Portable drip irrigation system bags are to be UV treated, reinforced polyethylene with a nylon toothed zipper. Provide one per tree unless noted otherwise on the drawings.
 - 1. Capacity: minimum 20 gallons of water.
 - 2. Bag is to be constructed to be attached around the tree and provide water from a minimum of 3 (three) drip points at ground level.
 - 3. Bag is to be calibrated to provide a minimum of 6 (s9x) gals. of water per square yard of planting pit per filling.

2.06 SOURCE QUALITY CONTROL

- A. Provide analysis of topsoil; comply with requirements of Section 014000.
- B. Provide testing of imported and existing topsoil.
- C. Analyze soil to ascertain:
 - 1. Organic and mineral component percentages
 - 2. Soil particle sizes (soil quality)
 - 3. Percentages of nitrogen, phosphorus, potash, calcium, sodium, aluminum, magnesium, sulfur, cadmium, ferrous oxide, copper, lead, manganese, and carbonate content.
 - 4. Soluble salts and conductivity
 - 5. pH value
 - 6. Analysis results listing soil remediation components and methods to be applied.
- D. Submit minimum 10 oz samples of topsoil proposed to the testing laboratory. Existing site topsoil should be tested at several areas of the site. Imported soil should be sampled from representative areas of the stockpile. Forward samples to testing laboratory in sealed containers to prevent contamination.
- E. If imported topsoil has been recently tested, retesting is not necessary. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.01 **EXAMINATION**

- A. Verify that prepared subsoil and planters is ready to receive work.
- B. Saturate soil with water to test drainage.
- C. Verify the locations of new and exiting underground site utilities and that their installation is complete. Coordinate planting bed preparation and planting locations.

3.02 PREPARATION OF SUBSOIL

A. Prepare subsoil to eliminate uneven areas. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

- B. Remove foreign materials, construction debris, weeds and undesirable plants and their roots. Remove contaminated subsoil.
- C. Scarify subsoil to a depth of 3 inches where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.
- D. Planting pits and beds are to be dug and prepared to a minimum of 12 inches for perennials and annuals, 24 inches for shrubs and a minimum of 24 inches for trees or as necessitated by the height of the root ball. Tree and shrub pits are to be a minimum of 3 times the width of the root ball or container in diameter.
- E. For typical balled and burlap wrapped trees, the planting pit is to be a minimum of twice the width of the root ball or greater.

3.03 PLACING TOPSOIL

- A. Spread topsoil to a minimum depth of 4 inches over area to be planted. Rake smooth.
- B. Place topsoil during dry weather and on dry unfrozen subgrade.
- C. Remove weeds, debris and foreign non-organic material from topsoil while spreading.
- D. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.
- E. Install topsoil into pits and beds intended for plant root balls, to a minimum thickness of 6 inches.
- F. Provide soil amendments as indicated by soil analysis to planting bed subgrade soils (below topsoil).

3.04 FERTILIZING

- A. Apply fertilizer in accordance with manufacturer's instructions.
- B. Apply after initial raking of topsoil.
- C. Mix thoroughly into upper 2 inches of topsoil.
- D. Lightly water to aid the dissipation of fertilizer.
- E. Do Not apply fertilizers within the rain garden/infiltration basin.

3.05 PLANTING

- A. Place plants for best appearance for review and final orientation by Landscape Architect.
- B. Set plants vertical. Ensure that the base of the root ball is supported beneath so that the tree or shrub will remain in an upright and vertical position.
- C. Remove non-biodegradable root containers.
- D. Set plants in pits or beds, partly filled with prepared plant mix, at a minimum depth of 6 inches under each plant. Remove burlap and other root ball materials, ropes, wires and wire baskets from the root ball.
- E. Set plants so that the top of the root ball/stem flare is at or slightly above the level at which the plant was grown at the nursery. Do not bury the top of the root ball or emergent stem.
- F. Bare root plants are acceptable only by permission of the landscape architect and will require special care in delivery, storage and placement. For allowed bare root plants, place plant materials so roots lie in a natural position. Backfill soil mixture in 6 inch layers. Ensure that the plant is supported so that it remains in an upright and vertical position.
- G. Saturate soil with water when the pit or bed is half full of topsoil and again when full.

3.06 PLANT RELOCATION AND RE-PLANTING

A. Relocate plants as indicated by Architect.

- B. Replant plants in pits or beds, partly filled with prepared topsoil mixture, at a minimum depth of 6 inches under each plant. Remove burlap, ropes, and wires, from the root ball.
- C. Place bare root plant materials so roots lie in a natural position. Backfill soil mixture in 6 inch layers. Maintain plant materials in vertical position.
- D. Saturate soil with water when the pit or bed is half full of topsoil and again when full.

3.07 TREE PRUNING

- A. Prune trees as recommended in ANSI A300 Part 1.
- B. Prune newly planted trees as required to remove dead, broken, and split branches.

3.08 FIELD QUALITY CONTROL

- A. Plants and plantings will be re-inspected upon completion of planting activities by the landscape architect.
- B. Plants will be rejected if the root ball, stem, branching system or overall acceptable condition of the plant has been damaged prior to or during planting.

3.09 MAINTENANCE

- A. Provide maintenance at no extra cost to Owner; Owner will pay for water.
- B. See Division 1 Sections for additional requirements relating to maintenance service.
- C. Provide a separate maintenance contract for maintenance service as desired by the Owner.
- D. Maintain plant life from the time of planting through the project construction period and for three months after Date of Substantial Completion.
- E. Install tree bags:
 - 1. Supply the required number of bags.
 - 2. Attach bag to tree shortly after tree installation and fill to top. Submit watering schedule, filling as needed. Check daily for water level. Do not leave bag empty.
- F. Tree bag maintenance:
 - 1. Check for damage to plants or bags. Remove bag temporarily to assess and treat tree damage; replace damaged bags as needed.
 - 2. Remove bags by December 1 and return to the Owner for storage. Discard damaged bags.
 - 3. Reinstall and fill bags by April 15 of the following year.
- G. Irrigate sufficiently to saturate root system and prevent soil from drying out.
- H. Cultivate and weed plant beds and tree pits.
- I. Remove dead or broken branches and treat pruned areas or other wounds.
- J. Neatly trim plants where necessary.
- K. Immediately remove clippings after trimming.
- L. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions or remove weeds and weed roots by hand cultivation.
- M. Control insect damage and disease. Apply pesticides in accordance with manufacturers instructions.
- N. Remedy damage from use of herbicides and pesticides.
- O. Replace mulch when deteriorated.

P. Maintain flexible staking ties, tree protection turnbuckles, and stakes where applicable. Check trees to ensure that staking does not become too loose or too tight. Adjust turnbuckles to keep guy wires tight. Repair or replace accessories when required.

SECTION 334101 - SITE STORM DRAINAGE PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Storm drainage piping, fittings, and accessories.

1.02 **RELATED REQUIREMENTS**

- A. Section 312316.13 Trenching: Excavating, bedding, and backfilling.
- B. Section 334413.23 Cleanouts and Drains
- C. Section 334413.13 Catch Basin and Curb Inlets
- D. Section 334416 Trench Drains
- E. Section 334903 Storm Drainage Inlets and Outlets
- F. Section 334913 Storm Drainage Manholes

1.03 **DEFINITIONS**

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.04 **REFERENCE STANDARDS**

- A. ASTM C 76 Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe; 2008.
- B. ASTM C 76M Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe [Metric]; 2008.
- C. ASTM C 443 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets; 2005a.
- D. AASHTO M 252M AND M 294M Standard Specification for Corrugated Polyethylene (PE) Drainage Pipe.
- E. ASTM F 667 Standard Specification for Large Diameter Corrugated Polyethylene (PE) Pipe and Fittings.
- F. ASTM F 447 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- G. ASTM D 3212 Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

1.05 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating pipe, pipe accessories, and fittings.
- C. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Project Record Documents:
 - 1. Record location of pipe runs, connections, catch basins, cleanouts, and invert elevations.
 - 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

Site Storm Drainage Piping	
----------------------------	--

2.01 SEWER PIPE MATERIALS

- A. Concrete Pipe: Reinforced, ASTM C 76 (ASTM C 76M), Class III with Wall type B; mesh reinforcement; inside nominal diameter as identified on the drawings, bell and spigot end joints. Approved manufacturers include:
 - 1. Cloud Concrete Products
 - 2. Forterra (formerly Sherman Dixie)
- B. Reinforced Concrete Pipe Joint Device: ASTM C 443 (ASTM C 443M) rubber compression gasket joint.
- C. Corrugated PE Drainage Pipe and Fittings: Type S, dual wall with smooth waterway for coupling joints and PE sleeve with gasket material that mates with pipe and fittings to make them <u>watertight</u>. Approved manufacturers are:
 - 1. Advanced Drainage Systems, Inc., N-12 Pipe (www.ads-pipe.com)
 - 2. Timewell, Dual Wall Pipe(www.timewelltile.com)
 - 3. Baughman Tile Company, Dual Wall Pipe (www.baughmantile.com)
 - 4. Hancor, Blue Seal Pipe (www.hancor.com)
 - 5. Prinsco, Goldflow WT (www.prinsco.com)
 - 6. J.M. Eagle- product Eagle Corr Dual Wall Watertight Pipe. (www.jmeagled.com)
 - 7. Substitutions: As submitted for review and approved by architect by addendum during the bidding process.

2.02 PIPE ACCESSORIES

- A. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required wye, bends, elbows, cleanouts, reducers, traps and other configurations required.
- B. Trace Tape: Magnetic detectable conductor, clear plastic covering, imprinted with "Storm Sewer Service " in large letters.

2.03 BEDDING AND COVER MATERIALS

- A. Bedding: As specified in Section 31 2316.13.
- B. Cover: As specified in Section 31 2316.13.

PART 3 EXECUTION

3.01 TRENCHING

- A. See Section 31 2316.13 for additional requirements.
- B. Hand trim excavation for accurate placement of pipe to elevations indicated.
- C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.02 INSTALLATION - PIPE

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.
- B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
- C. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch in 10 feet.

- D. Connect to building storm drainage system, foundation drainage system, and utility/municipal sewer system.
- E. Install continuous trace wire 6 to 12 inches below finish grade, above pipe line; coordinate with Section 31 2316.13.

3.03 FIELD QUALITY CONTROL

- A. See Division 1 Sections for general requirements for testing and inspections.
- B. Work does not meet specified requirements, remove Work, replace and retest at no cost to the Owner.
- C. Alignment: Piping where less than the full diameter of the inside of the pipe is not visible between structures will require replacement.
- D. Deflection Test: Piping with deflection that prevents passage of a ball or cylinder of size not less than
 92.5 percent of piping diameter will require replacement.
- E. Piping that is crushed, cracked, broken or otherwise damaged will require repair or replacement as determined by the Architect.
- F. The contractor is to provide someone to remove and replace all grates or covers on storm water structures for any punch list visits that involve the storm water system.

3.04 **PROTECTION**

A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

SECTION 334413.13 - CATCH BASINS AND CURB INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Catch basins and Combination Inlets.
- B. Precast concrete catch basins with grates, frames and accessories .
- C. Monolithic FRP catch basins and inlets, frames, covers, anchorage, and accessories.

1.02 RELATED REQUIREMENTS

A. Section 015713 - Temporary Erosion and Sediment Controls for temporary inlet protection

1.03 REFERENCE STANDARDS

- A. ASTM A 48/A 48M Standard Specification for Gray Iron Castings; 2003.
- B. ASTM A 123/A 123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2002.
- C. ASTM C 913 Standard Specification for Precast Reinforced Concrete Water Structures; 2008.
- D. ASTM C 478 Standard Specification for Precast Reinforced Concrete Manhole Sections; 2007.
- E. ASTM C 923 Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals; 2007.
- F. ASTM C 923M Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals [Metric]; 2007.
- G. ASTM D 3753 Standard Specification for Glass-Fiber-Reinforced Polyester Manholes and Wetwells; 2005.
- H. ASTM D3753 05e1 Standard Specification for Glass-Fiber-Reinforced Polyester Manholes and Wetwells

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate structure identification designations, locations, elevations, piping sizes and elevations of penetrations.
- C. Product Data: Provide structure data including configuration, grates, frames, steps and other components .

1.05 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.01 MATERIALS

- Pre-Cast Structure Sections: Reinforced precast concrete in accordance with ASTM C 478 (ASTM C 478M), with resilient connectors complying with ASTM C 923 (ASTM C 923M).
- B. Polyester Structure Sections: ASTM D 3753, glass-fiber reinforced polyester .
- C. Approved Pre-Cast Concrete Manufacturers include:
 - 1. Oldcastle Precast

- 2. Forterra (formerly Sherman-Dixie)
- 3. Substitutions: As submitted for review and approved by architect by addendum during the bidding process.
- D. Approved Polyester Structure Manufacturers include:
 - 1. Advanced Drainage Systems (ADS)
 - 2. HARCO
 - 3. Substitutions: As submitted for review and approved by architect by addendum during the bidding process.

2.02 CATCH BASIN AND CURB INLET COMPONENTS

- A. Concrete Structure Inlets:
 - 1. Catch Basin:
 - a. Grate Design: Per the storm drainage structure schedule on the drawings.
 - 2. Combination Inlet:
 - a. Grate Design: Per the storm drainage structure schedule on the drawings.
 - b. Curb Opening: Cast iron curb section to match height and width of designed concrete curb. Cast curb section to be adjustable with stainless steel or hot-dipped galvanized adjustment bolts.
- B. Polyester Structure Inlets:
 - 1. Area Drains (Landscaped Areas):
 - a. Grate Design: Per the storm drainage structure schedule on the drawings. All grates must meet or exceed H-20 loading.
 - b. Approved Manufacturers include:
 - 1) Harco PVC Drain Basins and In-Line Drains
 - 2) ADS Nyloplast Drain Basins and In-Line Drains
 - 3) Substitutions: As submitted for review and approved by architect by addendum during the bidding process.

2.03 **OTHER COMPONENTS**

- A. Grate and Frame: ASTM A 48/A 48M, Class 30B Cast iron construction, machined flat bearing surface, removable lockable grate, designed for H-20 loading; . Frames in pavement areas to allow for full asphalt pavement section to be located above the top of the concrete structure. Frames in landscape areas to be a minimum of 6-inches tall to allow for topsoil cover over top of concrete structure. Approved manufacturers include:
 - 1. J.R. Hoe and Sons
 - 2. Neenah Foundry Co.
 - 3. Substitutions: As submitted for review and approved by architect by addendum during the bidding process.
- B. Inlet Structure Steps: Formed Poly-Coated Steel rungs; 3/4 inch diameter. Formed integral with structure sections.

2.04 **CONFIGURATION**

- A. Shape: As identified in the storm structure schedule on the drawings.
- B. Clear Inside Dimensions: as required for piping layout shown with 48 inch minimum diameter for circular structures.
- C. Design Depth: As indicated.
- D. Clear Lid Opening: 24 inches diameter.
- E. Pipe Entry: Provide openings as required.
- F. Steps: 12 inches wide, 16 inches on center vertically, set into structure wall. Steps are required for all concrete structures that are 42-inches deep or deeper from grate elevation to the bottom of the structure. Steps are to be aligned as to not interfere with any pipe penetrations.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify items provided by other sections of Work are properly sized and located.
- B. Verify that built-in items are in proper location, and ready for roughing into Work.
- C. Verify excavation for structure is correct.

3.02 **PREPARATION**

A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

3.03 INSTALLATION - CATCH BASINS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Establish elevations and pipe inverts for inlets and outlets as indicated.
- C. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour as required.
- D. Mount grate and frame level in grout, secured to top slab to elevation indicated. Grate elevations shown on the drawings are for the highest point on the grate for combination inlets, and are the elevation where water will enter the structure for catch basins.
- E. All lift hook holes are to be grouted flush with the face of the structure using a hydraulic, non-shrink grout that will provide a finish to match that of the structure.
- F. Coordinate with other sections of work to provide correct size, shape, and location.

3.04 FIELD QUALITY CONTROL

- A. See Division 1 sections for field inspection and testing requirements.
- B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to the Owner.
- C. Structures and castings that are cracked, broken or otherwise damaged will require repair or replacement as determined by the Architect.
- D. The contractor is to provide someone to remove and replace all grates or covers on storm water structures for any punch list visits that involve the storm water system.

3.05 SCHEDULES

A. Storm Sewer Structures: See contract drawings for the storm structure schedule.

RTA 1904

SECTION 334413.23 - CLEANOUTS AND DRAINS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Plaza Drains and Cleanouts.

1.02 **RELATED REQUIREMENTS**

A. Section 0321313 - Concrete Paving.

1.03 REFERENCE STANDARDS

- A. ASTM A 48/A 48M Standard Specification for Gray Iron Castings; 2003.
- B. ASTM B 584-90 Copper Allow Sand Casting

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate structure identification designations, locations, elevations, piping sizes and elevations of penetrations.
- C. Product Data: Provide structure data including configuration, grates, frames, steps and other components .

1.05 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.01 MATERIALS AND MANUFACTURERS

- A. Concrete: As specified in Section 321313.
- B. Concrete Reinforcement: As specified in Section 321313.
- C. Bronze: Copper Alloy No. 844
- D. Approved Manufacturers include:
 - 1. Zurn Industries
 - 2. Substitutions: As submitted for review and approved by architect by addendum during the bidding process.

2.02 CLEANOUT AND DRAIN COMPONENTS

- A. Grates and Covers: Bronze , hinged to frame.
 - 1. Plaza Drain:
 - a. Lid Design: Bronze, Linear grill; Heel Safe and Traffic Duty
 - b. Nominal Lid and Frame Size: 6 inches diameter.
 - 2. Cleanout:
 - a. Lid Design: Bronze with tamper resistant set screws; Textured Surface; Traffic Duty
 - b. Nominal Lid and Frame Size: 4 inches diameter.

2.03 ACCESSORIES

A. Concrete Pad: For components that are located in landscape areas, a concrete pad of a shape that matches that of the component is to be installed. The pad shall be shall be constructed in accordance with the requirements for concrete sidewalks, be a minimum of 4-inches thick, and extend a minimum of 12-inches beyond the outer edge of the component. Refer to Section 321313 for concrete information.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify items provided by other sections of Work are properly sized and located.
- B. Verify that built-in items are in proper location, and ready for roughing into Work.
- C. Verify excavation for structure is correct.

3.02 **PREPARATION**

A. Coordinate placement of pipe and pavements required by other sections.

3.03 INSTALLATION

- A. Ensure pipe connections is adequately bedded and backfilled to prevent movement.
- B. Install component to proper elevation. Ensure top is level and protected against damage from concrete pad installation or other work.
- C. Where components are not located in paved areas, form and place cast-in-place concrete pad. Ensure the pad is finished per the sidewalk requirements with tooled edges, and is sloped for proper drainage away from the component.
- D. Level top surface of base pad; sleeve concrete shaft sections to receive storm sewer pipe sections.
- E. Clean and polish cover/grate to like new condition upon completion of work.
- F. Coordinate with other sections of work to provide correct size, shape, and location.

3.04 FIELD QUALITY CONTROL

- A. See Division 1 Sections for general requirements for testing and inspections.
- B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to {GT#0}.
- C. Components that are gouged, scratched, broken or otherwise damaged will require repair or replacement as determined by the Architect.
- D. The contractor is to provide someone to remove and replace all grates or covers for any punch list visits that involve the storm water system.

SECTION 334416 - TRENCH DRAINS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Vehicular Area Trench Drains and Pedestrian Area Trench Drains.

1.02 RELATED REQUIREMENTS

- A. Section 013329 Sustainable Design Reporting
- B. Section 015713 Temporary Erosion and Sediment Controls for temporary inlet protection
- C. Section 321313 Concrete Paving.
- D. Section 321313 Concret Paving for trench drain concrete.

1.03 **REFERENCE STANDARDS**

- A. ASTM A 123/A 123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2002.
- B. ASTM D 3753 Standard Specification for Glass-Fiber-Reinforced Polyester Structures; 2005.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate structure identification designations, locations, elevations, piping sizes and elevations of penetrations.
- C. Product Data: Provide structure data including configuration, grates, frames and other components .

1.05 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.06 FIELD CONDITIONS

A. Cold and Hot Weather Requirements: Comply with requirements of ACI 530.1/ASCE 6/TMS 602 or applicable building code, whichever is more stringent.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Concrete: As specified in Section 321313.
- B. Reinforcement: Formed steel wire, galvanized finish, wire diameter as indicated on drawings.
- C. Stainless Steel: Type 304 or 316
- D. Bronze: Copper Alloy No. 844
- E. Approved Manufacturers:
 - 1. Aco-Drain
 - 2. Zurn
 - 3. ABT, Inc.
 - 4. Balco, Inc.

2.02 TRENCH DRAIN COMPONENTS

- A. Pedestrian Grates: Bronze with tamper resistent fasteners; heel safe; 6 inch wide grate area; medium duty.
- B. Vehicular Grates: Cast Iron and bolt down; 12 inch wide grate area; traffic duty, H-20 loading.
- C. Trench Channel: pre-molded polyester or Fiber-reinforced resin with traffic duty H-20 load rating.

2.03 CONFIGURATION

- A. Clear Inside Dimensions: as required for grate and exit piping sizes shown above and on the drawings.
- B. Design Depth: 8 inch minimum depth. Channel is to slope to outlet pipe at a minimum of 1%.
- C. Pipe Penetrations: Provide openings as required with bottom or end outlets as specified on the drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify items provided by other sections of Work are properly sized and located.
- B. Verify that built-in items are in proper location, and ready for roughing into Work.
- C. Verify excavation for structure is correct.

3.02 PREPARATION

A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

3.03 INSTALLATION

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete anchors and drain channel sections as required by system manufacturer.
- C. Level top surface of base pad; sleeve concrete sections to receive storm sewer pipe sections.
- D. Establish elevations and pipe inverts for inlets and outlets as indicated.
- E. Anchor pre-manufactured channel sections to prevent floating during concrete installation.
- F. Coordinate with other sections of work to provide correct size, shape, and location.

3.04 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 014000.
- B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to the Owner.
- C. Structures that are cracked, broken or otherwise damaged will require repair or replacement as determined by the Architect.
- D. The contractor is to provide someone to remove and replace all grates or covers on storm water structures for any punch list visits that involve the storm water system.

1

SECTION 334903 - STORM DRAINAGE OUTLETS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Precast concrete headwalls with grates and accessories .

1.02 **REFERENCE STANDARDS**

- A. ASTM A 48/A 48M Standard Specification for Gray Iron Castings; 2003.
- B. ASTM C 478 Standard Specification for Precast Reinforced Concrete Manhole Sections; 2007.
- C. ASTM C 478M Standard Specification for Precast Reinforced Concrete Manhole Sections [Metric]; 2007.
- D. ASTM C 923 Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals; 2007.
- E. ASTM C 923M Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals [Metric]; 2007.

1.03 SUBMITTALS

- A. See Division 1 Sections for submittal procedures.
- B. Shop Drawings: Indicate structure identification designations, locations, elevations, piping sizes and elevations of penetrations.
- C. Product Data: Provide structure data including configuration, grates, frames, steps and other components .

1.04 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Pre-Cast Headwalls: Reinforced precast concrete in accordance with Kentucky Transportation Cabinet requirements.
- B. All headwalls are to be in compliance with Kentucky Transportation Cabinet requirements.
- C. Approved Pre-Cast Concrete Manufacturers include:
 - 1. Oldcastle Precast
 - 2. Forterra Pipe & Precast
 - 3. Substitutions: As submitted for review and approved by architect by addendum during the bidding process.

2.02 HEADWALL COMPONENTS

A. Grates: Rectangular steel bars, hot-dipped galvanized per Kentucky Transportation Cabinet standard drawings. Grates are to have security chains attaching them to the structure.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify items provided by other sections of Work are properly sized and located.

Storm Drainage Outlets		334903 -
------------------------	--	----------

- B. Verify that built-in items are in proper location, and ready for roughing into Work.
- C. Verify excavation for structure is correct.

3.02 PREPARATION

A. Coordinate placement of pipe required by other sections.

3.03 INSTALLATION - HEADWALLS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Establish elevations and pipe inverts for outlets as indicated.
- C. Set grate in recessed notches formed into the headwall wing walls, secure to top headwall with galvanized chain of a length that will allow removal for inspection.
- D. All lift hook holes are to be grouted flush with the face of the structure using a hydraulic, non-shrink grout that will provide a finish to match that of the structure.
- E. Coordinate with other sections of work to provide correct size, shape, and location.

3.04 FIELD QUALITY CONTROL

- A. See Division 1 Sections for general requirements for testing and inspections.
- B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to the Owner.
- C. Structures that are cracked, broken or otherwise damaged will require repair or replacement as determined by the Architect.
- D. The contractor is to provide someone to remove and replace all grates for any punch list visits that involve the storm water system.

3.05 SCHEDULES

A. Storm Sewer Headwalls: Refer to the storm structure schedule shown on the Contract Drawings.

SECTION 334913 - STORM DRAINAGE MANHOLES, FRAMES AND COVERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Modular precast concrete manhole sections with tongue-and-groove joints covers, anchorage, and accessories.

1.02 RELATED REQUIREMENTS

A. Section 015713 - Temporary Erosion and Sediment Controls for temporary inlet protection

1.03 REFERENCE STANDARDS

- A. ACI 530.1/ASCE 6/TMS 602 Specification For Masonry Structures; American Concrete Institute International; 2005.
- B. ASTM A 48/A 48M Standard Specification for Gray Iron Castings; 2003.
- C. ASTM C 478 Standard Specification for Precast Reinforced Concrete Manhole Sections; 2007.
- D. ASTM C 923 Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals; 2007.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate manhole locations, elevations, piping sizes and elevations of penetrations.
- C. Product Data: Provide manhole covers, component construction, steps, features, configuration, and dimensions.

1.05 **QUALITY ASSURANCE**

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.06 FIELD CONDITIONS

A. Cold and Hot Weather Requirements: Comply with requirements of ACI 530.1/ASCE 6/TMS 602 or applicable building code, whichever is more stringent.

PART 2 PRODUCTS

2.01 MATERIALS

A. Manhole Sections: Reinforced precast concrete in accordance with ASTM C 478 (ASTM C 478M), with resilient connectors complying with ASTM C 923 (ASTM C 923M).

2.02 COMPONENTS

- A. Lid and Frame: ASTM A 48/A 48M, Class 30B Cast iron construction, machined flat bearing surface, removable lid, scheduled lid design; live load rating of H-20; lid molded with identifying name ;.
 - 1. Solid lids shall have the designation of "STORM" cast into the lid.
- B. Manhole Steps: #4 Bar with formed Copolymer Polypropylene Plastic coating rungs; 3/4 inch diameter. Formed integral with manhole sections.

2.03 CONFIGURATION

A. Shaft Construction: Concentric with eccentric cone top section as required; lipped male/female joints; sleeved to receive pipe sections. Top slab opening is to be per the drawings and steps are to be aligned with the lid/grate opening.

Storm Drainage Manholes, Frames	22/012 1
and Covers	554915 - 1

- B. Shape: Cylindrical.
- C. Clear Inside Dimensions: As required for shown pipe sizes and configurations. Structure diameter is to remain consistent from the bottom section to the cone or top slab that supports the casting.
- D. Design Depth: As indicated.
- E. Clear Lid Opening: 24 inches diameter minimum.
- F. Steps: 12 inches wide, 16 inches on center vertically, set into manhole wall. Steps are required for all structures that are 36-inches deep or deeper from grate/lid to bottom of structure. Top manhole step is to be no more than 24-inches from the lid/grate elevation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify items provided by other sections of Work are properly sized and located.
- B. Verify that built-in items are in proper location, and ready for roughing into Work.
- C. Verify excavation for manholes is correct.

3.02 **PREPARATION**

A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

3.03 MANHOLES

- A. Place concrete base pad, trowel top surface level.
- B. Place manhole sections plumb and level, trim to correct elevations and anchor as necessary.
- C. Cut and fit for pipe.
- D. Seal section and top joints with Conseal Sealant or approved equivalent.
- E. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour as required.
- F. Set cover frames and covers level without tipping, to correct elevations.
- G. Coordinate with other sections of work to provide correct size, shape, and location.
- H. Grout pipes to structure.

3.04 FIELD QUALITY CONTROL

- A. See Division 1 Sections for general requirements for testing and inspections.
- B. Structures that are cracked, broken or otherwise damaged will require repair or replacement as determined by the Architect.
- C. The Contractor shall provide someone to remove and replace all grates for any punch list visits that involve the storm water system. Contractor shall also provide all required equipment needed to meet OSHA confined space requirements associated with inspecting the drainage structure.

Storm Drainage Manholes, Frames	
and Covers	

SECTION 334993 - DOWNSPOUT BOOTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Extruded aluminum and Cast aluminum & Stainless Steel downspout boots.
 - 1. Contractors to provide aluminum or stainless steel downspout boots at all locations.

1.02 RELATED REQUIREMENTS

A. Section 334101 - Site Storm Utility Drainage Piping.

1.03 DESIGN REQUIREMENTS

A. Conform to applicable code for size and method of rain water discharge.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate locations, configurations, jointing methods, fastening methods, locations, and installation details.
- C. Product Data: Provide data on prefabricated components.
- D. Coordination Data: Provide table of downspout boots and their corresponding downspout size. Table shoud show boot top opening dimensions, downspout dimensions, boot length, boot outlet size and subsurface drainage pipe/fitting size.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prevent contact with materials that could cause discoloration, staining, or damage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Extruded Aluminum Downspout Boots: Subject to compliance with requirements, manufacturers offering the following products that may be incorporated into the work include:
 - 1. Basis of Design: Design concept and the drawings indicate the size, profiles, dimensional requirements and aesthetics of the following:
 - a. Extruded Aluminum: McKinley Iron Works Type DS4 for connection to underground piping.
 - 2. Products by other manufacturers (listed below) may be considered, provided deviations in dimensions and profiles are minor and do not change the design concept as judged by the Architect:
 - a. Or equal approved through addendum prior to bidding.
- B. Cast Aluminum Downspout Boots: Subject to compliance with requirements, manufacturers offering the following products that may be incorporated into the work include:
 - 1. Basis of Design: Design concept and the drawings indicate the size, profiles, dimensional requirements and aesthetics of the following:
 - a. Cast Aluminum: Barry Pattern and Foundry Type B25A for connection to underground piping.
 - 2. Products by other manufacturers (listed below) may be considered, provided deviations in dimensions and profiles are minor and do not change the design concept as judged by the Architect:

- a. McKinley Iron Works Type DS4 for connection to underground piping.
- b. Or equal approved through addendum prior to bidding.
- C. Stainless Steel Downspout Boots: Subject to compliance with requirements, manufacturers offering the following products that may be incorporated into the work include:
 - 1. Basis of Design: Design concept and the drawings indicate the size, profiles, dimensional requirements and aesthetics of the following:
 - a. Stainless Steel: Piedmont Manufacturing Type SO for connection to underground piping.
 - 2. Products by other manufacturers (listed below) may be considered, provided deviations in dimensions and profiles are minor and do not change the design concept as judged by the Architect:
 - a. Or equal approved through addendum prior to bidding.

2.02 MATERIALS

- A. Extruded Aluminum Heavy duty extruded aluminum with integral fastening system.
 - 1. Length: As needed to have 24" above grade and a minimum of 6-inches below grade.
 - 2. Size: Coordinate with downspout sizes on Architectural plans
 - 3. Finish: Powder coat
 - 4. Color: Manufactor's standard color choices
- B. Cast Aluminum Heavy duty cast aluminum with integral fastening system.
 - 1. Length: As needed to have 24" above grade and a minimum of 6-inches below grade.
 - 2. Size: Coordinate with downspout sizes on Architectural plans
 - 3. Finish: Satin finish, ready for paint
 - 4. Color: Manufactor's standard color choices
- C. Stainless Steel ASTM A666 Type 3.4, soft temper, 12 gauge thick
 - 1. Length: As needed to have 24" above grade and a minimum of 6-inches below grade.
 - 2. Size: Coordinate with downspout sizes on Architectural plans
 - 3. Finish: Powder coat
 - 4. Color: Manufactor's standard color choices

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that surfaces are ready to receive work.

3.02 **PREPARATION**

- A. Paint concealed metal surfaces and surfaces in contact with dissimilar metals with protective backing paint to a minimum dry film thickness of 15 mil. Paint color is to match downspouts.
- B. All non-factory painted downspout boots are to receive one coat of primer and two coats of finish color paint prior to installation. A minimum of one additional coat of finish color paint is to be applied after installation. Any damage to paint or boot is to be repaired to like new condition. Paint color is to

match downspouts as selected by Architect.

3.03 INSTALLATION

- A. Install downspouts and accessories in accordance with manufacturer's instructions.
- B. Connect downspouts to downspout boots at a minimum of 24" above grade. Seal connection watertight.
- C. Connect downspouts to storm sewer system with the pipe connection and sleeve being completely below grade. Seal connection watertight.
- D. Where downspout boots extend through concrete pavement, protect boot from concrete using plastic or other protective material for the entire height of the boot. If concrete materials come into contact with the downspout boot, removal and replacement of the boot may be required. Remove plastic protection after concrete work has been completed.
- E. Where downspout boots extend through concrete pavement, provide isolation joint material around the boot. After concrete installation, remove top 1/2-inch of isolation joint material and install joint sealant in accordance with Section 321373- Pavement Joint Sealants.